OREA 17

Punta di Zambrone I

1200 BCE – a Time of Breakdown, a Time of Progress in Southern Italy and Greece

Reinhard Jung (Ed.)

AUSTRIAN ACADEMY OF SCIENCES PRESS

Reinhard Jung (Ed.)
Punta di Zambrone I

AUSTRIAN ACADEMY OF SCIENCES

Austrian Archaeological Institute
Department of Prehistory & West Asian / Northeast African Archaeology

Oriental and European Archaeology

Volume 17

Series Editor: Barbara Horejs

Publications Coordinator: Ulrike Schuh

Reinhard Jung (Ed.)

Punta di Zambrone I

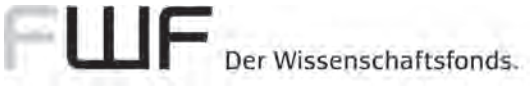
1200 BCE – a Time of Breakdown, a Time of Progress in Southern Italy and Greece

AUSTRIAN
ACADEMY
OF SCIENCES
PRESS

Accepted by the Publication Committee of the Division of Humanities
and the Social Sciences of the Austrian Academy of Sciences:

Michael Alram, Bert G. Fragner, Andre Gingrich, Hermann Hunger, Sigrid Jalkotzy-Deger, Renate Pillinger, Franz Rainer, Oliver Jens Schmitt, Danuta Shanzer, Peter Wiesinger, Waldemar Zacharasiewicz

Printed with the support of the Austrian Science Fund (FWF) PUB 746-Z



Open access: Except where otherwise noted, this work is licensed
under a Creative Commons Attribution 4.0 Unported License. To view a copy of this licence, visit
http://creativecommons.org/licenses/by/4.0/

Picture on the opposite page:
Punta di Zambrone seen from the northeast (photo: M. Pacciarelli)

This publication was subject to international and anonymous peer review.
Peer review is an essential part of the Austrian Academy of Sciences Press evaluation process. Before any book can be accepted for publication, it is assessed by international specialists and ultimately must be approved by the Austrian Academy of Sciences Publication Committee.

The paper used in this publication is DIN EN ISO 9706 certified
and meets the requirements for permanent archiving of written cultural property.

English language editing: Nicola Wood
Graphics and layout: Markus Baumann, Crossdesign Graz
Coverdesign: Mario Börner, Angela Schwab

Some rights reserved.
ISBN: 978-3-7001-8615-1
Copyright © Austrian Academy of Sciences, Vienna 2021

Print: Wograndl Druck, Mattersburg

https://epub.oeaw.ac.at/8615-1
https://verlag.oeaw.ac.at
Made in Europe



2011 • 2013

ORIENTAL AND EUROPEAN ARCHAEOLOGY

Vol. 1 B. Horejs – M. Mehofer (eds.), Western Anatolia before Troy. Proto-Urbanisation in the 4th Millenium BC? Proceedings of the International Symposium held at the Kunsthistorisches Museum Wien, Vienna, Austria, 21–24 November, 2012 (Vienna 2014).

Vol. 2 B. Eder – R. Pruzsinszky (eds.), Policies of Exchange. Political Systems and Modes of Interaction in the Aegean and the Near East in the 2nd Millennium B.C.E. Proceedings of the International Symposium at the University of Freiburg, Institute for Archaeological Studies, 30th May–2nd June, 2012 (Vienna 2015).

Vol. 3 M. Bartelheim – B. Horejs – R. Krauß (eds.), Von Baden bis Troia. Ressourcennutzung, Metallurgie und Wissenstransfer. Eine Jubiläumsschrift für Ernst Pernicka (Rahden/Westf. 2016).

Vol. 4 M. Luciani (ed.), The Archaeology of North Arabia. Oases and Landscapes. Proceedings of the International Congress held at the University of Vienna, 5–8 December, 2013 (Vienna 2016).

Vol. 5 B. Horejs, Çukuriçi Höyük 1. Anatolia and the Aegean from the 7th to the 3rd Millennium BC. With contributions by Ch. Britsch, St. Grasböck, B. Milić, L. Peloschek, M. Röcklinger and Ch. Schwall (Vienna 2017).

Vol. 6 M. Mödlinger, Protecting the Body in War and Combat. Metal Body Armour in Bronze Age Europe (Vienna 2017).

Vol. 7 Ch. Schwall, Çukuriçi Höyük 2. Das 5. und 4. Jahrtausend v. Chr. in Westanatolien und der Ostägäis. Mit einem Beitrag von B. Horejs (Vienna 2018).

Vol. 8 W. Anderson – K. Hopper – A. Robinson (eds.), Landscape Archaeology in Southern Caucasia. Finding Common Ground in Diverse Environments. Proceedings of the Workshop held at 10th ICAANE in Vienna, April 2016 (Vienna 2018).

Vol. 9 St. Gimatzidis – M. Pieniążek – S. Mangaloğlu-Votruba (eds.), Archaeology Across Frontiers and Borderlands. Fragmentation and Connectivity in the North Aegean and the Central Balkans from the Bronze Age to the Iron Age (Vienna 2018).

Vol. 10 E. Alram-Stern – B. Horejs (eds.), Pottery Technologies and Sociocultural Connections Between the Aegean and Anatolia During the 3rd Millennium BC (Vienna 2018).

Vol. 11 J. Becker – C. Beuger – B. Müller-Neuhof (eds.), Human Iconography and Symbolic Meaning in Near Eastern Prehistory. Proceedings of the Workshop held at 10th ICAANE in Vienna, April 2016 (Vienna 2019).

Vol. 12 M. Brami – B. Horejs (eds.), The Central/Western Anatolian Farming Frontier. Proceedings of the Neolithic Workshop held at 10th ICAANE in Vienna, April 2016 (Vienna 2019).

Vol. 13 L. Quillien – K. Sarri (eds.), Textile Workers. Skills, Labour and Status of Textile Craftspeople Between the Prehistoric Aegean and the Ancient Near East. Proceedings of the Workshop held at 10th ICAANE in Vienna, April 2016 (Vienna 2020).

Vol. 14 L. Naeh – D. Brostowsky Gilboa (eds.), The Ancient Throne. The Mediterranean, Near East, and Beyond, from the 3rd Millennium BCE to the 14th Century CE. Proceedings of the Workshop held at the 10th ICAANE in Vienna, April 2016 (Vienna 2020).

Vol. 15 A. E. Sollee (ed.), Formation, Organisation and Development of Iron Age Societies. A Comparative View. Proceedings of the Workshop held at the 10th ICAANE in Vienna, April 2016 (Vienna 2020).

Vol. 16 E. Aspöck – S. Štuhec – K. Kopetzky – M. Kucera (eds.), Old Excavation Data. What Can We Do? Proceedings of the Workshop held at the 10th ICAANE in Vienna, April 2016 (Vienna 2020).

Contents

Preface by the Series Editor 11

Reinhard Jung
Introduction 13

Section 1: Punta di Zambrone

Anja Buhlke
Topography and Geomorphodynamics of Punta di Zambrone 37

Burkart Ullrich – Wieke de Neef – Anja Buhlke – Rudolf Kniess
Geophysical Prospection and Verification at the Protohistoric Settlement of
Punta di Zambrone (Calabria, Italy) 45

Paola Romano (†) – Elda Russo Ermolli – Maria Rosaria Ruello – Giuseppe Ferraro –
Reinhard Jung – Valentino Di Donato – Nicoletta Insolvibile – Marco Pacciarelli
Coastal Landscapes at Punta di Zambrone (Capo Vaticano, Calabria) and their
Suitability for Harbour Facilities during the Bronze Age 55

Reinhard Jung – Marco Pacciarelli
The Settlement of Punta di Zambrone in its Local and Mediterranean Context
during the Recent Bronze Age 67

Cristina Capriglione
Punta di Zambrone (Calabria, Italy) and the Recent Bronze Age in the
Southern Tyrrhenian Region 113

Bernhard Weninger – Cristina Capriglione – Reinhard Jung – Marco Pacciarelli
The Absolute Chronology of the Recent Bronze Age at Punta di Zambrone 135

Marlies Klee – Barbara Zach – Ursula Thanheiser
Archaeobotanical Investigations at Punta di Zambrone (Calabria, Italy) 157

Alessia D'Auria
The Olive Tree and the Agroforestry Landscape at Punta di Zambrone during
the Bronze Age. 215

Gerhard Forstenpointner – Gabriela Slepecki – Alfred Galik – Gerald E. Weissengruber
Faunal Remains from the Bronze Age Settlement at Punta di Zambrone
(Calabria, Italy) 237

Fabian Kanz – Jan Cemper-Kiesslich – Nora Großschmidt – Reinhard Jung – Karl Großschmidt
Human Remains from the Filling of the Bronze Age Fortification Ditch of Punta di Zambrone (Italy) 257

Jan Cemper-Kiesslich – Petra Kralj – Reinhard Jung – Fabian Kanz – Walther Parson
Ancient DNA from Punta di Zambrone: Minute Traces of 3000-year-old DNA or 'Much Ado About Nothing'? 267

Alistair W. G. Pike – Matthew J. Cooper – Gerhard Forstenpointner – Reinhard Jung – J. Andy Milton – Marco Pacciarelli
Domesticate Animal Herding and Procurement Strategies, and the Childhood Origin of the Human Mandible (SP1) from the Bronze Age Site of Punta di Zambrone, Calabria, Italy: a Laser Ablation Sr Isotope Study 277

Tatjana M. Gluhak – Christoph Schwall – Reinhard Jung – Marco Pacciarelli
Provenance Determination of Bronze Age Grinding Stones from Punta di Zambrone 289

Pamela Fragnoli
The Impasto Pottery of Punta di Zambrone (Vibo Valentia, Calabria): Production, Use, Function and Exchanges within the South-Italian Recent Bronze Age Scenario 303

Pamela Fragnoli – Hans Mommsen – Reinhard Jung
Production Regions and Technology of Pottery at Punta di Zambrone: NAA and Petrography in a Combined Approach 321

Reinhard Jung – Mathias Mehofer – Marco Pacciarelli – Ernst Pernicka
The Metal Finds from Punta di Zambrone and Other Sites, and the Bronze Age Metal Supply in Southern Calabria 345

Christian-Heinrich Wunderlich
Analysis of a Recent Bronze Age Amber Bead Fragment from the Site Punta di Zambrone 401

Section 2: The Central and Eastern Mediterranean

Claudia Minniti
Animal Exploitation and Forms of Economic Interaction in Southern and Central Italy during the 13th and 12th Centuries BC 407

Alberto Cazzella – Giulia Recchia
Coping with Changes: Social and Economic Developments at Coppa Nevigata during the 12th Century BC 425

Riccardo Guglielmino
Roca and its Aegean Contacts in the Recent Bronze Age 445

Reinhard Jung – Riccardo Guglielmino – Francesco Iacono – Hans Mommsen
Neutron Activation Analysis of Aegean and Aegeanising Ceramics from Roca Vecchia and the Circulation of Pottery in Southern Italy 459

Marco Bettelli
From the Aegean to the Ionian Sea: Pottery, Technology and People in the Plain of Sybaris in the Late Bronze Age 491

Eleftheria Kardamaki – Adamantia Vasilogamvrou
Handmade Burnished Pottery in the Palace of Ayios Vasileios, Laconia (Southern Greece) 509

Salvatore Vitale
‘Turn and Face the Strain’: Continuity and Change on Kos during the Mycenaean Late Palatial and Early Post-palatial Periods 527

Elisabetta Borgna
The Trapeza Cemetery near Aigion: its Western Connection in a Diachronic Perspective . . 561

Index 587

Preface by the Series Editor

The 17th volume of the *Oriental and European Archaeology* publication series presents the results of excavations in Punta di Zambrone broadly contextualised within the central and eastern Mediterranean. This publication series was initiated in 2013 together with the newly founded Institute for Oriental and European Archaeology (OREA) at the Austrian Academy of Sciences. In accordance with our basic research approach, we strove for a cross-regional readership and authorship from both world areas, as well as seeking to consider and discuss these cultural zones as strongly related with regard to cultural development in human history. While the publication series can be designated as well-established after having published 16 volumes since 2013, its host institution has undergone some crucial structural reform. The formerly independent OREA institute merged together with other establishments to form the new Austrian Archaeological Institute (ÖAI) on 1.1.2021. Our new Archaeological Institute covers the investigation of human history from the Quaternary period up to the modern era, taking into consideration all material archaeological sources and written traditions. We transformed the former OREA institute into the Department of Prehistory and West Asian/Northeast African Archaeology, where the well-established research groups continue to pursue their main approach and engage in fieldwork without any changes. This publication series represents one aspect of this continuity, from now on being edited by the Department of Prehistory & WANA Archaeology of the new Austrian Archaeological Institute.

The scope of this volume *Punta di Zambrone I. 1200 BCE – a Time of Breakdown, a Time of Progress in Southern Italy and Greece* aims to illuminate the developments of societies in the Tyrrhenian, Adriatic and Ionian Seas based on new primary data, on scientific as well as on comparative analyses. The volume editor Reinhard Jung successfully initiated and managed the publication of essential data from this Calabrian site represented by a total of 17 contributions in the first section of this volume. They include all state-of-the-art fieldwork and material analyses by experts from a wide range of disciplines, making this southern Italian harbour site an important new point of reference in the Mediterranean Late Bronze age. The data presented by the experts cover the local and regional environment and topography, site-related studies of deposition and chronology, subsistence strategies, food production and herding management, anthropological analyses including genetics and isotopes, as well as archaeometric and typological material studies of pottery, metals and amber. This interdisciplinary outcome can be understood as a remarkable achievement of the site's excavators Reinhard Jung and Marco Pacciarelli only a couple of years after the fieldwork accomplished in 2013.

The project aims at a broad contextualisation and inclusive scientific discussion, which led to the organisation of an international conference on 14–16 April, 2015, initiated by the editor, hosted by the Austrian Historical Institute in Rome (ÖHI) and co-organised by the OREA institute. The fruitful debates during this conference are not only represented in the present discussion of the Punta di Zambrone data, but also offer an additional wider view of the central and eastern Mediterranean in the essential time of around 1200 BCE. Altogether eight papers from renowned experts are collected in the second section and offer the reader substantial additional perspectives. The overall sociocultural framework is provided by the editor Reinhard Jung in his introduction to this book, where he compiles the manifold data into a narrative about the societies of the Tyrrhenian, Adriatic and Ionian Seas in around 1200 BCE.

My sincere thanks go to the authors of all contributions for sharing their expertise and perspectives and to Reinhard Jung for his effort in publishing this OREA volume. Financial support

for the conference was provided by the FWF (P 23619) as well as by the ÖHI Rome, the OREA institute and the Austrian Academy of Sciences. The publication costs are covered by additional financial support from the Austrian Science Fund (PUB 746-Z). I warmly thank Ulrike Schuh for her competent management of the entire publication process.

Barbara Horejs
Scientific director of the Austrian Archaeological Institute
Vienna, 22 January 2021

Introduction

Reinhard Jung

The time around 1200 BCE saw the overthrow of many royal regimes in the eastern Mediterranean. In connection with their advancing demise, new modes of production were evolving, and new forms of social and political organisation took over – first and foremost in the eastern Mediterranean. However, it is now becoming clearer that the central Mediterranean did not remain unaffected by these events and economic developments.

The interconnection of historical processes unfolding in these two geographical areas is still far from being perfectly understood. However, new excavations are continuously bringing to light valuable evidence for re-assessing the development of local societies and their dialectic bond to super-regional historical trends. That new evidence is reinforcing the notion that the virtual distance between the central part of the Mediterranean and its eastern half, especially regarding the regions along the southern Tyrrhenian, the southern Adriatic, the Ionian and Aegean coasts, was shrinking in the later 13th and earlier 12th centuries BCE, and many different communities were becoming increasingly involved in uneven yet combined trajectories of historical progress. In fact, recent research makes us aware that groups of people inhabiting the coasts of the Apennine peninsula and the central Mediterranean islands or departing from those coasts were important actors in the aforementioned processes.

The scope of this volume is to be a contribution to this scientific progress – in terms of data presentation as well as of comparative discussion. In its first section, it presents results from the excavations inside the settlement of Punta di Zambrone on the Tyrrhenian coast of southern Calabria.

These form a thematic entity insofar as they are confined to the latest settlement phase, which dates to the Recent Bronze Age (RBA) and ended around 1200 BCE. The contributions by colleagues working at coeval sites in the central and in the eastern Mediterranean, in southern Italy as well as in Greece, form the second section of this book (Fig. 1). We invited a number of colleagues to the Austrian Historical Institute Rome (Österreichisches Historisches Institut Rom – ÖHI/Istituto Storico Austriaco a Roma), in order to discuss all our results related to that decisive period of early Mediterranean history during a conference held from April 14th to 16th 2015. The title of that workshop was ‘1200 B.C.E. – A Time of Breakdown, a Time of Progress in Southern Italy and Greece’.

In this way, we hoped first to gain a deeper insight into the problems characterising that time period between the Tyrrhenian Sea and the Aegean in a more general way, and second, we aimed to achieve a better understanding of specific similarities and differences between single settlements and certain regions. The present volume brings together contributions by those colleagues who attended the workshop and additional studies on artefact classes pertaining to that thematic entity.

Chronology, Environment and Population

‘Men make their own history, but they do not make it as they please; they do not make it under self-selected circumstances, but under circumstances existing already, given and transmitted from the past. The tradition of all dead generations weighs like a nightmare on the brains of the

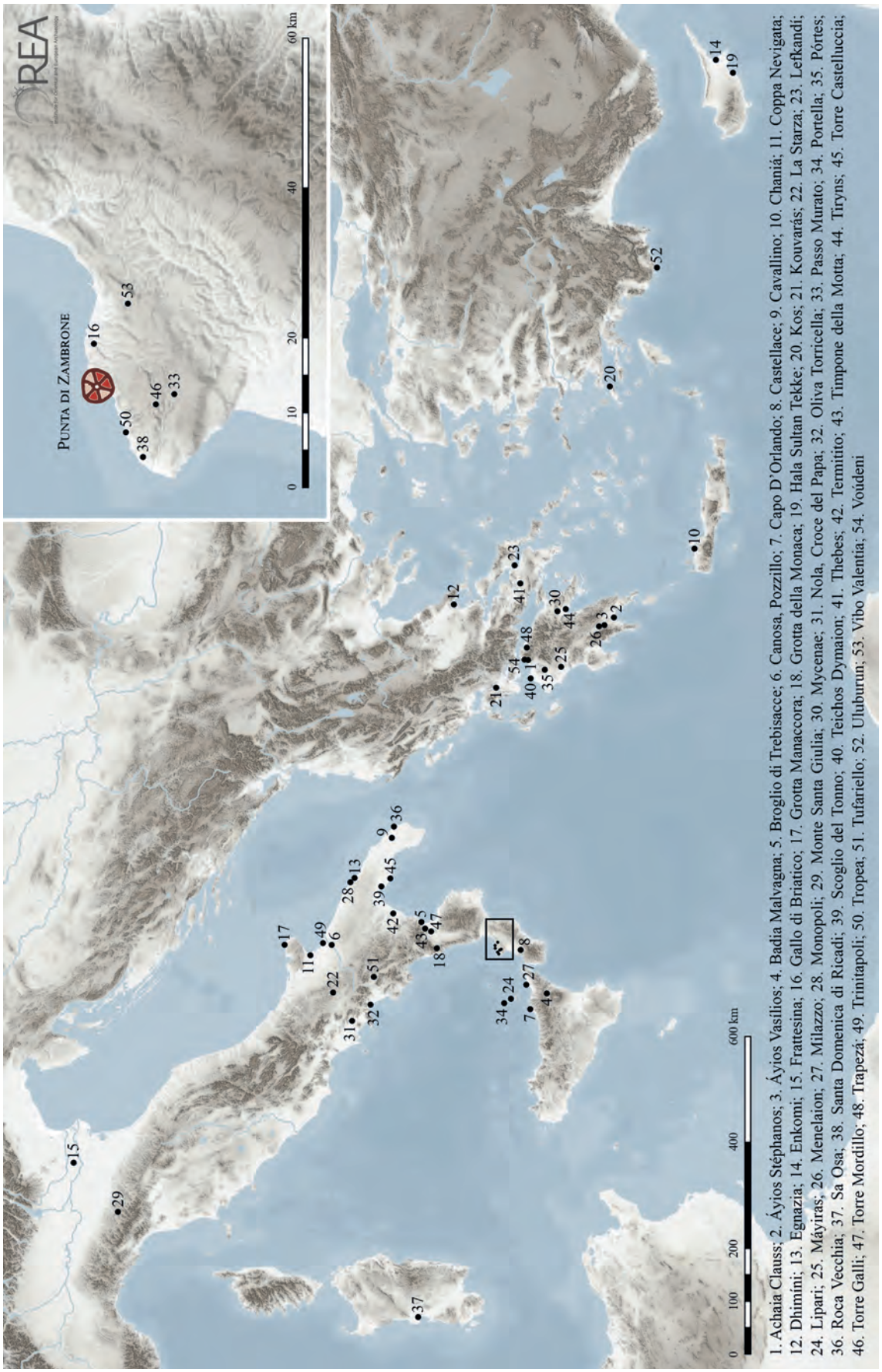


Fig. 1 Sites mentioned in the present book (cartography: M. Börner)

South Italian facies	Italian relative chronology	Greek mainland relative chronology	
Protovillanovan	FBA 1–2	LH IIIC Advanced – Submycenaean	1050
Subapennine	RBA 2	LH IIIC Early 1 – LH IIIC Advanced	1130
	RBA 1	LH IIIB	1220/10
Apennine	MBA 3	LH IIIA1 – IIIA2	1300

Fig. 2 Comparative chronology for southern continental Italy and southern Greece (absolute chronology according to historical-archaeological and ^{14}C-dates) (based on Peroni 1996, 46, fig. 1; Weninger – Jung 2009, 389–393; Jung 2017, 638 fig. 6; Weninger et al., this volume)

living.'[1] – If we build on this assessment by Karl Marx, we ought to reconstruct those historically shaped circumstances of human life in as much detail and from as many angles as possible.

All historical reconstruction using archaeological evidence depends, of course, on a reliable relative and absolute chronology anchored in stratigraphy (Fig. 2). At Punta di Zambrone different classes of finds are available for establishing a firm chronological framework. Regarding the Recent Bronze Age, the period of interest for the present publication, these are the local handmade *impasto* ceramics[2] and the bronze artefacts[3] linking the site to the chronological system of continental Italy and the Aeolian Islands; Mycenaean and, to a lesser extent, Minoan pots offering synchronisms with different regions in Greece[4] and, finally, animal and human bones as well as charred seeds and charcoal, which we sampled for radiocarbon dating.[5] By means of their relation to specific stratigraphical units as part of the overall site sequence,[6] all these finds serve to date the different subphases of the RBA settlement activities at Punta di Zambrone. These ended in abandonment around 1200 calBC, during a stage of RBA 2 that is contemporaneous with LH IIIC Early 1 in the Aegean.

Regarding the elucidation of those circumstances in which humans made their history, the endeavour starts with a reconstruction of the natural environment – always in synchronism with reference to absolute and relative chronological stages. The environment on the one hand determines the conditions of human life and on the other, confronts people with characteristics that result from the impact of previous human behaviour.

---

1 'Die Menschen machen ihre eigene Geschichte, aber sie machen sie nicht aus freien Stücken, nicht unter selbstgewählten, sondern unter unmittelbar vorgefundenen, gegebenen und überlieferten Umständen.' (Marx 1852 [1960], 115). English translation according to <https://www.marxists.org/archive/marx/works/1852/18th-brumaire/ch01.htm> (last accessed 2 Feb. 2019).

2 See the contribution by Cristina Capriglione in the present volume.

3 See the final publication of the Zambrone bronze objects by Reinhard Jung, Mathias Mehofer, Ernst Pernicka and Marco Pacciarelli in the present volume.

4 Jung et al. 2015a, 68–79; Jung 2017, 634–637; Weninger et al., this volume.

5 See the final publication of the ^{14}C-dates related to the RBA layers by Bernhard Weninger, Cristina Capriglione, Reinhard Jung and Marco Pacciarelli in the present volume.

6 For the stratigraphy see the contribution by Reinhard Jung and Marco Pacciarelli in the present volume.



Fig. 3 Punta di Zambrone from the south (photo: R. Jung)

In the quite diversified geographical region of the Poro peninsula, decades of survey activity by Marco Pacciarelli and his cooperation partners have yielded detailed information on the history of human–nature interaction going back by many periods prior to the first establishment at Punta di Zambrone (or Capo Cozzo as it is also known today).[7] This previous research was of great value to Pacciarelli and the author in their endeavour to initiate a new fieldwork project on the site of that coastal settlement.[8] The earliest project phase started in the summer of 2011 and consisted in documenting the topography of the site[9] and in investigating the buried remains by employing a number of geophysical prospection techniques in most of the zones that are not overbuilt by modern constructions.[10]

These first non-invasive investigations at Punta di Zambrone provided the team with the necessary evidence for selecting those areas in which the three planned campaigns of excavation (in 2011, 2012 and 2013) might produce representative data for drawing historical conclusions as to the character of the settlement and its development over time. Even a certain nightmarish aspect was not missing, as both topographic and geophysical investigation had demonstrated the extent to which 20th century CE terracing and deep ploughing had affected the site. However, these circumstances also encouraged our team to constantly examine what we think we know of the Italian Bronze Age and to stay in close communication with the teams working elsewhere in the Italian south.[11]

7 Pacciarelli 2000, 74–85, figs. 40–44; Pacciarelli 2011.

8 Jung – Pacciarelli, this volume.

9 Buhlke, this volume.

10 For the final publication of the geophysical prospection by the Eastern Atlas team see the contribution by Burkart Ulrich, Wieke de Neef, Anja Buhlke and Rudolf Kniess in the present volume.

11 Apart from the mentioned workshop in Rome, another workshop was held one year earlier. Marco Pacciarelli, co-director of the Punta di Zambrone excavation, and Luigi Cicala had organised it on the closure of their PRIN project no. 2009MF87BM (for the proceedings see Cicala – Pacciarelli 2017).



Fig. 4 3D model of Punta di Zambrone from the north (by Project Archaeocopter, M. Block-Berlitz and team, HTW Dresden, FU Berlin)

Cooperating with geologists in order to define the Bronze Age coastline was of primary importance for our understanding of the historical circumstances that caused people to settle at Punta di Zambrone. As many previous studies have shown, both sea level changes and erosive as well as sedimentary processes can be expected to have had a marked impact on the coastal topography in the course of several millennia. Taking the present-day extended sandy beach to the south of the cape and the small bay to the north as face value reference points for an interpretation of the possible maritime role the settlement had played could, therefore, have resulted in serious misconceptions (Figs. 3–4).

Indeed, immediately to the south of the cape of Punta di Zambrone the late Paola Romano and her team were able to verify the existence of a shallow bay, which is currently entirely covered by sediments. This former bay was well protected by a rocky ridge, which runs parallel to the coast and once stood out of the waves, but today is submerged and was therefore documented during an underwater investigation. A radiocarbon date from a sediment core taken in the area of the bay shows that the bay was open at least up until Roman times.[12] This bay was ideally suited for beaching ships and therefore must have constituted a major pull factor in enticing the Bronze Age people to inhabit that small cape from the end of the 3rd millennium BCE on. At the same time, its presence would explain the strong Mediterranean integration visible in many aspects of the material culture, mainly in the Recent Bronze Age layers of the site. Moreover, such a particular geomorphological situation seems to have been recurrent at a number of other Bronze Age settlements in southern Italy – though less so on the Tyrrhenian coasts and more often along the Apulian coasts, both on the Ionian and on the Adriatic sides.

Years ago, Friedrich-Wilhem von Hase underlined the importance of naturally protected harbour bays for the development of fruitful exchange relationships between the inhabitants of southern Italy and those of the Aegean. Particular cases, partly verified by geological investigations of the respective coastal areas, are the settlements of Scoglio del Tonno situated on the northern shore of the exterior bay Mar Grande in modern Taranto, Roca Vecchia with the Bacino Tamari on its rear side to the west, as well as Torre Guaceto and Scogli di Apani located close to a series of small bays fed by small fresh water streams.[13] Some but not all of these sites share the trait of a comparatively high amount and elevated diversity of items imported from the Aegean.[14]

---

12 See Paola Romano, Elda Russo Ermolli, Maria Rosaria Ruello, Giuseppe Ferraro, Reinhard Jung, Valentino Di Donato, Nicoletta Insolvibile and Marco Pacciarelli, in the present volume.

13 von Hase 1990, 106, fig. 25.2 (partially based on earlier work by Massimiliano Marazzi and Sebastiano Tusa, cf. Marazzi – Tusa 1979, 332–333, fig. 10); Pagliara 2005, 629–630, pl. 159b; Scarano et al. 2017.

14 The fact that at some of the Middle Bronze Age harbour settlements in Apulia no Aegean imports have turned up so far, points to the complexity of the phenomenon. Suitable protected bays seem to have been more common along the Adriatic coast than along the Tyrrhenian shores.

Punta di Zambrone thus belongs to a specific type of coastal settlement that possessed especially safe anchorages on the Mediterranean Sea routes during the later 2nd millennium BCE. Parallels can also be found in the eastern Mediterranean, e.g. the well-protected bay used as a harbour for the LC settlement of Hala Sultan Tekke.[15] Apart from taking advantage of such natural bays and lagoons, as the populations of the central Mediterranean did,[16] at least the Mycenaean and pharaonic states also organised work forces to engineer canals and artificial harbour basins. This is shown, for instance, by the results of geoarchaeological research for the harbours at the Selas mouth, close to Pylos in Messenia, and at the Pelusiac Nile branch at Tell el-Dabᶜā in the eastern Nile delta.[17]

Moving from the coast into the hinterland, the botanic studies conducted on the many soil samples obtained by flotation during the excavation campaigns at Punta di Zambrone, provide crucial data for reconstructing the closer and farther environment, in which the Bronze Age inhabitants lived. The final results of the team responsible for the charred plant remains (mainly seeds, fruit and chaff)[18] as well as the findings of the anthracological study are published in the present volume.[19] As all the samples come from well-defined stratigraphic contexts dating from EBA 1 to RBA 2, this archaeobotanic evidence can be combined with the survey data relating to those same chronological phases. Among other aspects, the survey results illustrate the shifting settlement pattern on the Poro promontory. In connection with the anthracological findings from the site (and also taking into account information on gathered fruit and wild plant seeds) they help us to understand the shrinking and expansion of forest cover as well as the changing forest exploitation by the population.

Regarding the inhabitants of Punta di Zambrone, we have the evidence from the osteological remains dispersed in the RBA ashy layers of the fortification ditch. The present volume unites the final results of three scientific studies conducted on those human remains. One team employed the methods of forensic anthropology,[20] a second conducted aDNA analysis,[21] while a third one measured the Sr isotope ratios on the teeth of one individual.[22] The forensic-anthropological study has shown that the bones – although found embedded in an ashy layer – are all unburnt and correspond to at least two individuals, an adolescent and a younger adult (likely to be male) with an age at death of around 20 to 30 years. Only the extant bones of the latter individual allowed further investigations. Although the sampled bones were excavated according to best practice as recommended by molecular archaeologists and were most likely not contaminated by modern DNA, unfortunately the DNA of the younger adult individual was not sufficiently preserved to allow for DNA-based sex identification. The strontium isotope measurements conducted on his three extant molars (M1–M3) by using laser ablation at the Southampton lab showed with all desired clarity that the Sr isotope ratios are compatible with those of the coastal zone and the immediate hilly hinterland of Punta di Zambrone. Therefore, this individual most probably grew up (at least until about 14 years of age) in precisely that region. It follows, then, that the specific deposition context of this (and probably also the second) individual is linked to some burial rite of the local population. These results are especially valuable when seen against the background of the general

15 After being partially silted up, the Larnaca Salt Lakes are what remains of that prehistoric bay, see Devillers et al. 2015.

16 Attested for the 2nd millennium BCE also along the Lebanese coast at Sidon and Tyre (Marriner et al. 2006).

17 Zanger et al. 1997, 613–623, fig. 46; Tronchère et al. 2008; Tronchère et al. 2012; Bietak 2017; for an overview see also Knapp 2018.

18 Contribution by Marlies Klee, Barbara Zach and Ursula Thanheiser in the present volume..

19 Contribution by Alessia D'Auria in the present volume..

20 Fabian Kanz, Jan Cemper-Kiesslich, Johanna Gaul, Nora Großschmidt, Reinhard Jung and Karl Großschmidt in the present volume.

21 Jan Cemper-Kiesslich, Petra Kralj, Reinhard Jung, Fabian Kanz and Walter Parson in the present volume.

22 Alistair W. G. Pike, Matthew J. Cooper, Gerhard Forstenpointner, Reinhard Jung and Marco Pacciarelli in the present volume.

scarcity of Recent Bronze Age burials all over southern Italy, a scarcity which has an even more pronounced character in Calabria.[23]

Subsistence Production and Regional Integration

All production means appropriation of nature by the individual within a certain society and mediated by that society,[24] and botanic and zoological research provide direct material evidence for an important part of the production in a society. To better describe the changes that may have been made in the sector of subsistence production throughout the Bronze Age, a long-term perspective seemed suitable to both the teams of botanists[25] and the teams of zoologists[26] working with the Zambrone finds. Consequently, they present the entirety of their data from the consecutive settlement phases of EBA 1, EBA 2 and RBA in this volume.

Interestingly, the RBA layers in the two excavation areas of the fortification ditch provide us with two quite different sets of evidence for the use the inhabitants made of their domestic animals and – to a much lesser extent – of the game hunted in the regions of the immediate hinterland. The first one is characterised by a clear predominance of cattle, at about 50% of the total, over sheep/goat and pigs, with percentages around 20% for each group.[27] Given that the zoologists found this use pattern in sediments that had been accumulating over time inside the ditch as well as in the final thick layer sealing that structure in Area B, this refuse should result from everyday consumption at Punta di Zambrone. Moreover, the comparison with the faunal remains from the EBA 2 structures excavated in the western part of Area B suggests that this kind of herding regime had a long tradition going back several centuries. In addition, the cooperation between the specialists for Sr isotope analyses and the zoologists has shown that one EBA 2 cow moved in a seasonal rhythm from the Poro high plain back down to the coast before ending up at the settlement of Punta di Zambrone, which indicates a short-range transhumance system of cattle breeding being at work.[28]

During the RBA, most of the animals slaughtered in or near the settlement came from the coastal zone and the hilly area to the east and south, but some were brought in from further away including the Poro high plain.[29] This confirms Pacciarelli's interpretation of the survey data, according to which the settlements on the Poro high plain, the inhabitants of which were mostly specialised in farming on the exceptionally fertile soils in that area, were integrated into a system with defensible settlements spread across the lower hill zone, which was mainly exploited by herding, and finally with the few coastal ports, one of which is Punta di Zambrone.[30] A similar situation may have existed in EBA 2, as suggested on the one hand by the mentioned evidence for a vertical transhumance regime[31] and on the other hand by the distribution of different settlement types belonging to the EBA 2 Cessaniti culture group.[32]

The results of the collaboration by different specialists in the natural sciences and archaeology for analysing the Zambrone evidence thus presents us with a rather rare case of direct proof for

---

23 For a more extensive discussion of those funerary rites see Jung – Pacciarelli, this volume with fig. 23.

24 ‚Alle Produktion ist Aneignung der Natur von seiten des Individuums innerhalb und vermittelst einer bestimmten Gesellschaftsform.' (Marx 1857 [1983], 23). For an English translation see <https://www.marxists.org/achive/marx/works/1857/grundrisse/ch01.htm> (last accessed 2 Feb. 2019).

25 See the contribution by Marlies Klee, Barbara Zach and Ursula Thanheiser in the present volume.

26 See the contribution by Gerhard Forstenpointner, Gabriela Slepecki, Alfred Galik and Gerald E. Weissengruber in the present volume.

27 Forstenpointner et al., this volume, fig. 5.

28 Pike et al., this volume.

29 Pike et al., this volume.

30 Cf. Pacciarelli 2000, 82–84, fig. 44 (top).

31 As well as by one EBA 2 pig that grew up in the hill zone south of Tropea (Pike et al., this volume).

32 Cf. Pacciarelli 2000, 78–80, fig. 42 (bottom).

the economic – and by extension probably political – integration of one region characterised by at least three ecological zones used in a diversified way by cooperating inhabitants of different settlement types in the course of the Bronze Age.

Those RBA strata that were richest in both faunal and plant remains yielded the second (and much larger) set of evidence for animal use at Punta di Zambrone. These are the ashy layers deposited during the final infill of the northern stretch of the fortification ditch. The analysis of the artefact spectrum allows us to conclude that those ashes had been accumulating inside the settlement as the result of recurrent consumption activities, which also had an ideological component.[33] The divergent spectrum of domestic animals with approximately equal shares of cattle, sheep/goats and pigs in those ashy layers would thus reflect more specific, non-everyday meat consumption.

Claudia Minniti's contribution in this volume gives an additional overview of the zoological evidence from many other settlements in southern as well as central Italy and elucidates the peculiarities of each region and the herding regimes of their inhabitants. Although some trends, such as the predominant use of cattle for traction and an increasing use of secondary products, seem to be common to different regions in the south of Italy, other data clearly show regional differences in the subsistence economies during the RBA.[34]

The diachronic analysis of the archaeobotanic data from Punta di Zambrone proves the consumption of emmer, barley and millet as the main cereals throughout the 2nd millennium BCE, while emmer had already assumed its dominant position by the EBA and millet was apparently known since that time, but had grown in importance in the RBA. Lentils are attested for the first time in the RBA layers. The team of botanists found further evidence for some change in agriculture in the increased presence of summer crop weeds in the RBA strata. There is a slight presence of olive stones in both EBA 2 and the RBA, while grapes were of importance only in the RBA. Olive stones are also rare at coeval settlements with the known exception of RBA Monopoli. Some differences to other southern Italian sites of the RBA can be noted though – such as the greater importance of emmer and millet at Punta di Zambrone. According to Marlies Klee, Barbara Zach and Ursula Thanheiser, the rarer occurrence of millet in the south as compared to the north of the Apennine peninsula may be due to the spread of millet cultivation from north to south.[35]

The contributions mentioned so far show that we can gain a very broad and, at the same time, detailed insight into many aspects of the Bronze Age subsistence economy of Punta di Zambrone by means of the botanic, zoological and isotopic studies. The means of labour are only partially present among the find materials retrieved at Punta di Zambrone, but do nevertheless complement that picture quite nicely. A few grinding stones were deposited together with the ashes in Area C. Apart from furnishing direct evidence for food production, they and their parallels from other Bronze Age settlements on the Poro promontory illustrate the regional economic integration of those settlements via the sea, as the chemical analyses by Tatiana Gluhak and Christoph Schwall revealed the Aeolian Islands as the origin of the volcanic rock they are made of.[36] The terracotta objects of the RBA provide information on craft activities, as there are a remarkable number of spindle whorls and loom weights, with different types and sizes in both categories attesting to a quite diversified textile production being practised at Punta di Zambrone.[37] Finally, the RBA bronze objects include a cutting tool for working harder natural materials and some awls, perhaps used in leather production.[38]

Pamela Fragnoli's petrographic work at Punta di Zambrone shows that in RBA pottery production functional differentiation of handmade *impasto* shapes went hand in hand with a specialised

33 See Jung – Pacciarelli, this volume.
34 Minniti, this volume.
35 Klee et al., this volume.
36 Gluhak et al., this volume.
37 Capriglione, this volume.
38 Jung, Mehofer, Pacciarelli, and Pernicka, this volume.

choice of raw materials and paste preparation modes – something that was an innovation compared to EBA 2. This specific tendency towards specialisation, which becomes visible in regard to the local pottery workshops at or close to this harbour site, cannot be found at other RBA coastal sites in the south.[39] Conversely, chemical analysis by NAA has shown that the inhabitants of Punta di Zambrone did not practise any local production of Mycenaean or Mycenaeanising pottery,[40] while in most regions from northern Calabria to Basilicata and Apulia such local production was very well developed by RBA 2 (though it found different expressions and was practised with variable intensity) – in fact starting much earlier at several of those sites.[41]

The typological analysis of the *impasto* pottery from the RBA layers at Punta di Zambrone by Cristina Capriglione provides further insight into the traditions which the producers continued at Punta di Zambrone, as well as into the close relationships they maintained with other communities in the Lower Tyrrhenian and beyond. This ceramic evidence comes from the first well-stratified deposits of RBA pottery excavated in southern Tyrrhenian Calabria, and the bulk of that material was found in the ashy levels of Excavation Area C. It shows a few traces of Sicilian tradition belonging to the previous Milazzese *facies* (culture group), the material culture of which was also present in southern Calabria during MBA 3. Capriglione further notes certain vessels of continental Italian, i.e. Apennine type, diverging, however, from what is known as the classical Apennine style. The Subapennine pottery from Punta di Zambrone finds its closest counterpart in the finds excavated by Luigi Bernabò Brea and Madelaine Cavalier on the acropolis of Lipari and also studied by Capriglione. The roots of this Subapennine style lie much further to the north, in the northern to central Adriatic regions of Italy. A similar switch from regional (Sicilian and southern Calabrian) traditions to those of northern continental Italy occurred in the bronze workshops of the region, as the finds from the Aeolian Islands have shown and as those from Punta di Zambrone once again underline with additional types (see below).

In Italy, Sicily is the region with the earliest manufacture and use of pithoi. It goes back to the beginning of the Early Bronze Age around 2000 BCE, as new evidence from the settlement of Castelluccio demonstrates.[42] On the Aeolian Islands as well as on the Tropea peninsula, regional types of pithoi were in use during the Middle Bronze Age.[43] The attestations of pithoi in the Milazzese settlements are very numerous. At least at Portella on Salina, those pithoi apparently served for storing the rain water – precious on that dry island.[44] A new development commenced during the Recent Bronze Age in different southern Italian regions. Since the RBA 2 phase, pithoi of Aegean type/style with wide horizontal plastic bands came into use, and Punta di Zambrone belongs to the sites, at which this new production trend found an early expression (though a still limited one from a quantitative point of view).[45] Communities across southern continental Italy adopted the new Aegean manufacturing techniques for large storage vessels in different ways, as Capriglione points out in her analysis. While from Lipari and southern Calabria up to the southern plain of Sybaris potters used to make coarse-ware pithoi, those along the Ionian coasts further north produced fine-ware pithoi.

---

39 Fragnoli points out that at Broglio di Trebisacce in northern Calabria as well as at Coppa Nevigata in northern Apulia the opposite can be observed, i.e. a homogenisation of clay recipes used for *impasto* pots, independent of vessel shapes. The more standardised production of RBA 2 *impasto* pottery as compared to EBA 2 *impasto* pottery is also supported by the NAA data published in this volume (contribution by Fragnoli et al., this volume).

40 Cf. Jung et al. 2015b and the contribution by Fragnoli et al. in the present volume.

41 See e.g. for Broglio di Trebisacce and Torre Mordillo: Bettelli, this volume; for Coppa Nevigata: Cazzella – Recchia, this volume; for Roca Vecchia: Jung, Guglielmino, Iacono and Mommsen, this volume (cf. also Bettelli, this volume).

42 Crispino 2016.

43 For a burial pithos of MBA 1/2 date from Tropea see Pacciarelli – Varricchio 1991–1992, 757 no. B.

44 Martinelli 2010, 126–127, 130, fig. 62; 255.

45 For the pithoi used at Punta di Zambrone see Capriglione, this volume, fig. 7.4–5. If we take the latest Mycenaean pottery found in those same RBA 2 layers as a point of reference, this pithos production should have happened at the latest during an early stage of RBA 2, coeval with LH IIIC Early 1. The pithoi from the Central Hut at Broglio di Trebisacce date to a later stage that was contemporary with LH IIIC Advanced (Jung – Pacciarelli 2017, 194).

Surplus Production and Mediterranean Exchange

Goods exchange between societies presupposes that humans in a given society produce more than they consume (i.e. more than they need to maintain themselves, to reproduce their labour power). This means that they not only perform necessary labour, but surplus labour and thus generate a surplus product, which can then be exchanged against the desired products of another community. Different relations of production entail different ways in which specific social groups control and appropriate surplus labour and surplus products.[46] 'The essential difference between the various economic forms of society, between, for instance, a society based on slave-labour, and one based on wage-labour, lies only in the mode in which this surplus-labour is in each case extracted from the actual producer, the labourer.'[47] This mode of extracting surplus labour from direct producers 'determines the relationship of rulers and ruled, as it grows directly out of production itself and, in turn, reacts upon it as a determining element.'[48] In the historical perspective, the development of goods exchange between different societies, the emergence of trade, pushes production from a system that mainly aims at producing the means of subsistence, use values, towards one that is oriented towards producing a surplus product, producing for exchange, producing commodities with an exchange value.[49]

If making use exclusively of archaeological correlates, it is a notoriously difficult endeavour to identify the specific forms that the control over surplus labour, over storage of products and over exchange processes have taken in a prehistoric society – especially regarding economic formations that have not (yet) developed bureaucratic mechanisms of such control (mechanisms that would leave behind sealings, counting tokens etc.). Here, archaeology needs to be supported by analyses of living or historically documented societies.[50]

However, archaeology and archaeometry provide us with a broad spectrum of methods for identifying the provenance of raw materials and – generally in a more indirect way – of finished products. Provenance analyses are the basis of archaeological studies that attempt to answer the question of which societies did exchange their products with each other and which routes were taken in order for that exchange to take place. Combining the results of such scientific analyses with those of typological character, as well as with distribution patterns including quantitative data, enables the researcher to grasp the degree to which labourers produced for exchange and how much the economic system, in which they produced, depended on goods exchange.

Copper and tin were, of course, the basic raw materials needed by almost every Bronze Age society to produce many crucial means of labour, but also weapons or dress accessories, and, obviously, most communities in Europe had to acquire them by means of goods exchange. A certain problem arises when one wishes to get a representative picture of the metal objects produced by the communities in a certain region during a specific phase. While pottery is present in almost every Bronze Age stratigraphic context, be it in the central or in the eastern Mediterranean,[51] metal objects are, of course, an entirely different matter.

---

46 Marx 1867/1890 [1962], 231, 562.

47 ‚Nur die Form, worin diese Mehrarbeit dem unmittelbaren Produzenten, dem Arbeiter, abgepreßt wird, unterscheidet die ökonomischen Gesellschaftsformationen, z.B. die Gesellschaft der Sklaverei von der der Lohnarbeit.' (Marx 1867/1890 [1962], 231. English translation after <https://www.marxists.org/archive/marx/works/1867-c1/ch09.htm> (last accessed 16 Feb. 2019).

48 'Die spezifische ökonomische Form, in der unbezahlte Mehrarbeit aus den unmittelbaren Produzenten ausgepumpt wird, bestimmt das Herrschafts- und Knechtschaftsverhältnis, wie es unmittelbar aus der Produktion selbst hervorwächst und seinerseits bestimmend auf sie zurückwirkt.' (Marx 1894 [1964], 799). English translation after <https://www.marxists.org/archive/marx/works/1894-c3/ch47.htm> (last accessed 16 Feb. 2019).

49 Cf. Marx 1894 [1964], 343–344; English translation after <https://www.marxists.org/archive/marx/works/1894-c3/ch20.htm> (last accessed 16 Feb. 2019).

50 For different models dealing with this aspect with regard to Bronze Age societies in Italy see: Peroni 1996, 4–43; Cazzella – Recchia 2013; Cardarelli 2015; Jung – Pacciarelli 2017. For recent studies on modes of extracting surplus in prehistoric societies or indeed on social strategies to resist such exploitation see Meller et al. 2018.

51 Apart, perhaps from metal hoards, but even those may have been deposited in ceramic vessels (such as is the case with one on the Lipari acropolis, see below).

In the two Calabrian RBA settlements that have been investigated over several seasons of excavation prior to Punta di Zambrone, Broglio di Trebisacce and Torre Mordillo, no substantial amounts of artefacts made of bronze or, indeed, any other metal have turned up so far.[52] The 36 catalogued bronze and lead objects (excluding amorphous fragments) of Recent Bronze Age date unearthed at Punta di Zambrone and published in the present volume are therefore an important addition to the Calabrian bronze corpus.[53] However, the well-known hoard find from the acropolis of Lipari,[54] 92km from Punta di Zambrone right across the Tyrrhenian Sea, contained 75kg of mostly fragmentary bronzes and copper ingots[55] and thus shows us that a wide spectrum of bronze work must have been circulating in the Lower Tyrrhenian region.

When taking a look at the larger regional and interregional picture, one realises that of all coeval south Italian settlement sites only Roca Vecchia yielded a notable number of bronze artefacts.[56] A single RBA 2 deposit of ashy sediment mixed with animal bones (partly in anatomic connection) handmade *impasto* as well as wheelmade Aegean-type pottery contained 42 metal objects – mainly bronze implements, rods and sheet bronze.[57] The composition of this deposit, which is described in detail in Riccardo Guglielmino's contribution to this volume, thus comes close to that of the approximately coeval uppermost fill layers in the Zambrone fortification ditch.

The largest single assemblage of RBA bronzes from continental southern Italy is the Surbo hoard,[58] and only by the Final Bronze Age period does hoard deposition seem to have become a more frequent practice, as exemplified by the two FBA 2 hoards of Roca Vecchia. The small number of RBA tombs known from the southern provinces of Italy[59] in combination with the austere burial rites, which apparently allowed for the placement of bronzes only in rare cases, are further important factors responsible for the scarcity of RBA metal finds in those regions.

Casting moulds provide additional evidence for the local manufacture of implements, weapons etc. in bronze and other metals. Moulds did not turn up at Punta di Zambrone, but are attested in other RBA settlements such as Coppa Nevigata and Roca Vecchia.[60]

From all the archaeometric studies implemented at Punta di Zambrone, metal analyses conducted as a combination of XRF (targeting the chemical composition) and mass spectrometry (for determining the lead isotope ratios) revealed the most wide-ranging contacts of that small community in southern Calabria.[61] Such analyses yielded similar results at other Bronze Age sites in southern Italy such as Roca Vecchia[62] or Trinitapoli[63]. This demonstrates that communities of quite different sizes and integrated into various types of regional settlement networks were able

---

52 For about 23 fragmentary bronzes from RBA and FBA contexts at Broglio di Trebisacce see: Buffa 1994 and Luppino et al. 2005, 731, pl. 97 (on top: a knife of the Alpine variety Matrei); for 29 fragmentary bronzes (excluding amorphous fragments) from MBA to FBA contexts at Torre Mordillo see Buffa 2001.

53 See the contribution by R. Jung, M. Mehofer, E. Pernicka and M. Pacciarelli in the present volume. 43 metal objects (counting all kinds of fragments) were found in an excavation area of only 35m² (Area C). The fact that the vast majority of the metal objects at Punta di Zambrone come from the ashy upper fill layers inside the fortification ditch points to the peculiar formation processes of those ashes as well as the chemical properties of the soil milieu favouring their preservation. These factors may partially explain the differences cited between the evidence from Punta di Zambrone and from other sites such as Broglio di Trebisacce and Torre Mordillo.

54 Most probably deposited during the Ausonian I settlement phase (Bernabò Brea – Cavalier 1980, 733–789; Moscetta 1988; Lo Schiavo et al. 2009, 147–156, 161–164, figs. 12–15; 165, fig. 16.1–14; 166–174, 176–215).

55 To which one can add a couple of fragmented bronzes spread around the different houses of the settlement (Bernabò Brea – Cavalier 1980, 583–586, figs. 109–110; Lo Schiavo et al. 2009, 156–157, 175).

56 For bronze artefacts from different RBA settlement phases at Roca Vecchia see Maggiulli 2007; Maggiulli 2017, 980–981, fig. 3.

57 Maggiulli 2017, 981.

58 Macnamara 1970.

59 See Jung – Pacciarelli, this volume, fig. 23.

60 For Coppa Nevigata see Cazzella – Recchia, this volume, fig. 7.2–3; for Roca see Guglielmino 2003, 103–106, figs. 18, 19, 21.

61 Jung, Mehofer, Pacciarelli, and Pernicka, this volume.

62 Jung et al. in press.

63 Jung et al. 2011, 241–242; Jung – Mehofer 2013, 178–179, fig. 5.

to successfully tap into Mediterranean transport routes and to organise a constant supply of vital raw materials by maintaining far-reaching connections.

At most of the southern Italian sites investigated so far, southern Alpine copper formed the basis for the production of bronze implements, dress accessories and weapons – from MBA 3 onwards and at least until a mature phase of the Final Bronze Age (FBA 2). One can now reconstruct an export system organised in such a way that this raw material passed through the Adriatic and Ionian Seas and reached southern Calabria, where Punta di Zambrone, at the moment, is the southernmost settlement relying on those northern ore deposits. The analytical evidence fits very well with the results of the typological assessment, yielding the result that many types well-known in the Italian north are for the first time attested as far south as that Calabrian harbour. In this respect, the Zambrone finds widen the spectrum known from Lipari. If these representations of the 'metallurgical koiné' – a concept named and first explained by Renato Peroni[64] – are seen in combination with the typological similarities most of the common Subapennine vessels from Punta di Zambrone and Lipari exhibit to ceramics products from far-away regions in the centre-north,[65] we begin to grasp the effects that the connection to a wide-ranging economic system via copper export/import had on the material culture of the participating communities. Of course, communication between members or groups of different societies may generate similarities in their material culture. The more intense such communication gets – e.g. in the framework of regular goods exchange – the more it will affect different aspects of culture. Here it may also be worth pointing out that regarding their geographical extension, the coeval metallurgical and pottery koiné phenomena of Subapennine (Recent Bronze Age) Italy are without comparison in Urnfield Europe.[66]

The analytical results of bronze objects from Punta di Zambrone also revealed that the local workshops had access to Cypriot copper. The many oxhide ingot fragments found as part of the Lipari hoard might suggest that the share of worked Cypriot copper in other settlements of the Lower Tyrrhenian region was, in fact, larger than the Zambrone analyses would lead us to believe.[67] However, due to the lack of lead isotope analyses in the case of the Lipari hoard, one cannot judge at the moment if that ingot copper was destined for use in a Lipari foundry or if its presence at the site is due to the location of Lipari close to the sea route towards Sardinia, where many coeval oxhide ingots have been found.[68]

In this volume, Alberto Cazzella and Giulia Recchia present us with further evidence for the exchange of goods with the Adriatic and wider Mediterranean from their excavation at the fortified settlement of Coppa Nevigata in northern Apulia. Different classes of artefacts such as antler and bone objects as well as the early appearance of the *Protovillanovan* style in pottery decoration underline the previously mentioned Adriatic routes linking Apulia to northeastern Italian regions such as the Po plain and the Marche. In addition, certain bronze types illustrate further relationships to the eastern Adriatic coasts of the Balkan peninsula. An RBA 2 stone weight with a suspension hole on top is of the utmost importance, as it attests to a shared system of reference parameters (weight standards) facilitating regular, recurring goods exchange, probably operating with a system of value equivalents. This weight from Coppa Nevigata belongs to a type attested predominantly in the *terramare* settlements of the Po plain,[69] but its most distant parallel comes from the Post-palatial settlement of Lefkandí on Euboea, roughly contemporary to RBA 2 Coppa Nevigata.[70]

---

64 Peroni 1969, 151.

65 Pacciarelli 2018; Capriglione, this volume.

66 The Carpathian Basin and southeastern Europe of course partook in the production of the metallurgical koiné in Bronze D and Hallstatt A1 (cf. Carancini – Peroni 1997), but in those areas bronze workshops created more regional types than did the bronze workers in Italy, while their fellow craftsmen in the potters' workshops between the Danube and the Aegean were bound to predominantly regional and micro-regional styles.

67 See n. 54.

68 Lo Schiavo 2009; Begemann et al. 2001.

69 Cazzella – Recchia, this volume.

70 Pare 2013, 511–512, fig. 29.2,5; Evely 2006, 273, fig. 5.5,4; 276; Jung – Pacciarelli 2017, 193.

This distribution pattern of stone weights from the north of Italy via Apulia as far as the central Aegean area during RBA 2 in all probability means that Adriatic–Aegean goods exchange had taken on a new dimension after the fall of the Mycenaean palaces and with the rise of economically and politically independent regional polities in the Aegean.

Moreover, Cazzella and Recchia make a good case for identifying a fragmentary object from the RBA layers at Coppa Nevigata as yet another example of that well-known ingot type in the central Mediterranean.[71] It is the first one from Apulia, a find that one might have expected judging from the most probable sailing routes that would have run along the Ionian and Adriatic coasts rather than across the open sea from Crete or the Peloponnese towards Sicily.

Provenance analyses on pottery open another window onto exchange processes using the sea routes that offered good connections for many regions in both Italy and Greece. In the Tyrrhenian Sea, maritime transport of local tableware across notable distances is already attested for the Capo Graziano 2 culture group of the Middle Bronze Age 1–2.[72] Pamela Fragnoli was also able to detect some imports among the RBA *impasto* pottery from Punta di Zambrone.[73]

On a larger scale, other classes of pottery circulated across the Ionian and Tyrrhenian Seas, as the NAA results on the wheelmade pottery from Punta di Zambrone and Roca Vecchia prove. Regarding the classes of Italian-made pottery, petrographic research combined with typological analysis has established the transport of pithoi, and most probably the products stored in them, from the southern Sybaris plain to the northern part of that region and sometimes beyond.[74] Apparently, this happened mainly from late RBA 2 onwards and into the Final Bronze Age. The new NAA results from Roca Vecchia assign one coarse-ware pithos (dating to late RBA 2 or FBA 1) to a group, the other members of which are precisely such products from the southern plain of Sybaris, according to their petrographic characteristics. Roca Vecchia is one of the most distant places where northern Calabrian pithoi (and agricultural products) arrived.

Another new aspect of the economic potential of the southern Sybaritis emerged, when it was possible to identify four Mycenaean-type vessels found at Punta di Zambrone in an earlier RBA 2/LH IIIC Early context as exports from that same region.[75] As they include both open and closed shapes, this export of local northern Calabrian Mycenaean pottery to southern Calabria relates to the exchange of tableware and thus reminds one of the previously mentioned EBA and MBA 1–2 pottery transport via the Tyrrhenian sea routes.

In many respects, however, the new NAA data from Punta di Zambrone and Roca Vecchia supplement and support the picture gained by typological and stylistic analyses, according to which the various southern Italian regions and micro-regions each had their own importation, production and consumption patterns for Mycenaean, Minoan and Aegeanising pottery.[76] A comparison between three major sites for those classes of pottery shows this with impressive clarity. One can point to the predominantly locally made Mycenaean and Mycenaeanising pottery

---

71 Cazzella – Recchia, this volume, fig. 8.1.

72 For the export of decorated Capo Graziano pottery from the Aeolian Islands to central Italy see e.g. Levi et al. 2006, 1104–1105, fig. 3. With high probability one can interpret the pottery assemblage found on the sea bottom close to Pignataro di Fuori off the cape Sciarra di Monte Rosa (Lipari) as a wreck site and thus as direct proof for the shipment of all classes of vessels already by the time of the Early Bronze Age Capo Graziano 1 *facies* (Castagnino Berlinghieri 2003; Levi et al. 2006, 1104 n. 31).

73 These were produced in either Campania or Sicily.

74 Levi – Jones 1999; Levi et al. 1999, 229, fig. 240; Schiappelli 2015, 236, 238–239, figs. 6a–b.

75 Already published in Jung et al. 2015b, 458–459, tab. 1.

76 In southern central Sicily, the site of Cannatello yielded substantial numbers of pottery vessels imported from Cyprus, in addition to Mycenaean and a few Minoan imports. This evidence attests to a kind of goods exchange with eastern Mediterranean communities very different from the contacts that can be reconstructed by means of material culture for Punta di Zambrone, for sites elsewhere in the Lower Tyrrhenian or, indeed, in southern continental Italy in general. One will therefore regret that although presented at the Rome workshop, the paper on Cannatello was not submitted for publication (for a short note on the imports see Levi et al. 2017, 126–128, pl. 44f).

repertoire from the (late) RBA 2 phase at Broglio di Trebisacce in the northern Sybaritis;[77] to the exclusively imported Mycenaean and Minoan assemblage deposited by early RBA 2 inside the fortification ditch at Punta di Zambrone[78] and to the unparalleled quantities of wheelmade painted and even unpainted pots found at Roca Vecchia and including both imported and Apulian products.[79] The latter belong to two different (yet close) chemical groups,[80] which underlines the important role that the strongly fortified coastal settlement of Roca must have also played on a regional level.

For a deeper understanding of the diachronically changing character of Italian–Aegean relations, a fine-phased relative chronology on both sides of the Adriatic is indispensable. It is, e.g., of fundamental importance to be able to chronologically relate a given stratigraphic context to either the last phase of the Mycenaean palace state or to the first phase of the subsequent small-scale Post-palatial communities in Greece. In this respect recent research has made quite some progress. Although we are still short of well-defined closed contexts of RBA 1 date in southern Italy, the vertical settlement sequence of Roca Vecchia and the uppermost deposits of the fortification ditch at Punta di Zambrone provide us with rich contexts linking an early stage of RBA 2 to the very first Post-palatial phase (LH IIIC Early 1) in Greece by means of Aegean imports and Aegean-type local products.[81] We are thus getting closer to analysing historically relevant time slices, so to speak.

On the Aegean side, the number of sites with well-stratified examples of Subapennine pottery in context with Minoan and Mycenaean ceramics is steadily growing.[82] The contribution by Eleftheria Kardamaki and Adamantia Vasilogamvrou to the present volume brings us such a new assemblage from Áyios Vassílios in Laconia and adds to the well-known material of the Menelaion further to the north in the Eurotas valley. Both find complexes belong to the time around 1200 BCE,[83] when we witness the first rise in the frequency of such Italian-related pottery in Greece. Dhimíni in coastal Thessaly is another example for that LH IIIC Early 1 phenomenon.[84] In Tiryns, the peak in the use of handmade Italian-type pottery was reached a few decades later,[85] and, indeed, according to the NAA results for Roca Vecchia and Punta di Zambrone, Argive pottery imports have so far not been verified for the earliest RBA 2 phase at these sites.[86]

One begins to get an impression of the new dynamics those seafarers from the Apennine peninsula developed in a few decades. Apparently, their ventures brought them as far as the Dodecanese, where Salvatore Vitale dates the earliest assemblage of Italian-type bronzes, a spearhead in combination with a Cetona sword (Naue II, type A) in a tomb at Kos-Langádha, to LH IIIB2 Late. For the following phases until LH IIIC Middle, he notes an increase of Italian-type objects in the

---

77 Bettelli, this volume, figs. 2.7 and 3.1–3. All three two-handled necked jars (or belly-handled amphoroid kraters) that were analysed by NAA at Bonn, belong to a specific chemical group (SybA) distinct from SybB that represents the southern plain of Sybaris. Apart from those belly-handled amphoroid kraters characteristic for Broglio (and missing at Torre Mordillo), SybA includes one Grey Ware vessel and one pithos with channelled decoration (see tab. 4 in the contribution by Jung, Guglielmino, Iacono and Mommsen, this volume) and thus most probably represents the northern part of the Sybaris plain, the region of Broglio itself.

78 Jung et al. 2015a.

79 Guglielmino, this volume.

80 Jung, Guglielmino, Iacono and Mommsen, this volume.

81 This volume: Guglielmino; Jung, Guglielmino, Iacono and Mommsen; Weninger et al. The finds from the Central Hut at Broglio di Trebisacce and from the layers of the Torre Mordillo rampart have already linked a late stage of the RBA 2 to LH IIIC Advanced (Jung 2006, 104–116, 125–134, 136–137).

82 Chaniá is the most important find place of Subapennine pottery on Crete and it is a pity that the Chaniá paper given at the Rome workshop is missing from this publication. Unfortunately, the same is true for the Achaea paper.

83 Kardamaki – Vasilogamvrou, this volume.

84 Adrimi Sismani 2014, 562–570.

85 Kilian 2007, 46, fig. 1; see now also Maran – Papadimitriou 2016, 29–31, fig. 20; 34–35, fig. 31; 50–52, fig. 70 (with some examples from the earliest LH IIIC Early horizon).

86 This is not to deny the importance of Italian contacts to the Argolid. Especially for the late palace period we have plenty of evidence suggesting the presence of people with an Italian origin including warriors at Mycenae (Jung 2018).

southeastern Aegean.[87] Vitale supports the view that the presence of warriors from Italy in this region was probably connected to pirates and these in turn to the 'Sea Peoples' of the Egyptian and Ugaritic sources. In this respect he also points to the iconographic record from the LH IIIC Early/Middle settlement of Serraglio. He further draws our attention to the destruction of Serraglio on Kos and Miletus in Asia Minor in the decades around 1200 BCE (LH IIIB–IIIC transition) as well as to the Hittite–Ahhiyawan tensions that had been mounting since the mid-thirteenth century according to Hittite written sources. His careful contextual analysis allows him to reconstruct a diachronically differentiated picture for the various micro-regions of the Dodecanese.

If we judge from the appearance of large pithoi only by RBA 2 (mainly late in that phase, see above), the settlement communities and micro-regional political-economic entities in southern Italy did not (yet) produce and store a large agricultural surplus in the decades around 1200 BCE. It is therefore understandable that they could not get access to large quantities of those goods leaving the Palatial Mycenaean workshops and travelling on the routes in the eastern Mediterranean. Raids and piracy may have offered some compensation and means for obtaining the desired products. The rather new phenomenon of fortified coastal settlements[88] on Crete, most probably starting in the later LM IIIB phases and increasing during LM IIIC along the Cretan coasts and in LH IIIC on the Aegean Islands,[89] has often been connected to the danger of sea-borne raids and piracy.

As their regular import of copper originating from the Trentino shows, we have no reason to doubt the nautical abilities of the communities inhabiting the coasts of Italy. Some portion of the exotic objects of eastern provenance in their settlements may result from pirate raids; others may have changed hands through reciprocal gift or goods exchange that was able to develop on a more equal footing once the Mycenaean palace bureaucracy was gone. Since that historical turning point, the Italian–Aegean goods exchange as well as the mobility of people did reach new levels, and the impressive rise of individual storage capacities for agricultural surplus in some southern Italian regions reveals the economic basis for that growth.[90]

Ideology

The realm of ideology is difficult to assess by archaeological means only.[91] There are indications that an ideological – most probably religious – component was of importance during those recurrent consumption practices leading to the production of the ashes that finally sealed the fortification ditch of Punta di Zambrone.[92] Due to their similar composition, certain primary deposits inside the settlements of Coppa Nevigata[93] and Roca Vecchia,[94] not far from the inner faces of their fortification walls, provide important comparative evidence. This may help us to reconstruct the rituals involved in such collective and periodic occasions of food and drink consumption that seem to have been quite common among the RBA communities of southern Italy.

The intensity of Italo–Aegean contacts growing from RBA 2 onwards is also reflected in the sphere of religious ideology, as the case of the chamber tomb cemetery at Trapeza in eastern

87 Vitale, this volume.

88 Nowicki (2018, 120) calls the sites with fortifications 'defensive', those without built fortification walls but with natural protection 'defensible'. Vokotopoulos and Michalopoulou instead (2018, 149, 164) opt for the terminological distinction 'citadels' versus 'defensible sites', but do not exclude the presence of 'poor quality fortifications' for the latter.

89 Karageorghis – Morris 2001; Schilardi 2016, 30–32, figs. 31–33; Nowicki 2018; Vokotopoulos – Michalopoulou 2018.

90 This is a different story starting about 100 years later, in the last decades of the 12th century, and lasting until the middle of the 11th (Jung – Pacciarelli 2017, 193–202).

91 For a methodological approach to prehistoric religion see among others Renfrew 1985, 11–26; Hansen 2003.

92 Jung – Pacciarelli, this volume.

93 Cazzella – Recchia, this volume.

94 Guglielmino, this volume.

Achaea shows. Elisabetta Borgna was able to identify elements among the material culture of the grave goods as well as in the funerary rituals that most probably relate to practices and religious symbols originating from the Apennine peninsula. The evidence she describes belongs to the latest Bronze Age phase of contacts between the central Mediterranean and the Aegean populations, LH IIIC Late – Submycenaean/Final Bronze Age 2.[95]

What lead the people to act the way they did? If the circumstances of their actions, the local, regional and interregional development of the societies on both sides of the Adriatic and Ionian Seas during the critical decades around 1200 BCE get better illuminated by the new data and the data analyses collected in the present volume, the publication will serve its purpose. It is hoped that it may stimulate further research into these matters.

Credits

The workshop at the ÖHI Rome that gave rise to this volume would not have been possible without the financial and organisational support of the OREA and the ÖHI institutes, and it is my pleasant duty to express my gratitude to their directors and staff for this. The FWF project 'Punta di Zambrone – a Bronze Age fortified settlement on the Tyrrhenian coast of Calabria' (project no. P23619-G19, directed by myself) also covered part of the costs. For the editing work I am grateful to Ulrike Schuh.

Finally, I would like to thank all cooperation partners and colleagues, who contributed to this volume and thus to our collective endeavour to edit the research results and to make use of the new data in the broadest possible way and from many different points of view.

Bibliography

Adrimi-Sismani 2014
Β. Αδρύμη-Σισμάνη, Ιωλκός. Η εϋκτισμένη πόλη του Ομήρου. Ένα αστικό κέντρο στο μυχό του Παγασιτικού Κόλπου. Το διοικητικό κέντρο, οι οικίες και το νεκροταφείο (Volos 2014).

Begemann et al. 2001
F. Begemann – S. Schmitt-Strecker – E. Pernicka – F. Lo Schiavo, Chemical composition and lead isotopy of copper and bronze from Nuragic Sardinia, European Journal of Archaeology 4, 2001, 43–85.

Bernabò-Brea – Cavalier 1980
L. Bernabò-Brea – M. Cavalier, L'acropoli di Lipari nella Preistoria, Meligunìs Lipára IV (Palermo 1980).

Bietak 2017
M. Bietak, Harbours and coastal military bases in Egypt in the second millennium B.C. Avaris, Peru-nefer, Pi-Ramesse, in: H. Willems – J.-M. Dahms (eds.), The Nile. Natural and Cultural Landscape in Egypt, Mainz Historical Cultural Sciences 36 (Bielefeld 2017) 53–70.

Buffa 1994
V. Buffa, I bronzi, in: R. Peroni – F. Trucco (eds.), Enotri e Micenei nella Sibaritide I. Broglio di Trebisacce (Taranto 1994) 571–574.

Buffa 2001
V. Buffa, Gli oggetti in metallo, in: F. Trucco – L. Vagnetti (eds.), Torre Mordillo 1987–1990. Le relazioni egee di una comunità protostorica della Sibaritide, Incunabula Graeca 101 (Rome 2001) 213–214.

Carancini – Peroni 1997
G. L. Carancini – R. Peroni, La koinè metallurgica, in: M. Bernabò Brea – A. Cardarelli – M. Cremaschi (eds.), Le Terramare. La più antica civiltà padana (Milan 1997) 595–601.

[95] Borgna, this volume.

Cardarelli 2015
A. Cardarelli, Different forms of social inequality in Bronze Age Italy, Origini 38, 2, 2015, 151–200.

Castagnino Berlinghieri 2003
E. F. Castagnino Berlinghieri, Il contesto archeologico sottomarino di Pignataro di Fuori. Una testimonianza diretta dell'imprenditoria mercantile eoliana nell'età del Bronzo antico, in: Istituto Italiano di Preistoria e Protostoria (ed.), Atti della XXXV Riunione Scientifica "Le comunità della preistoria italiana. Studi e ricerche sul Neolitico e le età dei metalli" in memoria di Luigi Bernabò Brea, Castello di Lipari, Chiesa di S. Caterina, 2–7 giugno 2000 (Florence 2003) 1043– 1048.

Cazzella – Recchia 2013
A. Cazzella – G. Recchia, The human factor in the transformation of southern Italian Bronze Age societies. Agency theory and Marxim reconsidered, Origini 35, 2013, 191–209.

Cicala – Pacciarelli 2017
L. Cicala – M. Pacciarelli (eds.), Centri fortificati indigeni della Calabria dalla protostoria all'età ellenistica. Atti del convegno internazionale, Napoli, 16–17 gennaio 2014, Archeologie. Temi, contesti, materiali 1 (Naples 2017).

Crispino 2016
A. Crispino, Castelluccio (Noto, Prov. di Siracusa). Nuovi dati sull'abitato, Notiziario di Preistoria e Protostoria 3, 2016, 83–86.

Devillers et al. 2015
D. Devillers – M. Brown – Ch. Morhange, Paleo-environmental evolution of the Larnaca salt lakes (Cyprus) and the relationship to second millennium BC settlement, Journal of Archaeological Science Reports 1, 2015, 73–80.

Evely 2006
D. Evely, The small finds, in: D. Evely (ed.), Lefkandi IV. The Bronze Age. The Late Helladic IIIC Settlement at Xeropolis, The British School at Athens Suppl. 39 (Athens 2006) 265–302.

Fotiadis et al. 2017
M. Fotiadis – R. Laffineur – Y. Lolos – A. Vlachopoulos (eds.), Έσπερος/Hesperos – The Aegean Seen from the West. Proceedings of the 16th International Aegaean Conference, University of Ioannina, Department of History and Archaeology, Unit of Archaeology and Art History, 18–21 May 2016, Aegaeum 41 (Leuven, Liège 2017).

Guglielmino 2003
R. Guglielmino, Il sito di Roca Vecchia. Testimonianze di contatto con l'Egeo, in: F. Lenzi (ed.), L'Archeologia dell'Adriatico dalla Preistoria al Medioevo. Atti del convegno internazionale, Ravenna, 7–8–9 giugno 2001 (Bologna 2003) 91–119.

Hansen 2003
S. Hansen, Archäologie zwischen Himmel und Hölle. Bausteine für eine theoretisch reflektierte Religionsarchäologie, in: M. Heinz – M. K. H. Eggert – U. Veit (eds.), Zwischen Erklären und Verstehen? Beiträge zu den erkenntnistheoretischen Grundlagen archäologischer Interpretation, Tübinger Archäologische Taschenbücher 2 (Münster 2003) 113–148.

Jung 2006
R. Jung, Χρονολογία comparata. Vergleichende Chronologie von Südgriechenland und Süditalien von ca. 1700/1600 bis 1000 v. u. Z., Veröffentlichungen der Mykenischen Kommission 26 (Vienna 2006).

Jung 2017
R. Jung, Chronological problems of the Middle Bronze Age in southern Italy, in: Th. Lachenal – C. Mordant – Th. Nicolas – C. Véber (eds.), Le Bronze moyen et l'origine du Bronze final en Europe occidentale (XVIIe–XIIIe siècle av. J.-C.). Colloque international de l'APRAB, Strasbourg, 17 au 20 juin 2014, Mémoires d'Archéologie du Grand-Est 1 (Strasbourg 2017) 621–642.

Jung 2018
R. Jung, Push and pull factors of the Sea Peoples between Italy and the Levant, in: J. Driessen (ed.), An Archaeology of Forced Migration. Crisis-induced Mobility and the Collapse of the 13th c. BCE Eastern Mediterranean, Aegis 15 (Louvain-la-Neuve 2018) 273–306.

Jung – Mehofer 2013
R. Jung – M. Mehofer, Mycenaean Greece and Bronze Age Italy. Cooperation, trade or war? Archäologisches Korrespondenzblatt 43, 2013, 175–193.

Jung – Pacciarelli 2017
R. Jung – M. Pacciarelli, Greece and southern Italy 1250–1050 BCE. Manifold patterns of interaction, in: Fotiadis et al. 2017, 185–204.

Jung et al. 2011
R. Jung – M. Mehofer – E. Pernicka, Metal exchange in Italy from the Middle to the Final Bronze Age (14th–11th cent. BCE), in: Ph. P. Betancourt – S. C. Ferrence (eds.), Metallurgy. Understanding How, Learning Why. Studies in Honor of James D. Muhly, Prehistory Monographs 29 (Philadelphia 2011) 231–248.

Jung et al. 2015a
R. Jung – M. Pacciarelli – B. Zach – M. Klee – U. Thanheiser, Punta di Zambrone (Calabria) – a Bronze Age harbour site. First preliminary report on the Recent Bronze Age (2011–2012 campaigns), Archaeologia Austriaca 99, 2015, 53–110.

Jung et al. 2015b
R. Jung – H. Mommsen – M. Pacciarelli, From West to West. Determining production regions of Mycenaean pottery of Punta di Zambrone (Calabria, Italy), Journal of Archaeological Science Reports 3, 2015, 455–463.

Jung et al. in press
R. Jung – M. Mehofer – E. Pernicka, Metal exchange in Bronze Age Italy. The Final Bronze Age hoards from Roca Vecchia, Apulia, in: R. Guglielmino – F. Iacono (eds.), Roca. A Bronze Age Port on the Adriatic Sea. Aegean Type Pottery and Late Bronze Age Sequence of Area IX (in press).

Karageorghis – Morris 2001
V. Karageorghis – Ch. E. Morris (eds.), Defensive Settlements of the Aegean and the Eastern Mediterranean After c. 1200 B.C. (Nicosia 2001).

Kilian 2007
K. Kilian, Die handgemachte geglättete Keramik mykenischer Zeitstellung, Tiryns XV (Wiesbaden 2007).

Knapp 2018
A. B. Knapp, Seafaring and Seafarers in the Bronze Age Eastern Mediterranean (Leiden 2018). Online <https://www.sidestone.com/bookviewer/9789088905544> (last accessed 15 Apr 2020).

Levi 1999
S. T. Levi, Produzione e circolazione della ceramica nella Sibaritide protostorica I. Impasto e dolii, Prima di Sibari 1, Grandi contesti e problemi della Protostoria italiana 1 (Florence 1999).

Levi – Jones 1999
S. T. Levi – R. E. Jones, Dolii al di fuori della Sibaritide, in: Levi 1999, 108–113.

Levi et al. 1999
S. T. Levi – R. E. Jones – M. Sonnino, La circolazione dei vasi nella Sibaritide (e fuoir di essa), in: Levi 1999, 228–232.

Levi et al. 2006
S. T. Levi – M. Sonnino – R. E. Jones, Eppur si muove … Problematiche e risultati delle indagini sulla circolazione della ceramica dell'età del bronzo in Italia, in: Istituto Italiano di Preistoria e Protostoria (ed.), Atti della XXXIX Riunione Scientifica "Materie prime e scambi nella preistoria italiana", Firenze, 25–27 novembre 2004 (Florence 2006) 1093–1111.

Levi et al. 2017
S. T. Levi – A. Vanzetti – E. De Miro, Cannatello, Sicily. The connective history of the LBA central Mediterranean hub, in: Fotiadis et al. 2017, 123–129.

Lo Schiavo 2009
F. Lo Schiavo, Oxhide ingots in Nuragic Sardinia, in: F. Lo Schiavo – J. D. Muhly – R. Maddin – A. Giumlia-Mair (eds.), The oxhide Ingots in the Central Mediterranean, Biblioteca di Antichità Cipriote 8 (Rome 2009) 225–390.

Lo Schiavo et al. 2009
F. Lo Schiavo – R. M. Albanese Procelli – A. Giumlia-Mair, Oxhide ingots in Sicily, in: F. Lo Schiavo – J. D. Muhly – R. Maddin – A. Giumlia-Mair (eds.), Oxhide Ingots in the Central Mediterranean, Biblioteca di Antichità Cipriote 8 (Rome 2009) 135–221.

Luppino et al. 2005
S. Luppino – R. Peroni – A. Vanzetti, Broglio di Trebisacce, campagna 2004, in: Tramonto della Magna Grecia. Atti del XLIV Convegno di Studi sulla Magna Grecia, Taranto 24–28 settembre 2004 (Taranto 2005) 729–731.

Macnamara 1970
E. Macnamara, A group of bronzes from Surbo. New evidence for Aegean contacts with Apulia during Mycenaean IIIB and C, Proceedings of the Prehistoric Society 36, 1970, 241–260.

Maggiulli 2007
G. Maggiulli, I manufatto metallici, contribution in: C. Pagliara – G. Maggiulli – T. Scarano – C. Pino – R. Guglielmino – J. De Grossi Mazzorin – M. Rugge – G. Fiorentino – M. Primavera – L. Calcagnile – M. D'Elia – G. Quarta, La sequenza cronostratigrafica delle fasi di occupazione dell'insediamento protostorico di Roca (Melendugno, Lecce). Relazione preliminare della campagna di scavo 2005 – Saggio SAS X, Rivista di Scienze Preistoriche 57, 2007, 311–362.

Maggiulli 2017
G. Maggiulli, I manufatti metallici dai livelli dell'età del Bronzo del SAS IX di Roca (LE), in: Radina 2017, 977–982.

Maran – Papadimitriou 2016
J. Maran – A. Papadimitriou, Gegen den Strom der Geschichte. Die nördliche Unterstadt von Tiryns: ein gescheitertes Urbanisierungsprojekt der mykenischen Nachpalastzeit, Archäologischer Anzeiger 2016/2, 19–118.

Marazzi – Tusa
M. Marazzi – S. Tusa, Die mykenische Penetration im westlichen Mittelmeerraum, Klio 61, 1979, 309–351.

Marriner et al. 2006
N. Marriner – Ch. Morhange – C. Doumet-Serhal – P. Carbonel, Geoscience rediscovers Phoenicia's buried harbors, Geology 34, 2006, 1–4.

Martinelli 2010
M. C. Martinelli, Archeologia delle Isole Eolie. Il villaggio dell'età del Bronzo medio di Portella a Salina. Ricerche 2006 e 2008 (Milazzo 2010) 165–171.

Marx 1852 [1960]
K. Marx, Der 18te Brumaire des Louis Bonaparte [first published 1852], Marx-Engels Werke 8 (Berlin 1960) 111–207.

Marx 1857 [1983]
K. Marx, Einleitung zu den „Grundrissen der Kritik der politischen Ökonomie" [first published 1857]), Marx-Engels Werke 42 (Berlin 1983) 15–45.

Marx 1867/1890 [1962]
K. Marx, Das Kapital. Kritik der politischen Ökonomie. Erster Band. Der Produktionsprozess des Kapitals [first published 1867/1890], Marx-Engels Werke 23 (Berlin 1962).

Marx 1894 [1964]
K. Marx, Das Kapital. Kritik der politischen Ökonomie. Dritter Band. Der Gesamtprozess der kapitalistischen Produktion [first published 1894], Marx-Engels Werke 25 (Berlin 1962).

Meller et al. 2018
H. Meller – D. Gronenborn – R. Risch (eds.), Überschuss ohne Staat. Politische Formen in der Vorgeschichte. 10. Mitteldeutscher Archäologentag vom 19. bis 21. Oktober 2017 in Halle (Saale) / Surplus without the State. Political Forms in Prehistory. 10th Archaeological Conference of Central Germany, October 19–21, 2017 in Halle (Saale), Tagungen des Landesmuseums für Vorgeschichte Halle 18 (Halle [Saale] 2018).

Moscetta 1988:
M. P. Moscetta, Il ripostiglio di Lipari. Nuove considerazioni per un inquadramento cronologico e culturale, Dialoghi di Archeologia 6, 1988, 53–78

Nowicki 2018
K. Nowicki, The late 13th c. BCE crisis in the East Mediterranean, in: J. Driessen (ed.), An Archaeology of Forced Migration. Crisis-induced Mobility and the Collapse of the 13th c. BCE Eastern Mediterranean, Aegis 15 (Louvain-la-Neuve 2018) 117–148.

Pacciarelli 2000
M. Pacciarelli, Dal villaggio alla città. La svolta protourbana del 1000 a.C. nell'Italia tirrenica, Grandi contesti e problemi della Protostoria italiana 4 (Florence 2000).

Pacciarelli 2011
M. Pacciarelli, L'Eneolitico della Calabria tirrenica. Nuovi dati sull'articolazione cronoculturale, Origini 33, 2011, 249–302.

Pacciarelli 2018
M. Pacciarelli, Le origini dell'Ausonio I, in: M. Bernabò Brea – M. Cultraro – M. Gras – M.C. Martinelli – C. Pouzadoux – U. Spigo (eds.), A Madeleine Cavalier (Naples 2018) 141–162.

Pacciarelli – Varricchio 1991–1992
M. Pacciarelli – M. R. Varricchio, Il promontorio di Tropea (Catanzaro). 1. Le facies archeologiche. 2. L'organizzazione del territorio, Rassegna di Archeologia 10, 1991–1992, 756–759.

Pagliara 2005
C. Pagliara, Rocavecchia (Lecce) Il sito, le fortificazioni e l'abitato dell'età del Bronzo, in: R. Laffineur – E. Greco (eds.), Emporia. Aegeans in Central and Eastern Mediterranean. Proceedings of the 10th International Aegean Conference / 10e Rencontre égéenne internationale, Athens, Italian School of Archaeology, 14–18 April 2004, Aegaeum 25 (Liège 2005) 629–635.

Pare 2013
Ch. Pare, Weighing, commodification, and money, in: H. Fokkens – A. Harding (eds.), The Oxford Handbook of the European Bronze Age (Oxford 2013) 508–527.

Peroni 1969
R. Peroni, Per uno studio dell'economia di scambio in Italia nel quadro dell'ambiente culturale dei secoli intorno al mille a.C., La Parola del Passato 125, 1969, 134–160.

Peroni 1996
R. Peroni, L'Italia alle soglie della storia (Rome, Bari 1996).

Radina 2017
F. Radina (ed.), Preistoria e Protostoria della Puglia, Studi di Preistoria e Protostoria 4 (Florence 2017).

Renfrew 1985
C. Renfrew, The Archaeology of Cult. The Sanctuary at Phylakopi, The British School at Athens Suppl. 18 (Athens 1985).

Scarano et al. 2017
T. Scarano – R. Auriemma – C. Alfonso, Approccio geoarcheologico per la ricostruzione dei paesaggi costieri e delle dinamiche insediative nel Salento del II millennio a.C., in: Radina 2017, 959–964.

Schiappelli 2015
A. Schiappelli, Along the routes of pithoi in the Late Bronze Age, in: A. Babbi – F. Bubenheimer-Erhart – B. Marín-Aguilera – S. Mühl (eds), The Mediterranean Mirror. Cultural Contacts in the Mediterranean Sea between 1200 and 750 B.C. (Mainz 2015) 231–243.

Schilardi 2016
Δ. Σχιλάρντι, Κουκουναριές Πάρου. Οι ανασκαφές και η ιστορία της πανάρχαιης ακρόπολης του Αιγαίου (Athens 2016).

Tronchère et al. 2008
H. Tronchère – F. Salomon – Y. Callot – J.-Ph. Goiran – L. Schmitt – I. Forstner-Müller – M. Bietak, Geoarchaeology of Avaris. First results, Ägypten & Levante 18, 2008, 327–339.

Tronchère et al. 2012
H. Tronchère – J.-Ph. Goiran – L. Schmitt – F. Preusser – M. Bietak – I. Forstner-Müller – Y. Callot, Geoarchaeology of an ancient fluvial harbor. Avaris and the Pelusiac branch (Nile River, Egypt), Géomorphologie: Relief, Processus, Environnement 18, 2012, 23–36.

Vokotopoulos – Michalopoulou 2018
L. Vokotopoulos – S. Michalopoulou, Megali Koryphi and the Aegean citadels of the 13th/12th c. BCE, in: J. Driessen (ed.), An Archaeology of Forced Migration. Crisis-induced Mobility and the Collapse of the 13th c. BCE Eastern Mediterranean, Aegis 15 (Louvain-la-Neuve 2018) 149–175.

von Hase 1990
F.-W. von Hase, Ägäische Importe im zentralen Mittelmeergebiet in späthelladischer Zeit (SH I–SH IIIC), in: Orientalisch-ägäische Einflüsse in der europäischen Bronzezeit. Ergebnisse eines Kolloquiums, Römisch-Germanisches Zentralmuseum, Forschungsinstitut für Vor- und Frühgeschichte Monographien 15 (Bonn 1990) 80–108.

Weninger – Jung 2009
B. Weninger – R. Jung, Absolute chronology of the end of the Aegean Bronze Age, in: S. Deger-Jalkotzy – A. Bächle (eds.), LH IIIC Chronology and Synchronisms III. LH IIIC Late and the Transition to the Early Iron Age. Proceedings of the International Workshop at the Austrian Academy of Sciences at Vienna, February 23rd and 24th, 2007, Veröffentlichungen der Mykenischen Kommission 30 (Vienna 2009) 373–416.

Zanger et al. 1997
E. Zanger – M. E. Timpson – S. B. Yazvenko – F. Kuhnke – J. Knauss, The Pylos Regional Archaeological Project. Part II: landscape evolution and site preservation, Hesperia 66, 1997, 549–641.

Section 1: Punta di Zambrone

Topography and Geomorphodynamics of Punta di Zambrone

Anja Buhlke[1]

Abstract: Due to the exposed location of Cape Punta di Zambrone, many abrasive processes take place here. The geological subsoil – situated in a rupture zone – with its vegetation, the Tyrrhenian Sea and weather phenomena form a constantly changing surface. Topographical surveys and observations in the field have led to the conclusion that the settlement area on the cape has decreased since the Bronze Age. However, the extent of this phenomenon over the last 3000 years cannot be exactly determined.

Keywords: abrasive processes,erosion,settlement area, topographical survey, weathering

The Bronze Age settlement area of Punta di Zambrone is located on the cape of the same name. The headland – also referred to as Capo Cozzo – forms part of the lowest level of Pleistocene terraces on the Poro peninsula. With a south–east/north–west span of c. 220m and an elevation of 30m to 40m, the cape forms a marked interruption in a section of coastline that runs mainly south–west/north–east. To the south, Punta di Zambrone borders a 400m-wide alluvial plain. Towards the northeast, the outcrop merges into a cliff line with a narrow sandy beach. When viewed from above, the rock formation, which narrows to the northwest, appears to meander slightly (Fig. 1). With inclines of between 45 and 82, its slopes are very steep, and the region of Punta di Zambrone that protrudes into the Tyrrhenian Sea is particularly craggy. Here, the cliff is still c. 170m wide with an elevation of between 30m and 40m above sea-level. The highest point of the cliff coincides with a c. 30m to 40m-wide seam containing a small number of seastacks. Continuing, the cape's form resembles that of four flat fingers that curl to the west (Figs. 2–3).

The lack of a sufficiently detailed, three-dimensional map of the area for research purposes necessitated a completely new topographical survey of Punta di Zambrone. This was undertaken in 2011 and 2012, based on polar mapping with a total station and a reflector. All geomorphometrically relevant points were surveyed, and for this, as much terrain as possible had to be covered. However, on the seastacks and steep coastal slopes (covered with the dense vegetation of, among other plants, Opuntia cacti, agaves and macchia) this was not possible, and here, reflectorless calibration was employed. This exhaustive fieldwork revealed that the cape was essentially composed of granite. However, the previously described fanned spur at the western tip of the cape consists of sandstone: a typical result of the advanced weathering of granite.[2] Indeed, when climbing the exposed areas of the steep coastal slopes, a generally high degree of weathering on a scale of 3 to 5[3] was observed. Granite slabs often broke under hand pressure and iron nails penetrated the rock quite easily. These findings would suggest a reduction in the size of the cape since the Bronze Age.

But how much land has been lost in the last 3000 years? Punta di Zambrone is part of a coastal landscape shaped by the effects of weathering, erosion and abrasion. Weathering is the effect of complex atmospheric processes on rock, but is difficult to quantify. The intensity of weathering on rock in any one place depends on several factors: the specific resistance of the

1 Dipl.-Ing. für Ausgrabungstechnik und Kartographie, Toblacher Str. 32, 13187 Berlin, Germany; info@anjabuhlke.de.

2 Kelletat 1973, 146–147.

3 Ahnert 2009, 74.

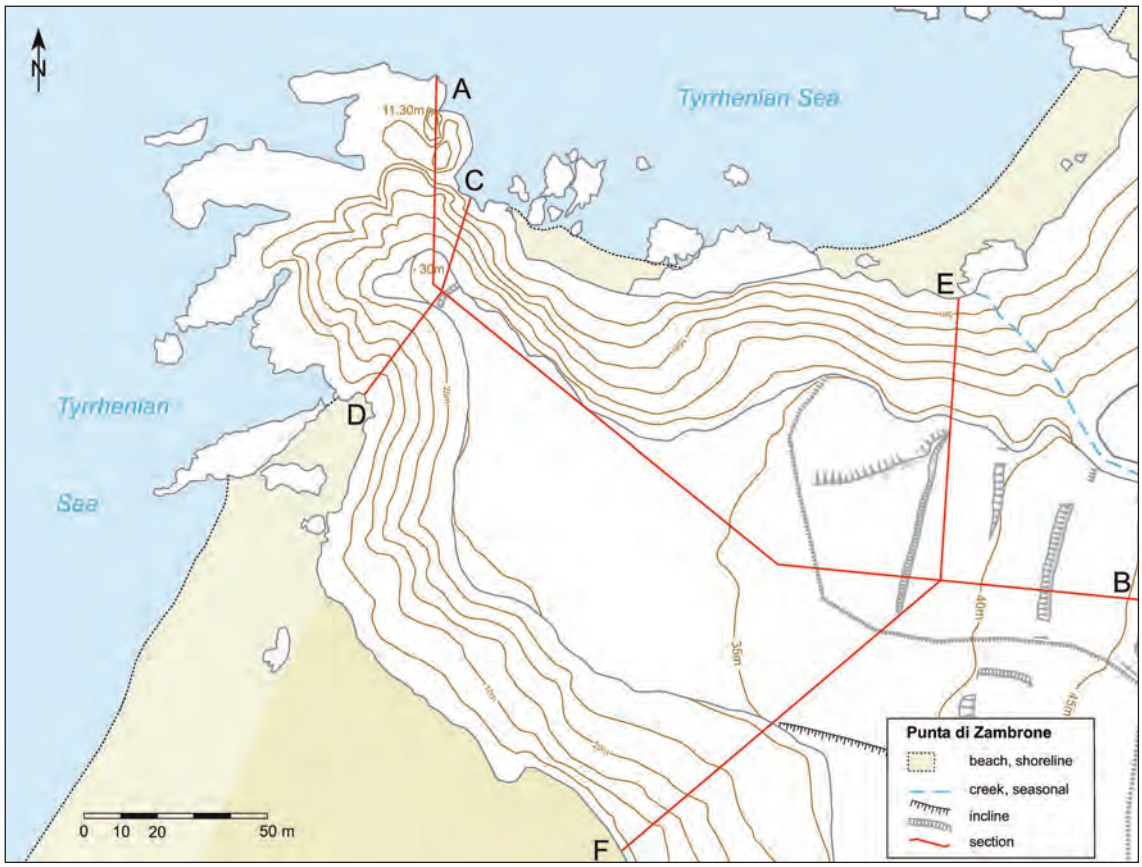


Fig. 1 Capo Cozzo, top view, positions of vertical sections (drawing: A. Buhlke)

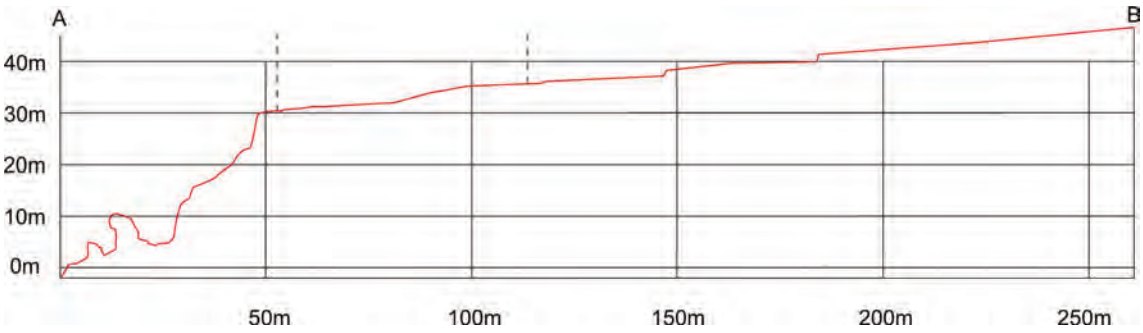


Fig. 2 Capo Cozzo, vertical section 1, longitudinal section (drawing: A. Buhlke)

rock (i.e. its physical strength as well as its chemical and mineralogical composition), the climate and the degree of sensitivity of the rock to atmospheric influence. In these respects, there has been no sampling, test series or any long-term observation of the geology of Capo Cozzo. Nevertheless, it is possible to verify certain tendencies regarding the intensity of the weathering processes at work here.

The components of plutonic granite (quartz, biotite and feldspar) are among the hardest and most resistant to chemical weathering. On the other hand, this mostly coarse-grained granite is porous and thus very susceptible to mechanical (physical) weathering, its structure being traversed by many crevices and fissures connected with its genesis. Moreover, direct sunlight and subsequent night-time cooling generate thermic change in the volume of the rock's crystalline structure. The subsequent loosening of the rock fabric, owing to the disordered directional positions of the crystalline axes, allows moisture to penetrate, resulting in hydrolysis of the feldspar

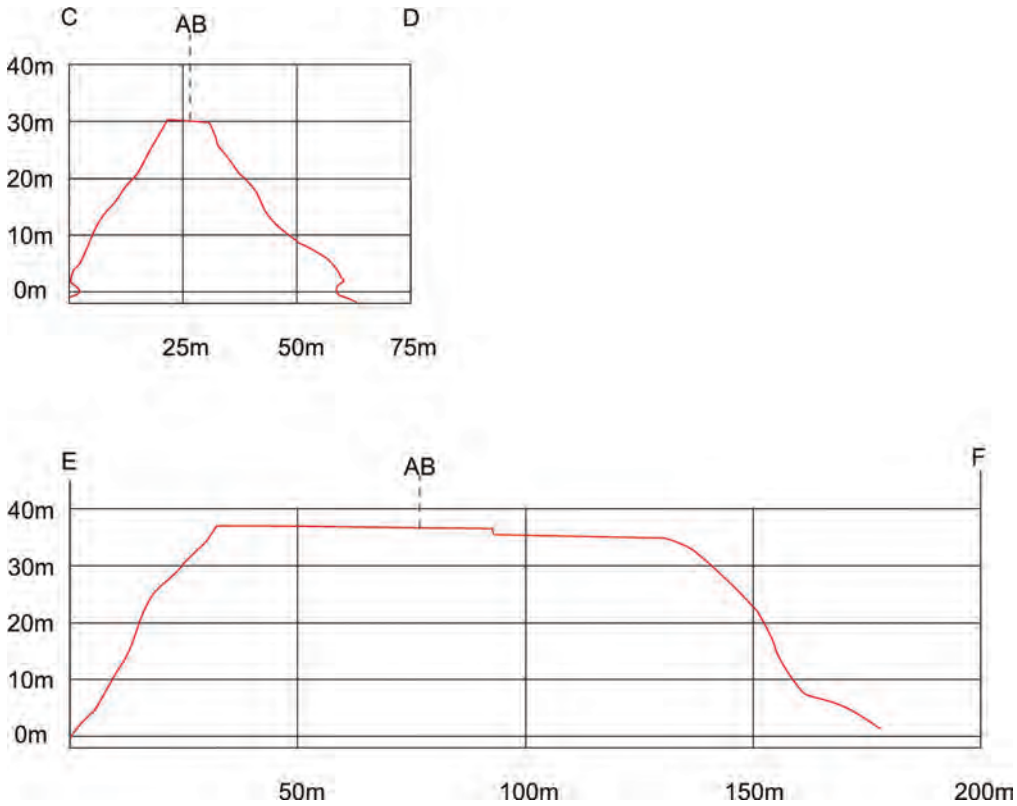


Fig. 3 Capo Cozzo, vertical section 2 and 3, cross sections (drawing: A. Buhlke)

and oxidation of the biotite – reactions which benefit from higher ambient temperatures.[4] In a coastal environment, such as Punta di Zambrone, additional salt weathering will occur through precipitation of salt crystals in the rock fissures. Measurements have revealed that, compared to bare rocks, the rate of weathering on surfaces covered with moisture-retentive vegetation cover is three times higher.[5] Indeed, the slopes of Capo Cozzo in the region of the compact cliffs are densely overgrown. A combination of its location and the prevailing maritime climate offer favourable conditions for weathering processes, which have resulted in structures characteristic of woolsack weathering. Metric data on the loss of substance are rarely found in scientific literature, but measurements do exist on the sediment loss of, for example, gravestones, buildings and a limited number of exposed steep slopes. In these cases, the degradation of rock varies from 0.04mm to 0.2mm/p.a. for granite and 10mm to 25mm/p.a. for sandstone.[6] Nonetheless, these figures illustrate only one aspect of weathering. If, considering all weathering processes, we were to assume a loss of 1mm/p.a. for Punta di Zambrone, this would equate to an inland displacement of the coastline of 3m over a 3000-year period, or a loss of 1600m² of settlement area (Fig. 4).

If we factor in the influence of the Tyrrhenian Sea, the exposed location of Capo Cozzo is certainly suggestive of a higher rate of erosion. The predominant current flow from south to north along this section of coastline[7] accounts for the shape of the headland and especially the formation of its 'fingers'. Also, the undercutting of the coast, once on both the southern and northern slopes, is a result of contact with a fierce surf. Moving north, the current flows around the tip of the cape, subsequently causing turbulence in the northern bay. This is a fundamental phenomenon of abrasion

4 Ahnert 2009, 61.
5 Ahnert 2009, 74.
6 Dachroth 2002, 160.
7 Wave energy can reach up to 3 sm/h here. Kelletat 2002, 151–152.

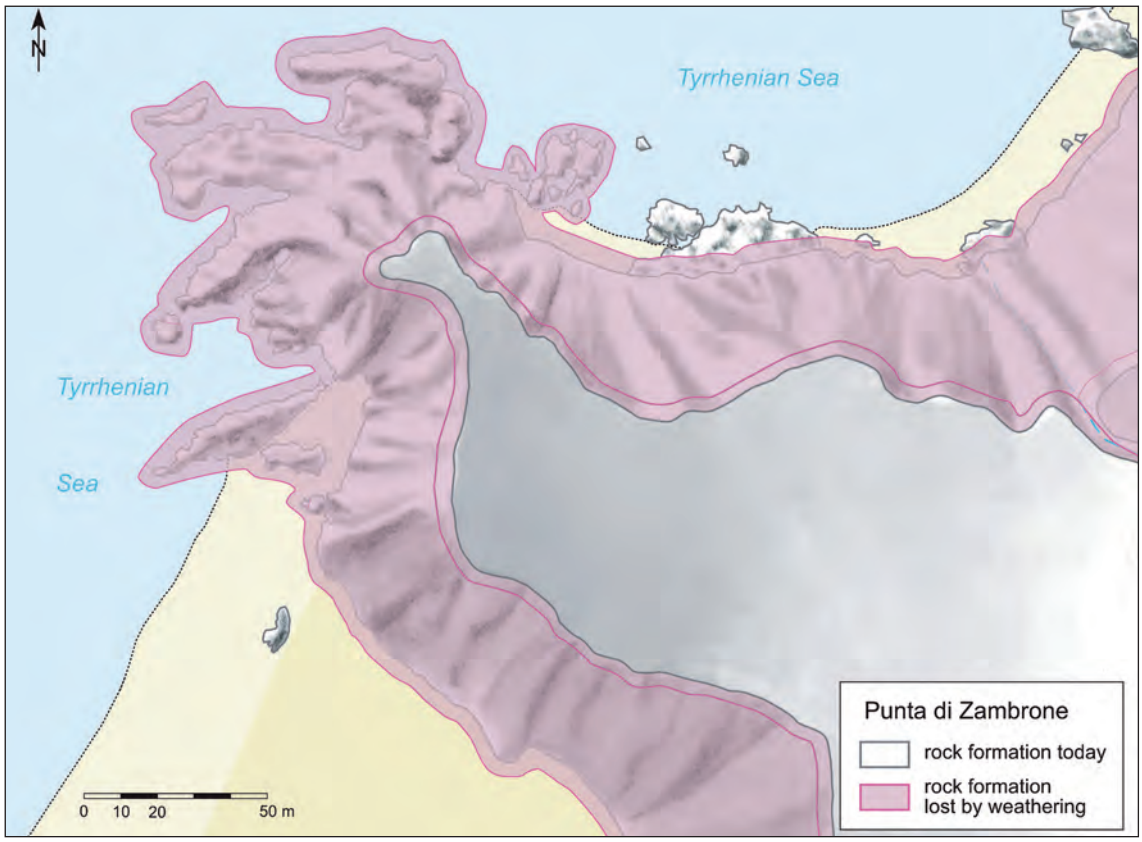


Fig. 4 Capo Cozzo, landmass possibly lost by weathering (drawing: A. Buhlke)

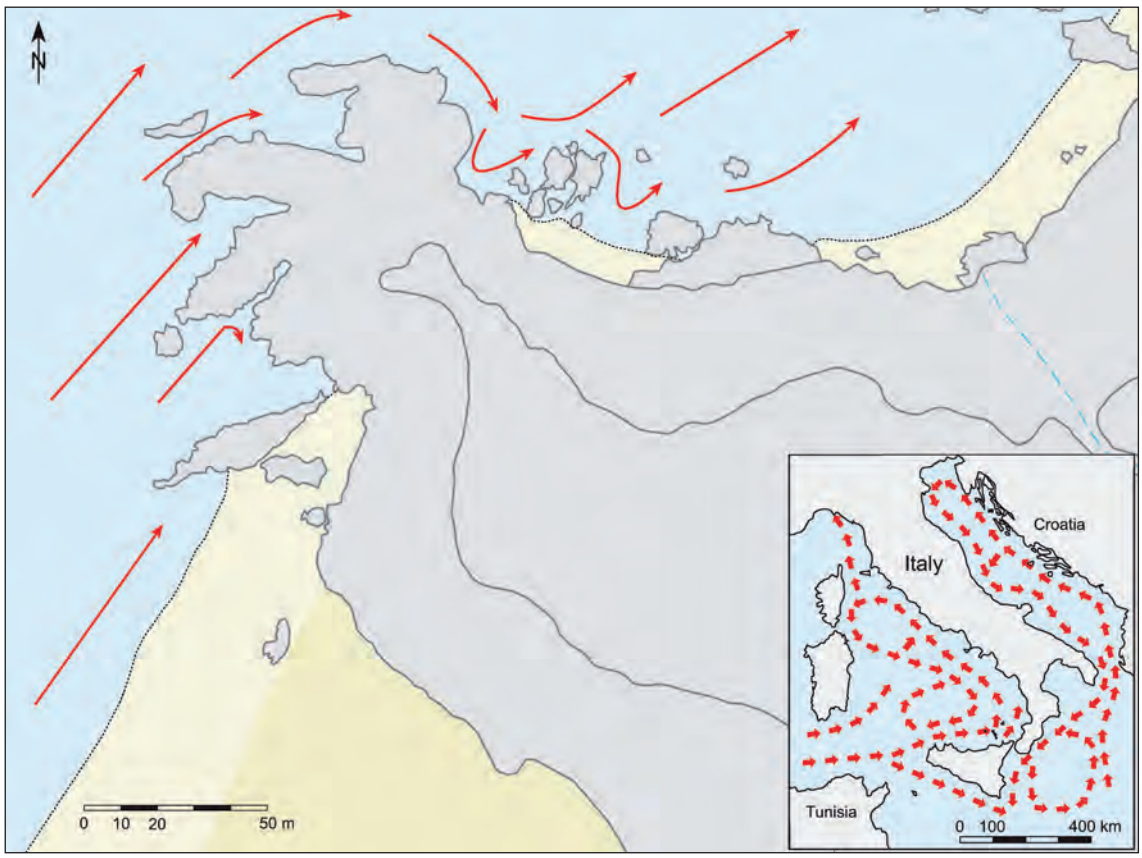


Fig. 5 Sea currents in the area of Capo Cozzo (drawing: A. Buhlke)

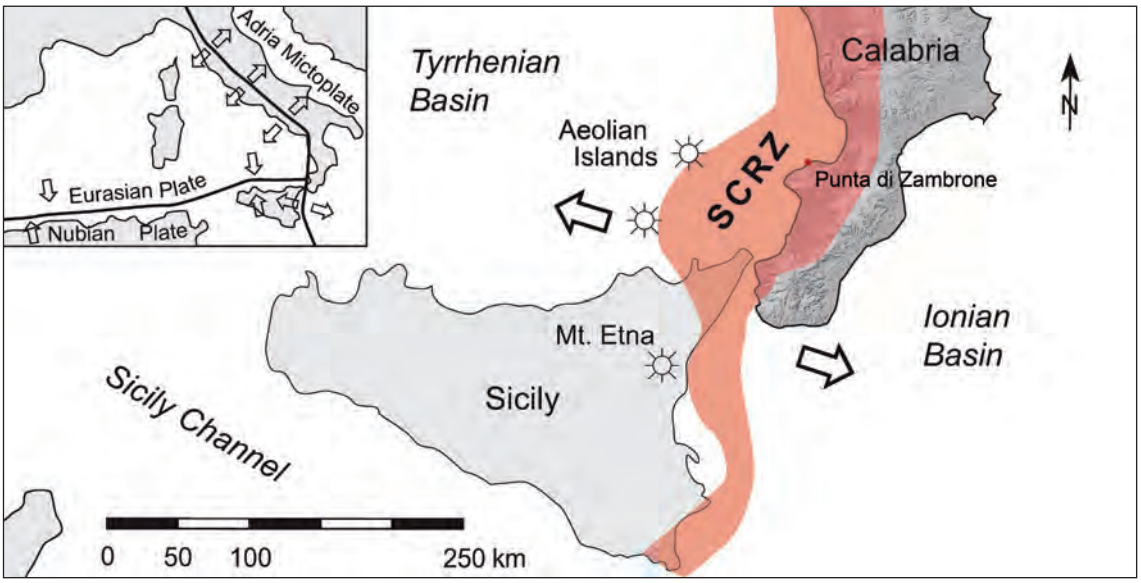


Fig. 6 Siculo-Calabrian Rift Zone (SCRZ) (drawing: A. Buhlke)

coastlines and the basis for the formation of overhangs, which eventually collapse resulting in substantial loss of land (Fig. 5).

The Poro peninsula is situated in the middle of the 'Siculo Calabrian Rift Zone' (SCRZ)[8], a region noted for frequent seismic activity and tsunamis. It can be reasonably assumed that strong earthquakes observed in the region (Tab. 1) have influenced and continue to impact the stability of the rock mass of Capo Cozzo. The appearance of rock fractures immediately after tremors of magnitude 7 and above on the Richter scale have been documented.[9] To date, the north bay is severely affected by rockfall, and indeed, during field work from 2011 to 2013, small landslides and rockfalls occurred.

An alternative method of tracking changes in the form of a landmass involves, in some cases, the use of historical maps. Since the beginning of compass navigation in the thirteenth century right up to the early nineteenth century, the most common form of cartography was the creation of portolan charts. In the Mediterranean region, these were characteristically rather small-scale

Date	Me	Location
1638 03 27	7	Calabria / Briatico
1659 11 05	6.6	Calabria centrale
1693 01 11	7.4	Sicilia orientale
1783 02 05	7	Calabria / Briatico
1783 02 07	6.6	Calabria / Briatico
1783 03 28	7	Calabria / Briatico
1894 11 16	6.1	Calabria meridionale
1905 09 08	6.7	Calabria / Briatico
1908 12 28	7.1	Calabria meridionale – Messina

Tab. 1 Selected earthquakes in the region above magnitude 6 on the Richter scale. INGV (Instituto Nazionale di Geofisica e Vulcanologia) 2016. Online <https://emidius.mi.ingv.it/CPTI15-DBMI15/query_eq> (last accessed 15 Apr. 2020)

8 Morelli 2008, 105.

9 Dachroth 2002, 138.

coastal maps, which were mostly plotted by private scholars. These maps portray very exact and detailed coastlines, but clearly exhibit distortion of measurement between each other. Great effort was put into the most realistic reproduction of the coastline and an exact positional reference. However, a lack of map projection together with an ignorance of the discrepancy between



Fig. 7 Map section from J.-B. Nolin, Le Royaume de Naples, 1:1,100,000, A. H. Jaillot (ed.), 1706. Online <https://www.mapy.mzk.cz/mzk03/001/063/067/2619269160/> (last accessed 28 Nov. 2016)

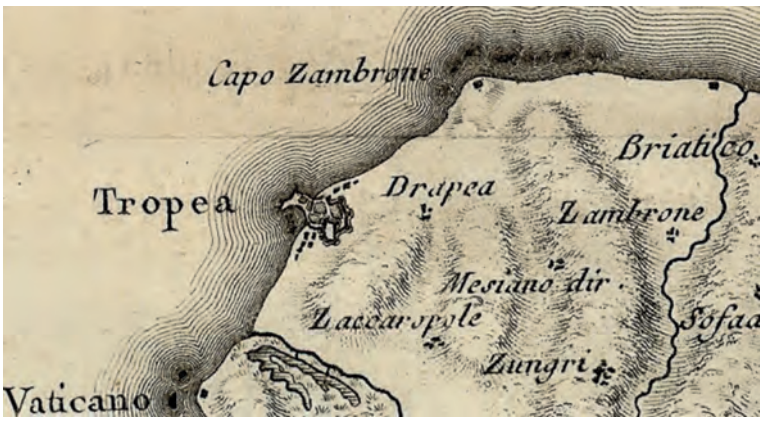


Fig. 8 Map section from G.-A. Rizzi Zannoni, Calabria, Messina Stretto, 1:411,000, 1769. Online <https://www.mapsandimages.it/eMaps/autore.htm?idAut=470> (last accessed 28 Nov. 2016)



Fig. 9 Map section from G.-A. Rizzi Zannoni, No. 30 (Tropea, Palmi, Squillace, Stilo), 1:114,000, 1788, to accompany: Atlante geografico del regno di Napoli 1808, G. Guerra (ed.), 1808. Online <https://www.davidrumsey.com> (last accessed 28 Nov. 2016)



Fig. 10 Map section from G. M. Cassini, La Calabria citeriore, Calcografia Camerale (Roma) (ed.), 1:540,000, 1790. Online <https://www.maps.bpl.org/id/14629> (last accessed 27 Nov. 2016)



Fig. 11 Map section from A. Stieler, Süd-Italien im Maßstabe von 1:1,850,000. Von A. Petermann. Gez. von H. Habenicht. Gest. v. A. Hanemann, Terrain v. C. Jungmann. Gotha: Justus Perthes 1874



Fig. 12 Map section from Istituto Geografico Militare (IGM), Carta Topografica della Calabria, F. 241 Nicastro, 1:100,000, 1926



Fig. 13 Map section from Centro Cartografico Regionale Calabria, Carta tecnica regionale della Calabria, F. 241III S.O. D, 1:10,000, 1954

magnetic and true north resulted in the assimilation of slight errors and inaccuracies. At the end of the eighteenth century, newly available instruments and surveying techniques married to the requirements of the military and state facilitated the production of precise topographical land surveys, and the first state-funded atlases of complete state territories emerged. In Italy, the work of Giovanni Antonio Rizzi Zannoni was preeminent. His 'Atlante Geografico del Regno di Napoli' dates from 1794 to 1812. The atlas is comprised of six sheet maps that cover Calabria on a scale of 1:114,545. Compared to earlier cartographic works, we can observe a clear and continuing increase in accuracy and detail density (Figs. 7–13). Nevertheless, the first large-scale detailed maps of Capo Cozzo only became available after the Second World War. In an important innovation for state-wide survey, the application of aerial photography emerged as the basis of cartographic production. From this point in time, it became possible, on a large scale, to record smaller changes in the landscape over narrow intervals of time.

Since the end of the eighteenth century, Punta di Zambrone has appeared on maps mainly in the form of a rather ill-defined, semi-circular coastal headland. From these historical sources, it is not possible to quantitatively assess the effects of coastal erosion. Interestingly, up to around 1870, most cartographers denoted small islands off the cape's coast. Today however, only a rock with dimensions of 20m × 25m is found offshore in the north bay of Punta di Zambrone.

In recent times, the topography of Capo Cozzo has also been influenced by man. An attempt was made in the 1950s to utilise the plateau agriculturally, resulting in the terracing of its hitherto uniform slope gradient and ploughing to a depth of c. 80cm. Moreover, a private plot with a house is located on the nearly narrowest point of the southwestern part of the cape. Its enclosed garden, which has been planted with trees, has been uniformly levelled and lies up to 1m lower than the northeastern area of the cape. These measures have been extremely damaging to the archaeological monument and only contexts deeply embedded in the rock, such as defensive ditches, have survived.

In summary, it can be stated that Punta di Zambrone is subject to considerable (non-continuous and therefore quantifiable) abrasive processes. The Bronze Age settlement area has partly been lost to weathering and erosion of the subsurface, to which it is still highly vulnerable. If we speculate that the cape originally assumed the complete area of today's visible (and submerged) rock, then about half of the total rock mass has been heavily eroded. The area thereof that was utilised for settlement activity in the Bronze Age remains uncertain.

Bibliography

Ahnert 2009
F. Ahnert, Einführung in die Geomorphologie (Stuttgart 2009).

Dachroth 2002
W. Dachroth, Handbuch der Baugeologie und Geotechnik (Berlin, Heidelberg 2002).

Kelletat 1973
D. Kelletat, Quartärmorphologische Untersuchungen an den Küsten der M. Poro-Halbinsel, Westkalabrien. Beiträge zur regionalen Küstenmorphologie des Mittelmeerraumes III, Eiszeitalter und Gegenwart 23/24, 1973, 141–153.

Morelli 2008
D. Morelli, La Cartografia Marina. Ricerche ed applicazioni orientata ai rischi geologico-ambientali in aree campinoe (PhD Diss., Scienze ambientali ambiente fisico, marino e costiero, XX ciclo, Università degli Studi di Trieste, Dipartimento di Scienze Geologiche Ambientale Marine, Trieste 2008).

Geophysical Prospection and Verification at the Protohistoric Settlement of Punta di Zambrone (Calabria, Italy)

Burkart Ullrich[1] *– Wieke de Neef*[2] *– Anja Buhlke*[3] *– Rudolf Kniess*[4]

Abstract: A multi-method geophysical survey was executed prior to archaeological excavations at Punta di Zambrone, Calabria, Italy. Magnetometry, ground penetrating radar and electrical resistivity tomography were applied under varying survey conditions in different parts of the promontory with the aim of mapping protohistoric traces at different burial depths. In this chapter we summarise the geophysical surveys and compare the results with observations made during the subsequent excavations of the defensive moat of the Bronze Age settlement.

Keywords: Geophysical prospection, magnetometry, ground penetrating radar, electrical resistivity tomography, archaeological interpretation, Bronze Age

Geophysical Surveys

Introduction

Prior to the excavations at Punta di Zambrone, geophysical surveys were conducted to establish the presence and character of archaeological features within the protohistoric settlement. All accessible areas on the promontory were subjected to magnetometer prospection; selected areas of special interest were investigated by ground penetrating radar (GPR) and electrical resistivity tomography (ERT, Fig. 1). In this paper we will discuss the applied methods, data collecting and processing routines, and results of the geophysical surveys.

The natural slope on the promontory is altered by several artificial terrace walls of 1.0–1.5m in height, constructed from local granite blocks. Soil accumulation behind these walls and deflation at the terrace bases potentially affect the preservation and detectability of archaeological features. The terrace surfaces are relatively flat and have few obstacles, except for some trees and shrubs. Access to the survey areas in the western part of the promontory was impeded by trees and the metal fence of a private property. The investigated area is demarcated in the east by a north–south-running railway track and in the north by a small creek along the steep coastline.

Methods and Techniques

Magnetometry uses the anomalous magnetic properties of objects and deposits within the Earth's magnetic field to detect near-surface features. In Punta di Zambrone we used magnetic gradiometers, which measure the difference in the vertical component of the magnetic field between two vertically stacked sensors. The measurements reveal small variations of a few nanoTesla (nT) in the c. 40,000nT of the Earth's magnetic field. The values of these variations provide a scale for the

[1] Eastern Atlas GmbH & Co. KG, Berliner Str. 69, 13189 Berlin, Germany; b.ullrich@eastern-atlas.com.
[2] Ghent University, Department of Archaeology, St-Pietersnieuwstraat 35, 9000 Ghent, Belgium; wieke.deneef@ugent.be.
[3] Dipl.-Ing. für Kartographie und Ausgrabungstechnik, Toblacher Str. 32, 13187 Berlin; info@anjabuhlke.de.
[4] Eastern Atlas GmbH & Co. KG, Berliner Str. 69, 13189 Berlin, Germany; r.kniess@eastern-atlas.com.

intensity and burial depth of local anomalous features. The magnetic survey was conducted with six Foerster FEREX fluxgate gradiometers with a vertical sensor distance of 0.4m, mounted on a cart array at 0.5m horizontal intervals (Fig. 2). Data were recorded with a 10-channel data logger LEA-D2, which was connected to a GPS receiver.

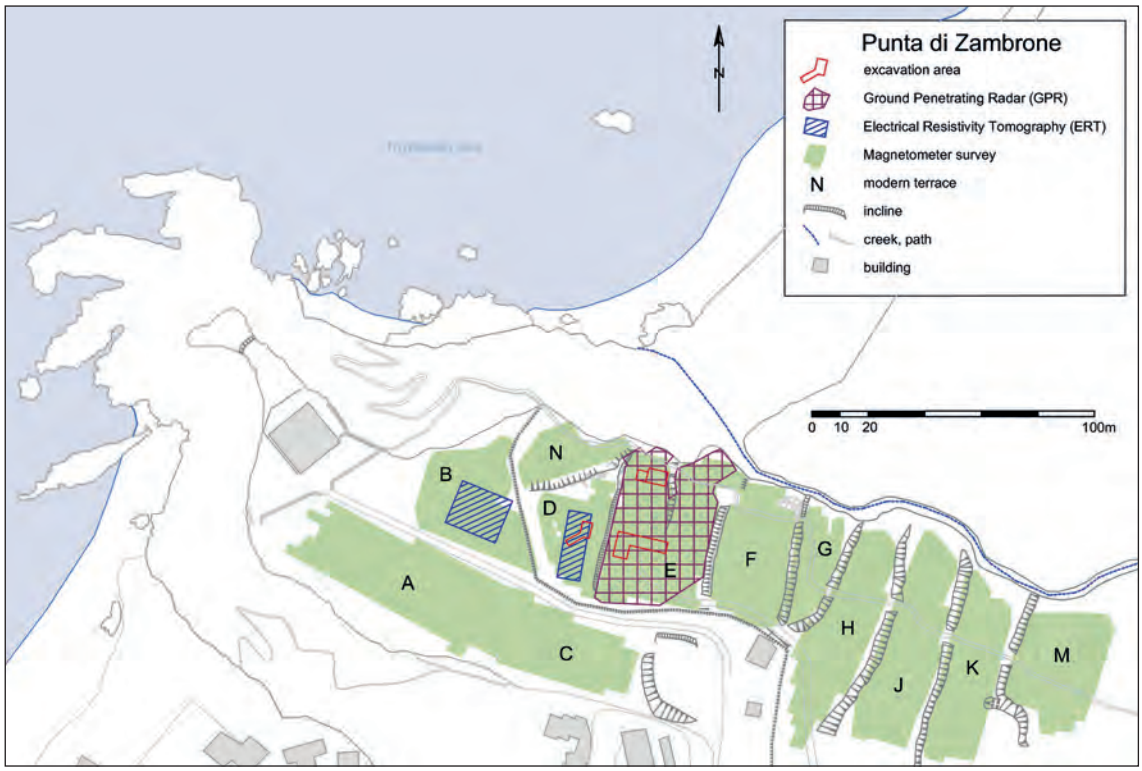


Fig. 1 Map of Punta di Zambrone (graphics: B. Ullrich)



Fig. 2 Magnetometer survey with the LEA MAX cart system on Terrace E (photo: R. Jung)

Ground penetrating radar emits high-frequency electromagnetic impulses into the ground, where local interfaces between features and deposits of varying dielectric properties (conductivity and dielectric permittivity) cause reflections in the electromagnetic waves. The reflected component is detected and recorded on the surface, using the return time-lapse to estimate the depth of the reflective body. GPR is commonly used for the detection of solid structures such as walls and foundations. In Punta di Zambrone we used a GSSI SIR-3000 system with a 270MHz antenna (Fig. 3).



Fig. 3 GPR survey on Terrace E using the SIR-3000 and a 270-MHz antenna (photo: R. Jung)



Fig. 4 Resistivity survey on Terrace B (photo: R. Jung)

Electrical resistivity techniques detect subsurface features by their specific electrical resistivity. While an electric current (I, in amperes) is conducted into the ground between two electrodes, the potential difference (V, in volts) of the ensuing electric field is recorded. The specific resistivity (ρ, in Ωm) is derived from the values of I and V combined with a geometric factor defined by the electrode positions. The distribution of specific resistivity in the ground is calculated using a numerical algorithm (inversion), so that horizontal levels or vertical sections can be visualised. The advantage of resistivity measurements over magnetometry and GPR is the exploration depth which can be reached; however, the spatial resolution is lower compared to the other techniques. In Punta di Zambrone we used the multi-electrode device GeoTom (Fig. 4). The investigated areas were covered by parallel resistivity transects, which allow us to calculate a 3D model of the resistivity distributions.

Measurements and Data Processing

The geophysical prospection campaign at Punta di Zambrone took place between 21st and 26th of August 2011. We started with the magnetometry survey, beginning at the private property in the western part of the promontory (areas on terraces A, B, C in Fig. 1), followed by the terraces between this property and the railroad (areas D–N; I and L do not exist). The magnetic data are visualised in greyscale, from negative minimum (white) to positive maximum (black) values (Fig. 5). The interpretation of the magnetic data is based on a classification of individual magnetic anomalies into four types according to dimensions, shape and amplitude (Fig. 6). The classification distinguishes positive magnetic anomalies which indicate secondary fills such as in pits and ditches (red), high-amplitude anomalies which may be caused by burnt features such as kilns or hearths (orange), strong anomalies which are most likely caused by modern disturbances such as tracks and scrap metal or topographical effects (green), and anomalies which can be related to geological phenomena such as outcropping crystalline bedrock (blue).

After a preliminary evaluation of the magnetometry data, the large central terrace E was selected for further investigations using GPR. An area of 1800m² was covered along parallel transects at intervals of 0.5m. Strong attenuation of the electromagnetic waves only allows us to make



Fig. 5 Data of the magnetometer survey in a ±10nT dynamic (graphics: B. Ullrich)

statements about features within the top 0.8m. The data are presented and interpreted in four horizontal slices for depths down to 0.8m, each visualising the cumulative reflection amplitudes of 4 nanosecond time intervals (Fig. 7). At an estimated wave velocity of 0.1m/ns, each slice represents a layer of 20cm thick.

At terraces B and D, resistivity measurements were conducted along parallel transects with electrode intervals of 1m. An area of 19 × 16m was covered on Terrace B and an area of 24 × 8m on Terrace D. Inversion models for 3D resistivity distributions were calculated, which are presented for both areas in four horizontal levels at depths between 0.25 and 1.00m (Fig. 8). The logarithmic colour scale for the specific electrical resistivity ranges from low resistivity at 20Ωm (blue) to high resistivity at 100Ωm (red).

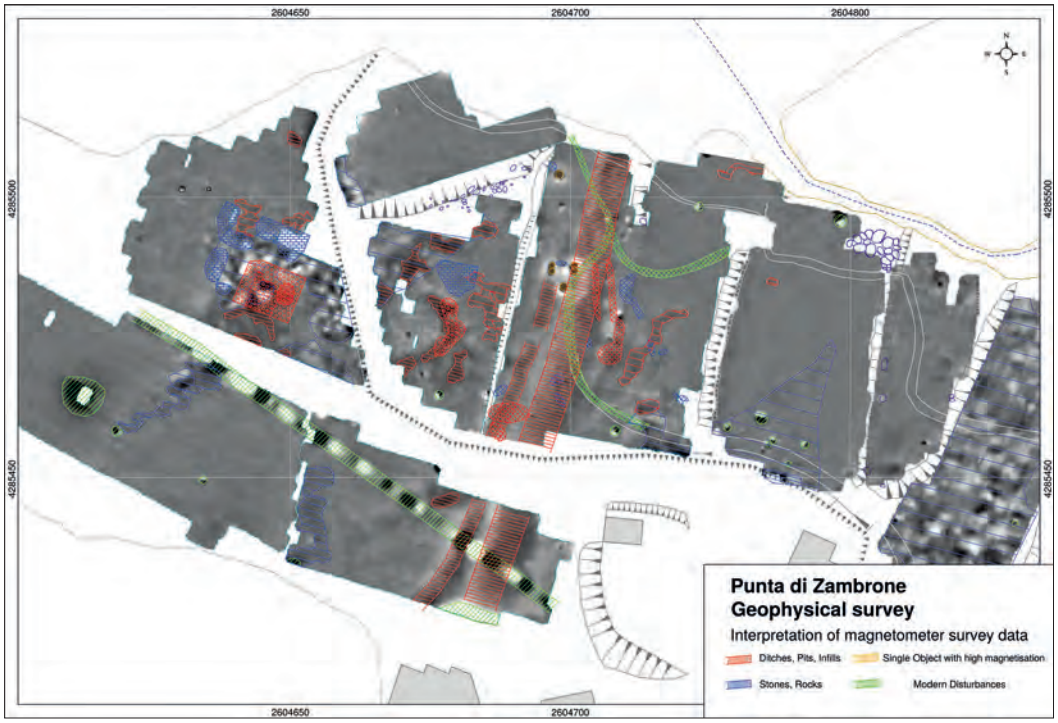


Fig. 6 Interpretation of the magnetic data, dynamic ±100nT (graphics: B. Ullrich)

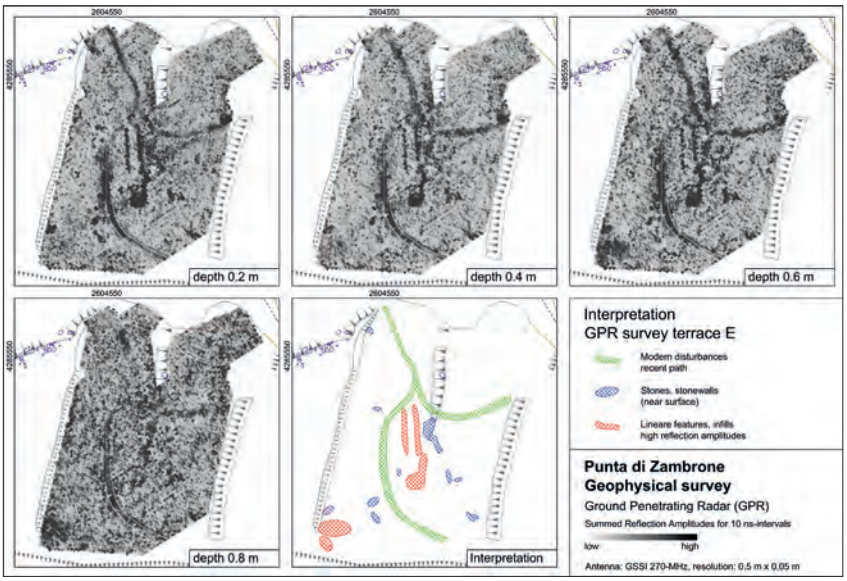


Fig. 7 GPR data for Terrace E: results and interpretation (graphics: B. Ullrich)

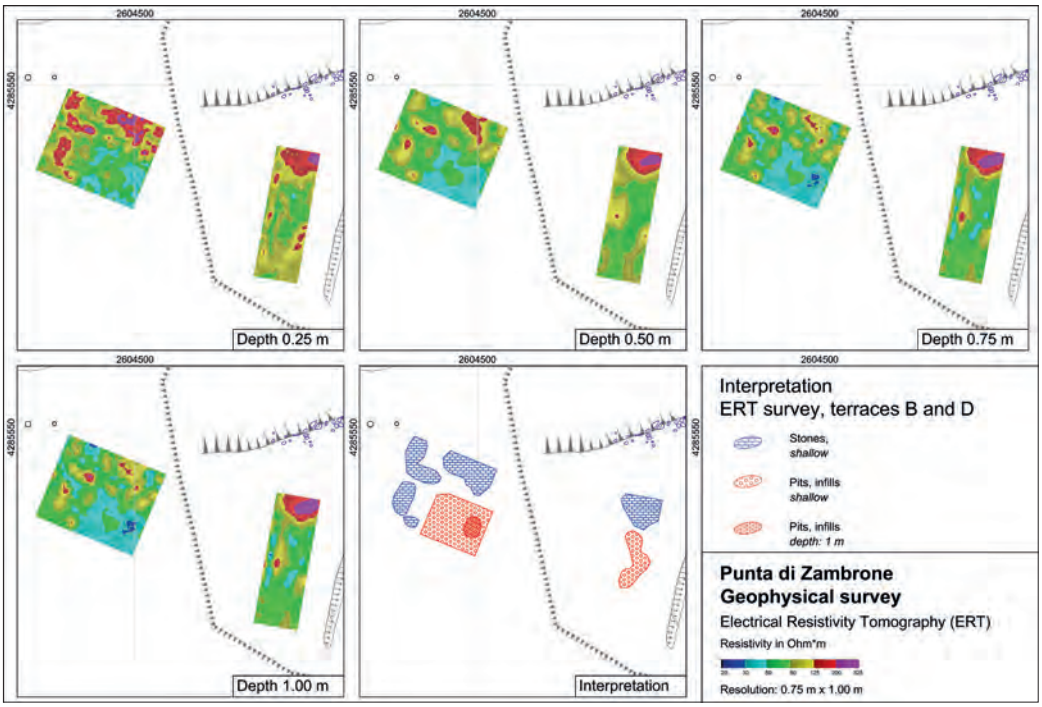


Fig. 8 ERT data for terraces B and D: results and interpretation (graphics: B. Ullrich)

Results

On the basis of the distribution of anomalies in the magnetic data (Fig. 5), the research area can be divided into a western, a central, and an eastern zone. In the western zone (terraces A, B, C, and D) magnetic anomalies were detected which may be associated with buried anthropogenic features. This western zone is bordered to the east by a NNE–SSW-running linear anomaly in Terrace E, which can be related to a ditch mapped during previous archaeological investigations in 1994.[5] The central zone (the eastern part of Terrace E, terraces F and G) yielded only a few magnetic anomalies, while the eastern zone (terraces H, J, K, M) was almost completely covered with features producing high amplitude magnetic anomalies.

The NNE–SSW-running linear feature, which was interpreted as the fortification ditch recorded in 1994, is clearly recognisable as a 6–8m-wide dipole anomaly with positive values (black) in the east and negative values (white) in the west (Fig. 9, feature 1). It covers a total length of approximately 85m, 50m of which are on Terrace E and a further 35m on the adjacent Terrace A. A parallel linear feature was recorded to the west of this ditch on terraces A and E. This second linear feature consists of mostly positive amplitudes and has a total length of 60m, interrupted by a gap of 12m between terraces A and E. Contrary to the ditch, this second feature does not continue into the northern part of Terrace E, and its orientation pivots towards the SW in the southern part of Terrace A. The nature of a 2–3m-wide gap in the middle of the second linear feature was investigated by the southernmost excavation trench (Fig. 9, feature 3). The amplitudes of both linear anomalies are higher on Terrace A than on Terrace E, which can be explained by a shallower burial depth in the lower-lying Terrace A. The location of the parallel linear features strongly suggests the presence of a fortified moat-and-wall system to defend and demarcate the western spur of the promontory.

In the central part of Terrace E, a large part of the ditch-like anomaly is obscured by strong magnetic anomalies. These occur in three clusters; two northern ones consisting of two adjacent

[5] Pacciarelli – Vagnetti 2004, 839–840; Jung et al. 2015, 57–58, fig. 2.

anomalies and a southern one of a single high-amplitude feature. The positive component of these anomalies measures approximately 1.0–1.5m in diameter. A similar anomaly with an amplitude of several 100nT was detected in the NW corner of Terrace E. These strong anomalies could be caused by modern metal objects but also by archaeologically relevant features with a strong thermoremanent magnetisation, such as kilns or hearths. The strong contrast of the dipoles and their regularity suggest that they are caused by metal near-surface disturbances, such as iron poles. However, archaeological thermoremanent features cannot be excluded as the cause for the strong dipoles.

The results of the GPR survey on Terrace E reveal only very little evidence for archaeological structures (Fig. 7, interpretation). Areas with high reflection amplitudes in the centre of the survey area are caused by stones on the surface and a wall (blue), which divides Terrace E into two parts. In the lower, western part, two parallel linear features of higher amplitudes are visible, each approximately 20m long and at c. 5m distance (red). These may be caused by structural features such as walls or filled ditches. To the south of these two linear features highly reflective features deeper than 0.2m were detected within an area of circa 20m². These features are probably related to an earlier terrace phase which is no longer visible on the surface. In the SW of the GPR survey area, high reflection amplitudes were recorded at depths of more than 0.6m in two areas of respectively 4m × 5m and 2m × 3m. These features do not appear to be related or connected, and cannot be interpreted. Several small areas with high reflective amplitudes recorded within the upper 0.2m are interpreted as stones or stone structures. The path which runs across the GPR survey area is clearly recognisable in the data and recorded as a modern disturbance (green).

Numerous magnetic anomalies were detected west of the ditch-like anomaly on terraces A, B, C, and D. Some of these have a clear dipole character with amplitudes over ±40nT. These anomalies are most likely produced by buried crystalline rocks: ferromagnetic minerals in the local granites, such as magnetite, cause a strong magnetisation. The large anomalies on terraces B and D are therefore interpreted as magnetic anomalies generated from stone and rock (Fig. 6).

Further anomalies can be associated with either topographical effects or archaeological features. The remarkable cluster of magnetic anomalies in an area of approximately 20m × 25m in the SE of Terrace B may be related to a flattened part of the natural relief. On the present surface, no crystalline rocks are visible that could explain these anomalies. Positive magnetic anomalies in other parts of Terrace B may be caused by pits or infills. Two positive magnetic anomalies, interpreted as pits, are remarkable because of their size and shape: a rectangular anomaly on Terrace D which consists of a 7–8m-long branch and a 2m-wide short branch, and an almost rectangular anomaly of 4m × 6m with a small annex on Terrace B. In the centre of the latter a strong magnetic anomaly was recorded, which is here interpreted as a rock or stone structure, but may also be caused by a thermoremanent feature such as a hearth or kiln.

The distinction between anomalies caused by either pits and fills or rock and stone structures is supported by the results of the resistivity measurements (Fig. 8). Clear contrasts can be seen in the resistivity distribution of the surveyed areas on terraces B and D. Areas with high specific electric resistivity indicate outcropping rock or stone structures, while zones with low resistivity most likely reflect pits and fills of loose, humid deposits. On Terrace B, high to very high resistivity values occur in the north and west of the investigated area of 19m × 16m. These are likely to be caused by crystalline bedrock or weathered rock at a shallow depth. Low resistivity areas were detected in a zone of approximately 90m² in the SE. The most conspicuous of these is an area of c. 10m² at a depth of 0.75–1.0m with very low specific resistivity at less than 30Ωm, which is interpreted as a pit. The cluster of magnetic anomalies interpreted as pits in the central part of Terrace D is visible in the ERT data as a horseshoe-shaped area. Particularly remarkable is an area with very high specific resistivity in the north, which may represent a cluster of extended and possibly compact stone structures. The narrow strip of low resistivity values along the western border of the investigated area is probably caused by high moisture content in soils near a row of eucalyptus trees.

Verification of the Geophysical Data

Excavations confirmed that the cluster of magnetic anomalies on terraces D and E are caused by the remains of a protohistoric settlement with an elaborate defence system. No invasive research was conducted in the private property in the west of the promontory (terraces A, B, and C).

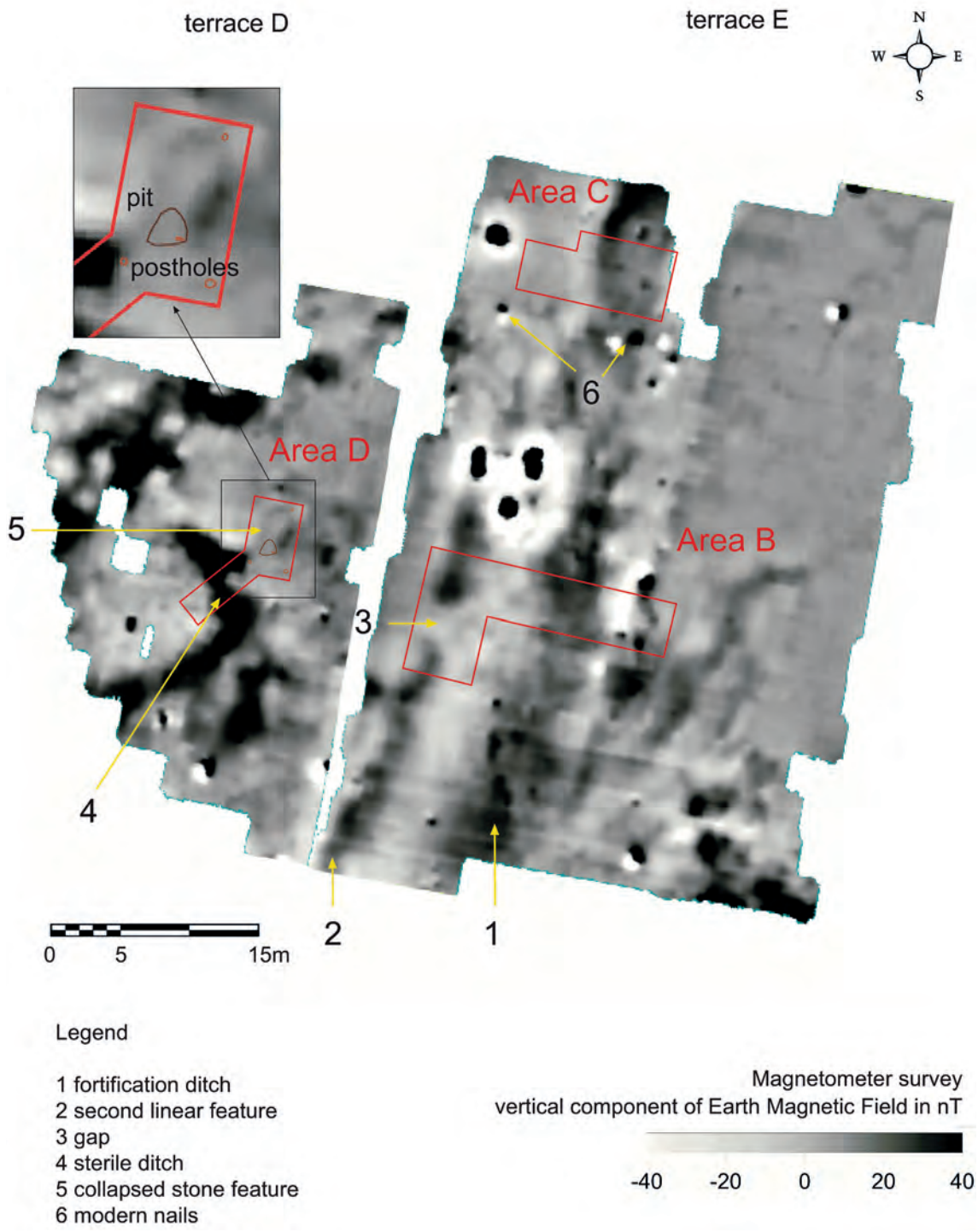


Fig. 9 Magnetic data and archaeological record (graphics: B. Ullrich)

Terrace E – Excavation Areas B and C

The 6–8m-wide, positive linear anomaly was targeted in excavation areas B and C (Fig. 9). These trenches exposed a 4.70–4.80m-wide ditch with a depth of approximately 2m, confirming the interpretation as a defensive moat. This ditch dates to the Recent Bronze Age (13th – early 12th century BCE) according to the artefacts found in its fill.[6] The bottom of the moat slopes down towards the north. If this is also the case in the unexcavated southern extent of the ditch, its strong amplitudes on the lower Terrace A can be explained by a considerable volume of infills. Terrace A slopes down towards the south, some 0.5–2.8m lower than Terrace E.

The cause of the linear magnetic anomaly running parallel to the west of the ditch was more difficult to interpret. A 2.30–3.0m-wide ditch-like feature with a maximum depth of 0.55m was recorded in Area B, also sloping down slightly towards the north. Contrary to the large ditch, the material from this feature 2 (Fig. 9) dates to a developed phase of the Early Bronze Age (c. 19th–18th century BCE)[7]. Further finds in Area B consist of a large number of sometimes worked stones, general settlement debris, a hearth place and four irregularly placed postholes. These features did not produce magnetically significant amplitudes and can thus not be recognised in the magnetic data.

The cause of the strong dipole anomalies of circa 1.0–1.5m diameter in the central part of Terrace E could not be established. They may be produced by metal objects such as pins used in the 1994 reconnaissance campaign, as iron nails associated with small dipole anomalies were indeed found in 2011. However, we cannot exclude the possibility that the strong anomalies are caused by burnt structures, fireplaces or kilns, since the ditch in Area C was filled with thick ash layers. The absence of intermediate sediments indicates that these layers must have been deposited within a short timeframe.[8]

Terrace D – Excavation Area D

The cluster of magnetic anomalies and associated horseshoe-shaped low-resistivity area on Terrace D was targeted in Excavation Area D. (Fig. 9) A sterile ditch with a width of 3.60m and a depth of 0.90m was recorded. In contrast to the rock-cut features exposed in excavation areas B and C on Terrace E, this ditch had very irregular scarps. No artefacts at all were retrieved from its fill. It could not be established whether this feature is of archaeological relevance. A positive, U-shaped magnetic anomaly directly north of this ditch was also investigated. Remains of an irregularly shaped, collapsed stone feature were recorded, covering a flat-bottomed pit. Three postholes were found on the edge of the stone feature, dug into the bedrock. A fourth, smaller posthole was recorded in the SE corner of the flat pit. A small, oval positive magnetic anomaly could be linked to a concentration of burnt loam.

Terraces E and F

The level of low amplitudes in the magnetic data in the NE of Terrace F can be explained by artificial soil accumulation related to terrace construction. In the eastern part of Terrace E, a small secondary terrace is formed by accumulated soil. Pottery fragments recorded here can probably be related to the settlement in the lower terraces to the west, and underline the (sub-)recent disturbances on the promontory. On Terrace F, only dispersed off-site material was found. Further off-site material was recorded during the topographic survey of the promontory, for instance along the western edge of Terrace K. Bronze Age pottery fragments were also found on the steep northern slope, on the beach where the small creek flows into the sea, and on the densely overgrown southern slope of the promontory.

---

6 Jung et al. 2015; Jung – Pacciarelli, this volume.

7 Jung – Pacciarelli, this volume.

8 For a discussion of possible processes that lead to the formation of these ash layers see Jung and Pacciarelli in: Jung et al. 2015, 59–61, fig. 5; Jung – Pacciarelli, this volume.

Conclusion

The multi-method geophysical survey at Punta di Zambrone has contributed significantly to the archaeological investigations of this Bronze Age settlement. The magnetic survey data provide an overview of the distribution of archaeologically relevant features prior to the excavations, including a large ditch-like feature. GPR data proved difficult to interpret, but ERT measurements provided additional information about the depth and consistency of archaeological targets.

The distribution and character of magnetic anomalies suggest a concentration of archaeological features on Terraces E, B, and D (Fig. 6). Markedly fewer features were recorded in the areas to the north (Terrace N) and south (terraces A and C). During the three research campaigns the team was able to observe clear evidence for topsoil stripping by machines and terracing that had happened in the past decades on terraces A, B, C and N.[9] This provides an explanation for the scarcity of archaeological features in these areas, which must have been part of the protohistoric settlement for they are located to the west of the fortification ditch.

A limited number of magnetic anomalies were recorded to the east of the remarkable parallel linear features on terraces E, F, and G; these were interpreted as stone structures or pits. The dense cluster of magnetic features in the east of the research area (terraces H, J, K, and M) are likely caused by near-surface crystalline bedrock or weathered rock. The strong amplitudes of these features are likely to be related to a shallow burial depth as a result of soil displacement. They possess such high amplitudes that no conclusions can be drawn about the presence of archaeologically relevant features with low magnetic amplitudes in this area.

Conversely, the excavation trenches have contributed to our understanding of the nature and cause of geophysically detected anomalies. The trenches, set out on the basis of the magnetic data, provided the possibility to verify our initial interpretations. The excavated areas confirmed the archaeological nature of many of the detected features and yielded useful information about their material properties and the burial depth.

Acknowledgements: The research reported in this article was financed by a research project of the Austrian Science Fund (no. P23619-G19, project lead by R. Jung).

Bibliography

Jung et al. 2015
R. Jung – M. Pacciarelli – B. Zach – M. Klee – U. Thanheiser, Punta di Zambrone (Calabria) – a Bronze Age harbour site. First preliminary report on the Recent Bronze Age (2011–2012 campaigns), Archaeologia Austriaca 99, 2015, 53–110.

Pacciarelli – Vagnetti 2004
M. Pacciarelli – L. Vagnetti, Punta di Zambrone (Zambrone, VV), abitato fortificato costiero del Bronzo medio e recente. Primi cenni sul contesto e sulle ceramiche di tipo egeo dallo scavo del 1994, in: Istituto Italiano di Preistoria e Protostoria (ed.), Atti della XXXVII Riunione Scientifica "Preistoria e protostoria della Calabria", Scalea, Papasidero, Praia a Mare, Tortora, 29 settembre – 4 ottobre 2002 (Florence 2004) 839–842.

[9] Local residents also confirmed that terracing activities had happened in the course of the 20th century.

Coastal Landscapes at Punta di Zambrone (Capo Vaticano, Calabria) and their Suitability for Harbour Facilities during the Bronze Age

Paola Romano (†)[1] – *Elda Russo Ermolli*[2] – *Maria Rosaria Ruello*[3] – *Giuseppe Ferraro*[4] – *Reinhard Jung*[5] – *Valentino Di Donato*[6] – *Nicoletta Insolvibile*[7] – *Marco Pacciarelli*[8]

Abstract: A multidisciplinary approach, including geomorphological and stratigraphical analyses as well as bathymetric, geophysical and subaqueous surveys, has been adopted to reconstruct the morphology of the coasts around the Punta di Zambrone site during the Bronze Age. The main aim was to examine the possibility of the existence of landing places and harbour facilities connected to the settlement, due to the important role that this centre exerted for the maritime trade exchanges in the Tyrrhenian and Aegean Seas. The geomorphological context of the coast north of Punta di Zambrone, characterised by the presence of shoals and rocky cliffs, seems to have been unfavourable to the presence of stable and equipped landing places during the protohistory, also in view of the exposure of the coast to dominant westerly waves. The chances of landing were probably limited to the plain south of the cape. Here, a geophysical survey, coupled with the analysis of a 28m sediment core, highlighted the presence of a protected shallow marine environment, which persisted in this area at least up to the Roman Age.

Keywords: Punta di Zambrone, geoarchaeology, geomorphology, harbour, palaeoecology, geophysics, sea level

Introduction

The Tyrrhenian Calabria relief has a complex geological and geomorphological history, the result of the interplay between endogenous and exogenous factors. The landscape is mainly characterised by landforms connected to the Quaternary extensional tectonic activity, which has affected this sector of southern Italy since the Pliocene,[9] giving rise to the uplift of the chain unit (mean rhythm: 1mm/yr).[10] This uplift, joined with the sea level variations driven by the Quaternary climatic cyclicity, shaped a flight of marine terraces,[11] now preserved along the coasts, interrupted by steep catchments and entrenched alluvial fans. The Tyrrhenian coastal profile of Calabria is

1 Dipartimento di Scienze della Terra, dell'Ambiente e delle Risorse, University of Naples Federico II, Via Cinthia 21, 80126 Naples, Italy.
2 Dipartimento di Scienze della Terra, dell'Ambiente e delle Risorse, University of Naples Federico II, Via Cinthia 21, 80126 Naples, Italy; ermolli@unina.it.
3 Dipartimento di Scienze della Terra, dell'Ambiente e delle Risorse, University of Naples Federico II, Via Cinthia 21, 80126 Naples, Italy; maria.ruello@hotmail.it.
4 Geofisica Misure s.n.c. Trebisacce, Viale della Libertà 132, 87075 Trebisacce, Italy; geofisica@alice.it.
5 Austrian Archaeological Institute, Austrian Academy of Sciences, Hollandstr. 11–13, 1020 Vienna, Austria; Reinhard.Jung@oeaw.ac.at.
6 Dipartimento di Scienze della Terra, dell'Ambiente e delle Risorse, University of Naples Federico II, Via Cinthia 21, 80126 Naples, Italy; valedido@unina.it.
7 nicolettainsolvibile@gmail.com.
8 Dipartimento di Studi Umanistici, University of Naples Federico II, Via Marina 33, 80133 Naples, Italy; marco.pacciarelli@unina.it.
9 Westaway 1993; Tortorici et al. 1995; Monaco et al. 1996.
10 Westaway 1993.
11 Myauchi et al. 1994; Tortorici et al. 2002; Tortorici et al. 2003; Bianca et al. 2011.



Fig. 1 Digital Elevation Model of the Tyrrhenian sector of Calabria, with location of sites cited in the text (drawing: M. R. Ruello)

characterised by structural highs made up of granitic, metamorphic and terrigenous rocks (Coastal Range, Capo Vaticano peninsula, Serre Range) separated by wide alluvial-coastal plains, such as the S. Eufemia Plain.[12] (Fig. 1) The coast along the rocky promontories shows alternating cliffs and small bays or narrow and discontinuous pebble beaches.

On the northern edge of the Capo Vaticano peninsula, the coastal site of Punta di Zambrone has represented a very important settlement since an early phase of the Early Bronze Age, with a major phase dated to the Recent Bronze Age. The site was well suited for maritime activities, with strategic control over large parts of the Tyrrhenian coast of Italy, the Aeolian archipelago and the sea north of Sicily.[13] The important role that this centre exerted for maritime goods exchange in the Tyrrhenian and Aegean seas, led us to examine the possibility of the existence of landing places and harbour facilities in its surrounding coastal areas. The outstanding quantity of Aegean imports at Punta di Zambrone, currently unparalleled in the surrounding region, allows us to suppose that the site was specifically chosen for the purpose of maritime traffic. The morphology of the site, however, presented severe limitations regarding defensive possibilities, given the presence of an unprotected open side of more than 80m in width. Therefore, it seemed reasonable to assume that this disadvantage was compensated for by the presence of excellent harbour facilities, not offered by other sites. This hypothesis also appeared plausible considering the comparisons with other coastal sites in southern Italy that provide similar archaeological evidence. Two of these sites, Roca Vecchia and Scoglio del Tonno at Taranto in Apulia, are characterised by protected inlet bays,[14] which, in turn, may explain the rich Aegean imports encountered at these sites.

12 Romano et al. 2017.
13 Jung – Pacciarelli, this volume.
14 von Hase 1990, 106, fig. 25.2; Pagliara 2005, 629–630, pl. 159b.

A multidisciplinary approach, including geomorphological and stratigraphical analyses as well as bathymetric, geophysical and subaqueous surveys, was adopted to reconstruct the morphology of the coasts during the Bronze Age (BA), on both the northern and the southern sides of the Punta di Zambrone site. This study is part of wider research aimed at reconstructing the Holocene environmental evolution and the people–environment relationship in Calabria on a regional scale.

Materials and Methods

Geomorphology

The coastal landscape surrounding Punta di Zambrone has been analysed at 1:5000 scale, by means of cartographic interpretation and topographic data processing. The latter were used as input data, loaded into specific map management software (ArcGis 9.3), to obtain a Digital Elevation Model of the terrain (DEM). The morphological analysis carried out on this DEM, combined with morphostratigraphic data, was used to recognise and reconstruct the geomorphological setting and the hydrographic network in order to speculate about their origin and history. Furthermore, geomorphological surveys have been focalised in some key sites in order to verify the presence of uplifted recent shorelines and the nature of the outcropping deposits.

A subaqueous survey was also carried out along the sea bottom in front of the southern coast of the Punta di Zambrone promontory in order to verify the nature and map the morphology of a rocky shallow ridge which is parallel to the modern beach.

Bathymetric Survey

A bathymetric survey was carried out to outline the morphology of the sea bottom in front of the Punta di Zambrone promontory and on its northern side. The survey lines were drawn with a NW–SE direction, perpendicular to the shore, with a maximum length of 400m in an area of about 0.2km^2. Within it, 183,300 points of measurement were acquired by using an Ecosounder Odom Hydrotrac, an instrument with millimetric resolution and geographically referencing the DGPS system.

Geophysical Survey

Along the southern side of the Punta di Zambrone promontory, a geophysical survey was carried out in order to define the morphology of the substratum top and to reconstruct the ancient coastal profile. The main aim was to understand if this coastal sector ever had protected inlets, favourable to ship-landing during the BA. The modern morphology of this sector does not suggest such a function, being characterised by a narrow and straight gravelly beach, which was probably built recently thanks to alluvial inputs.

The geophysical survey then focused on the modern beach south of Punta di Zambrone and the neighbouring coastal plain. The method adopted is known as the HVSR (Horizontal to Vertical Spectral Ratio) or Nakamura method,[15] and consists in the measurement of elastic transverse waves, which are non-transmittable in water and then directly related to the upper granular part and to the lithoid substrate below it. This method provides enough reliable estimates of the resonance frequencies of a site. The measurements were carried out at 33 sites, based on a square mesh with a side length of 50m. We used the three component seismograph Lennartz Electronics GmbH LE-3D/5s (vertical, north-south and east-west) with a natural frequency of oscillation of 0.2Hz, wideband spectral (sampling rate up to 100Hz). The method produces excellent results when, as in our case, the impedance contrast between the superficial ground layers and the substrate is high. In addition to the resonance frequency, the other variable needed to calculate the

[15] Nakamura 1989.

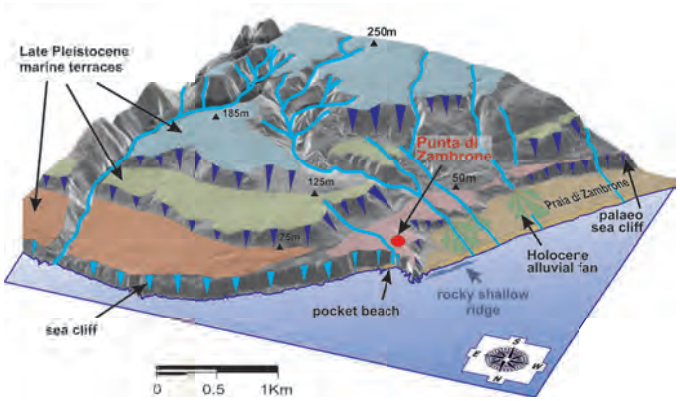


Fig. 2 Geomorphological elements of the studied area mapped on a three-dimensional DEM from a NW point of view (drawing: M. R. Ruello)

depth is the velocity of seismic transverse waves present in the ground above the rigid substrate. These were determined by the execution of four seismic surveys using the MASW (Multichannel Analysis of Surface Waves) methodology.[16] From the values of the transverse waves' velocity in the superficial ground layers, it was possible to calculate the thickness of the sedimentary cover, and thus the depth of the rigid lithoid substrate.

Stratigraphical Survey

In order to investigate the nature of the subsoil in the modern Zambrone coastal plain, a borehole has been created at 3.70m above sea level (asl), 45m inland with respect to the modern shoreline. The location of the borehole was driven by the results of the geophysical investigation. The sediment core reached 28m of depth and was realised through a continuous coring, 10cm in diameter. Samples were collected all along the core for palaeoecological and chronological (^{14}C-AMS) analyses.

Results

Geomorphology

The main geomorphological elements recognised in the investigated area are shown in the 3D DEM of Fig. 2. Four orders of Late Pleistocene marine terraces have been mapped in the surroundings of Punta di Zambrone, extending from 240 to 50m asl, separated by steep scarps of about 50–75m and interrupted by steep catchments. The Punta di Zambrone BA settlement is located on a flat area lying 30–35m asl, representing a part of the last order of the marine terraces. The site was strategically located at the top of a small cliffed promontory, nowadays stretching for 150m along the WNW–ESE direction. (Fig. 2) Northward, the cape is mainly exposed to sea and its active granitic cliff is partially protected by two small pocket beaches (Fig. 2). Southward, the nowadays densely inhabited narrow coastal plain of Praia di Zambrone, partially covered by Holocene alluvial fans, developed at the front of a Pleistocene palaeo-sea cliff that is characterised by gentle slopes interrupted by valleys. (Fig. 2)

No evidence of uplifted Holocene shorelines has been found along the coasts on either the northern or the southern side of the promontory of Punta di Zambrone.

The subaqueous survey allowed the nature and morphology of the shallow ridge, parallel to the southern coast, to be defined. It was made up of lithified layers of big rounded pebbles in a

[16] Park et al. 1999; Xia et al. 1999.

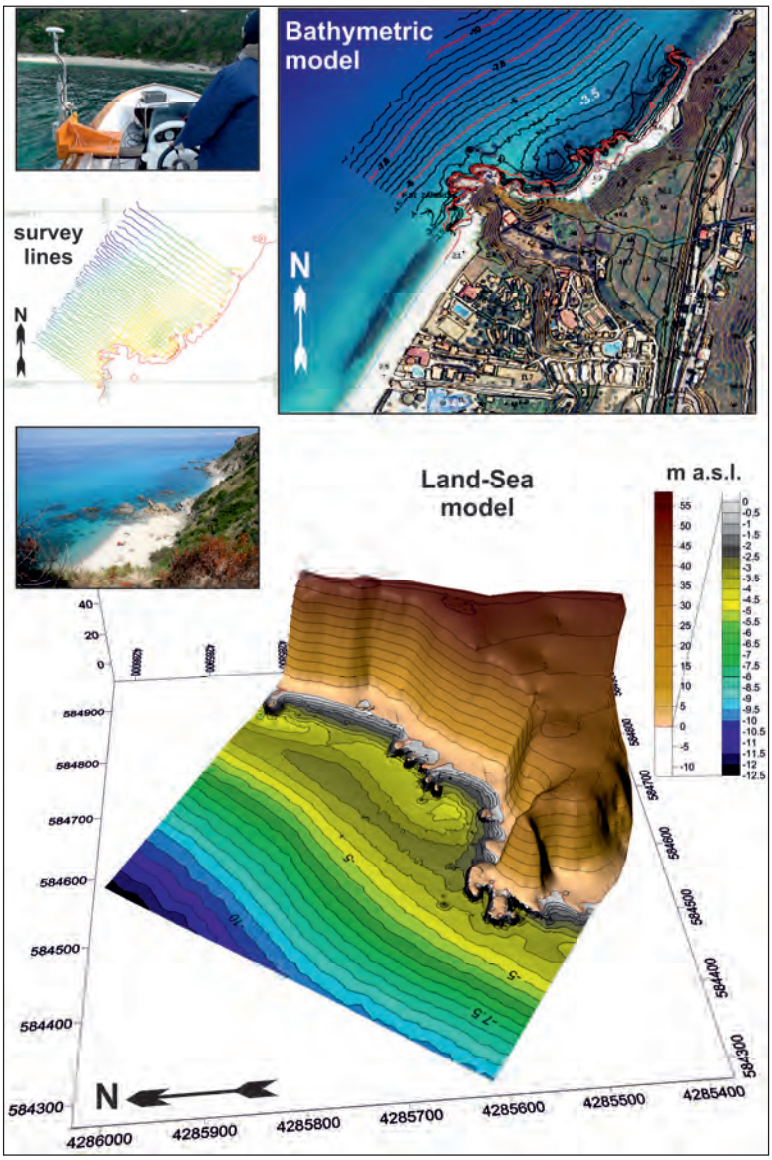


Fig. 3 Results of the bathymetric survey carried out on the northern side of Punta di Zambrone (illustration: M. R. Ruello and G. Ferraro)

sandy matrix which were tentatively interpreted as a remnant of an ancient alluvial fan, probably related to a Pleistocene glacial low-stand.

Bathymetry

The bathymetric survey allowed a model to be drawn for the marine sector north of the promontory. (Fig. 3) The interpolation of point measurements produced a detailed map with contour lines drawn every 0.5m, from 0 to -12.5m asl Further, a 3D land–sea model was realised by linking a terrain model, obtained by processing topographic data from the northern part of the Punta di Zambrone promontory (contour intervals of 5m), with the previous bathymetric model (Fig. 3). From the shoreline down to the maximum surveyed depth, an articulated sea bottom is present near the steep rocky sea cliff, made up of pebble sands and rocks. The -3.5m asl contour line outlines a ridge that extends from the peak of the promontory for about 300m along the NE–SW direction. It isolates a small area, one metre deeper at the rear, closer to the shoreline. Seaward, this ridge becomes a more gentle slope with a regular decline from -4.5m down to -12.5m asl (Fig. 3).

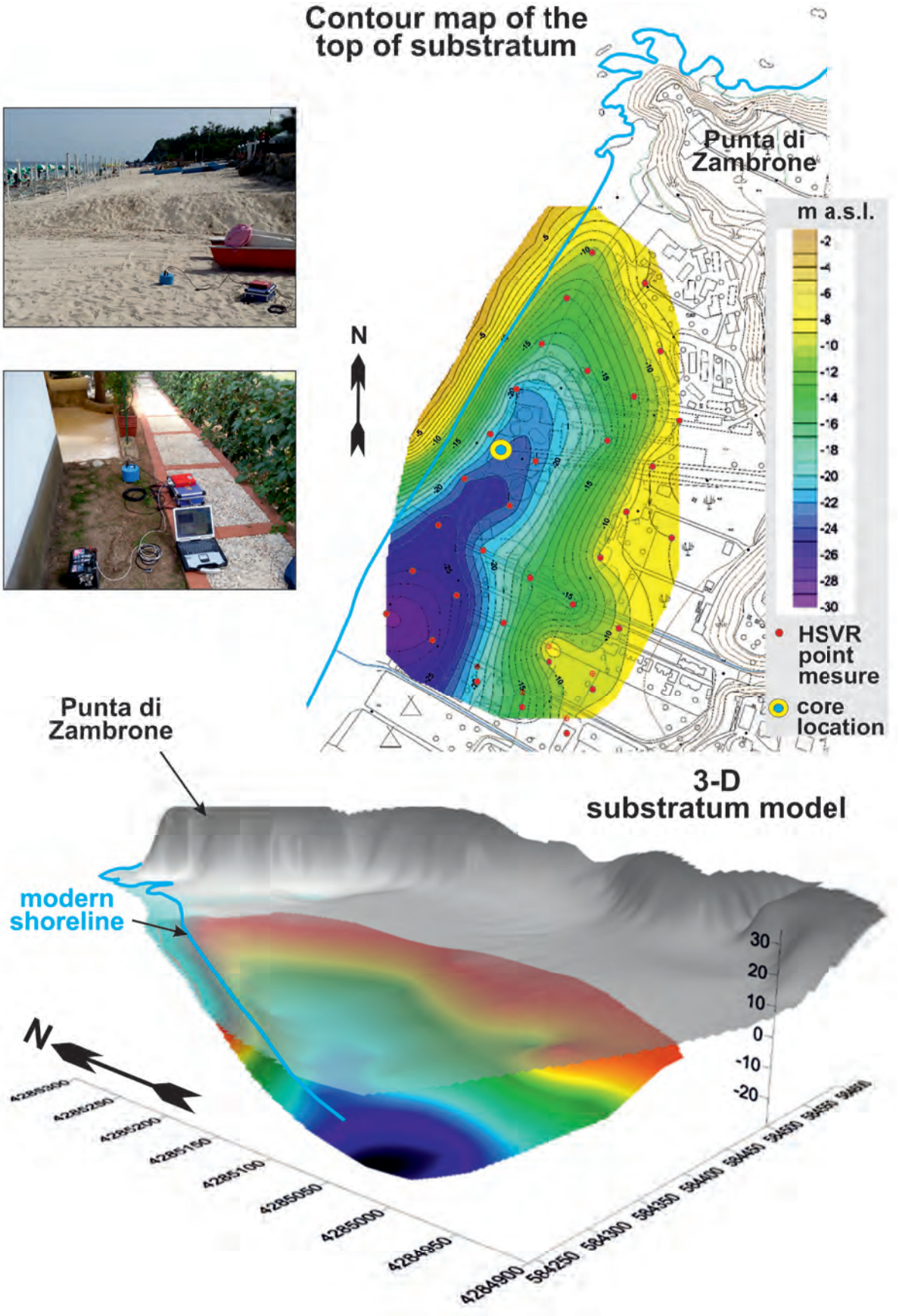


Fig. 4 Results of the geophysical investigation carried out on the southern side of Punta di Zambrone (illustration: M. R. Ruello and G. Ferraro)

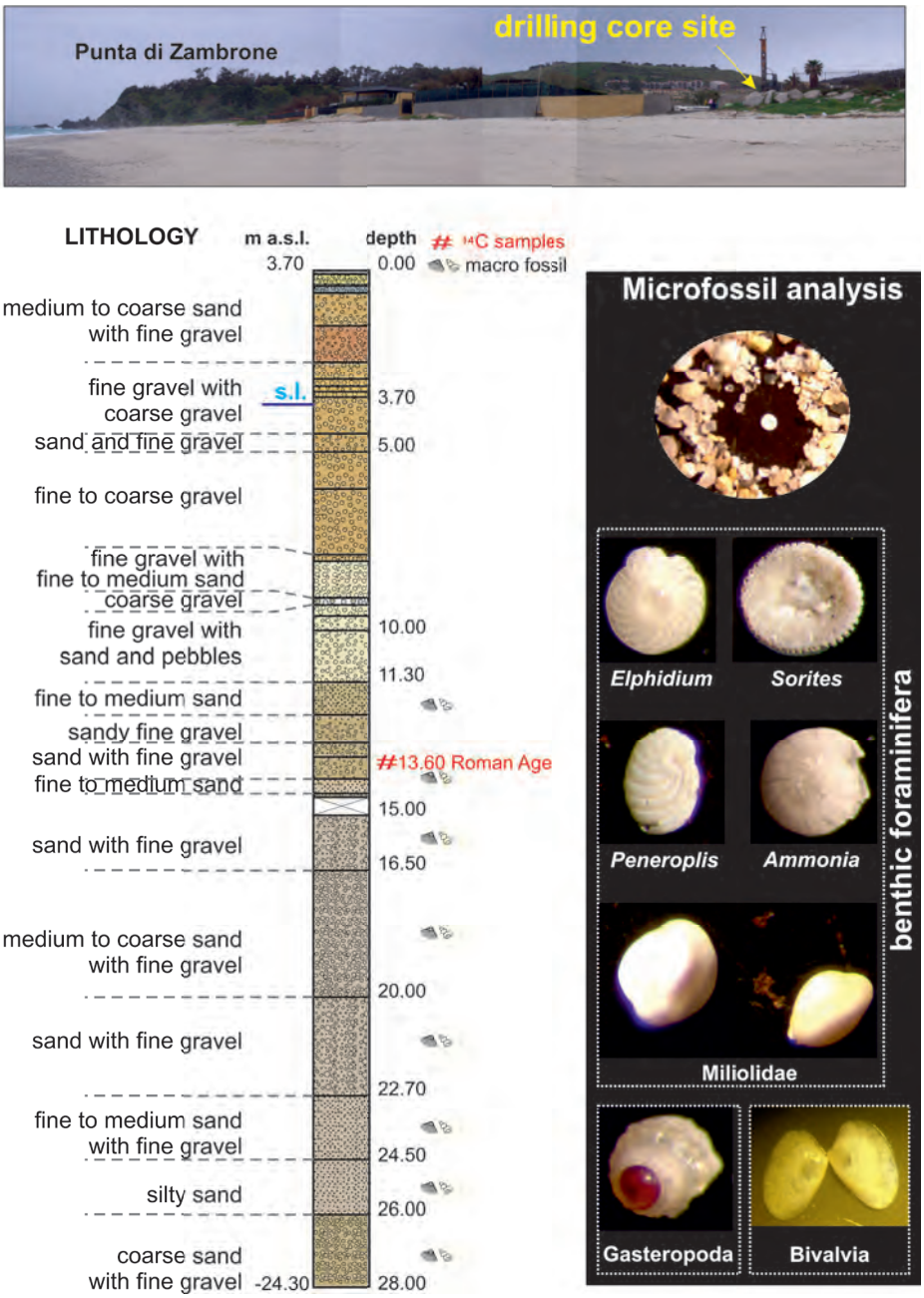


Fig. 5 Stratigraphical log of the core extracted in the Zambrone plain. For core location see Fig. 4 (drawing: M. R. Ruello)

Geophysics

The results of the geophysical investigation are shown in the contour map and 3D substratum model of Fig. 4. The analysis highlighted the presence of a wide depression in the substratum, aligned with the NE–SW direction, whose maximum depth reaches -30m asl. The depression has a spoon-like shape, closing towards the NE and suggests the existence of a protected coastal environment whose internal shores were located about 250m inland with respect to the modern shoreline. Toward the sea, the depression is limited by the shallow ridge, parallel to the coast, which was investigated through the subaqueous survey. In order to understand the nature of the infilling of such a depression, a core was taken in the most suitable place for the drilling equipment (Fig. 4).

Stratigraphy

The description log of the core collected in the Zambrone plain is shown in Fig. 5. The core is mainly composed of coarse sands and gravels; there are no meaningful *facies* changes along the cored sequence. The basal part shows a slightly finer granulometry and a greyish colour indicating deeper marine environments. Towards the top, the granulometry is coarser and the sandy matrix of the gravels is reddish, indicating more enhanced alluvial inputs from inland. Microfossil analysis of several samples collected all along the core highlighted the presence of poor faunal assemblages of shallow (max. depth 10m) marine water, including benthic foraminifera (*Elphidium* spp., *Ammonia* sp., *Sorites orbicularis*, *Peneroplis planatus*, Miliolidae), Gasteropoda, Bivalvia and Echinoderma fragments. The poverty of the assemblages can be interpreted as a sign of instability of the sea bottom, probably submitted to continuous arrivals of detritic material from the adjacent plain and to long-shore currents, which did not allow the establishment of suitable conditions for the development of a rich faunal diversity. A sample of foraminifera taken at 13.60m depth was dated through AMS at Mannheim (Curt-Engelhorn-Zentrum Archäometrie gGmbH) to the Roman age. The date is MAMS-24276: 1966 ± 17 BP (calibrated at 2 σ: calBC 31– calAD 76). A second sample taken at 18.0m depth unfortunately did not contain enough material to provide a date (MAMS-25672).

Discussion

The multidisciplinary analysis carried out in the area of the Punta di Zambrone site allowed the reconstruction of the coastal landscape during the late Holocene and in particular during the BA. The main aim of this investigation was to verify the possibility of the existence of landing places close to the settlement. In fact, archaeological evidence has shown that this BA village was surely connected to maritime sea routes between the Tyrrhenian and Aegean Seas.[17]

The Sea Level During the Bronze Age

Reconstructing coastal landscapes of the past is a rather difficult task, due to the instable character of this environment located at the transition between marine and continental realms. Especially during the Holocene, coasts have experienced profound changes linked to both the rising sea level and the increasing inputs from inland, resulting in a general tendency to progradation along the shores of coastal plains. This difficulty is enhanced along the Calabrian coast because of the recent tectonic activity which has resulted in hiccup and scattered uplift and/or subsidence phases of the Tyrrhenian sector throughout the Holocene. Recent investigations along the coasts of Capo Vaticano have evidenced the presence of uplifted late Holocene shorelines especially along the SW part of the peninsula.[18] The present level of such shorelines shows a decrease from the SW to the NE indicating a differential uplift rate of the promontory. In particular, at Tropea (Fig. 1), c. 8km south of Zambrone, shorelines dated between 3500 and 1900 BP are located at 1.3m asl. At the same site, more recent shorelines (younger than 1900 BP) are found at 0.7m asl, whereas at Briatico (Fig. 1), c. 5km north of Zambrone, the same shoreline is found at 0m asl. In the absence of BA palaeo-shorelines in the Briatico area, the uplift rate of this coast sector can only be inferred for the last 1900 years and corresponds to 0.7mm/yr.[19] Considering that in the Punta di Zambrone area there is no evidence for recent uplifts, it cannot be excluded that this area has been stable or uplifting slightly in the last 3500 years. Recent studies along the coasts of Italy, based on the analysis of geomorphological markers, coastal archaeological data and sedimentary cores, suggest that the mean absolute sea level during the BA was about 3m lower than today.[20] On the

17 Jung et al. 2015; Jung – Pacciarelli, this volume.
18 Spampinato et al. 2014.
19 Anzidei et al. 2013.
20 Lambeck et al. 2011.

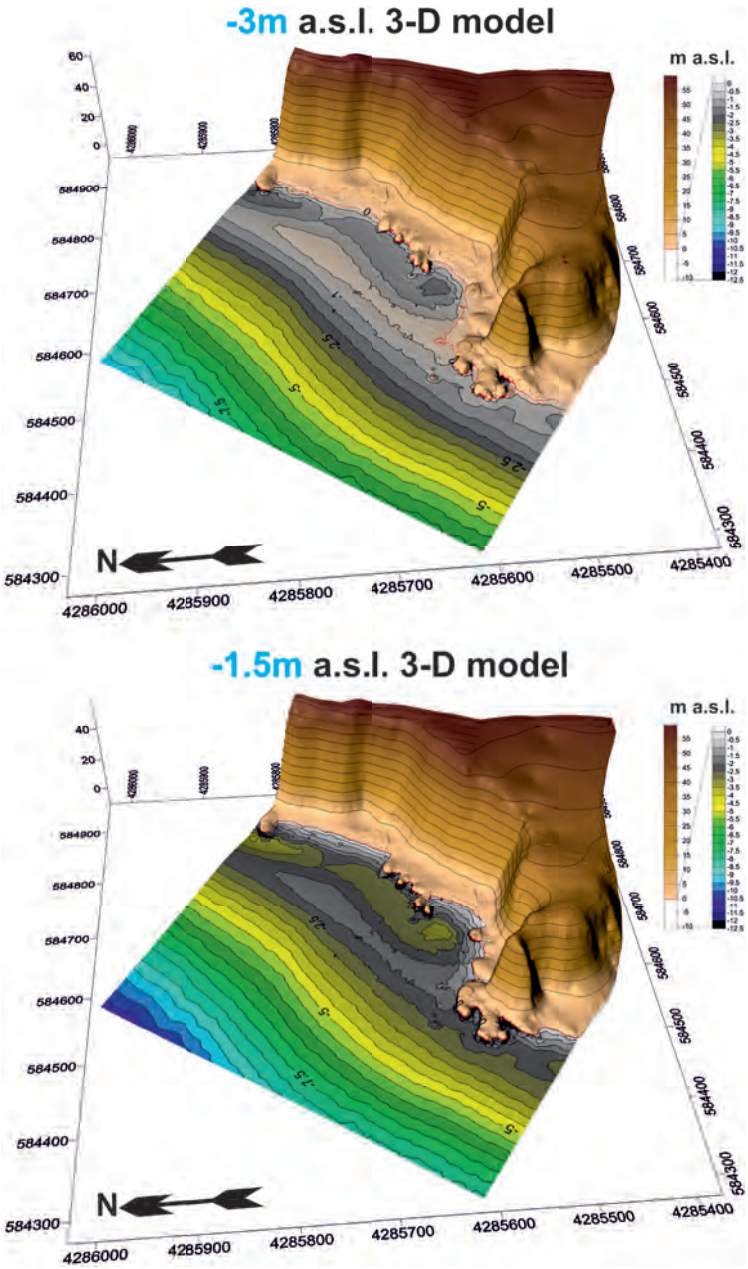


Fig. 6 Three-dimensional reconstructions of the northern side of Punta di Zambrone during the Bronze Age with the position of sea level at -3 and -1.5m asl (illustration: M. R. Ruello and G. Ferraro)

basis of the previous considerations, we can assume, for the reconstructions of the Zambrone coastal area presented here, a BA relative sea level ranging from c. -3 (stability) to c. -1.5m asl (0.7mm/yr of uplift).

The Coast North of Punta di Zambrone

Geomorphological and bathymetrical surveys showed that the coast north of Punta di Zambrone was unfavourable to the presence of stable and equipped landing places due to the morphology of the sea bottom, the steep nature of the rocky sea cliffs and the presence of scattered rocks close to the shore. If we consider that the BA mean sea level was between c. -3m (absolute) and c. -1.5m (relative) asl, this coastal sector is revealed as even more unsuitable for ship landing, as shown in the 3D models of Fig. 6.

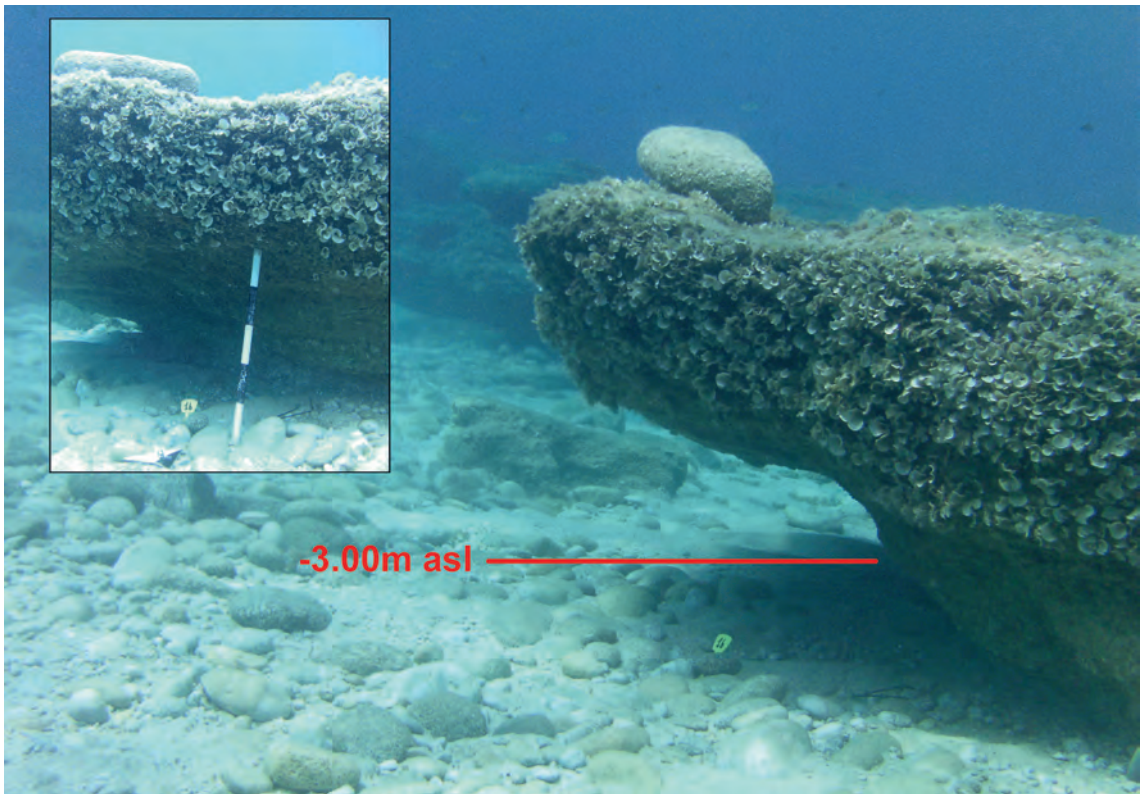


Fig. 7 Evidence of a sea level notch at -3m asl carved in the inner side of the currently submerged ridge extending in front of the modern beach (photos N. Insolvibile)

The Bay to the South of Punta di Zambrone

The chances of landing were probably limited to the plain south of the cape. Here, geophysical investigation highlighted the presence of a depression in the substratum, which surely represented a protected area along the coast. (Fig. 4) The infilling of such a depression, investigated through the analysis of a 28m sediment core, has shown, in fact, that a shallow marine environment was present at this site, at least up to the Roman Age. (Fig. 5)

The palaeogeographical model of Fig. 8 has been reconstructed taking the BA mean sea level as c. -3m asl (stability). In this case, the top of the rocky shallow ridge parallel to the modern beach emerged to a height of c. 1.5m. If we consider that the BA mean relative sea level was c. -1.5m asl (uplift), the barrier top stands close to the sea surface. In both cases, this ridge represented a protective barrier for the inlet, which could have easily been used for landing ships or even for the establishment of harbour facilities. This hypothesis is also strengthened by the morphological setting of the adjacent coastal plain, surrounded by less inaccessible slopes, compared to those north of the promontory, which were surely easier to climb in order to reach the plateau of the town headquarters for transporting shipped products. If the hypothesis of a Bronze Age sea level at -3m asl was valid, we could associate the notch found at that altitude on the inner side of the submerged ridge with this period (Fig. 7).

Conclusion

The archaeological evidence disclosed at the Punta di Zambrone site suggested that specific investigations were necessary to highlight the possible existence of landing places in the surroundings of the village, which proved to be an important harbour on the Mediterranean Sea routes of the BA.

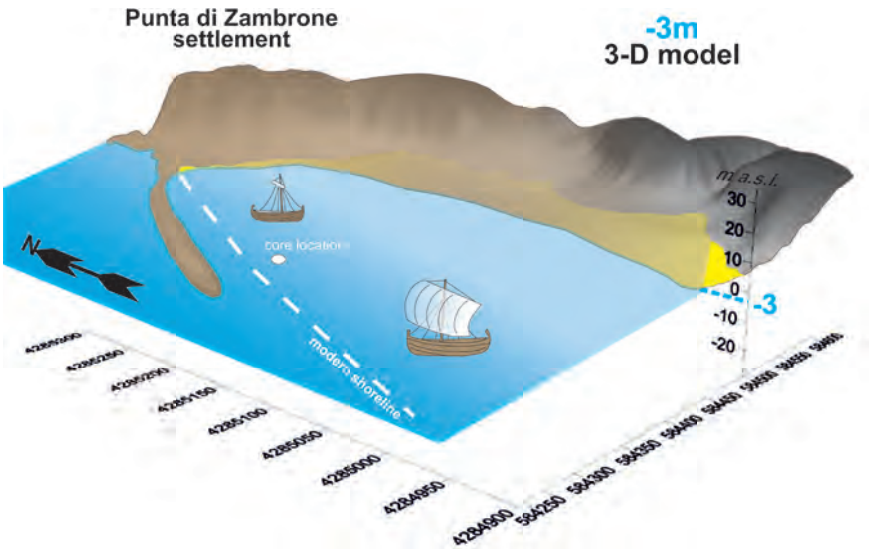


Fig. 8 Palaeogeographical reconstruction of the southern coast of Punta di Zambrone during the Bronze Age with a supposed sea level at -3m asl (drawing: M. R. Ruello)

The geoarchaeological approach was first focused on the analysis of the present landscape morphology and then addressed to more specific methodologies, aimed at disclosing the ancient landscape now buried below recent deposits. The application of geophysical analysis in the plain south of Punta di Zambrone proved fundamental for the discovery of a depression in the substratum, representing a protected marine environment which was present corresponding to the modern coastal plain. The recovery of a sediment core clarified the nature of the depression infilling and confirmed the existence of a protected bay which was probably used as a safe landing place for ships during the BA.

In conclusion, the geoarchaeological investigation presented here has again demonstrated that the interaction between archaeology and the earth sciences can make an excellent contribution to the progress of knowledge about human–environment interactions since prehistoric times.

Acknowledgements: The research was partly financed by MIUR (Ministero dell'Istruzione, dell'Università e della Ricerca, PRIN 2009 Project 'Centri fortificati, sistemi di insediamento e processi ambientali nella Calabria tirrenica tra secondo e primo millennio a.C.', project no. 2009MF87BM, project manager M. Pacciarelli), and by the Austrian Science Fund FWF (Project Punta di Zambrone, P23619-G19, project manager R. Jung).

Bibliography

Anzidei et al. 2013
M. Anzidei – F. Antonioli – A. Benini – A. Gervasi – I. Guerra, Evidence of vertical tectonic uplift at Briatico (Calabria, Italy) inferred from Roman age maritime archaeological indicators, Quaternary International 288, 2013, 158–167.

Bianca et al. 2011
M. Bianca – S. Catalano – G. De Guidi – A. M. Gueli – C. Monaco – G. M. Ristuccia – G. Stella – G. Tortorici – L. Tortorici – S. O. Troja, Luminescence chronology of Pleistocene marine terraces of Capo Vaticano peninsula (Calabria, Southern Italy), Quaternary International 232, 2011, 114–121.

Jung et al. 2015
R. Jung – M. Pacciarelli – B. Zach – M. Klee – U. Thanheiser, Punta di Zambrone (Calabria) – a Bronze Age harbour site. First preliminary report on the Recent Bronze Age (2011–2012 campaigns), Archaeologia Austriaca 99, 2015, 53–110.

Lambeck et al. 2011
K. Lambeck – F. Antonioli – M. Anzidei – L. Ferranti – G. Leoni – G. Scicchitano – S. Silenzi, Sea level change along the Italian coast during the Holocene projections for the future, Quaternary International 232, 2011, 250–257.

Miyauchi et al. 1994
T. Miyauchi – G. Dai Pra – S. Sylos Labini, Geochronology of Pleistocene marine terraces and regional tectonics in the Tyrrhenian coast of South Calabria, Italy, Il Quaternario 7, 1, 1995, 17–34.

Monaco et al. 1996
C. Monaco – L. Tortorici – R. Nicolich – L. Cernobori – M. Costa, From collisional to rifted basins: an example from the southern Calabrian arc (Italy), Tectonophysics 266, 1996, 233–249.

Nakamura 1989
Y. Nakamura, A method for dynamic characteristics estimation of subsurface using microtremor on the ground surface, Quarterly Report of RTRI 30, 1, 1989, 25–33.

Pagliara 2005
C. Pagliara, Rocavecchia (Lecce). Il sito, le fortificazioni e l'abitato dell'età del Bronzo, in: R. Laffineur – E. Greco (eds.), Emporia. Aegeans in Central and Eastern Mediterranean. Proceedings of the 10th International Aegean Conference / 10e Rencontre égéenne internationale, Athens, Italian School of Archaeology, 14–18 April 2004, Aegaeum 25 (Liège 2005) 629–635.

Park et al. 1999
C. B. Park – R. D. Miller – J. Xia, Multichannel analysis of surface waves, Geophysics 64, 1999, 800–808.

Romano et al. 2017
P. Romano – E. Russo Ermolli – M. R. Ruello – G. Ciampo – V. Di Donato – M. Rivieccio – F. Filocamo – P. Apreda – F. Terrasi, La Piana di Sant'Eufemia (Calabria) nell'Olocene. Ambienti, paesaggi ed occupazione antropica, in: L. Cicala – M. Pacciarelli (eds.), Centri fortificati della Calabria dalla protostoria all'età ellenistica. Atti del convegno (Naples 2017) 253–265.

Spampinato et al. 2014
C. R. Spampinato – L. Ferranti – C. Monaco – G. Scicchitano – F. Antonioli, Raised Holocene paleo-shorelines along the Capo Vaticano coast (western Calabria, Italy). Evidence of co-seismic and steady-state deformation, Journal of Geodynamics 82, 2014, 178–193.

Tortorici et al. 1995
L. Tortorici – C. Monaco – C. Tansi – O. Cocina, Recent and active tectonics in the Calabrian Arc (southern Italy), Tectonophysics 243, 1995, 37–55.

Tortorici et al. 2002
G. Tortorici – M. Bianca – C. Monaco – L. Tortorici – C. Tansi – G. De Guidi – S. Catalano, Quaternary normal faulting and marine terracing in the area of Capo Vaticano and S. Eufemia Plain (southern Calabria), Studi Geologici Camerti 1, 2002, 155–171.

Tortorici et al. 2003
G. Tortorici – M. Bianca – G. De Guidi – C. Monaco – L. Tortorici, Fault activity and marine terracing in the Capo Vaticano area (southern Calabria) during the Middle-Late Quaternary, Quaternary International 101–102, 2003, 269–278.

Xia et al. 1999
J. Xia – R. D. Miller – C. B. Park, Estimation of near-surface shear-wave velocity by inversion of Rayleigh waves, Geophysics 64, 1999, 691–700.

von Hase 1990
F.-W. von Hase, Ägäische Importe im zentralen Mittelmeergebiet in späthelladischer Zeit (SH I–SH IIIC), in: Orientalisch-ägäische Einflüsse in der europäischen Bronzezeit. Ergebnisse eines Kolloquiums, Römisch-Germanisches Zentralmuseum, Forschungsinstitut für Vor- und Frühgeschichte Monographien 15 (Bonn 1990) 80–108.

Westaway 1993
R. Westaway, Quaternary uplift of southern Italy, Journal of Geophysical Researches 98, 1993, 21741–21772.

The Settlement of Punta di Zambrone in its Local and Mediterranean Context during the Recent Bronze Age

Reinhard Jung[1] – *Marco Pacciarelli*[2]

Abstract: Punta di Zambrone is a Bronze Age settlement situated about 8km northeast of Tropea in southern Calabria (province of Vibo Valentia). The site is strategically located on a granite promontory projecting into the Tyrrhenian Sea. The purpose of its foundation must have been related to maritime activities, as the site could visually control large parts of the Tyrrhenian coast of Italy, the Aeolian archipelago and the sea north of Sicily. The earliest settlement phase dates back to an early phase of the Early Bronze Age, i.e. the end of the 3rd millennium BCE. This paper presents the stratigraphic evidence of the last and major settlement period dated to the Recent Bronze Age and gives an overview of the artefact categories found in the strata of that period. Punta di Zambrone flourished during the 13th century and came to an abrupt end around 1200 BCE. Following an initial geophysical prospection, various sectors were excavated between 2011 and 2013 by an international team. The most important Recent Bronze Age feature is the fortification ditch protecting the settlement along its accessible eastern and southeastern side. When the inhabitants abandoned the settlement, they filled in the ditch and obliterated the fortification completely. In its northern part, the final infill contained huge quantities of ash. These ashy layers were very rich in artefacts made of many different materials. In addition, there were plenty of archaeozoological and archaeobotanical remains. The archaeological evidence obtained from the fortification ditch thus provides ideal conditions for reconstructing life in the settlement during its ultimate phase of existence. We set out the different possibilities for interpreting the formation of those ashes and their subsequent deposition inside the ditch. Punta di Zambrone stands out in the southern Tyrrhenian region due to its strong evidence for intense Aegean contacts, indicated among other things by imported pottery, metal objects, jewellery and ivory, mostly found in the ashes, but also in the uppermost silty layers in the central part of the ditch.

Keywords: Punta di Zambrone, Recent Bronze Age, fortification, settlement stratigraphy, ashy layers, Recent Bronze Age burial rites.

Topography

The coastal settlement of Punta di Zambrone on the Tropea peninsula (or Poro promontory) in southern Calabria is located on a granite promontory projecting into the Tyrrhenian Sea in a west-northwestern direction (Figs. 1–2). The very steep and rocky scarps of this promontory offered natural protection on two sides (Fig. 3), while the flattened summit, which is gently sloping in an east-southeastern direction from 50m asl towards the tip of the cape at 30m asl, provided an ideal surface for the foundation of a settlement. As will be said, an artificial fortification was built in the Bronze Age to protect the open side to the east and southeast of this plateau.

To the north and south of the promontory the coast is currently bordered by beaches. However, the research conducted by the geologists proves that the ancient morphology of the coast differed considerably from the present one. Their results, especially regarding the reconstruction on the southern side of a protected bay well suited for harbouring boats, provide evidence for understanding the exceptional presence of various artefact classes related to long-distance maritime connections.[3]

[1] Austrian Archaeological Institute, Austrian Academy of Sciences, Hollandstr. 11–13, 1020 Vienna, Austria; Reinhard.Jung@oeaw.ac.at.

[2] Dipartimento di Studi Umanistici, University of Naples Federico II, Via Marina 33, 80133 Naples, Italy; marco.pacciarelli@unina.it.

[3] See Romano et al., this volume.



Fig. 1 Location of Punta di Zambrone (cartography: A. Buhlke)



Fig. 2 Punta di Zambrone seen from the northeast (photo: M. Pacciarelli)

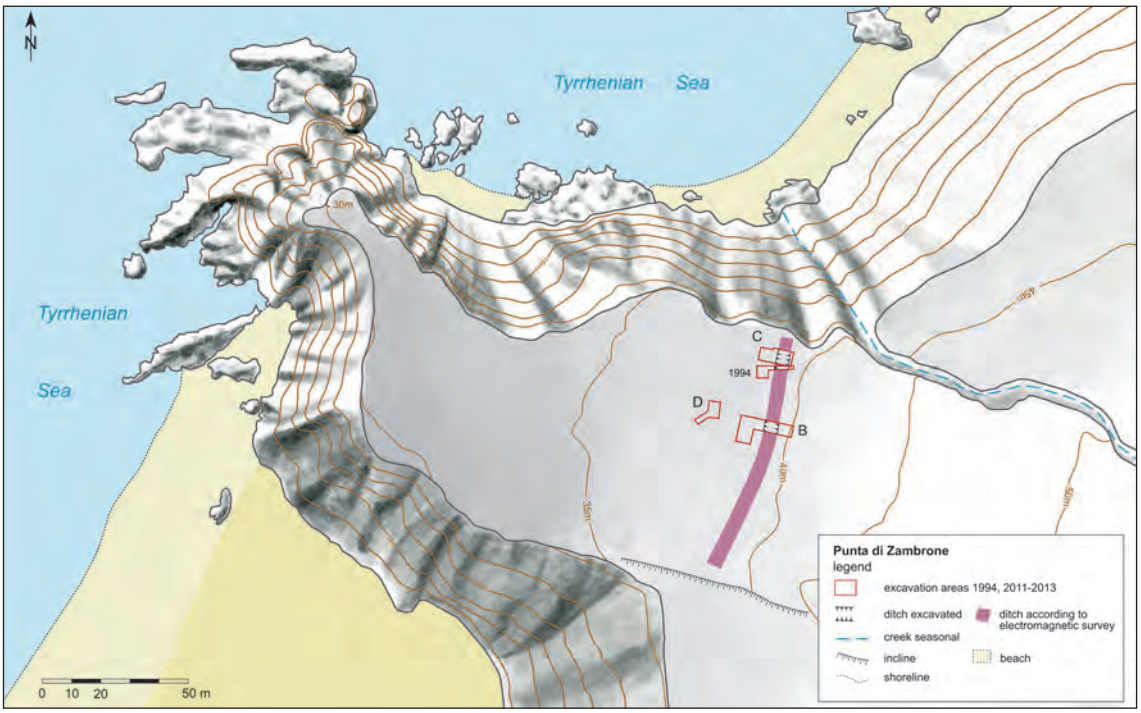


Fig. 3 Topographical map of Punta di Zambrone with excavation areas and course of the RBA ditch indicated (cartography: A. Buhlke)

The Region of the Poro Promontory

The site was discovered in 1991 during one of the survey campaigns which were carried out across the Tropea peninsula, and during which more than 100 sites dating between the Copper and the Iron Ages were identified. The results of that previous research provide precious evidence for a complete reconstruction of the local settlement and cultural history during the metal ages.[4]

Radical changes marked the Recent Bronze Age in this region. The 14th century BCE Thapsos *facies* (culture group), clearly of Sicilian origin, suddenly gave way to a new culture group strongly linked to continental Italy.

Subapennine pottery shapes and especially handles, mixed during the earliest stage with some pots bearing Apennine decoration, characterise this new *facies*. A further characteristic is bronze types of the Recent Bronze Age. They largely coincide with those of the so-called metallurgical koiné of the 13th and 12th centuries BCE.[5] As is well known, the same aspect of historical discontinuity – often following a horizon of destruction – also marks the spread of the Subapennine *facies* to northern Sicily and to the Aeolian Islands.[6]

The surveys carried out on the territory of the Tropea peninsula have shown that during the Recent Bronze Age a flourishing and complex settlement system had developed. On the Poro high plain several settlements are attested on flat and open locations, on the very fertile andosols that are of volcanic origin and highly suited for agricultural activities. On the edge of the high plain there were hilltop sites, which probably assumed strategic functions of defence and control. Punta di Zambrone appears as a third type of site within this system, in this case related to maritime activities.[7]

4 For the Bronze Age settlement evidence see Pacciarelli 2000, 78–85; Pacciarelli 2008. For the Bronze Age cultural sequence see Marino – Pacciarelli 1996; Pacciarelli 2000, 25–27, 30–33, 36, 38, 46–48; Pacciarelli – Varricchio 2004; Pacciarelli et al. 2015, 257–260.

5 Carancini – Peroni 1997.

6 See e.g. for northern Sicily Lentini et al. 2004 and for the Aeolian Islands Bernabò Brea – Cavalier 1980.

7 Pacciarelli 2000, 82–84.

This role was favoured not only by the possibility of disembarking ships in a protected bay, but also by the opportunity to acquire visual control over the entire southern Tyrrhenian, from the Calabrian coast in the north to the Aeolian Islands in the south.

The Excavation and the Geophysical Survey

In 1994 the *Soprintendenza per i Beni Archeologici della Calabria* undertook the first excavation at the site of Punta di Zambrone. An L-shaped trench already brought to light part of the Recent Bronze Age ditch, which, in the subsequent excavations (from 2011 to 2013), became the major object of investigation regarding this period (Fig. 3).[8]

The recent investigations began in 2011 with a geophysical survey.[9] In the area of the 1994 trench the course of the bipolar magnetic anomaly coincided perfectly with the partially excavated fill of the ditch. This serves to prove the existence of a fortification structure of approximately 85m in length. Its function was to protect – in association with a wall or rampart, of which we found some traces, mainly in the form of fallen debris, in the fill of the ditch (see below) – the easily accessible eastern side of the promontory. Immediately to the east of the fortification line, the terrace of the cape widens. Calculated on the basis of its present-day topography, the settlement area defended by the ditch and the natural slopes would have covered an area of at least 11,100m². The scarce surface finds on the higher terraces east and southeast of the fortification do not constitute sufficient evidence for the existence of any habitation areas beyond the fortified zone. Likewise, the results of the geophysical prospection do not provide any positive indication for a larger extension of the settlement in that direction.[10] However, considering the landslides affecting its steep slopes, the cape must have been significantly larger during the Bronze Age.[11]

The results of the geophysical survey formed the basis for choosing some specific excavation areas, investigated in three six-week campaigns in the years 2011, 2012 and 2013. Across the cape we measured a grid anchored in the geodetic reference system Gauss-Boaga, Datum ED 50. The grid consists of 1 x 1m squares numbered from west to east with Arabic numerals and from south to north with letters of the alphabet (in the northern part of the cape, where Area C was defined, with double letters). The excavation followed the extension of stratigraphical units. Inside each stratigraphical unit (SU), we collected pottery fragments and bones with an additional reference to the grid squares, in order to precisely document find scatters even in cases where the SU extended over several grid squares.[12] For other artefacts, as well as pottery fragments of special interest or whole vessels, we measured their precise coordinates. The code for a measured point is 'P' with numbering starting from '1' in each SU.[13]

The Earlier Bronze Age Remains: a Brief Reference

Early Bronze Age 1 layers came to light in Excavation Area D.[14] They contained many stones apparently belonging to disturbed structures, pottery vessels and a polished granite axe among other things. In the neighbouring Area B we have investigated part of an Early Bronze Age 2 rock-cut

8 Pacciarelli 2000, 83.

9 See Ullrich et al., this volume.

10 Some badly worn prehistoric sherds were found on terraces F and K (Ullrich et al., this volume with fig. 1).

11 Cf. Iaia 2017, 272, figs. 6e–f; Buhlke, this volume.

12 PZ151DD11 for instance is the code for artefacts from Punta di Zambrone, SU 151, square DD11 (in Area C). Numbered sherds got their number separated by a slash from the square code, e.g. PZ151DD11/49 for sherd no. 49 from PZ151DD11.

13 To give an example, PZ151/P43 is the 43rd measured point inside SU 151; it has the coordinates East: 2604707.110m; North: 4285500.559m; height asl: 36.496m.

14 For a short reference and two ^{14}C dates see Pacciarelli et al. 2015, 255, fig. 1; 257, 278.

trench, which, according to the electromagnetic prospection, ran across the eastern end of the cape – much in the same way as the later RBA fortification. A series of fill layers in this earlier negative structure yielded a rich array of fragmentary pots and biofacts.

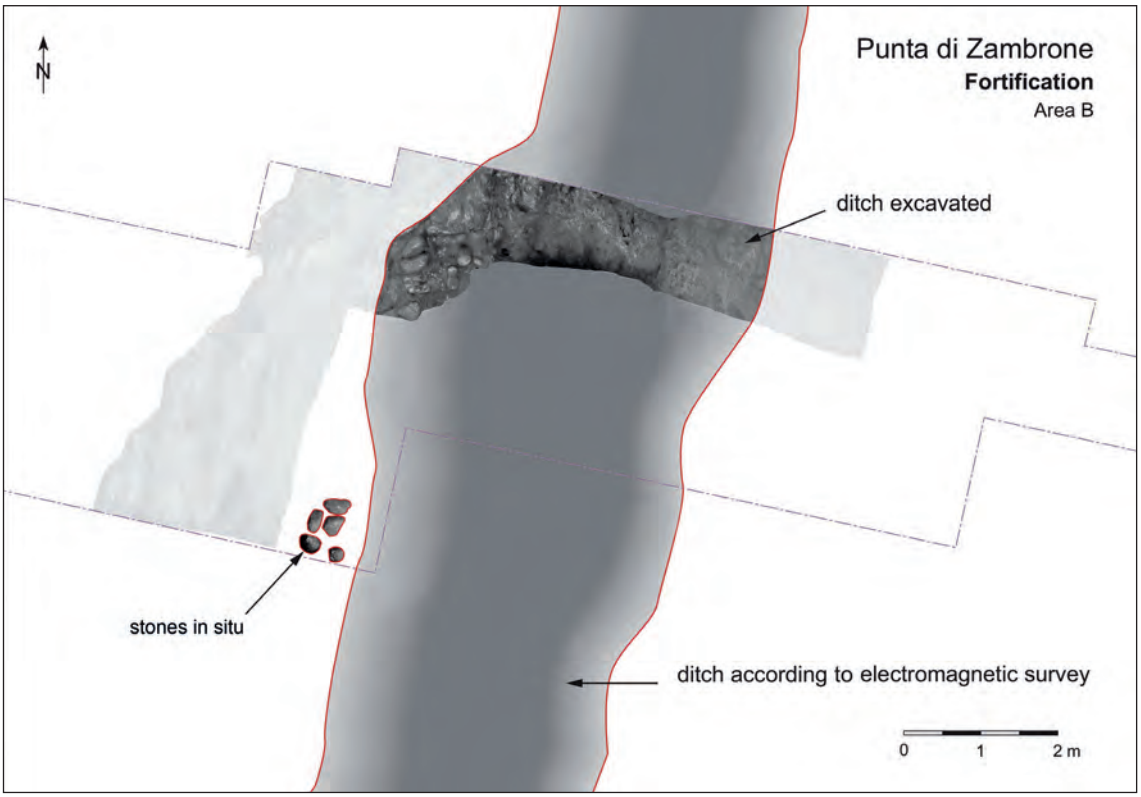


Fig. 4 Fortification ditch in Area B (documentation: A. Buhlke)



Fig. 5 Fortification ditch in Area B, from the south: to the left, at the western edge of the ditch, the bedrock and stones of the fortification in situ as well as in collapse position (documentation: A. Buhlke)



Fig. 6 Western edge of the fortification ditch in Area B, from the south: bedrock, stones of the fortification in situ and in collapse position (documentation: A. Buhlke)

The Recent Bronze Age: Structures, Stratigraphy, Human Remains

In Excavation Area D, the only one located where the RBA village should have been, there were no strata or structures of this period, which is certainly due to their removal by the combined action of natural erosion and agricultural and terracing works (especially those occurring in the 20th century CE and employing mechanical means).

The excavation uncovered the aforementioned RBA rock-cut fortification ditch in two different excavation sectors, i.e. Area B in the central part of the cape and Area C close to its northern scarp.[15] In Area B, at two spots a few stones had remained in situ right along the western edge of the ditch (Fig. 4). These are the remnants of a wall or rampart, most of which had collapsed into the ditch, as stone concentrations aligned in an oblique west–east direction inside the ditch fill of both excavation areas indicate (Figs. 5–6).

The width of the ditch varies from 4.50–4.70m in Area B to 4.80m in Area C, while its bottom is between 1.80 and 2.0m wide (Figs. 7–10). The minimum depth of the ditch oscillates around 2.00m, as measured from the base of the ploughsoil, which corresponds to the highest preserved surface of the rock. The eastern scarp has an inclination of 45°, while the inclination of the western one ranges from 55° in Area B to 60° in Area C. The decline of the ditch bottom amounts to 1.32%, as calculated from the height difference of 0.25m between the second northern section of Area B and the southern section of Area C (over a distance of 19m). This demonstrates that the ditch drained rain water from the highest central part to the lateral northern edge of the terrace, which is further verified by evidence of undercut features due to the erosive action of water on the eastern slope close to the bottom in both excavation areas.

[15] The bedrock has the stratigraphical units (SU) 8 = 94 in Area B and 30 = 32 in Area C. The cutting is defined by the SU 8 = 94 in Area B and 84 = 85 in Area C.

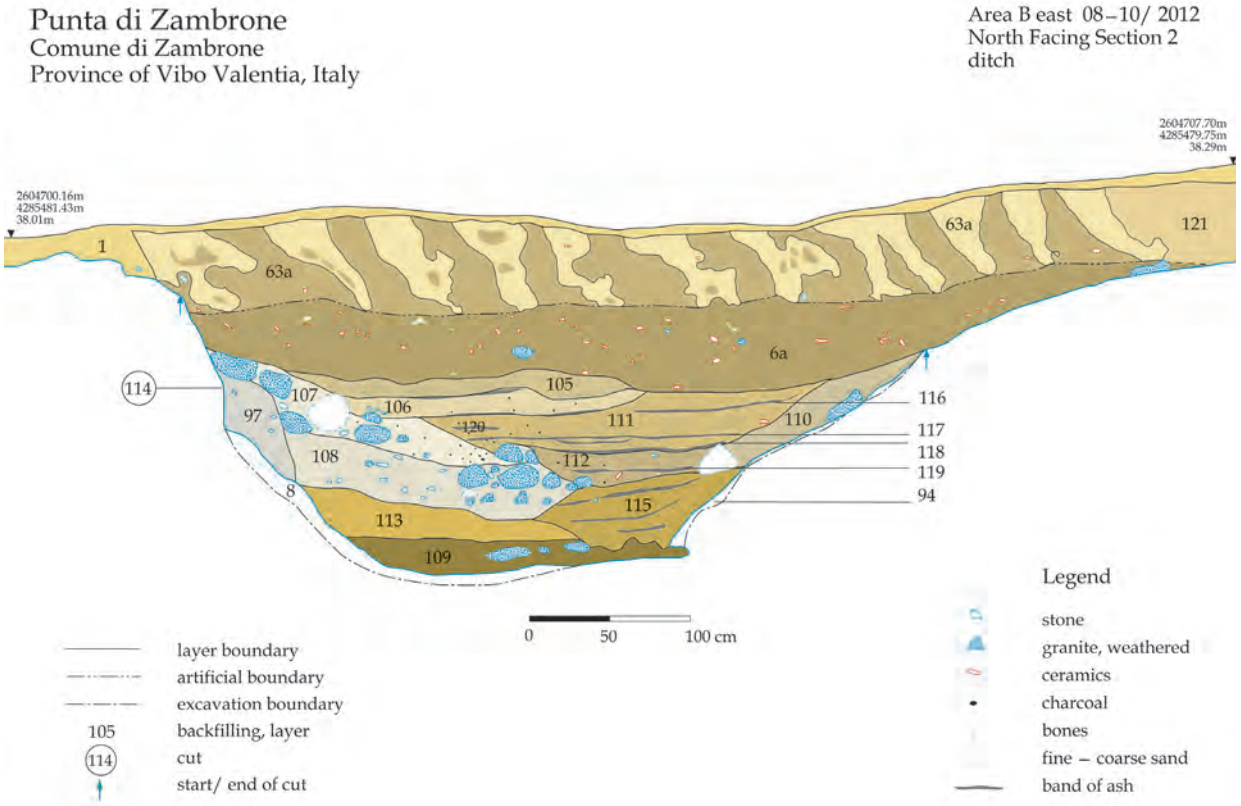


Fig. 7 Section B-2 of the fortification ditch in Area B, from the south (documentation: A. Buhlke and M. Pacciarelli)

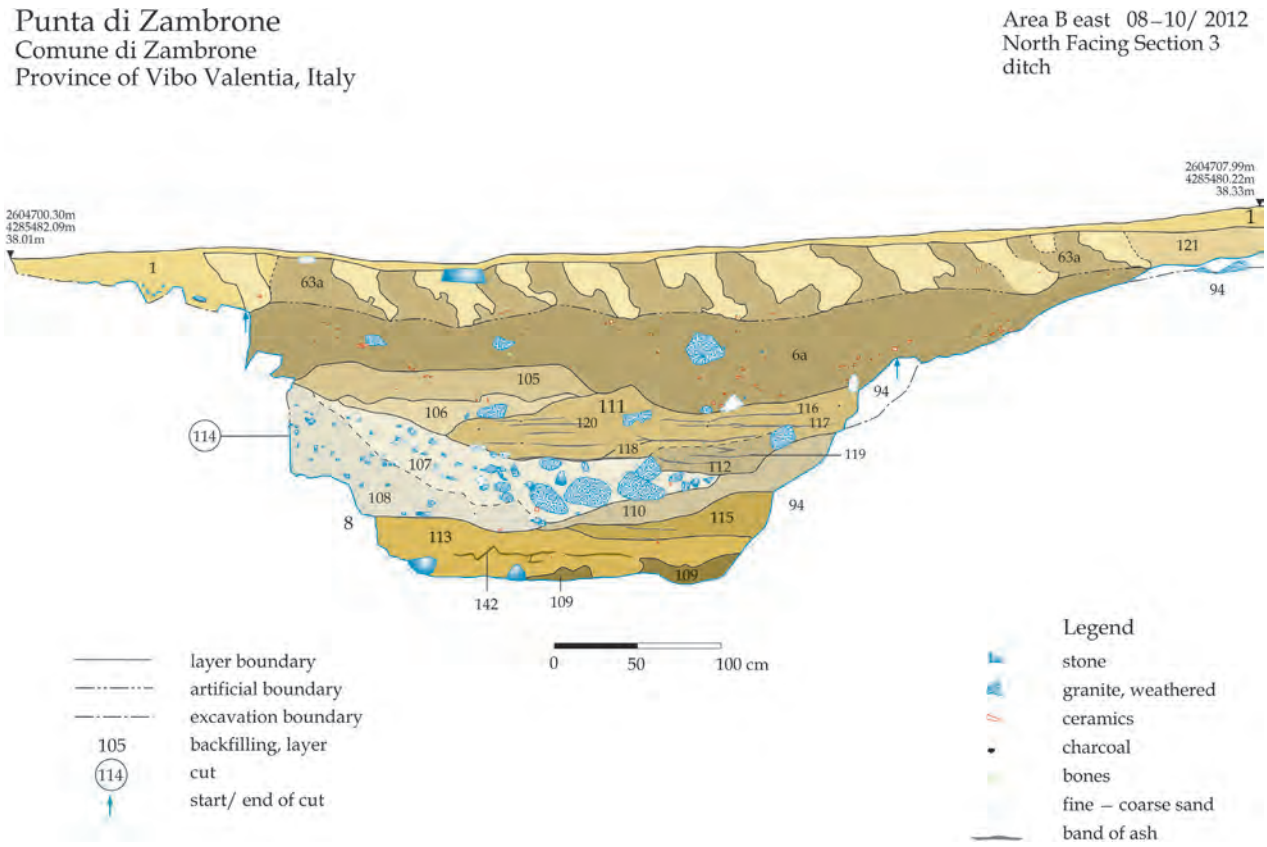


Fig. 8 Section B-3 of the fortification ditch in Area B, from the south (documentation: A. Buhlke)

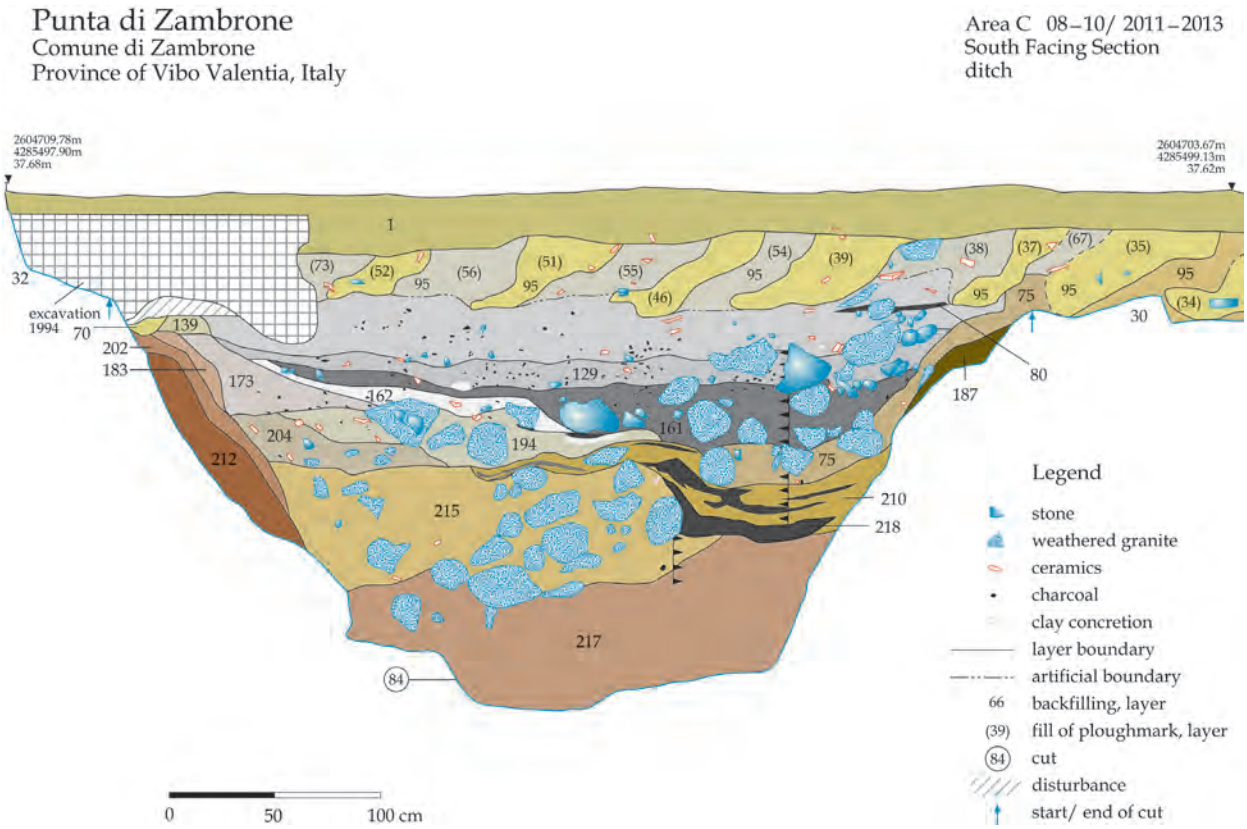


Fig. 9 South section of the fortification ditch in Area C, from the north (documentation: A. Buhlke)

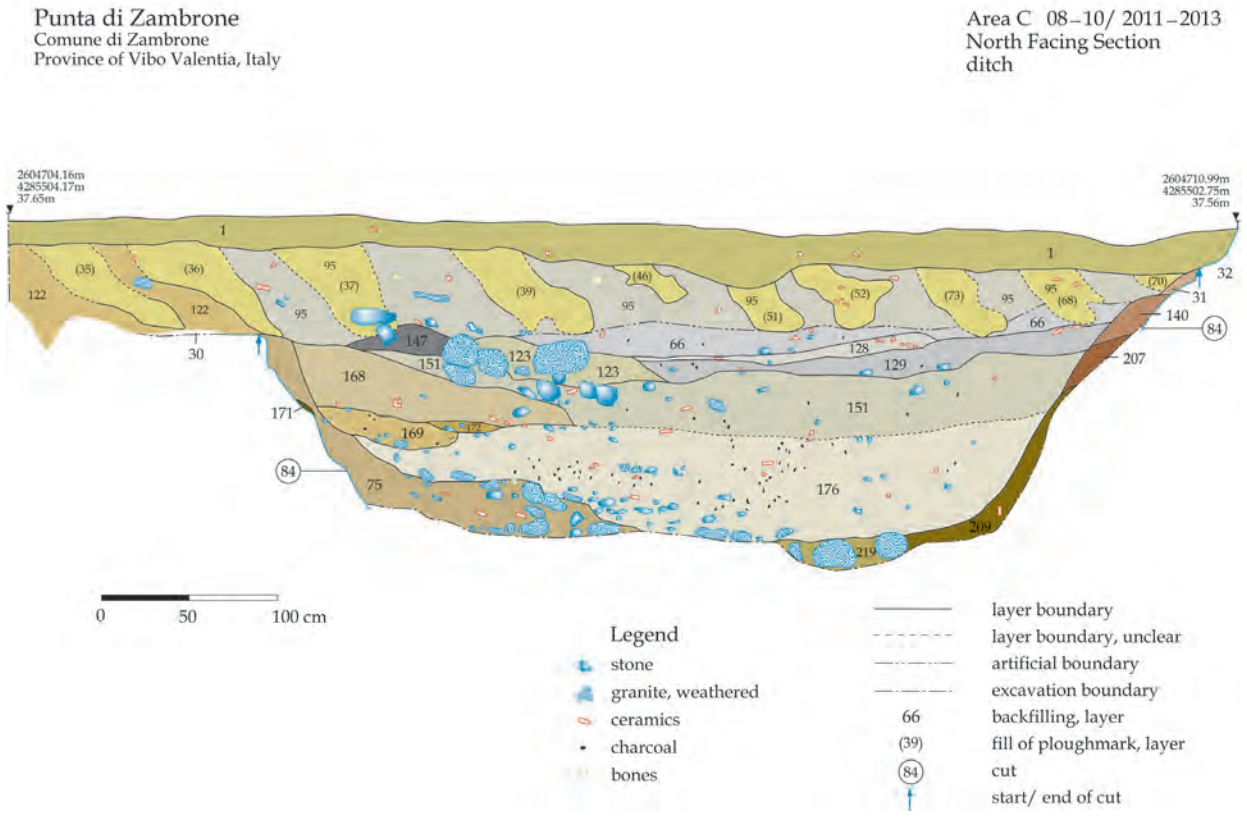


Fig. 10 North section of the fortification ditch in Area C, from the south (documentation: A. Buhlke)

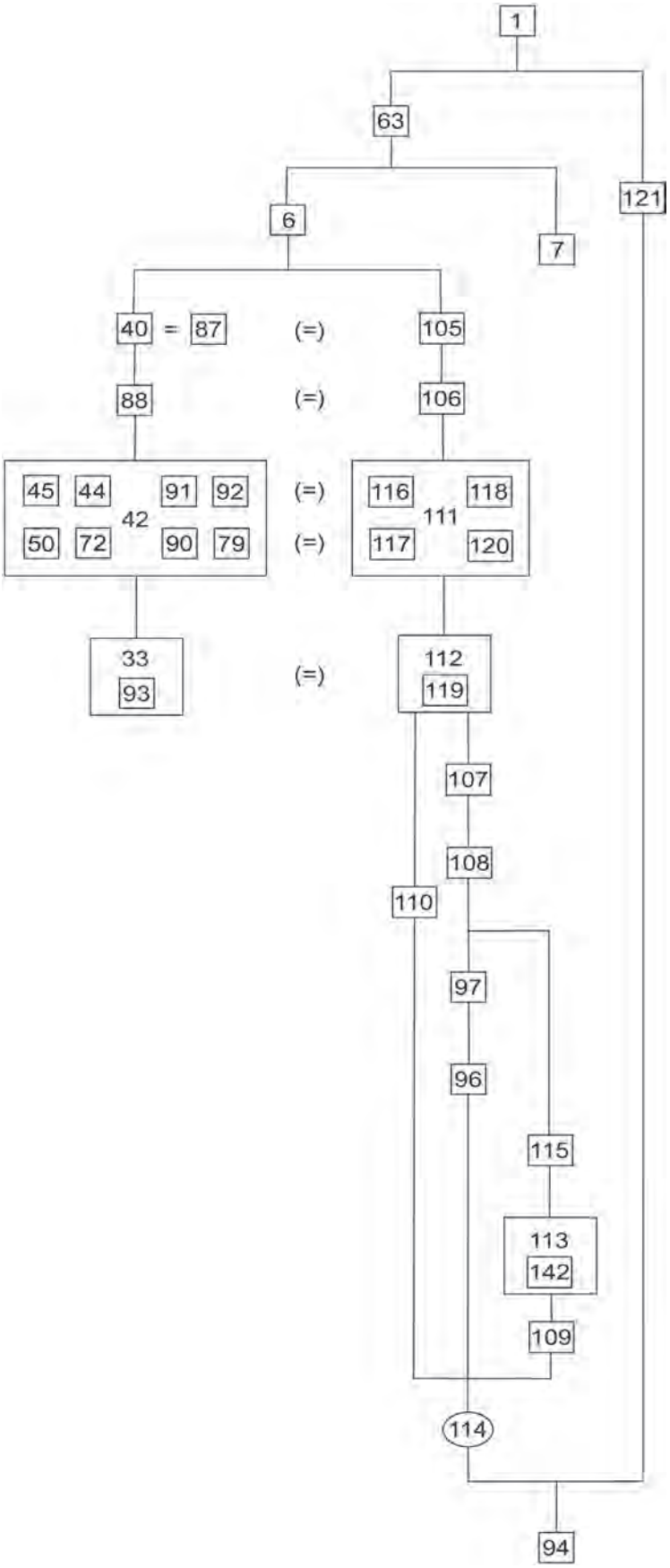


Fig. 11 Stratigraphical matrix of the fortification ditch in the eastern part of Area B (documentation: L. Soro, A. Buhlke)

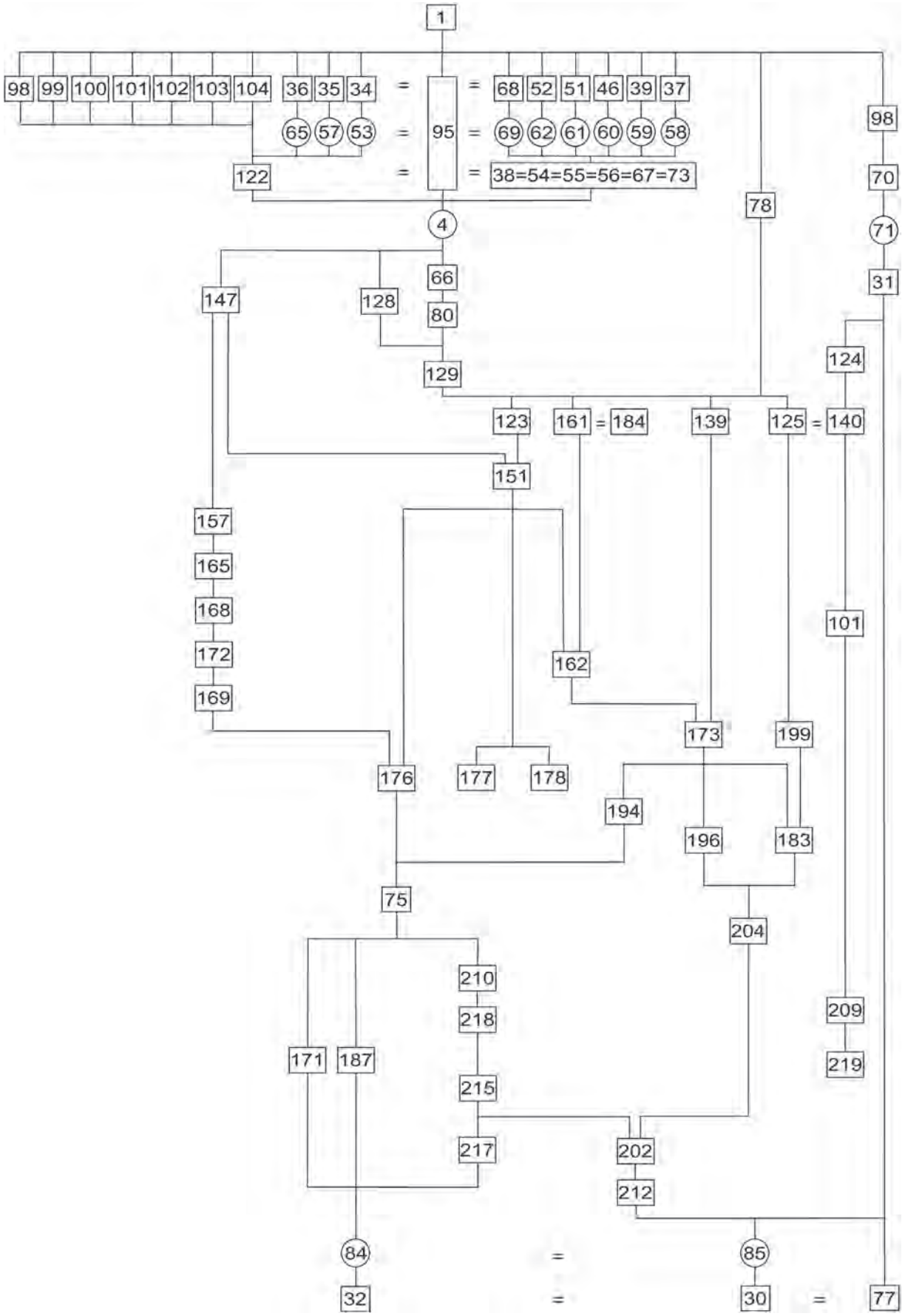


Fig. 12 Stratigraphical matrix of the fortification ditch in Area C (documentation: L. Soro, A. Buhlke)



Fig. 13 3D visualisation showing the collapse of the fortification structure in Area C, from the east (documentation and graphics: A. Buhlke)



Fig. 14 Deep *impasto* cup PZ129/P53 in situ embedded in the ashy layer SU 129 (photo: A. Buhlke)

When assessing the primary function of the fortification structure at Punta di Zambrone and its historical significance, one cannot find any published parallels in the Lower Tyrrhenian region. This may be partially due to lack of more extensive excavations and partially to the the presence of natural defences (high, steep slopes) all around the perimeter at several RBA sites such as the acropolis of Lipari.

By contrast, there are some parallels from Apulia, while comparable ditches are almost totally absent in the Aegean, with the exception of Troy VI middle/late.[16]

Steadily, the lower part of the ditch had filled up with sandy to clayey sediments (silty clay at the very bottom of Area B [SU 109] and sandy clay loam at the very bottom of Area C [SU 217],[17] Figs. 11–12). There follow further levels of similar composition (sand, loamy sand, silty loam, sandy loam) and origin, some of which in Area B contain thin ash lenses (SU 97, 113, 142, 115 in Area B and SU 202 and 212 among others in Area C). Thick levels of clayey to loamy composition and containing many medium to large stones covered these sediments in a west–east direction, evidently falling from the western edge of the ditch (SU 107 and 108, both of silty clay, in Area B and SU 215 of silty loam in Area C). There is a good probability that these debris layers derive from a partial collapse of the fortification rampart or wall, which was – as mentioned above – positioned along the western edge of the ditch. As the stones consist of the characteristic local weathered granite, they might originate from the excavation of the ditch. It seems that in the northern part of the ditch the inhabitants undertook some work inside the described debris layers, opening a narrow channel in order to facilitate the drainage function of the ditch. This channel subsequently filled up with thick intercalating charcoal and sandy/silty to loamy layers (SU 218 and 210 in Area C). More or less contemporaneously, in the central part of the ditch (Area B) a series of sedimentation processes produced a sequence of loamy to sandy layers (SU 105, 106, 111, 112), some of which include thin ash lenses (116, 117, 118, 119 and 120).

In the northern part, the sedimentation processes came to an end with another collapse of the western fortification, visible in a thick layer of clay loam and stones (SU 75, Fig. 13), on top of which we found the only entirely preserved vessel from Area C. It is a deep cup, which was reclining on its side with the mouth facing west and placed against a stone. It was embedded in a strongly ashy layer of sandy clay loam (SU 129), surrounded, and thus protected, by large sherds and stones (Fig. 14). These facts speak in favour of a careful intentional deposition of the cup on the surface of the fallen fortification. In our opinion this hints at a ritual act connected with the final dismantlement of the rampart or wall and the complete infill of the ditch.

In this northern part of the ditch (Area C), the final infill consists mainly of ashy layers (SU 66 [vertically subdivided into 66, 66a, 66b, 66c, 66d, 66e, and 66f[18]], 80, 129 [vertically subdivided into 129, 129a and 129b[19]] 151, 161, 162, 173, 176, 194 and 204). In this final infill of ashy material, but also in US 123 (with a sandy matrix), which is not one of the ashy layers, but still part of the final infill, there were more granite stones that must originate from the fortification structure. Some stones from SU 75, 129 and 151 show several (up to five) flat surfaces meeting at right angles and are, at least in part, worked stones (Figs. 15–18).[20] Thus, the wall or rampart did contain partly squared blocks. The stones uncovered in situ at the western end of the ditch in Area B in the central part of the fortification (see above) also seem to be worked and show flat surfaces meeting at right angles. This brings to mind the almost isodomic wall construction characterising

16 Jung et al. 2016, 176–179.

17 When describing sediments during excavation we referred to the Soil Texture Calculator triangle by the United States Department of Agriculture (USDA), see <https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/home/?cid=nrcs142p2_054167> (last accessed 15 Apr. 2020).

18 The basis for this internal vertical subdivision was sherd concentrations extending horizontally, while the matrix of the stratigraphical unit did not change.

19 Cf. note 18.

20 The advanced degree of weathering visible on the outcropping rock as well as on the stones originating from the collapsed fortification make it difficult to judge how many of the construction stones may have originally been worked.



Fig. 15 Worked stones from SU 129 and 151 in Area C (photo: R. Jung)



Fig. 16 Worked stones from SU 129 and 151 in Area C (photo: R. Jung)



Fig. 17 Worked stones from SU 129 and 151 in Area C (photo: R. Jung)



Fig. 18 Worked stones from SU 129 and 151 in Area C (photo: R. Jung)

the internal front of the RBA 2 fortification at Roca Vecchia.[21] Geographically closer to Punta di Zambrone, in the approximately contemporary Ausonian I settlement on the acropolis of Lipari, certain huts exhibit quite regularly built rows of stones with small blocks one could call squared according to the excavators.[22] Bernabò Brea and Cavalier ascribed such construction techniques at Lipari, which made their appearance even earlier, during the MBA 3 *Milazzese* phase, to Aegean influence.[23]

All the mentioned ashy layers, the matrix of which is mostly silt loam (sometimes clay loam or sandy loam), yielded large quantities of charred wood and seeds,[24] much animal bone[25] and pottery, as well as many other types of artefacts (e.g. metal tools, ornaments and weapons, faience beads, bone and ivory objects). Most of these finds are rather fragmented. The ashy layers show some variability in the colour and quantity of charcoal and granite grit. Nevertheless, there are numerous pottery joints between fragments found in different ash layers, even separated by several metres in a horizontal direction and dozens of centimetres in a vertical direction (Fig. 19). Very rarely only fragments of a single vessel are scattered over a restricted surface (for such an exceptional case see the carinated cup, Figs. 20–21).

---

21 Uncovered in Area SAS IX, architectural phases IV and V, see Pagliara et al. 2008, 239, 241, fig. 2; 248–249, figs. 6–7; Scarano 2012, 25–31, figs. 1.23, 1.26–1.33; Guglielmino et al. 2017, 552–554, fig. 1.4–5; see also Guglielmino, this volume, fig. 1. The stones of the Roca fortification are cut with different degrees of regularity – similar to the worked stones of the Zambrone fortification. The building material is different: limestone in the case of the Apulian site, granite in the case of the Calabrian one. However, the Lecce limestone is very soft and very workable (Scarano 2012, 39 n. 16), while the porous, coarse-grained granite of Punta di Zambrone also easily lends itself to working with simple tools (cf. Buhlke, this volume).

22 Bernabò Brea – Cavalier 1980, 561, pl. 35.2.

23 Bernabò Brea – Cavalier 1980, 547.

24 See the final report on the analysis of the archaeobotanic remains: Klee et al., this volume.

25 On which, see the final report on the analysis of the animal bones by Gerhard Forstenpointner, Gabriela Slepecki, Alfred Galik and Gerald E. Weissengruber in the present volume as well as their report on the remains of marine animals in: Jung et al. 2016, 195–197.

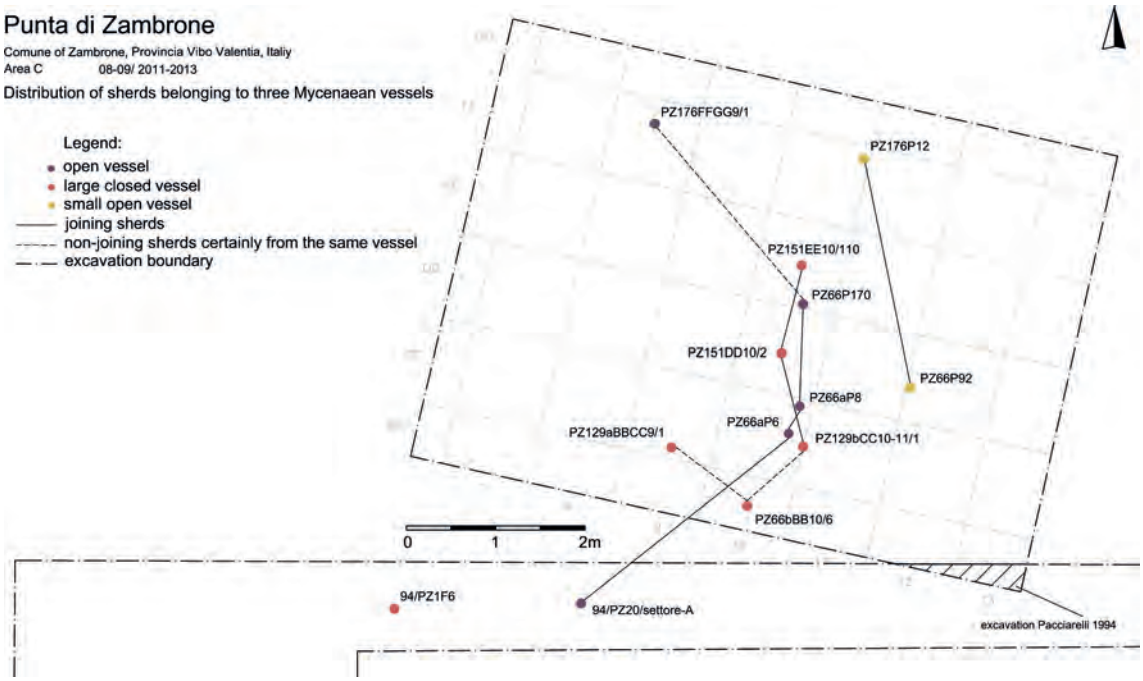


Fig. 19 Distribution of sherds belonging to three Mycenaean vessels in the ashy levels of Area C (1994, 2011, 2012 and 2013 campaigns) (documentation: A. Buhlke)



Fig. 20 Carinated *impasto* cup PZ66/P43/1.3.4 + PZ66/P44/1+ PZ66/P47/1.2 (photo: J. Lipták)

In addition, we have no evidence for a laminated stratigraphy typical for a gradual deposition process.[26] All this evidence leads us to reconstruct an anthropogenic and continuous action sealing the ditch. Furthermore, the aforementioned joints and the considerable time span represented by

[26] This would exclude processes of primary discard inside the ditches – i.e. activities similar to what happened in the ditches running through the settlement of Frattesina (Baldo et al. 2018, 15–17, 30, 37, 46, tab. 2; 55, fig. 9; for a reconstruction drawing of the activities at Frattesina see Bellintani et al. 2018, 22–23).

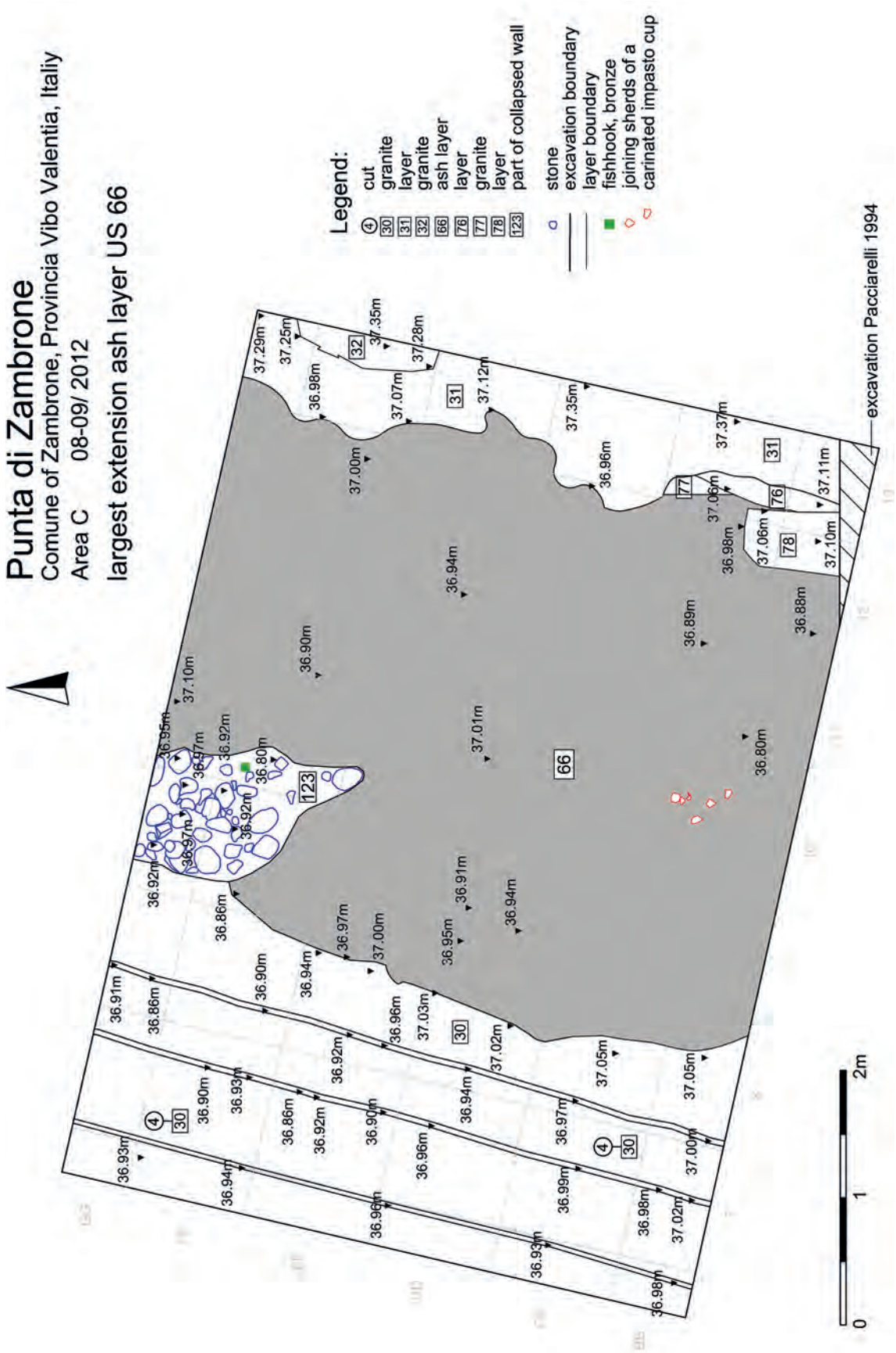


Fig. 21 Stratigraphical unit PZ66 with find positions of sherds belonging to the carinated *impasto* cup shown in Fig. 20 and of the fishhook PZ123/P19 in stratigraphical unit PZ123 (documentation: A. Buhlke)

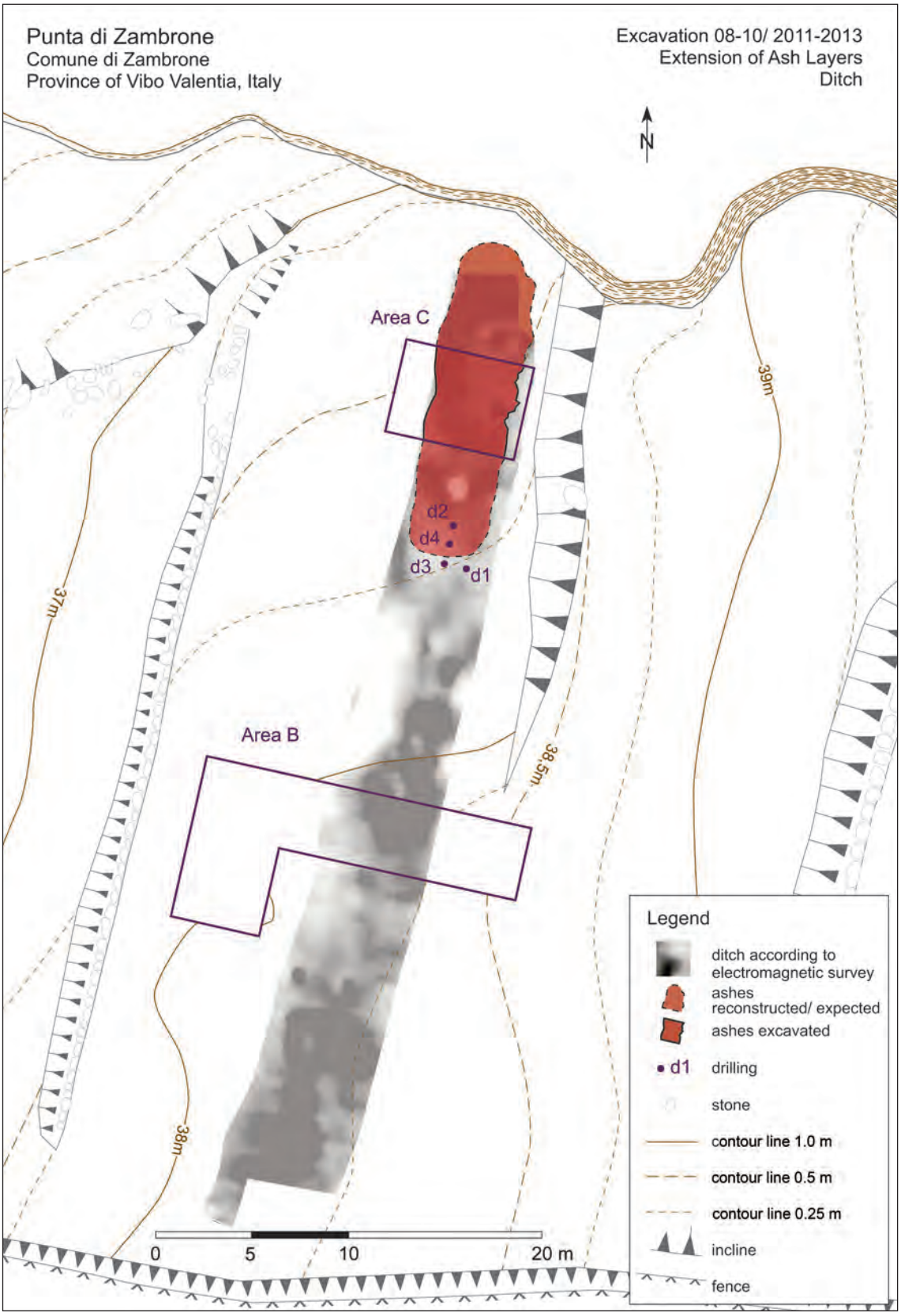


Fig. 22 Course of the fortification ditch as detected by electromagnetic prospection with extension of ashy layers indicated. Drill cores d1–d4 verified the extension of the ashes to the south of Area C (documentation: A. Buhlke, R. Jung, M. Pacciarelli; cartography: A. Buhlke)

both the *impasto* and the Aegean pottery (late MBA 3 to RBA 2 and LH IIIB to LH IIIC Early respectively) and also by the ^{14}C dates (in both models running from the 14th to the end of the 13th/start of the 12th century BCE) can only be explained by a secondary deposition of material, which had accumulated over time elsewhere.[27] The place where the presumed refuse heaps originally piled up, must have been protected in some way from wind and rain – considering the fact that erosion would easily have dispersed those ashes. Such a protected place might have been offered by the rear side of the fortification.

The undisturbed ash levels reach a thickness of 1.20m in the northern section and 0.80m in the southern section of Area C. By means of coring we determined the extension of the preserved ash deposit, which is still present at 5.65m south of the southern section of Area C (core d4 in Fig. 22). Given the thickness of the ash in the northern section, we may assume that it continued for another 5m up to the edge of the promontory. Inside Area C the ashes amount to 26.54m³, while the total calculated amount would add up to 54.09m³. We examined three different hypotheses for explaining the formation of those ashes.

(1) As the ash deposit apparently contained material from the last settlement phase, there may be a connection with a final destruction by fire. The conflagration destroying the RBA settlement phase Ausonian I on the acropolis of Lipari might offer an analogy – also when seen against the common geographical–historical milieu. However, the connection is not an immediate one. One must first note that the end of Lipari occurred some decades later, as the Protovillanovan (FBA) pots from the destruction layer demonstrate.[28] A second, more important point is the rarity of burnt ceramics and daub as well as the absence of large charcoal fragments in the Zambrone ash layers. Thus, these layers do not offer any evidence for houses destroyed by fire.

(2) According to a second hypothesis, the deposit may derive from domestic waste that had accumulated elsewhere over time. However, the huge quantities of ash seem to surpass ordinary domestic refuse.

(3) It seems apparent that the deposit resulted from some kind of activity that produced considerable amounts of ash. This might have been large-scale production of either pottery or metal objects. However, apart from a single piece,[29] we did not encounter any clearly misfired pots nor any moulds, tuyères, slags or other indicators for metallurgical craft activities.

(4) A fourth possible explanation would be food production or processing on a large scale (baking of bread[30], roasting of cereals, smoking of meat or fish). The presence of many burnt seeds and much chaff (see also below) may support this fourth hypothesis, but due to the absence of ovens or baking installations it is hard to prove it (given the lack of settlement structures preserved in situ).

(5) Finally, the ashes with their plant and animal remains (and also with the rich array of local and Aegean tablewares) may have been a by-product of cooking/feasting/ritual burning involving large groups of people. The percentage of burnt bones from the ashy layers, which is elevated in comparison to the contemporary animal bones from Area B, is another indication in this regard,[31] and even the high quantity of metal objects and beads of vitreous materials (and perhaps also the presence of the ivory statuette) may be tied to ritual activities.

In situ evidence for probably ritual feasting came to light in the early RBA 2 settlement levels of Roca Vecchia and included rather large quantities of ash, animal bones (burnt and unburnt, the latter partially in anatomical connection and deposited underneath branches) as well as local *im-*

---

27 We are thus dealing with secondary refuse *sensu* Schiffer, meaning the location of final discard is not the location of use (Schiffer 1972, 161–162, fig. 3).

28 Bernabò Brea – Cavalier 1980, 564.

29 PZ161BBCC10–12PUL/5, a waster of *impasto* pottery, for which see the contribution by Fragnoli, this volume.

30 Regarding the use of fire for large-scale food production, see the example – taken, of course, from a very different socio-economic context – of an Egyptian palace bakery of the First Intermediate Period and the early Middle Kingdom at Elephantine, where bread production lead to the accumulation of huge quantities of ash (Dreyer et al. 2002, 170–174, pl. 18).

31 See Forstenpointner et al., this volume.

pasto and Aegean-type vessels in considerable quantities.[32] Monte Santa Giulia in the Province of Modena is an example of a RBA ritual place with offerings of bronzes, ceramic vessels and food (cereals, pulses and meat) deposited on a pyre inside a pit.[33] The miniature vessels from the ash layers of Punta di Zambrone might fit with a place of ritual inside the settlement and thus speak in favour of a ritual practice being responsible for the ash formation. However, the quantity, i.e. eleven fragmentary vessels,[34] is not extraordinarily high, if judged against the overall quantities of retrieved pots and the long time span represented in the context.

The Apulian settlement of Coppa Nevigata in its RBA 2 phase offers a good model for reconstructing the formation process and even the original topographical context of the ashes inside the settlement. It is an open area within the fortification and outside a two-room building situated just behind the fortification line. It is covered by grey to black layers reaching a thickness of more than 0.50m. Just like the ashes inside the Punta di Zambrone ditch, these layers are rich in charred botanical remains, in bones and artefacts including metal objects, beads and Mycenaean-type vessels. According to the excavators this is a rubbish dump. It is possibly related to a second open zone with ovens and hearths, where collective food preparation took place.[35]

One more category of finds from the ash layers offers further support to the hypothesis that the activities leading to the formation of those discard deposits were not purely economic in character, but had some important ideological dimension as well. Scattered throughout the ash layers, we found fragmented human bones, which the anthropologists were able to assign to two different individuals. There is no stratigraphic indication that we are dealing with remains of disturbed in situ burials.[36] Instead, the available evidence can support two alternative scenarios. According to the first possibility, the human skeletal elements had accumulated together with the animal bones and artefacts at some place before they were eventually dumped inside the ditch. Alternatively, the inhabitants of the settlement had buried those two individuals inside the original ashy deposit, probably at the rear side of the fortification inside the settlement (see above). Later in time, however, those human remains ended up in the fill of the ditch, in disorder and together with all the materials that were once part of the original ashy deposit and now served to seal the ditch. The specific distribution pattern of the human bones inside the ditch also excludes the possibility that these remains belong to persons who were killed and fell into the ditch during fights related to the destruction of the settlement[37] or else were dumped there subsequently.

As the evidence indicates that the first depositional context of these human bones was one of discarded food remains and other types of refuse, one should take a closer look at what we know about the treatment of the dead during the RBA in southern Italy (Fig. 23).[38] In fact, the sole published cemeteries of RBA date are Canosa (Contrada Pozzillo) and Torre Castelluccia, both in Apulia, while all the other RBA burial sites are just isolated tombs or burials in collective tombs dating back to earlier chronological phases. On the Tropea peninsula, apart from the re-deposited assemblage of Vibo Valentia, we have just chamber tomb 4 of Bagneria, close to Santa Domenica di Ricadi. This tomb is part of a MBA 1–2 cemetery and was only re-used during the Recent Bronze Age.[39] This

---

32 Excavation Area SAS IX, Phase I and especially Phase II: Guglielmino 2009, 187–194, figs. 1.3–4; 2–3; Pagliara et al. 2008, 251–253, figs. 252–253; 270–276, figs. 17–21; Iacono 2015, 266–272; Guglielmino, this volume.

33 Cardarelli 2012, 40–43, fig. 3. Quoting a ritual place on a mountain summit in Emilia may not be out of place here given the fact that the Subapennine pottery from Punta di Zambrone exhibits strong ties to the North Italian regions of Romagna and Marche (see Pacciarelli 2015, 56–57).

34 Capriglione 2016, 185–186, 423, pl. 54.

35 Cazzella – Recchia 2012, 299–306.

36 See the mapping of the fragments and the detailed catalogue in the contribution by Fabian Kanz, Jan Cemper-Kiesslich, Nora Großschmidt, Reinhard Jung and Karl Großschmidt in the present volume. Many human bone fragments come from levels still reached by the plough, but several were found in deeper, undisturbed layers.

37 Such as the man fallen into the southern lateral chamber of the main entrance passage, the Monumental Gate, in the MBA 3 fortification at Roca Vecchia (cf. Scarano 2012, 102–105, figs. 3.99–3.101; 116, fig. 3.316; 139).

38 For an overview of Bronze Age funerary practice in southern Italy see Pacciarelli 2012.

39 Pacci 1987; Pacciarelli 2000, 184, fig. 108.

remarkable rarity of RBA burials in southern Italy may suggest that the population treated their dead in various ways including rites other than formal burial at specific cemetery sites located outside settlements.

Such a conclusion gains in strength when seen against the background of cemeteries dating to the preceding Middle and the following Final Bronze Age periods and located in the same regions as the RBA tombs cited. For the former period one may name, for instance, the Grotta

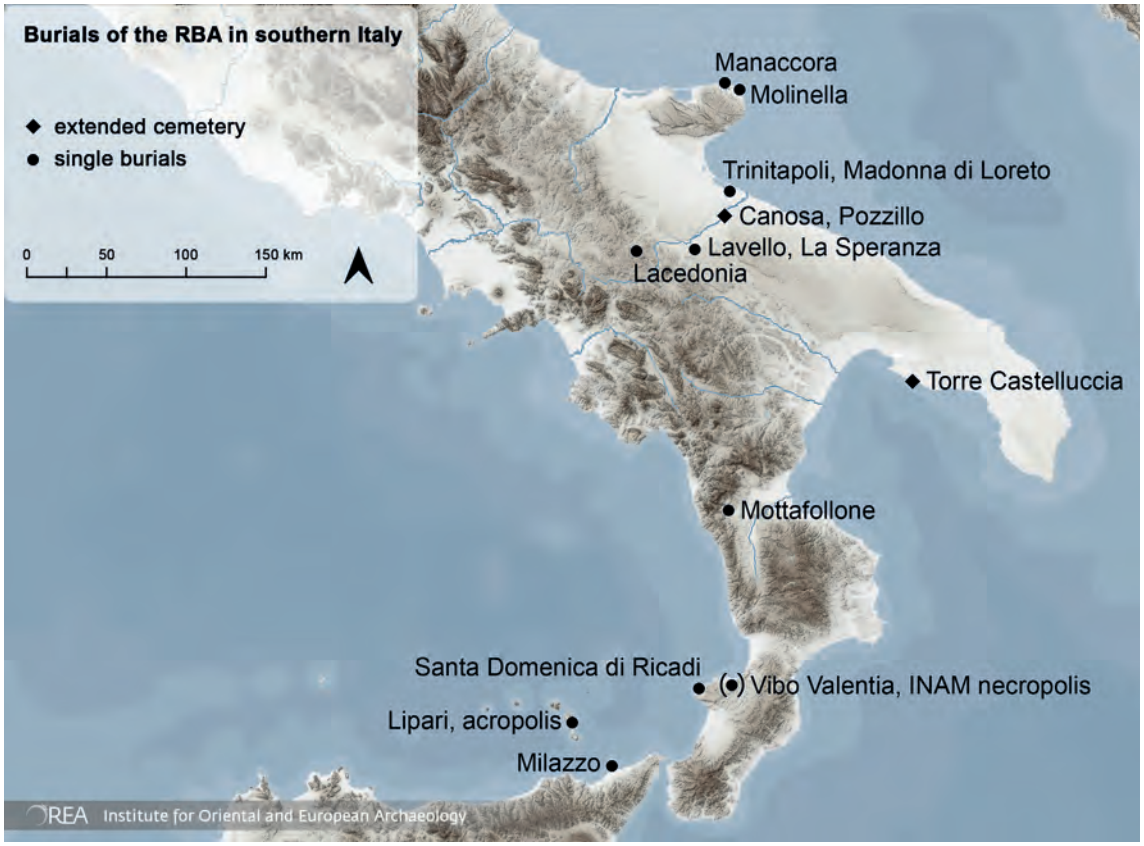


Fig. 23 Burials of the RBA in southern Italy. ♦ extended cemetery; ● single burials. – Canosa, Pozzillo (cremation burials in urns of mostly RBA date, part of a MBA3–RBA cemetery): Lo Porto 1997. – Lacedonia (RBA cremation burial in an urn): D'Agostino 1974; D'Agostino 1979, 484–485, fig. 5; Nava 1984, 128–129, fig. 156; Lo Schiavo 2010, 92 cat. no. 27, pl. 3.27; Pacciarelli 2012, 220–221. – Lavello, La Speranza, tomb 743 (hypogaeum with some RBA inhumations): Cipolloni Sampò 1999, 163–164. – Lipari, acropolis, underneath hut β I and outside hut β V (one certain and one probable RBA cremation burial in an urn): Bernabò Brea – Cavalier 1980, 114, 140, 148, 563, pls. 9.1, 4; 42.3, 4; 210.2; 218.3–4. – Manaccora, mouth of the 'Grotticella funeraria' (RBA inhumation burial with Naue II sword dependent on either type Cetona or Allerona): Bianco Peroni 1970, 72–74 cat. no. 174, pl. 24.174; Recchia 1993, 389, 394, fig. 27.B?. – Milazzo, Via XX Settembre (at least two RBA cremation burials in urns and one pottery stray find): Bernabò Brea – Cavalier 1959, 81, 87, pl. 32.6; Lo Schiavo 2010, 106–107, pl. 12.85B–C; Capriglione 2016, 25 with n. 42. – Molinella (probable RBA cremation burial in an urn with sword): Nava 1984, 117, 127, fig. 151; Pacciarelli 2012, 220, 233, fig. 2. – Mottafollone (RBA cremation burial in an urn with spiral-headed pin): Vanzetti 2013, 16. – Santa Domenica di Ricadi, Bagnerìa, tomb 4 (RBA use of a MBA 1–2 chamber tomb with inhumation burials): Pacci 1987; Pacciarelli 2000, 184, fig. 108. – Trinitapoli, Madonna di Loreto, Hypogaeum of the Bronzes (few artifacts of RBA date among the grave gifts of inhumation burials): Tunzi Sisto 1999, 254 cat. no. 264; 257, pl. 3.264; 270–271 cat. no. 1361; pl. 16.1361; Cataldo 1999, 238 cat. no. 1550; Pacciarelli 2012, 221. – Possibly also Trinitapoli, Giant's Hypogaeum (central interment, so-called Giant 1, an inhumation without datable grave goods, but with a ^{14}C-date on human bone with a published calibrated range of 1270–1010 calBC, i. e. RBA–FBA): Fabbri et al. 2006. – Torre Castelluccia (cemetery with at least 11 RBA cremation burials in urns as well as some inhumation burial[s] inside the chamber tomb): Müller-Karpe 1960–61; Gorgoglione 2002, 38–42, fig. 20; 43, fig. 21.1; 44, fig. 22.5,7; 59, 62, 64–66, figs. 39–43; Vanzetti 2002. – Vibo Valentia, INAM necropolis, tomb 156 (tomb of the 1st half of the 6th century BCE with two re-deposited RBA weapons): Bianco Peroni 1974, 3–4 cat. no. 145 A; 15 cat. no. 145 A, pl. 2.145A; Arslan 1986, 1044; Bianco Peroni 1994, 159 cat. no. 1592, pl. 89.1592; Pacciarelli 2000, 189–190, fig. 110 (cartography: M. Börner)

Manaccora,[40] the Hypogaea at Trinitapoli[41] as well as a series of dolmen tombs[42] in Apulia, the chamber tombs at Murgia Timone in Basilicata[43] and the inhumation burials (mostly inside jars and pithoi) of the podere Caravello plot at Milazzo in northeastern Sicily,[44] among others. For the latter period we have, e.g., the extended urnfield of Timmari in Basilicata,[45] the cemetery with pithos inhumation burials and urn cremation burials at the Piazza Monfalcone on Lipari[46] and the urnfield on the Via XX Settembre[47] of Milazzo. In southern Calabria there are the above-mentioned MBA chamber tomb necropolis of Santa Domenica di Ricadi, some MBA pithos inhumation burials,[48] several FBA urn burials at Tropea,[49] and the well-known group of FBA inhumation tombs at Castellace.[50]

Finds of human bone in settlement areas have been discussed previously with reference to a few Bronze Age settlements in southern Italy, i.e. Coppa Nevigata, La Starza (Ariano Irpino) and Broglio di Trebisacce. No clear-cut picture emerges from these investigations so far.[51] Although there is no uniformity of the phenomenon throughout the chronological sequence of single sites, the observed spatial-chronological patterns – e.g. at Coppa Nevigata – still leave two main interpretative options open to discussion. According to the first, the scattered bones could originate from disturbed or exhumed and partially dislocated inhumations that had been made inside the settlement area. The more extensively excavated southern Italian sites do, however, allow the conclusion that such interments inside habitation areas were not a regular practice during the Middle, Recent and Final Bronze Age periods.[52] The only extensively excavated RBA settlement in the Lower Tyrrhenian region, the one on the acropolis of Lipari, did not provide evidence for intramural inhumation graves, but only some jars, which the excavators found in a vertical position underneath the floors of Ausonian I huts and which they interpreted as cremation burials.[53] The second interpretative possibility would be to ascribe the presence of human bone in the Bronze Age settlement strata to practices which did not involve any burial of the complete corpse in the

40 Recchia 1993.

41 Tunzi Sisto 1999; Tunzi Sisto et al. 2005; Tunzi Sisto – Lo Zupone 2008.

42 E.g. Giovinazzo: Lo Porto 1967.

43 Matarese 2018.

44 Bernabò Brea – Cavalier 1959, 1–30.

45 Quagliati – Ridola 1906; Nava 2003.

46 Bernabò Brea – Cavalier 1960, 97–172.

47 Bernabò Brea – Cavalier 1959, 31–103. The first use of this cemetery apparently dates back to the RBA, as a few urn burials and one stray find attest (Bernabò Brea – Cavalier 1959, 81, 87, pl. 32.6; Lo Schiavo 2010, 106–107, pl. 12.85B–C; Capriglione 2016, 25 with n. 42) The pottery from tombs 18, 21 and 82 (exhibited in the Museo Paolo Orsi at Siracusa) argue in favour of a RBA date. Moreover, the two violin-bow fibulae with raised and twisted bows from tombs 18 and 21 find a quite good parallel at the settlement of Campestrin in Veneto, a site dated to a late stage of RBA 2 or Final Bronze Age 1 (cf. Salzani 2011).

48 Like those of Gallo di Briatico (Pacciarelli 2000, 185–187) and Tropea (Pacciarelli – Varricchio 1991–92, 757, fig. B). See also Pacciarelli 2012.

49 Pacciarelli 2000, 46–47, figs. 24–25A.B.

50 Pacciarelli 1999b; Pacciarelli 2000, 191–202.

51 Recchia 2007–2008; Vanzetti 2007–2008.

52 A few Bronze Age intramural burials are known. See e.g. the case of two burials dating to MBA 2B/3A ('Appenninico iniziale') inside two postern gates at Coppa Nevigata (Recchia 2007–2008, 105–107, fig. 7; Recchia 2012, 393, fig. 5; 395–396, figs. 7–8). There may be evidence for secondary burial rites in the MBA podere Caravello cemetery of Milazzo. Some of the vessels used for burials are very small, yet they contained unburnt fragments of long bones and crania, which the excavators ascribe to redeposited bones from exhumed earlier jar/pithos burials (Bernabò Brea – Cavalier 1959, 16, pl. 8.1, 2, 4, 5).

53 Bernabò Brea – Cavalier 1980, 563, plans 5, 7, 11. This interpretation is not unlikely, considering that the soil at Lipari usually does not preserve bone remains. The jar found underneath the floor of hut β I provides the clearest case, as it was closed with a stone slab and contained faience beads, an amber bead, two fragmentary bronze objects and some badly preserved fragments of burnt bone (Bernabò Brea – Cavalier 1980, 114, 563, pls. 9.1, 4; 218.3–4). Another jar was deposited outside hut β V and vertically inserted in the MBA 3 level below. It did not contain burnt bone, but a fragment of bronze and a faience bead (Bernabò Brea – Cavalier 1980, 140, 148, 563, pls. 42.3, 4; 210.2).

ground at all, but which included handling the body or body parts in ways that remain largely unknown to us.[54]

In the case of Punta di Zambrone, we cannot decide between one of these two hypotheses, as the RBA settlement area itself could not be excavated due to the severe damage that had affected the site in the 20th century CE. However, the results of the Sr isotope analyses suggest that at least one individual was local to the coastal zone of the Tropea peninsula.[55] This may then argue in favour of interpreting this specific individual as a resident of Punta di Zambrone rather than as a foreign enemy.

In contrast to the northern part of the ditch, the final infill of the central part (exposed in Area B) does not consist of ash layers, but is a 0.40 to 0.60m-thick stratum of compact silty clay and silt loam (SU 6 and 6a[56]). In terms of pottery finds, however, the ash levels in Area C and the uppermost clayey fill in Area B are very similar. Both stratigraphic complexes in the two excavation areas share characteristic RBA 2 features and Mycenaean pottery is present in both (see below).

The Recent Bronze Age: a Short Note on the Botanical and Zoological Remains

A considerable quantity of earth samples from archaeological layers passed flotation by means of sieves with mesh sizes of 2.0mm, 0.5mm and 0.2mm, which is still a rare case among prehistoric sites in Italy. From all three excavation areas (B, C and D), earth samples totalling around 1600 litres were collected and passed through flotation. 950 litres from the RBA layers in areas B and C yielded botanical remains. Moreover, this extensive flotation with fine-meshed sieves also enabled the collection of microfauna (still under study) as well as small artefacts (e.g. beads made of vitreous materials).

In the absence of pollen, which are not preserved in the soil samples examined so far, the anthracological remains (also in comparison with charred seeds, see below) provide the best evidence for obtaining a rough picture of the natural vegetation and especially of the plant species, which the inhabitants mainly selected as fuel.[57] The most frequent species are those of the Maquis shrubland – in a version with a quite high percentage of forested landscape – such as *Arbutus unedo, Rhamnus alaternus, Erica, Cistus, Olea europaea* (probably of the wild variety), *Quercus suber* and above all *Quercus ilex*, by far the most common taxon with 38 % of the examined samples.[58]

Significant results have also been obtained from the study of the charred remains of seeds, chaff and fruit.[59] During the RBA, cereals and legumes were grown for food purposes. More than a hundred samples indicate that emmer was the predominant cereal, while barley and millet were frequent as well. For emmer at least, one can safely assume local processing (and plausibly cultivation), which is based on the high quantities of emmer chaff. Among the pulses the field bean prevails, while the lentil is less common.

The botanic specialists also noted quite an abundant presence of (mostly collected) fruit. The high frequency among the fruit of grape pips, not easy to classify as either wild or cultivated species, indicates an intense collection and/or cultivation of grapevine. Tests in terms of organic

---

54 For treatment of dead bodies (or parts thereof) other than permanent burial in the ground see, among others, Weiss-Krejci 2011, 69–77, fig. 4.1. Such practices may be attested at RBA Coppa Nevigata, where, in two consecutive stratigraphic phases, several human bones are conspicuously associated with specific houses (Recchia 2012, 399–401, figs. 10–11).

55 See the contribution by Kanz et al., this volume.

56 SU 6a is the part of SU 6 that lies between the northern sections B2 and B3 of Area B (eastern part).

57 An ‘opportunistic’ way of harvesting timber during the RBA is indicated by the high presence of fungal hyphae, which grow only on (likely fallen) dead wood. This type of wood – of course usable only for the purpose of combustion – has lower calorific properties but is very easy and fast to collect (D’Auria et al. 2017, 610). Local people told us that the use of this resource is still quite common today.

58 D’Auria et al. 2017.

59 See Zach et al. 2015 and their final publication in the present volume.

residue analysis on different RBA pottery classes for finding evidence for its use in wine production are currently under way.

Acorns – likely coming from those evergreen oaks documented by the anthracological study[60] – could be used not only for pig feeding, but also for human nutrition.[61]

For olives, probably collected from wild plants, though evidence for their presence is far lower than it is for the EBA, we do not exclude a role in the inhabitants' diet. Also, in this case, the analysis of ceramic vessel contents could provide some indication in such a direction.

Likewise very important is the overall picture deriving from the study of RBA animal remains,[62] which gives information on wildlife and domestic fauna as well as on breeding, hunting and fishing activities. The strontium isotope analyses conducted on a selection of animal teeth of both domestic and wild mammals provide valuable indications regarding animal (and, indirectly, human) mobility.[63]

Regarding faunal remains, we refer to the specific and detailed reports in this volume.[64] Here, we would just like to mention the fact that the RBA breeding economy is characterised by different percentages of oxen, sheep/goats and pigs (balanced in the case of the ashy layers, but with a stress on cattle breeding in the other RBA strata). Remains of dog are fairly common, while those of horse are rather scarce. Pigs, as usual, were exploited to obtain meat, as the prevailing young culling ages indicate, while a large portion of the bovines and caprovines was kept alive for several years according to the culling patterns. This indicates that in addition to meat these animals likely provided secondary products like traction force in the case of cattle and milk and/or wool in the case of caprovines. An indistinct dominance of sheep and almost balanced ratios of the sexes indicate wool production, but milking cannot be excluded.[65]

The interesting differences in domestic animal percentages emerging between the ashy layers and the other, non-ashy deposits of the RBA may be taken as a further hint that the consumption practices producing the archaeozoological record of those ashy layers were not of an everyday character. The non-ashy deposits of RBA date with their dominance of cattle seem to indicate a continuation of animal husbandry patterns going back to EBA 2.[66] One might speculate that repeated feasting activities producing the ashy refuse did involve some considerable consumption of meat, which included beef, but to a lesser extent compared to pork and mutton, in order to spare the precious traction animals.[67]

A special relevance ascribed to cattle even in the ideological realm may also transpire in the attestation of a bovine skull fragment carefully cut so as to separate the part with the horns from the rest.[68] The well-known symbolism related to bulls and the related bucrania in Bronze Age Italy is therefore also present at Punta di Zambrone. In this way, the archaeozoological record nicely supplements the pottery evidence, which shows a strong predominance of paired horn types (whether called 'handle bar' or 'snail horns' etc.) among the handle projections.[69]

The hunted animal species, among which red deer dominates, amount to only about 3% of the bone remains. In the diet there was no lack of marine food, as the presence of different fish species

---

60 Cf. n. 58.

61 In Sardinia, for instance, they are still used to produce a particular sort of bread today.

62 See the contribution by Forstenpointner et al., this volume.

63 For fishing at RBA Punta di Zambrone see Jung et al. 2016.

64 See the contributions by Forstenpointner et al. and by Pike et al. in the present volume.

65 The ongoing organic residue analyses on pottery may eventually provide some supporting evidence for that.

66 Forstenpointner et al., this volume.

67 A high availability of oxen may have been necessary to make optimum use of the best season for ploughing (after rains between late summer and early autumn). In fact, the predominant culling age of cattle represented in the ashy layers of Area C (Forstenpointner et al., this volume, fig. 1a) points to animals that may already have been trained for traction (cf. Columella VI 2, who gives the best training age for cattle as 3–5 years). In those ashy layers their lower percentage in comparison to sheep/goats and pigs would account for that fact. However, we cannot exclude also reasons of food preference.

68 Forstenpointner et al., this volume, fig. 3.

69 Cf. the statistical data given by Cristina Capriglione in the present volume.

and very numerous shells of molluscs of the species *Patella caerulea* demonstrate. According to the results of the strontium isotope studies, most of the domestic animals were bred not far from Punta di Zambrone, but some come from pastures located on the Poro high plain (or on terraces immediately below it) at distances exceeding 6km from the settlement. A deer had been captured in the periphery of the strictly local zone, most likely in a forested area, while a horse had been relocated several times during its lifetime, confirming the idea of its use as an animal strictly functional to transport and mobility. Taken together with the survey results, all this evidence indicates that one may indeed reconstruct a regional economic – and possibly also political – system stretching from the Tyrrhenian coast across the hilly hinterland up to the Poro high plain and thus likely covering an area of more than 250km², c. 115km² of which provides very fertile volcanic soils ideally suited for agricultural use.[70]

The Recent Bronze Age: Artefacts

The large majority of artefacts consists of local handmade *impasto* pottery, which can be mostly assigned to the Subapennine culture group of the Recent Bronze Age, with types very similar to those of the so-called Ausonian I of Lipari.[71] Most of the vessels belong to types that, in the sequence of Isabella Damiani, are assigned to phase 2 of the RBA.[72] At the same time, the available data indicate that the village of Punta di Zambrone ended in an initial stage of RBA 2, roughly coeval to LH IIIC Early. A more evolved horizon is lacking, such as the one attested in the Ausonian I strata at Lipari by the first appearance of ceramic forms that spread widely during the Final Bronze Age,[73] and at the northern Calabrian settlements of Broglio di Trebisacce and Torre Mordillo by the presence of Aegean types produced during later Post-palatial phases up to LH IIIC Advanced.[74]

At Punta di Zambrone there are also some fragments that can be assigned to an earlier period, characterised by pottery with Apennine-type decoration and some types of handles (especially horizontal handles with two cylindrical projections) which, as stated elsewhere,[75] find their antecedents in MBA 3/early RBA types diffused in the Romagna and central-northern Marche regions (southeastern Po plain and part of the Middle Adriatic area). This most ancient stage is well attested on the Tropea peninsula by artefacts found in tomb 4 of Santa Domenica di Ricadi[76] and in settlements identified by survey.[77] This is the material culture that characterises the wave of change (probably accompanied by human mobility) that – in our opinion, in the last decades of the fourteenth century BCE –[78] led to the disappearance of the Thapsos-Milazzese culture group in the Lower Tyrrhenian, and to the spread in the same area of a new cultural entity that, at the beginning, was evidently in a transitional stage between those culture groups schematically defined as 'Apennine' and 'Subapennine' respectively.

The ^{14}C datings of samples coming from ash layers substantially agree with what we said above, being assignable, according to the statistical analysis,[79] to a period of time substantially falling somewhere between the 14th century and 1200 calBC. It is interesting to note that, according to the

70 Cf. Pike et al., this volume. For the settlements probably forming this system and cooperating in some form see Pacciarelli 2000, 82–84, fig. 44.

71 Bernabò Brea – Cavalier 1980, 563–581.

72 Damiani 2010; see also the contribution by Capriglione, this volume.

73 Bernabò Brea – Cavalier 1980, 567–568, 708, pl. 195.

74 Jung 2006, 104–137.

75 Pacciarelli 2017, 39.

76 Pacci 1987.

77 Pacciarelli 2000, 38, fig. 17, 9–10; Pacciarelli – Varricchio 2004, 376, fig. 9.8–10, 17–18, 22–23.

78 As argued in Jung 2006, 70–76, 81–87, almost all of the Aegean pottery finds from the phases of the Milazzese culture group in the Aeolian villages are products of the LH IIIA1 phase, while single pieces may date to an initial stage of LH IIIA2. This points to a date around the middle of the 14th century BCE or slightly later for the end of those settlements (cf. also Jung 2017a, 52–53).

79 See Weninger et al., this volume.

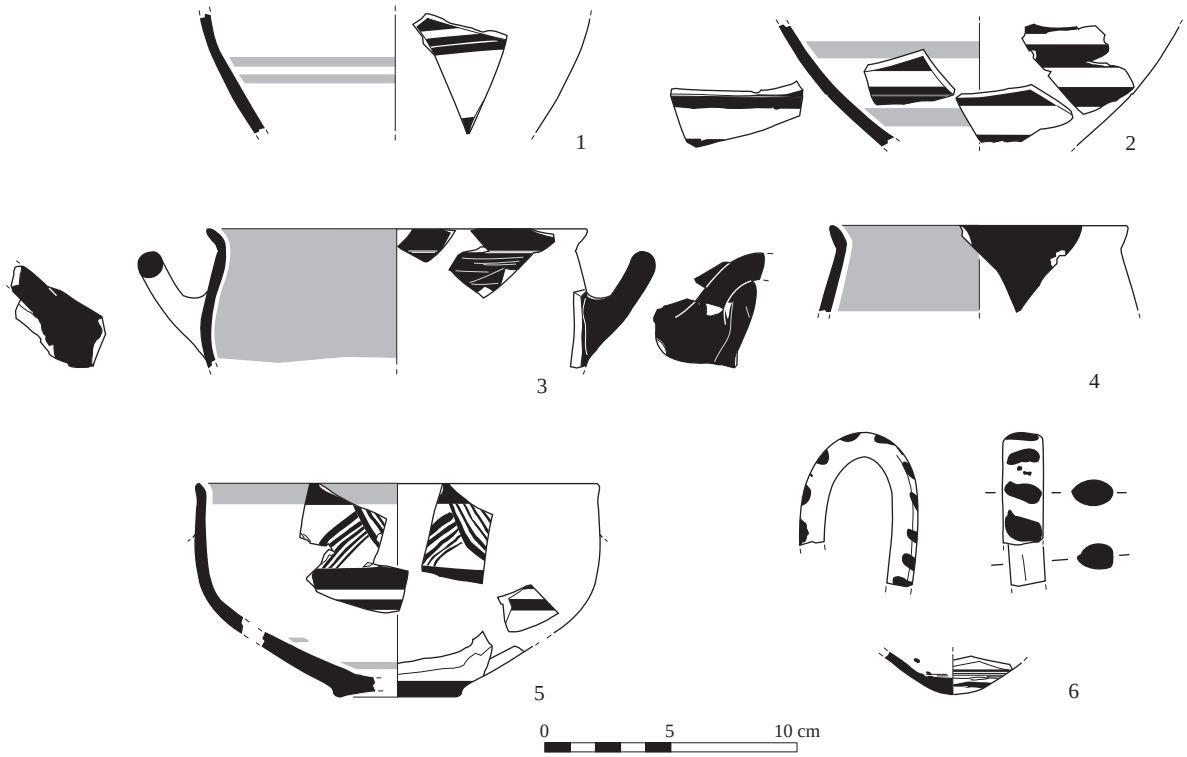


Fig. 24 Sherds of imported Mycenaean pottery (3, 4, 6); imported Minoan pottery (5); Mycenaean-type pottery imported from the southern plain of Sybaris (1, 2), scale 1:3 (drawings: R. Jung; digitisation: R. Yassine)

models, many dates fall throughout the 13th century calBC, also covering in a significant way the first half of the century. This fact is relevant for several reasons, and primarily because it documents the presence of an early phase of the RBA, characterised by the absence of Aegean imports (see below for the date of most Mycenaean vessels to the late 13th and early 12th centuries BCE). It probably indicates that the RBA ceramic complex of Punta di Zambrone formed over a long period of time, during which a process of cultural transformation took place, from the oldest moment of the material culture mentioned above until that stage datable around 1200 BCE and documented by more recent local ceramic types and most of the Aegean pottery. This process is not entirely recognisable at the moment because, as we said, the RBA artefacts have not been gradually stratified in situ but have been deposited in the upper fill layers of the ditch together with the ashes in one single act. In the analysis of this phenomenon of cultural transformation, we must take into account that the progress of research is proving that even the Subapennine culture group, beyond its apparent homogeneity, is the result of partially differentiated developments in the various regions of Italy. One can, for example, recognise this when studying the *impasto* ceramics of early RBA phases of Roca, which differ significantly from those of Punta di Zambrone, although they must be largely contemporary, being associated with similar Aegean types.[80] This means that for the dating of ceramic types we cannot always rely on long distance comparisons. Notwithstanding these limits and problems, a very important advance in knowledge of the RBA material culture in the Lower Tyrrhenian area will surely take place with the publication of the doctoral thesis of Cristina Capriglione, which includes the systematic study of all RBA ceramic finds from Punta di Zambrone and a large portion of those from the Ausonian I settlement phase on the acropolis of Lipari.

The Aegean-type pottery amounts to a total of 204 sherds and pots after mending and restauration. The majority of the classifiable fragments are of Mycenaean type, comprising both small and

[80] Scarano in: Pagliara et al. 2007, 330–332, fig. 9; Palmisano 2008, 256–260, fig. 13; Jung 2017b, 634–637.

large open vessels, as well as small and large closed vessels. The Mycenaean vessels mainly date to the early Post-palatial period (LH IIIC Early, see Fig. 24.1–4), while a few pieces may rather be products of the preceding final Palatial phases of LH IIIB (Fig. 24.6). A much smaller number of pots is Minoan in type. Those that can be dated with some precision represent a developed to late stage of LM IIIB (Fig. 24.5).[81]

Unlike the local handmade pottery, the wheelmade Mycenaean and Minoan pottery is very unevenly distributed across the succession of strata in both Area B and Area C. However, when we compare areas B and C, the Aegean pottery evidence looks remarkably similar. In the central as well as in the northern part of the ditch the Mycenaean fragments are concentrated only in the uppermost fill layers. In Area B, the SU 6a yielded 15 sherds and the disturbed ashes SU 63a another two.[82] With 4.17m³ of earth excavated from these two units, we arrive at an average of 4.08 sherds per cubic metre. The sum of the Aegean-type fragments from all ashy layers (including the level disturbed by ploughing) in Area C amounts to 114 fragments and vessels (after mending), which, calculated against 22.56m³ of excavated ashy strata, gives us a rate of 5.05 fragments per cubic metre.[83]

Taking into account the adverse preservation conditions in the silty matrix of SU 6a and 63a, the slightly larger share in Area C may not have any historical relevance. While the Aegean-type fragments from the ashy levels of Area C are generally in good to excellent condition and retain the often clinky hardness characteristic for most of their fabrics, those from Area B are reduced to small or even tiny fragments, which are soft as chalk, while their surfaces often appear totally worn off. Other pottery classes and animal bones were also retrieved in bad condition from those fill layers in Area B.[84] We may therefore fairly assume that discarded broken Mycenaean and Minoan vessels ended up in more or less equal quantities in all kinds of refuse contexts. Thus, at its time, the use of Aegean-type pottery was a rather general phenomenon in the settlement of Punta di Zambrone. It was not restricted to those practices producing the ashes that eventually went into the northern part of the ditch. The quantity of wheelmade Aegean pottery at Punta di Zambrone is outstanding when compared to the amount of Aegean ceramics at the Ausonian I settlement of Lipari.[85]

As already mentioned, the uneven presence of Mycenaean pottery at Punta di Zambrone has a chronological dimension. It is absent from the fill layers underneath the fortification debris (i.e. underneath SU 107 and 108 in Area B and SU 215 in Area C). A single Mycenaean sherd from SU 212, a rather thin stratum directly attached to the eastern scarp of the ditch and overlain by the early debris layer SU 215, constitutes the only exception. Due to the loamy sand matrix of SU 212, that fragment of a large closed vessel with two partly preserved belly bands is badly worn and not datable. It remains a fact, though, that the lowermost fill levels stratified on the horizontal ditch bottom are completely free of Mycenaean sherds.

Mycenaean pottery is also absent from the debris layers of the fortifications themselves (SU 107, 108 and 215).[86] Furthermore, even SU 75, the upper debris layer found only in Area C, did not yield even a single Mycenaean fragment, although we were able to excavate 1.2m³ of this stratum. We also cleared 3.83m³ of earth stratified below the ashy levels in Area C. Therefore, the

---

81 Jung et al. 2015a, 68–79, 93–100.

82 PZ6a and PZ63a make up that part of the uppermost fill excavated exclusively by hand between the second and the third northern sections of Area B (east part).

83 As the find materials from all excavation areas as well as from surface collections do not provide any evidence for human activity on site following the abandonment of the settlement during RBA 2 and prior to 20th century CE agriculture, it seemed reasonable to include ceramics from the disturbed upper levels of the fortification ditch in these sherd counts. Nevertheless, we did not include sherds from the humus level SU 1 (in both areas).

84 For animal bone preservation see the contribution by Forstenpointner et al., this volume.

85 With 46 sherds from Ausonian I and mixed Ausonian I + Milazzese strata (3,700m³) we get a frequency of only 0.012 Aegean-type sherds/m³ (Jung et al. 2015a, 69). Although these numbers are not directly compatible with those from Punta di Zambrone (for a variety of reasons, including the longer duration of the RBA habitation phase at Lipari), they can give an idea of the striking differences between those two settlements in the Lower Tyrrhenian Sea.

86 We excavated 1.04m³ of SU 215, which is not a negligible quantity, while the excavation removed altogether 0.81m³ of SU 107, 108 and 97 (the latter probably not consisting of debris fallen during the early collapse of the fortification).

(almost total) absence of Mycenaean pottery in the strata connected to the earliest RBA settlement activities at the site cannot be ascribed to lack of excavation.

We may therefore conclude that at Punta di Zambrone Mycenaean pottery was barely in use during the earliest MBA 3/RBA 1 settlement phase and remained substantially absent probably even well into RBA 1. This conclusion, drawn from the stratigraphical evidence, finds support in the typological and stylistic characteristics of the Aegean pottery itself. While there is a certain amount of local *impasto* vessels with Apennine traits and other *impasto* pieces that must be placed early in the RBA pottery development (see above), we have no Aegean sherds of certain LH IIIA date. Moreover, there are no good arguments for dating any of the few palace period vessels to the first half of LH IIIB.

The Aegean pottery assemblage of Punta di Zambrone comprises many small and medium open shapes including several deep bowls and even a dipper (Fig. 24.6). Furthermore, there are various small, medium and large closed vessels like alabastra, stirrup jars and amphorae. This type spectrum differs from that at most southern Italian sites, but in principle is not very different from settlement assemblages in the Aegean. This is a first hint that at least the majority of the Aegean-type pots reaching Punta di Zambrone probably did not pass through other Italian settlements.

In order to investigate the provenance of the pottery vessels found at Punta di Zambrone, we conducted petrographic and chemical analyses in cooperation with Pamela Fragnoli[87] and Hans Mommsen. In order to identify possible local products, so common at coeval sites all over Italy, we sampled local and regional clay beds of fine potter's clay, which were shown to us by Francesco Rombolà (Caria).[88]

Mommsen used Neutron Activation Analysis (NAA) on a selection of sherds representing 44 different vessels of Aegean-type wheelmade pottery.[89] At the Bonn lab, he was able to assign 35 of the analysed vessels to 9 different compositional patterns that are already known and part of the Bonn database. The most important result is the total absence of locally made Aegean or Aegeanising pottery,[90] as none of the pottery samples has a chemical composition matching the clay samples from the Tropea peninsula.

Twelve vessels from the wider region of Elis/Achaea on the western Peloponnese form the largest group of imported pots at Punta di Zambrone (Fig. 24.4, 6). They show a chemical pattern, which is the most common one among the Mycenaean ceramics from settlements and cemeteries between Olympia and Patras. Other chemical groups related to western Greece – such as Aetolia-Acarnania north of the Gulf of Patras (Fig. 24.3) and the island of Kephallenia – are present with fewer vessels at Punta di Zambrone. In total, the western Greek products amount to 21 pots, i.e. more than 50% of those 35 vessels that could be grouped in the statistical analysis.

Some further regions on mainland Greece are also represented among the analysed pots. There is one vessel assigned to Laconia, one to northwestern Boeotia, while two could originate from either central Crete or Boeotia. Yet another three have a chemical composition assignable to the Peloponnese in a more general way.

Finally, we can be certain that Cretan products also reached the southern Calabrian settlement, for three of the Zambrone vessels show compositions that are close to chemical patterns attested at Chaniá in the western part of the island, one of which is a typical late Minoan deep bowl (Fig. 24.5) and another one a small stirrup jar with a western Cretan motif on the shoulder.[91]

---

87 See Fragnoli, this volume.

88 Jung et al. 2015b, 456, fig. 1.

89 Jung et al. 2015b.

90 On the typological differentiation between Mycenaean (referred to by their Furumark numbers, FT) and Mycenaeanising/Aegeanising – in Italy called 'Italo-Mycenaean' – vessels (referred to by their number in Bettelli's initial typology) see Jung 2006, 15–19; Jung 2010, 150–154. In a typological sense it is misleading to call all Mycenaean vessels produced in Italy 'Italo-Mycenaean' instead of setting apart by terminology only those Italian-made vessels that diverge from the Mycenaean type repertoire.

91 Jung et al. 2015a, 70–71, fig. 13.6; 75, fig. 15; 96, cat. no. 6; 98, cat. no. 26; Jung – Pacciarelli 2017a, 316, 323, fig. 6.7.

Although there is no Aegean-type pottery made locally on the Tropea peninsula, Mycenaean pots made in Italy apparently were in use in the region. One chemical group comprising four Mycenaean vessels found at Punta di Zambrone represents products of northern Calabria (Fig. 24.1–2). The potters' workshops in question were probably located in the southern plain of Sybaris. Two pithos sherds found at Broglio di Trebisacce and belonging to the same chemical group as the four painted tableware vessels from Punta di Zambrone provide the clue for this identification. In her petrographic study, Sara Levi was able to assign these two pithoi to the southern Sybaritic plain. From this it follows that all the vessels in the same chemical group have this geographical origin. Thus, Punta di Zambrone becomes the first Italian site for which one can establish the import of Mycenaean-type pottery originating from the plain of Sybaris.

To sum up, the most important result of the provenience study is the very high amount of ceramic imports from the Aegean in combination with the absence of local or regional Aegean-type or Aegeanising products. In this respect, Punta di Zambrone is so far without comparison among the known RBA sites in southern Italy.

For several reasons the total absence of Argive ceramics at Punta di Zambrone is another very remarkable fact. First, at sites such as Mycenae, Tiryns or Midea there is abundant archaeological evidence for intense Argive contacts to Italy, contacts that continued all through the LH IIIB and LH IIIC periods.[92] Second, as our NAA results have proven, the ceramic products of many different Peloponnesian regions were delivered by one way or another to that rather small settlement on the southern Tyrrhenian coast of Calabria. Third, during the palace period the largest pottery producing workshops supplying the vast majority of Mycenaean export vessels going to Egypt, the Levant and Cyprus were operating in the northern Argolid, at or close to Mycenae.[93]

Our results suggest the existence of a much differentiated network of Italo-Mycenaean relations, a network in which each community established specific and targeted overseas contacts. The region of Punta di Zambrone was evidently linked in a direct way to the western Peloponnese and to other western Greek regions. The imports from Laconia and Crete may have been conveyed by the same Calabrian–western Greek network, or may indicate a further extension of direct relationships.

One may now approach the task of reconstructing the route on which and the modalities by which Aegean imports reached Punta di Zambrone in the west of southern Italy. The regional economic and, by extension, possibly also political system, the extension of which we have calculated at about 250km², provides us with some basis for an approximate and indirect comparison of the productive capacities of this southern Calabrian settlement landscape with that of other economic systems elsewhere in the Mediterranean. For instance, the traditional extension of the administrative territory of the Messenian palace of Pylos amounts to c. 2650km², i.e. an area roughly ten times that of the Tropea peninsula network. Considering the fact that the NAA results seem to suggest individual rather than combined exchange relationships of such southern Italian communities, the absence of Argive export pottery at Punta di Zambrone becomes more intelligible. It seems that communities drawing on the agricultural surplus product of regions with a size like the one of the Tropea peninsula were not able to enter the highly specialised and regular exchange relationships of the Mycenaean palaces. At least, they could not tap into the kind of goods exchange that the centralised palace administration was organising in order to exchange tons of raw materials and large quantities of sophisticated finished products.

For the Mycenaean Post-palatial period and the RBA 2 phase, we find that certain fortified coastal settlements in the Aegean are comparable in size to that of Punta di Zambrone, while others are considerably larger.[94] In general, the evidently fragmented political organisation of Greece

92 See e.g. Jung – Mehofer 2013 and Jung 2018, 280–286 with further bibliography.

93 Jung 2015.

94 The settlement of Teichos Dymaion inside the fortification covers 1.2ha (Gazis 2010, 243–244) and is thus almost identical in size to the fortified cape of Punta di Zambrone in its present-day extension (and most probably smaller than the Bronze Age settlement of Punta di Zambrone, if we take into account the loss of surface due to landslides, see above). The Lower Town at Tiryns may have reached an extension of 25 ha by LH IIIC (Kilian 1985, 75, 101,

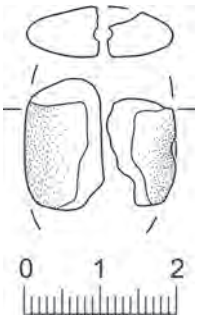


Fig. 25 Amber bead PZ66/P34, scale 1:1 (drawing: M. Pacciarelli; digitisation: R. Jung)

in the 12th century BCE would have enabled exchange patterns with the communities in Italy on a more equal footing.[95]

The careful excavation and especially the flotation with fine-meshed sieves of a great bulk of ashy deposits allowed the recovery of 60 beads made of vitreous materials, an extraordinary number for a settlement site in southern Italy.[96] These beads alone currently represent the overwhelming majority of RBA vitreous artefacts in central-southern Italy. Almost all the analysed specimens are made of faience, while only one is in glassy faience. In addition to six beads of medium to large size – a rosette button, a globular bead, two of depressed globular shape, one in the form of a toothed wheel and a flat-biconical one with radial incised lines – 53 tiny discoid beads in faïence of very small dimensions (average diameter of 0.2–0.3cm) were found, very rare elsewhere in the central Mediterranean (probably at least partly due to the limited use of very fine-meshed sieves). All these bead types are common or very frequent in the Aegean and the Near East, so that we can class them as imported goods, which, for some of them, is also supported by chemical analyses.[97]

In addition, there are the fragments of an amber bead,[98] which apparently once had an amygdaloid shape (Fig. 25).[99] According to the infrared spectroscopy results it was cut from a piece of Baltic amber.[100] In fact, most of the RBA amber finds found in Italy consist of Baltic amber.[101] This bead is the first to have been found in a secure RBA context in Calabria.[102] A very fragmentary amber bead of possibly similar shape was found in a Final Bronze Age context at Broglio di Trebisacce in northern Calabria.[103] The rather rare amygdaloid type has some parallels among

fig. 4), while the tell of Lefkandí on Euboea covers a surface of 6ha (Popham – Sackett 1968, 2–3, fig. 1). The latter size equals T. Scarano's estimate for the original size of Roca Vecchia, today preserved only on a cape of 3ha (Scarano 2012, 44).

95 We have discussed these aspects elsewhere in some detail (Jung – Pacciarelli 2017b).

96 See Jung et al. 2015a, 68, fig. 12.4; 82–83, figs. 19–20; Matarese et al. 2017; Conte et al. 2017; Matarese et al. 2018.

97 Angelini et al. 2005; Bellintani et al. 2006, Angelini et al. 2012; Bellintani – Usai 2012; Conte et al. 2015; Conte et al. 2017.

98 Matarese et al. 2017, 467.

99 PZ66/P34 (East: 2604708.909m; North: 4285498.958m; height asl: 36.987m), PZ66/P35 (East: 2604708.821m; North: 4285498.691m; height asl: 37.031m). Two non-joining fragments allow the following size determinations: maximum width c. 2cm; maximum preserved length 1.8cm.

100 See the contribution by Wunderlich, this volume.

101 Amber of different provenance is known – especially from southern Italy in Middle Bronze Age contexts (Angelini – Bellintani 2006, 1484, tab. II; 1487, fig. 5; Bellintani 2010, 145–146). Infrared spectroscopy conducted on one piece of raw amber from the warrior tomb 206 at the Torre Galli cemetery on the Poro high plain has shown this object from Torre Galli phase 1B (9th century BCE) to be Simitite, i.e. Sicilian amber (Guerreschi 1999; Pacciarelli 1999a, 188, 415, pl. 189C, tab. 1.206).

102 A few other Bronze Age amber artefacts from Calabria date to the MBA, while there are many from Early Iron Age contexts (Benedetti – Cardosa 2006). Four beads from tomb 4 at Bagneria near S. Domenica di Ricadi might theoretically be RBA products, because some of the ceramic vessels from the same tomb date to that period (Pacciarelli 2000, 184, fig. 108 [discoid and ring-shaped amber beads in the second row from below]).

103 Buffa 1994, 572, pl. 120.1.



Fig. 26 Steatite conulus PZ129EE11/78 (photo: J. Lipták)

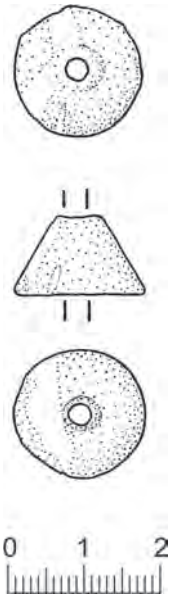


Fig. 27 Steatite conulus PZ129EE11/78, scale 1:1 (drawing: R. Jung; digitisation: P. Ftaras)

Mycenaean amber beads. However, the few attestations of this shape range from Early Mycenaean through to Post-palatial contexts.[104]

A steatite conulus from one of the ashy layers in Area C is almost certainly another import of Aegean origin[105] (Figs. 26–27), as such conuli are very rare in Italy,[106] while they belong to the most common stone artefacts in Minoan and Mycenaean (Palatial and Post-palatial) settlements and cemeteries. The find from Punta di Zambrone represents the most frequent and long-lived type (type 1a according to Rahmstorf) and the commonest material those objects were made of.[107] In the Aegean, stone conuli were objects of everyday life, but so far researchers have been unable to reach an agreement as to their precise use or function.[108] The presence of the conulus at Punta di Zambrone adds just another facet to the picture of Aegean contacts the inhabitants of the settlement were maintaining. Apart from this object, in the RBA layers stone artefacts are largely confined to small fragments of obsidian implements and production debris.[109] A polished stone axe from the uppermost disturbed part of the fill layer in the ditch at Area B[110] is an exception and most probably a redeposited EBA artefact (compare the EBA 1 stone axe from Area D).

---

104 Czebreszuk 2011, 79, 87, tab. 5; 265, pl. 1.17; 266, pl. 2.9; 271, pl. 7.6, 10.

105 PZ129EE11/78: maximum height 1.08cm, maximum diameter 1.69 × 1.72cm, mass 3.4g.

106 One (only slightly larger) parallel of different colour comes from Broglio di Trebisacce. Unfortunately it is a surface find (Bettelli 2002, 197–198, fig. 77.180).

107 The most complete overview on this artefact class is provided by Rahmstorf 2008, 126–134. For conuli from Achaea, the region with which Punta di Zambrone seems to have had especially direct contacts, see e.g. those from the chamber tomb cemeteries at Chalandrítsa (Aktypi 2017, 259–260, fig. 283.69, 96, 131–134, 242) and at Mitópoli (Christakopoulou-Somakou 2010, 36, 46, pl. 2.7; 53, 56, pl. 7.7; 65–66, 71, pl. 12.29, 31, 33; 88–89, 95, pl. 20.25).

108 Rahmstorf favours the explanations as spindle whorls and as beads and suggests a continuum between both uses, as implements and ornaments (Rahmstorf 2008, 134–138). Textile experts recently concluded from an evaluation of the diameters and weights of stone conuli that "there is no reason to assume that they could not have been used as spindle whorls" (Andersson Strand – Nosch 2015, 355). The weight and dimensions of the Zambrone conulus fall well into the overlap range of spindle whorls and conuli (see Andersson Strand – Nosch 2015, 355–356, figs. 7.6–7.7).

109 All the obsidian artefacts will be treated in a specific paper to be published in a forthcoming volume.

110 PZ63a/P2 (coordinates East: 2604702.516m; North: 4285481.072m; height asl: 37.887m): maximum length 7.3cm, mass 120.4g.



Fig. 28 Unfired clay spool PZ129/P85, scale 1:1 (photo: R. Jung)

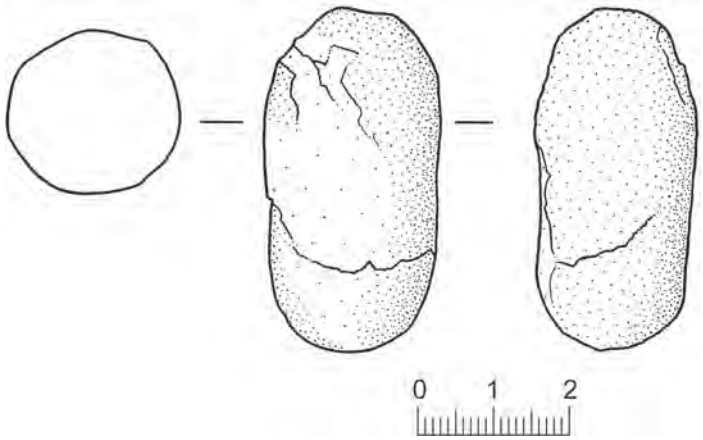


Fig. 29 Unfired clay spool PZ129/P85, scale 1:1 (drawing: R. Jung; digitisation: P. Ftaras)

In contrast to contemporary Adriatic settlements, which produced a wide array of bone and antler implements,[111] the RBA layers at Punta di Zambrone yielded only very few and simply made bone artefacts.

Metal objects, by contrast, are present in surprising numbers. They mainly come from the ashy layers of the fortification ditch and also, thanks to the data coming from archaeometric analyses, allow the reconstruction of a rich and complex picture, described in a specific contribution.[112] Here we briefly note that the bronze artefacts belong to various functional categories, including ornaments (pins, beads); implements for fishing, wood and leather processing (fishing hook, cutting tool, awls) and for personal care (tweezers); weapons (a dagger or small sword) and others (miniature ingot/balance weight). The types fit well into the so-called RBA metallurgical koiné,[113] which, as already supposed, in Italy evidently spread from north to south

[111] Pasquini 2005a; Pasquini 2005b; for Coppa Nevigata see Moscoloni 2012; for Roca Vecchia see Pagliara et al. 2008, 267–268, fig. 16, tab. IV.

[112] See the contribution by R. Jung, M. Mehofer, M. Pacciarelli and E. Pernicka in the present volume.

[113] Carancini – Peroni 1997.

along with the same wave of change that led to the diffusion of the Subapennine culture group. The lead isotopic analyses indicate for several objects a provenance of copper from those same deposits in the Alps that fuelled the flourishing RBA metallurgy not only in Northern Italy but also in a large part of the peninsula. This confirms that the circulation of this metal was a fundamental factor in both integration and economic development. But the picture is even more complex, because there are bronze artefacts made of Cypriot copper clearly coming from Mycenaean circuits, and also two small wheels (probably used as spindle whorls) made with lead extracted from Aegean ores.

Another type of product circulation is indicated by the grinding stones. Their analysis, published in this volume,[114] demonstrates that they are made of volcanic rocks from the Aeolian Islands. This important evidence proves the export of goods and/or raw materials from the Aeolian archipelago to Tyrrhenian Calabria.[115]

A unique object preserved only because it was embedded in the fine ashy layers of SU 129 provides us with a glimpse of implements that usually might go unrecognised in excavations uncovering settlement layers of silty and clayey composition. It is a piece of coarse, unfired clay with a roughly cylindrical shape and rounded ends (Fig. 28–29).[116] This object belongs to an artefact class much discussed throughout the Mediterranean and especially in its eastern half. From Greece to the Levantine coasts, contextual data, typological characteristics and use traces suggest that we are most probably dealing with loom weights. They were common from the 12th to the 11th centuries BCE, but have no predecessors in the eastern Mediterranean.[117] They appear in a variety of sizes, proportions and outlines (more cylindrical or more spool-shaped with concave long sides), while they can be well fired, slightly baked or not fired at all.[118]

One of the earliest contexts in the eastern Mediterranean with such spools is found in Room 3.6 at Síssi on the north coast of central Crete. It dates to a late stage of LM IIIB and comprises an assemblage of 58 spools of various proportion, some of which are described as "poorly fired".[119] There are several spools from late LH IIIB contexts in Boeotian Thebes,[120] while a supposedly LH IIIA2 specimen might also have a later date.[121]

A possible origin of the necessary know-how for producing and using such spools is sought in the central Mediterranean. The earliest examples come from MBA 3 settlements such as Castigli-

---

114 See Gluhak et al., this volume.

115 Another material found in the ashy layers of Punta di Zambrone and possibly imported from Lipari is the obsidian used in a lithic industry with 'opportunistic' features. However, a provenance from Neolithic nuclei collected along the coast of Tyrrhenian Calabria, where they are still quite common, is not excluded. For the discussion of this point we refer to a forthcoming contribution by M. Brandl.

116 PZ129/P85 (East: 2604706.445m; North: 4285501.073m; height asl: 36.728m): maximum length 4.53cm, maximum width 2.18 × 2.35cm, mass 22.4g (few chips missing).

117 Rahmstorf 2008, 59–73; Rahmstorf 2011, 320–322, 330, fig. 7 (distribution map).

118 For the wide variability see e.g. the many Tirynthian examples in Rahmstorf 2008, 61–63, fig. 26, pl. 23–32, 90.5–8. – For an unfired spool (only with traces of secondary burning) from a LH IIIB–IIIC Early context in the Kontopíghadho settlement in Attica see Kaza-Papageorgiou et al. 2011, 206, fig. 4.2.

119 Gaignerot-Driessen 2012, 73–74, fig. 4.13–4.14. For the chronology of the Room 3.6 assemblage see Langohr 2017, 215–217, figs. 7.17–7.19.

120 Alberti et al. 2015, 283, figs. 6.10.9–6.10.10; 288, 290, fig. 6.10.31.

121 It is not published in detail. The only available information is that it comes from the Odhós Pelopídou excavations (Alberti et al. 2015, 288, 290, fig. 6.10.31). The strata dated to LH IIIA2 from the Odhós Pelopídou site contain some pottery fragments, which represent types characteristic for LH IIIB and IIIC such as unpainted conical kylikes and painted deep bowls (Andrikou 2006, 16–27, 63 cat. no. 62; 67 cat. no. 102; 104, pl. 4.62A, 62B; 106, pl. 6.102). Furthermore, those strata immediately follow underneath LH IIIB Late and LH IIIC strata (cf. Andrikou 2006, 178–179, plans 1A–3). It may therefore not be possible to exclude a later date for the spool in question. We might find a supposedly LM IIIA2 specimen from Kastélli-Chaniá suspicious for similar reasons. Only this one spool is said to come from the LM IIIA2 settlement phase, while there is none from the LM IIIB1 phase, four from LM IIIB2 contexts and eighteen from the LM IIIC settlement (Bruun-Lundgren et al. 2015, 199, fig. 6.2.2). One single spool has been listed for the LM I and likewise for the LM IIIA phase at Ayía Triádha, but without any illustration, description or discussion of their contexts (Militello et al. 2015, 209, fig. 6.3.2).

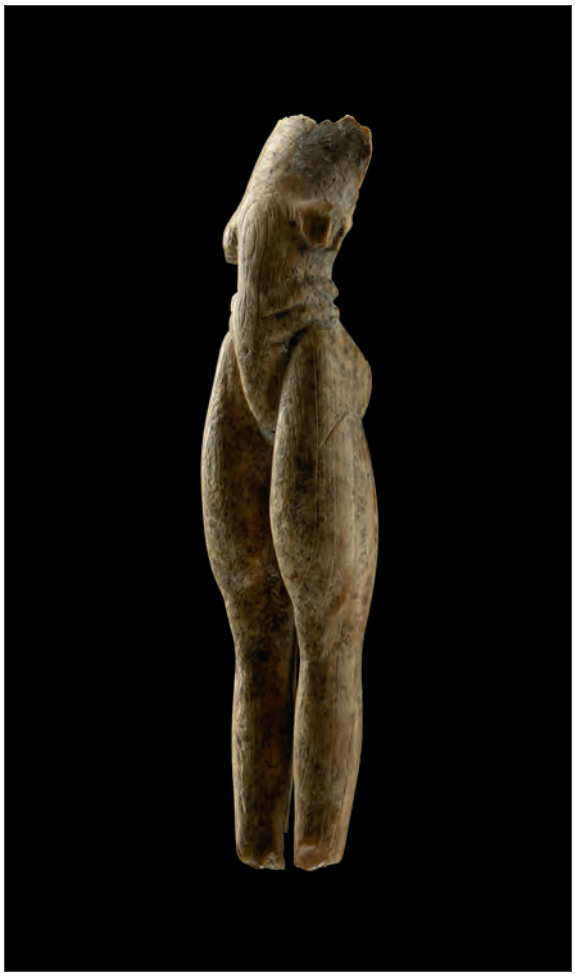


Fig. 30 Minoan ivory statuette PZ95EE12–13/41 (photo: J. Lipták)

one in Latium and thus antedate the earliest secure contexts in the Aegean such as Síssi by several decades.[122] In the Italian south objects with very similar proportions to the Zambrone specimen are found in the MBA 3 destruction level of Roca Vecchia, but they are much larger and heavier than the Calabrian artefact and all have a hole pierced through the central axis.[123] The object from Punta di Zambrone may be contemporaneous with or even slightly earlier than the Síssi assemblage, for the ashy layers of the ditch contain products of a long stretch of the RBA period as well as LM IIIB imports (see above). It is therefore not excluded that the knowledge transfer regarding such spool-shaped tools happened via southern continental Italy.

We conclude this overview of the RBA artefact categories with the most outstanding object, an ivory statuette of a man preserved to a height of 4.93cm (Fig. 30).[124] It brings us back to the issue of symbolic artefacts that are present inside the ashy deposits filling the fortification ditch in Area

[122] For Castiglione see Bietti Sestieri – De Santis 2000, 74–76, fig. 85; Rahmstorf 2011, 321. Another relevant coeval site in Latium (without any find post-dating MBA 3), excavated at Radicicoli Maffei near Rome, yielded two pottery spools (Francesco di Gennaro, personal communication; about the site see di Gennaro et al. 2008). At Borgo Ermada near Terracina (Latium) survey finds attest to the existence of a MBA 1–2 settlement. The collected artefacts include one possible specimen of such a spool (Alessandri 2009, 336–388, fig. 220.1.17).

[123] Scarano 2012, 322–323 cat. nos. 192–194; 326, pl. 51.

[124] PZ95EE12–13/41 from the disturbed uppermost level of the ashy deposits in Area C. Head, neck, shoulders, parts of the arms and feet are missing, and we estimate its original height at approximately 6.8cm.

C. As this small, fragmentary statuette of a man made of elephant ivory has been published and discussed in detail elsewhere,[125] we can limit ourselves to a short summary of its characteristics and date.

The standing man, wearing a breechcloth, has his arms sharply bent with the fists resting upon his body below the chest. Only very few male ivory statuettes with the gesture of the Zambrone specimen are known today. The largest parallel is a composite statuette of some 50cm and comes from an LM IB destruction context in the east Cretan settlement of Palaekastro, while other, much smaller ones also come from Mycenaean tombs on the Greek mainland.[126] All the details of type and style clearly point to a Minoan Neopalatial origin for this fine piece of craftsmanship. In a contextual analysis we came to the conclusion that such ivory statuettes were apparently strictly confined to the core regions of the Minoan and Mycenaean civilisations, while their use and deposition contexts show their relation to the ruling classes. They are inseparably linked to the religious ideology of those ruling classes and their respective societies and were not designed for export to neighbouring countries.[127]

The fists positioned symmetrically on the body are typical of Minoan male statuettes made of different materials and dating from the Cretan Protopalatial through to the Post-palatial periods. However, only some two-dimensional depictions on seal images showing this type of man in an interaction with others, or at least in an iconographic composition, allow us to draw conclusions as to the significance of his specific gesture. On those images the man is flanked by lions or supernatural creatures such as a winged agrimi or a Minoan Genius, and he can be seen standing on a pair of horns of consecration. On a golden signet ring stylistically dated to LM IB and found at the central Greek site of Elátia, a man with fists on his chest is apparently worshiped by other persons, while he is descending from the sky.[128] These iconographic associations support an interpretation of the man as a god.

The surprising presence of that Neopalatial Minoan statuette with its strong divine connotation at Punta di Zambrone warrants an explanation. First of all, its final deposition date (RBA 2 or LH IIIC Early) was not necessarily close to the date of its initial importation to southern Calabria. Departing from its production date, one might even envision a very early importation during the earlier phases of the Middle Bronze Age (MBA 1–2), i.e. in those centuries, when the well-known rich burial at Gallo di Briatico took place at a distance of just 5km to the east of Punta di Zambrone. The grave goods of that individual include a Minoan carnelian seal of Talismanic type, a silver spiral and a rock crystal bead, all of which were certainly, or with high probability, imports from Greece.[129] In respect of this assemblage, which is exceptional in all of southern Italy for the MBA 1–2 phases and attests to involvement in the overseas relations of high ranking personalities, the ivory statuette might theoretically even have been circulating in the region of the Tropea peninsula for centuries. Alternatively and perhaps more probably, it could have arrived in Italy only during the RBA, while it might have been stored or used in a Mycenaean or Minoan sanctuary in the preceding centuries. A direct Minoan connection could be indicated by the Late Minoan pottery found in the same ashy layers as the statuette (see above). Given the chronological proximity to the intensification of the raiding activities of the so-called Sea Peoples as they were documented during the reign of Pharaoh Merneptah (1224–1214 BCE) and the early reign of Pharaoh Ramesses III (1195–1164 BCE) as well as the contemporaneous spread of Italian-type weapons towards the eastern Mediterranean,[130] an RBA 2 importation of the statuette may have been the outcome of attacks and raiding in the Aegean.

---

125 Jung – Pacciarelli 2016.

126 Jung – Pacciarelli 2016, 30–32, pl. 16c.

127 Jung – Pacciarelli 2016.

128 CMS V Suppl. 2, 80–81 cat. no. 106. For the date see I. Pini in CMS V Suppl. 2, XXII.

129 Pacciarelli 2000, 185–187, fig. 109. For the results of XRF and lead isotope analyses conducted on the silver spiral see the contribution by Jung, Mehofer, Pernicka and Pacciarelli in the present volume.

130 For a recent summary of the Italian links of the Sea Peoples see Jung 2018.

Be it that the statuette arrived in Calabria in the process of some rare or exceptional type of goods exchange or that its presence at Punta di Zambrone is due to the sacking of an Aegean sanctuary or a similar act of depredation or piracy, its integration into the practices of the village community at the Calabrian coast is difficult to conceive. The very fact that it is the only figurative object found in all of the RBA layers at the site ties in very well with the general rarity of plastic or even two-dimensional art or handicrafts in RBA Italy. At the same time, it impedes any interpretation in terms of local religious ideology. However, even if it was deprived of its original meaning upon arrival at Punta di Zambrone, the immediately intelligible representation of a standing man must have provoked some sort of interpretation on the part of the population in that port settlement. Some of them may at least have been familiar with figurative craftwork from the Aegean and Aegean iconography.

The very diverse finds from the fortification ditch thus give us insight into several aspects of the last community inhabiting Punta di Zambrone (and partially of neighbouring communities living on the Tropea peninsula), most importantly into the subsistence economy, the acquisition of raw materials and other exchange processes, part of its material culture and, to a limited extent, also into the realm of ideology. The time span covered by these artefacts stretches over several decades, terminating around 1200 BCE, while the final sealing of the ditch accompanied by the (most probably ritual) deposition of an *impasto* cup immediately on top of the fortification debris SU 75 and subsequently embedded into the ashy layer SU 129 marks the end of that habitation phase. As there is no evidence for later settlement activities nor even for sporadic use of the cape prior to the 20th century CE, the definite dismantlement of the wall or rampart with the accompanying ritual took place in connection with the final abandonment of the settlement.

Different causes may have been responsible for that abandonment. Either the population retreated to other places (for the Tropea peninsula also remained inhabited during the late RBA 2 and throughout the FBA[131]), or it was forced to leave by other groups. In any case, the aforementioned deposition indicates that this abandonment had a somewhat orderly character, and those who organised it most probably intended to prevent an immediate resettlement of Punta di Zambrone when they apparently erased every trace of the protective fortification.

Synthesis

The large quantity of finds and data coming from the 2011–2013 excavations at Punta di Zambrone and related studies enriches our knowledge of Recent Bronze Age Italy both at a local as well as on an inter-regional level.

The already complex archaeological evidence available for the Tropea peninsula is now increased by an enormous amount of data on the natural environment and its use by the community of Punta di Zambrone, and on agriculture, the gathering of wild plants, the raising of livestock, hunting and fishing. The Sr isotope analyses of animal teeth have demonstrated, among other things, the full economic integration of the site within a territorial context that was not only local, but extended throughout the hilly interior up to the Poro high plain. This seems to confirm that the settlement was part of an integrated network of settlements that occupied and exploited a large part of the Tropea peninsula. The identification and hypothetical delineation of that network also enables a comparison with the territory's contemporary economic and political entities in the central and eastern Mediterranean.

[131] Final Bronze Age finds come from Tropea, Mesiano vecchio, Crista di Zungri (Pacciarelli 2000, 46, 83–85, figs. 24–25) and Torre Galli (Pacciarelli 1999a, 29–30, fig. 4; 337, pl. 111A). If compared with the higher number of RBA settlements (see Pacciarelli 2000, 84, fig. 44), then in this phase a remarkable contraction of the territorial occupation occurred. This crisis possibly began during RBA 2, because the majority of RBA sites seem to date to RBA 1 (or to the transition between the MBA 3 Apennine *facies* and the Early RBA).

Of course, knowledge of material culture in its various articulations has also increased greatly. Even greater are the gains that the new discoveries contribute to the knowledge of Mediterranean interactions during that crucial period that precedes and coincides with the collapse of the Mycenaean palace system.

Prior to the acquisition of this new evidence, all the studies on Aegean–Italian interconnections have greatly underestimated or almost ignored the role of Tyrrhenian Calabria and, more generally, of western peninsular Italy during the RBA. This was in large part due to the fact that until a few years ago Mycenaean-type pottery finds of this period in Tyrrhenian Italy were very scarce, and that those analysed were mostly attributed to Italo-Mycenaean production from southern Italy.

The reason for this underestimation evidently lay only in the lack of research in Tyrrhenian Italy, and, in particular, in the absence of excavation evidence for the RBA in respect of a particular category of sites that had a privileged role in exchange processes and for which the term of 'hub' or 'central place' is often used.[132] We can postulate that the site under examination had at least some functions of such a settlement type, considering the presence not only of a large quantity of imported Aegean ceramics (in the case of some closed vessels such as the stirrup jars perhaps arriving together with their contents), but also of several other categories of imports including objects made of metal (Cypriot copper and Aegean lead), vitreous materials (faience beads), stone (steatite conulus) and ivory (statuette and part of another artefact currently under study). This role was also favoured by particular topographical and environmental conditions – very rare along the Tyrrhenian coasts – such as the location on a promontory jutting into the sea and sufficiently high and well positioned to enable a very wide view, and the presence of a protected natural harbour.

It is important to stress that both the assessment of the relative chronology based on the development of artefact types as well as the absolute chronology relying on the radiocarbon dates indicate that the RBA village of Punta di Zambrone had a rather long duration, covering different phases, during which its role evolved. A first phase should correspond to the ceramic finds related to a transitional stage between the Apennine and Subapennine cultural groups, and to the oldest part of the ^{14}C sequence in the 14th century calBC. A second phase – indicated by the bulk of the ^{14}C dates positioned in the first half of the 13th century calBC according to the models, but in terms of material culture currently not easily discriminable from the first one – should correspond to RBA 1 of the Italian peninsula. There is no Aegean pottery that would unequivocally belong to a late stage of LH IIIA or an early stage of LH IIIB and could correspond to those first two RBA phases in the Punta di Zambrone sequence. The third and final phase is attested by local ceramic types of *impasto* pottery that can be ascribed to an advanced phase of the Subapennine culture group (i.e. RBA phase 2 of the Italian peninsula) and by the end of the radiocarbon sequence at the end of the 13th century or around 1200 calBC. It was in this last phase that abundant imports of Aegean pottery of later LH IIIB and LH IIIC Early date – consistent with the aforementioned ^{14}C dates – reached the site.

Since the beginning of the local historical cycle, characterised by the Subapennine culture group (and perhaps even slightly earlier), the site was occupied and defended with a ditch and a wall or rampart. Therefore, from the outset the territorial community of the Tropea peninsula conceived it as a site with control functions, perhaps partly to prevent attacks from the sea, but probably also with an active role of intervention in the routes of the Lower Tyrrhenian Sea. This role intensified and expanded over time, since the bulk of the Aegean pottery imports date only from the second half of the thirteenth century BCE (see above).

[132] See e.g. Marazzi – Tusa 2005, pl. 142; Kramer-Hajos 2016; Knapp 2018. – For Kramer-Hajos a 'hub' is a node in a network that attracts more links than others, and she equates it to Renfrew's 'central place' (Kramer-Hajos 2016, 23). Renfrew had defined a central place as a settlement that combines a higher position within a settlement hierarchy with a higher exchange rate or a 'hierarchy of exchange activity'. According to him, a central place is 'a locus for exchange activity, and more of any material passes through it (per head of population) than through a smaller settlement' (Renfrew 1977, 85).

The new data from Punta di Zambrone also contribute to a renewed perception of the modalities by which the Aegean imports arrived in Italy. Traditional interpretations favoured hypotheses proposing exchange processes of a predominantly economic and peaceful nature, as well as a substantially passive reception of Aegean goods by the central Mediterranean communities.

However, the RBA historical reality was certainly more complex. It can be no accident that the phase of the greatest influx of Aegean imports to Punta di Zambrone, i.e. later LH IIIB and the beginning of LH IIIC, corresponds exactly with the growing presence in the Aegean – and in particular in the same western regions with which Punta di Zambrone (and of course also other sites) had privileged relations – of various types of artefacts originating from Italy. This phenomenon was at least partially connected to the mobility of groups from west to east. There can therefore be no doubt that we have to reconstruct two-way relationships, perhaps managed to some degree by small groups of Italian origin that gradually integrated with the populations of some Aegean regions.

The discovery of the ivory statuette in particular opens up new relevant questions regarding the nature of those exchange processes. As mentioned above, the interpretation that seems to us the most probable one, is not the usual one of economic exchange or of the giving of gifts among peers, but it is the one which relates the arrival of this exceptional artefact to non-peaceful encounters – an explanatory hypothesis, which seems well suited to that particular period that saw the destruction and sacking of the Mycenaean palaces and many other Aegean centres.

Credits

Our excavation project and the subsequent study of the finds would not have been possible without the collaboration of many students, colleagues and friends. We wish to thank them all and list their spheres of responsibilities and contribution during the excavation and study campaigns here.

Assistants of the excavation directors: Anja Buhlke (excavation technology, topography), Cristiano Iaia (on-site documentation), Nicoletta Insolvibile (underwater archaeology), Laura Soro (on-site documentation, GIS), Veronica Ventorino (head of find registration and storage).

Excavation and find documentation team (archaeologists, botanists, zoologists, students): Carmela Ariano, Christian Besmer, Elisabeth Binder, Michael Brandl, Cristina Capriglione, Angela Cardinale, Ottavio Cavallo, Francesco Corpaci, Alessia D'Auria, Halinka Di Lorenzo, Susanne Eckl, Carmen Mariarosaria Esposito, Federico Filippi, Concetta Fiorillo, Gerhard Forstenpointner, Pamela Fragnoli, Alessia Fuscone, Gaia Isoldi, David Imre, Nicoletta Insolvibile, Marlies Klee, Bartłomiej Lis, Ilaria Matarese, Elena Maria Matricardi, Raffaele Palumbo, Josef Ries, Raffaella Rossi, Jens Rüdiger, Annalisa Rumolo, Nunzia Laura Saldalamacchia, Diana Savella, Maria Cristina Testa, Veronica Ventorino, Gerald Weissengruber, Ronny Weßling, Elisabeth Wuchse, Manuel Zinnà, Barbara Zach.

Local support (topographical information, survey data): Carlo Alberto De Monte, Alfonso Lo Torto, Ferdinando Staropoli, Francesco Rombolà.

We also warmly thank the Superintendence for the Archaeological Heritage of Calabria, and especially Simonetta Bonomi, Maria Teresa Iannelli and Francesco Paleologo for their excellent cooperation and unfailing support of our project during all its phases.

The excavation campaigns as well as the analyses of findings and artefacts took place in the framework of a cooperation between two research projects, one supported by the Austrian Science Fund and directed by R. Jung (FWF, project no. P23619-G19), the other supported by the Italian Ministry of Education, University and Research (PRIN: *Progetti di Ricerca di Rilevante Interesse Nazionale*; project no. 2009MF87BM), run by the University of Naples Federico II (also involving the University of Calabria) and directed by M. Pacciarelli. (Fig. 31)



Fig. 31 The Punta di Zambrone team in 2012 (photo: R. Jung)

Bibliography

Aktypi 2017
K. Aktypi, The Mycenaean Cemetery at Agios Vasileios, Chalandritsa, in Achaea (Oxford 2017).

Alberti et al. 2015
M. E. Alberti – V. Aravantinos – I. Fappas – A. Papadaki – F. Rougemont – E. Andersson Strand – M.-L. Nosch – J. Cutler, Textile tools from Thebes, mainland Greece, in: Andersson Strand – Nosch 2015a, 279–292.

Alessandri 2009
L. Alessandri, Il Lazio centromeridionale nelle età del Bronzo e del Ferro (PhD Diss., University of Groningen, Groningen 2009).

Andersson Strand – Nosch 2015a
E. Andersson Strand – M.-L. Nosch (eds.), Tools, Textiles and Contexts. Investigating Textile Production in the Aegean and Eastern Mediterranean Bronze Age, Ancient Textiles Series 21 (Oxford 2015).

Andersson Strand – Nosch 2015b
E. Andersson Strand – M.-L. Nosch, Summary of results and conclusions, in: Andersson Strand – Nosch 2015a, 351–383.

Andrikou 2006
E. Andrikou, The Late Helladic III Pottery, in: E. Andrikou – V. L. Aravantinos – L. Godart – A. Sacconi – J. Vroom, Thèbes. Fouilles de la Cadmée II.2. Les tablettes en linéaire B de la Odos Pelopidou. Le contexte archéologique. La céramique de la Odos Pelopidou et la chronologie du linéaire B (Rome 2006) 11–179.

Angelini – Bellintani 2006
S. Angelini – P. Bellintani, Archeometria delle ambre protostoriche: dati acquisiti e problemi aperti, in: Istituto Italiano di Preistoria e Protostoria (ed.), Atti della XXXIX Riunione Scientifica “Materie prime e scambi nella preistoria italiana”, Firenze, 25–27 novembre 2004 (Florence 2006) 1477–1493.

Angelini et al. 2005
S. Angelini – G. Artioli – P. Bellintani – A. Polla, Protohistoric vitreous materials of Italy. From early faience to Final Bronze Age glasses, in: H. Cool (ed.), Annales du 16e Congrès de l’Association Internationale pour l’Histoire du Verre, London, 7–13 Septembre 2003 (Nottingham 2005) 32–36.

Angelini et al. 2012
S. Angelini – Ch. Nicola – G. Artioli, Materiali vetrosi protostorici della Sardegna. Indagini archeometriche e confronto analitico con reperti coevi, in: Istituto Italiano di Preistoria e Protostoria (ed.), Atti della XLIV Riunione Scientifica "La preistoria e la protostoria della Sardegna", Cagliari, Barumini, Sassari, 23–28 novembre 2009 (Florence 2012) 1131–1150.

Arslan 1986
E. A. Arslan, Necropoli «INAM» di Vibo Valentia – Hipponion, Annali della Scuola Normale Superiore di Pisa 16, 1986, 1029–1058.

Baldo et al. 2018
M. Baldo – C. Balista – P. Bellintani, Frattesina di Fratta Polesine. Estensione, infrastrutture, definizione di aree funzionali ed evoluzione paleo-idrografica del territorio. Metodologie 'a basso impatto' e risultati delle indagini sul campo – anni 2014–2016, Padusa 51–54/2015–2018, 2018, 7–70.

Bellintani 2010
P. Bellintani, Ambra, una materia prima dal nord (ma non solo), in: F. Radina – G. Recchia (eds.), Ambra per Agamemnone. Indigeni e Micenei tra Adriatico, Ionio ed Egeo (Bari 2010) 141–146.

Bellintani – Usai 2012
P. Bellintani – A. Usai, Materiali vetrosi protostorici della Sardegna. Inquadramento crono-tipologico e considerazioni sulle relazioni tra Mediterraneo centrale e orientale, in: Istituto Italiano di Preistoria e Protostoria (ed.), Atti della XLIV Riunione Scientifica "La preistoria e la protostoria della Sardegna", Cagliari, Barumini, Sassari, 23–28 novembre 2009 (Florence 2012) 1121–1130.

Bellintani et al. 2006
P. Bellintani – I. Angelini – G. Artioli – A. Polla, Origini dei materiali vetrosi italiani. Esotismi e localismi, in: Istituto Italiano di Preistoria e Protostoria (ed.), Atti della XXXIX Riunione Scientifica "Materie prime e scambi nella preistoria italiana", Firenze, 25–27 novembre 2004 (Florence 2006) 1495–1531.

Bellintani et al. 2018
P. Bellintani – M. Baldo – C. Balista – A. Cardarelli – C. Cavazzuti – F. Gonzato – R. Peretto – F. Quondam – L. Salzani – M. Saracino – U. Thun Hohenstein – M. C. Vallicelli, Frattesina di Fratta Polesine. Traffici e mercanti nell'alto Adriatico, Archeologia Viva 188, Marzo/Aprile 2018, 22–38.

Benedetti – Cardosa 2006
L. Benedetti – M. Cardosa, Manufatti d'ambra nella Calabria protostorica, in: Istituto Italiano di Preistoria e Protostoria (ed.), Atti della XXXIX Riunione Scientifica "Materie prime e scambi nella preistoria italiana", Firenze, 25–27 novembre 2004 (Florence 2006) 1573–1587.

Bernabò Brea – Cavalier 1959
L. Bernabò Brea – M. Cavalier, Mylai, Monografie Archeologiche della Sicilia 2 (Novara 1959).

Bernabò Brea – Cavalier 1960
L. Bernabò Brea – M. Cavalier, La stazione preistorica della contrada Diana e la necropoli protostorica di Lipari, Meligunìs Lipára I (Palermo 1960).

Bernabò Brea – Cavalier 1980
L. Bernabò Brea – M. Cavalier, L'acropoli di Lipari nella preistoria, Meligunìs Lipára IV (Palermo 1980).

Bettelli 2002
M. Bettelli, Italia meridionale e mondo miceneo. Ricerche su dinamiche di acculturazione e aspetti archeologici, con particolare riferimento ai versanti adriatico e ionico della penisola italiana, Grandi contesti e problemi della Protostoria italiana 5 (Florence 2002).

Bianco Peroni 1970
V. Bianco Peroni, Die Schwerter in Italien / Le spade nell'Italia continentale, Prähistorische Bronzefunde IV, 1 (Munich 1970).

Bianco Peroni 1974
V. Bianco Peroni, Neue Schwerter aus Italien, in: H. Müller-Karpe (ed.), Beiträge zu italienischen und griechischen Bronzefunden, Prähistorische Bronzefunde XX, 1 (Munich 1974) 1–26.

Bianco Peroni 1994
V. Bianco Peroni, I pugnali nell'Italia Continentale, Prähistorische Bronzefunde VI, 10 (Stuttgart 1994).

Bietti Sestieri – De Santis 2000
A. M. Bietti Sestieri – A. De Santis, The Protohistory of the Latin Peoples. Museo Nazionale Romano Terme di Diocleziano (Milan 2000).

Bruun-Lundgren et al. 2015
M. Bruun-Lundgren – E. Andersson Strand – B. P. Hallager, Textile tools from Khania, Crete, Greece, in: Andersson Strand – Nosch 2015a, 197–206.

Buffa 1994
V. Buffa, I bronzi, in: R. Peroni – F. Trucco (eds.), Enotri e Micenei nella Sibaritide I. Broglio di Trebisacce (Taranto 1994) 571–574.

Capriglione 2016
C. Capriglione, I complessi di facies subappenninica di Punta di Zambrone (VV) e Lipari (ME) e i fenomeni storici e culturali del Bronzo Recente nel Basso Tirreno (PhD Diss. Università degli Studi di Napoli 'Federico II', Naples 2016).

Carancini – Peroni 1997
G. L. Carancini – R. Peroni, La koinè metallurgica, in: M. Bernabò Brea – A. Cardarelli – M. Cremaschi (eds.), Le Terramare. La più antica civiltà padana (Milan 1997) 595–601.

Cardarelli 2012
A. Cardarelli, Bronzezeitliche Waffenweihungen auf der italienischen Halbinsel, in: W. Meighörner (ed.), Waffen für die Götter. Krieger, Trophäen, Heiligtümer (Innsbruck 2012) 37–43.

Cataldo 1999
L. Cataldo, La ceramica, in: A. M. Tunzi Sisto, Ipogei della Daunia. Preistoria di un territorio (Foggia 1999) 234–253.

Cazzella – Recchia 2012
A. Cazzella – G. Recchia, Un trentennio di nuove ricerche a Coppa Nevigata. L'organizzazione dell'abitato e i sistemi di difesa durante le varie fasi dell'età del Bronzo, in: Cazzella et al. 2012, 247–318.

Cazzella et al. 2012
A. Cazzella – M. Moscoloni – G. Recchia (eds.), Coppa Nevigata e l'area umida alla foce del Candelaro durante l'età del Bronzo (Foggia 2012).

Christakopoulou-Somakou 2010
Γι. Χριστακοπούλου-Σωμάκου, Μυκηναϊκό νεκροταφείο Μιτόπολης Αχαΐας, Φαίδιμος 2 (Patras 2010).

Cicala – Pacciarelli 2017
L. Cicala – M. Pacciarelli (eds.), Centri fortificati indigeni della Calabria dalla protostoria all'età ellenistica. Atti del convegno internazionale, Napoli, 16–17 gennaio 2014, Archeologie. Temi, contesti, materiali 1 (Naples 2017).

Cipolloni Sampò 1999
M. Cipolloni Sampò, Ipogeismo funerario e cultuale nella Daunia meridionale, in: A. Gravina (ed.), Atti del 19° Convegno Nazionale sulla Preistoria – Protostoria – Storia della Daunia, San Severo, 27–29 Novembre 1998, vol. 2. Tavola rotonda "Ipogei della Daunia: Culti e riti funerari nella media età del Bronzo" (San Severo 1999) 155–188.

CMS
Corpus der minoischen und mykenischen Siegel.

Columella
L. Iunius Moderatus Columella, Zwölf Bücher über Landwirtschaft. Buch eines Unbekannten über Baumzüchtung. Lateinisch-deutsch, vol. 1–3, ed. and transl. by W. Richter (Munich 1981–1983).

Conte et al. 2015
S. Conte – I. Matarese – S. Quartieri – R. Arletti – R. Jung – M. Pacciarelli – B. Gratuze, The Bronze Age vitreous materials of Punta di Zambrone (southern Italy). Evidence of the use of different techniques, European Journal of Mineralogy 27, 2015, 337–351.

Conte et al. 2017
S. Conte – I. Matarese – R. Jung – M. Pacciarelli, Vaghi in materiali vetrosi da Punta di Zambrone (VV). Un approccio archeometrico, in: Cicala – Pacciarelli 2017, 471–473.

Czebreszuk 2011
J. Czebreszuk, Bursztyn w kulturze mykeńskiej. Zarys problematyki badawczej (Poznań 2011).

D'Agostino 1974
B. D'Agostino, Lacedonia, in: Seconda mostra della Preistoria e della Protostoria nel Salernitano (Salerno 1974) 109–111.

D'Agostino 1979
B. D'Agostino, Il periodo del Bronzo finale in Campania, in: Istituto Italiano di Preistoria e Protostoria (ed.), Atti della XXI Riunione Scientifica "Il Bronzo finale in Italia", Firenze, 21–23 ottobre 1977 (Florence 1979) 477–488.

Damiani 2010
I. Damiani, L'età del Bronzo recente nell'Italia centro-meridionale, Grandi contesti e problemi della Protostoria italiana 12 (Florence 2010).

D'Auria et al. 2017
A. D'Auria – E. Allevato – M. Buonincontri – A. Saracino – R. Jung – M. Pacciarelli – G. Di Pasquale, Evidence of a short-lived episode of olive (*Olea europaea* L.) cultivation during the Early Bronze Age in western Mediterranean (southern Italy), The Holocene 27, 2017, 605–612.

di Gennaro et al. 2008
F. di Gennaro – B. Barbaro – A. J. Nijboer, L'abitato del Bronzo Antico e Medio di Radicicoli Maffei. 1. L'indagine sul campo, Bullettino della Commissione Archeologica Comunale di Roma 109, 2008, 9–56.

Dreyer et al. 2002
G. Dreyer – H.-W. Fischer-Elfert – Ch. Heitz – A. Klammt – M. Krutzsch – C. von Pilgrim – D. Rauer – S. Schönenberger – Ch. Ubertini, Stadt und Tempel von Elephantine. 28./29./30. Grabungsbericht, Mitteilungen des Deutschen Archäologischen Instituts, Abteilung Kairo 58, 2002, 157–225.

Fabbri et al. 2006
P. F. Fabbri – I. Leone – A. M. Tunzi Sisto, L'ipogeo del Gigante a Trinitapoli (Fg). Analisi tafonomica e antropologica di una sepoltura dell'età del Bronzo, in: A. Gravina (ed.), 26° Convegno Nazionale sulla Preistoria – Protostoria – Storia della Daunia, San Severo, 10–11 Dicembre 2005, Atti (San Severo 2006) 125–136.

Gaignerot-Driessen 2012
F. Gaignerot-Driessen, The excavation of Zone 3, in: J. Driessen – I. Schoep – M. Anastasiadou – F. Carpentier – I. Crevecoeur – S. Déderix – M. Devolder – F. Gaignerot-Driessen – S. Jusseret – C. Langohr – Q. Letesson – F. Liard – A. Schmitt – C. Tsoraki – R. Veropoulidou, Excavations at Sissi III. Preliminary Report on the 2011 Campaign, Aegis 6 (Louvain-la-Neuve 2012) 69–79.

Gazis 2010
Μ. Γκαζής, Η. προϊστορική ακρόπολη του Τείχους Δυμαίων. Σε αναζήτηση ταυτότητας, in: Ν. Μερούσης – Ευ. Στεφανή – Μ. Νικολαΐδου (eds.), Ίρις. Μελέτες στη μνήμη της καθηγήτριας Αγγελικής Πιλάλη-Παπαστερίου (Thessaloniki 2010) 237–255.

Gorgoglione 2002
M. Gorgoglione, Torre Castelluccia. La storia degli scavi, in: M. Gorgoglione (ed.), Strutture e modelli di abitati del Bronzo tardo da Torre Castelluccia a Roca Vecchia. Rapporti ed interrelazioni sull'arco ionico da Taranto al canale d'Otranto e sul versante adriatico. Atti del Convegno di Studio 28–29 novembre 1996, Pulsano (TA) – Castello De Falconibus (Manduria 2002) 21–84.

Guerreschi 1999
G. Guerreschi, Il pane di ambra della t. 206. Determinazione della provenienza mediante analisi spettrofotometrica in I.R., in: Pacciarelli 1999a, 219–222.

Guglielmino 2009
R. Guglielmino, Le relazioni tra l'Adriatico e l'Egeo nel Bronzo recente e finale. La testimonianza di Roca, in: E. Borgna – P. Càssola Guida (eds.), Dall'Egeo all'Adriatico. Organizzazioni sociali, modi di scambio e interazione

in età postpalaziale (XII–XI sec. a. C.) / From the Aegean to the Adriatic. Social Organizations, Modes of Exchange and Interaction in Postpalatial Times (12th–11th c. BC), Atti del Seminario internazionale (Udine, 1–2 dicembre 2006), Studi e ricerche di protostoria mediterranea 8 (Rome 2009) 185–204.

Guglielmino et al. 2017
R. Guglielmino – F. Iacono – L. Coluccia, Roca e il mondo egeo tra il XVI e l'XI sec. a.C.: una messa a punto, in: F. Radina (ed.), Preistoria e Protostoria della Puglia, Studi di Preistoria e Protostoria 4 (Florence 2017) 549–555.

Iacono 2015
F. Iacono, Feasting at Roca. Cross-cultural encounters and society in the southern Adriatic during the Late Bronze Age, European Journal of Archaeology 18, 2015, 259–281.

Iaia 2017
C. Iaia, Dati per una ricostruzione dell'antico paesaggio costiero calabrese fra i fiumi Savuto e Mesima. Il contributo della cartografia storica, in: Cicala – Pacciarelli 2017, 267–279.

Jung 2006
R. Jung, Χρονολογία comparata. Vergleichende Chronologie von Südgriechenland und Süditalien von ca. 1700/1600 bis 1000 v. u. Z., Veröffentlichungen der Mykenischen Kommission 26 (Vienna 2006).

Jung 2010
R. Jung, Classification, counting and publication of Aegean-type pottery around the Mediterranean, in: B. Horejs – R. Jung – P. Pavúk (eds.), Analysing Pottery. Processing – Classification – Publication. Studia Archaeologica et Medievalia 10 (Bratislava 2010) 145–162.

Jung 2015
R. Jung, Imported Mycenaean pottery in the East. Distribution, context and interpretation, in: B. Eder – R. Pruzsinszky (eds.), Policies of Exchange. Political Systems and Modes of Interaction in the Aegean and the Near East in the 2nd Millennium B.C.E. Proceedings of the International Symposium at the University of Freiburg, Institute for Archaeological Studies, 30th May – 2nd June 2012, Oriental and Europaean Archaeology 2 (Vienna 2015) 243–275.

Jung 2017a
R. Jung, Le relazioni egee degli insediamenti calabresi e del basso Tirreno durante l'età del Bronzo, in: Cicala – Pacciarelli 2017, 51–68.

Jung 2017b
R. Jung, Chronological problems of the Middle Bronze Age in southern Italy, in: Th. Lachenal – C. Mordant – Th. Nicolas – C. Véber (eds.), Le Bronze moyen et l'origine du Bronze final en Europe occidentale (XVIIe–XIIIe siècle av. J.-C.). Colloque international de l'APRAB, Strasbourg, 17 au 20 juin 2014, Mémoires d'Archéologie du Grand-Est 1 (Strasbourg 2017) 621–642.

Jung 2018
R. Jung, Push and pull factors of the Sea Peoples between Italy and the Levant, in: J. Driessen (ed.), An Archaeology of Forced Migration. Crisis-induced Mobility and the Collapse of the 13th c. BCE Eastern Mediterranean. Aegis 15 (Louvain-la-Neuve 2018) 273–306.

Jung – Mehofer 2013
R. Jung – M. Mehofer, Mycenaean Greece and Bronze Age Italy. Cooperation, trade or war? Archäologisches Korrespondenzblatt 43, 2013, 175–193.

Jung – Pacciarelli 2016
R. Jung – M. Pacciarelli, A Minoan statuette from Punta di Zambrone in southern Calabria, in: E. Alram-Stern – F. Blakolmer – S. Deger-Jalkotzy – R. Laffineur – J. Weilhartner (eds.), Metaphysis. Ritual, Myth and Symbolism in the Aegean Bronze Age. Proceedings of the 15th International Aegean Conference, Vienna, Institute for Oriental and European Archaeology, Aegean and Anatolia Department, Austrian Academy of Sciences, and Institute of Classical Archaeology, University of Vienna, 22–25 April 2014, Aegaeum 39 (Leuven, Liège 2016) 29–36.

Jung – Pacciarelli 2017a
R. Jung – M. Pacciarelli, Gli scavi 2011–2013 a Punta di Zambrone, in: Cicala – Pacciarelli 2017, 313–324.

Jung – Pacciarelli 2017b
R. Jung – M. Pacciarelli, Greece and southern Italy 1250–1050 BCE. Manifold patterns of interaction, in: M. Fotiadis – R. Laffineur – Y. Lolos – A. Vlachopoulos (eds.), Έσπερος / Hesperos – The Aegean Seen from the West. Proceedings of the 16th International Aegaean Conference, University of Ioannina, Department of History and Archaeology, Unit of Archaeology and Art History, 18–21 May 2016, Aegaeum 41 (Leuven, Liège 2017) 185–204.

Jung et al. 2015a
R. Jung – M. Pacciarelli – B. Zach – M. Klee – U. Thanheiser, Punta di Zambrone (Calabria) – a Bronze Age harbour site. First preliminary report on the Recent Bronze Age (2011–2012 campaigns), Archaeologia Austriaca 99, 2015, 53–110.

Jung et al. 2015b
R. Jung – H. Mommsen – M. Pacciarelli, From west to west. Determining production regions of Mycenaean pottery of Punta di Zambrone (Calabria, Italy), Journal of Archaeological Science Reports 3, 2015, 455–463.

Jung et al. 2016
R. Jung – M. Pacciarelli – G. Forstenpointner –G. Slepecki – G. E. Weissengruber – A. Galik, Funde aus dem Müllhaufen der Geschichte im Befestigungsgraben von Punta di Zambrone. Angeln am spätbronzezeitlichen Mittelmeer, in: M. Bartelheim – B. Horejs – R. Krauß (eds.), Von Baden bis Troia. Ressourcennutzung, Metallurgie und Wissenstransfer. Eine Jubiläumsschrift für Ernst Pernicka, Oriental and Europaean Archaeology 3 (Rahden/Westf. 2016) 175–206.

Kaza-Papageorgiou et al. 2011
Κ. Καζά-Παπαγεωργίου – Ε. Καρδαμάκη – Π. Κουτής – Ε. Μαρκαπούλου – Ν. Μούκα, Κοντοπήγαδο Αλίμου Αττικής. Οικισμός των ΠΕ και ΥΕ χρόνων και ΥΕ εργαστηριακή εγκατάσταση, Αρχαιολογική Εφημερίς 150, 2011, 197–274.

Kilian 1985
K. Kilian, La caduta die palazzi micenei continentali. Aspetti archeologici, in: D. Musti (ed.), Le origini dei Greci. Dori e mondo egeo (Rome, Bari 1985) 73–115.

Knapp 2018
A. B. Knapp, Seafaring and Seafarers in the Bronze Age Eastern Mediterranean (Leiden 2018).

Kramer-Hajos 2016
M. Kramer-Hajos, Mycenaean Greece and the Aegean World. Palace and Province in the Late Bronze Age (Cambridge 2016).

Langohr 2017
Ch. Langohr, Late Minoan IIIB pottery at Sissi and Malia. Assessing local ceramic sequences, regional traditions and interregional interaction, in: Ch. Langohr (ed.), How Long is a Century? Late Minoan IIIB Pottery, Relative Chronology and Regional Differences, Aegis 12 (Louvain-la-Neuve 2017) 193–242.

Lentini et al. 2004
M. C. Lentini – F. Rovetto – F. G. Ardito, Resti di una capanna della tarda età del bronzo, in: U. Spigo (ed.), Archeologia a Capo d'Orlando. Studi per l'Antiquarium (Milazzo 2004) 69–78.

Lo Porto 1967
F. G. Lo Porto, Il «dolmen a galleria» di Giovinazzo, Bullettino di Paletnologia Italiana 76 [N. S. 28], 1967, 137–173.

Lo Porto 1997
F. G. Lo Porto, Kanysion 1. La necropoli protostorica a cremazione di contrada Pozzillo, Studi di Antichità 10, 1997, 71–118.

Lo Schiavo 2010
F. Lo Schiavo, Le fibule dell'Italia meridionale e della Sicilia dall'età del bronzo recente al VI secolo a. C., Prähistorische Bronzefunde XIV, 14 (Stuttgart 2010).

Marazzi – Tusa 2005
M. Marazzi – S. Tusa, Egei in occidente. Le più antiche vie marittime alla luce dei nuovi scavi sull'isola di Pantelleria, in: E. Greco – R. Laffineur (eds.), Emporia. Aegeans in Central and Eastern Mediterranean. Proceedings of the 10th International Aegean Conference / 10e Rencontre égéenne internationale, Athens, Italian School of Archaeology, 14–18 April 2004. Aegaeum 25 (Liège 2005) 599–609.

Marino – Pacciarelli 1996
D. Marino – M. Pacciarelli, Calabria, in: D. Cocchi Genick (ed.), L'antica età del bronzo in Italia. Atti del Congresso di Viareggio, 9–12 gennaio 1995 (Florence 1996) 147–162.

Matarese 2018
I. Matarese, Murgia Timone (Matera): le tombe a camera, Origines 33 (Florence 2018).

Matarese et al. 2017
I. Matarese – S. Conte – R. Jung – M. Pacciarelli, Vaghi di provenienza egea da Punta di Zambrone (VV). Una riflessione crono-tipologica, in: Cicala – Pacciarelli 2017, 467–469.

Matarese et al. 2018
I. Matarese – S. Conte – R. Jung – M. Pacciarelli, Ornamenti in materiale vetroso dell'età del bronzo dall'Italia meridionale e dall'area siciliano-eoliana: un inquadramento d'insieme alla luce di nuovi dati, Rivista di Scienze Preistoriche 68, 2018, 385–424.

Militello et al. 2015
P. Militello – E. Andersson Strand – M.-L. Nosch – J. Cutler, Textile tools from Ayia Triada, Crete, Greece, in: Andersson Strand – Nosch 2015a, 207–214.

Moscoloni 2012
M. Moscoloni, L'industria su osso e corno dagli scavi in estensione 1972–75 a Coppa Nevigata, in: Cazzella et al. 2012, 217–224.

Müller-Karpe 1960–61
H. Müller-Karpe, Osservazioni intorno ai bronzi dalle tombe ad incinerazione di Torre Castelluccia, Bullettino di Paletnologia Italiana 1960–61, 187–206.

Nava 1984
M. L. Nava, L'età dei metalli, in: M. Mazzei (ed.), La Daunia antica. Dalla preistoria all'altomedioevo (Milan 1984) 101–136.

Nava 2003
M. L. Nava, L'attività archeologica in Basilicata nel 2002, in: Ambiente e paesaggio nella Magna Grecia. Atti del XLII Convegno di Studi sulla Magna Grecia, Taranto 5–8 ottobre 2002 (Florence 2003) 653–717.

Pacci 1987
M. Pacci, Revisione e nuove proposte d'interpretazione per i materiali delle tombe di Santa Domenica di Ricadi, Sicilia Archeologica 20, 1987, 35–52.

Pacciarelli 1999a
M. Pacciarelli, Torre Galli. La necropoli della prima età del ferro (Scavi P. Orsi 1922–23) (Soveria Mannelli 1999).

Pacciarelli 1999b
M. Pacciarelli, La necropoli protostorica di Castellace e considerazioni sui processi culturali dei secoli XII–X a.C., in: L. Costamagna – P. Visonà (eds.), Oppido Mamertina, Calabria – Italia. Ricerche archeologiche nel territorio e in contrada Mella (Rome 1999) 35–80.

Pacciarelli 2000
M. Pacciarelli, Dal villaggio alla città. La svolta protourbana del 1000 a.C. nell'Italia tirrenica, Grandi contesti e problemi della Protostoria italiana 4 (Florence 2000).

Pacciarelli 2008
M. Pacciarelli, Il popolamento della Calabria meridionale tirrenica nelle età dei metalli, in: G. De Sensi Sestito (ed.), La Calabria tirrenica nell'antichità. Nuovi documenti e problematiche storiche (Soveria Mannelli 2008) 77–94.

Pacciarelli 2012
M. Pacciarelli, Le multiforme realtà delle pratiche funerarie del Bronzo nel Sud Italia. Esempi Dani e non, in: A. Gravina (ed.), 32° Convegno Nazionale sulla Preistoria – Protostoria – Storia della Daunia, San Severo, 12–13 novembre 2011 (San Severo 2012) 217–234.

Pacciarelli 2015
M. Pacciarelli, General notes on the Recent Bronze Age in Italy, with special reference to the southwest, contribution in: Jung et al. 2015a, 54–57.

Pacciarelli 2017
M. Pacciarelli, Il ruolo dei centri d'altura nei sistemi territoriali protostorici della Calabria tirrenica, in: Cicala – Pacciarelli 2017, 31–49.

Pacciarelli – Varricchio 1991–92
M. Pacciarelli – M. R. Varricchio, Il promontorio di Tropea (Catanzaro). 1. Le facies archeologiche. 2. L'organizzazione del territorio, Rassegna di Archeologia 10, 1991–92, 756–759.

Pacciarelli – Varricchio 2004
M. Pacciarelli – M. R. Varricchio, Fasi e facies del Bronzo medio e recente nella Calabria meridionale tirrenica, in: Istituto Italiano di Preistoria e Protostoria (ed.), Atti della XXXVII riunione scientifica "Preistoria e protostoria della Calabria", Scalea, Papasidero, Praia a Mare, Tortora, 29 settembre – 4 ottobre 2002 (Florence 2004) 359–379.

Pacciarelli et al. 2015
M. Pacciarelli – T. Scarano – A. Crispino, The transition between the Copper and Bronze Ages in southern Italy and Sicily, in: H. Meller – H. W. Arz – R. Jung – R. Risch (eds.), 2200 BC – Ein Klimasturz als Ursache für den Zerfall der Alten Welt? 7. Mitteldeutscher Archäologentag vom 23. bis 26. Oktober 2014 in Halle (Saale) / 2200 BC – A Climatic Breakdown as a Cause for the Collapse of the Old World? 7th Archaeological Conference of Central Germany, October 23–26, 2014 in Halle (Saale), Tagungen des Landesmuseums für Vorgeschichte Halle 12 (Halle [Saale] 2015) 253–281.

Pagliara et al. 2007
C. Pagliara – G. Maggiulli – T. Scarano – C. Pino – R. Guglielmino – J. De Grossi Mazzorin – M. Rugge – G. Fiorentino – M. Primavera – L. Calcagnile – M. D'Elia – G. Quarta, La sequenza cronostratigrafica delle fasi di occupazione dell'insediamento protostorico di Roca (Melendugno, Lecce). Relazione preliminare della campagna di scavo 2005 – Saggio SAS X, Rivista di Scienze Preistoriche 57, 2007, 311–362.

Pagliara et al. 2008
C. Pagliara – R. Guglielmino – G. Coluccia – I. Malorgio – M. Merico – D. Palmisano – M. Rugge – M. Minonne, Roca Vecchia (Melendugno, Lecce), SAS IX. Relazione stratigrafica preliminare sui livelli di occupazione protostorici (campagne di scavo 2005–2006), Rivista di Scienze Preistoriche 58, 2008, 239–280.

Palmisano 2008
D. Palmisano, Analisi tipologica preliminare della ceramica d'impasto, contribution in: Pagliara et al. 2008.

Pasquini 2005a
M. Pasquini, L'industria su corno di Moscosi di Cingoli (Macerata). Classificazione, in: Istituto Italiano di Preistoria e Protostoria: Atti della XXXVIII Riunione Scientifica "Preistoria e protostoria delle Marche", Portonovo, Abbadia di Fiastra, 1–5 ottobre 2003 (Florence 2005) 979–984.

Pasquini 2005b
M. Pasquini, L'industria su corno di Moscosi di Cingoli (Macerata): forme principali e loro diffusione, in: Istituto Italiano di Preistoria e Protostoria: Atti della XXXVIII Riunione Scientifica "Preistoria e protostoria delle Marche", Portonovo, Abbadia di Fiastra, 1–5 ottobre 2003 (Florence 2005) 985–991.

Popham – Sackett 1968
M. R. Popham – L. H. Sackett (eds.), Excavations at Lefkandi, Euboea 1964–66 (London 1968).

Quagliati – Ridola 1906
Q. Quagliati – D. Ridola, Necropoli arcaica ad incinerazione presso Timmari nel Materano, Monumenti Antichi 16, 1906, 5–166.

Rahmstorf 2008
L. Rahmstorf, Kleinfunde aus Tiryns, Tiryns XVI (Wiesbaden 2008).

Rahmstorf 2011
L. Rahmstorf, Handmade pots and crumbing loomweights. 'Barbarian' elements in the eastern Mediterranean in the last quarter of the 2nd millennium BC, in: V. Karageorghis – O. Kouka (eds.), On Cooking Pots, Drinking Cups, Loomweights and Ethnicity in Bronze Age Cyprus and Neighbouring Regions. An International Archaeological Symposium held in Nicosia, November 6th–7th 2010 (Nicosia 2011) 315–330.

Recchia 1993
G. Recchia, Grotta Manaccora (Peschici). Considerazioni sulla grotticella funeraria e sull'area antistante (scavi Rellini-Baumgärtel), Origini 17, 1993, 317–401.

Recchia 2007–2008
G. Recchia, Antenati, «eroi», nemici. Sepolture e resti umani in alcuni abitati dell'età del Bronzo dell'Italia peninsulare, Scienze dell'Antichità 14, 2007–2008, 83–121.

Recchia 2012
G. Recchia, Sepolture e resti umani nelle varie fasi dell'abitato dell'età del Bronzo di Coppa Nevigata, in: Cazzella et al. 2012, 389–409.

Renfrew 1977
C. Renfrew, Alternative models for exchange and spatial distribution, in: T. K. Earle – J. E. Ericson (eds.), Exchange Systems in Prehistory (New York, San Francisco, London 1977) 71–90.

Salzani 2011
L. Salzani, Campestrin di Grignano Polesine (Rovigo), in: F. Marzatico – R. Gebhard – P. Gleirscher (eds.), Le grandi vie delle civiltà. Relazioni e scambi fra mediterraneo e il centro Europa dalla preistoria alla romanità (Trento 2011) 429–430.

Scarano 2012
T. Scarano, Roca I. Le fortificazioni della media età del Bronzo. Strutture, contesti, materiali (Foggia 2012).

Schiffer 1972
M. B. Schiffer, Archaeological context and systemic context, American Antiquity 37, 1972, 156–165.

Tunzi Sisto 1999
A. M. Tunzi Sisto, Ipogei della Daunia. Preistoria di un territorio (Foggia 1999).

Tunzi Sisto – Lo Zupone 2008
A. M. Tunzi Sisto – M. Lo Zupone, Il santuario dell'età del Bronzo di Trinitapoli, in: A. Gravina (ed.), 28° Convegno Nazionale sulla Preistoria – Protostoria – Storia della Daunia, San Severo, 25–26 novembre 2007 (San Severo 2008) 187–210.

Tunzi Sisto et al. 2005
A. M. Tunzi Sisto – B. Barbaro – R. Peroni – A. Vanzetti, Gli ipogei del Tavoliere. Aspetti culturali e del rituale funerario, in: P. Attema – A. Nijboer – A. Zifferero (eds.), Papers in Italian Archaeology VI. Communities and Settlements from the Neolithic to the Early Medieval Period. Proceedings of the 6th Conference of Italian Archaeology held at the University of Groningen, Groningen Institute of Archaeology, The Netherlands, April 15–17, 2003, British Archaeological Reports International Series 1452 (I) (Oxford 2005) 129–136.

Vanzetti 2002
A. Vanzetti, La necropoli a incinerazione di Torre Castelluccia, in: M. Gorgoglione (ed.), Strutture e modelli di abitati del Bronzo tardo da Torre Castelluccia a Roca Vecchia. Rapporti ed interrelazioni sull'arco ionico da Taranto al canale d'Otranto e sul versante adriatico. Atti del Convegno di Studio 28–29 novembre 1996, Pulsano (TA) – Castello De Falconibus (Manduria 2002) 117–123.

Vanzetti 2007–2008
A. Vanzetti, Appunti per l'indagine sulle deposizioni umane in abitato durante la protostoria europea, Scienze dell'Antichità 14, 2007–2008, 745–769.

Vanzetti 2013
A. Vanzetti, Sibari protostorica, in: G. Delia – T. Masneri (eds.), Sibari. Archeologia, storia, metafora (Castrovillari 2013) 11–33.

Weiss-Krejci 2011
E. Weiss-Krejci, The formation of mortuary deposits. Implications for understanding mortuary behavior of past populations, in: S. C. Agarwal – B. A. Glencross (eds.), Social Bioarchaeology (Malden, Oxford, Chichester 2011) 68–106.

Zach et al. 2015
B. Zach – M. Klee – U. Thanheiser, Preliminary results obtained from the archaeobotanical analysis of materials from the 2011 excavation season, contribution in: Jung et al. 2015a.

Punta di Zambrone (Calabria, Italy) and the Recent Bronze Age in the Southern Tyrrhenian Region

Cristina Capriglione[1]

Abstract: This contribution focuses on the *impasto* production of the Recent Bronze Age site of Punta di Zambrone (Calabria), with the aim of defining the cultural processes taking place in the southern Tyrrhenian region between the 13th and 12th centuries BC. This very large set of new findings has been the object of a typological classification, together with other materials from the geographical area of the site (Lipari, southern Tyrrhenian Calabria, northeastern Sicily). Some of the most peculiar Subapennine ceramic classes are described in this paper, namely: bowls and cups within the open shapes; typical Subapennine handle projections, amphorae, jars and large storage containers within the closed shapes and, finally, spindle whorls and loom weights among the terracotta artefacts. Although Punta di Zambrone is substantially a single-phase Recent Bronze Age 2 site, there are a few fragments dating back to Middle Bronze Age 3 (Apennine/Thapsos-Milazzese *facies*) and to Recent Bronze Age 1. The presence of those more ancient sherds raises some questions about the chronology of the site and of the 'Ausonian' invasion in the southern Tyrrhenian region of Italy.

Keywords: *impasto* pottery, chronotypology, Subapennine *facies*, Ausonian I, southern Calabria, Aeolian Islands

The Southern Tyrrhenian Region in the Recent Bronze Age: Starting Point and New Perspectives

This contribution focuses on the conspicuous set of *impasto* pottery fragments dating to the Recent Bronze Age (mainly the 13th and early 12th centuries BC) found in the layers of ash, charcoal, earth and stones filling part of the defensive ditch of the site of Punta di Zambrone. This site was excavated between 2011 and 2013 within the international research project conducted by the University of Naples Federico II and the Institute for Eastern and European Archaeology in Vienna (OREA). The study of these finds, carried out in the framework of a PhD at the University of Naples Federico II, is providing a large amount of new data that may lead to a better definition of the regional aspect of the Subapennine cultural group that is characteristic for the southern Tyrrhenian region of Italy and can be called 'Ausonian'. It is also noteworthy that Punta di Zambrone offers the first case of Recent Bronze Age pottery coming from a very well stratified settlement in southern Tyrrhenian Calabria.

On the one hand, this study addresses the new *impasto* pottery from Zambrone and on the other hand it offers a complete re-examination of the stratigraphy and the ceramic finds from the Ausonian I settlement on the acropolis of Lipari, found in the 1950s and 1960s by Luigi Bernabò Brea and Madeleine Cavalier. The fundamental purpose of this research is to create a typology for the Recent Bronze Age *impasto* pottery of the area, a typology that integrates materials from all the sites of the southern Tyrrhenian region. The aim is to arrive at a more precise definition of the local aspect, to pinpoint typical regional models and to define in a better way their chronology and duration. This may contribute to a refined interpretation of cultural processes taking place in the southern Tyrrhenian region between the 13th and 12th centuries BC.

[1] Direzione Regionale Musei Campania, Museo archeologico di Calatia, via Caudina 353, 81024 Maddaloni (Caserta), Italy; cristina.capriglione@beniculturali.it.

The 'Crisis' of the Recent Bronze Age in the Literary and Archaeological Records

In all the territories of southern Tyrrhenian Calabria, northeastern Sicily and the Aeolian Islands, during the Recent Bronze Age we witness a radical reorganisation of the settlements and the abandonment of the previous villages of the Middle Bronze Age. In addition, the Middle Bronze Age 'Thapsos-Milazzese' material culture, which was of a Sicilian type, is substituted by a new one that is typically continental Italian, i.e. the Subapennine culture. Luigi Bernabò Brea designated this phenomenon with the term 'Ausonio',[2] and explained it with the sudden and traumatic arrival in Lipari of new people coming from the Italian mainland; it is probably the only case with plausible archaeological evidence of violent invasion for Italian protohistory. According to Bernabò Brea, the ancient Greek historians commemorated antique migrations of populations that had happened several centuries before the Greek colonisation of southern Italy. Diodorus Siculus,[3] for instance, tells us that the prince Liparus, son of the king Auson, had to abandon his homeland (located, according to the myth, in the region of Sorrento), and went to the island of Lipari with ships and soldiers. He conquered the island and gave it his name. According to other historians, instead, the population of Siculi arrived on the northeastern coasts of Sicily with another migration from the Italian mainland; the Siculi also rejected the autochthonous Sicanian population in the western region of the island. For Thucydides this migration happened nearly three centuries before the Greek colonisation; for Hellanicus the same event dates back to three generations before the Trojan War.[4] The date provided by Hellanicus, according to Bernabò Brea, was more consistent with the archaeological finds, because it fell around 1270 BC, which is more or less the beginning of the Recent Bronze Age in Italy. Bernabò Brea explained the date given by Thucydides not simply as a mistake, but he thought that it could indicate a later moment in the same process, which likely had more than one wave.[5]

Notwithstanding the later written sources and their hypothetical relationship to historical processes of the 2nd millennium, the archaeological record does provide evidence for a Bronze Age immigration in this region. For the promontory of Tropea, and in particular for the site of Punta di Zambrone, archaeological data are also congruent with an arrival of foreign people. During the Recent Bronze Age, in fact, a new and complex territorial system developed on the promontory of Tropea. The area is now densely occupied by different types of settlements depending on the features of the territory.[6] On the Poro plateau, for instance, we have six sites with agricultural propensity, while on the hills we can find sites in a defensive position, near to grazing lands and woodlands, such as Pirara, Mesiano Vecchio and Mancipa. On the coastline, by contrast, there are sites situated on promontories, but which nonetheless have harbours.[7] Those sites, i.e. Tropea and Punta di Zambrone among others, were dedicated to maritime activities and overseas exchanges. It is evident that in this area of southern Tyrrhenian Calabria, between the end of the Middle Bronze Age 3 and the Recent Bronze Age, there was a drastic reorganisation of the settlement pattern, with precise political and territorial planning. This phenomenon is due to the economic and political impact of the new population groups coming from the Italian peninsula, as has been described for the Aeolian Islands, even though there is as yet no known evidence of violent destructions or fires at the sites.[8]

---

2 Bernabò Brea 1952; Bernabò Brea 1958; Bernabò Brea 1964/1965; Bernabò Brea 1976/77; Bernabò Brea 1979; Bernabò Brea – Cavalier 1956; Bernabò Brea – Cavalier 1980.

3 Diod. V, 7.

4 Thuc. VI, 2–5.

5 For a complete review of all the ancient literary and historical sources regarding the Sicilian protohistory, see Bernabò Brea 1964/1965. However, one has to be cautious, as more recent research indicates that historical facts are not handed down for many generations if there are no specific cultural mechanisms in operation that serve to preserve historical knowledge (cf. Assmann 1999).

6 More information about the dynamics of the human occupation of the promontory of Tropea during protohistory can be found in Pacciarelli 2001, 74–85; Pacciarelli 2004; Pacciarelli 2009.

7 See Romano et al., this volume.

8 The fact that the fortification ditch of Punta di Zambrone was mainly filled with layers of ash cannot be taken as proof of destruction by fire; the ceramic materials found in those layers, in fact, show almost no sign of exposure to fire. However, the question of the interpretation of the nature of those ashes is still open.

Moreover, archaeological data indicate that the Subapennine aspect of southern Tyrrhenian Calabria has many characteristics in common with other contemporaneous find assemblages of the region and in particular with the Aeolian Islands with which it constitutes a real cultural koiné.

The Pottery from Punta di Zambrone

Punta di Zambrone is one of the key sites for comprehending the historical and cultural processes involving the southern Tyrrhenian region between the 13th and 12th centuries BC. We must highlight the importance of the *impasto* pottery, the subject of this paper, from both a qualitative and a quantitative point of view. This is, in fact, the first large and representative set of well datable material coming from the area, apart from the old findings from Lipari.

The pottery that is the subject of inquiry was found in the layers of the Recent Bronze Age, dug up in areas B (eastern part) and C of the Punta di Zambrone excavations. Both of these excavation areas revealed, at different points, the fill of the fortification ditch of the site. We are dealing with a huge amount of ceramics: Area C, in fact, yielded the impressive number of over 40,000 *impasto* sherds, including 7552 diagnostic fragments and 33,699 body sherds. By contrast, a reduced amount of pottery was obtained from the eastern part of Area: 846 diagnostic fragments and 6251 body sherds. An intensive drawing campaign produced a final total number of over 1200 drawings of *impasto* pottery, representing the most relevant diagnostic fragments from a typological point of view.

The quantity of Mycenaean pottery found in Punta di Zambrone is also quite remarkable: in fact, it was possible to identify a total number of 189 pieces. Among them are 23 rims, 179 body sherds and 5 bases. This fact is even more significant in comparison to the number of Mycenaean pieces from the Ausonian I layers of Lipari. According to the first calculations by Reinhard Jung,[9] at Punta di Zambrone we have 106 Mycenaean sherds per 100m³ of excavated soil, while in Lipari, considering both pure and mixed Ausonian I contexts, we have 1.2 sherds per 100m³. Thus, the amount of Mycenaean-type pottery at Punta di Zambrone is approximately 88 times higher than that from the Ausonian I layers at the acropolis of Lipari.[10]

However, the main innovative aspect of those finds is the strong chronological homogeneity of the sample: with the exception of a few pieces that we will examine in detail later, almost all the *impasto* pottery from Punta di Zambrone dates to a late phase of the Recent Bronze Age. This situation, together with the fact that several joining fragments were found in different stratigraphic units, often far from each other in terms of depth and horizontal distance, allowed us to confirm the hypothesis already proposed during the excavation, according to which the different fill layers of the ditch formed contemporaneously or at least within a very short time interval.

Pottery from Phases Antedating the Recent Bronze Age

A rather small number of pottery fragments dates to a phase preceding Recent Bronze Age 2, which is clearly the prevalent period at the site of Punta di Zambrone. For instance, 31 small fragments[11] (plus 2 from other sites on the promontory of Tropea[12]) present the typical Apennine decoration with incised lines; small dots, often filled with white paste, and carved grooves, triangles and rectangles, and refer to the Middle Bronze Age 3 Apennine *facies*.

---

9 For the calculations so far, only the sherds coming from the excavation campaigns of 2011–2012 have been considered: Jung et al. 2015, 68–69.

10 For a new calculation based on all three campaigns of excavation in both areas B and C see Jung – Pacciarelli, this volume.

11 Thirty-one is the number of all the fragments with this kind of decoration, without taking into account a possible but unsure attribution of more fragments to the same vase.

12 Pacciarelli – Varricchio 2004, 376, fig. 9, 22–23.

It was possible to recognise seven typical decorative patterns, like single or multiple rectilinear lines (Fig. 1.1), zigzags or bands with incised dots (Fig. 1.2–4), spirals or curvilinear carved grooves (Fig. 1.5) and ‘dogtooth’ patterns (Fig. 1.6). However, the Apennine aspect of Punta di Zambrone seems to be partially different from the classic Apennine culture.

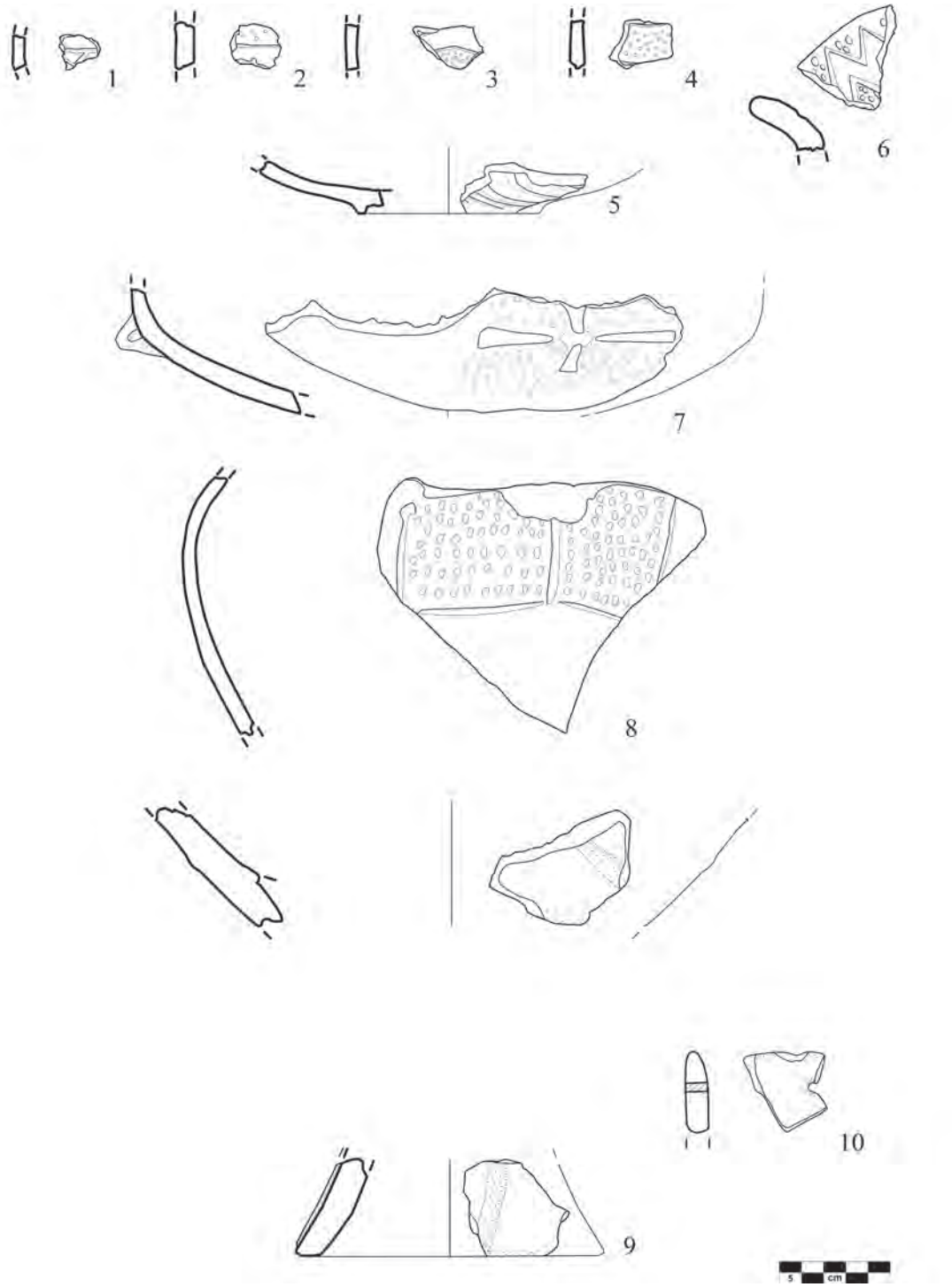


Fig. 1 Pottery from the Middle Bronze Age: 1–8. Incised or carved Apennine decoration; Thapsos-Milazzese pottery: 9. bowl on high foot decorated with ribs; 10. casserole with a row of holes (scale 1:3) (drawings: C. Capriglione, F. Corpaci, E. Matricardi and R. Palumbo; digitisation: C. Capriglione)

For instance, there are two patterns, one of which is made up of large carved grooves organised in the shape of a cross around a knob, creating four slices filled with irregular and chaotic dots (Fig. 1.7). There are three sherds with that decoration, probably parts of the same vase. The second pattern, known from two fragments, presents metopes surrounded by large incised lines and filled with irregular carved rectangles or triangles (Fig. 1.8); this decoration appears on body fragments of vessels with a rounded profile, like big bowls or cups, or on the shoulders of closed shapes. Those decorative patterns are almost unattested outside Punta di Zambrone: it is only for the second one that a parallel exists in one fragment from Avella[13] dating to the final stages of the Middle Bronze Age 3, while the other one still remains a *unicum*.

On the other hand, only a few pieces refer to the Thapsos-Milazzese culture (also dating to Middle Bronze Age 3). For example, there is a typical bowl on a high foot decorated with ribs (Fig. 1.9), in three fragments, and a little sherd of rim with a small circular hole, which probably pertains to a casserole with a row of small holes (Fig. 1.10), typical of this culture and well known in the promontory of Tropea.[14] The Middle Bronze Age culture of this region of Calabria clearly shows a strong connection with Sicily: the Thapsos-Milazzese aspect found there, in fact, has very strict parallels with the coeval aspect of northern and western Sicily, in particular with the 'Faraglioni' settlement on Ustica.[15]

Even if the number of fragments dating back to the Middle Bronze Age is too low to indicate the existence at Punta di Zambrone of a stable settlement in this period, it is nevertheless very important. It is possible, in fact, on the one hand that those decorative patterns lasted longer in Punta di Zambrone, beyond the Middle Bronze Age at least until the early phases of the Recent Bronze Age. On the other hand, however, it is also conceivable that the new Subapennine *facies* arrived at the southern Tyrrhenian coasts of Calabria earlier than at Lipari (where, in fact, the mainland Italian *facies* arrived in an articulated form).[16] The second solution seems to be more plausible, even if we cannot yet explain why we found such a high number of Apennine fragments in Punta di Zambrone, compared to the almost complete lack of attestations of Thapsos-Milazzese pottery, when quite the opposite situation should be expected.[17]

The Pottery Finds from the Early Phase of the Recent Bronze Age

In addition to those few, probably residual elements of Middle Bronze Age 3, we can identify a slightly more significant presence of typological elements datable to the first phase of the Recent Bronze Age.

In particular, we can here name some types of handle projections. The first is the class of the axe-shaped knobs (category V, class a), of which three types have been identified (47–49) based on the height of the knob and the shape of its extremity. Only two fragments from Punta di Zambrone, both with a convex extremity of the axe (type 47; Fig. 2.1), are preserved; in addition to these, we have another four pieces from Lipari and only one from other sites on the promontory of Tropea.

Type 49 is an unusual type of projection, the shape of which is halfway between an axe and a cylinder, because it has a shaft with a circular section like a cylinder, but ending with a thinner, flat and more expanded extremity (Fig. 2.4); only one specimen is attested at Punta di Zambrone and so far, it is a *unicum*.

---

13 Albore Livadie et al. 2008, 236, fig. 9.8.

14 Pacciarelli 2001, 33, fig. 13.15.

15 Pacciarelli – Varricchio 2004.

16 Pacciarelli – Varricchio 2004, 377.

17 This fact has to be connected with the ^{14}C dates of the layers filling the fortification ditch of Punta di Zambrone, the lowermost of which appear to date back to the 14th century calBC (cf. Weninger et al., this volume).

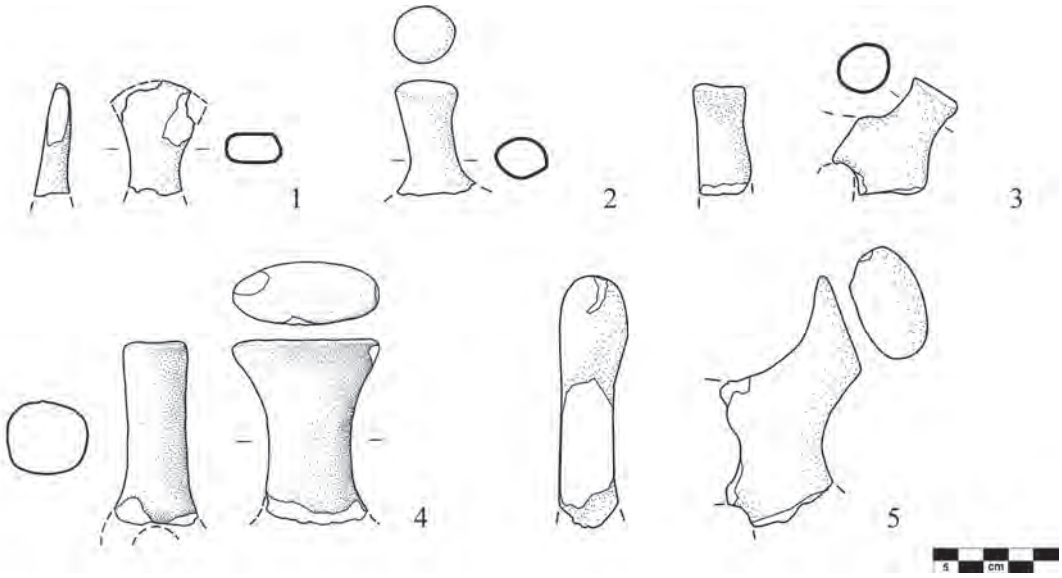


Fig. 2 Pottery datable to Recent Bronze Age 1: 1. axe-shaped knobs; 2. axe with expanded extremity; 3. cylinder-shaped knobs; 4. couple of cylinders set on a horizontal handle raising above the rim; 5. boot-shaped cylinders (scale 1:3) (drawings: C. Capriglione, M.R. Cinquegrana, F. Corpaci, M. Pacciarelli; digitisation: C. Capriglione)

The other class dating back to Recent Bronze Age 1 is that of the cylinder-shaped handle projections (class b). The ceramic production of the southern Tyrrhenian region has two types of cylindrical projections (50–51), but only one fragment from Punta di Zambrone, in which the cylinder has a flat and slightly expanded extremity, is undoubtedly attributable to the class (Fig. 2.2). Several other fragments of cylinders found in Punta di Zambrone are too poorly preserved for classification: in fact, they may be either part of this class or of other classes, like snail horns or pairs of cylinders set on horizontal handles. For this reason, the majority of attestations of cylindrical projections come, obviously, from Lipari, where an early phase of occupation during the Recent Bronze Age is quite well attested.

Finally, we also have several specimens of pairs of cylinders set on horizontal handles attached on top of the rim (class c) which, according to different morphological elements, such as the length of the cylinders or the shape of their extremities, can be divided into three types (types 52–54; Fig. 2.3). Type 54 is a noteworthy one; it includes horizontal handles with a boot-shaped kind of cylinder (Fig. 2.5). This type sends us back to the central Adriatic coastline,[18] to the time between the final stage of Middle Bronze Age 3 and Recent Bronze Age 1. However, this type is also very frequent on Lipari and on the promontory of Tropea. One can say that this type of boot-shaped projection attached to horizontal handles is one of the most distinctive features of an early phase of the Ausonian aspect. Therefore, its widespread presence at Punta di Zambrone and in its surroundings is very important, although insufficient to indicate a settlement of Recent Bronze Age 1. It is more likely that the peninsular population groups conquering the territory brought with them knowledge of those RBA 1 and Apennine (MBA 3) types (i.e. the habit of manufacturing them), so that these types occur at the site of Punta di Zambrone as residual typological elements. It is possible to imagine that the first contacts with the 'Ausonian' populations happened in a very early phase of the Recent Bronze Age, still with the presence of previous Apennine elements, but they did not lead to the establishment of a stable settlement at Punta di Zambrone. A

[18] Especially to the Marche region; see, for example, Conelle di Arcevia (Danesi – Galluzzi 2009, 78, pl. II.2 [collection Anselmi]; 79, pl. III.3, 7–9, 12 [excavations by Puglisi]. The authors suggest for this type a Middle Bronze Age 3 origin with continuity in the Recent Bronze Age.

stable settlement was, however, established at Lipari, where we have a clear Recent Bronze Age 1 phase, but a much more evanescent Apennine presence.

The Typology of the Subapennine Pottery from the Southern Tyrrhenian Region

We can now start with a synthetic review of the materials which were the subject of the typological analysis. This typological classification deals exclusively with the *impasto* production from the Recent Bronze Age contexts of Punta di Zambrone and Lipari – material that I have personally examined. A few published finds from other sites on the promontory of Tropea and the rest of the southern Tyrrhenian region have been added to the typology, in order to reconstruct a complete picture of the Ausonian ceramic production. The classification is based on 28 large ceramic categories, indicated by Roman numerals, as shown in Tab. 1.

CATEGORIES				
OPEN SHAPES	OPERN SHAPES: HANDLES/LUGS	CLOSED SHAPES	FICTILE NON-VASCULAR OBJECTS	OTHER
I) baking trays	V) handles with projections	VII) mugs	XIII) baking plates	XVIII) foots
II) bowls	VI) handles raising above the rim	VIII) small jars	XIV) coking stands/ovens	XIX) lids
III) large open shapes		IX) amphorae	XV) spindle whorls	XX) miniature vessels
IV) cups		X) jars	XVI) loom weights	OUT OF CLASSIFICATION
		XI) bucket-shaped jars	XVII) tokens	XXI) Apennine pottery with incised/carved decoration
		XII) large storage containers		XXII) Thapsos-Milazzese pottery
				XXIII) painted pottery
				XXIV) daub
				XXV) rims of undefinable shapes
				XXVI) bottoms
				XXVII) walls with plastic decorations
				XXVIII) gripping elements

Tab. 1 The 28 ceramic categories at the basis of the typological classification

Thereafter, I have subdivided the larger categories into ceramic classes designated by lower case letters. The next step was the creation, where possible, of typological families, gathering several types with similar features. For every type recognised, varieties or variations have also been identified, when needed; the first indicated with capital letters, the second with lower case letters. Finally, some *unica* were singled out, i.e. types without known parallels in the coeval ceramic production. Typological families and types follow a sequential numeration throughout the whole classification.

In this paper, only a selection of the ceramic categories identified will be presented, namely: bowls, cups, handles with projections, amphorae, jars, and large storage vessels. Loom weights and spindle whorls have been chosen from the terracotta objects.

Open Shapes: Bowls and Cups

The first one to be presented is category II: bowls. Bowls are quite numerous at Zambrone (257 fr. of rims inventoried), although not at the same level as the cups. They may be arranged in two classes: bowls with continuous or non-continuous profile. 10 types of bowls have been identified and then grouped in 5 families, which can be summarised as follows:

Family 1 (Fig. 3.1): hemispherical small bowls (types 7–8);
Family 2 (Fig. 3.2): bowls with a thickened rim (types 9–11);
Family 3 (Fig. 3.3): deep bowls with a non-articulated profile (types 12–13);
Family 4: bowls with an angular profile (type 14);
Family 5 (Fig. 3.4): bowls with an incurving rim (types 15–17).

Several profoundly innovative elements immediately emerge in comparison to the spectrum known from the peninsular Subapennine culture. The first is undoubtedly represented by family 1, the small hemispherical shallow bowls. In this family we can distinguish two types based on the characteristics of the rim and the general dimensions and morphology; they often present a bottom with *omphalos*, and are generally without handles. When they present gripping elements, these are horizontal handles rising above the rim, simple or ending in diverging coils.

The small hemispherical bowls are not very frequently attested in southern Italy, compared to the 32 specimens uniquely identified at Punta di Zambrone. Moreover, they are consistently present at Lipari and thus constitute a feature of the area in question. Parallels can be found with family 4, types 5 and 6A as defined by Isabella Damiani.[19] Those types are quite widespread both geographically and chronologically: type 4, for example, is characteristic of the middle and southern Tyrrhenian coastline and lasts for all the Recent Bronze Age, while variety 6A is typical of the Adriatic coastline, up to Romagna and the Po Valley, in Recent Bronze Age 1. Several specimens are also present in Recent Bronze Age 2 at Torre Mordillo, on the Ionic coast of Calabria.[20]

By contrast, bowls with an internally thickened rim (family 2) are well known and well attested in the Subapennine repertory of continental Italy. At Punta di Zambrone there are 42 specimens of bowls with a thickened rim, and they can be divided into three types according to the shape of the rim, the depth of the body and the dimensions. These bowls with thickened rims are present throughout the territory of the Subapennine *facies*, starting from as early as the final stages of Middle Bronze Age 3.[21] They generally have lobe-shaped lugs or horizontal handles attached to the rim and rising above it; these are simple or, more often, they have horizontal handles ending in diverging coils or with pairs of bird's head-shaped projections generally positioned with the beaks facing the inside of the container. Bernabò Brea called this kind of bird's head-shaped projections, very frequent in Lipari, '*anse di padelle*'. He made a reconstruction of those '*padelle'* as very shallow, almost flat bowls where the birds' heads rest at the same level as the bottom of the bowl.[22] Nevertheless, the study of the pottery of Punta di Zambrone and Lipari allowed a partial correction of the reconstruction of the shape of these so-called '*padelle*', because it was possible to see that they are attached to deeper bowls.

Family 5, bowls with an inverted rim, is also of great interest. Traditionally, these bowls are thought to be typical for the Protovillanovan Culture of the Final Bronze Age. However, we can see that they are already present from the final stages of Recent Bronze Age 2 on, as is demonstrated by their presence at Punta di Zambrone and especially in the more recent layers of the Ausonian settlement of Lipari. In the typology presented here, we included 11 pieces from Punta di Zambrone and 10 from Lipari, organised into 3 types, with a rim varying from slightly to strongly inverted, and with a profile ranging from curved to straight. The bowls with inverted rim in the southern Tyrrhenian region generally have a horizontal or oblique handle placed on the maximum diameter, or

[19] For type 5 see Damiani 2010, 135, pl. 6B 1–3; 136, pl. 7.1–6, 7–8; for variety 6A: Damiani 2010, 136, pl. 7.10–12.
[20] It is the type 21B from Torre Mordillo: Trucco – Vagnetti 2001, 140, fig. 77.1.
[21] This family is practically equivalent to the family 1 in Damiani 2010.
[22] Bernabò Brea – Cavalier 1980, pl. 204.3.

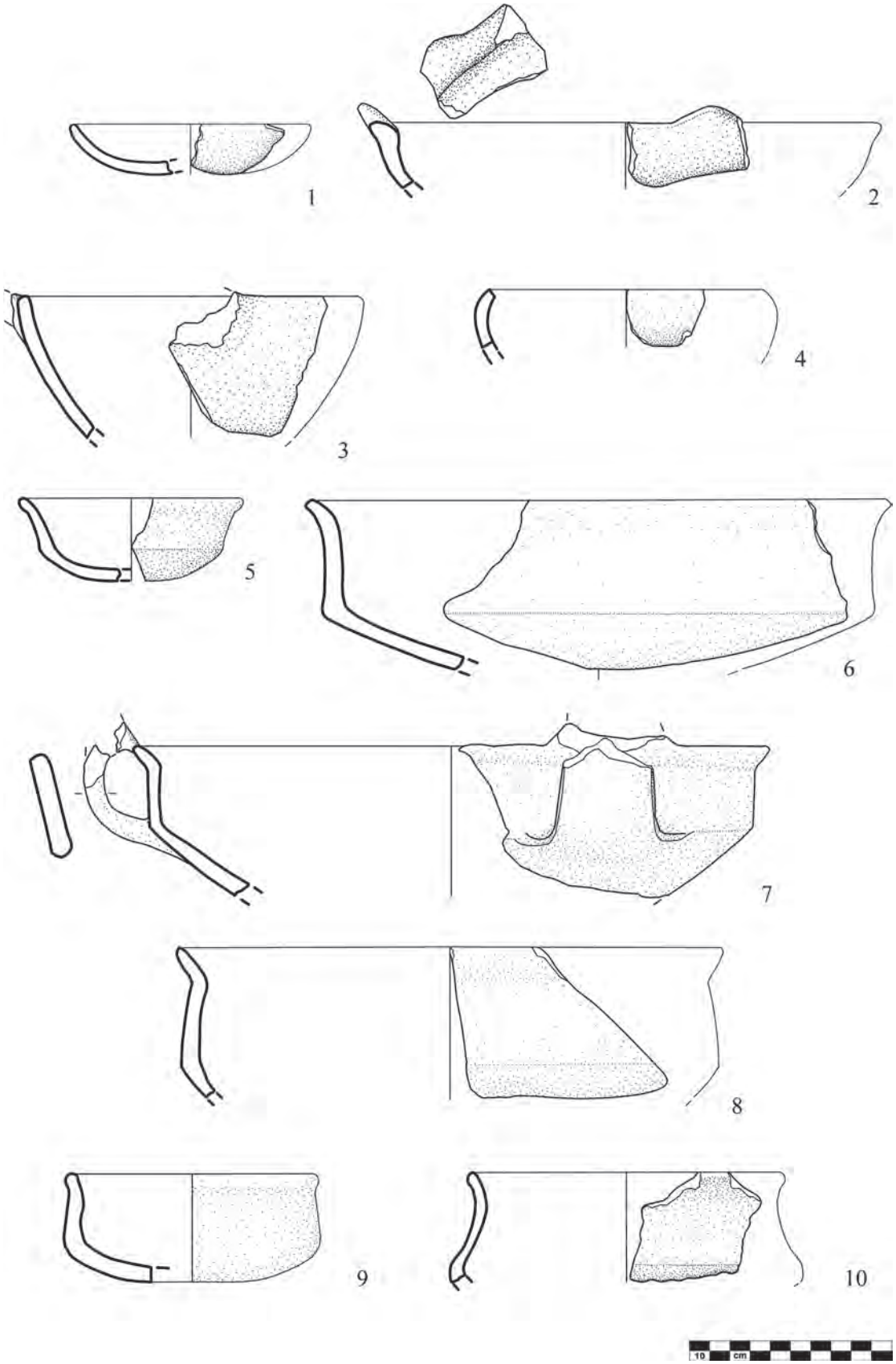


Fig. 3 Open shapes: 1–4. Category II: bowls; 5–10. Category IV: cups (scale 1:3) (drawings: C. Capriglione, M. R. Cinquegrana, F. Corpaci; digitisation: C. Capriglione)

lugs made with horseshoe-shaped ribs. Bowls with an inverted rim find their best parallels among family 6 as defined by Isabella Damiani, typical of the Middle Tyrrhenian and Middle Adriatic coast, but they are also well represented in many other Recent Bronze Age 2 sites in central and southern Italy, such as Sposetta, Oratino, Torre Mordillo, Broglio di Trebisacce, etc.[23]

The following category is that of the cups (category IV), for which the inventory includes over 800 rim fragments, divided into a class of carinated cups (class a) and another one of non-carinated cups (class b). Depending on the morphological features, particularly the profile beneath the rim, 6 families have been identified, to which 24 types belong:

Family 6 (Fig. 3.5): carinated cups with a short concave profile above the carination (types 23–30);

Family 7 (Fig. 3.6): carinated cups with a high concave profile above the carination (types 31–34);

Family 8 (Fig. 3.7): carinated cups with a straight profile above the carination (types 35–39);

Family 9 (Fig. 3.8): carinated cups with a convex profile above the carination (type 40);

Family 10 (Fig. 3.9): non-carinated cups/dippers with a rounded body (types 41–44);

Family 11 (Fig. 3.10): 'collared' cups (types 45–46).

Cups with a concave profile above the carination are the most numerous: family 6, in fact, numbers 114 pieces from Punta di Zambrone and 21 from Lipari in the typology, and in family 7 there are 70 pieces from Punta di Zambrone and 6 from Lipari: in total we have 184 cups with a concave profile above the carination from Punta di Zambrone and 27 from Lipari. Other families comprise fewer members: 78 fragments from Punta di Zambrone and 18 from Lipari for family 8; 7 from Punta di Zambrone for family 9; 29 from Punta di Zambrone and 12 from Lipari in family 10, and 4 pieces from Punta di Zambrone and 1 from Lipari are in family 11. Therefore, we can affirm that the carinated cups with a concave profile above the carination (both short and high) are the most numerous and, in fact, they exhibit a higher inner variability in terms of types and varieties. The parallels found show a widespread presence of all the types of cups in the southern Tyrrhenian region. These types of cups appear mainly to date back to a later phase of the Recent Bronze Age. However, they are present throughout the territory in which the Subapennine *facies* occurs: from the middle Tyrrhenian coast, to the Adriatic one; from the region of Sybaris to the area of the *terramare* in northern Italy, etc.[24] Type 44 appears to be the only one confined to the southern Tyrrhenian region. Its members in fact mostly come from Lipari, with a minor presence at Punta di Zambrone, and there are a few parallels along the Ionian coast of Calabria, at Broglio di Trebisacce.[25]

Handles with Projections

We also have quite a large number of the following classes of typical Subapennine handle projections (category V) and handles rising above the rim (category VI). The specimens in category V include:

Class d (Fig. 4.1–2): a couple of bird's head-shaped projections attached to horizontal handles, in 3 types (55–57). The pieces of this class mostly come from Lipari with 23 pieces, while only 5 specimens are from Punta di Zambrone;

Class e (Fig. 4.3–4): horizontal handles rising above the rim and ending in diverging coils, subdivided into 2 families, according to the characteristics of shape and dimensions of handles, holes and coils. Family 12 comprises 3 types (59–61), while family 13 has 2 types (62–63). It is

[23] For Damiani's family 6 see Damiani 2010, 140–143; for Sposetta see Damiani et al. 2010; for Oratino see Cazzella et al. 2006; Cazzella et al. 2007; for Torre Mordillo see Trucco – Vagnetti 2001; for Broglio di Trebisacce see Peroni – Trucco 1994; for Monte di Giove see Villari 1981.

[24] Cf. the typological classification of cups in Damiani 2010, 130–250.

[25] Type 44 in fact, perfectly corresponds to family 10, types 20–21 as defined by Damiani 2010, 151, fig. 16.1–4; 153, fig. 17A.1–9.

one of the most attested classes of handle projections; we have, in fact, 36 specimens from Punta di Zambrone, 30 from Lipari, 2 from the promontory of Tropea (Pirara, Taureana), 4 from north-eastern Sicily (Milazzo, Capo d'Orlando, Pietro Pallio).[26] This class of projections is undoubtedly one of the most characteristic of the southern Tyrrhenian region;

Class f (Fig. 4.5): vertical handles ending in snail horns, including 27 specimens from Punta di Zambrone[27] and 12 from Lipari; 6 types have been identified (62–69).

Class g (Fig. 4.6–7): vertical handles ending in handlebar horns, in 5 types (70–75). Twenty-seven fragments from Punta di Zambrone, 18 from Lipari, 1 from the promontory of Tropea (Pirara) and 1 from Capo d'Orlando were included in the typology.[28]

The following classes are recognisable within category VI with handles rising above the rim:

Class a (Fig. 5.1–2): handles with a circular section rising above the rim, including two families. Family 14 comprises three types (76–78) with 42 examples from Punta di Zambrone and 4 from Lipari. The presence, in variety 76B, of a small drop-shaped impression on the interior surface at the base of the handle is very interesting and quite unusual (Fig. 5.2).[29] Family 15 (Fig. 5.3) includes handles with a circular section rising above the rim with small knobs on the top of the handle, alluding to a horse head, subdivided into three types (79–81). This is one of the most characteristic kinds of handles from Recent Bronze Age 2 and is attested with 6 specimens from Punta di Zambrone and 7 from Lipari;

Class b (Fig. 5.4): strap handles rising above the rim, in only one type (82), with different varieties. Strap handles can be plain, or sagged, or have a slight central midrib. We have 26 fragments from Punta di Zambrone and 3 from Lipari;

Class c (Fig. 5.5–6): horizontal handles rising above the rim (basket handles), known in 10 pieces from Punta di Zambrone, 8 from Lipari. It is possible to recognise only one type (83) and to divide it into two varieties. Variety 83B has horizontal handles with shallow grooves on the external surface (Fig. 5.6).

A complex and almost unique kind of handle projection (type 57: Fig. 4.2) deserves a brief digression. It is a quadrangular horizontal handle with concave sides and an oval hole surmounted by a horned appendix. The two extremities are bird's heads facing each other, with the beaks pointed upwards and inwards. The beaks have an oval expanded shape, while conical oblong knobs make up the heads of the birds. On the one hand it may be reminiscent of the typical Ausonian handles with diverging coils in the shape of the horizontal handle and the so called *'anse di padelle'* for the upper part, even if, in our case, the beaks are not pointing towards the inside of the container. On the other hand, however, those Ausonian models are somehow modified, with a reference to a shape of birds' heads placed on top of strap handles, widespread mainly in the northern-central Adriatic region (especially Marche and the Po Valley). This shape has been classified as shape A40 by Isabella Damiani[30]; it had a prolonged production period, spanning from Recent Bronze Age 1 (with some forerunners at the end of the Middle Bronze Age 3) to the Final Bronze Age.

It is probably more useful to link, where possible, the type of handle to the shape of the container rather than making a long and detailed description of types, varieties and variations of the handles. For instance, we can see that the horns are exclusively present on carinated cups and, in particular, we find the snail horns (Vf) only on cups with short concave walls above the carination, while handlebar horns (Vg) are used for carinated cups with both concave and straight walls. Horizontal handles with projections, by contrast, appear to be more widespread among the different kinds of

---

[26] Pirara: Pacciarelli – Varricchio 2004, 376, fig. 9.11; Taureana di Palmi: Pacciarelli 2002, pl. IIB3; Milazzo, viale dei Cipressi: Levi et al. 2009, 134, pl. 54.269; Capo D'Orlando, via Libertà: Lentini et al. 2004, 76, nos. 10–12; 77, nos. 14–15; Pietro Pallio: Genovese 1977, 24, pl. 11.

[27] There are another approximately 30 fragmentary horns that cannot be assigned to any specific type because it was impossible to decide if they were parts of snail horn or handlebar horn projections.

[28] Pirara: Pacciarelli – Varricchio 2004, 376, fig. 9.13; Capo D'Orlando: Lentini et al. 2004, 77, no. 13.

[29] The best parallel is a cup with a drop-shaped impression at the base of the handle from Cavallo Morto tomb 27, datable to the Recent Bronze Age 2: Angle et al. 2004, fig. 5.2.

[30] Damiani 2010, 313, pl. 111.1–3 (type A40C); 313, pl. 111.8–9 (type A40D).

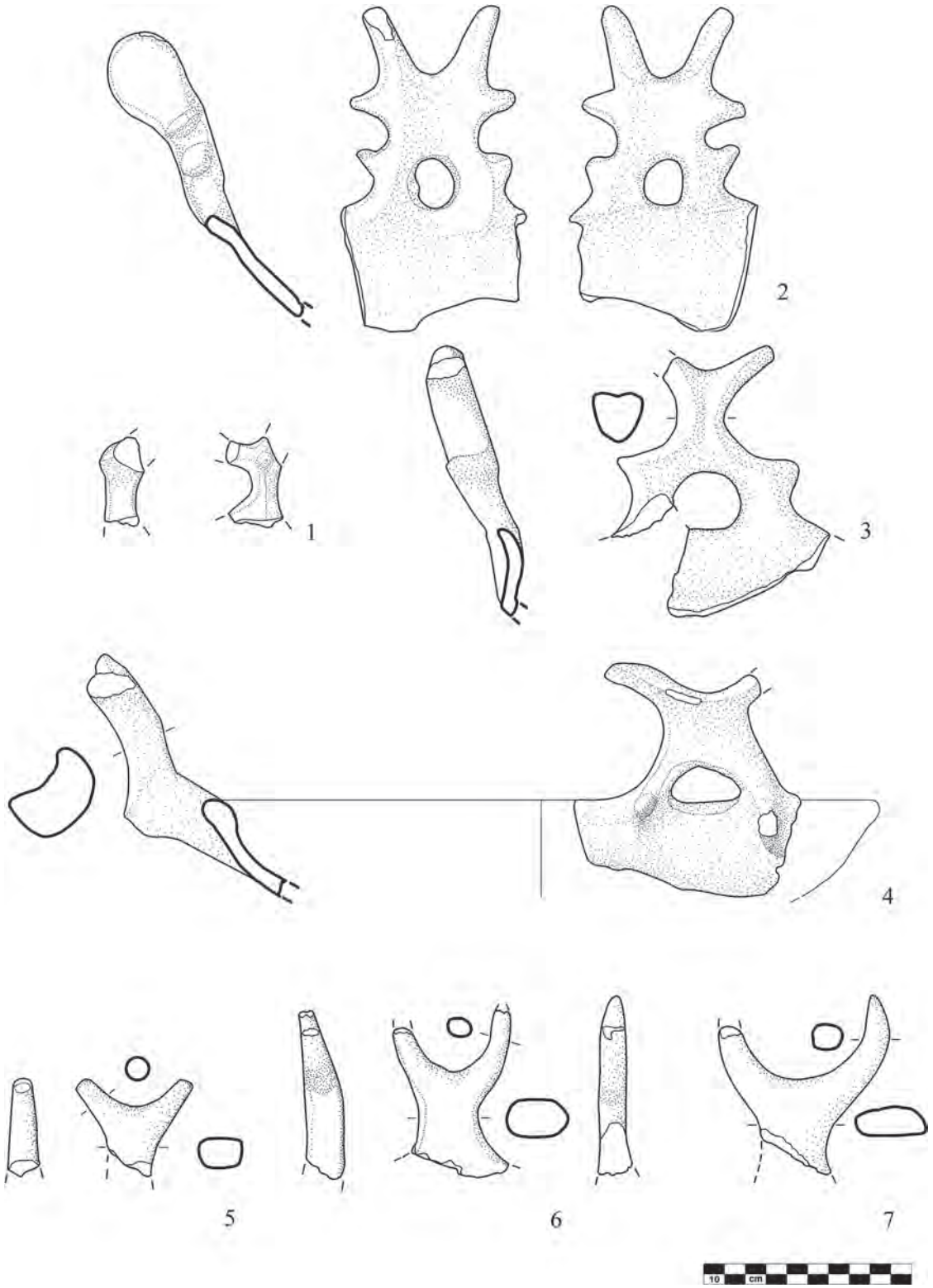


Fig. 4 Category V: handles with projections: 1–2. Class d: bird's head-shaped projections; 3–4. Class e: horizontal handles ending in diverging coils; 5. Class f: vertical handles ending in snail horns; 6–7. Class g: vertical handles ending in handlebar horns (scale 1:3) (drawings: C. Capriglione, M. R. Cinquegrana; digitisation: C. Capriglione)

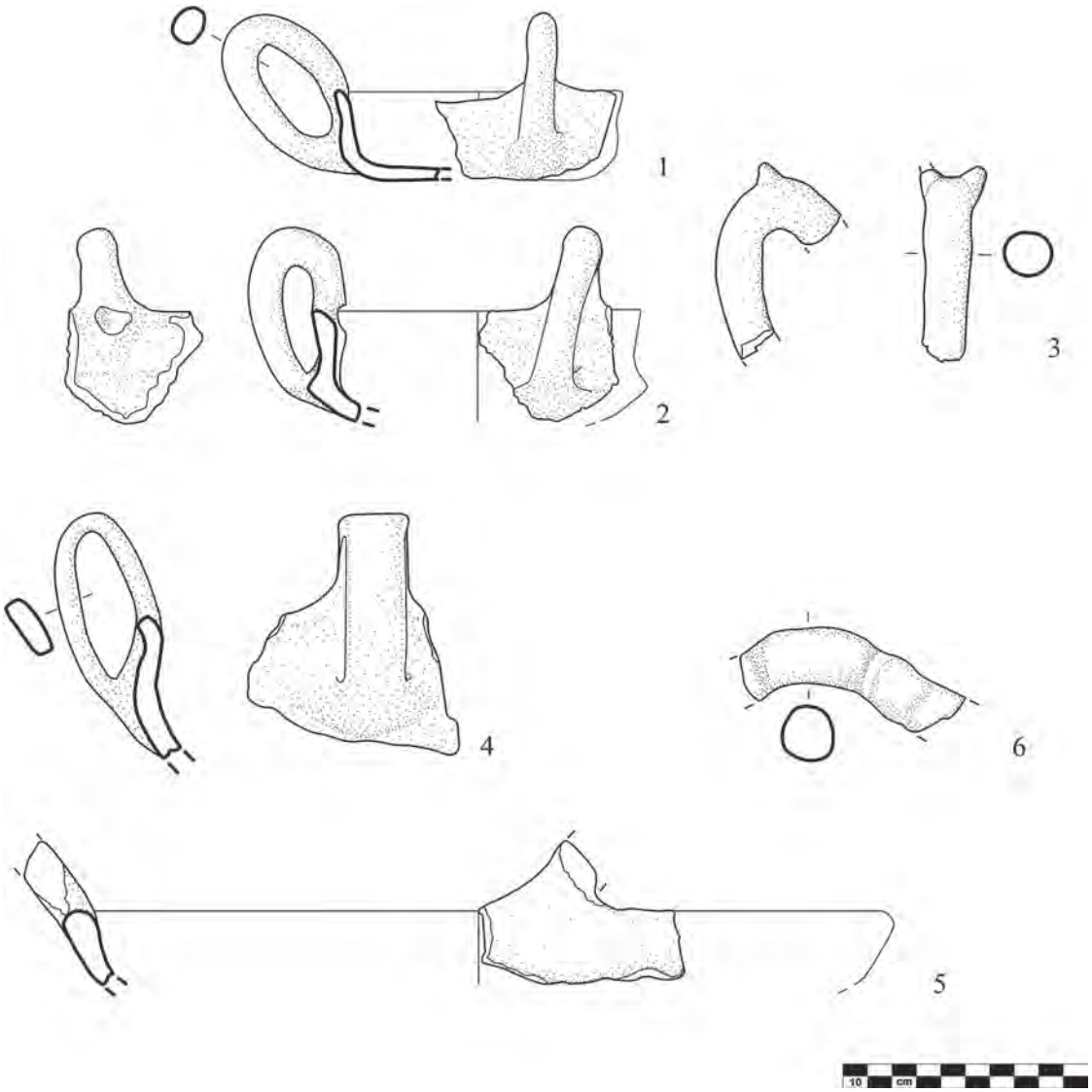


Fig. 5 Category VI: handles rising above the rim. 1–2. Class a: handles with circular section; 3. horse-head handles; 4. Class b: strap handles; 5–6. Class c: horizontal handles (scale 1:3) (drawings: C. Capriglione, R. Jung, D. Imre, A. Rumolo; digitisation: C. Capriglione)

containers. The pairs of birds' heads (Vd), for example, are present both on carinated cups with short concave walls and on bowls, where they are slightly more frequent (especially on bowls with a thickened rim). The projections with diverging coils (Ve) can also be found on both carinated cups (with short concave and straight walls) and bowls (especially on small and shallow hemispherical bowls and on bowls with a thickened rim). Simple or grooved raised horizontal handles (VIc) are prevalent on bowls with a thickened rim and deep non-articulated bowls, while we find them only rarely on cups with high concave walls.

We note an exclusive presence of cylinder-shaped projections (Vb) on carinated cups with short or high concave walls above the carination, and the same is true for the axe handles (Va) and the pairs of cylinders attached to horizontal handles (Vc). Unfortunately, we have no information about the kind of containers, to which pairs of boot-shaped cylinders were attached (Vc, type 54).

Vertical handles with a circular section (VIa, family 14) are present on various families of carinated cups (short concave wall and straight wall) and on dippers with a rounded body. Concerning family 15 (horse-head handles), unfortunately the container is preserved in only one case, which is a carinated cup with a high concave profile above the carination. Finally, the strap han-

dles rising above the rim (VIb) can be found equally on various families of carinated cups and on dippers with a rounded body. Therefore, it is evident that there is no direct appreciable connection between the kind of handle and the shape of the container.

Closed Shapes: Amphorae, Jars, Large Storage Vessels

Moving to the closed shapes, the large amount of finds that could be integrated into the typology should be stressed. This is certainly a new situation for the Recent Bronze Age, especially considering the fact that for the first time, or nearly so, such a numerous and articulated *corpus* of closed vessels has been found in a substantially single-phased Recent Bronze Age 2 site. This fact is even more relevant since scholars often do not offer an in-depth discussion of those shapes in site reports or in broader typological studies. In fact, they usually focus on other categories, such as open shapes or handles with projections that usually have the advantage of being easier to recognise and to date, just because more studied. Moreover, the great continuity in production continuity and the resultant reduction in standardisation of the shapes make it more difficult to verify their exact dating, especially in the long-duration sites that form the majority. Consequently, Punta di Zambrone is again fundamental for casting light on a not particularly studied aspect of the ceramic production of the Recent Bronze Age.

The first category of closed shapes presented is category IX: amphorae. Fifty-four fragments of amphora rims have been inventoried, of which 28 have been included in the typology, together with 9 pieces from Lipari.

Amphorae from the southern Tyrrhenian region belong to three families:

Family 18 (Fig. 6.1): vessels with a simple rim and concave neck; divided into 2 types (98–99) with the related varieties;

Family 19 (Fig. 6.3): vases with an everted rim and cylindrical neck; it has 3 types (100–102);

Family 20 (Fig. 6.4): vases with an everted rim and truncated conical neck (type 103).

Amphorae from the southern Tyrrhenian region often present a peculiarity, that is a horizontal groove placed between the neck and the shoulder; it is possible to find it in family 18, variety 99B; family 19, type 101, and family 20, variety 103B (Fig. 6.2). This feature seems to be quite rare outside the southern Tyrrhenian region, and usually appears in very late Recent Bronze Age contexts in other regions.[31]

Considering now the jars, we must say that they are one of the most frequent categories at Punta di Zambrone. For instance, 963 fragments of jar rims have been identified and inventoried; of these, 107 specimens were typologically classified, together with another 13 from Lipari, one from Capo D'Orlando and one from Milazzo.[32] There are essentially 2 big families for the jars. The first one (family 21), jars with a simple rim and non-articulated body, includes the majority of the fragments. It has 5 types, according to the shape of the body: cylindrical for type 106 (Fig. 6.5), cylindrical-ovoid with a slightly inverted wall for type 107 (Fig. 6.6), ovoid with an inverted wall and rounded body for type 108 (Fig. 6.7), wide ovoid with a strongly inverted wall for type 109 (Fig. 6.8), and truncated ovoid for type 110 (Fig. 6.9).

Looking at the number of specimens assigned to every type of family 21, we can see that the most numerous type is that of the cylindrical jars (106), followed by the ovoid ones (107). All the types are equally present in the region, except for the truncated ovoid jars, which seem to be exclusive to Punta di Zambrone. For type 106, we, in fact, have 35 fragments from Punta di Zambrone and 2 from Lipari, while for type 107, we have 10 from Punta di Zambrone and 2 from Lipari. For type 108 there are 10 specimens from Punta di Zambrone and 3 from Lipari; for type

[31] E.g. at Roca Vecchia: Pagliara et al. 2008, 254, fig. 11.9. The amphora from Coppa Nevigata (excavations 1972–1975, from early Subapennine layers: Cazzella – Recchia 2012, 77, fig. 7.6), with one horizontal groove between the neck and shoulder is probably the best parallel, but it seems to be an isolated case at that Apulian site.

[32] Capo D'Orlando, via Libertà: Lentini et al. 2004, 74, no. 4; Milazzo, Viale dei Cipressi: Levi et al. 2009, 134, pl. 54.312.

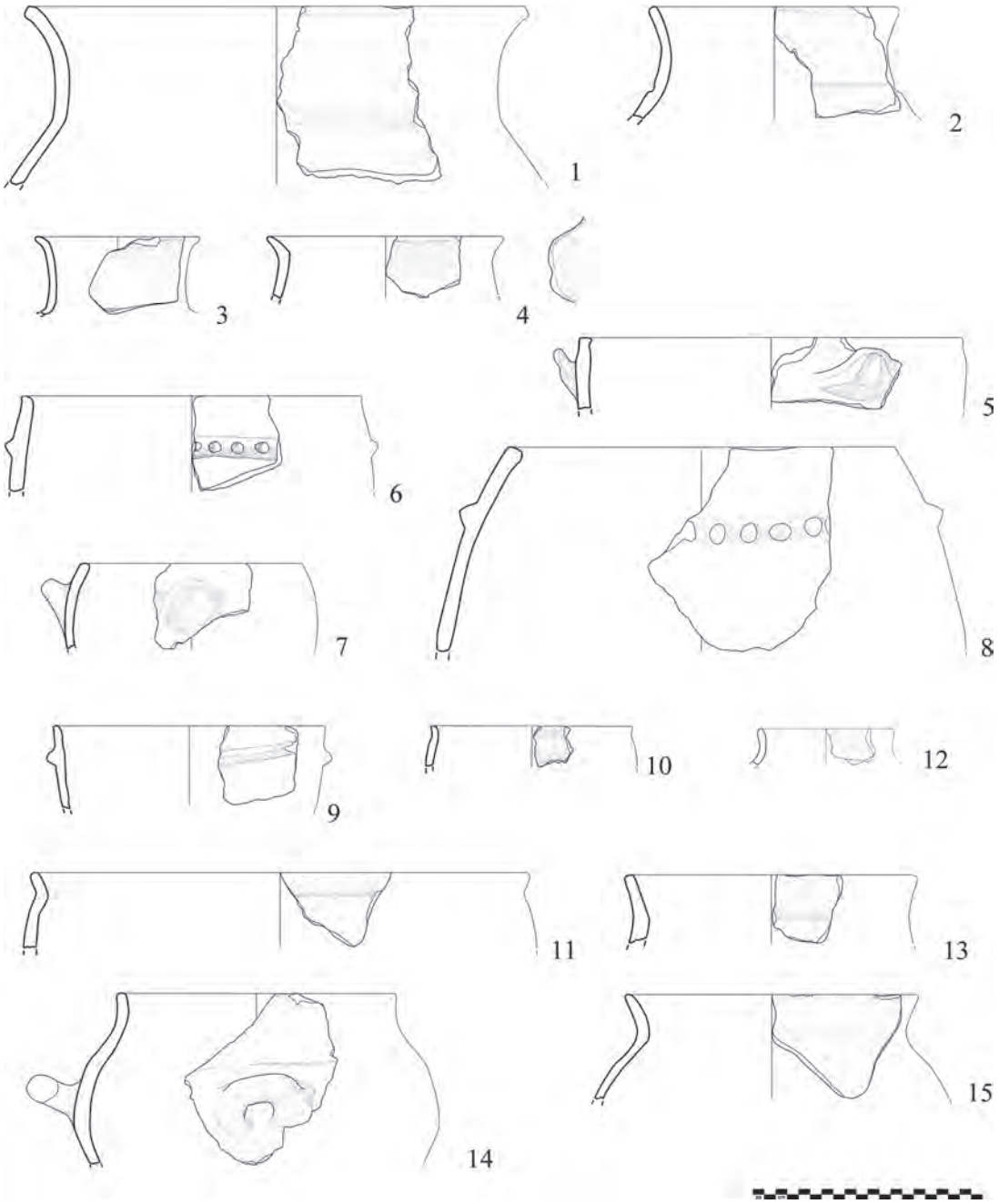


Fig. 6 Closed shapes: 1–4. Category IX: amphorae; 5–9. Category X, family 21: jars with non-articulated body; 10–15. Family 22: jars with articulated body (scale 1:6) (drawings: C. Capriglione, M. R. Cinquegrana, F. Corpaci, F. Grilli, R. Jung, D. Imre, M. Pacciarelli, R. Palumbo, A. Rumolo; digitisation: C. Capriglione)

109, 18 from Punta di Zambrone and 4 from Lipari, and type 110, finally, only contains 6 pieces from Punta di Zambrone.

The second family of jars (family 22), jars with an everted rim and articulated body, has 6 types. Type 111 includes jars with a barely everted rim, a body with a rounded profile, not very bellied (Fig. 6.10); type 112 consists of jars with an everted rim and a body with an ovoid bellied profile (Fig. 6.11); type 113 has jars with an everted rim and short concave neck (Fig. 6.12); type 114 comprises jars with a funnel-shaped rim (Fig. 6.13); type 115, globular jars with a short, slightly concave neck (Fig. 6.14) and, finally, type 116 comprises globular jars with a funnel-shaped rim (Fig. 6.15).

Jars from family 22 are numerically less common: for type 111 there are only 4 attestations from Punta di Zambrone, 7 from Punta di Zambrone and 1 from Lipari for type 112, and 5 from Punta di Zambrone, and 1 from Lipari for type 113. Types 114, 115 and 116 have respectively 4, 5 and 3 specimens, none of them from Lipari.

An interesting fact about the jars of the southern Tyrrhenian region is that in every type there are jars indiscriminately with or without plain or finger-impressed ribs and/or with tongue-shaped lugs or handles. We must also notice that finger-impressed ribs are clearly more common than the plain ones, with a proportion of approximately three times the number of the plain ribs.

The category of large storage containers (XII) unites two different vessel classes sharing features like the big dimensions (rim diameters of more than 40cm) and the possible function as storage containers (Fig. 7.1–3). The first class includes large storage jars with a body that is usually not or only slightly articulated. It follows a local tradition. Indeed, these vessels have the same shapes as the jars, from which they differ only in their much larger size (in the Italian scholarly tradition they are called *'dolii'*). The vases of the second class, by contrast, can be called *'pithoi'*, because their manufacturing techniques, morphological features and even bigger dimensions relate them to the huge *pithoi* of Aegean tradition, notoriously widespread in southern Italy and starting during the Recent Bronze Age.[33] The fact that we have exclusively handmade *impasto pithoi* in this area, suggests the presence of a differentiation in the production of the southern Tyrrhenian from the Recent Bronze Age on. In fact, while, as was noticed by Sara Levi,[34] starting from the very late Recent Bronze Age it is possible to highlight two different production areas of 'Aegean-style' *pithoi* in the Sybaritis – one in the upper Ionian coastal area, where wheelmade fine-ware *pithoi* are prevalent, and another one, including the southern Sybaritis, where mainly handmade impasto *pithoi* are produced – a similar differentiation in production along the southern Ionian and Tyrrhenian coasts of Calabria, on the Aeolian Islands and in Sicily, has so far only been noticed during the Final Bronze Age and Early Iron Age, when handmade *pithoi* are starkly preponderant.[35]

The presence in the territory characterised by the 'Ausonian' cultural aspect (southern Tyrrhenian coasts of Calabria, Aeolian Islands and north-eastern Sicily) of *pithoi* with wide, undecorated plastic bands with a flat or concave profile is also very relevant (Fig. 7.4–5). This kind of decoration is very well known, and it is the more characteristic one for the Recent Bronze Age on the Ionian coasts.[36] So far, the presence of those *pithoi* in the region of interest has been noted only at Monte di Giove in northeastern Sicily, but in a chronologically uncertain context.[37] The new contribution made by the present study is the addition of at least four different specimens at Lipari (not previously published) and two at Punta di Zambrone.[38] The latter are very fragmentary, but they can, to some extent, help to fill the gap in the presence of those *pithoi* along the southern Tyrrhenian coastline.

Terracotta Artefacts: Spindle Whorls and Weights

Punta di Zambrone also yielded many terracotta artefacts, among which implements for spinning and weaving are the most common: spindle whorls and loom weights.

27 spindle whorls were brought to light, all in Area C. According to their profile, we can recognise 6 types (136–141): discoidal (Fig. 8.1); conical (with straight or concave sides; Fig. 8.2);

33 Schiappelli 2006.

34 Levi 1999, 107–108.

35 Capriglione et al. 2012, 350.

36 E.g. in Calabria: Broglio di Trebisacce, Torre Mordillo, Timpone della Motta, Bisignano; in Apulia: Roca Vecchia, Torre Castelluccia, Otranto; in Basilicata: Termitito, Timmari. For a more detailed list of sites, see: Bettelli 2002, 19–32.

37 Villari 1981, 33, fig. 5g; the materials from Monte di Giove come from a surface collection and the author dates them back to the phase Ausonian I only on a typological basis.

38 A further fragment with wide plastic band from Punta di Zambrone is very small and uncertain.

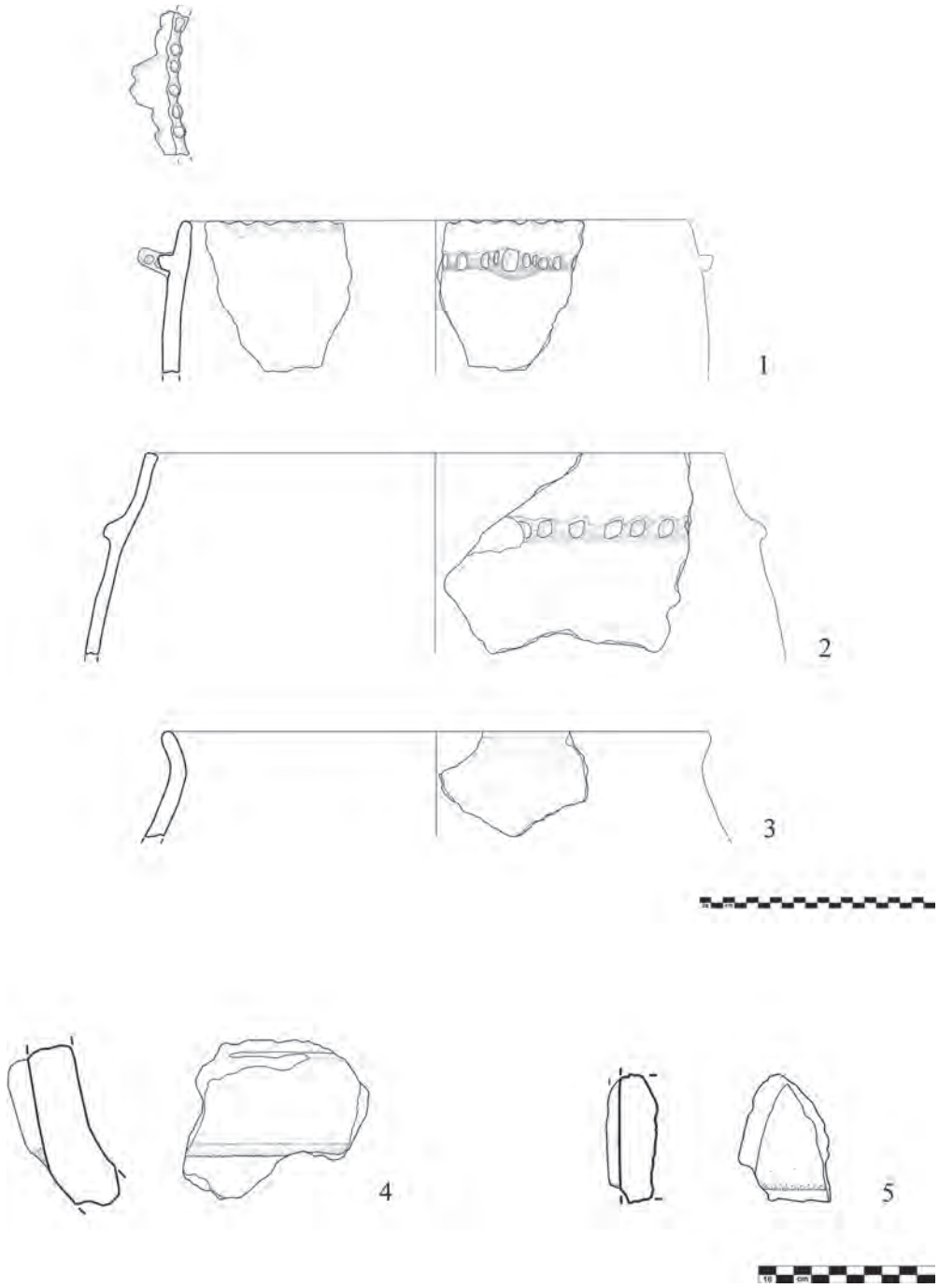


Fig. 7 Category XII: Large storage containers: 1–3. 'dolii' (scale 1:6). 4–5: 'pithoi' with undecorated plastic band (scale 1:4) (drawings and digitisation: C. Capriglione)

truncated conical (with straight or concave sides; Fig. 8.3); biconical (with cones with a straight or convex profile; Fig. 8.4–5); hexagonal (Fig. 8.6) and globular (spherical or pressed at the poles; Fig. 8.7).

The most common spindle whorls are the biconical ones, with 10 specimens preserved. The other types are represented by 3 or 4 specimens each at most. In Lipari we have the same situation as at Punta di Zambrone.

If we consider the weight, the spindle whorls from Punta di Zambrone can be compared with the groups created for S. Rosa di Poviglio, which is one of the few seriously conducted studies

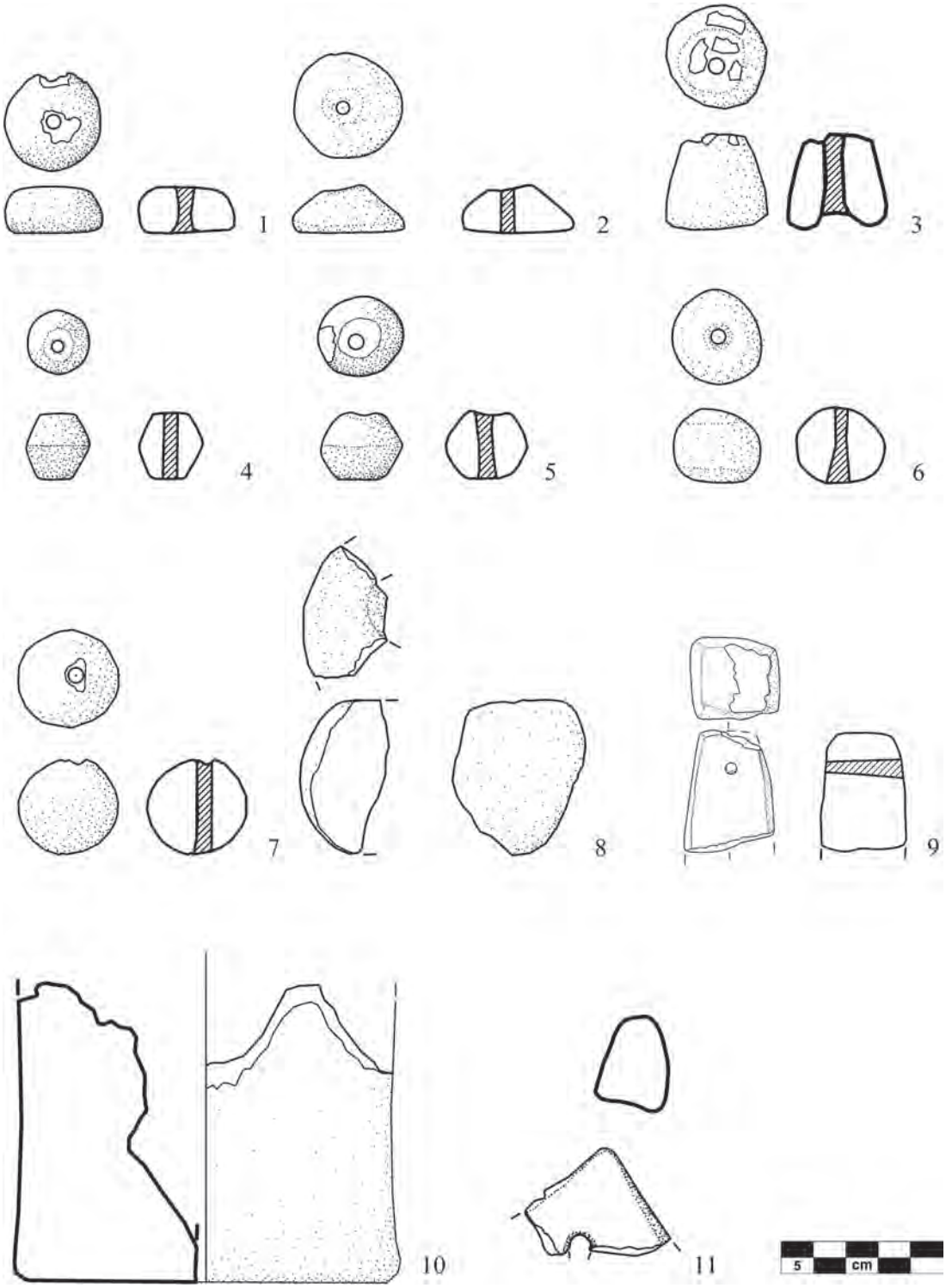


Fig. 8 Artifacts for spinning and weaving: 1–7. Category XV: spindle whorls; 8–11. Category XVI: loom weights (scale 1:2) (drawings: C. Capriglione, M. R. Cinquegrana, D. Imre; digitisation: C. Capriglione)

dedicated to spinning and weaving in the Italian Bronze Age.[39] Only one specimen from Punta di Zambrone can be assigned to the group of light spindles (up to 8g), 14 specimens are in the medium

[39] Bernabò Brea et al. 2003.

spindle whorls group (between 10 and 15g), although we can suppose that other fragments were part of this range. Four specimens (plus 2 fragments of which we can reconstruct the weight) belong to the medium–heavy group (15–21g) and 3 specimens belong to the heavy group (25–30g). None of the spindle whorls found belongs to the very heavy group. At Punta di Zambrone we can see a preponderance of medium and medium–heavy spindle whorls, just as at S. Rosa di Poviglio. This fact is probably due to the use of a single type of yarn or fibre, or of similar types. However, there does not seem to be a clear correlation between the morphology and weight of the spindles, since specimens of different weight belong to the same morphological type.

Eight (loom) weights come from Area C of Punta di Zambrone. From a typological point of view, we can distinguish 4 types (142–145): disc-shaped (Fig. 8.8), cylindrical (Fig. 8.10), pyramidal (Fig. 8.9) and squared loom weights (Fig. 8.11). The pyramidal ones are the most common.

Unfortunately, none of the weights is completely preserved, so we cannot make a classification based on their weight. The preserved fragments range from a minimum of 25.5g to a maximum of 68.9g for the smaller category, and from 331.7g to 397.6g for the bigger one. Consequently, it is not possible to elaborate any hypotheses about the presence and the possible types of looms at Punta di Zambrone, because we do not have enough data to make reliable reconstructions, and it is also possible that some of the weights had other different uses (for instance, add weights for fishing nets).

Nevertheless, without any doubt the presence of such a high number of finds, which testify to the activity of spinning and weaving at the site, is very remarkable. The fact is even more important considering the general scarcity of those artefact categories in publications on the Bronze Age, and particularly the Recent Bronze Age, and considering the meagre quantitative as well as qualitative information about this subject.

Conclusions

It is necessary to underline again the great importance and innovative nature of the findings from Punta di Zambrone. The study of the *impasto* pottery production of this site and its geographical area allowed us to cast new light on some aspects of the Recent Bronze Age in southern Italy. In particular, we noticed that some ceramic classes appear to be strictly connected to the southern Tyrrhenian region between the 13th and 12th centuries BC. On the one hand, there are the boot-shaped projections attached to horizontal handles, which constitute one of the most distinctive features of the Recent Bronze Age 1 phase of the Ausonian aspect. On the other hand, however, other classes such as shallow hemispheric bowls, horizontal handles with pairs of bird's head projections attached to shallow bowls and horizontal handles rising above the rim and ending in diverging coils are characteristic of the later phase. The presence of a unique type of bird-head ending that appears to be a mixture of typological elements coming from different geographical areas is also noteworthy. In particular, the typological relationship with the central Adriatic coastal zone, where we can find several interesting comparisons, seems to be very strong.

Furthermore, we underlined the strong presence of some ceramic classes, such as jars or amphorae, which are usually not so numerous and articulated in the Bronze Age settlements. The presence of *pithoi* of Aegean tradition in this area of the Mediterranean during the Recent Bronze Age is very interesting, too. Archaeometrical analyses, currently in progress, will open up new and interesting perspectives on this aspect.

A further remarkable aspect is the presence of several pieces dating back to the Apennine *facies* of Middle Bronze Age 3, although too low to indicate the existence at Punta di Zambrone of a stable settlement in that period. A plausible explanation is that the Subapennine *facies* arrived on the southern Tyrrhenian coast of Calabria earlier than on Lipari, even if the almost complete lack of attestations of Thapsos-Milazzese pottery is quite strange. It is more likely

that, since even the types datable to Recent Bronze Age 1 are quite scarce, the first contacts with the Ausonian populations happened in a very early phase of the Recent Bronze Age, with a belated presence of earlier Apennine elements, but without leading to a stable settlement in Punta di Zambrone. A stable settlement was, however, established at Lipari, where we have a clear Recent Bronze Age 1 phase, but a much more evanescent Apennine presence. Therefore the Apennine fragments found at Punta di Zambrone can be interpreted in terms of residual elements of older pottery-making traditions that partially survived among the immigrant population.

Bibliography

Albore Livadie et al. 2008
C. Albore Livadie – E. Di Giovanni – G. Carboni, I livelli appenninici dell'insediamento pluristratificato del Fusaro (Avella – Avellino), Origini 30, 2008, 221–246.

Angle et al. 2004
M. Angle – C. Belardelli – M. Bettelli, «…e i regali ricambiati devono somigliare ai regali ricevuti». La tarda età del Bronzo nel Latium Vetus. Nuovi dati, in: G. Ghini (ed.), Lazio e Sabina 2. Atti del Convegno "Secondo Incontro di Studi sul Lazio e la Sabina", Roma, 7–8 maggio 2003 (Rome 2004) 203–214.

Assmann 1999
J. Assmann, Das kulturelle Gedächtnis. Schrift, Erinnerung und politische Identität in frühen Hochkulturen (Munich 1999).

Bernabò Brea 1952
L. Bernabò Brea, Civiltà preistoriche delle isole Eolie, Archivio de Prehistoria Levantina 3, 1952, 69–93.

Bernabò Brea 1958
L. Bernabò Brea, La Sicilia prima dei Greci (Milan 1958).

Bernabò Brea 1964/1965
L. Bernabò Brea, Leggenda e Archeologia nella protostoria siciliana, Kokalos 10–11, 1964/1965, 1–33.

Bernabò Brea 1976/1977
L. Bernabò Brea, Eolie, Sicilia e Malta nell'età del Bronzo, Kokalos 22–23, 1976/1977, 33–110.

Bernabò Brea 1979
L. Bernabò Brea, L'età del Bronzo Tarda e Finale nelle isole Eolie, in: Il Bronzo Finale in Italia, Atti della XXI Riunione scientifica dell'Istituto Italiano di Preistoria e Protosoria (Florence 1979) 571–598.

Bernabò Brea – Cavalier 1956
L. Bernabò Brea – M. Cavalier, Civiltà preistoriche delle isole Eolie e del territorio di Milazzo, Bullettino di Paletnologia Italiana 65, 1956, 7–99.

Bernabò Brea – Cavalier 1980
L. Bernabò Brea – M. Cavalier, L'acropoli di Lipari nella preistoria, Meligunìs Lipára IV (Palermo 1980).

Bernabò Brea et al. 2003
M. Bernabò Brea – P. Bianchi – S. Lincetto, La produzione tessile nell'età del Bronzo. Fusaiole e pesi da telaio nelle terramare emiliane. Esempi di studio dai villaggi di S. Rosa di Poviglio (RE) e Forno del Gallo a Beneceto (PR), in: M. Bazzanella – A. Mayr – L. Moser – A. Rast-Eicher (eds.), Textiles. Intrecci e tessuti dalla preistoria europea. Catalogo della mostra di Trento (Trento 2003) 111–120.

Bettelli 2002
M. Bettelli, Italia meridionale e mondo miceneo. Ricerche su dinamiche di acculturazione e aspetti archeologici, con particolare riferimento ai versanti adriatico e ionico della penisola italiana, Grandi contesti e problemi della Protostoria italiana 5 (Florence 2002).

Capriglione et al. 2012
C. Capriglione – A. De Bonis – G. De Tomaso – V. Guarino – M. Iuliano – D. Marino – V. Morra – M. Pacciarelli, Grandi dolii protostorici d'impasto dalla Calabria centromeridionale. Contributo allo studio cronotipologico, tecnologico e funzionale, Rivista di Scienze Preistoriche 62, 2012, 331–362.

Cazzella – Recchia 2012
A. Cazzella – G. Recchia, La ceramica d impasto dagli scavi in estensione 1972–1975. Analisi tipologica e confronto con i dati degli scavi 1955–1971, in: Cazzella et al. 2012, 47–147.

Cazzella et al. 2006
A. Cazzella – V. Copat – M. Danesi, I livelli subappenninici del sito della Rocca di Oratino (CB). Nuovi dati dalla Valle del Biferno, in A. Gravina (ed.), Atti 26° Convegno Nazionale sulla Preistoria – Protostoria – Storia della Daunia, San Severo 10–11 dicembre 2005, vol. I (San Severo 2006) 137–170.

Cazzella et al. 2007
A. Cazzella – V. Copat – M. Danesi, Il sito dell'età del Bronzo Recente di Oratino-La Rocca (Campobasso), Rivista di Scienze Preistoriche 67, 2007, 277–310.

Cazzella et al. 2012
A. Cazzella – M. Moscoloni – G. Recchia (eds.), Coppa Nevigata e l'area umida alla foce del Candelaro durante l'età del Bronzo (Foggia 2012).

Damiani 2010
I. Damiani, L'età del Bronzo recente nell'Italia centro-meridionale, Grandi contesti e problemi della Protostoria italiana 12 (Florence 2010).

Damiani et al. 2010
I. Damiani – P. Petitti – F. Trucco, Aspetti cronologici e primo inquadramento del villaggio sommerso di Sposetta nel lago di Bracciano, in: N. Negroni Catacchio (ed.), L'Alba dell'Etruria. Fenomeni di continuità e trasformazione nei secoli XII–VIII a.C. Ricerche e scavi, Atti del Nono incontro di studi Preistoria e Protostoria in Etruria (Milano 2010) 685–696.

Danesi – Galluzzi 2009
M. Danesi – V. Galluzzi, Dinamiche di circolazione dei modelli terramaricoli in ambito subappenninico. Un caso campione: il sito marchigiano di Conelle di Arcevia, in: M. Silvestrini – T. Sabbatini (eds.), Fabriano e l'area appenninica dell'alta valle dell'Esino dall'età del Bronzo alla romanizzazione, Atti del Convegno di Studi di Archeologia (Ancona 2009) 65–79.

Diod.
Diodorus Siculus, Library of History. Books IV.59–VIII, transl. by C. H. Oldfather, The Loeb Classical Library 340 (Cambridge, London 1939).

Genovese 1977
P. Genovese, Testimonianze archeologiche e paletnologiche nel bacino del Longano, Sicilia Archeologica 11, 1977, 9–37.

Jung et al. 2015
R. Jung – M. Pacciarelli – B. Zach – M. Klee – U. Thanheiser, Punta di Zambrone (Calabria) – a Bronze Age harbour site. First preliminary report on the Recent Bronze Age (2011–2012 campaigns), Archaeologia Austriaca 99, 2015, 53–110.

Lentini et al. 2004
M. C. Lentini – F. Rovetto – F. G. Ardito, Resti di una capanna della tarda età del bronzo, in: U. Spigo (ed.), Archeologia a capo d'Orlando. Studi per l'Antiquarium (Milazzo 2004) 69–78.

Levi 1999
S. T. Levi, Produzione e circolazione della ceramica nella Sibaritide protostorica I. Impasto e dolii, Grandi contesti della Protostoria italiana 1, Prima di Sibari 1 (Florence 1999).

Levi et al. 2009
S. T. Levi – B. Prosdocimi – A. Vanzetti, Facies Capo Graziano, in: G. Tigano (ed.), Mylai II. Scavi e ricerche nell'area urbana (1996–2005) (Messina 2009) 32–136.

Pacciarelli 2001
M. Pacciarelli, Dal villaggio alla città. La svolta protourbana del 1000 a.C. nell'Italia tirrenica, Grandi contesti e problemi della Protostoria italiana 4 (Florence 2001).

Pacciarelli 2002
M. Pacciarelli, L'insediamento dell'età del Bronzo di Taureana di Palmi, in: R. Agostino (ed.), Palmi: un territorio riscoperto. Revisioni e aggiornamenti. Fonti e ricerca archeologica (Soveria Mannelli 2002) 139–152.

Pacciarelli 2004
M. Pacciarelli, Punta di Zambrone (VV), abitato fortificato costiero del Bronzo medio e recente. Primi cenni sul contesto e sulle ceramiche di tipo egeo dallo scavo del 1994, in: Istituto Italiano di Preistoria e Protostoria (ed.), Atti della XXXVII riunione scientifica "Preistoria e protostoria della Calabria", Scalea, Papasidero, Praia a Mare, Tortora, 29 settembre – 4 ottobre 2002 (Florence 2004) 839–842.

Pacciarelli 2009
M. Pacciarelli, Il popolamento della Calabria meridionale tirrenica nell'età dei metalli, in: G. De Sensi Sestito (ed.), La Calabria tirrenica nell'antichità. Nuovi documenti e problematiche storiche, Atti del Convegno (Soveria Mannelli 2009) 77–94.

Pacciarelli – Varricchio 2004
M. Pacciarelli – M. R. Varricchio, Fasi e facies del Bronzo medio e recente nella Calabria meridionale tirrenica, in: Istituto Italiano di Preistoria e Protostoria (ed.), Atti della XXXVII riunione scientifica "Preistoria e protostoria della Calabria", Scalea, Papasidero, Praia a Mare, Tortora, 29 settembre – 4 ottobre 2002 (Florence 2004) 359–379.

Pagliara et al. 2008
C. Pagliara – R. Guglielmino – L. Coluccia – I. Malorgio – M. Merico – D. Palmisano – M. Rugge – F. Minonne, Roca Vecchia (Melendugno, Lecce), SAS IX. Relazione stratigrafica preliminare sui livelli di occupazione protostorici (campagne di scavo 2005–2006), Rivista di Scienze Preistoriche 58, 2008, 239–280.

Peroni – Trucco 1994
R. Peroni – F. Trucco, Enotri e Micenei nella Sibaritide I. Broglio di Trebisacce (Taranto 1994).

Schiappelli 2006
A. Schiappelli, Dolii e magazzini tra Bronzo e Primo Ferro: una panoramica tra Italia Meridionale e mondo egeo-mediterraneo, in: Studi di protostoria in onore di Renato Peroni (Florence 2006) 393–398.

Thuc.
Thucydides, History of the Peloponnesian War. Books V and VI, transl. by Ch. F. Smith, The Loeb Classical Library 110 (Cambridge, London 1977).

Trucco – Vagnetti 2001
F. Trucco – L. Vagnetti (eds.), Torre Mordillo 1987–1990. Le relazioni egee di una comunità protostorica della Sibaritide, Incunabula Graeca 101 (Rome 2001).

Villari 1981
P. Villari, Monte di Giove e Fiumedinisi (Verona 1981).

The Absolute Chronology of the Recent Bronze Age at Punta di Zambrone

Bernhard Weninger[1] – *Cristina Capriglione*[2] –
Reinhard Jung[3] – *Marco Pacciarelli*[4]

Abstract: This paper presents a series of twelve radiocarbon dates that provide the absolute chronology for all stratigraphic subphases that we can ascribe to the last settlement period of Punta di Zambrone. The dates, all obtained on short-lived materials (mainly seeds, but also bone and short-lived twigs), are modelled by the Gaussian Monte Carlo Wiggle Matching method based on their stratigraphical position inside the fortification ditch by using CalPal software. We then combine the resulting ^{14}C models with the relative chronologies based on local handmade (*impasto*) and imported wheelmade Mycenaean pottery and present an absolute chronology for the latest settlement period of the site.

Keywords: Punta di Zambrone, Bronze Age Calabria, Gaussian Monte Carlo Wiggle Matching, radiocarbon dates, Recent Bronze Age

Introduction

At present, there are considerable gaps in the foundations of the absolute chronology of the Bronze Age culture groups (*facies*) in southern Italy. Surprisingly, the absolute dates still rest very much on Aegean–Italian pottery synchronisms. This is largely due to the scarcity of series of high-quality radiocarbon dates for the 2nd millennium BCE. In particular, for the Recent and Final Bronze Age phases only a very limited number of ^{14}C dates are available, and the few dates that do exist are confined to Apulia in the east.[5] In terms of absolute dates, for periods following the Middle Bronze Age,[6] the southern Tyrrhenian regions define an almost completely white area on the map, the only exception being two dates on charcoal from the advanced Final Bronze Age (Ausonian II) destruction of the settlement on the acropolis of Lipari.[7]

Unfortunately, we must also face a very similar situation in regions east of the Ionian Sea, where the Mycenaean Palatial age and the following Post-palatial period are not covered by

1 Institut für Ur- und Frühgeschichte, Universität zu Köln, Weyertal 125, 50931 Cologne, Germany; b.weninger@uni-koeln.de.

2 Direzione Regionale Musei Campania, Museo archeologico di Calatia, via Caudina 353, 81024 Maddaloni (Caserta), Italy; cristina.capriglione@beniculturali.it.

3 Austrian Archaeological Institute, Austrian Academy of Sciences, Hollandstraße 11–13, 1020 Vienna, Austria; Reinhard.Jung@oeaw.ac.at.

4 Dipartimento di Studi Umanistici, University of Naples Federico II, Via Marina 33, 80133 Naples, Italy; marco.pacciarelli@unina.it.

5 There are two dates from Recent Bronze Age contexts at Coppa Nevigata (Calderoni et al. 2012, 459, 463): Rome-338: 2880 ± 60 BP (on animal bone); BM-2412: 2980 ± 45 BP (on charcoal). The excavators of Roca Vecchia produced two dates from Recent Bronze Age and two from Final Bronze Age layers (L. Calcagnile – M. D'Elia – G. Quarta in: Pagliara et al. 2007, 356–357): LTL-1864A: 2926 ± 55 BP (RBA 2, on charcoal of Rhamnus/Phillyrea sp.); LTL-1866A: 2947 ± 55 BP (RBA 2, on charcoal of Euphorbus sp.); LTL-1868A: 3163 ± 60 BP (FBA 1, on charcoal of Myrtus communis); LTL-1872A: 2876 ± 60 BP (FBA 2, on charred seeds of Vicia Faba minor).

6 For radiocarbon dates from the MBA 3 settlement of Portella on Salina see Calderoni – Martinelli 2005; Martinelli – Fiorentino 2010.

7 There are three dates from the wooden construction of Hut α (Alessio et al. 1980, 841–842): R-181: 2555 ± 50 BP; R-367: 2820 ± 50 BP; R-367α: 2770 ± 50 BP.

any continuous series of radiocarbon dates from any of the major settlements that otherwise provide us with a number of important pottery sequences, which together form the backbone of the chronology for wide areas in southeastern Europe and the eastern Mediterranean. Even at the Palatial sites of Mycenae, Tiryns and Pylos, the only available radiocarbon dates were all produced decades ago, are essentially all measured in long-lived charcoal samples, and even the few available stratified dates, which are useful for pottery-synchronisms,[8] were at best measured from only two immediately consecutive stratigraphic phases. The only simultaneously extended *and* continuous radiocarbon sequence from a vertical stratigraphy of the 2nd millennium in southern Greece, i.e. that from the Kolónna settlement on Aegina, ends somewhere during a LH II building phase, while the three dates from LH IIIA contexts follow a stratigraphic hiatus.[9] The only multi-phase radiocarbon sequence that covers the later Late Bronze Age phases is the one recently published for the tell of Xirópoli (Lefkandí). Five dates were produced from the strata in excavation area M and one further date derives from a stratum in excavation area T. The pottery dates of these contexts reach from LH IIIC Early/Middle to LH IIIC Late/Submycenaean.[10]

As for northern Greece, and again focusing on sites that have produced ^{14}C dates from longer vertical stratigraphies, we can mention the tell-settlements of Kastanás, Thessaloníki Toúmba, Ássiros, and Prehistoric Olynthus/Áyios Mámas, all of which have yielded both stratified ^{14}C ages as well as datable Mycenaean-type pottery of the Palatial and the Post-palatial era.[11]

Taking into consideration the state of research outlined above, and now aimed at the application of high-precision ^{14}C-AMS dating, the prime objective of the excavations at Punta di Zambrone was to obtain a set of reliably stratified ^{14}C ages for as many of the different settlement phases as possible. To optimise the chronological precision, the sampling was highly restricted to short-lived samples from taphonomically well-understood contexts. Having established a precise site chronology, the second objective was to contribute to the construction of a similarly precise ^{14}C-based absolute chronology for the later Bronze Age in southern Italy (similar work is in progress for the Early Bronze Age). The third objective of our research was to compare the new science-based absolute chronology with the established historical-archaeological chronology, which has its main foundation in synchronisms of the local *impasto* pottery with imported (or locally made) Mycenaean and Minoan pottery. Such pottery is found at Punta di Zambrone, as well as at several other sites in southern Italy.

Sample Description

Within the context of the ^{14}C-AMS dating programme outlined above, the sampling programme was naturally restricted to the primary selection of animal bone and seeds, with plant-derived charcoal allowed as a second choice, but only on condition that botanical analysis had either demonstrated its short-lived character, or that no other organic materials were available in the specific context to be dated. In total we took 13 samples from Recent Bronze Age contexts (Tab. 1). Of these, one is an

8 Warren – Hankey 1989, 180. At Pylos construction timbers of the palace provide seven dates for the LH IIIB period (Ralph – Stuckenrath 1962, 151–152). At Mycenae two or three charcoal dates refer to a LH IIIB destruction level (Lawn 1970, 584). At Tiryns there are two dates on charcoal from two Post-palatial post holes in the Upper Citadel (Maran 2000, 9–10): Hd-20286: 3020 ± 41 BP; Hd-20272: 3085 ± 65 BP.

9 Wild et al. 2010.

10 We will have to wait for the publication of the pottery contexts in order to obtain more precise pottery dates. Note also that five of the dated samples come from pit contexts. The dates are as follows (Toffolo et al. 2013, 5–6 tab. 1): RTK-6370: 2880 ± 55 BP (on wheat); RTT-6104: 2980 ± 55 BP (on charcoal); RTK-6123: 2975 ± 30 BP (on animal bone); RTK-6124: 2850 ± 30 BP (on animal bone); RTK-6127: 2920 ± 30 BP (on animal bone); RTK-6156: 2855 ± 50 BP (on animal bone).

11 Jung et al. 2009; Weninger – Jung 2009 (with bibliography of earlier publications of Kastanás dates); Hänsel et al. 2010; Wardle et al. 2014 (with bibliography of earlier publications of Ássiros dates).

Context no. (SU and measured point or squares)	Lab. Code	Area, squares	Height asl (m)	East (m)	North (m)	Anthropological, zoological or botanic determination	Sample quantity (g)	DNA-ID, botanic sample no. (BP) or charcoal sample no. (CP)	Libby Age (BP)	δ 13C (‰)	Calendric Age calBC (95%)	Comments	Relative chronology (deposition date according to latest datable pottery)
PZ95/P9	MAMS-17724	C, FF12	37.01	2604709.70	4285501.57	human, part of the left mandible, individual 2 (age at death 20–30 years)	2.6	D041625	/	/		no collagen	RBA 2 / LH IIIC Early 1
PZ95/P8	MAMS-17723	C, FF12	36.99	2604709.95	4285502.78	pig, left maxilla with Pd3, Pd4, M1 (age at death 8–10 months)	2.4	D041626	2889 ± 19	-21.1	1186–1005	C:N 3.6. %C 3.4. %coll 7.7	RBA 2 / LH IIIC Early 1
PZ95/P1	MAMS-17722	C, FF12	37.05	2604709.73	4285502.00	human, skull fragment, individual 2 (age at death 20–30 years)	15.0	D041637	2988 ± 19	-18.8	1306–1130	C:N 3.2. %C 12.8. %coll 3.7	RBA 2 / LH IIIC Early 1
PZ66a BBCC9	MAMS-19524	C, BBCC9	37.03–37.11			Hordeum vulgare (3 charred seeds)		BP 25	3048 ± 21	-20.0	1394–1231		RBA 2 / LH IIIC Early 1
PZ66b CC12	MAMS-19523	C, CC12 (South-west)	36.94–37.04			Vicia faba (7 charred seeds and fragm.)		BP 72	3038 ± 22	-20.0	1389–1222		RBA 2 / LH IIIC Early 1
PZ66c CC10	MAMS-19525	C, CC10	36.92–36.97			Triticum dicoccum (2 charred seeds)		BP 70	3044 ± 21	-24.0	1391–1226		RBA 2 / LH IIIC Early 1
PZ129 DD 11	MAMS-21650	C, DD11	36.74–36.77			Vicia faba (3 charred fragm.)		BP 130	3025 ± 31	-21.5	1394–1132		RBA 2 / LH IIIC Early 1
PZ129 CC 12	MAMS-21651	C, CC12	36.68			Vitis vinifera (7 charred fragm.)		BP 215	3021 ± 31	-20.8	1391–1131		RBA 2 / LH IIIC Early 1
PZ161 BBCC 10	MAMS-21653	C, BBCC10	36.65–36.73			Hordeum vulgare (8 charred seeds)		BP 251	3026 ± 33	-25.3	1395–1132		RBA 2
PZ161/P4	MAMS-22496	C, BB10	36.6	2604706.78	4285498.88	Rhamnus alaternus (charred twig with bark and 3.5 rings)	1.2	CP 66	2990 ± 26	-27.5	1368–1124		RBA 2
PZ151 DD 10	MAMS-21652	C, DD10	36.51–36.56			cultivated pulses (5 charred fragm.)		BP 248	3038 ± 32	-28.1	1402–1211		RBA 2 / LH IIIC Early 1
PZ33 I12-I13	MAMS-19520	B, I12 – I13	36.83–36.94	2604704.75–2604704.88	4285478.68–4285478.91	Triticum (8 fragm.)		BP 18	3070 ± 21	-24.5	1407–1273		(RBA ?)
PZ217/P1	MAMS-19922	C, CC10	35.45	2604706.40	4285499.25	Myrtus communis (charcoal)	0.046	CP 80	3060 ± 25	-21.0	1407–1236		?

Tab. 1 Punta di Zambrone: radiocarbon samples from the fill levels of the RBA fortification ditch in Areas B and C

animal bone, two are human bones,[12] two samples are charcoals of shrubs belonging to the Mediterranean macchia, and the remaining eight samples consist of charred seeds (grain and legumes). The first charcoal sample (PZ161/P4) can be identified as short-lived, since during species identification the archaeobotanist Alessia D'Auria was able to count three and a half rings on a small charred twig fragment (the bark of which was preserved when found). The second charcoal sample (PZ217/P1) could be classified to species level, but ring counting was not possible due to its bad state of preservation. This potentially long-lived sample was nevertheless submitted to ^{14}C-AMS-analysis, as an exception, because the layer it was found in contained neither well-preserved pottery, nor sufficient quantities of charred seeds. The importance of this layer for reconstructing the settlement history is considerable, as it is the lowermost fill level of the fortification ditch and thus provides us with the best *terminus ante quem* for the cutting of the ditch (see below).

In terms of the sampling schedule, which was also to be optimised as far as possible, the five bone and charcoal samples were already chosen and collected during the excavation. This allowed complete documentation of their individual stratigraphic location, including measurement of their precise site coordinates (Tab. 1). The seed samples were carefully selected from among the available set of archaeobotanical samples, according to the species identification criteria provided by the archaeobotanists Marlies Klee, Ursula Thanheiser and Barbara Zach. During excavation, we collected botanical samples from the majority of stratigraphical units by the following procedure. Generally, the horizontal extension of the sample collection was confined to one square of the excavation grid measuring 1m² (e.g. DD11). If, as an exception, the given stratigraphical unit exceeded one square metre in extension, we regularly collected more than one botanical sample from different parts of that stratigraphical unit. In no cases did the extension of the archaeobotanical sampling exceed one and a half squares, i.e. 1.5m² (e.g. BBCC10).[13]

As it turned out, only 12 of the 13 radiocarbon samples contained a sufficient quantity of carbon for AMS measurement.[14] All of the 12 measured samples originate from fill layers of the Recent Bronze Age fortification ditch. This sampling may be to some extent biased towards dating of the fortification ditch, since we unfortunately did not encounter any preserved Recent Bronze Age habitation level to the west of the ditch, and are consequently not able to date any house contexts.[15] Nonetheless, the ditch, with its multilayer and well-defined stratigraphy created by consecutive filling events, does indeed provide us with a sequence of ^{14}C ages, which show a clear relation to the overall settlement history of Punta di Zambrone, as requested. One further sample comes from Area B in the middle of the ditch; all others are from Area C towards the northern end of the ditch (Tab. 1)

Coming now to the stratigraphic analysis, the sample sequence from the ditch in Area C basically relates to two different kinds of fill. Sample PZ217/P1 comes from the lowermost fill level and was taken from a point precisely 18cm above the bottom of the ditch. The corresponding stratigraphic unit, PZ217, consists of a sandy clay loam with a high percentage of granite grains, which was most probably formed by a longer-lasting process of sedimentation.[16] At an elevation of 35.52m asl, a hollowing of the bedrock in the eastern scarp of the ditch is visible. An analogous hollowing can also be seen at an elevation of 36.10m asl in the eastern scarp of the ditch in Area B. Considering that the local granite does not resist erosion very well, we ascribe these features to

[12] The initial objective in dating the human bones was to ascertain their Bronze Age date. Because they were found in stratigraphical unit PZ95, the uppermost ashy level (cf. below) is disturbed by 20th century AD deep ploughing (samples PZ95/P1 and PZ95/P9). A pig maxilla from the same stratigraphical unit and same square FF12 was sampled (PZ95/P8) in order to further test the Bronze Age date of the finds from that level. The radiocarbon results confirm the Bronze Age date of these bones. Thus, they were included in the chronological model.

[13] For the methodology applied by the archaeobotanists see Zach, Klee and Thanheiser in: Jung et al. 2015, 84.

[14] Only the human maxilla sample PZ95/P9 (MAMS-17724) did not contain enough collagen to be dated.

[15] All the habitation levels inside the fortified area seem to have fallen victim to 20th century CE levelling and terracing operations. The only habitation level that remained in situ (albeit disturbed by recent deep ploughing) is an Ancient Bronze Age 1 level in Area D. In the western part of Area C (west of the ditch) the plough had cut deeply into the bedrock, and no identifiable remains of anthropogenic constructions remained intact.

[16] Fine sub-levels of higher or lower sand content were visible, but it was impossible to separate them during excavation.

the action of running water. The ditch has an inclination of 1.32% between excavation areas B and C and the water would have drained towards the beach north of the promontory. These findings allow the conclusion that the ^{14}C age MAMS-19922: 3060 ± 25 BP of sample PZ217/P1 refers to an early use stage of the fortification or at least to an early stage of the infill.

By contrast, the ashy layers to which all the other radiocarbon samples of Area C belong were deposited in the final backfilling process that defunctionalised the fortification ditch. The matrix of these ashy layers shows some variability, ranging from silt to silty loam and sandy loam. As explained in detail elsewhere,[17] a number of observations allow the conclusion that the ash levels were the result of an intentional backfilling action. Our observations also provide arguments for suggesting that the backfilling was a quick process lasting not longer than a few days (or at maximum up to a few weeks). However, the minimum of c. 54m³ stratified ashy layers that we calculated based on our excavation and additional boreholes situated between areas B and C presupposes a truly enormous production of ash. Numerous pottery joins between all of the ash layers – sometimes even between one of the lower and one of the highest layers – provide additional evidence for the conclusion that these masses of ash must have accumulated elsewhere, before they were thrown into the ditch.[18] Because of the close spatial relationship between the ditch and the dismantled wall or rampart, we suggest that the place where the ash had initially accumulated cannot have been far away from its final deposit, most probably even immediately adjacent to the fortification wall or rampart.

It is interesting to note an apparently quite analogous case in the grey to black layers that appear at the Apulian settlement of Coppa Nevigata in its RBA 2 phase, and which reach a thickness of more than 0.50m. These layers are also rich in charred botanical remains, in bones and artefacts. The excavators interpret these levels as an accumulation of rubbish, which extends on the inside of the fortification and outside a two-room building situated just behind the fortification line. Close by, there is another open zone with various installations used in connection with fire such as ovens and hearths.[19] Based on the aforementioned evidence and bearing in mind the approximately contemporaneous settlement of Coppa Nevigata, we may assume that the ashy deposits at Punta di Zambrone accumulated over a longer period of time at some place on the inside of the fortification.[20]

To conclude, the majority of radiocarbon samples from Area C originate from a thick sequence of ashy layers (stratigraphic units PZ66, PZ129, PZ161, PZ151, as well as PZ95 that has been disturbed by ploughing) that was apparently *deposited* in a quite short period of time immediately prior to the abandonment of the fortification. However, the original *formation* of the ashy deposits must have been a longer-lasting process, probably extending over many years during the habitation period of the Recent Bronze Age settlement. We conclude this due to the tremendous size of the ashy deposits, and to the presence of artefacts belonging to different archaeological sub-phases.

One final radiocarbon date can be attributed to the time segment between the earliest processes of sedimentation in the ditch and the final backfill action. The sample is MAMS-19520: 3070 ± 21 BP, measured on eight fragmentary seeds of Triticum (sample PZ33I12–13) from Area B. The relevant stratigraphic unit PZ33 is covered by the final fill layer PZ6 (and its disturbed part PZ63) of the ditch and further by some preceding sedimentation layers with interspersed thin ashy levels (PZ40, PZ42, PZ44, PZ45, PZ50). During the excavation campaign of 2011 we excavated level PZ33, but we did not reach the bottom of the ditch. The results of the following excavation campaign in 2012 suggest that PZ33 most probably was not the lowermost fill layer of the ditch in Area B. According to the complete stratigraphic sequence obtained during that campaign, PZ33 represents an intermediate level deposited some time during the use period of the ditch. Therefore, in the chronological model

[17] See Jung et al. 2015, 59–60; Jung – Pacciarelli, this volume.

[18] Documented pottery joins include SU 1 + 129; SU 66a + 66c + 129; SU 66 + 176; SU 129b + 161; SU 129b + 151.

[19] Cazzella – Recchia 2012b, 299–306.

[20] We refer to Jung – Pacciarelli, this volume, for a more detailed discussion of the formation process of those refuse accumulations.

(Tab. 2) we have inserted the date MAMS-19520 (sample PZ33I12–13 from Area B) between the date MAMS-19922 (measured on the lowermost sediment level PZ217) and the whole sequence of dates from the ashy backfill layers of Area C. With this decision, it is possible to incorporate the single date from Area B into the longer Area C sequence. However, we must keep in mind that the accumulation of ashes outside the ditch in the northern zone of the fortification (excavated in Area C) was a longer-lasting process. Therefore, it might even be the case that some portion of the ashes had already formed close to the northern stretch of the ditch, when level PZ33 was deposited in the central part of the ditch. As such, the exact relative chronological position of the formation of PZ33 (in Area B) in relation to the fill layers (in Area C) cannot be determined. Strictly speaking, therefore, the inclusion of MAMS-19520 in the sequence remains hypothetical.

Radiocarbon Calibration Methodology

The method of Gaussian Monte Carlo Wiggle Matching (GMCWM) used in the present paper is a procedure aimed at using the known temporal structure of archaeological ^{14}C ages to enhance the dating precision. This is achieved by comparing the structured ^{14}C ages with the corresponding sequence of atmospheric ^{14}C variations (*wiggles*) in order to find the statistically best-fitting position on the underlying scale of tree-ring dating. The comparison is based on a Chi-Squared (χ^2) test[21] that is designed to measure, and then minimise, the differences between the discrete archaeological ^{14}C data (with values $D_i \pm \sigma(D)_i$ [BP]) and the continuous ^{14}C age calibration curve data (with values $K(t) \pm \sigma(K)_i$ [BP]). As shown schematically in Equation (1), the best-fitting year t is obtained by minimising the summed square distances between the archaeological data D and the calibration curve data K. To allow for errors in the archaeological and the calibration data, the statistical distances of individual dates D_i (i=1,..n) are weighted according to their standard deviations $\sigma(D)_i$, and the standard deviations σ_K of the calibration curve at corresponding calendric age positions:

$$X^2 = \sum_{i=1}^{n} \frac{(D_i - K(t)_i^2)}{(\sigma(D)_i^2 + \sigma(K)_i^2)} \quad (1)$$

What complicates matters is the existence of multiple solutions i.e. often there exist different best-fit years t, which have equal (although maximised) probability. We will return to this problem ('quantisation') below. For convenience in interpretation, the initially obtained set of maximised $\chi^2(\gamma,n)$-values (which are a function of the degrees of freedom $\gamma = n-1$; n=number of dates) can be used to calculate a set of probabilities $p(\chi^2,\gamma)$. In CalPal software, which uses Fortran 90 as the programming language, the necessary calculations of the incomplete Gamma function make use of the IMSL®-mathematical libraries, and specifically the GAMMQ subroutine, with calls to further functions. This is illustrated schematically in Equation (2).

$$P(X^2,\nu) \rightarrow \text{Gamma Function (Fortran IMSL-Library: GAMMQ)} \quad (2)$$

Originally the 'wiggle matching' method was developed for the analysis of floating tree-ring sequences, for which the numeric intra-sample distances in the ^{14}C sequence were pre-established by direct growth-ring counting.[22] A first generalisation of the method called 'archaeological wiggle matching' was to apply the method to sets of stratified ^{14}C ages, in which case it was possible to

[21] Cf. Pearson 1983; Pearson 1986; Weninger 1986.
[22] Cf. Pearson 1983; Pearson 1986.

analyse archaeological stratigraphies (for example in tell-mounds) as well as ^{14}C sequences based on pottery seriation.[23] From a mathematical point of view, such approaches require some further flexibility in the scaling of the sample sequence, to allow e.g. for the (initially unknown) length of the sequence, the potential non-linearity of the age-depth model, or the technical handling of data gaps. Although such generalisations may complicate the software-implementation of the method, they do not necessitate the introduction of basic changes to the mathematical approach.

Beginning with studies described in Benz et al. (2012), we have implemented in CalPal an increasing variety of Monte Carlo procedures, all of which aim at deriving numeric dating uncertainties for statistical curve fitting studies under the most realistic archaeological conditions possible. In extension of previously established techniques, in which the optimal length for the given sample sequence was derived by simultaneously optimising the dating probability and the dating precision,[24] the new approach now supports some additional modes of modelling. Most important is the (optional) grouping of ^{14}C ages with group-internal randomisation of the sample order.[25] The main advantage of this option is that it supports the derivation of marginal probabilities, both for the beginning and the end of the sequence, as well as for intermediate sample positions. Beyond addressing the need for realistic estimates of dating errors, a further intention of the new software development is to enhance our understanding of the archaeological conditions under which the disturbing (so-called) 'lock-in' or 'quantisation' effects may occur. The quantisation of dating results is currently most apparent in the often quite extreme and clearly artificial spikes that invariably appear in the Bayesian-based construction of summed calibrated probability distributions for larger data sets.[26] Although less apparent, such effects can also be observed in the minutely oscillating superstructure of the Bayesian probability distributions obtained for single ^{14}C ages. At least in theory, furthermore, we have reason to assume that similar distortion will also occur for Bayesian sequencing, but with currently unknown quantitative magnitude.[27] Presumably, the quantisation will be stronger for the traditional (ordinal-scaled) Bayesian sequencing than for the metric-scaled sequencing approach that is implemented in CalPal. Due to the mathematical complexity of the underlying non-commutative calibration algebra, full comprehension of what we term '*Radiocarbon Quantum Chronology (RQC)*' is yet to be achieved. As mentioned above, by providing our curve fitting software with a 'real-time' animated screen output, the eye can actually 'see' the quantum effects such that, under certain (unfortunately rare) conditions during sequence expansion, the fitted data does not move linearly, but shows some small yet conspicuous 'jumps' along the calibration curve. To support our understanding of these effects, in the new 'real-time' GaussWM algorithms the Monte Carlo approach has been integrated to show, step-wise on the screen, the best-fitting data position that is achieved when the length of the sample sequence is steadily increased. In parallel, the algorithms are designed such that the eye can follow the random re-ordering of the samples within their respective phases (groups), both on-screen as well as in tabular form. Additionally, by using different colours for the different variables in the statistical graphs, the observer can more easily evaluate the dating effects of changes in the summed probability curve (red), the precision histogram (blue), and the optimised combination of both (green) (Fig. 1).

In technical terms, the GaussWM studies on which we report in the present paper were achieved with CalPal (version 2016.3) using the workstation Celsius W530® with Xeon E3-1281v3® 3.7 GHz CPU. Beginning with this programme version, the GMCWM data input as well as optional data output is now possible not only in ASCII format but also in Excel©[in 32 bit technology i.e. xls format], with data transfer via the ODBC© Interface (Open Database Connectivity). This

[23] Weninger 1986.

[24] Horejs et al. 2015; Krauß et al. 2016.

[25] Horejs et al. 2015.

[26] E.g. Culleton 2008; Steele 2010; Bueno et al. 2013; French – Collins 2015; Goldberg et al. 2016.

[27] Both the extreme shape-distortion of the probability distributions for phase 4, and the apparent hiatus (~50yr length) that exists in the Bayesian sequence for Assiros between phases 4 and 3 (Wardle et al. 2014, fig. 2) may be due to such quantisation (as forecast by Weninger et al. 2011; Weninger et al. 2015).

greatly simplifies the analysis. Monte Carlo run-times were typically in the order of 5–1000 minutes, depending on the numeric resolution requested.

	Lab Code	^{14}C-Age (BP)	Group	Model 1 Units	Result 1 (calBC, 68%)	Group	Model 2 Units	Result 2 (calBC, 68%)
1	MAMS-17723	2889 ± 19	1	0	1201 ± 6	1	0	1205 ± 14
2	MAMS-17722	2988 ± 19	1	50	1226 ± 6	1	10	1214 ± 12
3	MAMS-19523	3038 ± 22	2	100	1250 ± 6	1	20	1224 ± 11
4	MAMS-22496	2990 ± 26	2	112	1256 ± 5	1	30	1233 ± 9
5	MAMS-21651	3021 ± 31	2	124	1262 ± 5	1	40	1242 ± 7
6	MAMS-21650	3025 ± 31	2	136	1268 ± 5	1	50	1252 ± 6
7	MAMS-19524	3048 ± 21	2	148	1274 ± 5	1	60	1261 ± 6
8	MAMS-21652	3038 ± 32	2	160	1280 ± 6	1	70	1270 ± 6
9	MAMS-21653	3026 ± 33	2	172	1286 ± 6	1	80	1280 ± 6
10	MAMS-19525	3044 ± 21	2	184	1292 ± 6	1	90	1289 ± 7
11	MAMS-19520	3070 ± 21	3	200	1300 ± 6	2	100	1299 ± 10
12	MAMS-19922	3060 ± 25	4	300	1348 ± 8	3	200	1392 ± 29

Tab. 2 Model input and results for two different age models (Model 1 and Model 2) for Gauss WM analysis of stratified ^{14}C ages from Punta di Zambrone. The samples are arranged in stratigraphic order, with the stratigraphically highest ('youngest') sample (MAMS-17723) at the top of the table, and the stratigraphically lowest ('oldest') sample (MAMS-19922) at the bottom. By quadratic addition of 5 years, the marginal uncertainties allow for the width of the tree-ring samples used in the calibration curve construction

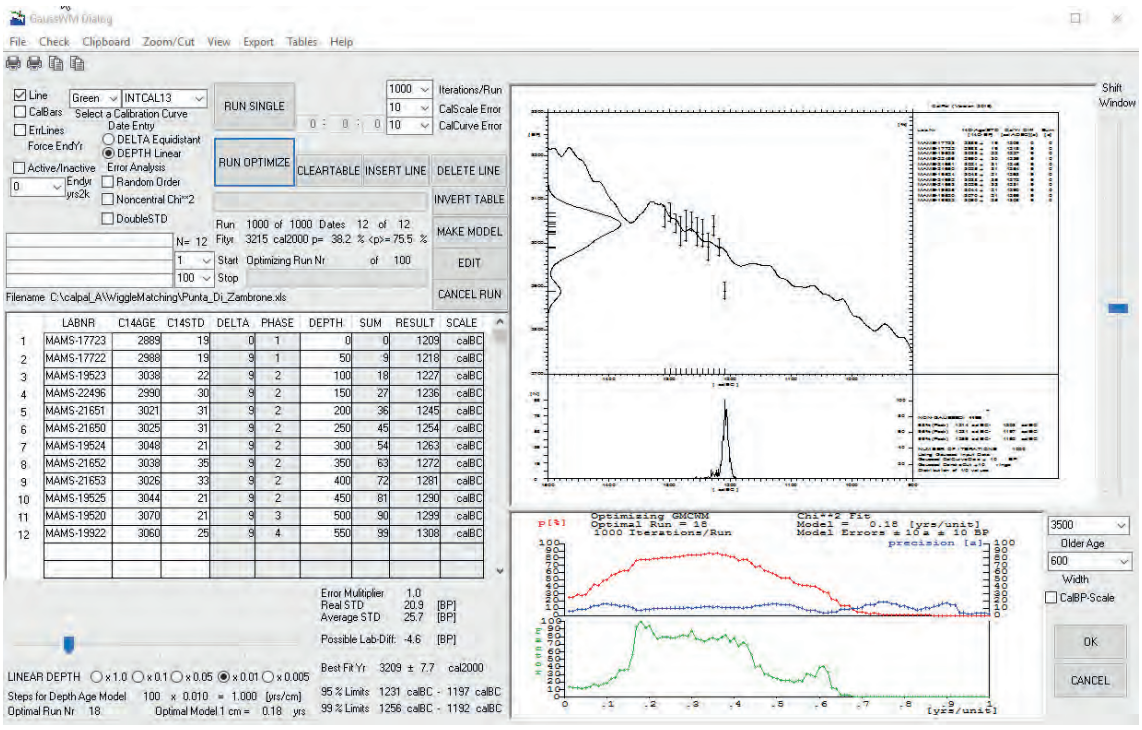


Fig. 1 Gaussian Monte Carlo Wiggle Matching (GaussWM) Dialog (CalPal version 2016.3), illustrating the statistical analysis of the Punta di Zambrone ^{14}C sequence. Note: animated graphs and refreshed tables show the Monte Carlo results in real-time, with screen refreshing in the order of seconds. A typical explorative analysis requires a c. 5 min run-time. Final runs require 6–12 hours. Left: Programme functions; data input spreadsheet; tools for age-model construction; tools for statistical analysis. Right Upper: Output Graph showing the archaeological ^{14}C sequence together with the ^{14}C age calibration curve. Right Middle: Histogram showing distribution of best-fit results. Right Lower: Statistical fit parameters shown as functions of the systematically expanded sequence length. Red= dating probability; Blue=dating precision; Green=simultaneously optimised precision and probability (graphics: B. Weninger)

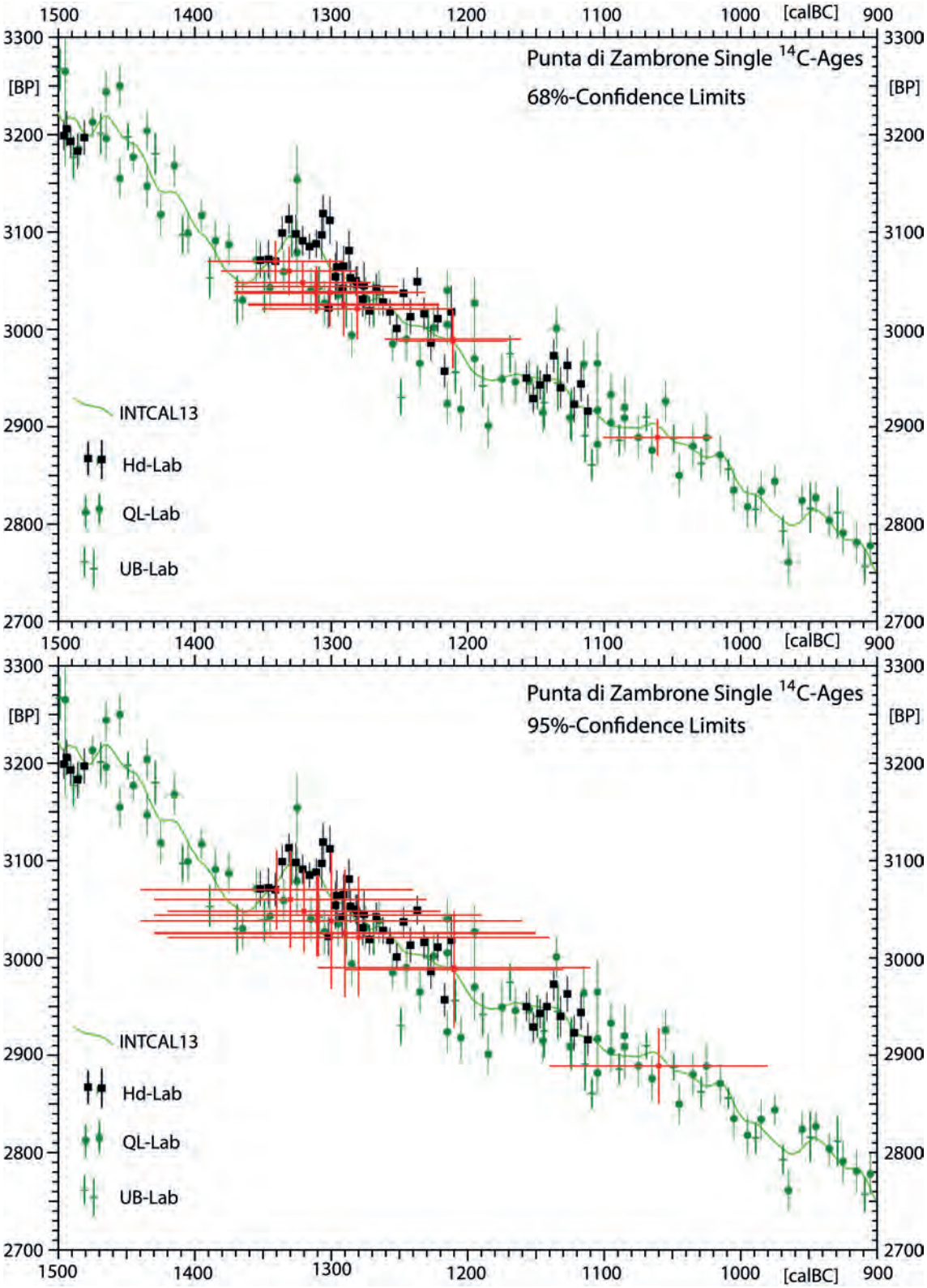


Fig. 2 Results of single ^{14}C age analysis for the Punta di Zambrone ^{14}C data (Tab. 1). Both graphs illustrate the same chronological results, but with calibrated error bars of the Punta Di Zambrone data (red) shown for different levels of statistical confidence. Upper: 68% confidence error bars; Lower: 95% confidence error bars. Laboratory abbreviations: Hd=Heidelberg: INTCAL13-SET5; QL=Queens' Lab: INTCAL13-SET1; UB=University Belfast: INTCAL13-SET2. Note: the measurement precision (~20–30 BP) of the Punta ^{14}C ages is similar to that of the high-precision laboratory raw data used in construction of the INTCAL13 calibration curve (Reimer et al. 2013) (graphics: B. Weninger)

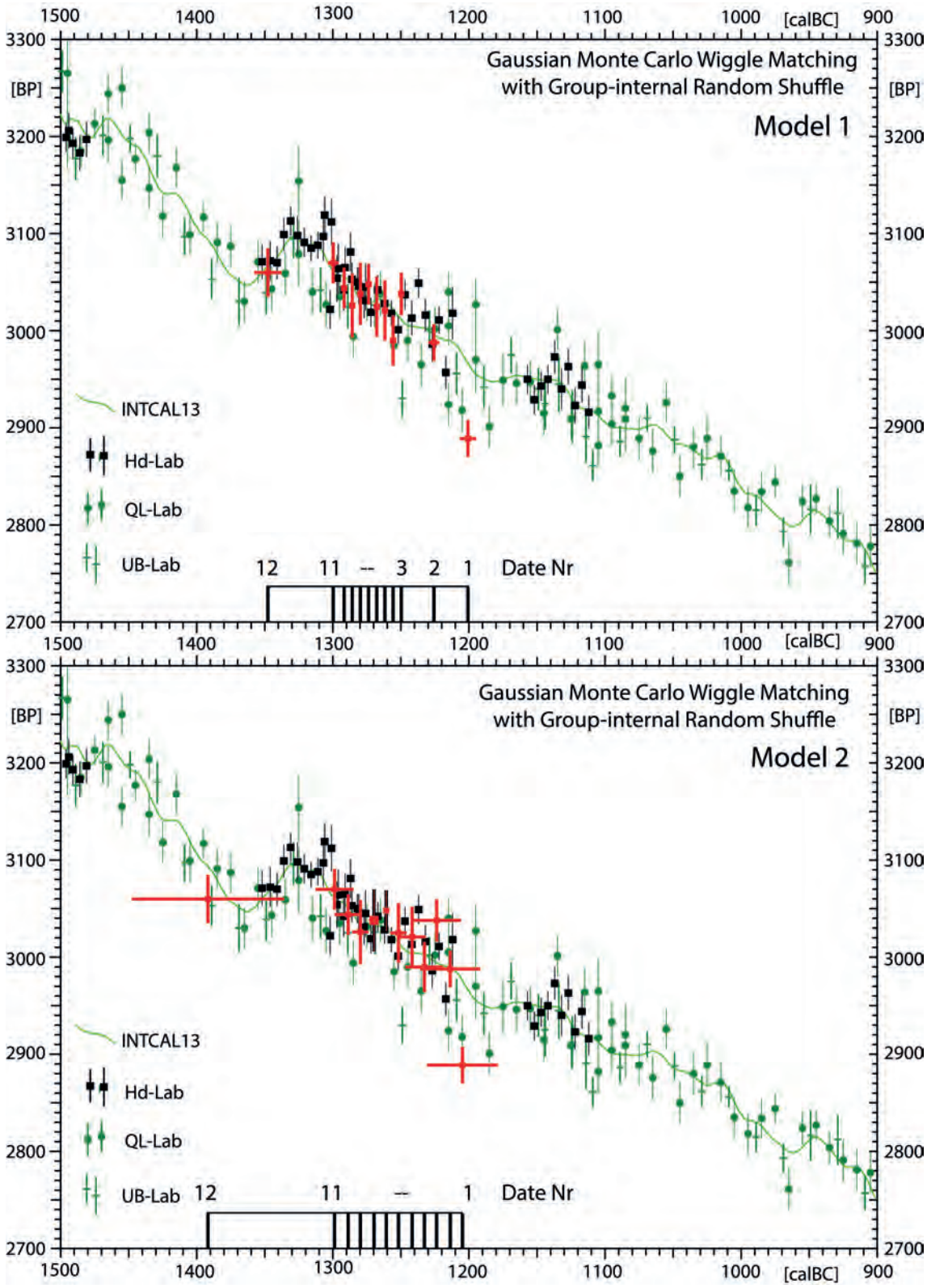


Fig. 3 Results of GMCWM analysis for modelled ^{14}C ages from Punta di Zambrone according to two different age models (Tab. 2) (graphics: B. Weninger)

Results

For purposes of comparison we applied the Monte Carlo methodology to the Punta di Zambrone data (Tab. 1) according to two different age models (Tab. 2). The model data input and results are documented in Tab. 2. Both models correspond to the sample stratigraphy described above (cf. Tab. 1 – ditch sections in areas B and C), and differ only in minor details of the sample grouping. It is important to note that, in contrast to the apparently fixed stratigraphic sample order as shown in Tab. 2, during the Monte Carlo modelling the sample order was actually changed many millions of times, mainly group-internally (by Monte Carlo randomisation) but to some extent also between the different groups (by Gaussian distance modelling). The two basic models are as follows:

Model 1

The twelve samples are assigned to four (assumed) phases of the stratigraphy. Each of the four phases (in Tab. 2 named as data groups 1, 2, 3, and 4) is assigned an equal (unknown) time span that is represented by 100 model units (cf. Tab. 2).

Model 2

The twelve samples are assigned to three (assumed) phases of the stratigraphy. Each of the three phases (in Tab. 2 named as data groups 1, 2, and 3) is assigned an equal (unknown) time span that is represented by 100 model units (cf. Tab. 2).

Run-Time Parameters

Both models were run for a total of $300*300*80 = 7.2*10^6$ random iterations, with the following fixed parameters: 80 = number of steps in the sequence expansion; 300 = number of Monte Carlo iterations (group-internal re-ordering); 300 = number of Gaussian iterations (simulated Gaussian re-measurement of each ^{14}C age according to its standard deviation). During the run-time, in parallel to the group-internal randomised sample order, the sample distances were also randomised, with additional Gaussian cal-scale errors set to $\sigma = 10$ yrs. Finally, also as a component of each individual random iteration, the calibration curve was re-calculated, with the new spline in each case based on the original INTCAL13 raw data which were theoretically re-measured with Gaussian ^{14}C-scale errors set to $\sigma = 10$ BP. The run-times for both models were in the order of 12 hours.

Discussion of Results

As can be seen from Tab. 2, the overall spread of ^{14}C ages for the Punta di Zambrone data is extremely small, even when measured in relation to the themselves already low standard deviations, which range from $\sigma = 19$ BP (MAMS-17723) to $\sigma = 33$ BP (MAMS-21653). Indeed, from a purely statistical point of view, if, *only as a Gedankenexperiment*, we were to assume that all measurements (with one notable exception, see below) had been performed on one and the same (annual growth) sample, then we would obtain as a weighted average a ^{14}C age of 3032 ± 7 BP ($p = 18\%$). Hence, although this tells us nothing about their underlying calendric ages, all samples have at least essentially the same (hypothetical) ^{14}C age, independent of their stratigraphic position, and this is already quite informative in later judging the outcome of the archaeological modelling. The interesting exception is MAMS-17723: 2889 ± 19 BP, which has by far (> 100 BP) the youngest ^{14}C age, but also comes from the very highest stratigraphic level. Prior to the analysis, for MAMS-17723 as the only exception, we consequently assumed that *either* the ^{14}C measurement *might* be an outlier, *o*r the respective sample *might* be contaminated with younger carbon, *or else* the sample *might* indeed be younger and stratigraphically *out of context*. Such judgement, however,

was only based on the *seemingly* too young ^{14}C age of this sample, which *in all other* respects has e.g. chemical properties (as judged by its collagen preservation) and a stratigraphic location (near to sample MAMS-17722 with a near-average ^{14}C age of 2988 ± 19 BP), that are entirely inconspicuous. On the other hand, from previous experience, we are aware of the problem that correct judgement of literally all so-called ^{14}C 'outliers' or 'extreme values' obtained under similar circumstances is virtually impossible to obtain simply by evaluating the given series-internal spread of ^{14}C ages. The solution that we routinely apply to evaluate the occurrence of extreme values on the >3σ level of confidence is to show the archaeological data (post-analysis) in graphic context with the raw data of the laboratories involved in calibration curve construction.

The results are shown graphically in Fig. 3, with precise numeric values supplied in Tab. 2. We observe maximal differences in the range of a few decades between the different models (model-comparison), and a similar variability is obtained for the marginal sample positions (model-internal). What is also notable is the reproducible age position of the 'outlier' date (MAMS-17723) at around 1200 calBC, and, in particular, its good agreement with a number of high-precision measurements from the INTCAL13 data sets. For the sake of completeness, Fig. 2 shows that essentially identical results (although at significantly lower dating precision) are obtained by single-age analysis.

We emphasise, in particular, the satisfactory stability of the Monte Carlo results for the central and end regions of the sequence. As already discussed above, due to the apparently extreme position of the ^{14}C age MAMS-17723 (2889 ± 19 BP) both in relation to the other ^{14}C ages of the sequence, as well as in relation to the INTCAL13 calibration curve (cf. Fig. 2 and Fig. 3), one might expect the GaussWM results to be strongly dependent on the decision whether (or not) MAMS-17723 represents an outlier. As it turned out, based on a large number of extended (10–20hr) test runs that we performed to address this question, the dating results are actually only to some small extent (in the order of 10 years) dependent on MAMS-17723. Instead an end year close to 1200 calBC is *naturally* achieved by the given data set, if only in combination with the applied method of Monte Carlo wiggle matching. This is because the GaussWM method is *purposely designed* (via statistical philosophy) to spread the ^{14}C age readings *as far as possible* in both directions (younger and older) along the calendric scale, such that the true (but unknown ages) are safely covered. Now, as for younger ages, the necessary expansion is strongly inhibited by the step in the calibration curve that occurs around 1200 calBC (cf. Fig. 2). Hence, quite simply, it is the existence of this step in the calibration curve (and *not* the existence of MAMS-17723, despite its step-confirming properties) that provides the GaussWM algorithms with good reason to recognise an age of ~1200 calBC as the most 'likely' youngest age of the sequence. As such, we obtain ~1200 cal BC as the most frequently counted end year, whether or not MAMS-17723 is included in the analysis. In Bayesian terminology, the only influence that MAMS-17723 has on the dating result is to enhance our belief in the truth of this particular end year, which was nonetheless established independently. In conclusion, (1) the Punta di Zambrone sequence begins at some (unfortunately rather unclear) time between 1400 and 1300 calBC, and most likely around 1350 calBC, (2) the large majority of samples have ages in the range of 1300–1250 calBC, and (3) the sequence ends with highest likelihood (modelled probability) at 1200 ± 15 calBC. These results are rounded to the nearest 5 years.

Conclusions Regarding the Absolute Chronology of the Recent Bronze Age

The sequence of radiocarbon dates for Punta di Zambrone offers the possibility to establish absolute dates for the various phases of the Recent Bronze Age and possibly even for the end of the Middle Bronze Age, too. The ashy layers, from which most of the dated samples were taken (stratigraphical units PZ95, PZ66, PZ129, PZ151, and PZ161), contain mostly local *impasto* pottery of the second Recent Bronze Age phase (RBA 2).[28] In fact, due to the aforementioned

[28] Pacciarelli 2015, 61–68; Capriglione, this volume.

long-lasting formation processes of the ashy deposits, it is also possible to find in these layers a certain number of pottery fragments that are probably residual and date to a phase preceding RBA 2. First, there are a few pieces with the typical MBA 3 Apennine incised or cut-out decoration, and even fewer sherds assignable to the local MBA 3 Thapsos-Milazzese culture.[29] In addition, we count a slightly more significant number of typological elements datable to the phase RBA 1,[30] more specifically some types of handle projections: axe-shaped projections, cylinder-shaped projections, pairs of cylinders set on top of horizontal handles rising above the rim, simple or with boot-shaped projections. While the first two – the axe- and cylinder-shaped projections – are geographically widespread types of RBA 1, but not very frequent in Punta di Zambrone, things are different with the other types. Those types of handle projections, which are very characteristic of the southern Tyrrhenian region, show a remarkably strong connection with pottery from the central-northern Adriatic coastal zones, especially in the regions of Marche and Emilia-Romagna. This link is very strong in the initial phases (presumably there are two): (1) a transitional stage between the Apennine culture group of MBA 3 and the early Subapennine culture group of RBA 1; (2) RBA 1, but lasting throughout the RBA and leading to the affirmation in the southern Tyrrhenian area of a very well-characterised regional Subapennine aspect of RBA 2. This regional style includes types like the pairs of bird-headed projections (called *'anse di padelle'* in the terminology of L. Bernabò Brea and M. Cavalier[31]) that are usually attached to bowls with thickened rims, and horizontal handles rising above the rim and ending in diverging coils. In addition, the southern Tyrrhenian workshops produced their own, regional features. These include a type of complex bird's head projection that appears to be an original and unique creation inspired by influences of different origins and intertwined with local features.[32] Another example is offered by two types of handles with diverging coils, characterised by two protuberances flanking the handle hole.[33] These mainly belong to RBA 2 and predominantly appear in the southern Tyrrhenian region, while some specimens are also found in inland central Italy, in particular in Abruzzo and Molise.[34] Open fine-ware shapes of *impasto* pottery like cups with or without carination[35] are in general long-lasting types and show a very widespread distribution reaching from the middle Tyrrhenian coast to the Adriatic one and from the Sybaritis to the area of the *terramare* settlements in the Po Valley etc. A dipper type with rounded body[36] appears to be the only one exclusive to the southern Tyrrhenian region. The known specimens mostly come from Lipari with a minor presence at Punta di Zambrone, while there are also a few parallels in the Ionian coastal areas of Calabria, at Broglio di Trebisacce and Torre Mordillo.[37] The ashy fill layers of the fortification ditch of Punta di Zambrone, however, also yielded some of the most characteristic type fossils of the RBA 2 aspect of the Subapennine *facies,* such as the high-swung loop handles with circular section – either simple or with small knobs added on top of the handle.[38] Typical for Punta di Zambrone is the presence of a small drop-shaped impression on the interior surface of the handle.[39] Other types of fossils from RBA 2 at Punta di Zambrone are strap handles – either simple or

29 See Capriglione, this volume, fig. 1.
30 See Capriglione, this volume, fig. 2.
31 The type, one of the most frequent in Lipari, is described in Bernabò Brea – Cavalier 1980, 577, pl. 204.3.
32 Type 57; see Capriglione, this volume, fig. 4.2.
33 See Capriglione, this volume, fig. 4.
34 Types 62–63 within family 13; see Capriglione, this volume, fig. 4.4. The best parallels for these types of handle projections come from Oratino La Rocca (Cazzella et al. 2006, 168 fig. 4.12; Cazzella et al. 2007a, 286, fig. 4.13; 293, fig. 8.14) and Monteroduni (Cazzella et al. 2007b, 40, fig. 6.10) in Molise, and from Ortucchio strada 28 (Ialongo 2007, 61, fig. 40.100), Ortucchio Balzone (Ialongo 2007, 78, fig. 54.39) and Trasacco 2 (Ialongo 2007, 139, fig. 104.3). Ialongo classifies this type of projection as 'manico 43A'.
35 See Capriglione, this volume, fig. 3.
36 Type 44; see Capriglione, this volume.
37 Type 44 corresponds with family 10, types 20–21 in Damiani 2010, 151 fig. 16.1–4; 153, fig. 17a.1–9.
38 See Capriglione, this volume, fig. 5.1 for family 14, types 76–78 (simple handles) and fig. 5.3 for family 15, types 79–81 (horse-head handles).
39 Type 76B; see Capriglione, this volume, fig. 5.2.

with a slight midrib – and horizontal handles with shallow grooves on the external surface[40] that are very common in the southern Tyrrhenian as well as in the Marche and Abruzzo regions[41]. One may also name here the bowls with an incurving rim,[42] which are very common in RBA 2 contexts of central-southern Italy, e.g. at Oratino-La Rocca in Molise, and at Torre Mordillo and Broglio di Trebisacce in the Sybaritis, Coppa Nevigata in Apulia etc.[43] Another typical feature of the Punta di Zambrone *impasto* pottery is the presence of a horizontal groove placed between the neck and the shoulder on amphorae.[44] This feature seems quite rare outside the southern Tyrrhenian region. Where it appears, it is usually characterised by a group of two or three horizontal grooves, often with circular impressions; this decoration can be found in late Recent Bronze Age contexts, like at Roca Vecchia,[45] or in contexts for which the dating is uncertain, like at Torre Mordillo,[46] even if it is also occasionally present in earlier contexts such as in the Recent Bronze Age necropolis of Casinalbo in northern Italy.[47] The amphora from Coppa Nevigata[48] with one horizontal groove between the neck and the shoulder is probably the best parallel for our type 101, but it seems to be an isolated case. This brief *excursus* about the most important typological features of the Subapennine aspect of Punta di Zambrone and about its integration into a wider archaeological context,[49] highlights the great importance of the radiocarbon dates from Punta di Zambrone, both *per se* and in conjunction with the stratigraphic sequences of central-southern Italy as well as with the historical-archaeological dates based on Mycenaean pottery imports.

The imported Mycenaean pottery from the mentioned ashy layers of the Punta di Zambrone fortification ditch includes to a lesser extent products of the final Palatial period, while the majority of the sherds are of early Post-palatial date.[50] No typological and stylistic features of these ceramics would suggest a later date, i.e. to the middle and late phases of LM/LH IIIC. The typologically and stylistically most advanced characteristics date to LH IIIC Early. Some pieces find especially close parallels in the first subphase, LH IIIC Early 1. These are the monochrome deep bowls FT 284/285. Three of the four rim fragments, of which enough is preserved to allow a certain or very probable ascription to the monochrome type,[51] show the everted rim that characterises the monochrome deep bowls from the palace destruction level at Pylos (LH IIIC Early 1).[52] According to the NAA results, two of the Zambrone monochrome deep bowls are western Greek products, while the third one can only be ascribed to the Peloponnese in a general way.[53] Therefore, the Pylos parallels appear significant for achieving a fine chronological classification,

40 Types 82 and 83B; see Capriglione, this volume, fig. 5.4, 6.

41 Conelle di Arcevia (Moscoloni et al. 2007, 90, fig. 5.6); Bachero di Cingoli (Lollini 1979, 199, fig. 6.12); Monteroduni (Cazzella et al. 2005, 407, fig. 8.3); Oratino La Rocca (Cazzella et al. 2006, 149).

42 Types 15–17; see Capriglione, this volume, fig. 3.4.

43 See family 5, type 8A and family 6, type 9A-B-C in Damiani 2010, 139, fig. 9.1–3; 141, fig. 10.1–10; 142, fig. 11.1–3. – For Oratino La Rocca see Cazzella et al. 2006, 167, fig. 3.6, 11, 13–16; Cazzella et al. 2007a, 287, fig. 4.7, 10; for Torre Mordillo see Trucco – Vagnetti 2001, 64, fig. 28.5–7; 67, fig. 34.8; for Broglio di Trebisacce see Giardino 1994, 219, fig. 68; for CoppaNevigata see Belardelli 2004, 36, fig. 7.11–12; Cazzella– Recchia 2012a, 80, fig. 11.4; 90, fig. 22.12, 17, 19–20.

44 This feature can be found on types 99B, 101 and 103B; see Capriglione, this volume, fig. 6.2.

45 Roca Vecchia, SAS IX, phase V, SU 11289, which is a very late RBA 2 context (Pagliara et al. 2008, 254, fig. 11.9). This amphora, differently to the amphorae of the southern Tyrrhenian, presents two horizontal grooves with a series of small circular impressions on top.

46 An example from Torre Mordillo, Area F, comes from a surface collection (Arancio et al. 2001, 148, fig. 81.5).

47 Casinalbo (Modena), tomb 40: RBA 1 (Cardarelli – Pellacani 2004, 117, fig. 4.8).

48 Coppa Nevigata, excavations 1972–1975, from layers of the 'early Subapennine' phase (Cazzella – Recchia 2012a, 77, fig. 7.6).

49 See Capriglione, this volume, for further information about the typological classification of the *impasto* pottery of Punta di Zambrone.

50 Jung in: Jung et al. 2015a, 68–79; 95–99.

51 Jung in: Jung et al. 2015a, 69–70, fig. 13.4; 95–96, cat. no. 4; Jung – Pacciarelli, this volume, fig. 24.3–4.

52 Blegen – Rawson 1966, 110, 189–190, 308, 398, figs. 385.594, 1172, 1176; 386.594; Mountjoy 1999, 352, cat. nos. 116 and 117, fig. 110.117.

53 Jung et al. 2015b, 458, tab. 1: sample nos. Zamb 1, 39 and 40.

although one cannot exclude that some chronologically less sensitive LH IIIC Early vessels from the ashy levels may have been produced in the second subphase LH IIIC Early 2. The only Italian products in the wheelmade pottery assemblage of Punta di Zambrone are four fragmentary vessels from the southern plain of Sybaris.[54] Two of these are deep bowls FT 284/285A with broad bands on both the inside and the outside of the lower body. This is a deep bowl decoration that in Greece became common during the first subphase of LH IIIC Early. At Broglio di Trebisacce and at Torre Mordillo (the latter in the region of origin of the vessels imported to Punta di Zambrone) deep bowls with the same type of decoration are stratified in RBA 2 contexts just as at Punta di Zambrone.[55] However, the fact that the relevant contexts in the Sybaris plain also contained Aegean-type vessels of LH IIIC Advanced date (some of which are Greek imports)[56] suggests that the production of deep bowls with the mentioned banded decoration lasted longer in the Sybaritis than in southern Greece. The Aegean–Italian synchronisms established in northern Calabria also suggest that the latest habitation phase of Punta di Zambrone represents an earlier stage of RBA 2 than the central Hut of Broglio di Trebisacce or the rampart of Torre Mordillo.

Among the stratified settlement deposits of southern Italy, it is the earliest RBA habitation phase of Roca Vecchia (in Area SAS IX, phase I) which provides the Aegean-type pottery assemblage that is best comparable with the one from the RBA 2 layers of Punta di Zambrone. Just as at Punta di Zambrone, some of the Mycenaean pots are late Palatial products, while the typologically most recent ones were produced in LH IIIC Early 1.[57] The *impasto* pottery of that settlement phase at Roca Vecchia (Area IX, phase I, and Area X, phase II) can be dated to a period between RBA 1 and RBA 2, given the presence of ceramic types attributable to both phases of the period. Some types that are rather characteristic for RBA 2 appear in that settlement phase and find several interesting parallels among the material coming from the ashy layers of the fortification ditch of Punta di Zambrone. In the earliest RBA settlement phase of Roca Vecchia we note a remarkable presence of a great number of open shapes (cups and bowls) and of handle projections with very close parallels in the Subapennine *impasto* pottery of Punta di Zambrone. For instance, a cup from Area IX, phase I, is directly comparable to the Punta di Zambrone variety 24C,[58] while the handle with two knobs from the same settlement phase[59] relates to the variety 79B. Both types date to the phase RBA 2. The same situation is observable for pottery finds from the earliest RBA settlement phase in the second excavation area of Roca Vecchia (Area X, phase II). Here, three cups[60] conform to the Punta di Zambrone varieties 34A, 45 (RBA 2) and 29B.[61] The bowls from the same settlement phase[62] are equally rather characteristic of the southern Tyrrhenian. One corresponds to the Punta di Zambrone variety 11B (RBA 2), while the other shows several similarities to variant b of the variety 10B (RBA 1–2). Handles from this phase can be related to the Punta di Zambrone variety 61C (RBA 1–2).[63] Regarding the closed shapes, there are also some interesting parallels between Roca Vecchia on the Adriatic coast and Punta di Zambrone on the Tyrrhenian coast. Two jars from Area X, phase II, can be compared to the Punta di Zambrone varieties 112A and 110.[64] Those types, frequent in the southern Tyrrhenian, are quite late ones. They have long production periods starting in the RBA 2 and continuing into the beginning of the FBA.

54 Jung et al. 2015b, 458, tab. 1: sample nos. Zamb 18, 20, 31 and 42.
55 Jung in: Jung et al. 2015a, 70–72, fig. 13.7; 96, ca. no. 7.
56 Jung 2006, 125–126, 132–134.
57 Guglielmino in: Pagliara et al. 2008, 262–264, fig. 15.A; 266; Guglielmino 2009, 189–193, fig. 2 and 3.1, 2.
58 Pagliara et al. 2008, 256–257, fig. 13C.28.
59 Pagliara et al. 2008, 256–257, fig. 13C.26.
60 Pagliara et al. 2007, 330, fig. 9.II.1–2, II.10.
61 The latter variety of type 29 is not very well attested outside the southern Tyrrhenian. By contrast, the variety 29A is more widespread and dates back to RBA 1.
62 Pagliara et al. 2007, 330, fig. 9.II.11–12.
63 Cf. Pagliara et al. 2007, 330, fig. 9.II.4.
64 Cf. Pagliara et al. 2007, 330, fig. 9.II.9, II.15.

In conclusion, the most plausible Aegean synchronism for the RBA 2 habitation phase of Punta di Zambrone is the phase LH IIIC Early 1. According to the historical-archaeological chronology based on Aegean, Levantine and Egyptian synchronisms, the production of the LH IIIC Early pottery styles should have started shortly before 1200 BCE, which is also in agreement with radiocarbon dates from tell stratigraphies in northern Greece.[65] Therefore, the end date of the Punta di Zambrone ^{14}C sequence with its highest modelled probability at 1200 ± 15 calBC that we established in the present paper is in full agreement with the historical-archaeological chronology of the late Palatial to early Post-palatial Aegean pottery phases, as well as the radiocarbon dates of those same pottery phases.

While the relative chronology of the ashy fill levels overlying the debris of the fortification wall does not pose any problems, the local *impasto* pottery finds from the debris itself unfortunately do not permit a precise chronological assignment. None of the aforementioned type fossils of RBA 2 is present among the *impasto* pottery from the lowermost levels of the fortification debris (PZ97, 107, 108 in Area B and PZ215 in Area C)[66].

By contrast, the upper level of fortification debris, attested in Area C (PZ75), does contain several types of RBA date, some of which belong to the phase RBA 2. Some sherds cannot be attributed to a precise phase of the RBA, either because they represent types with a prolonged production period (e.g. the aforementioned type 61C of handles with diverging coils; type 12 of deep bowls with non-articulated profile; the carinated cup type 40A with a convex profile above the carination; type 67B of vertical handles ending in snail horns; type 106A-B of cylindrical jars with or without plain or finger-impressed cordons and/or with tongue-shaped lugs or handles) or because they constitute a quite rare feature outside the immediate geographical area of Punta di Zambrone (e.g. type 101 of amphorae with a horizontal groove at the base of the neck, see above). It is therefore difficult to assign those fragments more precisely to either RBA 1 or 2. Yet, the stratigraphical unit PZ75 also contained some sherds, which can undoubtedly be attributed to RBA 2. Here we are referring to type 11B (very deep bowls with slightly thickened rims), type 24C (small to medium carinated cups with a short concave profile above the carination), and type 62 (handle with diverging coils, characterised by two protuberances flanking the handle hole.)[67] The last sherd, type 62, has been identified as a local feature of the Subapennine *facies* (see above).

In addition, we must point out that some types coming from the upper level of the debris, such as an axe-shaped handle projection (type 47A) are more characteristic for the preceding phase RBA 1,[68] while even some residual material of MBA 3 date is present in those debris levels[69]. However, a join between two fragments of a strap handle belonging to a pithos (Fig. 4),[70] from the stratigraphical units PZ75 (debris) and PZ151 (ashy layer), might suggest a simultaneous formation of the material making up the two units (prior to their stratification inside the ditch). Yet, we would need more evidence to verify such an inference. In addition, we also have to note that in the fortification debris no Mycenaean pottery was found that could offer additional chronological evidence.

---

65 Jung et al. 2009; Weninger – Jung 2009. – The new raised chronology of the 19th and 20th dynasties places Ramesses III's reign between 1195 and 1164 BCE (Schneider 2010, 402). This would result in a slightly raised date for the start of LH IIIC Early at c. 1220/10 BCE, which is now in better agreement with the terminus ante quem for LH IIIC Early 2 around 1180 calBC established by means of the ^{14}C sequences of Kastanás and Thessaloníki Toumba (Jung et al. 2009, 196; Weninger – Jung 2009, 393).

66 The *impasto* pottery from these levels is not very abundant, the only significant sherds being a bowl from PZ215 in Area C (type 8C) and a jar from PZ107 (type 107C). Both types can be attributed in general terms to the RBA, without any further specification. We must notice, however, that type 107 is a very long duration type during the RBA.

67 See n. 34.

68 The ^{14}C dates between 1300 and 1250 calBC probably correspond to this chronological stage.

69 A very small rim fragment coming from PZ75 exhibits a typical Apennine decoration with incised lines, forming a herringbone or a zig-zag pattern.

70 PZ75FFGG8–9/10 + PZ151DD11/49. The strap handle of the pithos in itself is difficult to date to either RBA 1 or RBA 2.



Fig. 4 Pithos handle PZ75FFGG8–9/10 + PZ151DD11/49, joined from fragments found in the fortification debris and in the ashy layer (photo: R. Jung)

In Area B the *impasto* pottery coming from the stratigraphic unit PZ33 beneath the final fill layer of the ditch PZ6 is unfortunately very scarce and fragmentary and generally not well preserved. Consequently, it is impossible to obtain from that material any typological and/or chronological information.

The date of the lowermost fill level of the fortification ditch in Area C is of considerable interest, for it is both the earliest date in our radiocarbon sequence, and the charcoal was probably deposited at the very beginning of the fortification use period (see above). Unfortunately, the relevant stratigraphical unit (PZ217) contained only very small and worn sherds that do not have any chronological significance. Fortunately, however, in Area B the analogous fill level that was overlying the bottom of the rock-cut ditch (PZ109) yielded one *impasto* fragment that appears to be typologically and chronologically significant. We may ascribe it – although with uncertainty due to the poor preservation of the sherd – to a high foot typical for the Thapsos-Milazzese *facies* of the Middle Bronze Age 3 phase in the southern Tyrrhenian.[71] This tentative date for the fragment from the lowermost fill layer of the ditch and the modelled starting date of the Punta di Zambrone radiocarbon sequence somewhere during the 14th century calBC (based on the date MAMS-19922 from PZ217) might suggest a building date for the fortification of Punta di Zambrone in MBA 3.[72]

[71] The amount of material from the filling of the ditch dating back to Middle Bronze Age 3 (Apennine or Thapsos-Milazzese *facies*) is very low. Therefore, it is hazardous to link those scarce fragments to the presence at Punta di Zambrone of a stable settlement in this period. Nevertheless, their presence remains a very important fact. It is possible, in fact, that the new Subapennine *facies* arrived at the southern Tyrrhenian coast of Calabria in a very early stage, in which older materials/decorative patterns still survived. However, at present we have no explanation for the fact that we found at Punta di Zambrone a quantity of Apennine fragments that is much larger than the Thapsos-Milazzese ones, while one would expect quite the opposite situation (see Capriglione, this volume).

[72] In the southern Tyrrhenian MBA 3 is basically connected to the Aegean phase LH IIIA1 by much Mycenaean pottery from Punta Milazzese, Portella and Lipari or to an early stage of LH IIIA Late at the latest (judging by a few stylistically advanced vessels from the acropolis of Lipari; see Jung 2006, 70–76, 83–88, pl. 20.2–3). However, the Mycenaean imports from Thapsos and other sites in southeastern Sicily offer synchronisms of the Thapsos aspect of the Thapsos-Milazzese *facies* with LH IIIA Late (Jung 2006, 174–175). For a discussion of the ^{14}C dates for the MBA 3 huts of Portella (cf. n. 6) and a comparison with historical-archaeological dating ranges for LH IIIA1 see Jung 2017, 633–634. Note, however, that we have no ^{14}C dates for huts F and F' (or F1) yielding the only Aegean imports at Portella.

However, among the few datable sherds from the lower collapse layer in Area B (PZ107) there is at least one fragment of seemingly RBA date, which would hint at a construction date during the RBA (type 107C).[73] Furthermore, the upper collapse in Area C (PZ75) did contain numerous RBA types (see above). Even when ascribing all the advanced RBA types from that upper collapse layer to some later repair of the wall or rampart, most of the indications provided by the *impasto* pottery point to a RBA rather than a MBA 3 construction date. This should also imply a RBA date for the cutting of the ditch, especially when considering that the granite bedrock of the ditch is the same material as that used in the wall or rampart.

Acknowledgements: The ^{14}C studies reported in this contribution were carried out within the framework of the research programme P23619-G19 ('Punta di Zambrone – a Bronze Age Fortified Settlement on the Tyrrhenian Coast of Calabria') of the Austrian Science Fund (FWF). R. Jung and M. Pacciarelli conducted the excavations at Punta di Zambrone as an international research cooperation with funding by the mentioned FWF project for the Austrian side (University of Salzburg in 2011 and 2012; OREA in 2013, project no. P23619-G19) and a PRIN (*Progetti di Ricerca di Rilevante Interesse Nazionale*) project (no. 2009MF87BM) of the Italian Ministry of Education, Universities and Research, run by the University of Naples Federico II.

Bibliography

Alessio et al. 1980
M. Alessio – F. Bella – C. Cortesi – B. Turi, Datazione con il carbonio-14 di alcuni orizzonti degli insediamenti preistorici dell'Acropoli e di Contrada Diana, in: L. Bernabò Brea – M. Cavalier, L'acropoli di Lipari nella preistoria, Meligunìs Lipára IV (Palermo 1980) 837–844.

Arancio et al. 2001
M. L. Arancio – V. Buffa – I. Damiani – F. Trucco, Catalogo delle unità stratigrafiche e dei reperti, in: Trucco – Vagnetti 2001, 61–153.

Belardelli 2004
C. Belardelli, Coppa Nevigata. Materiali da scavi e rinvenimento 1903–1909 (Florence 2004).

Benz et al. 2012
M. Benz – A.Coşkun – I. Hajdas – K. Deckers – S. Riehl – K. Alt – B. Weninger –V. Özkaya, Methodological implications of new radiocarbon dates from the Early Holocene site of Körtip Tepe, southeast Anatolia, Radiocarbon 54, 2012, 291–304.

Bernabò Brea – Cavalier 1980
L. Bernabò Brea – M. Cavalier, L'acropoli di Lipari nella preistoria, Melingunìs Lipàra IV (Palermo 1980).

Blegen – Rawson 1966
C. W. Blegen – M. Rawson, The Palace of Nestor at Pylos in Western Messenia I. The Buildings and their Contents (Cincinnati 1966).

Bueno et al. 2013
L. Bueno – A. Schmidt Dias – J. Steele, The Late Pleistocene/Early Holocene archaeological record in Brazil. A geo-referenced database, Quaternary International 301, 2013, 74–93. doi:10.1016/j.quaint.2013.03.042

Calderoni – Martinelli 2005
G. Calderoni – M. C. Martinelli, Cronologia radiocarbonio, in: M. C. Martinelli (ed.), Il Villaggio dell'età del Bronzo medio di Portella a Salina nelle Isole Eolie (Florence 2005) 287–297.

Calderoni et al. 2012
G. Calderoni – A. Cazzella – M. Preite Martinez, Il contributo della cronologia radiocarbonio alla definizione delle fasi dell'età del Bronzo di Coppa Nevigata. Risultati raggiunti e problemi ancora aperti, in: Cazzella et al. 2012, 457–464.

[73] See n. 66.

Cardarelli – Pellacani 2004
A. Cardarelli – G. Pellacani, La necropoli di Casinalbo (Formigine, Modena), in: Cocchi Genick 2004, 111–120.

Cazzella – Recchia 2012a
A. Cazzella – G. Recchia, La ceramica d'impasto dagli scavi in estensione 1972–1975. Analisi tipologica e confronto con i dati degli scavi 1955–1971, in: Cazzella et al. 2012, 47–147.

Cazzella – Recchia 2012b
A. Cazzella – G. Recchia, Un trentennio di nuove ricerche a Coppa Nevigata. L'organizzazione dell'abitato e i sistemi di difesa durante le varie fasi dell'età del Bronzo, in: Cazzella et al. 2012, 247–318.

Cazzella et al. 2005
A. Cazzella – A. De Dominici – G. Recchia – C. Ruggini, Il sito dell'età del Bronzo recente di Monteroduni-Paradiso (Isernia), Rivista di Scienze Preistoriche 55, 2005, 385–438.

Cazzella et al. 2006
A. Cazzella – V. Copat – M. Danesi, I livelli subappenninici del sito della Rocca di Oratino (CB). Nuovi dati dalla valle del Biferno, in: A. Gravina (ed.), Atti del 26° Convegno Nazionale sulla Preistoria, Protostoria e Storia della Daunia (San Severo 2006) 137–170.

Cazzella et al. 2007a
A. Cazzella – V. Copat – M. Danesi, Il sito dell'età del Bronzo Recente di Oratino – La Rocca (Campobasso). Nuovi dati dalla valle del Biferno, Rivista di Scienze Preistoriche 57, 2007, 277– 310.

Cazzella et al. 2007b
A. Cazzella – A. De Dominici – G. Recchia – C. Cristiana, Elementi di ispirazione egea dai livelli della tarda età del Bronzo del sito di Monteroduni – loc. Paradiso (IS), Conoscenze 1/2005, 2007, 35–44.

Cazzella et al. 2012
A. Cazzella – M. Moscoloni – G. Recchia (eds.), Coppa Nevigata e l'area umida alla foce del Candelaro durante l'età del Bronzo (Foggia 2012).

Cocchi Genick 2004
D. Cocchi Genick (ed.), L'età del bronzo recente in Italia, Atti del Congresso Nazionale di Lido di Camaiore, 26–29 ottobre 2000 (Viareggio 2004).

Culleton 2008
B. J. Culleton, Crude demographic proxy reveals nothing about Paleoindian population, Proceedings of the National Academy of Sciences of the United States of America 105, 50, 2008, E111. doi: 10.1073/pnas.0809092106

Damiani 2010
I. Damiani, L'età del bronzo recente nell'Italia centro-meridionale, Grandi contesti e problemi della protostoria italiana 12 (Borgo San Lorenzo 2010).

French – Collins 2015
J. C. French – C. Collins, Upper Palaeolithic population histories of southwestern France. A comparison of the demographic signatures of ^{14}C date distributions and archaeological site counts, Journal of Archaeological Science 55, 2015, 122–134.

Giardino 1994
C. Giardino, I materiali dell'età del bronzo recente, in: Peroni – Trucco 1994, 185–264.

Goldberg et al. 2016
A. Goldberg – A. M. Mychajliw – E. A. Hadly, Post-invasion demography of prehistoric humans in South America, Nature 532, 2016, 232–235.

Guglielmino 2009
R. Guglielmino, Le relazioni tra l'Adriatico e l'Egeo nel Bronzo recente e finale. La testimonianza di Roca, in: E. Borgna – P. Càssola Guida (eds.), Dall'Egeo all'Adriatico. Organizzazioni sociali, modi di scambio e interazione in età postpalaziale (XII–XI sec. a. C.) / From the Aegean to the Adriatic. Social Organizations, Modes of Exchange and Interaction in Postpalatial Times (12th–11th c. BC), Atti del Seminario internazionale (Udine, 1–2 dicembre 2006), Studi e ricerche di protostoria mediterranea 8 (Rome 2009) 185–204.

Hänsel et al. 2010
B. Hänsel – B. Horejs – R. Jung – B. Weninger, Die absolute Chronologie der Schichten des Prähistorischen Olynth, in: B. Hänsel – I. Aslanis, Das Prähistorische Olynth. Ausgrabungen in der Toumba Agios Mamas 1994–1996. Die Grabung und der Baubefund, Prähistorische Archäologie in Südosteuropa 23 (Rahden/Westf. 2010) 301–381.

Horejs et al. 2015
B. Horejs – B. Milic – F. Ostmann – U. Thanheiser – B. Weninger – A. Galik, The Aegean in the early 7th millenium BC: Maritime networks and colonization, Journal of World Prehistory 28, 4, 2015, 289-330. doi:10.1007/s10963-015-9090-8.

Ialongo 2007
N. Ialongo, Il Fucino nella Protostoria, Grandi contesti e problemi della protostoria italiana 10 (Florence 2007).

Jung 2006
R. Jung, Χρονολογία comparata. Vergleichende Chronologie von Südgriechenland und Süditalien von ca. 1700/1600 bis 1000 v. u. Z., Veröffentlichungen der Mykenischen Kommission 26 (Vienna 2006).

Jung 2017
R. Jung, Chronological problems of the Middle Bronze Age in southern Italy, in: Th. Lachenal – C. Mordant – Th. Nicolas – C. Véber (eds.), Le Bronze moyen et l'origine du Bronze final en Europe occidentale (XVIIe–XIIIe siècle av. J.-C.). Colloque international de l'APRAB, Strasbourg, 17 au 20 juin 2014, Mémoires d'Archéologie du Grand-Est 1 (Strasbourg 2017) 621–642.

Jung et al. 2009
R. Jung – St. Andreou – B. Weninger, Synchronisation of Kastanás and Thessaloníki Toumba at the end of the Bronze and the beginning of the Iron Age, in: S. Deger-Jalkotzy – A. Bächle (eds.), LH IIIC Chronology and Synchronisms III. LH IIIC Late and the Transition to the Early Iron Age. Proceedings of the International Workshop at the Austrian Academy of Sciences at Vienna, February 23rd and 24th, 2007, Veröffentlichungen der Mykenischen Kommission 30 (Vienna 2009) 183–202.

Jung et al. 2015a
R. Jung – M. Pacciarelli – B. Zach – M. Klee – U. Thanheiser, Punta di Zambrone (Calabria) – a Bronze Age harbour site. First preliminary report on the Recent Bronze Age (2011–2012 campaigns), Archaeologia Austriaca 99, 2015, 53–110.

Jung et al. 2015b
R. Jung – H. Mommsen – M. Pacciarelli, From west to west. Determining production regions of Mycenaean pottery of Punta di Zambrone (Calabria, Italy), Journal of Archaeological Science Reports 3, 2015, 455–463.

Lawn 1970
B. Lawn, University of Pennsylvania Radiocarbon Dates XIII, Radiocarbon 12, 1970, 577–589.

Lollini 1979
D. Lollini, Il Bronzo Finale nelle Marche, Rivista di Scienze Preistoriche 34, 1979, 179–215.

Manning et al. 2010
S. W. Manning – B. Kromer – C. Bronk Ramsey – C. L. Pearson – S. Talamo – N. Trano – J. D. Watkins, ^{14}C Record and Wiggle Matching Placement for the Anatolian (Gordion Area) Juniper Tree-Ring Chronology ~1729 to 751 cal BC, and typical Aegean/Anatolian (Growing Season Related) Regional ^{14}C Offset Assessment,Radiocarbon 52, 2010, 1571–1597.

Maran 2000
J. Maran, Das Megaron im Megaron. Zur Datierung und Funktion des Antenbaus im mykenischen Palast von Tiryns, Archäologischer Anzeiger 2000, 1–16.

Martinelli – Fiorentino 2010
M. C. Martinelli – G. Fiorentino, Le datazioni al radiocarbonio, in: M. C. Martinelli, Archeologia delle Isole Eolie. Il villaggio dell'età del Bronzo Medio di Portella a Salina. Ricerche 2006 e 2008 (Muggiò 2010) 243–250.

Moscoloni et al. 2007
M. Moscoloni – M. Danesi – V. Galluzzi, L'insediamento subappenninico di Conelle di Arcevia (Ancona), Origini 29, 2007, 75–118.

Mountjoy 1999
P. A. Mountjoy, Regional Mycenaean Decorated Pottery (Rahden/Westf. 1999).

Pacciarelli 2015
M. Pacciarelli, The local impasto pottery of the Recent Bronze Age, contribution in: Jung et al. 2015a, 61–68.

Pagliara et al. 2007
C. Pagliara – G. Maggiulli – T. Scarano – C. Pino – R. Guglielmino – J. De Grossi Mazzorin – M. Rugge – G. Fiorentino – M. Primavera – L. Calcagnile – M. D'Elia – G. Quarta, La sequenza cronostratigrafica delle fasi di occupazione dell'insediamento protostorico di Roca (Melendugno, Lecce). Relazione preliminare della campagna di scavo 2005 – Saggio SAS X, Rivista di Scienze Preistoriche 57, 2007, 311–362.

Pagliara et al. 2008
C. Pagliara – R. Guglielmino – L. Coluccia – I. Malorgio – M. Merico – D. Palmisano – M. Rugge – F. Minonne, Roca Vecchia (Melendugno, Lecce), SAS IX. Relazione stratigrafica preliminare sui livelli di occupazione protostorici (campagne di scavo 2005–2006), Rivista di Scienze Preistoriche, 58, 2008, 239–280.

Pearson 1986
G. W. Pearson, Precise calendrical dating of known growth-period samples using a 'curve fitting' technique, Radiocarbon 31, 1986, 824–832.

Pearson 1983
G. W. Pearson, The Development of High Precision Carbon-14 Measurement and its Application to Archaeological Time-Scale Problems (PhD Diss., Queens's University of Belfast, Ireland, Belfast 1983) [Source: Dissertation Abstracts International, Volume: 50-01, Section: B, page: 0231].

Peroni – Trucco 1994
R. Peroni – F. Trucco (eds.), Enotri e Micenei nella Sibaritide I. Broglio di Trebisacce (Taranto 1994).

Ralph – Stuckenrath 1962
E. K. Ralph – R. Stuckenrath, University of Pennsylvania radiocarbon dates V, Radiocarbon 4, 1962, 144–159.

Reimer et al. 2013
P. J. Reimer – E. Bard – A. Bayliss – J. W. Beck – P. G. Blackwell – C. Bronk Ramsey – C. E. Buck – H. Cheng – R. L. Edwards – M. Friedrich – P. M.Grootes – T. P.Guilderson – H. Haflidason – I. Hajdas – C. Hatté – T. J. Heaton – D. L. Hoffmann – A. G. Hogg – K. A. Hughen – K. F. Kaiser – B. Kromer – S. W. Manning – M. Niu – R. W.Reimer – D. A. Richards – E. M. Scott – J. R. Southon – R. A. Staff – C. S. M. Turney – J. van der Plicht, INTCAL13 and Marine INTCAL13 radiocarbon age calibration curves 0-50,000 years cal BP, Radiocarbon 55, 2013, 1869–1887.

Schneider 2010
Th. Schneider, Contributions to the chronology of the New Kingdom and the Third Intermediate Period, Ägypten und Levante 20, 2010, 373–403.

Steele 2010
J. Steele, Radiocarbon dates as data. Quantitative strategies for estimating colonization front speeds and event densities, Journal of Archaeological Science 37, 2010, 2017–2030.

Toffolo et al. 2013
M. B. Toffolo – A. Fantalkin – I. S. Lemos – R. C. S. Felsch – W.-D. Niemeier – G. R. Sanders – I. Finkelstein – E. Boaretto, Towards an absolute chronology for the Aegean Iron Age. New radiocarbon dates from Lefkandi, Kalapodi and Corinth, PLoS ONE 8, 12, 2013, e83117. doi:101371/journal.pone.0083117

Trucco – Vagnetti 2001
F. Trucco – L. Vagnetti, Torre Mordillo, 1987–1990. Le relazioni egee di una comunità protostorica della Sibaritide (Rome 2001).

Wardle et al. 2014
K. Wardle – Th. Higham – B. Kromer, Dating the end of the Greek Bronze Age. A robust radiocarbon-based chronology from Assiros Toumba, PLoS ONE 9, 9, 2014, e106672. doi:10.1371/journal.pone.0106672

Warren – Hankey 1989
P. Warren – V. Hankey, Aegean Bronze Age Chronology (Bristol 1989).

Weninger 1986
B. Weninger, High-precision calibration of archaeological radiocarbon dates, Acta Interdisciplinaria Archaeologica IV (Nitra 1986) 11–53.

Weninger – Jung 2009
B. Weninger – R. Jung, Absolute chronology of the end of the Aegean Bronze Age, in: S. Deger-Jalkotzy – A. Bächle (eds.), LH IIIC Chronology and Synchronisms III. LH IIIC Late and the Transition to the Early Iron Age. Proceedings of the International Workshop at the Austrian Academy of Sciences at Vienna, February 23rd and 24th, 2007, Veröffentlichungen der Mykenischen Kommission 30 (Vienna 2009) 373–416.

Weninger et al. 2011
B. Weninger – K. Edinborough – L. Clare – O. Jöris, Concepts of probability in radiocarbon analysis, Documenta Praehistorica 38, 2011, 1–20.

Weninger et al. 2015
B. Weninger – L. Clare – O. Jöris – R. Jung – K. Edinborough, Quantum theory of radiocarbon calibration, World Archaeology 47, 2015, 543–566.

Wild et al. 2010
E. M. Wild – W. Gauss – G. Forstenpointner – M. Lindblom – R. Smetana – P. Steier – U. Thanheiser – F. Weninger, ^{14}C dating of the Early to Late Bronze Age stratigraphic sequence of Aegina Kolonna, Greece, in: Nuclear Instruments and Methods in Physics Research, Section B 268 (Beam Interactions with Materials and Atoms. Proceedings of the Eleventh International Conference on Accelerator Mass Spectrometry, Rome, Italy, September 14–19, 2008), 2010, 1013–1021.

Archaeobotanical Investigations at Punta di Zambrone (Calabria, Italy)

Marlies Klee[1] – *Barbara Zach*[2] – *Ursula Thanheiser*[3]

Abstract: The Bronze Age site of Punta di Zambrone, located on the Tyrrhenian coast of Calabria, southern Italy, was excavated between 2011 and 2013, accompanied by archaeobotanical investigations. Although sediments from the Early Bronze Age and the Recent Bronze Age were uncovered, none of the sediments belong to the Middle Bronze Age. It was possible to investigate more than 200 samples for charred plant remains. They shed light on the crop assemblages, gathered wild plants and plant species from the surroundings in both phases and the significant difference between them. During the Bronze Age emmer is the main crop. The change from the Early to the Recent Bronze Age layers is observable in a strongly increasing proportion of broomcorn millet. The archaeologically established Aegean contacts in the Recent Bronze Age confirmed by ceramics and artefacts is not visible in the characteristic spectrum of useful plants with mainly emmer and pulses, dominated by field bean.

Keywords: Bronze Age, Calabria, subsistence strategies, charred plant remains, cultivated and gathered plants, cereals, pulses, Aegean contacts

Introduction

Bronze Age Punta di Zambrone in southern Italy is one of the Bronze Age sites along the coast of the Apennine peninsula, Sicily and the Aeolian Islands. The indigenous settlement was founded during the Early Bronze Age (EBA 1, 2100–2000 BC) as part of a regional settlement system.[4] Previous research has revealed a cultural break characterising 'the transition from the Middle Bronze Age (MBA) to the Recent Bronze Age (RBA) on the Aeolian Islands and on the opposing coast of Calabria. In MBA 3 many sites were destroyed and subsequently abandoned, on the Aeolian Islands and in southern Calabria as well'. For the Recent Bronze Age phase of Punta di Zambrone, imported Aegean-type artefacts raise questions regarding the nature of the relations between the settlement of Punta di Zambrone and specific regions in the Aegean. The indigenous character of the RBA settlement is proved by artefacts typical for the Subapennine *facies*.[5] The plant remains provide evidence of Bronze Age life and its abrupt end in around 1200 BC.

Systematic research excavations of Bronze Age settlements on the promontory of Tropea in Calabria are still quite rare. Many surveys in the area have been conducted by Pacciarelli.[6] The excavation of the Bronze Age site of Punta di Zambrone should fill this gap and contribute to the archaeological and archaeobotanical research of the Bronze Age in southern Italy. Our study aims to uncover the development of the site from an economical point of view during the Bronze Age, with regard to the changes in the presence of plants in the settlement from the Early to the Recent Bronze Age. We want to know how Punta di Zambrone fits into the pattern of contemporaneous

1 Labor für Archäobotanik, Innsbrucker Str. 3, 79111 Freiburg, Germany; Marlies.Klee@unibas.ch.
2 Archäobotanik Labor Zach, Weidachring 4, 86975 Bernbeuren, Germany; B.Zach@uni-hohenheim.de.
3 VIAS-Archaeobotany, Vienna University, Althanstraße 14, UZA II – Geozentrum, 1090 Vienna, Austria; ursula.thanheiser@univie.ac.at.
4 Jung – Pacciarelli, this volume. For the ^{14}C dates of the EBA 1 phase at Punta di Zambrone see Pacciarelli et al. 2015, 257, 278.
5 Jung et al. 2015, 56, 83.
6 Pacciarelli 2001.

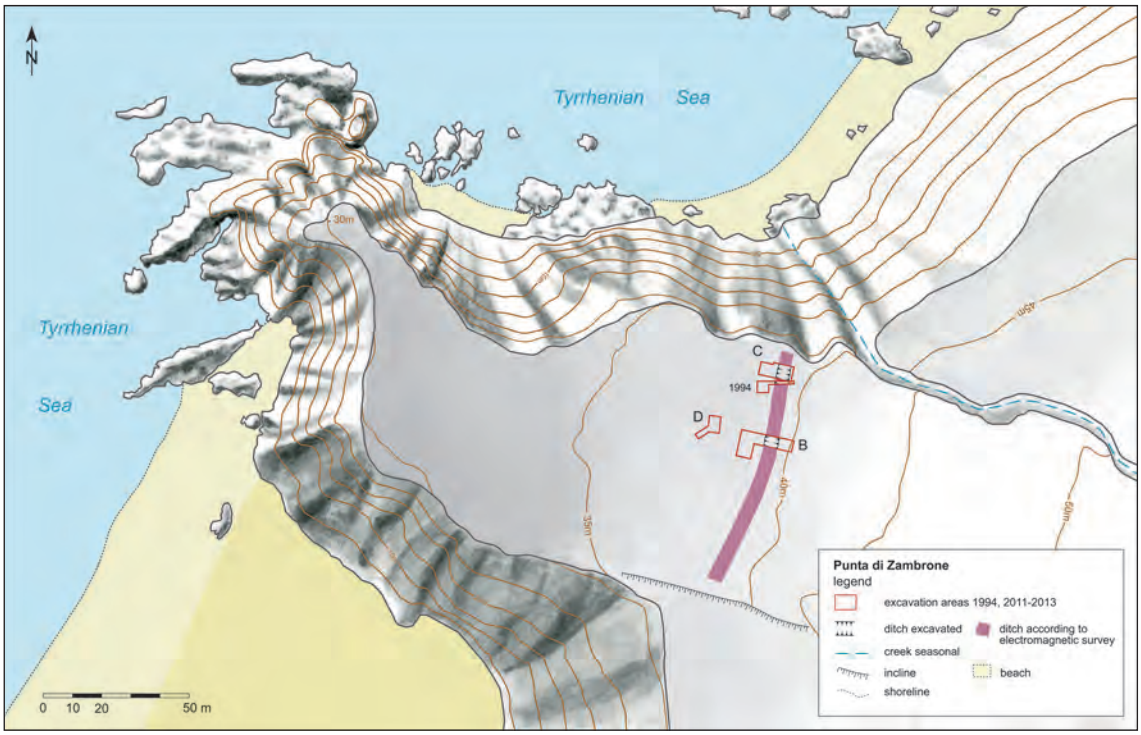


Fig. 1 Topographical map of Punta di Zambrone with excavation areas and course of the RBA ditch indicated (cartography: A. Buhlke)

sites. The question arises whether there is additional information on subsistence strategies as a reaction to cultural and climatic changes in the Middle Bronze Age. Did Aegean relations have an impact on agricultural production?

The Site of Punta di Zambrone

Punta di Zambrone is situated directly on the coast, on top of a steep precipice on a terrace 35m above sea level.[7] It belongs to the granite peninsula of Tropea on the Tyrrhenian Sea, near the Aeolian Islands, just opposite Stromboli. A Bronze Age harbour existed to the south of the rocky promontory.[8]

The place was first inhabited during the Early Bronze Age (phases EBA 1 and 2) and existed with a possible hiatus during the Middle Bronze Age lasting until the late 2nd millennium BC, i.e. until the Recent Bronze Age (RBA), when the site was fortified.[9] Local Recent Bronze Age pottery was found in context with Mycenaean- and Minoan-type pottery.[10] Around 1200 BC the settlement was abandoned.[11]

During the excavation three areas, B, C and D, were opened and investigated. In areas B and C a RBA fortification ditch was encountered. The ditch in Area C was partially filled with ashy layers of considerable thickness. In Area D a small surface was uncovered, on which the disturbed floor of a house was detected (Fig. 1).

7 Punta di Zambrone: Latitude 38.7°, longitude 15.9°.
8 See the contribution by Romano et al., this volume.
9 For the chronology and nomenclature of the Bronze Age phases see Jung – Pacciarelli, this volume.
10 Jung et al. 2015, 55, 57.
11 For the absolute chronology based on ^{14}C dates see Weninger et al., this volume.

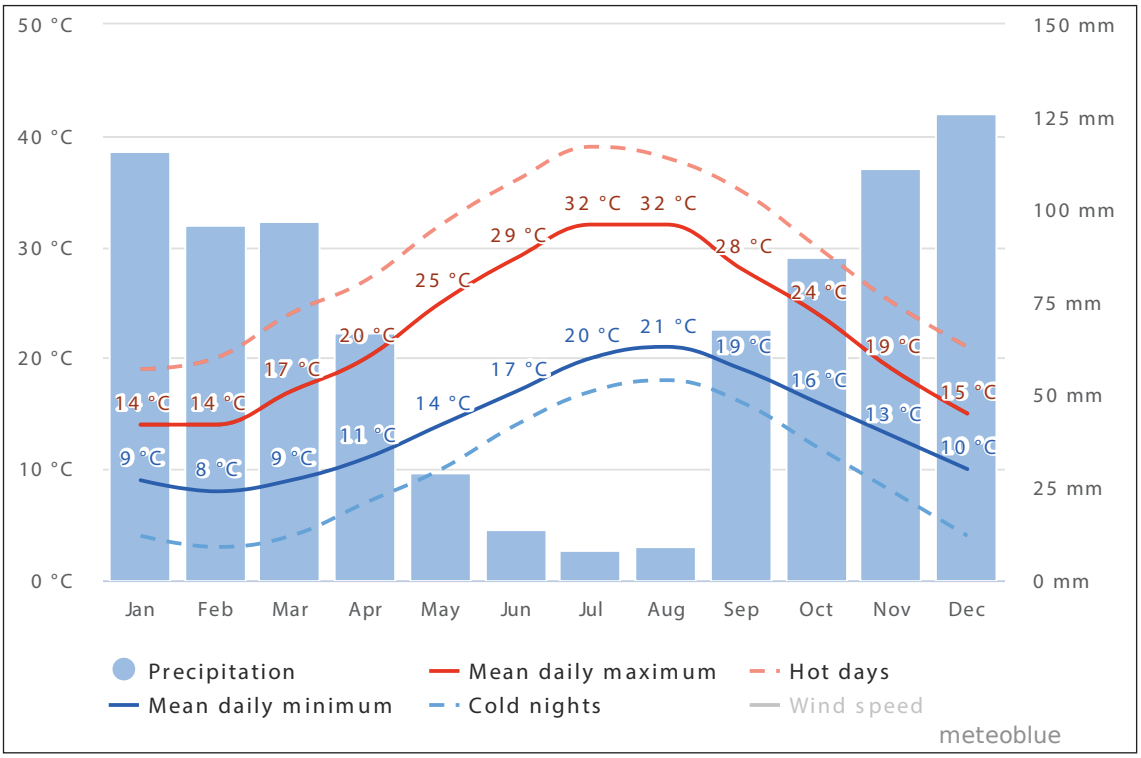


Fig. 2 Climate diagram of Tropaea, Calabria, average temperatures and precipitation (meteoblue <https://www.meteoblue.com/en/weather/historyclimate/climatemodelled/tropea_italy_2522847> [last accessed 21 March 2020])

Coastal Climate and Vegetation Today

The coastal climate today is typical of the Mediterranean with the driest summer months from June to August and with the highest temperatures from July to September (Fig. 2). Winter months are mild to cool and wet. The summer temperature reaches up to 40°C.

Today, beyond the cultivated land evergreen trees such as pines (*Pinus*) and oaks (*Quercus*) dominate the woody vegetation near the coast. Oaks are very common with a high number of taxa in the forests.[12] They are present with at least seven species in Calabria's costal area.[13] Shrubs of the macchia type as well as grassland species are typical. The grazing impact results in an open landscape with patches of grassland. Typical taxa are *Olea oleaster*, *Pistacia lentiscus*, *Pistacia terebinthus*, *Laurus nobilis*, *Arbutus unedo*, *Myrtus communis* and *Briza maxima* according to field guides as well as our own records, documented along several transects and surveys at the site and in the surrounding landscape.[14] A collection of the naturally growing seeds and fruits was set up to compare with the archaeobotanical records.

Material and Methods

During the excavations at Zambrone 207 samples for archaeobotanical investigations were systematically taken (Tab. 1).[15] All archaeologically important features, such as fire places etc. were sampled. In addition, from the ash layers in Area C a ten litre bucket of soil was extracted from

[12] Taxon describes nomenclature terms like plant species, genus, plant family etc.

[13] According to Pignatti 1982, Vol. 2, 113–120, in coastal areas there are seven *Quercus* species possible: *Q. ilex*, *Q. petraea*, *Q. virgliana*, *Q. pubescens*, *Q. aurea*, *Q. frainetto* and above 100m *Q. cerris*.

[14] Schönfelder – Schönfelder 2008, 318.

[15] Jones 1991, 53–62.

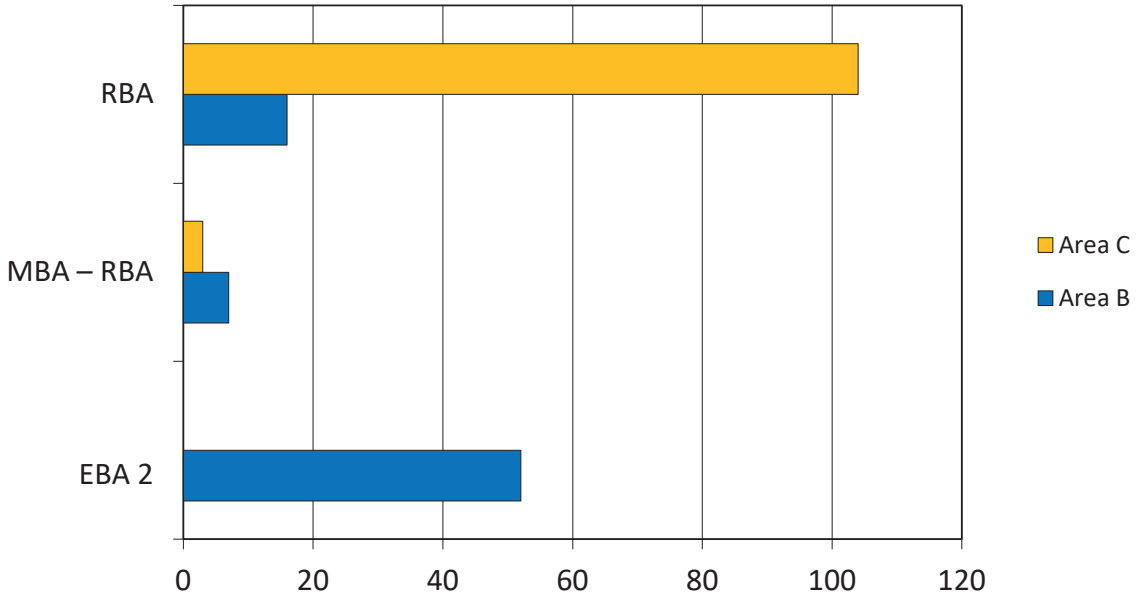


Fig. 3 Number of samples examined per Bronze Age phase of Punta di Zambrone (graphics: M. Klee)

every square metre by random sampling in different depths. In total, 1606 litres of sediment were processed near the site using both a flotation tank and the classical bucket or hand flotation method.[16] The light fraction was divided in three sieves with mesh sizes of 2.0mm, 0.5mm and 0.2mm and was then dried and taken for later identification.[17] Most of the heavy stony fractions were screened immediately at Zambrone under a microscope with magnification from 6 to 40 times. Processing the samples during the ongoing excavation led to methodological adaptations. It also brought to light small artefacts such as beads and other small objects relevant for archaeological interpretation, which could be discussed at once on the site. Also, small zoological remains such as fragments of animal bones and stings from sea urchins or the remains of limpets were registered (Tab. 2).

Number of samples processed	207
Volume of sediment in litre	1599
Number of samples contributing to results	182
Number of samples without plant remains	21
Number of samples contaminated by modern residues or from disturbed sediments, not analysed	27

Tab. 1 Basic data of samples processed at Zambrone

The results are recorded by the number of remains found in the archaeobotanical database ArboDat.[18] Measurements from useful plants were taken and illustrations are given as photographs and drawings. In total, 22 botanical samples (charcoal, charred seeds and carbonised organic matter), of which 17 consisted of charred seeds, selected for radiocarbon dating were submitted to the Mannheim lab.[19]

16 Jacomet – Kreuz 1999, 120–123.
17 Zach et al. 2015, 84, is to be corrected in this respect.
18 Kreuz – Schäfer 2002; Kreuz – Schäfer 2004; Kreuz – Schäfer 2016.
19 For a discussion of the results see Weninger et al., this volume.

Phase	EBA2	Phase	MBA – RBA	Phase	RBA	Total	
Number of Samples	52	Number of Samples	10	Number of Samples	120	Number of Samples	182
Area	B	Area	B / C	Area	B / C	Area	B / C
Number of Plant Remains	1168	Number of Plant Remains	640	Number of Plant Remains	27,986	Number of Plant Remains	29,794
Volume of Samples (litre)	437	Volume of Samples (litre)	72	Volume of Samples (litre)	950	Volume of Samples (litre)	1459
Concentration (items per litre)	3	Concentration (items per litre)	9	Concentration (items per litre)	29	Concentration (items per litre)	20
conglomerates	(x)	conglomerates	(x)	conglomerates	xxxx	conglomerates	xxxx
mica	xxxx	mica	xxxx	mica	(x)	mica	xxxx
bones (fragments)	x	bones (fragments)	xx	bones (fragments)	xxx	bones (fragments)	x
teeth	(x)	teeth	xx	teeth	x	teeth	x
imprints in clay	1	shell (fragments)	x	horn (fragments)	x	horn (fragments)	x
charcoal	xx	sea urchin (fragments)	x	shell (fragments)	x	shell (fragments)	x
obsidian	(x)	limpets	x	sea urchin (fragments)	x	sea urchin (fragments)	x
silex	(x)	fish bones	3	limpets	x	limpets	x
		imprints in clay	xx	fish bones	x	fish bones	x
		charcoal	xx	imprints in clay	10	imprints in clay	12
		silex	(x)	charcoal	xxxx	charcoal	x
				mineralised seeds and fruits	x	mineralised seeds and fruits	4
				mineralised wood	x	mineralised wood	x
				amber	1	amber	x
				bronze	2	bronze	1
				obsidian	1	obsidian	x
				beads	41	beads	41
				silex	3	silex	x

Tab. 2 Finds in the botanical samples from Bronze Age layers

Using the volume and counted remains per sample, the concentration (density) was computed to get an impression of the human activity compared with the neighbourhood or during the period. The number of taxa may give an impression of the diversity of useful plants or of the wild flora.

For various reasons, ubiquity may be helpful for interpretations. Ubiquity or presence analysis gives the number of sample occurrences of a taxon as a percentage of the samples. For this, the same level of preservation and enough samples etc. are important.[20]

Most of the samples came from Area B and from Area C. It was also possible to retrieve some from the use level of a house within Area D. Usually the structures can be related to more than one Bronze Age phase. Twice as many samples correlate to the RBA as to EBA 2 (Fig. 3).

The complete species list of all identified plant remains is given in Table 3. Plants are arranged by their relevancy for humans, then by ecological categories on the basis of shared requirements. These are crops and useful wild plants followed by wild plants in plant sociological groups (ecological groups) of the most probable habitat they might have derived from. The reconstruction of probable habitats is based on today's knowledge of the requirements of each plant species.[21]

Phase	EBA 2	MBA–RBA	RBA	
Number of Samples	52	10	120	
Sample Volume (litre)	437.0	71.5	950.1	
Number of Plant Remains	1168	640	27986	
Cereal Grains				
Hordeum vulgare L.	2	15	590	hulled barley
Hordeum vulgare L. lump			2	barley lump
Triticum aestivum L./durum Desf.	1		9	naked wheat
Triticum dicoccon Schrank	16	43	441	emmer wheat
Triticum monococcum L.	1	6	25	einkorn wheat
Triticum L.	10	62	755	wheat
Cerealia	74	68	1780	cereal
Panicum miliaceum L.	2*	4	919	broomcorn millet
cf. Panicum miliaceum L. lump			1	probably broomcorn millet lump
Cereal Chaff				
Hordeum vulgare L.			1	barely, rachis fragments
Tiriticum dicoccon Schrank	92	181	3342	emmer wheat, glumes, forks, rachis fragments
Triticum durum Desf.			6	naked wheat, rachis fragments
Triticum monococcum L.		5	37	einkorn wheat, glumes, forks, rachis fragments
Triticum L.	13	28	901	wheat, glumes, forks, rachis fragments
Pulses				
Lens culinaris Med.			6	lentil
Vicia faba L.	3		326	field bean, broad bean
Fabaceae cf. cultivated	26	4	847	probably cultivated pulse
Fruits and Nuts				
Corylus avellana L.			1	hazel
cf. Malus sylvestris Miller			2	probably crab apple
Myrtus communis L	2	1	34	myrtle

[20] Jones 1991, 58, 59; Jacomet – Kreuz 1999, 145.

[21] Pignatti 1982.

Phase	EBA 2	MBA–RBA	RBA	
Olea europaea L.	6		5	olive
Prunus spinosa L.			3	sloe
Quercus L.	5		86	oak
Rubus fruticosus L.		2	11	blackberry
Sambucus L.			6	elder
Vitis vinifera L.	2	28	391	grape vine
Segetals				
Bromus secalinus L.	35		1	rye-brome
Buglossoides arvensis (L.) Johnston			4	gromwell
Digitaria ischaemum (Schreb.) Muhl.			3	red millet
Echinochloa crus-galli (L.) P.B.			3	cockspur
Fallopia convolvulus L.			1	black bindweed
Galium tricornutum L.			1	rough corn bedstraw
Setaria viridis (L.) P.B.			1	foxtail
Sherardia arvensis L.			1	field madder
Silene gallica L.	2		42	common catchfly
Stellaria media (L.) Vill.			21	chickweed
Vaccaria hispanica (Mill.) Rauschert			2	cowherb
Vicia cf. angustfolia Grufb.	1		3	probably common vetch
Vicia cf. hirsuta (L.) S. F. Gray	1			probably hairy tare
Vicia L.		1	14	vetch (small seeded)
Meadows - Pastures				
Cynosurus cristatus L.		2	81	crested dog's-tail
Leucanthemum ircutianum Turcz.	1		3	ox-eye daisy
Lotus corniculatus L.	4		19	common bird's-foot trefoil
Potentilla reptans L.			1	creeping cinquefoil
Woodland - Hedges				
Atropa belladonna L.			2	deadly nightshade
Briza maxima L.			11	blowfly grass
Polygonum dumetorum L.			1	copse bindweed
cf. Rosmarinus officinalis L.			1	probably rosemary leaf
Ruderals				
Atriplex hastata L.			4	goosefoot family
Chenopdium album L.		1	25	fat hen
Chenopodium murale L.			1	nettle-leaved goosefoot
Hyoscyamus niger L.			6	henbane
Lathyrus sativus L./cicera L.			1	grass pea/wild grass pea
Medicago arabica (L.) Huds.	5		97	spotted medick, seed, husk
Plantago major L.			1	ribwort plantain
Polygonum aviculare L.			1	knotgrass
Silene alba (Mill.) Krause/S. dioica (L.) Clairville			1	white/red campion
Solanum nigrum L.			1	black nightshade
Torilis Adans.			2	hedge parsley
Others				
Asteraceae			8	aster family
Atriplex L.			10	goosefoot

Phase	EBA 2	MBA–RBA	RBA	
Avena L.	2		7	oat (awns, grains)
Carduus L.	4			centaury
Carex L.			3	sedge
Caryophyllaceae			1	pink family
Chenopodiaceae			4	goosefoot family
Cirsium L.			1	thistle
Fumaria cf. capreolata L.			1	probably ramping fumitory
Galium L.			1	cleavers
Lithospermum L.			1	gromwell
Malva L.			7	mallow
Paniceae (wild)			1	millets
Poa L.			2	grass
Poaceae	5	11	83	grass
Polygonum L.		2	1	knotweed
Ranunculus L.			1	crowfoot, buttercup
Rosa L.			1	rose
Rubus L.			3	blackberry
Rumex L.			8	dock
Silene L.	1			crowfoot
Solanaceae			1	nightshade family
Trifolieae	1		17	clover family
Trifolium L.			5	clover
Vicieae	16	4	852	vetch
Unidentified Plant Remains				
stalks, stems, leaves	1		36	
resin? (amorphous material)	1		12	
bread, pulp, seeds and fruits	833	172	16,036	
mineralised seeds and fruits			4	

* One of the two millet seeds from EBA 2 layers dates to the 20th cent. C.E. (see footnote 48)

Tab. 3 Summary species list of the identified charred plant remains in the Bronze Age phases from Punta di Zambrone, Calabria. The botanical nomenclature follows Oberdorfer (2001)

Results and Interpretation

Only undisturbed sediments and those not contaminated by modern seeds contribute to the appraisal. The majority of finds are charred seeds, fruits and chaff remains.

Overview of the Distribution of Samples and Plant Remains

After the first analyses of 30 samples that were taken during the first excavation campaign in 2011 and of which 7 came from EBA and 23 from RBA layers, now the complete results of 182 samples can amplify the results.[22] The samples originate from 1459 litres of sediment from the three different areas B, C and D.[23] All in all, 29,794 charred plant remains were identified, belonging to 59 taxa.

[22] The results of that first study are published by Zach, Klee and Thanheiser in: Jung et al. 2015.

[23] For the contexts dated to the MBA or RBA see: Jung – Pacciarelli, this volume; Capriglione, this volume; Weninger et al., this volume.

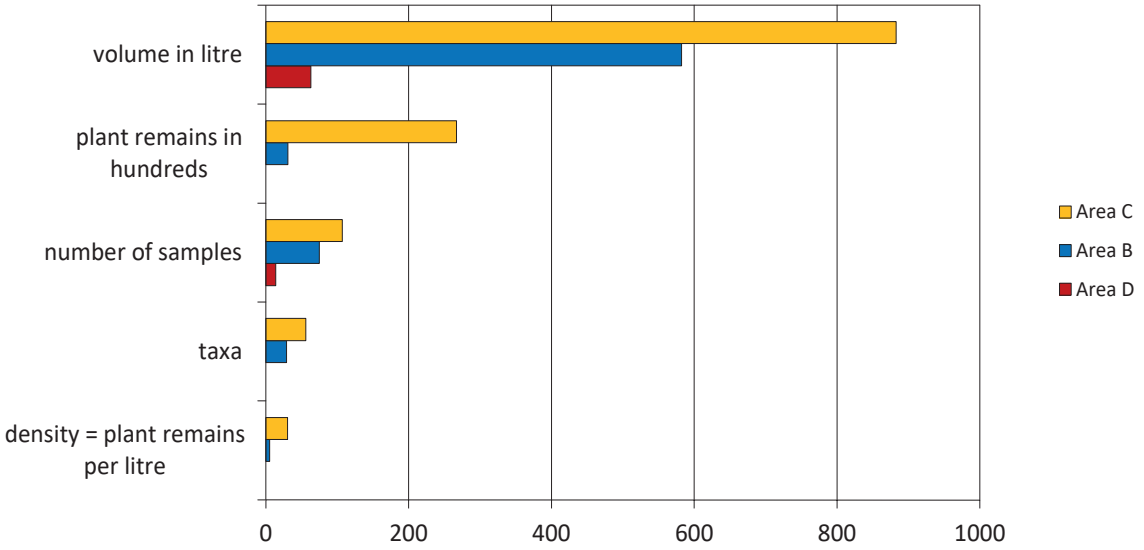


Fig. 4 Comparison of archaeobotanical parameters between the three different excavated areas in Punta di Zambrone (graphics: M. Klee)

In Area B, all Bronze Age phases except EBA 1 yielded seeds or fruits but the density of plant remains must be described as low. In Area C, all samples are dated to the RBA. Here the density of plant remains is higher, in a few samples considerably high. Only in this Area C did beads and hints for the consumption of seafood emerge. The most variable composition of taxa appears in Area C. The situation in the eight samples dated to Early Bronze Age 1 and coming from Area D is completely different: only charcoal but no seed or fruit remains were present.

The earliest settlement phase of Zambrone shows up in Area D with an initial phase of EBA 1 without any seeds or fruit. The EBA 2 phase was only detected in Area B. In the 52 samples dated to this phase, a volume of 437 litres of sediment from ten layers provided 1168 plant remains relating to 16 plant categories (taxa) with an average of 3 finds per litre (Tab. 3a).

The Middle Bronze Age and the transition from the MBA to the RBA will be excluded from the following interpretations because of its poor representation (Tab. 3b).

From the latest settlement phase, the RBA phase, 16 samples derived from the fortification ditch in Area B, while 104 samples were taken from the ashy layers in Area C (Tab. 3c). The density of plant remains per litre differs significantly between the filling of the ditch in Area B, and the ashy layers in Area C. In the 99 litres of sediments from Area B, 1843 plant remains from 22 taxa were identified. The average density is 19 remains per litre. From Area C 851 litres of sediment were analysed, delivering 26,143 remains from 58 taxa. The average density for the RBA is 31 remains per litre. In the part of the ditch exposed in Area C, the sample selection covered all filling phases of the ditch, from the lowermost level of sandy sediment up to the ashy levels disturbed by the modern plough. The ^{14}C dates indicate a time range between the 14th century and 1200 BC.[24]

[24] For ^{14}C dates see Weninger et al., this volume.

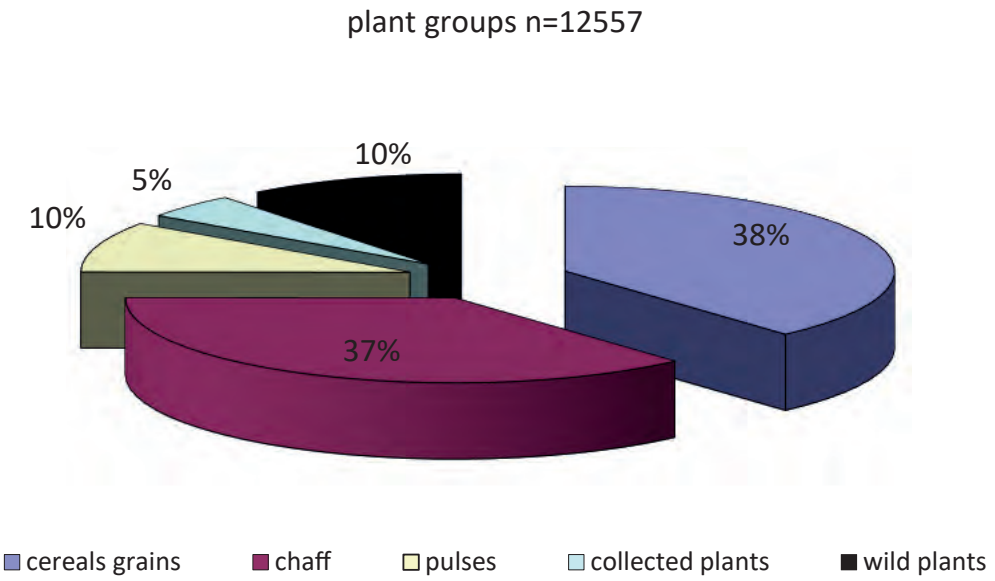


Fig. 5 Numbers of remains in groups of plants in percentage, the MBA is included (graphics: M. Klee)

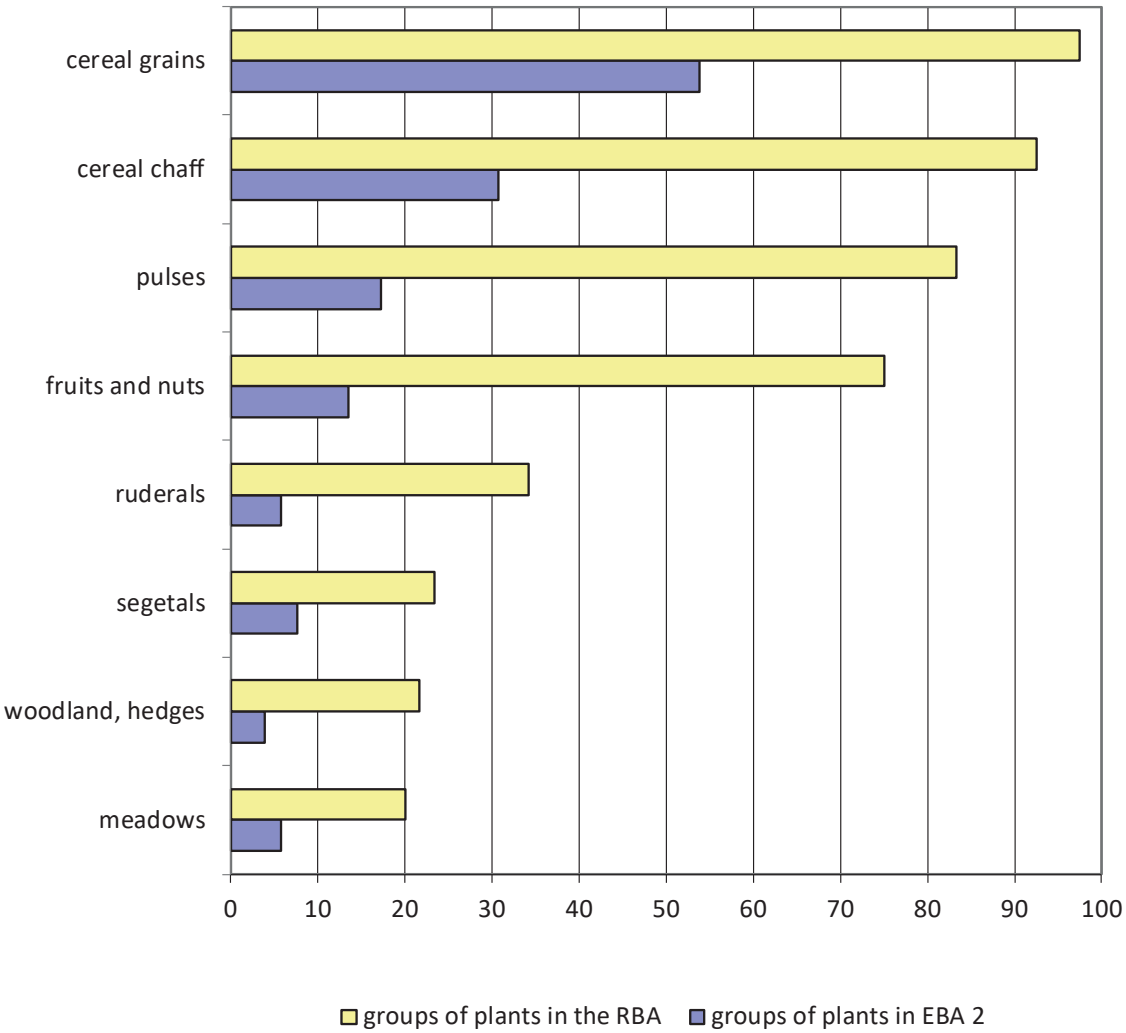


Fig. 6 Ubiquities of plant groups, given in percentages for the EBA and the RBA. The X-axis shows the number of samples as a percentage (graphics: M. Klee)

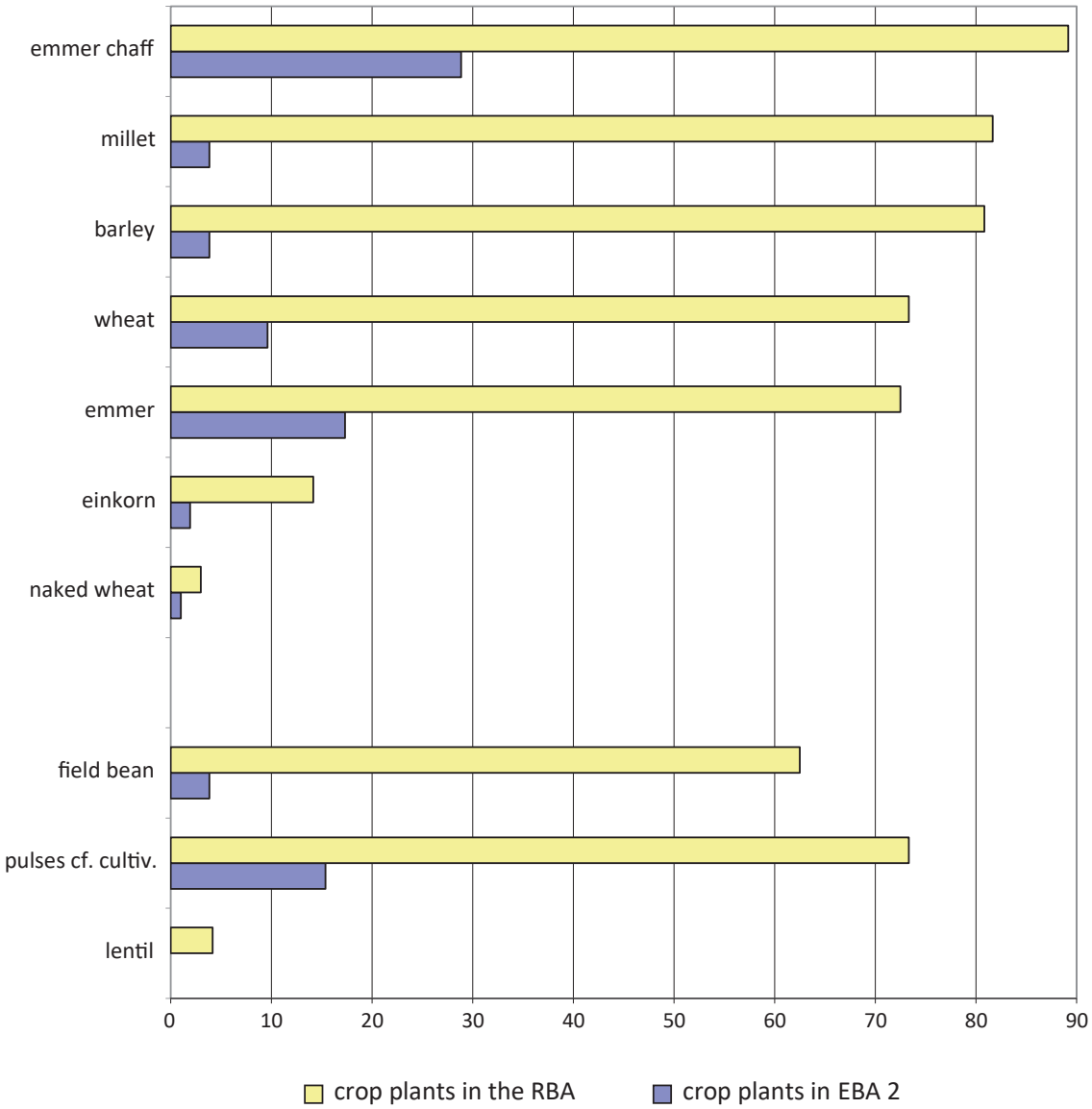


Fig. 7 Ubiquities of cereal species in the EBA and the RBA. Grains, if not otherwise noted. The X-axis shows the number of samples as a percentage (graphics: M. Klee)

The Plant Species and their Interpretation – Plant Groups

The majority of charred plant remains derive from arable farming: cereal grains and chaff, pulses, followed by collected and wild plants (Fig. 5). Five species of cereals were identified. Together their numbers reach about 74% of all identified remains, while two pulses make up 10% and nine gathered plant species together 5%. They occur in small numbers. Other wild plants comprise 11%.

The preservation of Bronze Age plant remains is down to the 'chance' of getting charred. Hulled cereals seem to have a very high likelihood of getting charred: most probably they were roasted for easier dehusking. Beans *(Vicia faba)* and acorns *(Quercus)* may have been roasted too. This may, therefore, be the reason for a possible overrepresentation when the absolute numbers of seeds, fruits or chaff is concerned. Their importance cannot be inferred from the absolute numbers alone. Instead, ubiquity gives an impression of how usual species were in the settlement.[25] Most of the figures and

[25] Percentage of samples with a presence of a certain taxon.



Pl. 1 Photos of charred remains of cereals and pulses, length of line is 1mm. 1–8. grains seen from three (resp. 2) sides; 9. rachis fragment seen from two sides; 10–11. seeds seen from three (resp. 2) sides; 1. emmer *Triticum dicoccon* from sample PZBP 112; 2. emmer *Triticum dicoccon* from sample PZBP 251; 3. hulled barley *Hordeum vulgare* from sample PZBP 251; 4. broomcorn millet *Panicum miliaceum* from sample PZBP 51; 5. einkorn *Triticum monococcum* from sample PZBP 53; 6. einkorn *Triticum monococcum* from sample PZBP 216; 7. naked wheat *Triticum aestivum/durum* from sample PZBP 136; 8. naked wheat *Triticum aestivum/durum* from sample PZBP 216; 9. rachis fragment of tetraploid *Triticum durum* from sample PZBP 287; 10. lentil *Lens culinaris* from sample PZBP 25; 11. field bean *Vicia faba* from sample PZBP 61 (A. G. Heiss)



Pl. 2 Photos of charred seeds and fruit fragments, length of line is 1mm. 12. grape vine *Vitis vinifera* from sample PZBP 27; 13. grape vine *Vitis vinifera* from sample PZBP 25; 14. olive *Olea europaea* from sample PZBP 210; 15. acorn *Quercus* base of the cupula from sample PZBP 201; 16. myrtle *Myrtus communis* from sample PZBP 29; 17. blowfly grass *Briza maxima* from sample PZBP 76 (A. G. Heiss)

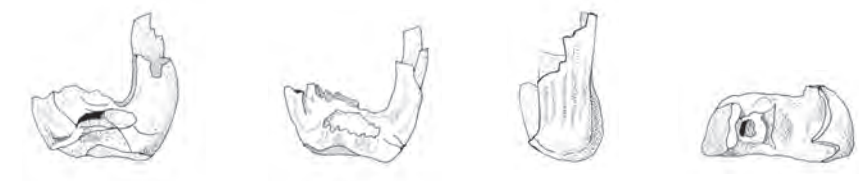
the interpretation are based on the computed ubiquities of taxa. This is possible only if enough samples can be investigated as was the case at this excavation. In all the investigated samples, cereals and pulses together with gathered fruits and nuts show the highest ubiquities (Fig. 6).

Crops of Zambrone

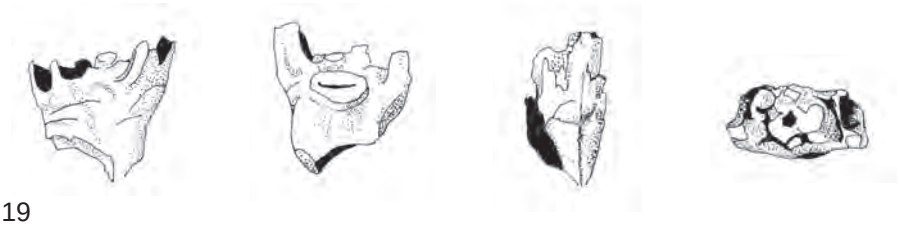
Cereals

Emmer *Triticum dicoccon* (Pls. 1.1, 2; 3.18) is the most frequent and the most abundant cereal at Bronze Age Zambrone (Fig. 7). Emmer, hulled barley *Hordeum vulgare* (Pls. 1.3; 3.23) and broomcorn millet *Panicum miliaceum* (Pls. 1.4; 3.21, 22) occur with high frequencies. By contrast, there are only a few grains of einkorn *Triticum monococcum* (Pl. 1.5, 6; Pl. 3.19) and most probably naked wheat *Triticum aestivum/durum* (Pls. 1.7–9; 3.20) as well as fragments of cereal grains *Triticum* (wheat), which could not be identified confidently due to the absence of distinct diagnostic features. We believe them most probably to derive from emmer, especially as no hulled wheat species other than emmer and a very few grains of einkorn were identified. All the chaff finds derive from wheat. Hulled grains were stored in their glumes and were dehusked only for preparing food.[26] Because most of the chaff is from emmer, it can be assumed that this is also true for all the unidentified wheat chaff. Barley and millet chaff were not found, but this is not unusual.

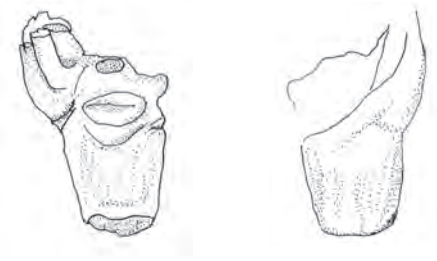
[26] Jacomet – Kreuz 1999, 151.



18



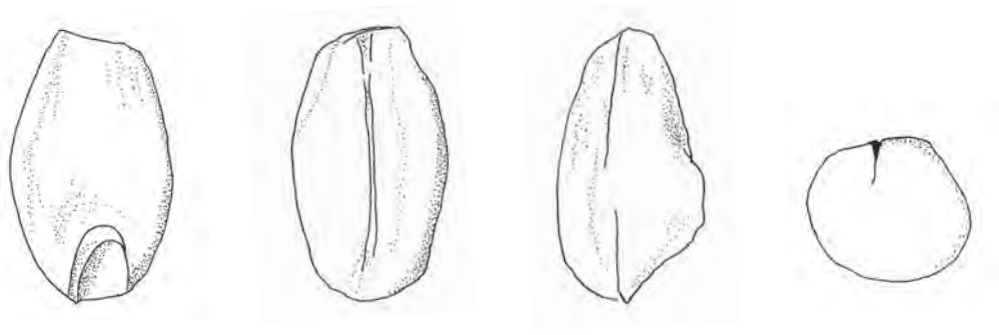
19



20

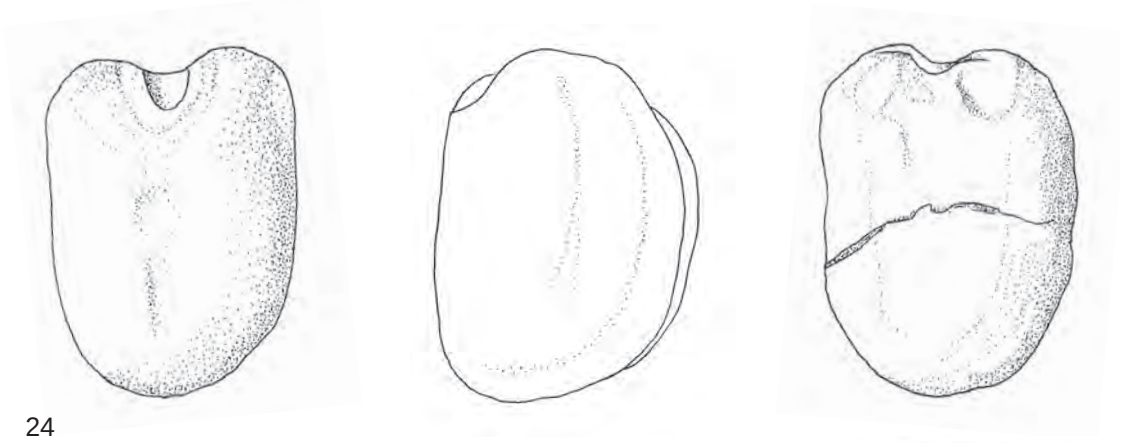


21 22

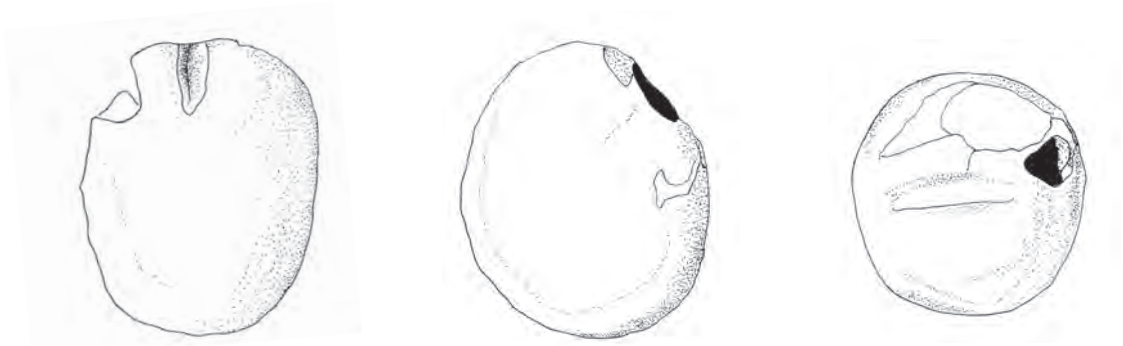


23

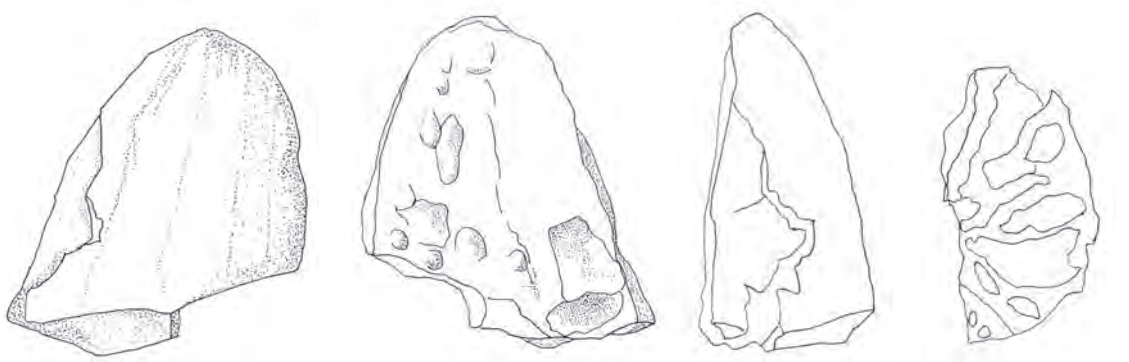
Pl. 3 Drawings of charred plant remains, length of line is 1mm. 18. spikelet fork of emmer *Triticum dicoccon* from sample PZBP 216; 19. spikelet fork of einkorn *Triticum monococcum* from sample PZBP 70; 20. rachis fragment of naked wheat *Triticum aestivum/durum* from sample PZBP 52; 21. grain of broomcorn millet *Panicum miliaceum* from sample PZBP 7; 22. grain of broomcorn millet *Panicum miliaceum* from sample PZBP 22; 23. grain of hulled barley *Hordum vulgare* from sample PZBP 18 seen from four sides (M. Klee)



24



25



26

Pl. 4 Drawings of charred plant remains, length of line is 1mm. 24. field bean *Vicia faba* from sample PZBP028 seen from four sides; 25. field bean *Vicia faba* from sample PZBP 216 seen from three sides; 26. *Quercus* from sample PZBP 60 seen from four sides (M. Klee)

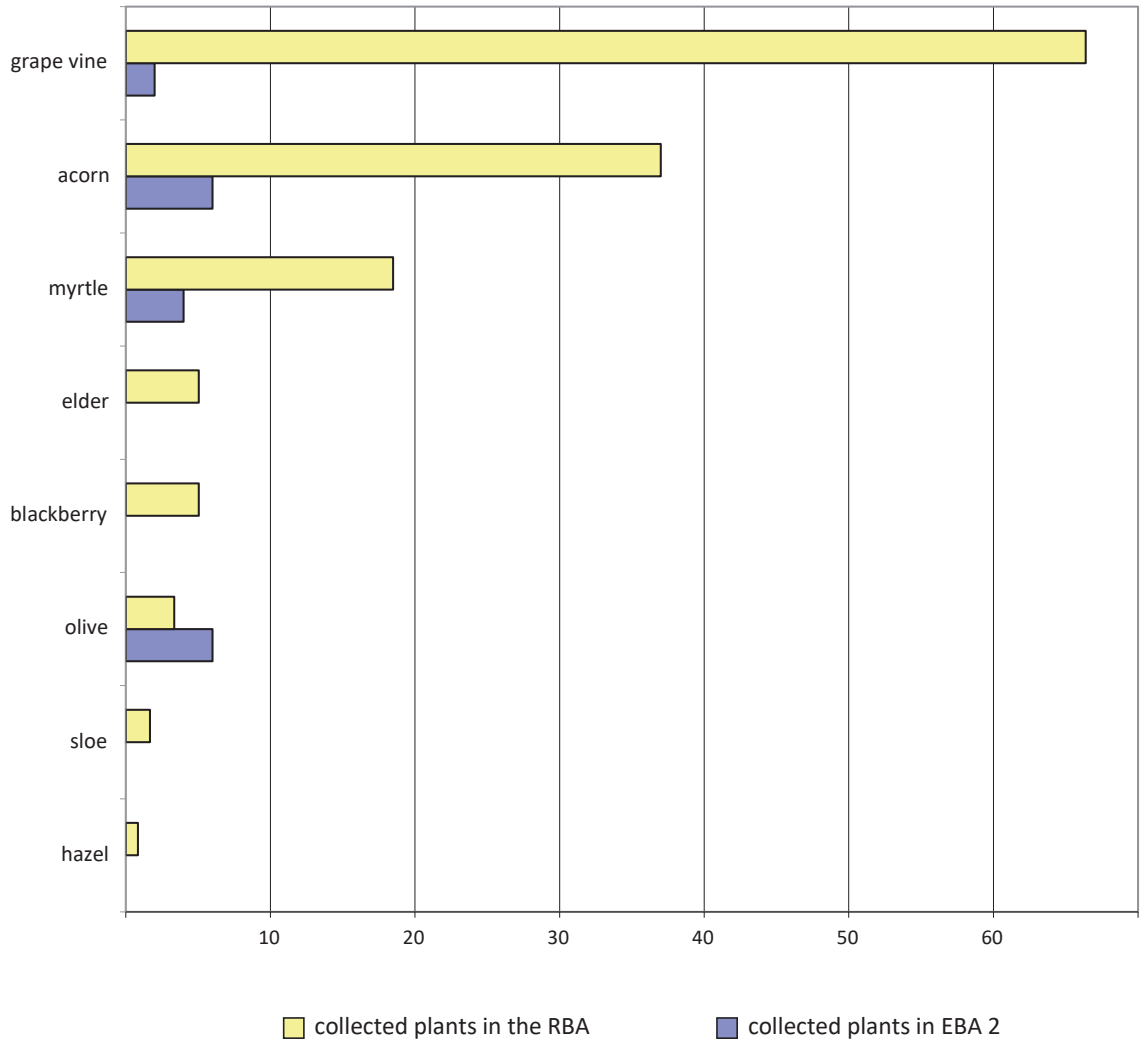


Fig. 8 Ubiquities of useful wild plants as a percentage of samples in the EBA and the RBA. The X-axis shows the number of samples as a percentage (graphics: M. Klee)

Pulses

Another important group of crop plants are pulses. Most of them lack diagnostic features for a reliable identification and often only fragments were present. Present are field bean *Vicia faba* (Pls. 1.11; 4.24–25) and very small amounts of lentil *Lens culinaris* (Pl. 1.10), but as all lacked the seed coat and hilum, identification of the species remains debatable (Fig. 7). The dominant vegetable at Zambrone is 'Fabaceae cf. cultivated', fragments of large seeded legumes probably deriving from field bean, although larger grained wild pulses cannot be excluded. Pulses were not only an important source of proteins; they also improve the soil by fertilising it with nitrogen.

Useful Wild Plants

Bronze Age people from Zambrone gathered fruits and nuts that can be found in forests, along hedgerows and the edges of the woods or perhaps in protected areas. Most frequent were fruit remains from grape vine *Vitis vinifera* (Pls. 2.12, 13; Fig. 8). Eight useful plant species were found. Besides grape vine, olive *Olea europaea* (Pl. 2.14), acorn, *Quercus* (Pls. 2.15; 4.26), myrtle *Myrtus communis* (Pl. 2.16), elder *Sambucus*, blackberry *Rubus fruticosus*, sloe *Prunus spinosa*, and hazelnut *Corylus avellana* were probably gathered in the wild.

For the whole Bronze Age, the ubiquity of fruits and nuts in EBA 2 is 13% and rises to 75% in the RBA (Fig. 6). The difference in amount and ubiquity between crops and gathered plants is striking. Normally the likelihood of being charred is small for wild plants, an exception being acorn. In general, collected plants are underrepresented in the archaeobotanical record compared to cereals.[27] It could be assumed that collected wild fruits, like other edible parts of plants, were eaten in bigger quantities. Either they do not leave traces in the dry soil or they were consumed without leaving identifiable residues. Evidence can be expected only from other types of preservations, such as wet soil.

Zambrone's bitter fruits

The acorns at Zambrone do not occur by accident, they were collected from forests. Fragments of at least 90 oak fruits were counted, 5 in EBA 2 in 3 samples representing a ubiquity of 6%; 85 acorns were found in 43 samples from the RBA, which constitutes 36% of all samples (Pls. 2.15; 4.26). Most of them come from Area C. Although no link to any other taxon was recognisable, they are often found in combination with other useful plants from the wild. There is always one of the two cotyledons or their fragments present, never a complete fruit. The hilum or the cupula, which would have made identification possible, was not detected, nor was it possible to measure the length or diameter, the index of which can give hints as to the species.[28]

Acorns, as well as the bark of oak, contain bitter tasting, astringent tannin which is poisonous. This makes acorns valuable as medicine. However, since the bark contains even more tannin than the acorns, it is the bark that is preferred for dyeing. Acorns are highly esteemed by pigs, while cows and horses cannot digest them.[29] The same species of oak may provide not only bitter but also sweet fruits, trees yielding fruits poor or even free of tannin. These trees are not distinguishable from the ones with bitter fruit so you have to know where they grow and this knowledge has to be passed on.

Acorns are also edible for humans. There is no reason to collect and peel them for the pigs; therefore the finds at Zambrone indicate human consumption. The likelihood of charring is high because they must be processed by heating to be edible. They can be eaten directly or ground for bread or pulp.[30]

Acorns are rich in carbohydrates and also contain fat and proteins.[31] Several oak species are extant in Europe, especially in the Mediterranean. All of them produce acorns which could have provided food for the people of Zambrone. In southern Italy the evergreen holm oak *Quercus ilex* is a part of the natural environment. Acorns from this species are poor in tannin and were most probably the source of the recovered subfossil specimens. At Zambrone the wood of holm oak is established in the Early Bronze Age (EBA 1, 2) in the settlement layers from areas D and B as well as for the Recent Bronze Age (RBA) from the ditch.[32]

The question remains as to whether acorns at Zambrone were consumed because of their taste or because it was a reliable food if the harvest failed. Acorns are a common nutrient source not only in periods of famine, as the numerous finds in many sites show.

Sour grapes at Zambrone?

Grape pips (Pl. 2.12, 13) are grouped with the gathered plants together with other wild-growing fruits and nuts which occur in even lower numbers. They grow in or near the riparian forest. The proportion of gathered fruits and nuts among the useful plants is 5 percent, of which the fragments

27 Jacomet 2009, 47–59.
28 Primavera – Fiorentino 2013, 218.
29 Deforce et al. 2009, 381–392.
30 Several methods of gathering and processing the fruit are described in Primavera – Fiorentino 2013, 219–222.
31 Primavera – Fiorentino 2013, 223, tab. 2.
32 D'Auria et al. 2017, 605–612.

of grape pips make up two-thirds of the remains. Most pips are present as fragments and all fragments were counted. Since calculating the number of complete pips from fragments is fraught with problems, we did not attempt to do so. Nevertheless it can be assumed that the true number of pips was high. In total, we counted 421 items. Two of them appeared in Area B from EBA 2 and 391 in the RBA layers.[33] The small numbers and frequencies in the EBA 2 layers of Area B indicate that they had no relevance in this phase. However, taphonomy plays an important role. In the domestic sphere of Area B over a longer period, charred pips occur from time to time. In Area C, the ashy layers, which formed during a certain time span inside the settlement before they were deposited in the fortification ditch at the end of the last habitation period, the high ubiquity of charred pips suggests that grape vines were important during the RBA at Punta di Zambrone.

Only 19 pips were complete but did not show clearly the characteristic diagnostic features necessary to distinguish between wild and domesticated grape vines. Some of them tended more to the wild form; some showed features from domesticated forms. Wild and domesticated forms of charred grape pips can be distinguished by several features.[34] It is important to measure a number of seeds high enough to yield reliable statistical results. This is not possible at Zambrone. But even the obtainable data are restricted in their significance. According to Zohary and Hopf, the dimensions of wild and cultivated forms of grape pips often overlap; the variation is high.[35] It is known that despite cultivation, some cultivated grape vines may have continued to yield grapes with morphologically wild-looking pips.[36]

This provokes the question of whether the pips originated from gathered wild grapes, from locally grown or from imported grapes. Is it possible to verify wild grape vine in the Bronze Age in the region? Analyses of charcoal did not detect the wood.[37] Were the grapes of Bronze Age Zambrone imported raisins? More evidence is needed to prove local gathering or cultivation or even production of wine, such as the recovery of typical tools or a wine press, wood of the grape vine or pressing remains of the grapes themselves.

Zambrone's beautiful flower: Myrtle

Several whole myrtle seeds *Myrtus communis* (Pl. 2.16) and fragments were present in the RBA from Area C while they occurred solely in two EBA 2 samples from Area B. The ubiquity in the EBA and RBA is 4 and 18% respectively. Among the eight gathered plant species, myrtle is the third in importance after acorn and grape (Fig. 8). The samples containing myrtle also contain other gathered plants.

Myrtle grows in the macchia today. It may also have been gathered near woods or degraded woodland on soils which were slightly damp and deficient in lime.[38] The plant is present throughout Italy, mainly on the west coast.[39] The berries can be eaten and, just like the leaves, they are used as a spice and for medical purposes. Tools are made from the wood and, last but not least, it has a spiritual relevancy for feasts and is mentioned in old mythologies.

Zambrone's oil-wells

Olive stones *Olea europaea* (Pl. 2.14) turned up at Zambrone as early as EBA 2, but in low numbers. Six fragments are present; in the RBA three were found. The numbers may reflect the lack

33 28 pip fragments were found in samples from the MBA–RBA contexts.

34 Index following Stummer: the relationship between the width and the length (Stummer 1911, 283–327); index following Mangafa: index of length of the seed, length of the stem of the seed and the distance between the chalaza and the end of the stem (Mangafa – Kotsakis 1996, 409–418); following Perret: the index refers to the relationship between the length of the stem of the seed and length of the complete seed (Perret 1997).

35 Zohary – Hopf 2000, 153.

36 Valamoti et al. 2015.

37 D'Auria et al. 2017, 607.

38 Jahn – Schönfelder 1995, 202.

39 Pignatti 1982, Vol. 2, 149.

of importance of olives. For olives, the opportunity to come into contact with fire by processing is relatively small. The poor but steady presence throughout the complete Bronze Age at Zambrone can be seen as underrepresentation of this species. It may have played a more important role than the pure numbers reflect.

Can wild olive trees in the Bronze Age be proven for the region? Olive fruits are counted as gathered plants, the same as other fruits and nuts from the macchia already mentioned above. The question of whether the stones derive from gathered wild or from domesticated olives, whether they were locally grown or imported cannot be answered by examining the stones alone. No complete stones were found. And as with grape vines, additional archaeological finds such as an oil press or wood of the olive tree are necessary to prove a local growing or oil production.

In contrast to the grape vine, charcoal from olive wood was found. However, the wood from wild or domesticated olive trees cannot be distinguished. The wood was verified from EBA 1 to the RBA.[40] Wild and feral olive trees are widespread in the southern Mediterranean, also today around Zambrone.[41]

Besides eating the fruits, they can also be processed for oil which, in contrast to other types of oils, is not highly perishable. The oil has a high nutritional value, is good for cosmetics but also as fuel for lamps and is therefore a valuable commodity for trade.[42] The storage stability even permits an extended trade. The wood of the olive tree may have been used for tool-making, but also for fire wood.

At Zambrone the results of the charcoal analyses led to hypotheses of an episode of olive cultivation, not necessarily implying domestication, at the beginning of the EBA.[43]

Other Wild Plants

Wild plants brought into the settlement unintentionally, form 11% of the total amount of remains (Fig. 5), combining 43 taxa, the 12 segetals included. The latter came in together with the harvested cereals and give indications about soil features and harvesting methods. Most are winter crop weeds, but four of them are typical for summer crops (i.e. *Digitaria ischaemum, Echinochloa crus-galli, Setaria viridis, Stellaria media*).

Plants which today are typical for pastures or meadows are rare; they may also have derived from arable fields or from places at the fringes of fields, paths or fallow land like the ruderal plants. Equally scarce are species from woodland or its fringes, which were brought in unintentionally. At least the importance of the wilderness is shown by the fact that all of the useful collected plants derive from these places.

Medical Plants

We can only speculate about the use of plants for medicine. Some of the discovered wild plant species possess healing potential. The astringent tannin, which is toxic, makes acorns valuable as medicine for skin eruptions, sore throats and other diseases.[44] The slightly poisonous myrtle plays quite a role as a remedy for respiratory disease, as well as acting as an antibacterial, pain relief and secretolytic.[45] Rosemary and two toxic Solanaceae, deadly nightshade *Atropa belladonna* and henbane *Hyoscyamus niger*, are also healing plants, if the use is known.[46]

40 D'Auria et al. 2017, 605–612.
41 Pignatti 1982, Vol. 2, 325.
42 Zohary – Hopf 2000, 145.
43 D'Auria et al. 2017, 605–612.
44 Roth et al. 1994, 598.
45 Frohne – Jensen 1992, 166.
46 Roth et al. 1994, 157, 622, 505.

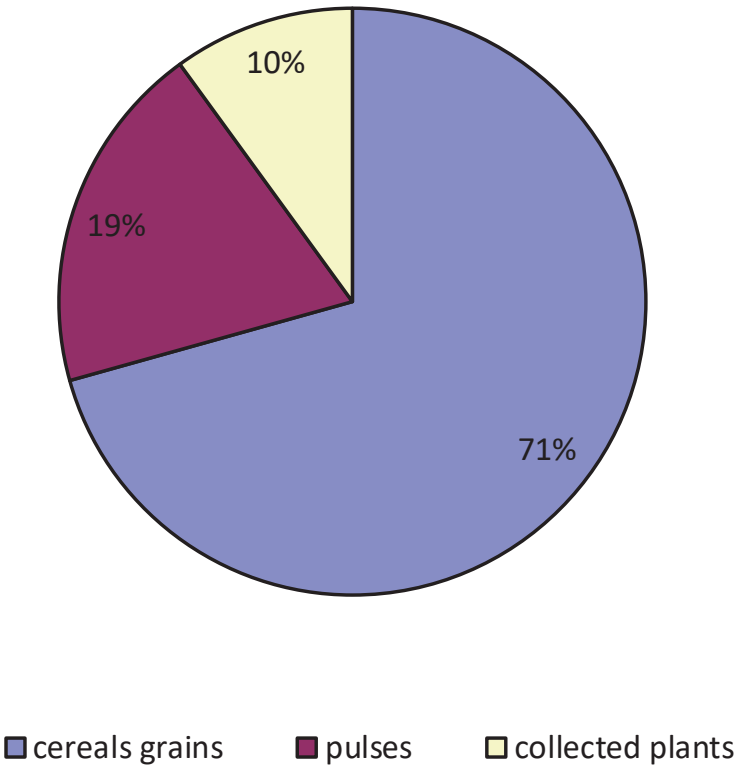


Fig. 9 Useful plants from 52 samples from EBA 2 from Area B. Number of remains n=150 (graphics: M. Klee)

The Bronze Age Phases of Zambrone

Early Bronze Age 2

In Early Bronze Age 2 (Tab. 3a), only excavated in Area B, emmer wheat and field bean are the dominant crops. As there are only a few grains, einkorn wheat, as well as a supposed naked wheat, barley and millet may have appeared as weeds in the emmer fields. Fragments of most probably cultivated Fabaceae are present in 16% of the samples, whereas the identified field bean is proven in two samples. Based on our present knowledge, field bean seems to be the only pulse grown (Fig. 7). Other useful plants in this early phase of the settlement are fruits such as acorns, myrtle, olives and grapes, which might have been collected (Fig. 8).

The remains of useful plants consist of 71% cereal grains, 19% pulses and 10% collected wild plants in EBA 2 (Fig. 9).[47] Even though 52 samples were examined, it is striking that only a small number of remains were preserved. This makes it difficult to judge their actual significance. Are barley and millet really not more than contaminations?[48] What could be the reason for the poor finds? Besides the destruction in prehistoric times by the inhabitants themselves due to daily life, the agriculture of modern times could have destroyed evidence.

From ten stratigraphical units (SUs) in Area B, six of them yielded one sample each; the others comprise two and four as well as 22 (SU 86) and 19 (SU 166) samples. Two samples show a

[47] Only edible remains, that means without chaff.

[48] Indeed one of two millet seeds from the EBA 2 contexts in Area B clearly contains ^{14}C that is derived from the atmospheric nuclear bomb explosions of the 1950s and 1960s. It is sample PZ149I3 from PZBP 228 (Lab Code MAMS-21647) with (negative) ^{14}C age noted as -570 ± 27 BP. This ^{14}C age can be back-translated as measured AMS-ratio of F^{14}C 1.074+-0.0037. The sample is thus not actually 'contaminated' by bomb-^{14}C, but has its true growth period in the 20th century CE.

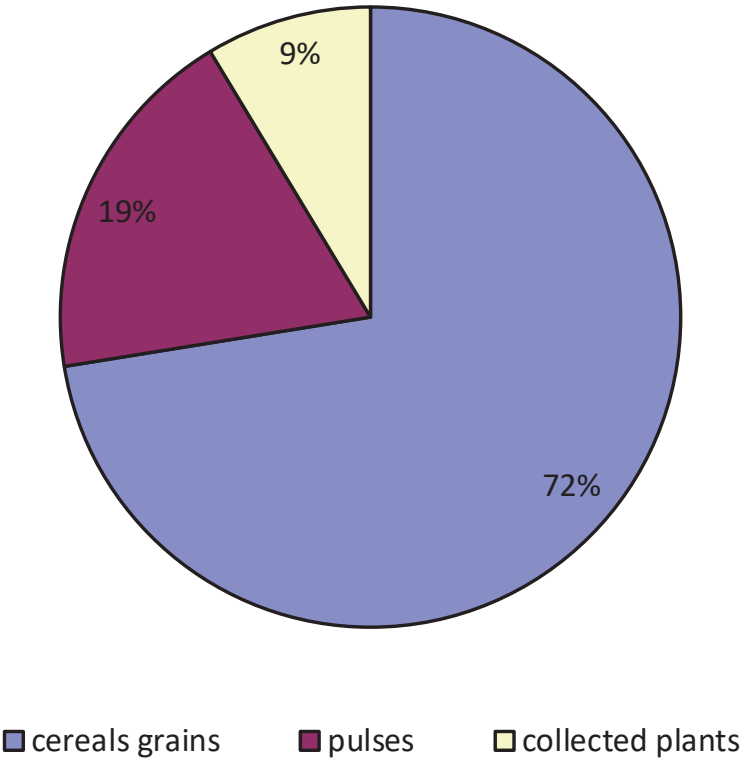


Fig. 10 Useful plants from 120 samples from the RBA from areas B and C. Number of remains n=6237 (graphics: M. Klee)

slightly higher quantity of plant remains compared to the low numbers in the other EBA 2 samples.[49] Sample PZBP 206 contains a lot of cereal grains, chaff and food remains such as bread, pulp or fruit and pulses, but no collected plants. In sample PZBP 253, however, a lot of chaff has been found as well as some amorphous food remains. Both samples may give hints of domestic activities such as cereal processing and the deposing of waste from crop processing in the ditch.

Recent Bronze Age

Seen in an overview in the RBA (Tab. 3c), the amount of remains of useful plants with 72% grains and with 19% pulses is similar to that in EBA 2 and at 9% shows the same percentage of collected wild plants (Fig. 10).

In the last phase, more barley and millet were found and reduce the percentage of emmer wheat. Millet kernels reach nearly twice the number of barley grains (Fig. 11). Now emmer, barley and millet yield the equivalent ubiquity of about 80% of RBA samples (Fig. 7). Grains of einkorn and probably naked wheat are still rare. Because the grains of millet are much smaller than those of other cereals, the number of grains necessary to reach the same volume is higher and may then give the impression of being very important. Therefore, the small size of the grains has to be compensated for by numbers.

Again, field bean occurs in high amounts and its ubiquity is nearly as high as that of cereal grains, reaching more than 60% (Fig. 7). Some rare lentil seeds appear. All of the gathered plant species found at Zambrone occur in the RBA phase. Grape vine shows a ubiquity of more than 60%, while most of the other collected plants do not even reach 10% (Fig. 8). Numerous finds of myrtle and oak are present. Olive is scarce. In the RBA phase new weed species emerge, espe-

[49] SU 86/PZBP 206 and SU 166/PZBP 253.

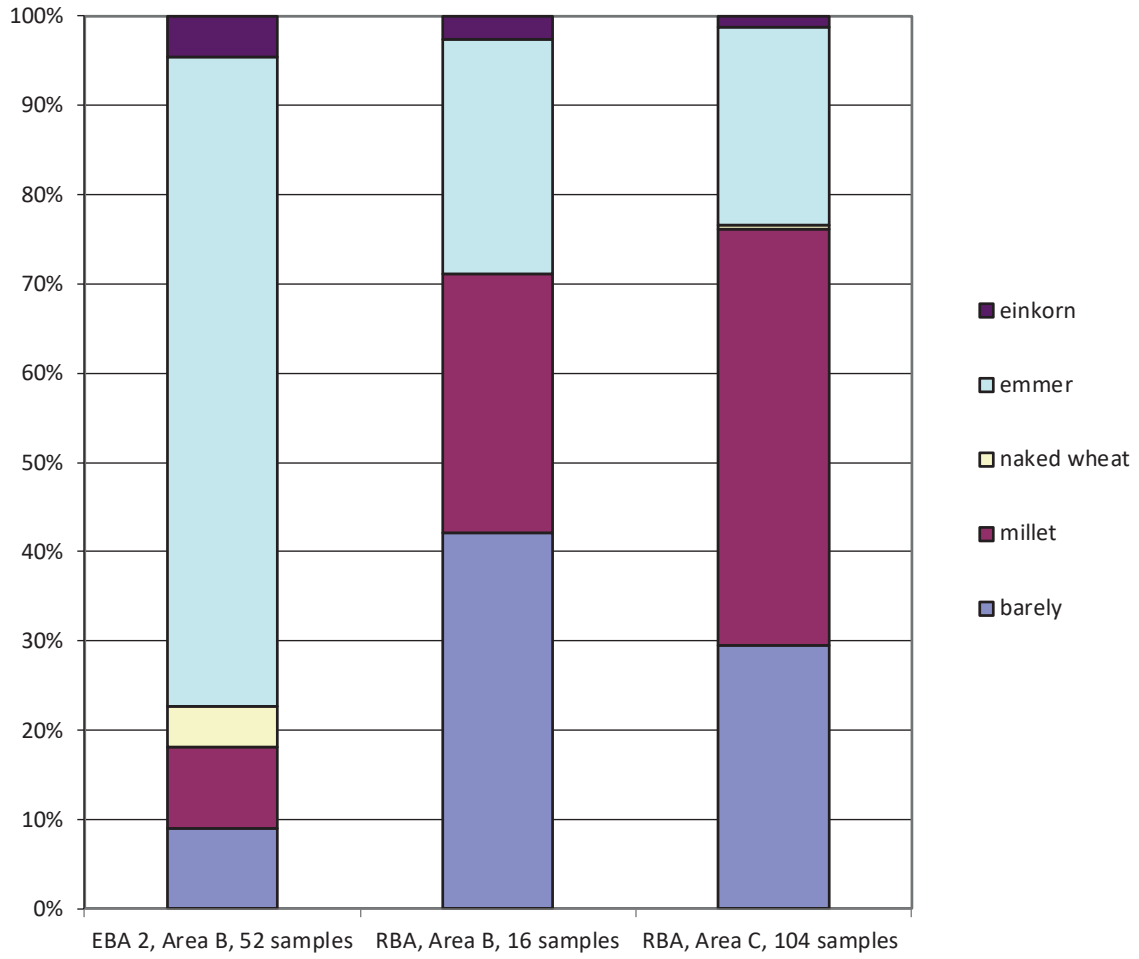


Fig. 11 Cereal grains per phase and area. EBA 2/ Area B: 52 samples, n=22. RBA/ Area B: 16 samples, n=38, RBA/ Area C: 104 samples, n=1946 (graphics: M. Klee)

cially summer crop weeds; this may be connected with millet cultivation. The sparse numbers of cereal weeds in most of the samples in every phase may be the result of effective cleaning of the cereals. It has to be kept in mind that they are only detectable if high amounts of plant remains can be analysed.

Recent Bronze Age layers occurred in the filling of the ditch in both Area B and Area C.[50] The plant spectrum shows no significant deviation in Area B and Area C of different cereal species (Fig. 11), but a big difference in the amount of chaff residues, which are extraordinarily high in the RBA phase of Area B (Fig 12).

The sample PZBP 132 from Area B, revealed the highest density of all samples from Zambrone with 314 remains per litre. All identified cereal taxa are present here, dominated by the chaff remains of the wheat species (Fig. 13). No pulses, only a few wild plants, and no collected plants apart from grape vine were detected in sample PZBP 132. Another four samples from Area C with a very high density of plant remains are PZBP 76, 215, 216 and 251 (Fig. 14).[51] The composition of cereal grains is more or less similar in the rich samples of Area B and the rich ones from Area

[50] In Area B seven SUs furnished one sample each, three SUs furnished 2 and one furnished 3 samples. In Area C six SUs comprise one sample each; two furnished 2 samples, and the remaining three SUs furnished 11, 13 and 70 samples respectively.

[51] Area B: SU 117 PZBP 132, Area C: SU 66 PZBP 76, SU 129 PZBP 215 & 216, SU 161 PZBP 251.

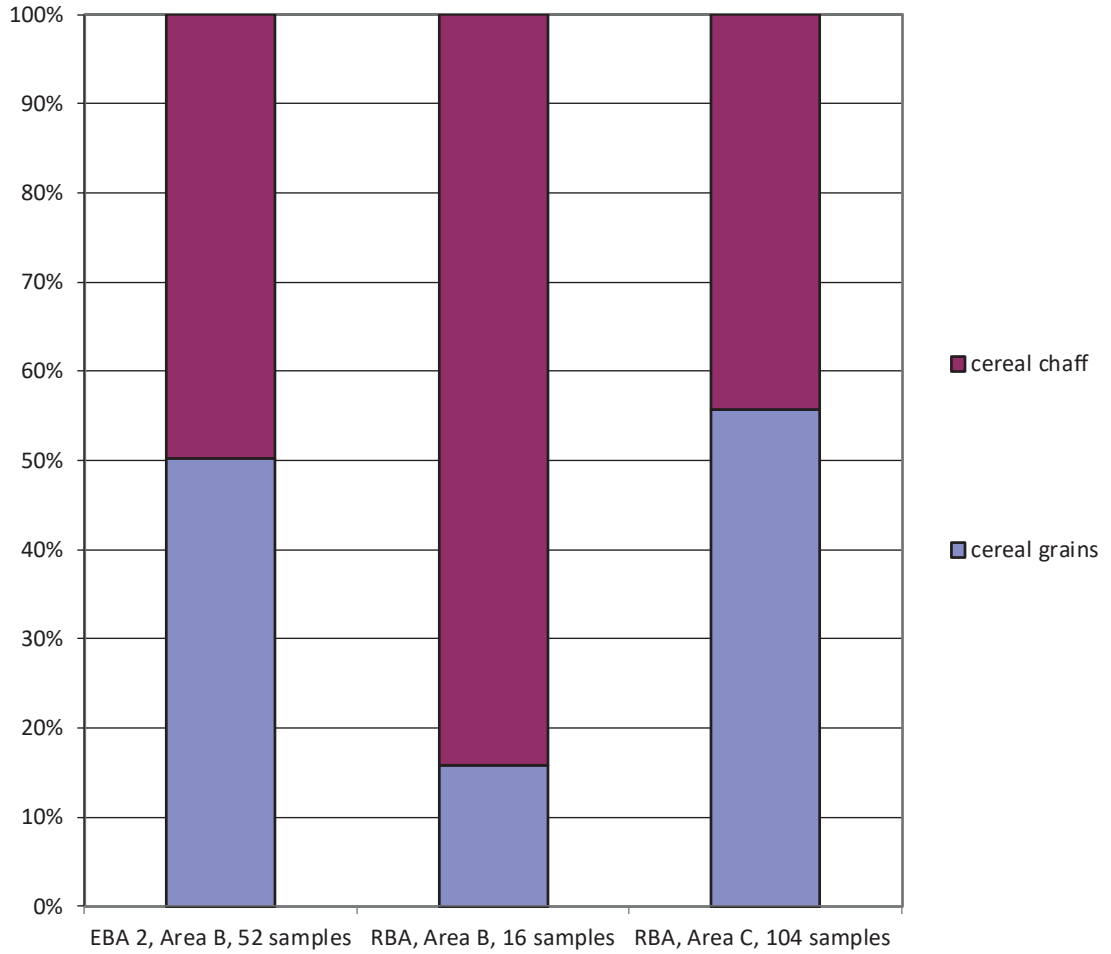


Fig. 12 Comparison of percentages of cereal grains with chaff groups in different phases and areas (EBA2/B: 52 samples, n=294, RBA /B: 16 samples, n=1015, RBA /C: 104 samples, n=9506 (graphics: M. Klee)

C, as well as the rest of Area C. It is noticeable that three of the rich samples contain not only the highest amount of millet, but also almost all of the summer crop weeds, which are new in the Recent Bronze Age of Zambrone.[52] It is conspicuous that all the rich samples from the RBA, from Area B and the four from Area C, contain the most grape pip fragments compared to the other samples.

The plant assemblage from the RBA in Area B seems very similar to that of EBA 2 from Area B. There are low densities of botanical remains, with one exception in PZBP 132. Some pulses, weeds and collected plants, but no artefacts such as faience beads or residues from seafood, as found in Area C, and no 'conglomerates' are present. Sample PZBP 132 in SU 117 shows a 'hot spot' of cereal processing. Was this the place where the harvest was processed or where the waste from it was deposited? Apart from the different taphonomy in Area B, most probably all the samples represent traces of domestic life, with different menus from those leading to the formation of the ashes deposited in Area C. The contrast between Area B and Area C in the Recent Bronze Age seems to go back to a domestic area with its trash being deposited in Area B, while Area C became a place of rubbish disposal for a rather specific kind of ashy refuse. Prior to their deposition in the ditch, those ashes had accumulated over a certain time span with material originating from the last

[52] PZBP 215 and 216 in SU 129 and PZBP 251 in SU 161.

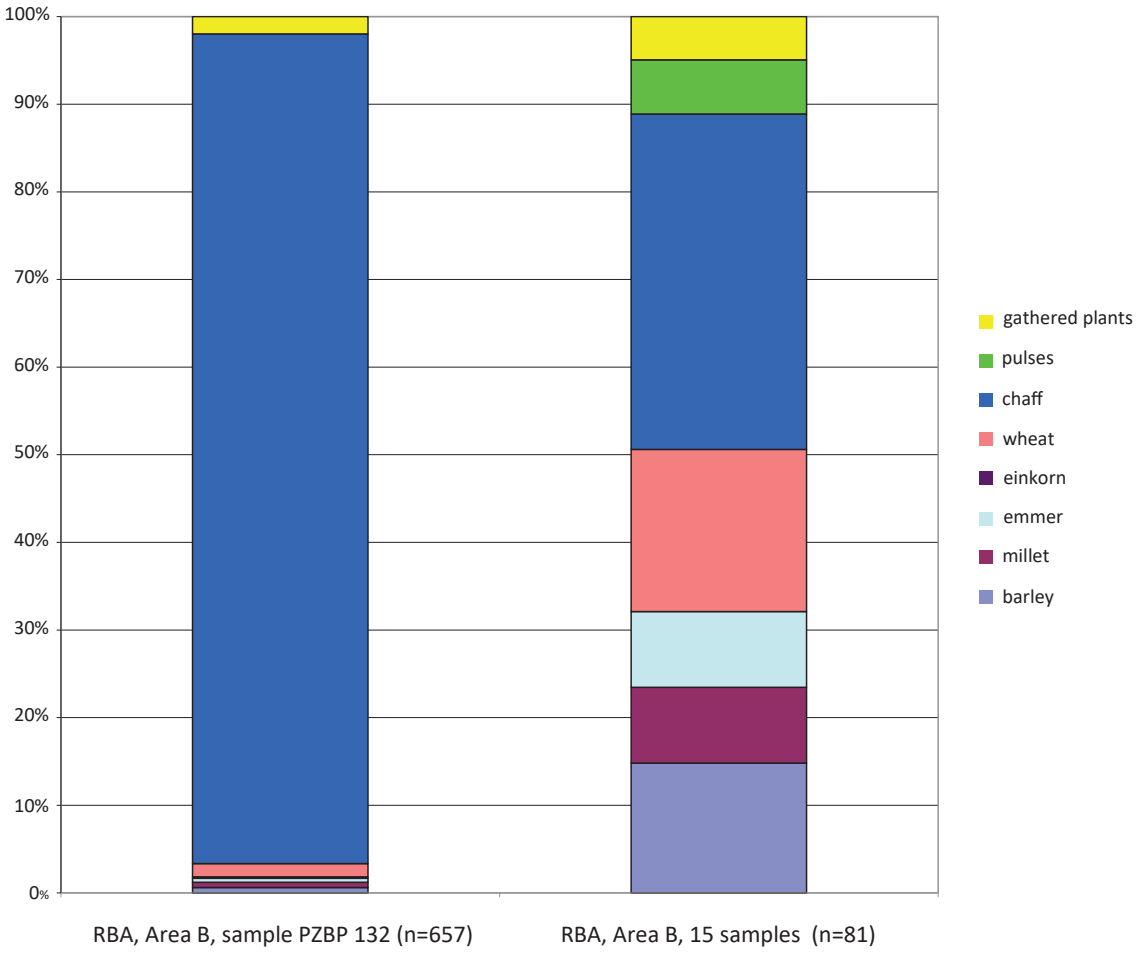


Fig. 13 Comparison of percentages of useful plants in the rich sample PZBP132, with the remaining 15 samples of the RBA of Area B (graphics: M. Klee)

settlement phase.[53] The interpretation of the activities which produced this huge amount of ash is difficult from the archaeobotanical point of view.

Comparison of the Phases

It is evident that the numbers of cereal grains and other species in the RBA samples are high enough to assess their role in the former economy. Changes in the cereal spectrum compared to EBA 2 can be observed (Fig. 7, Fig. 11). All five cereals, emmer, einkorn, naked wheat, barley and millet, occur during the whole Bronze Age but both barley and millet play a minor role in EBA 2, whereas in the RBA they attain a similar importance to emmer. Einkorn and naked wheat may have played a role as weeds during the whole Bronze Age in Zambrone. Lentil seems to arrive as a new crop in the RBA. Olive, on the other hand, is scarce in the EBA 2 and RBA phases, which seems to be reflected also in the decrease in olive wood from EBA 2 to RBA 2.[54] The emergence of summer crop weeds in the rich samples and the increase of millet may indicate changes in agriculture in the RBA.

[53] For a discussion of the formation and deposition processes see Jung – Pacciarelli, this volume; for the time period of ash accumulation (prior to its final deposition in the ditch) see also Weninger et al., this volume.

[54] D'Auria et al. 2017, 607, fig. 2.

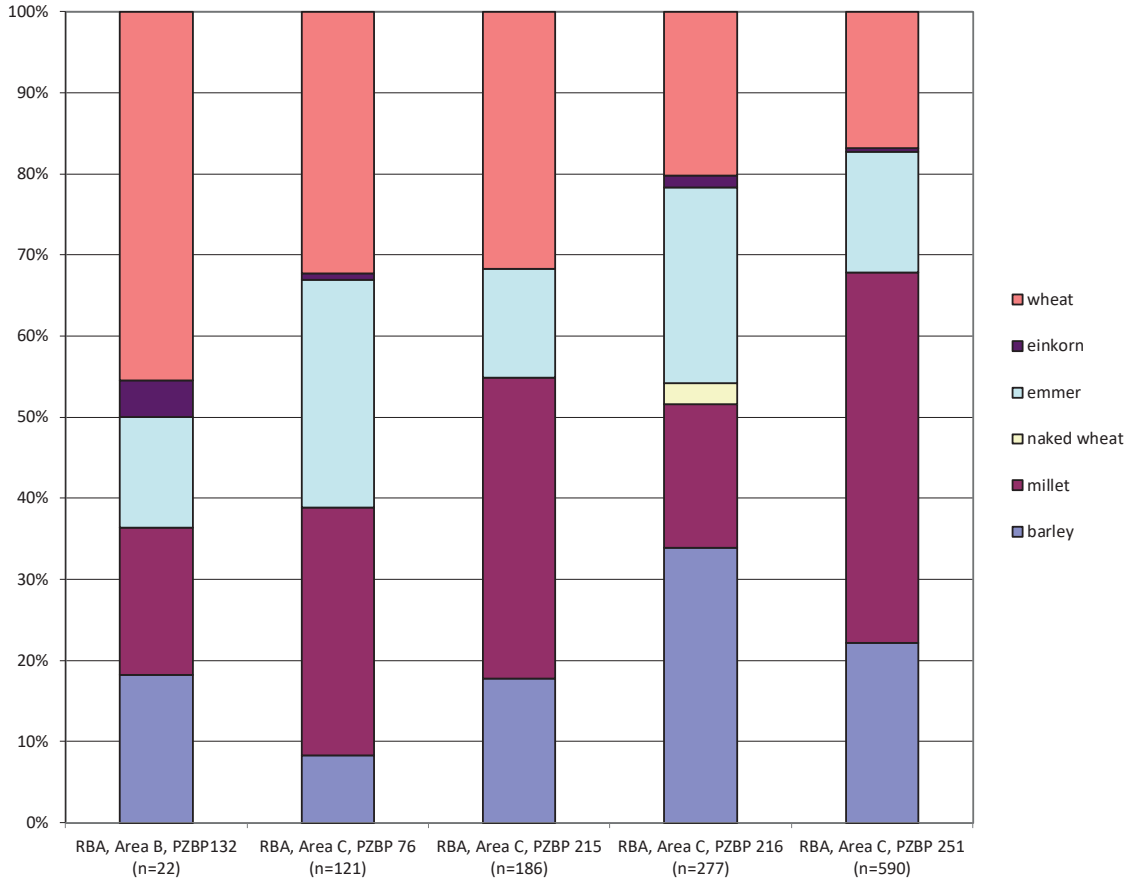


Fig. 14 Comparison of percentages of cereal grains in the five richest samples of the RBA (graphics: M. Klee)

The very high ubiquity of grape pip fragments is almost restricted to Area C. Even RBA samples from Area B, with the exception of PZBP 132, do not yield many pips. In the ashy layers of Area C their high ubiquity may show that grape was important then.

A closer look at the results shows that there are two important influences. First, how much is preserved in a layer depends on the taphonomy. Nearly all the samples from EBA 2 as well as from the RBA in Area B are poor, but rich samples derive from Area C. On the other hand the number of species and their combination alter and double from EBA 2 to the RBA, which may also be due to a cultural change (Fig. 3). The cultivation of summer crops in EBA 2 cannot be ruled out, but it was definitely practised in the RBA, and in this case new agricultural techniques were required.

The rubbish and ash deposition in the RBA in Area C may also distinguish cultural attitudes at this place, e.g. eating seafood, the use of luxury goods such as faience beads and others. This can only be seen in the waste of the RBA ashy layers and not in the RBA settlement area.

Subsistence Strategies in the Bronze Age

Agriculture

The environment of Punta di Zambrone with its alluvial deposits and fertile volcanic soils is most suitable for agriculture. Cereals and pulses provide evidence for arable farming; the recovered weeds indicate good soils. The finding of weeds, especially cereal weeds, but also some of the ruderals as well as some plants from diverse places, point to cereal fields in the surroundings of the site.

Emmer wheat and pulses belong to the most important crops over a long period. It seems that it was not until the end of the Bronze Age of Zambrone that new crops became important. From Zambrone nothing is known from the period of the Middle Bronze Age when, presumably, the changes took place. From Zambrone's EBA 2 phase only winter crop weeds exist, which suggests that crops were only cultivated in the winter. Later in the RBA there is also evidence of summer crop cultivation.

Emmer, einkorn and naked wheat, as well as barley, are known as winter crops, sown in the autumn, but they can also be sown as summer crops in the spring, earlier than millet. Millet is a summer crop with a short growth period. Winter and summer crops are harvested from June to July. The hulled wheat cereals and barley have to be sown during the same short time span, regardless of whether they are sown in spring or in winter. This means a lot of work has to been done at once, if the farmers had only winter or summer crops. The harvest of winter and summer crops takes place in nearly the same period, only barley is a bit earlier. Pulses may also be cultivated as winter or summer crops; they ripen at the end of spring, and before cereal crops are mature.[55]

Ethnobotany may shed light on agricultural practices. Concerning millet cultivation, these are harvesting methods, e.g. cutting with a sickle, with the weeds rejected. The main product of millet is the grain. Its straw can be used for forage for stabled cattle. Until consumption the grains are covered by a husk. Grains must be warmed up to 40–50°C in the sun or in ovens to remove the hulls.[56] The lack of winnowing products like glumes from millets is evident for grains for human consumption but not for fodder, but it cannot be excluded that the straw was used for animals. Normally porridge is made from millet.

The variety of cereals helps to organise the timetable of fieldwork, reduces the risk of crop failures and extends the spectrum of food. Besides agriculture, acorns were an important part of the subsistence strategy during the whole Bronze Age at Zambrone.

Zambrone's environment over time

The different plant groups give a picture of the former landscape. Arable fields and woodland existed beside a more or less degenerate forest, the macchia. We cannot expect meadows or pastures since only few plants indicate these habitats.[57] Cows, goats and sheep browsed the fallow land, macchia and forest fringes; the pigs may have grubbed in the forests. Plant species which may represent woodlands, hedges and macchia in the records are deadly nightshade *Atropa belladonna*, blowfly grass *Briza maxima* (Pl. 2.13) and most of the collected useful wild plants. Despite a few typical macchia species, there is not enough evidence for this vegetation type.

The woody vegetation is also reflected by the charcoal pieces from archaeological sites in the region dated to the Bronze Age.[58] The settlers gathered wood appropriate to the intended use and the recovered remains give an impression of the available species similar to the collected plants.[59] The charcoal of the evergreen trees *Quercus ilex, Arbutus unedo* and *Olea europaea* in the samples represent a rather arid climate, but these species are still present in the more humid phase of the RBA.[60]

The best evidence of the development of nature and vegetation in the surrounding landscape is obtainable from pollen analyses, currently under way.[61]

55 Primavera et al. 2017, 92.
56 Moreno-Larrazabal et al. 2015, 541–554.
57 D'Auria et al. 2017, 605–612.
58 Nisbet – Ventura 1994; Coubray 2001; Fiorentino et al. 2010.
59 D'Auria et al. 2017, 605–612.
60 D'Auria et al. 2017, 607.
61 The Zambrone team has taken a pollen core on the Poro high plain at the location 'Lacco'. H. Di Lorenzo is currently studying this core.

Current State of Research

Climate change

Palaeoclimatic studies show that drier conditions developed in the south central Mediterranean after 6000 calBC.[62] This was accompanied by the mediterraneanisation of the vegetation in southern Europe.[63] Since the Bronze Age, human impact has also played a role in this process. While in central and southern Italy environmental changes during the Eneolithic occur in about 2400–2100 calBC, mainly due to a climate change in the first half of the 3rd millennium calBC, a more prolonged event and eventually intense land exploitation left traces.[64] During the Middle and Late Bronze Age, an increasing aridity appeared due to changes in the seasonal precipitation patterns in the central Mediterranean, accompanied by a decrease in deciduous oaks and an increase in olive trees.[65]

The Aeolian palaeoclimate curve shows a period of increased aridity at 1500–1250 calBC.[66] In the archaeobotanical results from Punta di Zambrone a significant change between Early Bronze Age 2 and the Recent Bronze Age is visible. This could have occurred in the Middle Bronze Age, which is not clearly represented at Zambrone, or later in the RBA. The question arises as to whether the changes in the plant spectrum from the EBA to the RBA are due to climatic challenges or brought in with new influences from the Aegean world, visible in the archaeological record, by innovations, or by both.

The development at Zambrone may reflect similar processes to Apulia, where investigations showed two transformations of agricultural strategies, one in the Middle and one in the Recent Bronze Age. In Apulia, during the Middle Bronze Age subsistence strategies were adapted to an increasing aridity dating to 1590–1500 and 1390–1250 calBC respectively, during a general rise in mean temperature and a change in seasonal precipitation patterns.[67] It is supposed that in the Recent Bronze Age the change in agrarian practices occurred in order to accumulate 'surpluses'.[68]

Comparison with other places in Italy

The Bronze Age useful plants of Zambrone have been compared with the results of 17 archaeological sites in the southern part of Italy, including six in Sardinia, and with the results of five sites located in northern Italy.[69] Emmer, einkorn and naked wheat play an important role together with barley during the whole Bronze Age in Italy.

The main cereal throughout the Bronze Age sequence at Zambrone is emmer. At other sites it is rare and it is almost missing in Sardinia. An exception is the cave of Grotta della Madonna at Praia a Mare (Cosenza) on the Tyrrhenian Sea, a Middle Bronze Age 3 context, where emmer is the dominant species, as at Punta di Zambrone.[70] Emmer seems to be the preferred cereal at these two sites, while it is barley at most of the other sites. Einkorn is present in all sites but plays a minor role.

Free threshing wheat was detected at Zambrone mainly in the Recent Bronze Age. In Italy it was quite abundant in the earlier part of the MBA ('Protoappeninnico Recente') and during the RBA of Coppa Nevigata in Apulia.[71] It is also a main cereal in Sardinia, together with barley.

---

62 Primavera et al. 2017, 88–91.
63 Sadori et al. 2011, 117, 126.
64 Sadori et al. 2011, 118, 125.
65 Giraudi et al. 2011, 112, 113; Peyron et al. 2011, 132.
66 Caracuta et al. 2012, 689–700; Primavera et al. 2017, 90–91. This curve is used to identify short-term changes in past rainfall intensity.
67 Primavera et al. 2017, 91.
68 Primavera et al. 2017, 91–92.
69 Some more sites can be added in northern and central Italy after the research by Stika – Heiss 2013.
70 Peña-Chocarro – Rottoli 2004.
71 Fiorentino – D'Oronzo 2012, 334.

Small amounts of naked cereals compared to hulled ones are common within settlement contexts.[72] Naked wheat can be identified with certainty only by its chaff. Perhaps there was more naked wheat which is not preserved. The grains have only a small likelihood of getting charred because they do not have to be processed by parching. The chaff should be found outside the settlement, where it can accumulate during the threshing procedure, which took place immediately after the harvest.[73]

Hulled barley is the dominant cereal or at least represented in high numbers in all phases of the Bronze Age and in all regions, as it is at Zambrone.[74] In the EBA and the MBA in Sardinia, barley and bread wheat are the main cereals. At Meana (Sardinia) barley consists of equal amounts of hulled and free threshing forms, which could show a lagging behind of the main trend of this island site.[75]

In Italy the typical Bronze Age cereal broomcorn millet was known in early Bronze Age times at Zambrone, but rises in its importance towards the RBA. Millet is missing at most of the other sites in southern Italy. It is only present in Campania during an early stage of Early Bronze Age 2, at Nola-Croce del Papa and at the nearby Oliva Torricella. The destruction of the settlements by volcanic activity can be dated to 1900 ± 30 calBC.[76]

For the MBA, increased millet cultivation is observed only in the north. [77] Also, at one site in southern Lazio in a MBA layer inside Grotta Misa, some millet was recorded.[78] Additional insight derives from stable carbon isotope analysis of human bone. Evidence for the consumption of millets is an enriched value for ^{13}C in bones, which is characteristic for the consumption of plants with a C_4 photosynthetic pathway such as millets.[79] No millet was found in the MBA at the central southern Italian sites of Toppo Daguzzo and Lavello, both in Campania, while in EBA sites in northern Italy it was proven. This may be due to the fact that millet was introduced into Italy from central Europe and reached southern regions only later.

At Zambrone millet is abundant in the RBA, but in most other regions in the south and in Sardinia it is missing.[80] An explanation may be the spread of millet from north to south.

Pulses of the Bronze Age in northern Italy are *Cicer arietinum*, *Lathyrus sativus/cicera*, *Lens culinaris*, *Pisum sativum*, *Vicia erivilia*, *Vicia faba*, and *Vicia sativa*; only the field bean occurs in high numbers.[81] In the EBA and MBA in southern Italy field bean is almost the sole pulse. Field bean occurred in the EBA records of Oliva Torricella, Campania; in Punta di Zambrone and in Monte Meana (Sardinia).[82] In Sardinia and northern Italy field bean, lentil, pea and others are present throughout the consecutive phases of the Bronze Age. It is remarkable that the RBA samples from Zambrone and the MBA site from Monte Meana in Sardinia are the only places with a huge number of field beans.[83]

Gathered fruits are important sources for nutrition in the Bronze Age. Acorns are widespread in Zambrone and all over Italy from the EBA, the MBA to the RBA, as are grapes, olives, and myrtles.

Acorns are frequent in Zambrone. They seem to have been a dominant wild food source during the Bronze Age. They are found at many sites and sometimes in high numbers. At Punta di Zambrone they are present continuously. Evidence from Apulian Middle and Recent Bronze Age sites supports this idea. Four sites are described where the archaeological context proves storing and

72 Maier 1999; Bellini et al. 2008, 110.
73 Boardman – Jones, 1990.
74 Fiorentino 1998, 215; Costantini et al. 2007, 710; Fiorentino – D'Oronzo 2012, 328.
75 Ucchesu et al., 2015a, 348, 351.
76 Costantini et al. 2007, 710; Delle Donne 2011, 134; Jung 2013, 239.
77 For Modena see Bandini Mazzanti – Taroni 1989, 205, 207.
78 Costantini – Costantini Biasini 2007.
79 Tafuri et al. 2009, 146–153.
80 See also Stika – Heiss 2013.
81 After Stika – Heiss 2013.
82 Delle Donne 2011, 134.
83 Ucchesu et al. 2015a, 348, tab. 2.

cooking.[84] The gathering and use of acorns for consumption is and was widespread throughout the period. In Apulian coastal regions the fruits of holm oak have been gathered until modern times.[85] Oaks belong to the most frequent trees in Europe which means they were available everywhere and acorns could be gathered and stored easily. An example for the high esteem in which it was held may be the religious context of the discovery of acorns at Roca, Apulia, from the Recent Bronze Age.[86]

In the Bronze Age grapes were most likely eaten as fruits since there is no information about any treatment such as fermentation. However, in Italy cultivation of the grape vine in the MBA is supposed.[87] From some sites pips are described as looking more or less domesticated.

Information about wild and domesticated forms of pips dated to the MBA comes from the nearby Aeolian isle of Salina.[88]

Most of the grape pips recovered from the MBA wells at Sa Osa show a morphologically intermediate position between the wild and domesticated forms, whereas the pips from the RBA look much more like cultivars. Probably a secondary domestication started in the Nuragic culture from the MBA and happened in the RBA.[89] Another theory suggests that the technology of cultivating and producing wine was adopted from the Minoans or the Mycenaeans, with whom the people of the Nuragic culture maintained exchange relationships.[90]

Known from Tuscany, wild grape vine had been gathered since Neolithic times. A huge amount of sub-fossil grape pips stored in a MBA silo from San Lorenzo a Greve, Florence, indicates the importance of grapes in the diet in Bronze Age times. From the Bronze Age of Tuscany most of the grape pips show wild forms; however, they are accompanied by pips showing features of cultivated and intermediate forms.[91]

There are also hints for cultivation in the Recent Bronze Age in northern Italy at the *terramare* settlement of Montale, close to Modena.[92]

Proof of wine production was not possible anywhere. It is certain that the cultivation of domesticated grape vine could have started during the Recent Bronze Age.

Charcoal of Vitis in archaeological contexts is rare and is recorded from a period in which domestication has been established.[93] The analysis of pollen in the wider region did not prove it either, but grape vine pollen does not spread over big distances. Wild grape vine is common in the whole Mediterranean region except in Libya and Egypt. Zambrone is located in the potential area of its occurrence.[94]

Seeds of myrtle are evident at Zambrone during the whole Bronze Age. Further archaeobotanical detections of the fruits are known only from Sardinia from the EBA, the MBA to the RBA. In some cases, numerous seeds are found, e.g. from the EBA and MBA at Monte Meana and the RBA at Sa Osa.[95] They are described as edible fruits. Wood remains from *Myrtaceae* are only proven from MBA Portella on Salina and Roca in Apulia, but not from Zambrone.[96]

Olive is detected at Zambrone and twelve other Bronze Age sites in Campania, Sardinia, Apulia, the Aeolian Islands and Calabria from the EBA, MBA, RBA and FBA (Tab. 4). Olive stones

84 Primavera – Fiorentino 2013, 222–224.
85 Primavera – Fiorentino 2013, 213.
86 Primavera – Fiorentino 2013, 215.
87 Forni 2005; Bellini et al. 2008, 110.
88 Fiorentino et al. 2010.
89 Ucchesu et al. 2015b, 587–600.
90 Ucchesu et al. 2015b, 589.
91 Bellini et al. 2008, 110; Mariotti Lippi et al. 2009, 1137.
92 Cardarelli et al. 2015, 2.
93 Ucchesu et al. 2015a, 595.
94 Zohary – Hopf 2000, 154.
95 Sabato et al. 2015, 208; Ucchesu et al. 2015a, 348, tab. 2.
96 Fiorentino et al. 2010; Primavera – Fiorentino 2012.

Author	Region	Site	phase	type	preservation	olive kernels	olive charcoal
D'Auria et al. 2017, 607	Calabria	Punta di Zambrone	EBA	settlement	charred		x
Klee et al. this volume	Calabria	Punta di Zambrone	EBA	settlement	charred	6	
Costantini et al. 2007, 710, 714	Campania	Nola	EBA	settlement	charred	1	
Lacroix-Phippen 1975, 79	Campania	Tufariello	EBA/MBA	settlement	charred	x	
Fiorentino – D'Oronzo 2012, 328	Apulia	Coppa Nevigata	MBA	settlement	charred		404
Fiorentino et al. 2010, 236	Aeolian Islands	Portella on Salina	MBA	settlement	charred		152
Nisbet – Ventura 1994, 582	Sybaritis	Broglio di Trebisacce	MBA	settlement	charred		69
Fiorentino 1998, 215.	Apulia	Monopoli 2	MBA	settlement	charred	2	
Ucchesu et al. 2015a, 345	W. Sardinia	Sa Osa	MBA	well V	non-charred		1
Ucchesu et al. 2015a, 349, 350	W. Sardinia	Meana	MBA	settlement	charred	1	
Coubray 2001, 42	Sybaritis	Torre Mordillo	RBA	settlement	charred		7
D'Auria et al. 2017, 607	Calabria	Punta di Zambrone	RBA	settlement	charred		x
Klee et al. this volume	Calabria	Punta di Zambrone	RBA	settlement	charred	5	
Nisbet – Ventura 1994, 582	Sybaritis	Broglio di Trebisacce	RBA	settlement	charred		133
Fiorentino 1998, 215	Apulia	Monopoli 3	RBA	settlement	charred	93	
Primavera – Fiorentino 2012, 352	Apulia	Roca	RBA	settlement	charred		x
Ucchesu et al. 2015a, 349, 350	W. Sardinia	Cuccurada	RBA	nuraghe	charred	2	
Sabato et al. 2015, 208, 214, 215	W. Sardinia	Sa Osa	RBA	well N	non-charred	2	12
Nisbet – Ventura 1994, 582	Sybaritis	Broglio di Trebisacce	FBA	settlement	charred	3	87

Tab. 4 Literature concerning finds of olive *Olea* kernels and wood in southern Italy

are attested at ten sites, and at ten sites olive wood was found, with both kernels and wood in four of them. While at Punta di Zambrone and most of the other sites only a few stones were detected, at the Apulian settlement of Monopoli 3, Piazza Palmieri (RBA), 93 charred stones make up a larger accumulation. In the Nuraghic settlement of Sa Osa, well V, dating to the MBA, yielded waterlogged olive wood and well N, dating to the RBA, was filled with a rich assemblage of uncharred or sub-fossil remains. Nevertheless, it delivered only two olive stones and some pieces of olive wood but a lot of mastic *Pistacia lentiscus*, from which the extracted oil from the seeds is used for lamps and also for cooking. This gives the impression that during the whole Bronze Age no large-scale production of olive oil took place, but the fruit was consumed. At least, both the fruit and the wood were used, or rather valued.

The growing area of wild olive trees overlaps with that of the wild grape vine, which, however, ranges further to the north.[97] Since their cultivation in the Bronze Age in the Levant, olive trees have been one of the most important fruit-producing trees in the Mediterranean.[98] Recent studies also refer to a second nucleus of domestication in the Mediterranean.[99]

Sloes, hazelnut, blackberry and elder occurr in small amounts at Zambrone. Sloes are found throughout the Bronze Age phases in Italy but always in small numbers.[100] Blackberry and elder are even scarcer. Fragments of shells from hazelnut are detected sporadically (EBA, MBA).[101]

Some interesting species are missing at Zambrone. Figs are not present at Zambrone, but are found from the MBA on in Calabria, Apulia and especially in Sardinia (MBA: Meana and Sa Osa).[102] Here they are already present in the EBA (Meana).[103] In the rich assemblage of well N, dating to the RBA, from Sa Osa, a huge amount of figs were found.[104] No figs are known from northern Italy.

The objective meaning of wild fruits and nuts for daily life is not clear as the evidence is scarce. The results from the MBA site at Sa Osa in Sardinia shed more light on this question. There a waterlogged plant assemblage shows a wide variety of cultivated fruits and species collected by the people. Among others, edible fruits from myrtle, mastic, fig, grape, olive, melon, elderberry, sloe and blackberry were identified. The most interesting finds are seeds of melon (*Cucumis melo*), which are the most ancient of this species in this region of the Mediterranean world, and an early find of mulberry *Morus* sp.[105] The Sa Osa site shows international relationships in the RBA with the exotic fruits of melon and mulberry. Besides this, it demonstrates the highly important role in the diet that useful plants gathered in the wild seem to have had.

At Nola, near Naples, almonds *Prunus dulcis* were apparently consumed in the EBA 2 settlement.[106] This is the only site in Italy and in the Bronze Age where almond was found. This fact shows that not all things are conveyed that were available then. The almond tree originates from the Near East.[107] Whether it was more widespread then, whether it was cultivated or whether the almonds were imported is not known.

97 Zohary – Hopf 2000, 147.
98 Zohary – Hopf 2000, 145–151.
99 Newton et al. 2014, 567–575.
100 Bellini et al. 2008, 262; Marriotti-Lippi et al. 2009, 1138.
101 Bandini Mazzanti – Taroni 1989, 202, 207; Costantini et al. 2007, 710; Bellini et al. 2008, 262; Marriotti-Lippi et al. 2009, 1138, 1140.
102 Fiorentino 1998; Coubray 2001; Peña-Chocarro – Rottoli 2004, 801, 802.
103 Ucchesu et al. 2015a, 348, tab. 2.
104 Sabato et al. 2015, 208.
105 Sabato et al. 2015.
106 Costantini et al. 2007, 708, 710.
107 Zohary – Hopf 2000, 185–187.

Conclusions

The plant assemblage of Punta di Zambrone sheds light on the diversity of the plant diet and agricultural techniques developed in the course of the Bronze Age in southern Italy. Apart from cereals and cultivated pulses, fruits and nuts were important in the plant diet.

As there are only small numbers of charred plant finds in the EBA 2 samples, their relevancy cannot be assessed with confidence. Presumably the reason is of a taphonomic kind. The reverse can be applied to the samples of the RBA: for taphonomic reasons the frequencies and numbers of plant remains are both high. The composition of charred plant remains; fragments of animal bones, burnt and not burnt; seafood residues and small artefacts such as faience beads lead us to assume that we are dealing with rubbish of different kinds, although other explanations are possible.

The cereal species emmer, some einkorn and barley are typical for the Bronze Age in Europe. The difference to the northern parts of Italy and Europe is the massive predominance of emmer and the missing spelt wheat. Field bean is a Bronze Age innovation, but apart from Sardinia and northern Italy it is quite rare in the remainder of Bronze Age Italy. Besides cereals and pulses it must be emphasised that acorn played an important role in nutrition in all phases of the Bronze Age. Again typical for the Recent Bronze Age, with its clear difference to earlier phases, is the distinct increase in broomcorn millet. Yet the expected presence of domesticated grape vine, fig and olive trees is not proven. Remarkable is the constant use of myrtle at Zambrone, which could not be observed elsewhere, apart from Sardinia.

It should be emphasised that to date free-threshing wheat, broomcorn millet, field bean and grape vine emerged for the EBA at Zambrone and only three additional places in southern Italy. They demonstrate the early presence of typical Bronze Age plants at Zambrone which became more important over time. It should be borne in mind that Middle Bronze Age layers are not clearly attested at Punta di Zambrone. The emergence of summer crop weeds and the increase of millet indicate changes in agricultural techniques in the RBA at the latest. The MBA would have been the time span during which certain cultural changes might have occurred. These were possibly due to climatic challenges as well as to foreign influences. This effect may be an adaptation to the increasing aridity in the MBA. In the Recent Bronze Age, Aegean contacts and supposed foreign influences are visible which may explain the observed tendencies in the results from the ashy layers.

Our observations fit perfectly in the contemporary context of Bronze Age Italy and the changes through this period.

Acknowledgements: We want to thank PD Dr. Reinhard Jung, and Prof. Dr. Marco Pacciarelli for involving us in the Punta di Zambrone project and the Fonds zur Förderung der wissenschaftlichen Forschung (FWF, Austria, project P23619-G19) for funding and including the archaeobotanical part in the research. Dr. Andreas G. Heiss was a great help with the photos, thank you.

Area	B	B	B	B	B	B	B	B
Stratigraphic Unit (SU)	48	48	48	48	83	86 a	86 a	86 a
Sample No. (PZBP)	26	36	39	23	48	211	206	212
Sample Volume (litres)	6.0	9.0	7.0	8.0	7.0	12.0	10.0	11.0
Number of Plant Remains	1	10	36	55	14	6	131	5
Concentration (items per litre)	0.2	1.1	5.1	6.9	2.0	0.5	13.1	0.5
Cereal Grains								
Triticum dicoccon Schrank			2				3	
Triticum L.							2	
Cerealia			2	19	3		12	1
Cereal Chaff								
Tiriticum dicoccon Schrank			6	4		1	19	
Triticum L.				6				
Pulses								
Vicia faba L.							2	
Fabaceae cf. cultivated			2			3	3	
Segetals								
Silene gallica L.							2	
Ruderals								
Medicago arabica (L.) Huds.				2				
Others								
Vicieae							11	
Unidentified Plant Remains								
bread, pulp, seeds and fruits	1	10	24	24	11	2	77	4

Area	B	B	B	B	B	B	B	B
Stratigraphic Unit (SU)	86 a	86 a	86 a	86 a	86 a	86 b	86 b	86 b
Sample No. (PZBP)	209	210	208	218	213	222	221	241
Sample Volume (litres)	12.0	12.0	10.0	4.0	10.0	9.0	10.0	7.5
Number of Plant Remains	9	37	14	16	61	4	10	10
Concentration (items per litre)	0.8	3.1	1.4	4.0	6.1	0.4	1.0	1.3
Cereal Grains								
Triticum L.					2			
Cerealia			3					
Panicum miliaceum L.								1
Cereal Chaff								
Tiriticum dicoccon Schrank	1	3			1			
Pulses								
Vicia faba L.				1				
Fabaceae cf. cultivated					6			

Area	B	B	B	B	B	B	B	B
Stratigraphic Unit (SU)	86 a	86 a	86 a	86 a	86 a	86 b	86 b	86 b
Sample No. (PZBP)	209	210	208	218	213	222	221	241
Fruits and Nuts								
Olea europaea L.		4						
Quercus L.					2			
Segetals								
Vicia cf. hirsuta (L.) S. F. Gray					1			
Meadows - Pastures								
Lotus corniculatus L.					2			
Ruderals								
Medicago arabica (L.) Huds.		2						
Others								
Silene L.		1						
Trifolieae		1						
Vicieae		1			1			
Unidentified Plant Remains								
resin? (amorphous material)					1			
bread, pulp, seeds and fruits	8	25	11	15	45	4	10	9

Area	B	B	B	B	B	B	B	B
Stratigraphic Unit (SU)	86 b	86 b	86 b	86 b	86 b	86 b	86 b	86 c
Sample No. (PZBP)	220	229	238	231	219	240	217	232
Sample Volume (litres)	10.0	10.0	10.0	9.0	10.0	9.0	4.0	6.0
Number of Plant Remains	46	4	12	12	6	16	26	3
Concentration (items per litre)	4.6	0.4	1.2	1.3	0.6	1.8	6.5	0.5
Cereal Grains								
Hordeum vulgare L.	1					1		
Triticum dicoccon Schrank	2						2	
Cerealia				1		1		
Cereal Chaff								
Tiriticum dicoccon Schrank				1				
Pulses								
Fabaceae cf. cultivated	5							
Fruits and Nuts								
Myrtus communis L.		1						
Olea europaea L.	1							
Quercus L.					1			
Unidentified Plant Remains								
bread, pulp, seeds and fruits	37	3	12	10	5	14	24	3

Area	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**
Stratigraphic Unit (SU)	86 c	86 c	86 c	133	135	137	149	149
Sample No. (PZBP)	234	236	205	140	134	136	228	239
Sample Volume (litres)	5.0	11.0	10.0	3.5	2.5	1.5	10.0	7.0
Number of Plant Remains	3	10	15	25	4	1	16	30
Concentration (items per litre)	0.6	0.9	1.5	7.1	1.6	0.7	1.6	4.3
Cereal Grains								
Triticum aestivum L./durum Desf.						1		
Cerealia		1					4	
Panicum miliaceum L.							1*	
Cereal Chaff								
Tiriticum dicoccon Schrank			3	6				
Pulses								
Fabaceae cf. cultivated		2						
Fruits and Nuts								
Myrtus communis L.			1					
Quercus L.								2
Unidentified Plant Remains								
bread, pulp, seeds and fruits	3	7	11	19	4		11	28

Area	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**
Stratigraphic Unit (SU)	166	166	166	166	166	166	166	166
Sample No. (PZBP)	262	254	266	261	259	256	253	252
Sample Volume (litres)	11.0	10.0	11.0	11.0	8.0	9.0	9.0	10.0
Number of Plant Remains	8	89	28	16	29	82	154	39
Concentration (items per litre)	0.7	8.9	2.5	1.5	3.6	9.1	17.1	3.9
Cereal Grains								
Triticum dicoccon Schrank	1	3					1	1
Triticum L.					3			
Cerealia	3	4	1	4	4	4		2
Cereal Chaff								
Tiriticum dicoccon Schrank		11			4	1	30	
Triticum L.								7
Pulses								
Fabaceae cf. cultivated		3	2					
Fruits and Nuts								
Olea europaea L.							1	
Vitis vinifera L.				2				
Segetals								
Bromus secalinus L.						35		
Vicia cf. angustfolia Grufb.			1					
Meadows – Pastures								
Leucanthemum ircutianum Turcz.							1	
Lotus corniculatus L.				1			1	

* This millet seed has been directly dated. Its growth period is in the 20th cent. C.E. (see footnote 48)

Area	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**
Stratigraphic Unit (SU)	166	166	166	166	166	166	166	166
Sample No. (PZBP)	262	254	266	261	259	256	253	252
Ruderals								
Medicago arabica (L.) Huds.							1	
Others								
Avena L.		1	1					
Carduus L.			3					
Poaceae			5					
Vicieae		1						1
Unidentified Plant Remains								
bread, pulp, seeds and fruits	4	66	15	9	18	42	119	28

Area	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**
Stratigraphic Unit (SU)	166	166 a	166 a	166 a	166a	166a	166a	166 a
Sample No. (PZBP)	264	285	269	271	273	274	275	286
Sample Volume (litres)	11.0	6.0	10.0	10.0	8.0	9.0	9.0	6.0
Number of Plant Remains	8	6	4	3	26	6	6	4
Concentration (items per litre)	0.7	1.0	0.4	0.3	3.3	0.7	0.7	0.7
Cereal Grains								
Triticum dicoccon Schrank					1			
Triticum monococcum L.						1		
Triticum L.	2				1			
Cerealia							2	
Cereal Chaff								
Tiriticum dicoccon Schrank								1
Others								
Carduus L.					1			
Unidentified Plant Remains								
bread, pulp, seeds and fruits	6	6	4	3	23	5	4	3

Area	**B**	**B**	**B**	**B**				
Stratigraphic Unit (SU)	166 a?	181	191	191				
Sample No. (PZBP)	277	281	284	296				
Sample Volume (litre)	9.0	1.0	7.0	9.0				
Number of Plant Remains	3	3	4	1				
Concentration (items per litre)	0.3	3.0	0.6	0.1				
Cereal Grains								
Cerealia		3						
Others								
Vicieae				1				
Unidentified Plant Remains								
bread, pulp, seeds and fruits	3		4					

Tab. 3a Complete species list per sample of the EBA 2 phase at Zambrone.

Area	B	B	B	B	B	B	B	C	C	C
Stratigraphic Unit (SU)	97	107	108	142	109	113	115	210	217	218
Sample No. (PZBP)	141	131	133	137	138	143	139	289	295	293
Sample Volume (litres)	10.0	7.0	6.0	4.5	6.0	6.0	7.0	9.0	9.0	7.0
Number of Plant Remains	27	16	6	4	2	3	2	324	33	223
Concentration (items per litre)	2.7	2.3	1.0	0.9	0.3	0.5	0.3	36.0	3.7	31.9
Cereal Grains										
Hordeum vulgare L.								7		8
Panicum miliaceum L.			1					3		
Triticum L.								42		20
Triticum dicoccon Schrank								35	1	7
Triticum monococcum L.								2		4
Cerealia	2	4	2					19		41
Cereal Chaff										
Hordeum vulgare L.										
Triticum L.		1						12	2	13
Tiriticum dicoccon Schrank	2			2			2	80		95
Triticum monococcum L.										5
Pulses										
Fabaceae cf. Cultivated		1								3
Fruits and Nuts										
Myrtus communis L										1
Rubus fruticosus L.								2		
Vitis vinifera L.		1						4	19	4
Segetals										
Vicia L.										1
Meadows - Pastures										
Cynosurus cristatus L.								2		
Ruderals										
Chenopdium album L.								1		
Others										
Poaceae								2		9
Polygonum L.								1		1
Vicieae		2						2		
Unidentified Plant Remains										
bread, pulp, fruit or seeds and fruits	23	7	3	2	2	3		110	11	11

Tab. 3b Complete species list per sample of the MBA–RBA phase at Zambrone

Area	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**
Stratigraphic Unit (SU)	6	6	33	33, 42, 44, 50	40 & 42	6 & 40	6 & 40	106
Sample No. (PZBP)	7	12	18	9	8	11	13	121
Sample Volume (litres)	7.5	8.0	8.5	9.0	7.0	6.0	8.,0	8.0
Number of Plant Remains	30	54	88	25	45	17	96	14
Concentration (items per litre)	4.0	6.8	10.4	2.8	6,4	2.8	12.0	1.8
Cereal Grains								
Hordeum vulgare L.		1	1				4	
Triticum dicoccon Schrank			1		1			2
Triticum L.			9					
Cerealia		5	13	6	1	4	10	
Panicum miliaceum L.	1			1			1	
Cereal Chaff								
Triticum dicoccon Schrank			3		1		1	
Triticum L.			3					
Pulses								
Vicia faba L.		1						
Fabaceae cf. cultivated						2		
Fruits and Nuts								
Prunus spinosa L.		1						
Quercus L.							1	
Segetals								
Vaccaria hispanica (Mill.) Rauschert		1			1			
Ruderals								
Medicago arabica (L.) Huds.			1					
Others								
Poa L.						2		
Poaceae	1				1			
Polygonum L.			1					
Vicieae		6				1	4	3
Unidentified Plant Remains								
bread, pulp, seeds and fruits	28	39	56	18	40	8	75	9

Area	B	B	B	B	B	B	B	B
Stratigraphic Unit (SU)	106	106	111	116	117	117	118	126
Sample No. (PZBP)	122	123	135	126	132	116	128	124
Sample Volume (litres)	7.5	6.0	7.5	3.0	4.0	4.0	2.0	3.0
Number of Plant Remains	43	51	11	21	1256	67	17	8
Concentration (items per litre)	5.7	8.5	1.5	7.0	314.0	16.8	8.5	2.7
Cereal Grains								
Hordeum vulgare L.				1	4	5		
Triticum dicoccon Schrank	1	1		1	3			
Triticum monococcum L.					1			
Triticum L.					10	5	1	
Cerealia	4	3			29	14	3	
Panicum miliaceum L.		2			4		2	
Cereal Chaff								
Triticum dicoccon Schrank	4	4	1		170	11		
Triticum monococcum L.			2					
Triticum L.					622		1	
Pulses								
Vicia faba L.						1		1
Fruits and Nuts								
Quercus L.		1						
Vitis vinifera L.		1			13			
Segetals								
Silene gallica L.					11	1		
Vicia L.								1
Meadows - Pastures								
Cynosurus cristatus L.		1						
Ruderals								
Plantago major L.						1		
Others								
Avena L.					3			
Carex L.					1			
Malva L.					5			
Poaceae						3		
Trifolium L.		1						
Vicieae	4	3			6	1		
Unidentified Plant Remains								
bread, pulp, seeds and fruits	30	34	8	19	374	25	10	6

Area	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**
Stratigraphic Unit (SU)	66	66	66	66	66	66	66	66
Sample No. (PZBP)	30	37	40	101	102	104	105	106
Sample Volume (litres)	6.3	7.3	7.0	10.0	10.0	10.0	9.0	11.0
Number of Plant Remains	206	139	70	350	300	73	234	118
Concentration (items per litre)	32.7	19.0	10.0	35.0	30.0	7,3	26.0	10.7
Cereal Grains								
Hordeum vulgare L.	2		6	2	5	2	3	
Triticum dicoccon Schrank	2	3			6	2	2	1
Triticum monococcum L.			1					
Triticum L.	8	3	2	6	3	8	6	5
Cerealia	17	4	10	12	19	2	19	4
Panicum miliaceum L.	8			2	6		5	1
Cereal Chaff								
Triticum dicoccon Schrank	10	61	1	28	29	8	35	4
Triticum L.							1	
Pulses								
Vicia faba L.	4		2		6	4		2
Fabaceae cf. cultivated			9	8	5		4	6
Fruits and Nuts								
Myrtus communis L				1	3			
Olea europaea L.				1				
Quercus L.				2	4		1	2
Vitis vinifera L.		4		7	5		6	
Segetals								
Buglossoides arvensis (L.) Johnston	1			2		1		
Silene gallica L.				1				
Stellaria media (L.) Vill.	1							
Meadows - Pastures								
Lotus corniculatus L.		2	2					
Ruderals								
Medicago arabica (L.) Huds.	4	10	2	1				
Others								
Poaceae					1			
Trifolieae						2		
Vicieae	4			11	12	14	8	
Unidentified Plant Remains								
resin? (amorphous material)	2			4				
bread, pulp, seeds and fruits	143	52	35	262	196	30	144	93

Area	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**
Stratigraphic Unit (SU)	66	66	66	66	66a	66a	66a	66a
Sample No. (PZBP)	107	108	110	111	21	22	25	27
Sample Volume (litres)	10.0	9.0	8.0	8.0	8.5	8.5	8.0	7.0
Number of Plant Remains	190	174	220	126	649	366	373	227
Concentration (items per litre)	19.0	19.3	27.5	15.8	76.4	43.1	46.6	32.4
Cereal Grains								
Hordeum vulgare L.	1	1	3		3	4	3	4
Hordeum vulgare L. lump								2
Triticum dicoccon Schrank		2	2	1	5	8	3	1
Triticum monococcum L.	1				1		2	
Triticum L.	6	3	3	7	9		4	1
Cerealia	8	10	4	10	23	17	23	13
Panicum miliaceum L.	3	3	3	1	11	4	3	
Cereal Chaff								
Triticum dicoccon Schrank	9	7	11	11	71	39	13	18
Triticum L.					24	8	1	7
Pulses								
Lens culinaris Med.							2	1
Vicia faba L.		2	3	3	1			
Fabaceae cf. cultivated	5	10	6	6		3	10	10
Fruits and Nuts								
Myrtus communis L					1	1		
Quercus L.	1	2	8					
Sambucus L.							1	
Vitis vinifera L.	13	3	7	3	8	6	4	3
Segetals								
Silene gallica L.	1					1		
Vicia cf. angustfolia Grufb.							2	
Meadows - Pastures								
Cynosurus cristatus L.	1						1	
Lotus corniculatus L.								2
Woodland - Hedges								
Briza maxima L.		1			1	1		
Ruderals								
Chenopdium album L.	1							
Medicago arabica (L.) Huds.				1	1	1	15	3
Torilis Adans.							2	
Others								
Asteraceae					1			
Atriplex L.	1							
Avena L.							1	
Chenopodiaceae					1			
Malva L.					1			
Poaceae	1			1	3		1	1
Rubus L.								1
Trifolium L.				1				
Vicieae	7	13	9	1			14	1

Area	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**
Stratigraphic Unit (SU)	66	66	66	66	66a	66a	66a	66a
Sample No. (PZBP)	107	108	110	111	21	22	25	27
Unidentified Plant Remains								
stalks, stems, leaves					4			1
bread, pulp, seeds and fruits	131	117	161	80	480	273	268	158
mineralised seeds and fruits					1			

Area	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**
Stratigraphic Unit (SU)	66a	66a	66a	66a	66a	66a	66a	66a
Sample No. (PZBP)	28	29	31	32	33	34	35	38
Sample Volume (litres)	9.5	7,0	6,5	7.0	7,0	9.2	6.5	8.0
Number of Plant Remains	319	161	150	156	230	54	60	164
Concentration (items per litre)	33.6	23.0	23.1	22.3	32.9	5.9	9.2	20.5
Cereal Grains								
Hordeum vulgare L.	3	4	3		3		3	5
Triticum dicoccon Schrank	2	1		2	3			1
Triticum L.		3	3	3	5		2	1
Cerealia	15	7	11	8	12	10	9	4
Panicum miliaceum L.	4	2	2	5	1	1		2
Cereal Chaff								
Triticum dicoccon Schrank	36	9	5	8	13			6
Triticum L.	15				1			
Pulses								
Lens culinaris Med.		1						
Vicia faba L.	2		1	1	1	4		
Fabaceae cf. cultivated	7	8	2	4	13		3	14
Fruits and Nuts								
Myrtus communis L		1						
Quercus L.	2							
Rubus fruticosus L.	1							
Vitis vinifera L.	3	1	1		1			3
Meadows - Pastures								
Lotus corniculatus L.	6	3		1				
Ruderals								
Medicago arabica (L.) Huds.	6	1		3	1			2
Others								
Asteraceae								1
Poaceae	1				1			
Rosa L.	1							
Vicieae	16							
Unidentified Plant Remains								
stalks, stems, leaves		3						
resin? (amorphous material)		1						
bread, pulp, seeds and fruits	199	116	122	121	175	39	43	125

Area	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**
Stratigraphic Unit (SU)	66a	66b	66b	66b	66b	66b	66b	66b
Sample No. (PZBP)	42	43	45	46	47	49	54	55
Sample Volume (litres)	9.0	6.0	6.0	8.5	7.0	9.0	8.0	7.0
Number of Plant Remains	117	99	86	106	77	86	306	154
Concentration (items per litre)	13.0	16.5	14.3	12.5	11.0	9.6	38.3	22.0
Cereal Grains								
Hordeum vulgare L.	3	4	1	2	1	2	1	1
Triticum aestivum L./durum Desf.	1							
Triticum dicoccon Schrank	5	3					9	4
Triticum monococcum L.							1	
Triticum L.	5			3	1			1
Cerealia	5	5	5	2	1	17	21	17
Panicum miliaceum L.	1	2		2	2	5	2	9
cf. Panicum miliaceum L. lump								1
Cereal Chaff								
Triticum dicoccon Schrank	9	2	2	22	1	4	9	10
Triticum L.		1					2	
Pulses								
Vicia faba L.	2	4	3	2		3	10	8
Fabaceae cf. cultivated	12	7	6	2	15	7	26	12
Fruits and Nuts								
Quercus L.	1			1		1		
Vitis vinifera L.	1					1	4	
Meadows - Pastures								
Lotus corniculatus L.		1						
Ruderals								
Chenopdium album L.								1
Medicago arabica (L.) Huds.								1
Others								
Poaceae			1					
Trifolium L.	1							
Vicieae		14	2			1		
Unidentified Plant Remains								
bread, pulp, seeds and fruits	71	56	66	70	56	45	221	89

Area	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**
Stratigraphic Unit (SU)	66b	66b	66b	66b	66b	66b	66b	66b
Sample No. (PZBP)	56	57	58	60	61	62	63	64
Sample Volume (litres)	7.0	8.5	9.0	7.0	7.0	7.0	7.0	8.0
Number of Plant Remains	120	285	102	145	134	226	60	195
Concentration (items per litre)	17.1	33.5	11.3	20.7	19.1	32.3	8.6	24.4
Cereal Grains								
Hordeum vulgare L.	2	2	2	1	19	4		4
Triticum dicoccon Schrank	3	8	4	1		2	1	5
Triticum monococcum L.	1	1						
Triticum L.		4	1	7		5		12
Cerealia	12	28	6	32	1	31	3	10
Panicum miliaceum L.		8	6	2	2	9	5	7
Cereal Chaff								
Triticum dicoccon Schrank	2	8	1	7	13	7	1	17
Triticum monococcum L.	1		1					
Triticum L.		2						
Pulses								
Lens culinaris Med.								1
Vicia faba L.	6	4	4		1	14	2	10
Fabaceae cf. cultivated	10	18	14	12	13		8	18
Fruits and Nuts								
Quercus L.				2		1		1
Vitis vinifera L.		2	3	5	8			3
Meadows - Pastures								
Cynosurus cristatus L.							1	
Ruderals								
Medicago arabica (L.) Huds.	6	2			1	8		
Asteraceae						1		
Poaceae	1							4
Vicieae	6	20				15		
Unidentified Plant Remains								
stalks, stems, leaves						1		
bread, pulp, seeds and fruits	70	178	60	76	76	128	39	103
mineralised seeds and fruits								2

Area	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**
Stratigraphic Unit (SU)	66b	66b	66b	66c	66c	66c	66c	66c
Sample No. (PZBP)	65	69	72	50	51	52	53	59
Sample Volume (litres)	7.0	9.0	8.0	7.0	8.0	7.0	7.0	8.0
Number of Plant Remains	131	503	443	155	358	232	143	299
Concentration (items per litre)	18.7	55.9	55.4	22.1	44.8	33.1	20.4	37.4
Cereal Grains								
Hordeum vulgare L.	1	10	8	4	5	3	1	6
Triticum dicoccon Schrank	1		2		3	4	3	5
Triticum monococcum L.							1	3
Triticum L.	6	7	8	1	20	6		18
Cerealia	6	23	24	28	16	14	7	37
Panicum miliaceum L.	4	3	5	1	13	8	1	19
Cereal Chaff								
Triticum dicoccon Schrank	13	34	15	15	16	3	6	16
Triticum durum Desf.		1	1			1		
Triticum L.		22		3		1		
Pulses								
Vicia faba L.		7	8	1	13	11	1	9
Fabaceae cf. cultivated	16	47	6	6	16	9	15	20
Fruits and Nuts								
Myrtus communis L							1	
Prunus spinosa L.							2	
Quercus L.			1		6	2		5
Vitis vinifera L.	2			3		1	4	2
Segetals								
Silene gallica L.								1
Vicia L.								2
Ruderals								
Medicago arabica (L.) Huds.			2	1			1	
Galium L.		1						
Poaceae		6				1		1
Trifolieae							3	
Vicieae		8	51	4	19	27		21
Unidentified Plant Remains								
stalks, stems, leaves				8				
resin? (amorphous material)				2	3			
bread, pulp, seeds and fruits	82	334	312	78	228	141	97	134

Area	**C**	**C**	**C**	**C**	**C**	**C**	**C**
Stratigraphic Unit (SU)	66c	66c	66c	66c	66c	66c	66c
Sample No. (PZBP)	66	67	68	70	71	73	76
Sample Volume (litres)	7.5	7.0	6.5	7.3	8.5	7.0	7.0
Number of Plant Remains	200	219	258	270	261	270	1067
Concentration (items per litre)	26.7	31.3	39.7	37.0	30.7	38.6	152.4
Cereal Grains							
Hordeum vulgare L.	3	2	2	4	3	9	10
Triticum dicoccon Schrank		2	1	2	5	7	34
Triticum monococcum L.							1
Triticum L.	2	1	12	4	9	11	39
Cerealia	5	6	9	21	22	22	28
Panicum miliaceum L.	2	1		1	5	11	37
Cereal Chaff							
Triticum dicoccon Schrank	22	13	18	28	39	14	287
Triticum durum Desf.		1					
Triticum monococcum L.				1			4
Triticum L.			6	1	14	8	1
Pulses							
Vicia faba L.	1	4	1	2		8	6
Fabaceae cf. cultivated	10	7	2	6	1	12	17
Fruits and Nuts							
Corylus avellana L.							1
Myrtus communis L		2		1			4
Quercus L.		5	1				
Sambucus L.		1					
Vitis vinifera L.	2	9	10	4	3	1	17
Segetals							
Sherardia arvensis L.							1
Silene gallica L.							4
Vicia cf. angustfolia Grufb.							1
Meadows - Pastures							
Cynosurus cristatus L.							1
Lotus corniculatus L.							1
Potentilla reptans L.							
Woodland - Hedges							
Briza maxima L.							1
Ruderals							
Medicago arabica (L.) Huds.							4
Silene alba (Mill.) Krause/S. dioica (L.) Clairville							1
Others							
Atriplex L.							1
Poaceae					2	5	
Rubus L.							1
Rumex L.				1			
Vicieae		3	8	12	6	20	19
Unidentified Plant Remains							
bread, pulp, seeds and fruits	153	162	188	182	152	142	546
mineralised seeds and fruits							1

Area	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**
Stratigraphic Unit (SU)	66c	66c	66c	66c	66c	66d	66d	66e
Sample No. (PZBP)	77	78	79	80	81	75	82	112
Sample Volume (litres)	7.0	8.0	7.0	8.5	6.5	6.0	6.5	8.0
Number of Plant Remains	169	553	196	279	213	259	339	327
Concentration (items per litre)	24.1	69.1	28.0	32.8	32.8	43.2	52.2	40.9
Cereal Grains								
Hordeum vulgare L.	3	8	3	12	9	5	3	10
Triticum dicoccon Schrank		6	4	2	3	2	4	2
Triticum monococcum L.		1					1	
Triticum L.	6	25	8	6	14	5	7	9
Cerealia	9	47	8	23	4	26	23	10
Panicum miliaceum L.	2	17	1	7	12	5	9	2
Cereal Chaff								
Triticum dicoccon Schrank	10	109		21	8	29	30	1
Triticum monococcum L.		12	2				9	
Triticum L.		1						
Pulses								
Vicia faba L.	4	8	5	6	12	2	8	4
Fabaceae cf. cultivated	4	9	13	4	31	15	38	15
Fruits and Nuts								
Myrtus communis L			1					
Quercus L.		2			1			
Sambucus L.		1						
Vitis vinifera L.	5	5	5	1	3	1	7	4
Segetals								
Silene gallica L.		2						
Meadows - Pastures								
Cynosurus cristatus L.		2						
Ruderals								
Chenopdium album L.								1
Medicago arabica (L.) Huds.	1	4						1
Others								
Avena L.		1						
Cirsium L.								1
Poaceae	1			1		1		1
Rubus L.				1				
Rumex L.		1					1	
Solanaceae								
Trifolium L.							1	
Trifolieae								2
Vicieae	7	29	11	36	6	7	20	15
Unidentified Plant Remains								
bread, pulp, seeds and fruits	117	263	135	159	110	161	178	249

Area	**C**	**C**	**C**	**C**	**C**	**C**	**C**
Stratigraphic Unit (SU)	66e	66f	66f	66f	66f	66f	66f
Sample No. (PZBP)	113	117	118	119	120	125	127
Sample Volume (litres)	10.0	8.0	10.0	10.0	10.0	10.0	8.0
Number of Plant Remains	233	210	62	196	188	142	63
Concentration (items per litre)	23.3	26.3	6.2	19.6	18.8	14.2	7.9
Cereal Grains							
Hordeum vulgare L.	3	3	2	2		2	1
Triticum dicoccon Schrank	1	1	1	1		4	
Triticum monococcum L.		1					
Triticum L.	3	5	8	5	4	8	4
Cerealia	6	6	7	15	7	5	8
Panicum miliaceum L.	3	12	2	7	6	1	1
Cereal Chaff							
Triticum dicoccon Schrank	1	8	1	7	6		4
Triticum L.						3	
Pulses							
Vicia faba L.	7	1		2		2	
Fabaceae cf. cultivated	25	2				3	
Fruits and Nuts							
cf. Malus sylvestris Miller				2			
Myrtus communis L		2				1	
Quercus L.			1	2	2		
Sambucus L.			1				
Vitis vinifera L.		2		2	3		
Meadows - Pastures							
Cynosurus cristatus L.	1	1					
Leucanthemum ircutianum Turcz.			1	1			
Lotus corniculatus L.	1						
Ruderals							
Medicago arabica (L.) Huds.	1						
Others							
Rumex L.		1					
Vicieae	18	13	9	3	4	8	2
Unidentified Plant Remains							
bread, pulp, seeds and fruits	163	152	29	147	156	105	43

Area	**C**	**C**	**C**	**C**	**C**	**C**	**C**
Stratigraphic Unit (SU)	75	75	80	123	129	129	129
Sample No. (PZBP)	267	294	203	204	129	130	144
Sample Volume (litres)	7.0	6.0	11.0	12.0	8.0	9.0	8.0
Number of Plant Remains	39	63	171	60	143	183	233
Concentration (items per litre)	5.6	10.5	15.5	5.0	17.9	20.3	29.1
Cereal Grains							
Hordeum vulgare L.	2	1		1	3	3	1
Triticum aestivum L./durum Desf.	1						
Triticum dicoccon Schrank		8	1	2	1	3	1
Triticum monococcum L.				1			
Triticum L.			9			6	11
Cerealia	8	28	21		8	9	8
Panicum miliaceum L.	3	1	6		1	9	3
Cereal Chaff							
Triticum dicoccon Schrank	1	12	14		8	5	41
Triticum L.	1			4			3
Pulses							
Vicia faba L.			4		3	4	1
Fabaceae cf. cultivated	1		15		4	8	6
Fruits and Nuts							
Myrtus communis L						2	
Quercus L.			1	2			
Rubus fruticosus L.		2					
Vitis vinifera L.	3		5	2	1	1	11
Segetals							
Vicia L.					1		
Ruderals							
Medicago arabica (L.) Huds.			2	2			
Asteraceae					1		
Fumaria cf. capreolata L.					1		
Lithospermum L.				1			
Poaceae		3					
Vicieae			12	2	4		10
Unidentified Plant Remains							
bread, pulp, seeds and fruits	19	8	81	43	107	133	137

Area	**C**	**C**	**C**	**C**	**C**	**C**	**C**
Stratigraphic Unit (SU)	129	129	129	129	129	129	129
Sample No. (PZBP)	145	146	147	148	149	150	201
Sample Volume (litres)	9.0	7.0	8.0	8.0	9.0	9.0	10.0
Number of Plant Remains	127	135	123	144	79	39	342
Concentration (items per litre)	14.1	19.3	15.4	18.0	8.8	4.3	34.2
Cereal Grains							
Hordeum vulgare L.	3		1	2	4	2	9
Triticum dicoccon Schrank	2	1	2	3		2	3
Triticum L.		5	3	6	1	3	11
Cerealia	12	10	7	9	6		36
Panicum miliaceum L.	1	3	1	5	3		5
Cereal Chaff							
Triticum dicoccon Schrank	4	13	5	6	2	1	44
Triticum L.							11
Pulses							
Lens culinaris Med.				1			
Vicia faba L.	1	3	1		1	1	10
Fabaceae cf. cultivated		7	15	6	5	1	13
Fruits and Nuts							
Myrtus communis L							1
Quercus L.	1	3	1	1			1
Vitis vinifera L.	2	2		1	2		3
Segetals							
Bromus secalinus L.							
Digitaria ischaemum (Schreb.) Muhl.		1					
Silene gallica L.			2				
Meadows - Pastures							
Cynosurus cristatus L.				1			
Ruderals							
Medicago arabica (L.) Huds.	1				2		1
Others							
Asteraceae				2			1
Avena L.		1					
Poaceae			1				1
Trifolium L.				1			
Vicieae	8	9	11	3	2	4	27
Unidentified Plant Remains							
bread, pulp, seeds and fruits	92	77	73	97	51	25	165

Area	**C**	**C**	**C**	**C**	**C**	**C**	**C**
Stratigraphic Unit (SU)	129	129	129a	151	151	151	151
Sample No. (PZBP)	202	215	216	224	233	237	242
Sample Volume (litres)	10.0	10.0	11.0	10.0	8.0	9.5	9.0
Number of Plant Remains	133	1456	1290	120	235	137	249
Concentration (items per litre)	13.3	145.6	117.3	12.0	29.4	14.4	27.7
Cereal Grains							
Hordeum vulgare L.	2	33	94	3		1	
Triticum aestivum L./durum Desf.			7				
Triticum dicoccon Schrank	1	25	60		2	1	
Triticum monococcum L.			4				
Triticum L.		59	56	6	4	3	2
Cerealia	13	173	48	2	5	8	18
Panicum miliaceum L.	4	69	49	1	2	2	4
Cereal Chaff							
Triticum dicoccon Schrank	21	555	276	3	53	29	16
Triticum durum Desf.		1					
Triticum monococcum L.		5					
Triticum L.		28	47				
Pulses							
Vicia faba L.	2	2	22			4	
Fabaceae cf. cultivated		8	16	5	5	4	2
Fruits and Nuts							
Myrtus communis L	1	1			1		2
Olea europaea L.		2					
Quercus L.	1	2					1
Rubus fruticosus L.	4		1				1
Vitis vinifera L.		26	20	2	6	6	5
Segetals							
Digitaria ischaemum (Schreb.) Muhl.			2				
Echinochloa crus-galli (L.) P.B.			1		2		
Galium tricornutum L.					1		
Setaria viridis (L.) P.B.			1				
Silene gallica L.		3	2	4	2		1
Stellaria media (L.) Vill.		2	1				
Vicia L.		4					
Meadows - Pastures							
Cynosurus cristatus L.		9	23				
Woodland - Hedges							
Atropa belladonna L.		2					
Briza maxima L.		4					
Polygonum dumetorum L.							
cf. Rosmarinus officinalis L.			1				

Area	**C**	**C**	**C**	**C**	**C**	**C**	**C**
Stratigraphic Unit (SU)	129	129	129a	151	151	151	151
Sample No. (PZBP)	202	215	216	224	233	237	242
Ruderals							
Atriplex hastata L.			4				
Chenopdium album L.		4	4				
Medicago arabica (L.) Huds.	1	3					
Others							
Asteraceae			1				
Avena L.			1				
Carex L.		1	1				
Caryophyllaceae			1				
Malva L.		1					
Poaceae		5	23				
Rumex L.		2	1				
Solanaceae			1				
Trifolieae	1	4	3				
Vicieae		22	36		2	6	10
Unidentified Plant Remains							
stalks, stems, leaves		6					
bread, pulp, seeds and fruits	82	395	483	94	150	73	187

Area	**C**	**C**	**C**	**C**	**C**	**C**	**C**
Stratigraphic Unit (SU)	151	151	151	151	151	151	151
Sample No. (PZBP)	243	244	245	246	248	249	260
Sample Volume (litres)	10.5	8.0	8.0	9.0	8.5	8.0	10.0
Number of Plant Remains	517	279	110	88	298	268	266
Concentration (items per litre)	49,2	34.9	13.8	9.8	35.1	33.5	26.6
Cereal Grains							
Hordeum vulgare L.	2	1	1		10	6	3
Triticum dicoccon Schrank	2	4	3		3	9	3
Triticum L.	2	5		5	6	6	5
Cerealia	22	11	10	8	18	20	17
Panicum miliaceum L.	6	5	10	1	8	30	4
Cereal Chaff							
Triticum dicoccon Schrank	78	7	8	7	6	16	29
Triticum L.	4				3		
Pulses							
Vicia faba L.	2	1			12	3	
Fabaceae cf. cultivated	7		6	5	15	14	3
Fruits and Nuts							
Myrtus communis L		1					
Olea europaea L.		1					
Quercus L.		1		3	1	1	
Vitis vinifera L.	18	4	1	2	7	5	4

Area	**C**	**C**	**C**	**C**	**C**	**C**	**C**
Stratigraphic Unit (SU)	151	151	151	151	151	151	151
Sample No. (PZBP)	243	244	245	246	248	249	260
Segetals							
Silene gallica L.	1						1
Vicia L.	1					1	
Meadows - Pastures							
Potentilla reptans L.		1					
Woodland - Hedges							
Briza maxima L.						1	1
Ruderals							
Lathyrus sativus L./cicera L.							1
Others							
Poaceae	2	1					3
Ranunculus L.	1						
Trifolieae						1	
Vicieae	10	5			28	25	6
Unidentified Plant Remains							
bread, pulp, seeds and fruits	359	231	71	57	181	130	186

Area	**C**	**C**	**C**	**C**	**C**	**C**
Stratigraphic Unit (SU)	161	161	162	176	194	194/P1
Sample No. (PZBP)	250	251	279	290	287	288
Sample Volume (litres)	9.0	9.0	10.0	9.0	9.0	0.03
Number of Plant Remains	378	1589	498	29	672	5
Concentration (items per litre)	42.0	176.6	49.8	3.2	74.7	167
Cereal Grains						
Hordeum vulgare L.	2	131	2	3	2	
Triticum dicoccon Schrank	1	88	4		4	
Triticum monococcum L.		3				
Triticum L.	3	99	16		7	
Cerealia	3	160	11	4	36	
Panicum miliaceum L.	26	269	19		31	
Cereal Chaff						
Hordeum vulgare L.					1	
Triticum dicoccon Schrank	85	142	131	6	201	1
Triticum durum Desf.					1	
Triticum L.	2		14		36	
Pulses						
Vicia faba L.		4				
Fabaceae cf. cultivated	1	3	6	2		

Area	**C**	**C**	**C**	**C**	**C**	**C**
Stratigraphic Unit (SU)	161	161	162	176	194	194/P1
Sample No. (PZBP)	250	251	279	290	287	288
Fruits and Nuts						
Myrtus communis L	1	4			1	
Olea europaea L.					1	
Quercus L.	2		3		2	
Rubus fruticosus L.					2	
Sambucus L.		1			1	
Vitis vinifera L.	6	19	4	4	4	
Segetals						
Bromus secalinus L.	1					
Fallopia convolvulus L.	1					
Silene gallica L.		3			1	
Stellaria media (L.) Vill.	3	14				
Vicia L.		4				
Meadows - Pastures						
Cynosurus cristatus L.	14	24	1			
Leucanthemum ircutianum Turcz.		1				
Woodland - Hedges						
Briza maxima L.					1	
Polygonum dumetorum L.		1				
Ruderals						
Chenopdium album L.	7	7				
Chenopodium murale L.	1					
Hyoscyamus niger L.	4	2				
Polygonum aviculare L.	1					
Solanum nigrum L.		1				
Others						
Atriplex L.	5	3				
Chenopodiaceae	3					
Paniceae (wild)				1		
Poaceae	4					
Rumex L.					1	
Trifolieae	1					
Vicieae	1	10	6		11	
Unidentified Plant Remains						
stalks, stems, leaves		13				
bread, pulp, seeds and fruits	200	583	281	9	328	4

Tab. 3c Complete species list per sample of the RBA phase at Zambrone

Bibliography

D'Auria et al. 2017
A. D'Auria – M. P. Buonincontri – E. Allevato – A. Saracino – R. Jung – M. Pacciarelli – G. Di Pasquale, Evidence of a short-lived episode of olive (*Olea europaea* L.) cultivation during the Early Bronze Age in western Mediterranean (southern Italy), The Holocene 27, 2017, 605–612.

Bandini Mazzanti – Taroni 1989
M. Bandini Mazzanti – I. Taroni, Frutti e semi dell'Età del Bronzo, in: Modena dalle origini all'anno mille, Studi di archeologia e storia I (Modena 1989) 202–208.

Bellini et al. 2008
C. Bellini – M. Mariotti Lippi – M. Mori Secci – B. Aranguren – P. Perazzi, Plant gathering and cultivation in prehistoric Tuscany (Italy), in: Proceedings of the 14th Symposium of the International Work Group for Palaeobotany, Kraków 2007, Vegetation History and Archaeobotany 17, Suppl. 1 (Berlin 2008) 103–112.

Boardman – Jones 1990
S. Boardman – G. Jones, Experiments on the effects of charring cereal plant components, Journal of Archaeological Science 17, 1990, 1–11.

Caracuta et al. 2012
V. Caracuta – G. Fiorentino – M. C. Martinelli, Plant remains and AMS. Dating climate change in the Aeolian Islands (northern Sicily) during the 2nd millennium BC, Radiocarbon 54, 2012, 689–700.

Cardarelli et al. 2015
A. Cardarelli – G. Bosi – R. Rinaldi – M. Ucchesu – G. Bacchetta, 3.31. Vino o non Vino? Nuovi dati sui vinaccioli della Terramara di Montale (Modena) tra la fine della media età del Bronzo e il Bronzo recente – breve nota, in: C. Belardelli – J. De Grossi Mazzorin (eds.), Preistoria del Cibo. 50ma Riunione Scientifica dell'Istituto Italiano di Preistoria e Protostoria, Roma, 5–9 ottobre 2015. Sessione 3: Manipolare e conservare. Gli aspetti technici ed economici della gestione delle risorse (Rome 2015) 1–9. Online <http://preistoriadelcibo.iipp.it/sessione3-download.html> (last accessed 14 Feb. 2019).

Climate Tropaea
Climate Tropaea, Calabria, Italy, 38.67°N 15.9°E 61m asl. Data sampled the last 30 years. Online <https://www.meteoblue.com/en/weather/forecast/modelclimate/tropea_italy_2522847> (last accessed 9 July 2017).

Costantini – Costantini Biasini 2007
L. Costantini – L. Costantini Biasini, Economia agricola del Lazio a sud del Tevere tra Bronzo antico e Bronzo medio, in: Istituto Italiano di Preistoria e Protostoria (ed.), Atti della XL Riunione Scientifica "Strategie di insediamento fra Lazio e Campania in età preistorica e protostorica", Roma, Napoli, Pompei, 30 novembre – 3 dicembre 2005 (Florence 2007) 787–801.

Costantini et al. 2007
L. Costantini – M. Costantini Biasini – M. Delle Donne, L'agricoltura del villaggio prostorico di Nola, loc. Croce del Papa (Napoli), in: Istituto Italiano di Preistoria e Protostoria (ed.), Atti della XL Riunione Scientifica "Strategie di insediamento fra Lazio e Campania in età preistorica e protostorica", Roma, Napoli, Pompei, 30 novembre – 3 dicembre 2005 (Florence 2007) 705–718.

Coubray 2001
S. Coubray, Étude anthracacologique et carpologique, in: F. Trucco – L. Vagnetti (eds.), Torre Mordillo 1987–1990. Le relazioni egee di una comunità protostorica della Sibaritide, Incunabula Graeca 101 (Rome 2001) 419–431.

Deforce et al. 2009
K. Deforce – J. Bastiaens – H. van Calster – S. Vanhoutte, Iron Age acorns from Boezinge (Belgium). The role of acorn consumption in prehistory, Archäologisches Korrespondenzblatt 39, 2009, 381–392.

Delle Donne 2011
M. Delle Donne, Analisi archeobotaniche preliminari, in: A. Campanelli (ed.), Dopo lo tsunami. Salerno antica (Naples 2011) 134–137.

Fiorentino 1998
G. Fiorentino, Le risorse vegetali, in: A. Cinquepalmi – F. Radina (eds.), Documenti dell'età del Bronzo. Ricerche lungo il versante adriatico pugliese (Fasano di Brindisi 1998) 211–221.

Fiorentino – D'Oronzo 2012
G. Fiorentino – C. D'Oronzo, Analisi dei macroresti vegetali. Strategie agronomiche, alimentazione e caratteristiche del paleoambiente a Coppa Nevigata nel corso dell'età del Bronzo, in: A. Cazzella – M. Moscoloni – G. Recchia (eds.), Coppa Nevigata e l'area umida alla foce del Candelaro durante l'età del Bronzo (Foggia 2012) 327–337.

Fiorentino et al. 2010
G. Fiorentino – G. Colaianni – A. M. Grasso – A. Stellati, Caratteristiche del paleoambiente e modalità di sfruttamento dei vegetali a Salina nel corso dell'età del Bronzo, in: M. C. Martinelli, Archeologia delle Isole Eolie. Il Villaggio dell'età del Bronzo Medio di Portella a Salina. Ricerche 2006 e 2008 (Milazzo 2010) 235–241.

Frohne – Jensen 1992
D. Frohne – U. Jensen, Systematik des Pflanzenreichs unter besonderer Berücksichtigung chemischer Merkmale und pflanzlicher Drogen (Stuttgart 1992).

Forni 2005
G. Forni, Tappe e tracce della domesticazione della vite, in: A. Ciacci – A. Zifferero (eds.), Vinum. Un progetto per il riconoscimento della vite silvestre nel paesaggio archeologico della Toscana e del Lazio settentrionale (Siena 2005) 41–46.

Giraudi et al. 2011
C. Giraudi – M. Magny – G. Zanchetta – R. N. Drysdale, The Holocene climatic evolution of Mediterranean Italy. A review of the continental geological data, The Holocene 21, 2011, 105–115.

Jacomet 2009
S. Jacomet, Plant economy and village life in Neolithic lake dwellings at the time of the Alpine Iceman, Vegetation History and Archaeobotany 18, 2009, 47–59.

Jacomet – Kreuz 1999
S. Jacomet – A. Kreuz, Archäobotanik. Aufgaben, Methoden und Ergebnisse vegetations- und agrargeschichtlicher Forschung (Stuttgart 1999).

Jahn – Schönfelder 1995
R. Jahn – P. Schönfelder, Exkursionsflora für Kreta (Stuttgart 1995).

Jones 1991
M. K. Jones, Sampling in palaeoethnobotany, in: W. van Zeist – K. Wasylikowa – K.-E. Behre (eds), A retrospective view on the occasion of 20 years of the International Work Group for Palaeoethnobotany (Rotterdam, Brookfield 1991) 53–62.

Jung 2013
R. Jung, The time around 1600 B. C. in southern Italy. New powers, new contacts and new conflicts, in: H. Meller – F. Bertemes – H.-R. Bork – R. Risch (eds.), 1600 – Kultureller Umbruch im Schatten des Thera-Ausbruchs? 4. Mitteldeutscher Archäologentag vom 14. bis 16. Oktober 2011 in Halle (Saale) / 1600 – Cultural Change in the Shaddow of the Thera-Eruption? 4th Archaeological Conference of Central Germany, October 14–16, 2011 in Halle (Saale), Tagungen des Landesmuseums für Vorgeschichte 9 (Halle [Saale] 2013) 235–251.

Jung et al. 2015
R. Jung – M. Pacciarelli – B. Zach – M. Klee – U. Thanheiser, Punta di Zambrone (Calabria) – a Bronze Age harbour site. First preliminary report on the Recent Bronze Age (2011–2012 campaigns), Archaeologia Austriaca 99, 2015, 53–110.

Kreuz – Schäfer 2002
A. Kreuz – E. Schäfer, A new archaeobotanical database program, Vegetation History and Archaeobotany 11, 2002, 177–179.

Kreuz – Schäfer 2004
A. Kreuz – E. Schäfer, 1,4 Millionen auf der Bank. Das hessische Datenarchiv für archäobotanische Großreste ArboDat, Hessen Archäologie 2003, 2004, 170–174.

Kreuz – Schäfer 2016
A. Kreuz – E. Schäfer, Archäobotanisches Datenbankprogramm ArboDat. Handbuch (Wiesbaden 2016).

LaCroix Phippen 1975
W. LaCroix Phippen, Vegetal remains, Contribution in: R. Ross Holloway – N. P. Nabers – S. S. Lukesh – G. Barker – N. B. Hartmann – E. R. Eaton – H. Mc Kerrell – W. L. Phippen, Buccino. The Early Bronze Age village of Tufariello, Journal of Field Archaeology 2, 1975, 78–80.

Maier 1999
U. Maier, Agricultural activities and land use in a Neolithic village around 3900 B.C. Hornstaad Hörnle I A, Lake Constance, Germany, Vegetation History and Archaeobotany 8, 1999, 87–94.

Mangafa – Kotsakis 1996
M. Mangafa – K. Kotsakis, A new method for the identification of wild and cultivated charred grape seeds, Journal of Archaeological Science 23, 1996, 409–418.

Mariotti Lippi et al. 2009
M. Mariotti Lippi – C. Bellini – M. Mori Secci – T. Gonnelli, Comparing seeds/fruits and pollen from a Middle Bronze Age pit in Florence (Italy), Journal of Archaeological Science 36, 2009, 1135–1141.

Moreno-Larrazabal et al. 2015
A. Moreno-Larrazabal – A. Teira-Brión – I. Sopelana-Salcedo – A. Arranz-Otaegui – L. Zapata, Ethnobotany of millet cultivation in the north of the Iberian Peninsula, Vegetation History and Archaeobotany 24, 2015, 541–554.

Newton et al. 2014
C. Newton – C. Lorre – C. Sauvage – S. Ivorra – J.-F. Terral, On the origins and spread of *Olea europaea* L. (olive) domestication. Evidence for shape variation of olive stones at Ugarit, Late Bronze Age, Syria – a window on a Mediterranean Basin and on the westward diffusion of olive varieties, Vegetation History and Archaeobotany 23, 2014, 567–575.

Nisbet – Ventura 1994
R. Nisbet – G. Ventura, I dati archeobotanici, in: F. Trucco – R. Peroni (eds.), Enotri e Micenei nella Sibaritide I. Broglio di Trebisacce (Taranto 1994) 577–585.

Oberdorfer 2001
E. Oberdorfer, Pflanzensoziologische Exkursionsflora für Deutschland und angrenzende Gebiete. 8. Aufl. (Stuttgart 2001).

Pacciarelli 2001
M. Pacciarelli, Dal villaggio alla città. La svolta protourbana del 1000 a.C. nell'Italia tirrenica, Grandi contesti e problemi della protostoria italiana 4 (Florence 2001) 72–85.

Pacciarelli et al. 2015
M. Pacciarelli – T. Scarano – A. Crispino, The Transition between the Copper and Bronze Ages in southern Italy and Sicily, in: H. Meller – H. W. Arz – R. Jung – R. Risch (eds.), 2200 BC – Ein Klimasturz als Ursache für den Zerfall der Alten Welt? 7. Mitteldeutscher Archäologentag vom 23. bis 26. Oktober 2014 in Halle (Saale) / 2200 BC – A Climatic Breakdown as a Cause for the Collapse of the Old World? 7th Archaeological Conference of Central Germany, October 23–26, 2014 in Halle (Saale), Tagungen des Landesmuseums für Vorgeschichte Halle 12 (Halle [Saale] 2015) 253–281.

Peña-Chocarro – Rottoli 2004
L. Peña-Chocarro – M. Rottoli, La campagna di scavo 2002 nella Grotta della Madonna di Praia a Mare a (Cosenza). Appendice 2: le analisi archeobotaniche, in: Istituto Italiano di Preistoria e Protostoria (ed.), Atti della XXXVII Riunione Scientifica "Preistoria e protostoria della Calabria", Scalea, Papasidero, Praia a Mare, Tortora, 29 settembre – 4 ottobre 2002 (Florence 2004) 800–803.

Perret 1997
M. Perret Caractérisation et évaluation du polymorphisme des génotypes sauvages et cultivés de Vitis vinifera L. à l'aide de marqueurs RAPD et de certains traits morphologiques (Travail de diplome, Université de Neuchâtel 1997).

Peyron et al. 2011
O. Peyron – S. Gorign – I. Dormay – U. Kotthoff – J. Pross – J.- L. de Beaulieu – R. Drescher-Schneider – B. Vannière – M. Magny, Holocene seasonality changes in the Mediterranean region reconstructed from the pollen sequences of Lake Accesa (Italy) and Tenaghi Philippon (Greece), The Holocene 21, 2011, 131–146.

Pignatti 1982
S. Pignatti, La flora d'Italia, vol. 1–3 (Bologna 1982).

Primavera – Fiorentino 2012
M. Primavera – G. Fiorentino, I resti vegetali delle postierle B e C, in: T. Scarano, (eds.), Roca I. Le fortificazioni della media età del Bronzo. Strutture, contesti, materiali (Foggia 2012) 352–358.

Primavera – Fiorentino 2013
M. Primavera – G. Fiorentino, Acorn gatherers: fruit storage and processing in south-east Italy during the Bronze Age, Origini 35, 2013, 211–227.

Primavera et al. 2017
M. Primavera – C. D'Oronzo – I. M. Muntoni – F. Radina – G. Fiorentino, Environment, crops and harvesting strategies during the II millennium BC. Resilience and adaptation in socio-economic systems of Bronze Age communities in Apulia (SE Italy), Quaternary International 436, 2017, 83–95.

Roth et al. 1994
L. Roth – M. Daunderer – K. Kormann, Giftpflanzen, Pflanzengifte (Karlsruhe, Munich 1994).

Sabato et al. 2015
D. Sabato – A. Masi – C. Pepe – M. Ucchesu – L. Peña-Chocarro – A. Usai – G. Giachi – C. Capretti – G. Bacchetta, Archaeobotanical analysis of a Bronze Age well from Sardinia. A wealth of knowledge, Plant Biosystems 149, 2015, 205–215. doi:10.1080/11263504.2014.998313 (last accessed 14 Feb. 2019).

Sadori et al. 2011
L. Sadori – S. Jahns – O. Peyron, Mid-Holocene vegetation history of the central Mediterranean, The Holocene 21, 2011, 117–129.

Schönfelder – Schönfelder 2008
I. Schönfelder – P. Schönfelder, Die Kosmos-Mittelmeerflora (Stuttgart 2008).

Stika – Heiss 2013
H. P. Stika – A. G. Heiss, Plant cultivation in Bronze Age, in: H. Fokker – A. Harding (eds.), The Oxford Handbook of the European Bronze Age (Oxford 2013) 348–360.

Stummer 1911
A. Stummer, Zur Urgeschichte der Rebe und des Weinbaus, Mitteilungen der Anthropologischen Gesellschaft in Wien 41, 1911, 283–296.

Tafuri et al. 2009
M. A. Tafuri – O. E. Craig – A. Canci, Stable isotope evidence for the consumption of millet and other plants in Bronze Age Italy, American Journal of Physical Anthropology 139, 2009, 146–153.

Ucchesu et al. 2015a
M. Ucchesu – L. Peña-Chocarro – D. Sabato – G. Tanda, Bronze Age subsistence in Sardinia, Italy. Cultivated plants and wild resources, Vegetation History and Archaeobotany 24, 2015, 343–355.

Ucchesu et al. 2015b
M. Ucchesu – L. Peña-Chocarro – D. Sabato – G. Tanda, Earliest evidence of a primitive cultivar of *Vitis vinifera* L. during the Bronze Age in Sardinia (Italy), Vegetation History and Archaeobotany 24, 2015, 587–600.

Valamoti et al. 2015
S. M. Valamoti – P. Darcque – Ch. Koukouli-Chrysanthaki – D. Malamidou – Z. Tsirtsoni, An archaeobotanical investigation of prehistoric grape vine exploitation and wine making in northern Greece. Recent finds from Dikili Tash, in: A. Diler – K. Şenol – Ü. Aydınoğlu (eds.), Olive Oil and Wine Production in Eastern Mediterranean during Antiquity / Antikçağ'da doğu akdeniz'de zeytinyağı ve şarap üretimi. International Symposium Proceedings, 17–19 November 2011, Urla / Uluslararası sempozyum bildirileri 17–19 kazım 2011, Urla – İzmir (Izmir 2015) 125–139.

Zach et al. 2015
B. Zach – M. Klee – U. Thanheiser, Preliminary results obtained from the archaeobotanical analysis of materials from the 2011 excavation season, contribution in: Jung et al. 2015, 83–90.

Zohary – Hopf 2000
D. Zohary – M. Hopf, Domestication of Plants in the Old World. The Origin and Spread of Cultivated Plants in West Asia, Europe and the Nile Valley (Oxford 2000).

The Olive Tree and the Agroforestry Landscape at Punta di Zambrone during the Bronze Age

Alessia D'Auria[1]

Abstract: Anthracological analyses carried out at the archaeological site of Punta di Zambrone on the Tyrrhenian coast of Calabria provide evidence for reconstructing the vegetation and the agricultural landscape of this coastal settlement during the Bronze Age and for explaining the modalities and timings according to which the vegetation changed over a period of 1000 years under the influence of human activities. The present paper is the final publication of the archaeological charcoals retrieved from this settlement. Particular emphasis will be given to the history of the olive tree. The kind of agriculture based upon the triple cereals, olives and grapevines constituted the basis for the Mediterranean economy up to recent times. The olive tree, *Olea europaea* L. (Oleaceae), is the most important fruit tree in the Mediterranean basin. The high frequency of *Olea europaea* detected among the charred wood remains dated to the Early Bronze Age settlement phase suggests that the inhabitants of that period may well have cultivated the tree in terms of favouring the spread of the scant olive trees growing wild in the region. In the samples coming from a more recent phase of the fortified settlement and dating to the Recent Bronze Age, the frequency of olive charcoal is considerably reduced. The anthracological data indicate an expansion of a more or less dense forest dominated by *Quercus*. This forest expansion must have happened during the immediately preceding chronological phase. This suggests interpreting the change of vegetation and the decline in olive frequency (as well as the end of its possible cultivation) as the outcome of a settlement decrease that characterised the end of the Middle Bronze Age in the region. Possibly, this forest increase was related to the diffusion of the Subapennine culture towards southern Calabria, as it brought about a new economic system and innovative agronomic knowledge. The differences in landscape noted between the Early Bronze Age and the Recent Bronze Age can also be observed by means of other archaeobotanical proxies on the central and southern Italian peninsula.

Keywords: Anthracology, Calabria, cultivation, *Olea europaea*, vegetation cover change

Introduction

The olive (*Olea europaea* L.) is one of the most important fruit trees of the Mediterranean basin.[2] Olive, grape vine, fig and date constitute the oldest group of plants that found horticulture in the Old World.[3] In the Mediterranean area there are two distinct groups of olive genus: one which includes all wild forms (*Olea europaea* L. var. *sylvestris*), which is a long-lived evergreen sclerophyllous tree spreading in the termo-Mediterranean belt between 41°N and 39°N,[4] and another that includes all the cultivated forms (*Olea europaea* var. *europaea*). The crop is propagated either by cutting or grafts.[5] The wild olive is the ancestor of the modern varieties of the cultivated olive that have been obtained through a long history of domestication and cultivation. Nowadays cultivation of the olive tree represents one of the most important sources of wealth of many Mediterranean populations, who produce edible fruits and oil.[6]

[1] Department of Humanities – ancient and modern languages, literature and cultures, University of Perugia, Via Armonica 3, 06123, Perugia, Italy; alessia.dauria@unipg.it. This contribution results from a Master's Thesis at the Department of Agricultural Sciences, Plant and Wood Anatomy Lab, University of Naples Federico II. A subsequent study of more finds was financed by the FWF project "Punta di Zambrone – a Bronze Age fortified settlement on the Tyrrhenian coast of Calabria" (project no. P23619-G19).

[2] Zohary – Hopf 2000, 145.

[3] Zohary – Spiegel-Roy 1975, 319; Stager 1985, 4.

[4] Ozenda – Lucas 1975, 53

[5] Breton et al. 2009.

[6] Zohary – Hopf 2000, 145.

Various and extensive research has been carried out to increase our knowledge on the origin and distribution of the olive, and, of course, on the nature and timing of domestication. So far, both archaeobotanical evidence[7] and, above all, molecular genetic analyses[8] have helped to trace the history of this emblematic Mediterranean tree. However, there are several gaps in our knowledge, and discussions of conflicting interpretations of domestication/cultivation regarding the origin of present-day cultivars are ongoing.

Several authors, on the basis of archaeobotanical remains, refer to first olive cultivation at about 4000 BC in the Near East.[9] Van Zeist[10] suggested that olive cultivation first developed in Greece around 2500 BC and subsequently spread in a gradual way towards the West in a process involving the Phoenicians, Etruscans, Greeks and finally the Romans. This is the classic theory known as the 'Monocentric theory'. According to a second one, called the 'Polycentric Theory', the domestication of the olive not only happened in the Near East, but also in various areas of the western Mediterranean in an independent manner and at different times. The existence of one or more domestication events in the Mediterranean region is also a matter of debate, and recent genetic studies propose a multiple origin of cultivars across the Mediterranean area. However, it remains unclear whether this reflects secondary diversification or multiple independent primary events.[11] In this regard genetic analyses show that most cultivars have tight relationships with eastern oleasters, while the cultivars from a second branch have kinship relationships with the western oleasters. This confirms the hypothesis that several domestication events have occurred. In particular, nine domestication events of olive took place, but these origins were blurred by gene flow from oleaster and by human displacements. It is possible that these origins reflect different reason and uses to domesticate the oleaster.[12] However, it is difficult to know through the analysis the stones alone, if the stones of olive derive from gathered wild or from domesticated olives.[13] Indeed, the diversity based on fruit morphology and pit size between the wild and modern cultivars is doubtful.[14] Concerning the Italian peninsula, the preliminary publication of the Punta di Zambrone evidence was a first contribution focused on olive cultivation/domestication.[15]

The present paper is the final publication of the archaeological charcoal (charred wood) data from all excavation areas at the Bronze Age settlement of Punta di Zambrone, and it includes analytical data of previously unpublished samples (from six new stratigraphical units) as well as microscope photos of different characteristic species. Some further 328 charcoal fragments were newly analysed, in particular 150 from two stratigraphical units (SU) in the eastern part of Area B and 178 from three stratigraphical units in Area C. In addition, 150 charcoal fragments from a particular stratigraphic unit (SU 218) in Area C were analysed.

These data have a good resolution both in space and time, because charcoal originates directly from human activities.[16] Apart from issues related to vegetation history and climate, it focuses on the relevance of the Zambrone evidence for the history of olive cultivation, especially in the context of southern Italy. The available archaeological charcoal data from Punta di Zambrone on the southern Tyrrhenian coast of southern Italy represent three different time horizons, an early and a late aspect of the Early Bronze Age (EBA) and – after a chronological gap – the Recent Bronze Age (RBA).

---

7 Zohary – Spiegel-Roy 1975, 319–327; Zohary – Hopf 2000, 241–249; Terral et al. 2004, 63–77; Rodríguez-Ariza – Montes Moya 2005, 551–561; Carrión et al. 2010, 952–96.

8 Besnard – Bervillé 2000, 173–181; Besnard et al. 2002, 1353–1361; Lumaret et al. 2004, 343–351; Breton et al. 2006, 1916–1928; Breton et al. 2009, 1059–1064.

9 Van Zeist 1980, 129–145; Lipschitz et al.1991, 450–451; Zohary – Hopf 2000, 241; Brun 2003, 123–128.

10 Van Zeist 1980, 129–145.

11 Trujillo et al. 1990; Besnard – Bervillé 2000; Besnard et al. 2001; Besnard et al. 2002; Baldoni et al. 2006; Besnard et al. 2007; Breton et al. 2009; Belaj et al. 2012; Diez et al. 2015.

12 Breton et al. 2009.

13 Klee et al., this volume.

14 Bartolini et al. 1998.

15 D'Auria et al. 2017.

16 Chabal et al. 1999, 43.

The Archaeological Site of Punta di Zambrone and the Features of the Sampling Areas

Punta di Zambrone (38°42′53″N, 15°58′20″E) is an elongated promontory jutting into the sea on the Poro promontory (or peninsula of Tropea). The Bronze Age settlement occupied the upper flat part and was fortified, at least during the RBA, by a defensive ditch associated with a wall or a rampart.[17]

The excavation areas analysed are three. Area D is situated inside the protohistoric village. Here, settlement layers of an initial stage of the Early Bronze Age (EBA 1) were found; in the western part of Area B the excavators investigated a use level and the fill of an elongated rock-cut structure (EBA 2). These layers contained abundant finds of the advanced Early Bronze Age. In the eastern part of Area B, two complete sections of a subsequent rock-cut defensive ditch were excavated and documented. The fill contains a limited quantity of pottery, mainly of RBA date. In Area C a large portion of the fill of the same defensive ditch could be investigated. Here it consists mainly of very fine layers of ash containing small charcoals and some stones that can be ascribed to the collapse of the fortification. These ashy layers contained large quantities of artefacts dating to the RBA.

Materials and Methods

Archaeological sediments from thirteen stratigraphic units coming from four excavation areas namely Area D (EBA 1), Area B west (EBA 2), Area B east (RBA 1) and Area C (RBA 2), were sampled. The stratigraphical units to be analysed were carefully selected from among those containing scattered charcoal and dispersed by long-term activities and processes following Chabal[18] and Figueiral and Mosbrugger.[19]

The Zambrone team floated and sieved the sediment samples selected for archaeobotanical analysis during the excavation on a sieving column with 2.0mm, 0.5mm, and 0.2mm meshes. By applying this strategy, it was possible to recover charcoal fragments and other archeaobotanical remains as well as small zoological remains and archaeological artefacts. A team directed by Ursula Thanheiser of the University of Vienna and including Marlies Klee and Barbara Zach has studied the archaeobotanical remains.[20] Regarding the charcoal samples, all fragments with a size larger than 2.0mm were identified by an incident light microscope working between 100× and 1000× magnification. The identification was based on the consultation of both atlases[21] and the charcoal reference collection at the Laboratory of Vegetation History and Wood Anatomy at the University of Naples Federico II. Taxon percentages were calculated from the total of the analysed charcoal on two analytical levels: (1) on the level of the single stratigraphic unit and (2) on the level of the three chronological phases represented in the excavation.

Results

A total of 852 charcoal fragments were analysed, and 13 taxa were identified (Fig. 1).

In particular, we have 70 fragments from 2 stratigraphic units from Area D (EBA 1) (Fig. 2), 200 from 3 SU in the western part of Area B (EBA 2) (Fig. 3), 150 from 2 SU in the eastern part of Area B (RBA) (Fig. 4), while there are 432 fragments from 4 SU in Area C (RBA 2) (Fig. 5).

17 See the contribution by Jung and Pacciarelli in the present volume.
18 Chabal 1997, 25–37.
19 Figuerail – Mosbrugger 2000, 397–407.
20 See Zach et al. 2015, 83–90, and their contribution in the present volume.
21 Greguss 1955; Greguss 1959; Schweingruber 1990; Abbate-Edlmann et al. 1994; Vernet et al. 2001.

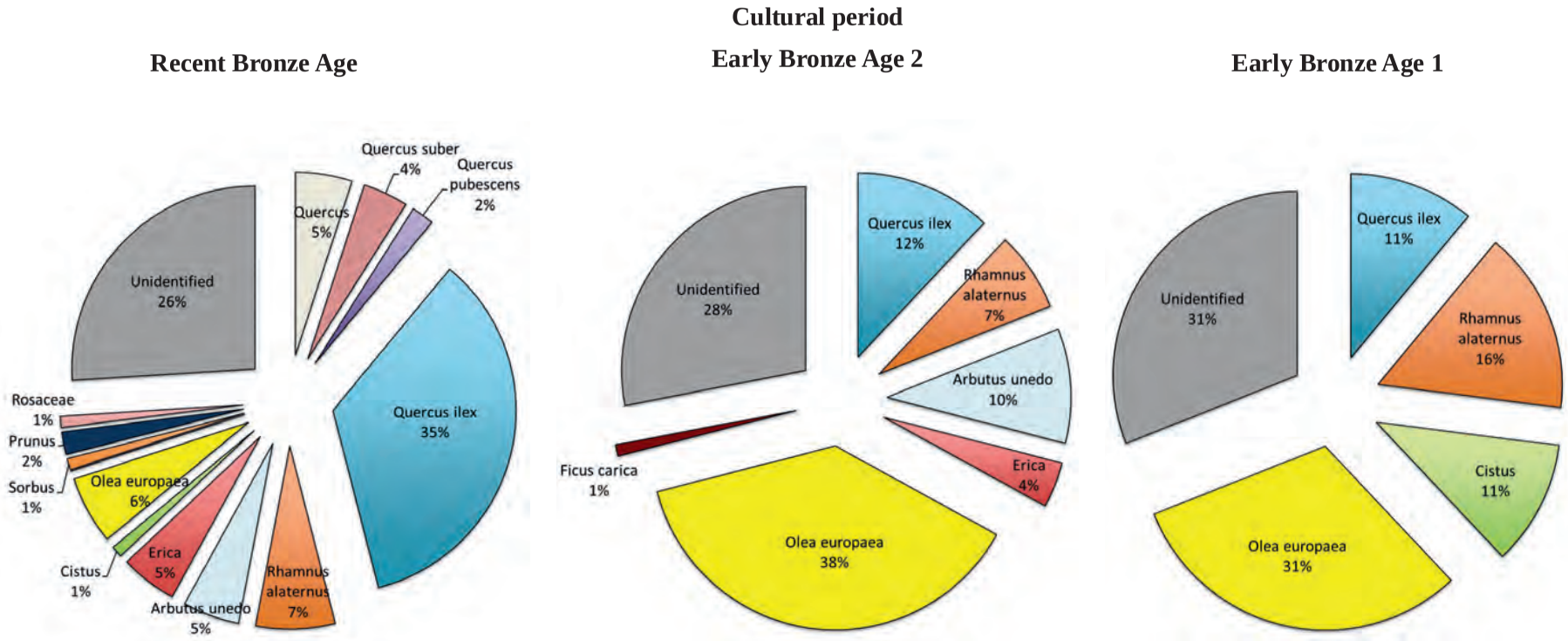


Fig. 1 Results of charcoals according to dating and taxa. Frequencies (%) are calculated from the total number of charcoal fragments in each chronological phase (graphics: A. D'Auria)

In this context, the calculation of the total sample number for Area C does not include SU 218, which yielded 150 charcoal fragments. This is due to the fact that SU 218 is a particular case, as the count yielded the result that the vast majority of the charcoals belongs to one and the same species, namely *Olea europaea*. As a percentage, in this case, the value is 1 and not 150, because the evidence is probably related to a 'unique' event that took place in a single moment of time.

All the charred wood remains from the three excavation areas are highly fragmented; no larger pieces were observed during excavation.

Area D

Taxa	US 205	US 197	US 192	TOT
Quercus ilex	0	16	0	16
Quercus suber	0	0	0	0
Quercus pubescens	2	0	0	2
Quercus	0	3	0	3
Rhamnus alaternus	0	12	0	12
Arbutus unedo	0	0	0	0
Erica	0	0	0	0
Cistus	0	0	4	4
Olea europaea	0	8	9	17
Ficus carica	0	0	0	0
Rosaceae	0	0	0	0
Prunus	0	0	0	0
Sorbus	0	0	0	0
Unidentified	1	11	7	19
TOT	3	50	20	73

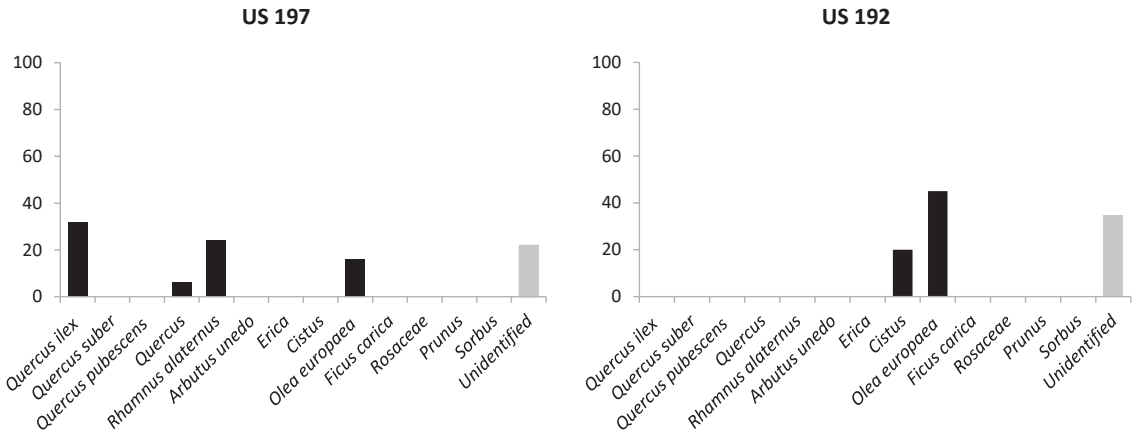


Fig. 2 Number of charcoal fragments analysed for stratigraphic units: Area D. In the graphic with percentages, I have not included the stratigraphic unit 205 because I have analysed only 3 charcoal fragments and it probably consists of the impletion of a post pit (graphics: A. D'Auria)

Area B west

Taxa	US 191	US 166	US 86	TOT
Quercus ilex	1	6	17	24
Quercus suber	0	0	0	0
Quercus pubescens	0	0	0	0
Quercus	0	0	0	0
Rhamnus alaternus	0	4	10	14
Arbutus unedo	3	4	13	20
Erica	0	4	3	7
Cistus	0	0	0	0
Olea europaea	36	19	22	77
Ficus carica	0	0	1	1
Rosaceae	0	0	0	0
Prunus	0	0	0	0
Sorbus	0	0	0	0
Unidentified	10	13	34	57
TOT	50	50	100	200

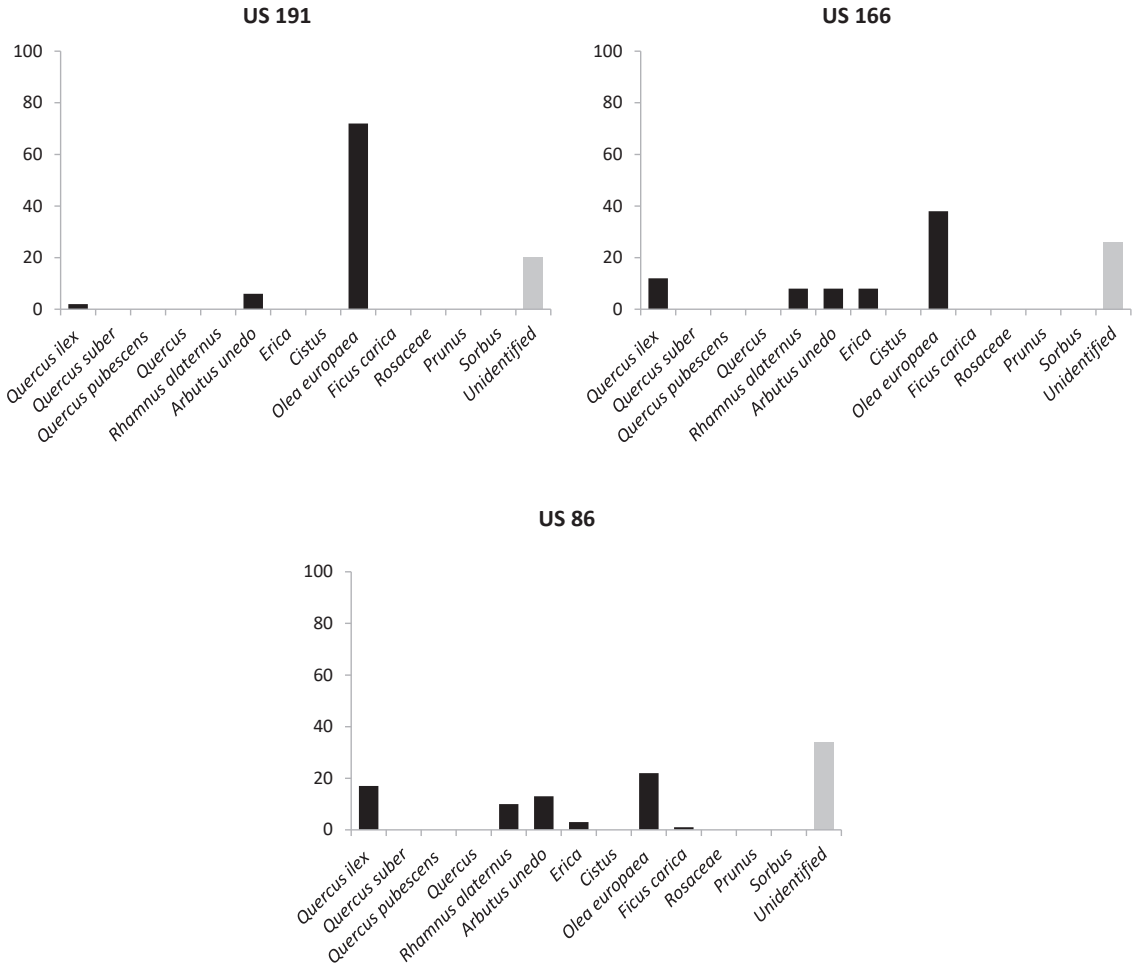


Fig. 3 Number of charcoal fragments analysed for stratigraphic units: Area B west (graphics: A. D'Auria)

Area B east

Taxa	US 117	US 106	TOT
Quercus ilex	10	26	36
Quercus suber	3	7	10
Quercus pubescens	3	7	10
Quercus	5	11	16
Rhamnus alaternus	5	11	16
Arbutus unedo	1	0	1
Erica	4	8	12
Cistus	0	0	0
Olea europaea	5	9	14
Ficus carica	0	0	0
Rosaceae	1	0	1
Prunus	0	7	7
Sorbus	0	0	0
Unidentified	13	14	27
TOT	50	100	150

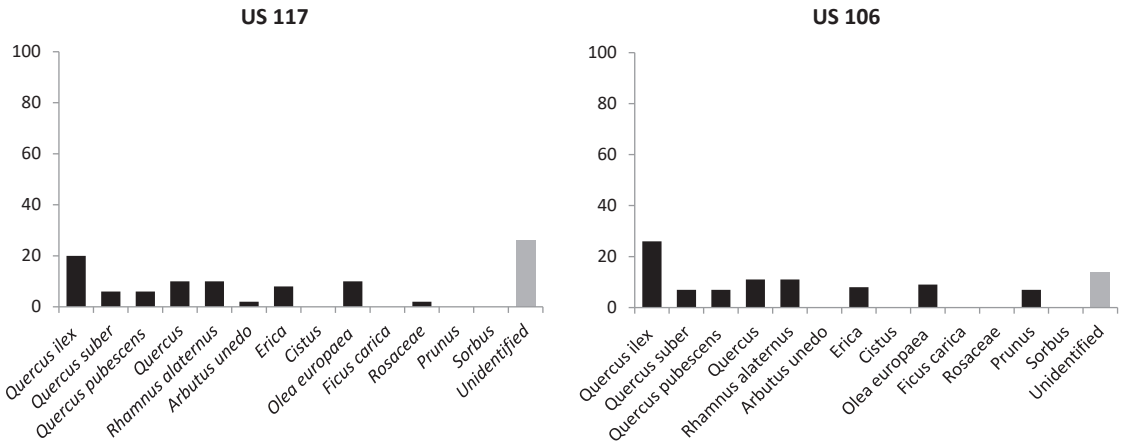


Fig. 4 Number of charcoal fragments analysed for stratigraphic units: Area B east (graphics: A. D'Auria)

Area C

Taxa	US 217	US 215	US 210	US 66	TOT
Quercus ilex	13	10	51	97	171
Quercus suber	5	0	8	0	13
Quercus pubescens	0	2	0	0	2
Quercus	3	4	0	3	10
Rhamnus alaternus	4	1	2	18	25
Arbutus unedo	2	4	4	17	27
Erica	0	2	0	18	20
Cistus	3	2	4	0	9
Olea europaea	0	4	0	17	21
Ficus carica	0	0	0	0	0
Rosaceae	0	2	0	2	4
Prunus	2	0	0	0	2
Sorbus	0	2	0	0	2
Unidentified	18	17	31	60	126
TOT	50	50	100	232	432

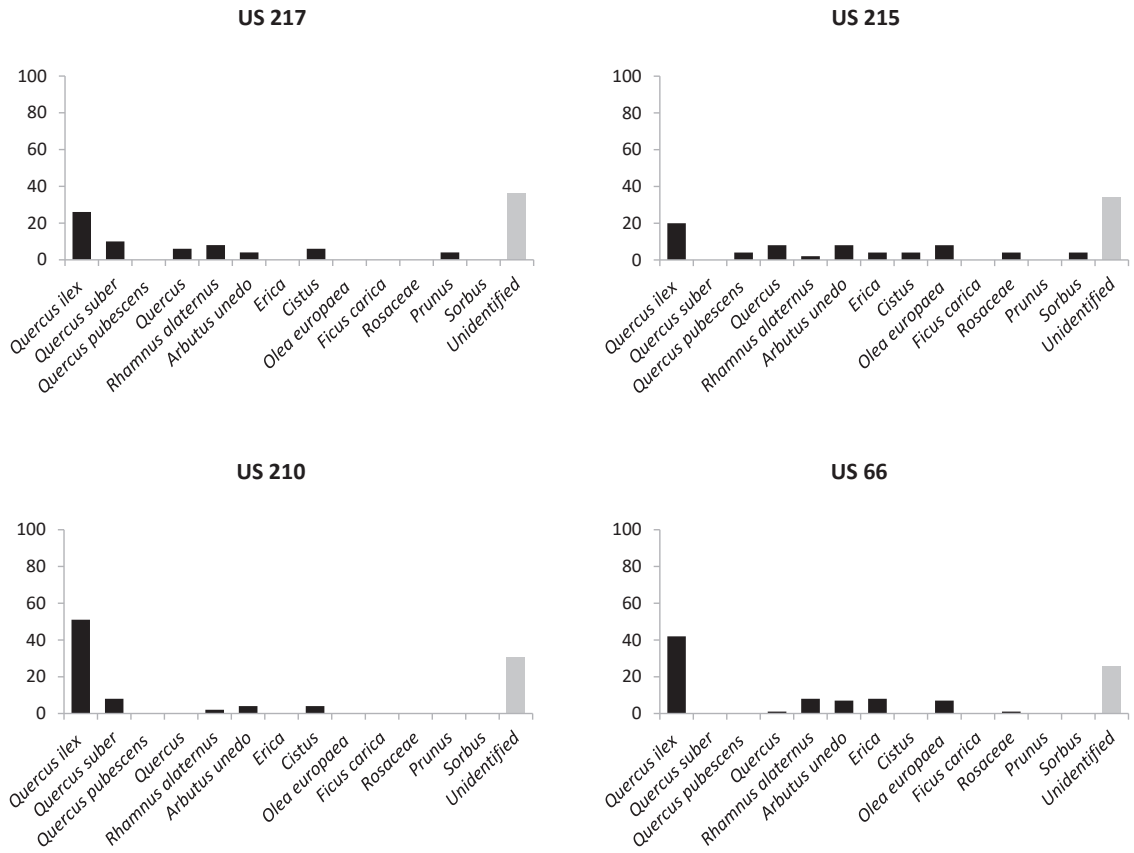


Fig. 5 Number of charcoal fragments analysed for stratigraphic units: Area C (graphics: A. D'Auria)

Early Bronze Age 1 (EBA 1)

From the earliest settlement phase, excavated in Area D, 70 charcoals were analysed. The predominant taxon is *Olea europaea* (31%) followed by *Quercus ilex* (11%), *Rhamnus alaternus* (16%) and finally *Cistus* (11%) (Fig. 2). One should note that in the case of *O. europaea*, the wild olive (*O. europaea* subsp. *sylvestris*) is not distinguishable from the cultivated one (*O. europaea* subsp. *europaea*) on the basis of wood anatomy.[22]

Early Bronze Age 2 (EBA 2)

In this settlement phase, attested in the western part of Area B, *O. europaea* is again abundantly attested (38%). It is followed by evergreen taxa such as *Q. ilex* (12%), *Arbutus unedo* (10%), *R. alaternus* (7%) and *Erica* (4%). In addition, *Ficus carica* was found in very small quantities (1%) (Fig. 3).

Recent Bronze Age (RBA)

In the Recent Bronze Age, represented by samples from the eastern part of Area B and from Area C (Figs. 4 and 5), the number of identified taxa increases to 13. In this phase, *Q. ilex* became the main taxon (35%) while *O. europaea* declined sharply to 6%. The Mediterranean evergreen vegetation is also represented by *R. alaternus* (7%), *Erica* (5%), *A.unedo* (5%), *Cistus* (1%), *Quercus* (5%), *Rosaceae* (1%).

Quercus suber (4%), *Quercus pubescens* (2%), *Prunus* (2%) and *Sorbus* (1%) appear.

These percentages differ in respect to the publication in 'The Holocene'[23] due to an increase in charcoal studied.

In this context, SU 218 presents us with a particular case, the results of which are considered separately inasmuch as they reflect a different phenomenon without parallels among the other stratigraphical units at Punta di Zambrone. SU 218 is a black layer with a high percentage of charred wood. This stratigraphic layer is stratified below SU 75, which corresponds to the final collapse level of the fortification and is a charcoal layer at the base of SU 210 and thicker than the black layers inside of SU 210. The underlying stratigraphical units 215 and 217 are sediments accumulated during the use of the moat.

It's possible that SU 218 relates to a unique moment of combustion during the last habitation phase of the fortified settlement.

This hypothesis is confirmed by the identification of charcoal wood. In SU 218 there is a high presence of olive charcoal (85%) that represents almost the total of the fragments of charcoal wood analysed (125 fragments out of 150) and this surely corresponds to a single moment of combustion (Fig. 6). It is for this reason that the percentage has been considered as one and by extension as the expression of a single moment. Therefore, the result has not been included in the total of all charcoal wood analysed from Area C.

This single and unique event is also confirmed by the comparison with the charred wood from SU 210. Indeed, the charcoals of SU 210 are similar to the evidence from other stratigraphical units from Area C. In this layer there is a high presence of *Q. ilex* (51%), while, interestingly, in this unit the olive is totally absent. Furthermore this confirms that SU 218, which is a carbon layer at the base of SU 210, represents a unique moment of combustion, in which the olive wood was probably used for a particular purpose.

---

22 Schweingruber 1990, 573.

23 D'Auria et al. 2017.

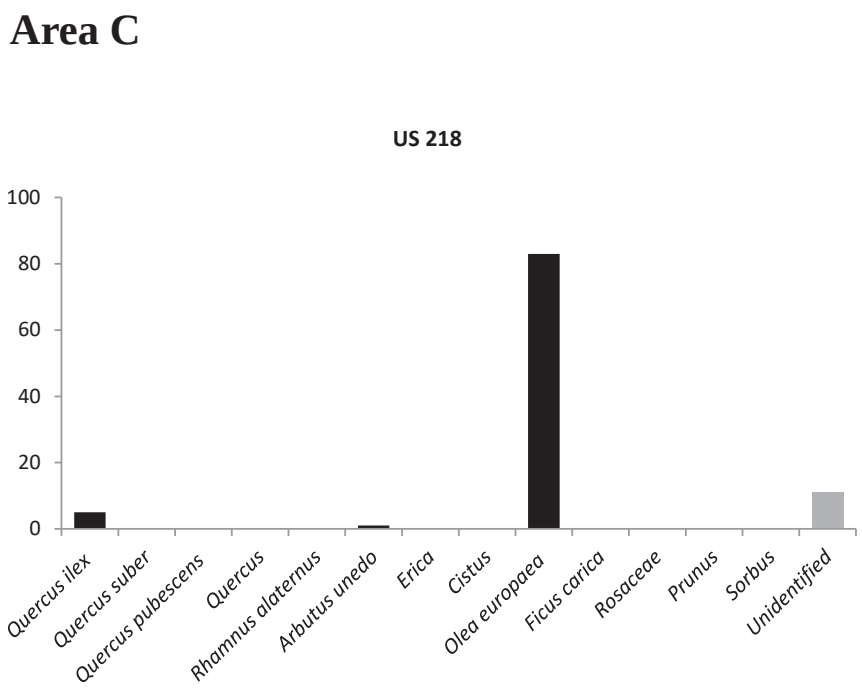


Fig. 6 Results of charcoals identified for SU 218, Area C (graphics: A. D'Auria)

Discussion

Early Bronze Age

During the Copper Age (starting from 3700/3600 BC) the communities inhabiting the Poro promontory preferred the fertile soils of the Poro high plain (600–700m asl), located at the summit of the Poro promontory. In the Early Bronze Age the occupation of the high plain continued, but several settlements spread to the lower altitudes towards the sea coast.[24]

During this historical period, the charcoal data show the stable presence of a Mediterranean evergreen vegetation with *O. europaea* (Fig. 7), *Q. ilex* (Figs. 8.1, 8.2), *R. alaternus*, *Cistus*, *A. unedo* (Fig. 9), and *Erica* (Fig. 10) in both the periods investigated (EBA 1 and EBA 2). The strong presence of *O. europaea* ranging between 31% and 38% respectively in EBA 1 and EBA 2 and the presence of the fruit tree *F. carica* are noteworthy.

Following Spampinato et al.,[25] the potential vegetation of this Tyrrhenian coastal district is represented by the mixed forest with both deciduous and evergreen oaks, here the presence of *O. europaea* var. *sylvestris* should be limited to coastal rocky slopes. In this respect, the strong presence of olive in the charcoal records seems to be quite incompatible with a natural vegetation cover and ecological condition in this area.

The potential natural vegetation is the vegetation that a location can host in the present climatic and soil conditions without human influence. The map of vegetation series was realised as the integration of a deductive and inductive cognitive process. The work was based on a hierarchical approach of territorial ecological classification and analysis of bioclimatic characteristics.[26]

[24] Pacciarelli 2001, 75–80.
[25] Spampinato et al. 2010, 422.
[26] Spampinato et al. 2010, 10.

Actually, paleoclimatic studies show that from the middle Holocene onwards (c. 2500 BC) drier conditions developed in the south-central Mediterranean under latitudes below 40° N.[27] The anthracological assemblage does not agree with this climatic phase that might justify the expansion of a termoxerophilous vegetation. Indeed, the presence of *R. alaternus* and *A. unedo* testify to a relatively humid climate. Moreover, the relatively high frequencies (11%) of light-demanding and fire-adapted *Cistus*[28] in EBA 1 could indicate open spaces generated by anthropogenic disturbance through fire and clearing activities.

As published earlier, our hypothesis is 'that the large amount of olive charcoal can be explained by cultivation, not necessarily implying domestication, carried out by local communities probably with agronomic practices devoted to favouring the spread of the trees already growing in the wild vegetation community'.[29] One could explain the high amount of olive wood at Punta di Zambrone by assuming that the inhabitants of the settlement used pruned branches as firewood. The existence of pruning practices that aimed at stimulating the production of higher quality fruit would offer further support for the cultivation hypothesis.[30]

On the present evidence from the central-western Mediterranean, the cultural history of the olive tree seems to have started in this region during the Neolithic. As archaeobotanical data from the southern Iberian Peninsula[31] and from southern Italy (northern Sicily, Grotta dell'Uzzo[32]) show, the gathering of wild olives was a common practice among the human populations in that period.

Several studies support the hypothesis of a multiple origin of the cultivars throughout the Mediterranean basin. It is probably related to multiple independent primary events of domestication.[33] This hypothesis, the 'Polycentric theory' or 'multiple events of domestication theory', contrasts with the 'Monocentric theory', according to which the central Mediterranean was an area of secondary domestication processes, in which hybridisation between locally exploited wild forms and introduced cultivars occurred from the Iron Age (1st millennium BC) onwards due to the activities of the Phoenicians and Greeks.[34] The data produced at Punta di Zambrone could testify to an early domestication event that can be dated to phase EBA 1. This would argue in favour of the 'multiple events of domestication theory'.

Throughout the Early Bronze Age, Calabria was characterised by a settlement pattern basically consisting of small villages. For the Poro high plain the survey data show that the number of settlements increased during EBA 2.[35] The San Sebastiano Cave at Bagnara Calabra (Fig. 11), c. 70km south of Tropea, provides evidence for a phase dated to the Eneolithic and the EBA with a strong presence of olive charcoal accompanied by *Fraxinus ornus, A. unedo* and *Rhamnus-Phillyrea*.[36] The vegetation reconstructed on the basis of the charcoal assemblage closely resembles that of Punta di Zambrone. Thus, Bagnara Calabra and Punta di Zambrone share the same potential vegetation, suggesting that the high presence of olive resulted from cultivation practices carried out in the vicinity of those sites by the local population. Therefore, the charcoal data from the San Sebastiano Cave and from Punta di Zambrone provide evidence in support of the hypothesis that the olive tree was cultivated in a wide area along the southern Tyrrhenian coast. In this context, it is interesting to note that 100 olive pits have already been recorded for the beginning of the MBA at the settlement of Tufariello Buccino (Fig. 11), which is situated at an inland location at about

27 Magny et al. 2013, 2049.
28 Thanos et al. 1992, 258–260.
29 D'Auria et al. 2017, 608.
30 Asouti 2003, 480–481.
31 Rodrìguez-Ariza – Montes Moya 2005, 551–561.
32 Costantini 1981, 233–247.
33 Besnard et al. 2001, 251–268; Besnard et al. 2007, 737–738; Baldoni et al. 2006, 935–936; Breton et al. 2009, 1059–1064; Belaj et al. 2012, 365–367.
34 Zohary – Hopf 2000, 142–145; Terral et al. 2004, 63–77.
35 Pacciarelli 2001, 71–85; Pacciarelli 2010, 383–388.
36 Martinelli et al. 2004, 269.

400m asl and at a distance of c. 300km to the north of Punta di Zambrone.[37] The location of this site outside the natural area of the wild olive tree, attests to the consumption and the transportation of olives (probably by means of goods exchange) at the outset of the MBA.

Further data are available for the Adriatic coast of Italy. Charcoal analysis conducted in the framework of the excavations at the fortified settlement of Coppa Nevigata (Fig. 11) revealed the presence of a mixed deciduous forest. However, olive charcoal reaches percentages exceeding 40%.[38] This high presence of olive permits us to suppose evidence for olive cultivation at the fortified settlement of Coppa Nevigata in the mid-MBA (15th century BC). In addition, organic residue analysis indicated the presence of oil among the contents of two ceramic vessels found in a context of even earlier date (18th century BC).[39]

These data allow the conclusion that the EBA and the early MBA may have been an early period of olive cultivation throughout a large portion of Tyrrhenian and Adriatic southern Italy, very probably starting from wild olive trees that were growing naturally in the surroundings of the settlements. Furthermore, this southern Italian olive cultivation would have developed independently of the influence of contacts with Mycenaean Greece, as it largely antedates the Mycenaean Age. However, one cannot fully exclude the possibility that an external stimulus resulting from Italo-Aegean contacts stood behind the start of olive cultivation. In this case, the know-how transfer from the Aegean would have occurred at the end of the Copper Age (Eneolithic/Chalcolithic) as part of the so-called Cetina exchange network functioning between Sicily, southern Italy, the eastern Adriatic and the Aegean and extending as far as Troy.[40] In the Aegean, olive cultivation started during the EBA (end of the 4th to the late 3rd millennium) and more precisely in a late stage of that period.[41] On Santorini, *Olea* cultivation can be traced back to the EBA according to charcoal data from a deep sounding at the settlement site of Akrotíri. Olive amounts to more than 40% of that EBA assemblage.[42] It is interesting to note that the olive growing started in the Aegean region during the 4th millennium BC for the production of olive oil. By contrast, the olive was absent during the Neolithic and the Bronze Age in the north of Greece and was only introduced there during the Iron Age by Greek colonisation.[43] However, the earliest available evidence for oil extraction and, therefore, for olive cultivation on a larger scale dates to c. 2100–2000 BC in Crete, at the settlement site of Chamalevri.[44]

Coming back to Punta di Zambrone, one should note, in addition, that the EBA 2 charcoal assemblage includes evidence for fig (*F. carica*, Fig. 3). According to present knowledge, the fig tree belongs to the first domesticated trees of the Old World. In this respect it resembles the olive tree, which can be explained by that fact that both can be easily manipulated, as they multiply simply after cuttings.[45] The simultaneous presence of two early domesticated trees such as olive and fig further supports the view that the inhabitants of Zambrone possessed the necessary horticultural knowledge to grow them.

The Recent Bronze Age

Archaeological evidence gathered during extensive surveys demonstrated that towards the end of the earlier part of the Middle Bronze Age (MBA 1–2, 17th to 15th century BC) many settlements on the Poro promontory were abandoned, with the result that in the following MBA 3 phase (14th century BC), only a few well-fortified sites survived.[46] By contrast, the Recent Bronze Age (13th

37 LaCroix Phippen 1975, 79–80.
38 Fiorentino – D'Oronzo 2012, 328, tab. 3.
39 Samples CN21 and CN24: Evans – Recchia 2005, 191, tab. 1; 193 tab. 2; 196, fig. 1.CN21, CN24; 200–201.
40 Maran 2007, 14–16; Jung – Weninger 2015, 246; Pacciarelli et al. 2015, 253–281.
41 For a review see Margaritis 2013.
42 Asouti 2003, 474, tab. 1; 481.
43 Valamoti et al. 2017, 13.
44 Sarpaki 1999, 40–41.
45 Zohary – Hopf 2000, 160–163.
46 Pacciarelli 2001, 80–82.

to 12th century BC) distinguishes itself by a new complex territorial organisation characterised by undefended sites on the Poro plateau, defended settlements in the hill zone and a few defended coastal sites suited for marine activities.

Unfortunately we do not have any charcoal at our disposal from the MBA settlement phase. The next available anthracological materials come from RBA levels post-dating the EBA 2 settlement by c. 400 years. In the RBA, the taxa known from the EBA 2 phase re-appear, but one notes a strong rise in *Q. ilex*, while broadleaf oaks (*Q. pubescens*) and cork oak (*Q. suber*) are new in the landscape. By contrast, the frequency of olive is significantly reduced (to 6%, Fig. 1). These data seem to indicate that a notable feature of this settlement phase is the high number of fungal hyphae present among the charcoal fragments (35% in the RBA layers vs. 0.35% in the EBA layers) (Fig. 12). Fungal hyphae show the intervention of fungi, vegetal microorganisms lacking chlorophyll, and therefore heterotrophic, that feed on already grown organic materials. The development of fungi

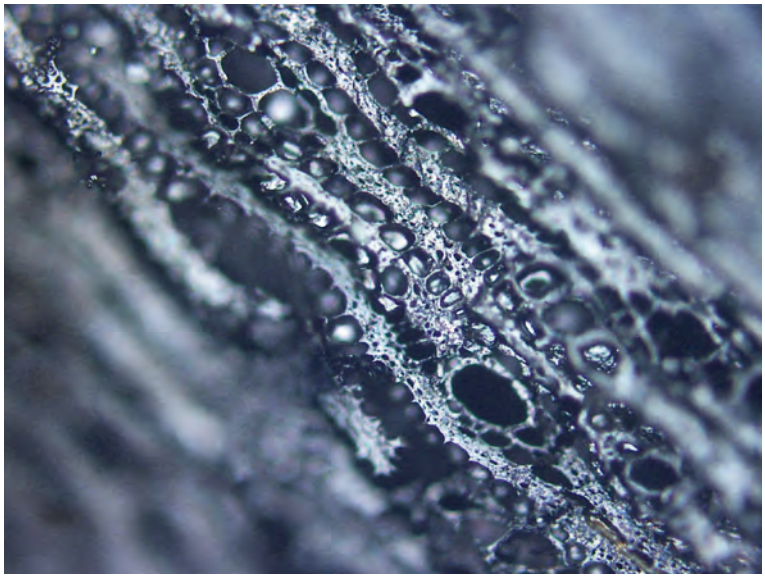


Fig. 7 Charcoal fragment of *Olea europaea* under incident light microscope (200× magnification) (photo: A. D'Auria)

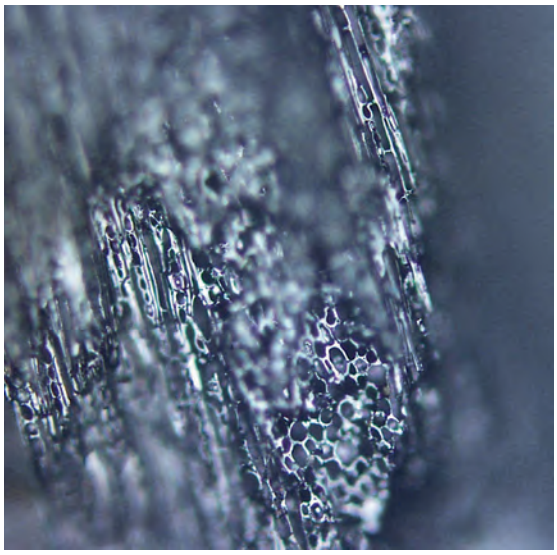


Fig. 8.1 Charcoal fragment of *Quercus ilex* under incident light microscope (200× magnification) (photo: A. D'Auria)

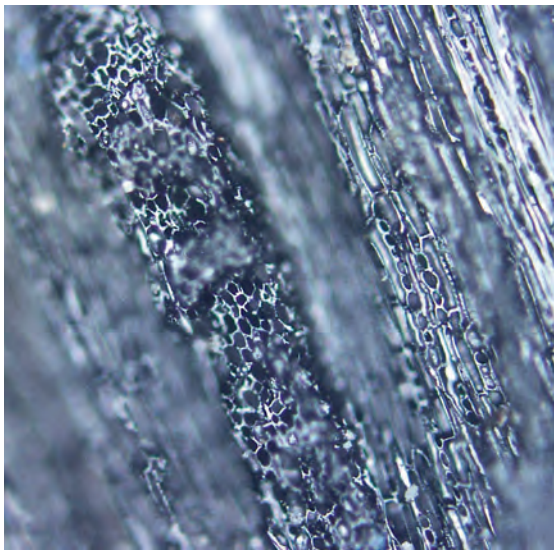


Fig. 8.2 Charcoal fragment of *Quercus ilex* under incident light microscope (200× magnification) (photo: A. D'Auria)

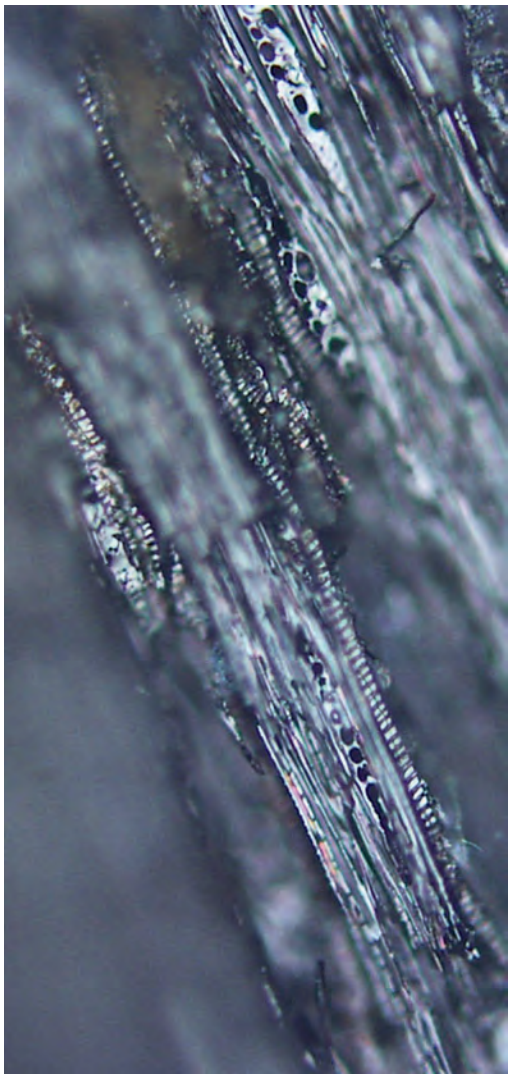


Fig. 9 Charcoal fragment of *Arbutus unedo* under incident light microscope (200× magnification) (photo: A. D'Auria)

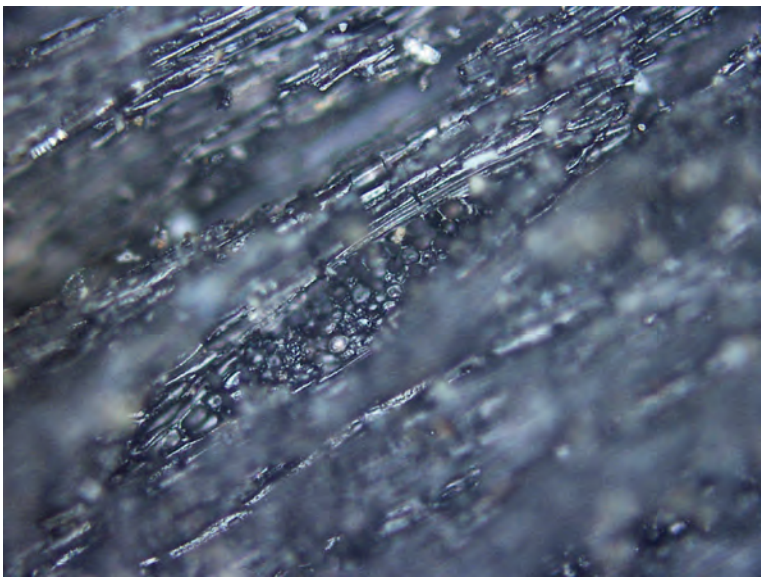


Fig. 10 Charcoal fragment of *Erica* under incident light microscope (200× magnification) (photo: A. D'Auria)



#	Site	Elevation (m a.s.l.)	Geografical coordinates		Bioclimatic level (Blasi et al., 2010)	References
			Latitude (°N)	Longitude (°E)		
1	Manfredonia - Coppa Nevigata	2	41,557,531	15,829,436	Mesomed.	Fiorentino and D'Oronzo (2012)
2	Buccino - Tufariello	423	40,597,974	15,410,491	Mesomed.	Holloway (1975)
3	Meledugno - Roca Vecchia	5	40,292231	18,419679		Primavera and Fiorentino (2012)
4	Trebisacce - Broglio	164	39,864,086	16,504,474	Mesomed./Thermomed.	Celant (2002), Nisbet and Ventura (1994)
5	Spezzano Albanese - Torre Mordillo	96	39,715,167	16,315,476	Thermomed.	Coubray (2001)
6	Punta di Zambrone	19	38,714,103	15,972,835	Mesomed./Thermomed.	D'Auria et al. (2016)
7	Bagnara Calabra - San Sebastiano	48	38,317,019	15,826,804	Mesomed./Thermomed.	Martinelli et al. (2004)
8	Serro del Capo - Portella a Salina	300	38,567947	14,835147	Termophilic/helioph.	Fiorentino et al. (2010)

Fig. 11 Sites with *Olea europaea* wood-charcoal and fruit in southern Italy (below 42°N) cited in the text with the key of the site identities, geographical coordinates and references. Available *O. europaea* frequency data are reported in the text (graphics: A. D'Auria)

is related to temperature and the water content of timber. The presence of the hyphae within the charcoal indicates that the wood was dead when it was collected and used, that the hyphae existed before combustion and charred together with the wood. These will become visible under the microscope as thin filaments.[47] This evidence suggests that the inhabitants of Punta di Zambrone gathered dead wood with a low calorific value and poor technological proprieties – as compared to seasoned healthy wood. One interpretation would be that they followed a more opportunistic strategy in collecting quickly and easily the wood to be used in daily domestic activities.

As the transition from the Middle to the Recent Bronze Age in the southern Tyrrhenian was characterised by profound cultural and economic change connected to the southward diffusion of the so-called Subapennine culture from northeastern Italy,[48] the settling of new population groups on the Poro promontory might have brought about innovations regarding land-use practices.

At the San Sebastiano Cave of Bagnara Calabra (see above), charcoal analyses documented a similar change of vegetation cover characterised by an increase in evergreen *Quercus* and a steep decline in *O. europaea*.[49] Here, however, this change is attested already for MBA 3. A forest expansion accompanied by a disappearance of olive is also recorded far from our study area, along the southern Adriatic coast in a RBA context at Coppa Nevigata (Fig. 11).[50] Thus, from the beginning of the RBA, charcoal data clearly show a vegetation cover change involving a large portion of southern Italy. This may have been related to the establishment in this territory of agronomic practices different from those of the preceding EBA. This cultural and/or economic change appears to have been responsible for the end of the preceding period of early olive cultivation.

A major change in land use, albeit without implications regarding olive cultivation, is also documented at the Lago di Mezzano[51] (central Latium, 452m asl). Here, the pollen sequence shows a first phase of more intense agricultural activities occurring during the EBA/MBA and a forest expansion corresponding to a period of abandonment in the RBA that was followed by a less intense land exploitation phase. A strong deforestation period during the EBA and the MBA followed by an expansion of mixed oak woods during the RBA is also documented in several other pollen sequences in central Italian regions (Lake Albano and Lake Nemi, Latium[52]) as well as in a central Adriatic marine core.[53] This evidence relates, at the same time, to a reduction of human impact.

Here one should note that the Ionian coast of Italy was characterised by a different landscape history, especially regarding the olive tree. At Broglio di Trebisacce[54] located in the plain of Sybaris (at 164m asl, Fig. 11) the presence of olive is stable from the MBA to the RBA. At this settlement, olive is attested by charcoal and by imprints of leaves,[55] as well as by organic residues. One gas chromatographic analysis of residues in a Final Bronze Age pithos sherd provides evidence for oil, but it was not possible to establish with certainty that the oil in question was indeed olive oil.[56]

For the RBA, olive started to be moderately attested also on the plateau-like hilltop site of Torre Mordillo (Fig. 11) at 200m asl, about 23km to the SW of Broglio di Trebisacce.[57] In my opinion, the vegetation context with mainly deciduous tree taxa, clearly suggests that in the plain of Sybaris the presence of olive was related to its cultivation. However, due to the lack of EBA strata at Broglio di Trebisacce and Torre Mordillo, one cannot know if the beginning of olive cultivation in this area predates the contacts with Aegean population groups.

47 Guggiari et al. 2011, 806.
48 Pacciarelli 2015, 56–57.
49 Martinelli et al. 2004, 269.
50 Fiorentino – D'Oronzo 2012, 328–329, tab. 3 and 5.
51 Sadori et al. 2004, 5–17.
52 Mercuri et al. 2002, 263–276.
53 Mercuri et al. 2012, 353–372.
54 Nisbet – Ventura 1994, 572–581.
55 Celant 2002, 91; Nisbet – Ventura 1994, 572–581.
56 Peroni 1994, 855–856, fig. 231.
57 Coubray 2001, 419–431.

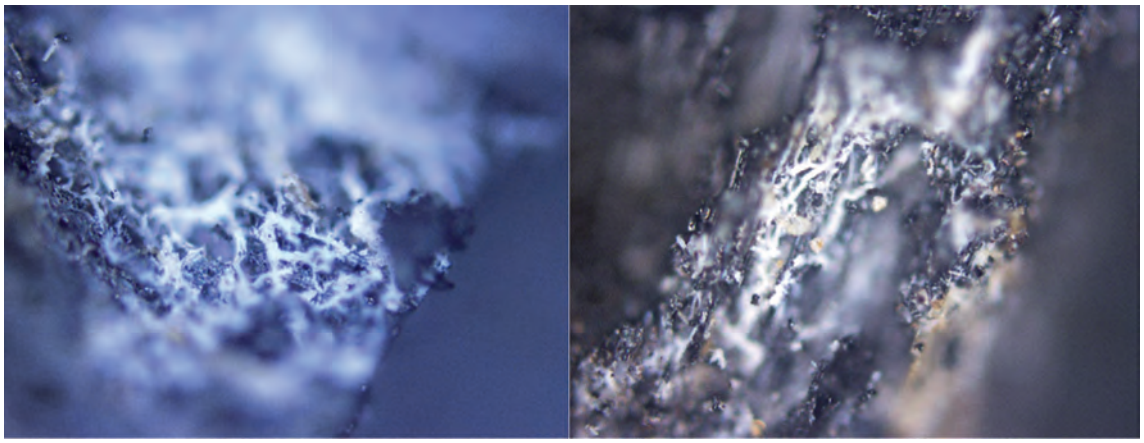


Fig. 12 Fungal hyphae present in the charcoal fragments of Punta di Zambrone (photos: A. D'Auria)

Two cases that differ completely from that of Punta di Zambrone are the settlement of Portella on the Aeolian Island of Salina (0–300m asl) and the settlement of Roca Vecchia in southern Apulia (5m asl).

At MBA 3 Portella, analysed charcoals amount to 962 fragments, belonging to both structural elements (in particular from the roof) and to firewood. 11 taxa have been identified and include cfr. *Genista* sp. (23.28%), *Erica* (21.16%), *O. europaea* (15.8% and considered as *O. europaea* var. *sylvestris*), Leguminosae (11.12%) and *Cistus* (7.06%). Three charcoal fragments of olive were possibly situated inside the wall and could belong to furniture elements. This is selected wood material in the surrounding vegetation related to particular functional choices.[58]

The Bronze Age settlement of Roca Vecchia[59] (Fig. 11) provides us with an important example for the use of olive wood in a fortification structure destroyed by fire in MBA 3. The charcoals are mainly assignable to structural elements and in particular to the collapse layer of walls and posts. The use of olive wood as carpentry elements is notable. Indeed, the olive wood, together with oak, is used for vertical posts, while in the stratigraphic units belonging to the collapse layers the use of olive wood appears to be exclusive. However, the use of the olive wood for structural elements appears as singular, inasmuch it is a particular wood characterised by a timber very resistant and rich in knurls, which makes it rather difficult to work. Surely the wood of olive is particularly widespread in nature if we consider the spontaneous vegetation of this area during the 2nd millennium BC as shown in the pollen core taken close to Laghi Alimini just a few kilometres from the site of Roca Vecchia.[60] According to M. Primavera and G. Fiorentino, it is possible that the presence of these two very different types of wood was due to wear of the structure during its use period. The oak posts used in the initial construction, which later deteriorated because of the excessive humidity, may have been replaced by those of olive, more readily available in the area.[61]

The cases of Roca and Portella on Salina illustrate a particular use of olive wood during the Bronze Age in southern Italy.

Conclusions

Due to their very exact spatial and chronological positioning, archaeological charcoal data can make an important contribution to the reconstruction of vegetation history, first in relation to

58 Fiorentino et al. 2010, 236–238, 241, fig. 119.1.
59 Primavera – Fiorentino 2012, 352–357.
60 Di Rita – Magri 2009, 295–306.
61 Primavera – Fiorentino 2012, 352–357.

climatic change and second, most importantly, in relation to specific human activities, as in the case of the Punta di Zambrone. The Zambrone data reveal vegetation changes occurring on a local scale between the EBA and the RBA including important information for reconstructing the history of the olive tree. For this study area, I have formulated the hypothesis of an early episode of olive cultivation, not necessarily implying domestication, at the beginning of the EBA. The data gathered at Punta di Zambrone argue against the earlier theory according to which olive cultivation should be seen as a result of contacts with Mycenaean Greece.[62] The Zambrone evidence, in combination with published archaeobotanical evidence from other Bronze Age sites, suggests that the populations in vast areas of southern Italy were involved in this first cultivation episode at about the same time.

It seems that olive cultivation was interrupted at least during the RBA, which was probably related to the diffusion of cultural and economic innovations.[63] The expanded forest cover, the impact of which becomes visible during the RBA, can be ascribed to a partial abandonment of cultivated fields during the MBA 3 phase as well as to the possible changes in land use brought about by the RBA populations. This changed human impact on the landscape is also recorded in a wider area of central and southern Italy. It seems plausible that olive cultivation and the subsequent increase in forest cover did not depend on climatic factors.

To sum up, the significance of the new data from Punta di Zambrone is not confined to the local level but can be considered as a chapter in the history of olive cultivation in a larger part of southern Italy.

Bibliography

Abbate-Edlmann et al. 1994
M. L. Abbate-Edlmann – L. De Luca – S. Lazzeri, Atlante anatomico degli alberi ed arbusti della macchia mediterranea (Firenze 1994).

Asouti 2003
E. Asouti, Wood charcoal from Santorini (Thera). New evidence for climate, vegetation and timber imports in the Aegean Bronze Age, Antiquity 77, 2003, 471–484.

Baldoni et al. 2006
L. Baldoni – N. Tosti – C. Ricciolini – A. Belaj – S. Arcioni – G. Pannelli – M. A. Germana – M. Mulas – A. Porceddu, Genetic structure of wild and cultivated olives in the central Mediterranean Basin, Annals of Botany 98, 2006, 935–942.

Bartolini et al. 1998
G. Bartolini – G. Prevost – C. Messeri – G. Carignani – U. G. Menini, Olive Germplasm. Cultivars and World-wide Collections (Rome 1998).

Belaj et al. 2012
A. Belaj – M. C. Dominguez-Garzia – S. G. Atienza – N. M. Urdíroz – R. De la Rosa – Z. Satovic – A. Martín – A. Kilian – I. Trujillo – V. Valpuesta – C. Del Río, Developing a core collection of olive (*Olea europaea* L.) based on molecular markers (DArTs, SSRs, SNPs) and agronomic traits, Tree Genetics and Genomes 8, 2012, 365–378.

Besnard – Bervillé 2000
G. Besnard – A. Bervillé, Multiple origins for Mediterranean olive (*Olea europaea* L. ssp. *europaea*) based upon mitochondrial DNA polymorphisms, Comptes Rendus de l'Académie des Sciences – Series III – Sciences de la Vie 323, 2000, 173–181.

Besnard et al. 2001
G. Besnard – P. Baradat – C. Breton – B. Khadari – A. Bervillé, Olive domestication from structure of oleasters and cultivars using nuclear RAPDs and mitochondrial RFLPs, Genetics Selection Evolution 33, 2001, 251–268.

62 D'Auria et al. 2017, 610.
63 D'Auria et al. 2017, 610.

Besnard et al. 2002
G. Besnard – B. Khadari – P. Baradat – A. Bervillé, Olea europaea (Oleaceae) phylogeography based on chloroplast DNA polymorphism, Theoretical and Applied Genetics 104, 2002, 1353–1361.

Besnard et al. 2007
G. Besnard – R. Rubio de Casas – P. Vargas, Plastid and nuclear DNA polymorphism reveals historical processes of isolation and reticulation in the olive tree complex (*Olea europaea* L.), Journal of Biogeography 34, 2007, 736–752.

Breton et al. 2006
C. Breton – M. Tersac – A. Bervillé, Genetic diversity and gene flow between the wild olive (oleaster, Olea europaea L.) and the olive. Several Plio-Pleistocene refuge zones in the Mediterranean basin suggested by simple sequence repeats analysis, Journal of Biogeography 33, 2006, 1916–1928.

Breton et al. 2009
C. Breton – J. F. Terral – C. Pinatel – F. Médail – F. Bonhomme – A. Bervillé, The origins of the domestication of the olive tree, Comptes Rendus Biologies 332, 2009, 1059–1064.

Brun 2003
J. P. Brun, Le vin et l'huile dans le Méditerranée antique. Viticulture, oléiculture et procédés de transformation (Paris 2003).

Carrión et al. 2010
Y. Carrión – M. Ntinou – E. Badal, *Olea europaea* L. in the north Mediterranean Basin during the Pleniglacial and the Early-Middle Holocene, Quaternary Science Reviews 29, 2010, 952–968.

Celant 2002
A. Celant, Appendice 2: Risultati delle indagini paleobotaniche eseguite su impronte e resti vegetali incombusti relativi a frammenti di intonaco di capanna e di fornelli dell'abitato protostorico di Broglio di Trebisacce (CS), in: C. Moffa, L'organizzazione dello spazio sull'acropoli di Broglio di Trebisacce. Dallo studio delle strutture e dei manufatti in impasto di fango all'analisi della distribuzione dei reperti, Grandi contesti e problemi della Protostoria italiana 6, Prima di Sibari 2 (Florence 2002) 91.

Chabal 1997
L. Chabal, Forêts et sociétés en Languedoc (Néolitique final, Antiquité tardive). L'anthracologie, méthode et paléoécologie (Paris 1997).

Chabal et al. 1999
L. Chabal – L. Fabre – J. F. Terral – I. Théry-Parisot, L'anthracologie, in: C. Bourquin-Mignot – J. É. Brochier – L. Chabal – S. Crozat – L. Fabre – F. Guibal – P. Marinval – H. Richard – J. F. Terral – I. Rhéry (eds.), La Botanique (Paris 1999) 43–104.

Costantini 1981
L. Costantini, Semi e carboni del mesolitico e neolitico della grotta dell'Uzzo, Trapani, Quaternaria 23, 1981, 233–247.

Coubray 2001
S. Coubray, Étude anthracologique et carpologique, in: F. Trucco – L. Vagnetti (eds.), Torre Mordillo 1987–1990. Le relazioni egee di una comunità protostorica della Sibaritide, Incunabula Graeca 101 (Rome 2001) 419–431.

D'Auria et al. 2017
A. D'Auria – M. P. Buonincontri – E. Allevato – A. Saracino – R. Jung – M. Pacciarelli – G. Di Pasquale, Evidence of a short-lived episode of olive (*Olea europaea* L.) cultivation during the Early Bronze Age in western Mediterranean (southern Italy), The Holocene 27, 2017, 605–612.

Diez et al. 2015
C. M. Diez – I. Trujillo – N. Martinez-Urdiroz – D. Barranco – L. Rallo – P. Marfil – B. S. Gaut, Olive domestication and diversification in the Mediterranean Basin, New Phytologist 206, 1, 2015, 436–447.

Di Rita – Magri 2009
F. Di Rita – D. Magri, Holocene drought, deforestation and evergreen vegetation development in the central Mediterranean. A 5500 year record from Lago Alimini Piccolo, Apulia, southeast Italy, The Holocene 19, 2009, 295–306.

Evans – Recchia 2005
J. Evans – G. Recchia, Pottery function. Trapped residues in Bronze Age pottery from Coppa Nevigata (Southern Italy), Scienze dell'Antichità 11, 2005, 187–201.

Figueiral – Mosbrugger 2000
I. Figueiral – V. Mosbrugger, A review of charcoal analysis as a tool for assessing Quaternary and Tertiary environments. Achievements and limits, Palaeogeography, Palaeoclimatology, Palaeoecology 164, 1, 2000, 397–407.

Fiorentino – D'Oronzo 2012
G. Fiorentino – D'Oronzo, Analisi dei macroresti vegetali. Strategie agronomiche, alimentazione e caratteristiche del paleoambiente a Coppa Nevigata nel corso dell'età del Bronzo, in: A. Cazzella – M. Mascoloni – G. Recchia (eds.), Coppa Nevigata e l'area umida alla foce del Candelaro durante l'età del Bronzo (Foggia 2012) 327–339.

Fiorentino et al. 2010
G. Fiorentino – G. Colaianni – A. M. Grasso – A. Stellati, Caratteristiche del paleoambiente e modalità di sfruttamento dei vegetali a Salina nel corso dell'età del Bronzo, in: M. C. Martinelli, Archeologia delle Isole Eolie. Il villaggio dell'età del Bronzo medio di Portella a Salina. Ricerche 2006 e 2008 (Milazzo 2010) 235–241.

Greguss 1955
P. Greguss, Identification of Living Gymnosperms on the Basis of Xylotomy (Budapest 1955).

Greguss 1959
P. Greguss, Holzanatomie der Europaïschen Laubhölzer und Straucher (Budapest 1959).

Guggiari et al. 2011
M. Guggiari – R. Bloque – M. Aragno – E. Verrecchia – D. Job – P. Junier, Experimental calcium-oxalate crystal production and dissolution by selected wood-rot fungi, International Biodeterioration & Biodegradation 65, 2011, 803–809.

Jung – Weninger 2015
R. Jung – B. Weninger, Archaeological and environmental impact of the 4.2 ka calBP event in the Central Eastern Mediterranean, in: H. Meller – H. W. Arz – R. Jung – R. Risch (eds.), 2200 BC – Ein Klimasturz als Ursache für den Zerfall der Alten Welt? 7. Mitteldeutscher Archäologentag vom 23. bis 26. Oktober 2014 in Halle (Saale) / 2200 BC – A Climatic Breakdown as a Cause for the Collapse of the Old World? 7th Archaeological Conference of Central Germany, October 23–26, 2014 in Halle (Saale), Tagungen des Landesmuseums für Vorgeschichte Halle 12 (Halle [Saale] 2015) 205–234.

Jung et al. 2015
R. Jung – M. Pacciarelli – B. Zach – M. Klee – U. Thanheiser, Punta di Zambrone (Calabria) – a Bronze Age harbour site. First preliminary report on the Recent Bronze Age (2011–2012 campaigns), Archaeologia Austriaca 99, 2015, 53–110.

LaCroix Phippen 1975
W. LaCroix Phippen, Vegetal Remains, contribution in: R. Ross Holloway – N. P. Nabers – S. S. Lukesh – G. Barker – N. B. Hartmann – E. R. Eaton – H. Mc Kerrell – W. L. Phippen, Buccino. The Early Bronze Age village of Tufariello, Journal of Field Archaeology 2, 1975, 78–80.

Lipschitz et al. 1991
N. Lipschitz – R. Gophna – M. Hartman – G. Biger, The beginning of Olive (*Olea europaea* L.) cultivation in the old world. A reassessment, Journal of Archaeological Science 18, 1991, 441–453.

Lumaret et al. 2004
R. Lumaret – N. Ouazzani – H. Michaud – G. Vivier – M. F. Deguilloux – F. Di Giusto, Allozyme variation of oleaster populations (wild olive tree) (*Olea europaea* L.) in the Mediterranean Basin, Heredity 92, 2004, 343–351.

Magny et al. 2013
M. Magny – N. Combourieu-Nebout – J. L. de Beaulieu – V. Bout-Roumazeilles – D. Colombaroli – S. Desprat – A. Francke – S. Joannin – O. Peyron – M. Revel – L. Sadori – G. Siani – M. A. Sicre – S. Samartin – A. Simonneau – W. Tinner – B. Vannière – B. Wagner – G. Zanchetta – F. Anselmetti – E. Brugiapaglia – E. Chapron – M. Debret – M. Desmet – J. Didier – L. Essallami – D. Galop – A. Gilli – J. N. Haas – L. Millet – A. Stock – J. L. Turon – S. Wirth, North-south palaeohydrological contrasts the central Mediterranean during the Holocene. Tentative synthesis and working hypotheses, Climate of the Past 9, 2013, 2043–2071.

Maran 2007
J. Maran, Seaborne contacts between the Aegean, the Balkans and the Central Mediterranean in the 3rd millennium BC. The unfolding of the Mediterranean world, in: I. Galanaki – H. Tomas – Y. Galanakis – R. Laffineur (eds.), Between the Aegean and Baltic Seas. Prehistory Across Borders. Proceedings of the International Conference Bronze and Early Iron Age Interconnections and Contemporary Developments between the Aegean and the Regions of the Balkan Peninsula, Central and Northern Europe. University of Zagreb, 11–14 April 2005, Aegaeum 27 (Eupen 2007) 3–21.

Margaritis 2013
E. Margaritis, Distinguishing exploitation, domestication, cultivation and production. The olive in the third millennium Aegean, Antiquity 87, 2013, 746–757.

Martinelli et al. 2004
M. C. Martinelli – R. Agostino – G. Fiorentino – G. Mangano, La grotta di San Sebastiano a Bagnara Calabra (RC). Primi risultati, in: Istituto Italiano di Preistoria e Protostoria (ed.), Atti della XXXVII riunione scientifica "Preistoria e protostoria della Calabria", Scalea, Papasidero, Praia a Mare, Tortora, 29 settembre – 4 ottobre 2002 (Florence 2004) 259–273.

Mercuri et al. 2002
A. M. Mercuri – C. A. Accorsi – M. B. Mazzanti, The long history of cannabis and its cultivation by the Romans in central Italy, shown by pollen records from Lago Albano and Lago di Nemi, Vegetation History and Archaeobotany 11, 2002, 263–276.

Mercuri et al. 2012
A. M. Mercuri – M. B. Mazzanti – P. Torri – L. Vigliotti – G. Bosi – A. Florenzano – L. Olmi – I. Massamba N'siala, A marine/terrestrial integration for mid-late Holocene vegetation history and the development of the cultural landscape in the Po Valley as a result of human impact and climate change, Vegetation History and Archaeobotany 21, 2012, 353–372.

Nisbet – Ventura 1994
R. Nisbet – G. Ventura, I dati archeobotanici, in: R. Peroni – F. Trucco (eds.), Enotri e Micenei nella Sibaritide I. Broglio di Trebisacce (Taranto 1994) 577–585.

Ozenda – Lucas 1975
P. Ozenda – M. J. Lucas, Documents de cartographie écologique, Résumé 16, 1975, 49–64.

Pacciarelli 2001
M. Pacciarelli, Dal villaggio alla città. La svolta protourbana del 1000 a.C. nell'Italia tirrenica (Florence 2001).

Pacciarelli 2010
M. Pacciarelli, Verso i centri protourbani. Situazioni a confronto da Etruria meridionale, Campania e Calabria, Scienze dell'Antichità 15, 2010, 371–416.

Pacciarelli 2015
M. Pacciarelli, General notes on the Recent Bronze Age in Italy, with special reference to the Southwest, contribution in: Jung et al. 2015, 54–57.

Pacciarelli et al. 2015
M. Pacciarelli – A. Crispino – T. Scarano, The transition between the Copper and Bronze Age in Southern Italy and Sicily, in: in: H. Meller – H. W. Arz – R. Jung – R. Risch (eds.), 2200 BC – Ein Klimasturz als Ursache für den Zerfall der Alten Welt? 7. Mitteldeutscher Archäologentag vom 23. bis 26. Oktober 2014 in Halle (Saale) / 2200 BC – A Climatic Breakdown as a Cause for the Collapse of the Old World? 7th Archaeological Conference of Central Germany, October 23–26, 2014 in Halle (Saale), Tagungen des Landesmuseums für Vorgeschichte Halle 12 (Halle [Saale] 2015) 253–281.

Peroni 1994
R. Peroni, Introduzione alla Protostoria Italiana (Taranto 1994).

Primavera – Fiorentino 2012
M. Primavera – G. Fiorentino, I resti vegetali delle postierle B e C, in: T. Scarano, Roca I. Le fortificazioni della media età del Bronzo. Strutture, contesti, materiali (Foggia 2012) 352–357.

Rodríguez-Ariza – Montes Moya 2005
M. O. Rodríguez-Ariza – E. Montes Moya, On the origin and domestication of *Olea europaea* L. (olive) in Andalucía, Spain, based on the biogeographical distribution of its finds, Vegetation History and Archaeobotany 14, 2005, 551–561.

Sadori et al. 2004
L. Sadori – C. Giraudi – P. Petitti – A. Ramrath, Human impact at Lago di Mezzano (central Italy) during the Bronze Age. A multidisciplinary approach, Quaternary International 113, 2004, 5–17.

Sarpaki 1999
A. Sarpaki, The archaeobotanical study of Tzambakas House, Rethymnon, Crete, in: Y. Tzedakis – H. Mart (eds.), Minoans and Mycenaeans. Flavours of Their Time (Athens 1999) 40–41.

Schweingruber 1990
F. H. Schweingruber, European Wood Anatomy (Bern 1990).

Spampinato 2010
G. Spampinato – L. Bernardo – N. G. Passalacqua, Carta delle serie di vegetazione della Regione Calabria, in: C. Blasi (ed.), La vegetazione d'Italia I (Rome 2010) 411–428.

Stager 1985
L. E. Stager, The archaeology of the family in ancient Israel, Bulletin of the American Schools of Oriental Research 260, 1985, 1–35.

Terral et al. 2004
J. F. Terral – N. Alonso – R. Buxò i Capdevila – N. Chatti – L. Fabre – G. Fiorentino – P. Marinval – G. P. Jordà – B. Pradat – N. Rovira – P. Alibert, Historical biogeography of olive domestication (*Olea europaea* L.) as revealed by geometrical morphometry applied to biological and archaeological material, Journal of Biogeography 31, 2004, 63–77.

Thanos et al. 1992
C. A. Thanos – K. Georghiou – C. Kadis – C. Pantazi, Cistaceae. A plant family with hard seeds, Israel Journal of Botany 41, 1992, 251–263.

Trujillo et al. 1990
I. Trujillo – L. Rallo – E. A. Carbonell – M. J. Asins, Isoenzymatic variability of olive cultivars according to their origin, Acta Horticulturae 286, 1990, 137–140.

Valamoti et al. 2017
S. M Valamoti – E. Gkatzogia – M. Ntinou, Did Greek colonisation bring olive growing to the north? An integrated archaeobotanical investigation of the spread of Olea europaea in Greece from the 7th to the 1st millennium BC, Vegetation History and Archaeobotany, 2017, 1–19.

Van Zeist 1980
W. Van Zeist, Aperçu sur la diffusion des végétaux cultivés dans la region méditerranéenne, in: M. Denizot – C. Sauvage (eds), La mise en place, l'évaluation et la caractérisation de la flore et des végétations circumméditerranéennes (Montpellier 1980) 129–145.

Vernet et al. 2001
J. L. Vernet – P. Ogereau – I. Figueiral – M. Machado Yanes – C. Yanes – P. Uzquiano, Guide d'identification des charbons de bois préhistoriques du Sud-Ouest de l'Europe (Paris 2001).

Zach et al. 2015
B. Zach – M. Klee – U. Thanheiser, Preliminary results obtained from the archaeobotanical analysis of materials from the 2011 excavation season, contribution in: Jung et al. 2015, 83–90.

Zohary – Hopf 2000
D. Zohary – M. Hopf, Domestication of Plants in the Old World (Oxford 2000).

Zohary – Spiegel-Roy 1975
D. Zohary – P. Spiegel-Roy, Beginnings of fruit growing in the Old World, Science 187, 1975, 319–327.

Faunal Remains from the Bronze Age Settlement at Punta di Zambrone (Calabria, Italy)

Gerhard Forstenpointner[1] *– Gabriela Slepecki*[2] *–*
Alfred Galik[3] *– Gerald E. Weissengruber*[4]

Abstract: Excavations at the Bronze Age site of Punta di Zambrone yielded faunal remains from two habitational phases of the settlement, comprising two small samples from the Early Bronze Age 2 (EBA 2, NISP=114) and the Recent Bronze Age 2 (RBA 2, NISP=137) layers of Area B and a large assemblage from massive ashy filling layers of Area C (RBA 2, NISP=3439). Additionally, a very small sample (NISP=63) came from earlier horizons of Area C, possibly representing the early Recent or even Middle Bronze Age. All three small samples show very similar patterns of species composition, characterised by the distinct predominance of bovine remains and balanced ratios of pigs and ovicaprines. The large RBA 2 sample from Area C differs strongly from the other assemblages, mainly in terms of livestock representation which shows balanced ratios of all main domestic species and a remarkably high percentage of canine bones which, additionally, show frequent traces of butchering. These features resemble closely patterns of husbandry from other Calabrian sites, in particular MBA Broglio di Trebisacce, however, the deposition of faunal remains, comprising also meaningful objects like bucrania or eagle bones, in a series of ashy layers might also indicate ritually motivated forms of consumption that may not necessarily reflect the regular livestock economy of the settlement.

Keywords: Archaeozoology, Bronze Age, Calabria, Punta di Zambrone, transhumance

Introduction

Faunal records from southernmost Italian Bronze Age sites are mainly available from Apulia and, to a lesser extent, also from Calabria. While almost all published data refer to the Middle, Recent and Final Bronze Age, Early Bronze Age evidence is particularly scarce. Two sites in Apulia, Cavallino near Lecce and Coppa Nevigata near the promontory of Gargano, provide rather small samples of explicitly assigned finds.[5] Another two settlements in Campania, La Starza (province of Avellino) and Tufariello (province of Salerno), yielded Protoapennine layers that, in terms of absolute chronology, overlap with the Early Bronze Age 2 habitation phase of Punta di Zambrone.[6] By contrast, a broad variety of Middle and Late Bronze Age finds, mainly recovered at coastal sites, are available. In Apulia, the aforementioned Coppa Nevigata is regarded as a key site, first of all well-known because of its large-scale purple production, proven from the Early Bronze Age 2 phase ('Early Protoapennine') until the Recent Bronze Age.[7] Also the remains of vertebrate fauna are numerous and have been studied extensively.[8] Additionally, short reports on

1 Institute of Topographic Anatomy, University of Veterinary Medicine Vienna, Veterinärplatz 1, 1210 Vienna, Austria; gerhard.forstenpointner@vetmeduni.ac.at.
2 Institute of Topographic Anatomy, University of Veterinary Medicine Vienna, Veterinärplatz 1, 1210 Vienna, Austria; gabriela.slepecki@vetmeduni.ac.at.
3 Institute of Topographic Anatomy, University of Veterinary Medicine Vienna, Veterinärplatz 1, 1210 Vienna, Austria; Austrian Archaeological Institute, Austrian Academy of Science, Franz-Klein-Gasse 1, 1190 Vienna, Austria; alfred.galik@oeai.at.
4 Institute of Topographic Anatomy, University of Veterinary Medicine Vienna, Veterinärplatz 1, 1210 Vienna, Austria; gerald.weissengruber@vetmeduni.ac.at.
5 For Cavallino see Sorrentino 1979; for Coppa Nevigata see Siracusano 1995.
6 For La Starza see Albarella 1999; for Tufariello see Barker 1975.
7 Minniti 2012.
8 Siracusano 1995; Siracusano 2001; Siracusano 2012.

exclusively quite small Apulian samples are available from Torre Castelluccia[9] near Taranto and from Roca Vecchia[10] near Lecce and a helpful overview on the earlier state of research was provided by Barbara Wilkens.[11]

In Calabria not a single site with assured Early Bronze Age evidence on faunal remains could be found. The abundant assemblage of faunal remains from Grotta Cardini, even if frequently denominated as Early Bronze Age material, covers a broad occupation phase from the third to the middle of the 2nd millennium BC, but lacks comprehensive chronological assignment.[12] Comparable data on patterns of faunal exploitation in the Middle, Recent and Final Bronze Age are available from four sites near the ancient city of Sybaris, Broglio di Trebisacce,[13] Francavilla Marittima,[14] Torre Mordillo[15] and Timpone della Motta[16] as well as from the cave site Grotta della Madonna[17] on the west coast of Calabria and close to Grotta Cardini in the town of Praia a Mare.

Materials and Applied Methods

Only two excavated trenches, Area B and Area C, yielded more or less representative samples of faunal remains. According to the stratigraphic evidence, the majority of finds could be assigned to the habitational phases of the settlement (Tab. 1). By far the most voluminous sample came from Area C, the bones embedded in ashy filling layers of the Recent Bronze Age 2 (RBA 2) fortification ditch. Area B yielded smaller quantities of faunal remains from the Early Bronze Age 2 (EBA 2) and Recent Bronze Age 2 layers. In both areas the Recent Bronze Age 2 layers inside the fortification ditch overlaid earlier horizons that should be assigned to earlier stages of the Recent or maybe even the Middle Bronze Age but unfortunately lacked significant datable finds. These intermediate layers yielded very small and therefore poorly significant bone samples.

		Area B			Area C		
		total	NISP	Indet	total	NISP	indet
EBA 2	n	1009	114	895			
	w	2002	1491.2	510.8			
RBA 2	n	394	137	257	10826	3439	7387
	w	1247.8	961.8	286	37474.2	30084.7	7389.5
Intermediate layers	n	16	11	5	161	63	98
	w	97.9	91.1	6.8	1163.3	988.1	175.2

Tab. 1 Size and chronological assignment of investigated samples. Abbr.: EBA – Early Bronze Age, RBA – Recent Bronze Age, NISP – Number of Identified SPecimens, indet – specimens not identifiable up to family level, n – number, w – weight (g)

The extraction of finds has been processed by manual collection as well as by wet-sieving. All samples showed a high grade of fragmentation which caused a very high score of undeterminable specimens. Determination was carried out on-site by means of a mobile reference collection, which enabled ascertained identification of all significant mammalian and avian skel-

9 Corridi 1993.
10 de Grossi Mazzorin – Rugge 2007; Rugge 2008.
11 Wilkens 1998.
12 Tagliacozzo et al. 1989.
13 Tagliacozzo 1994; Elevelt –Tagliacozzo 2009/10.
14 Elevelt 2005.
15 Tagliacozzo – Curci 2001.
16 Elevelt 2012a; Elevelt 2012b.
17 Facciolo –Tagliacozzo 2002.

etal elements, including ribs and vertebrae, at least up to family level. Analysis of micro-faunal remains, including all aquatic species, is still in progress and will not be presented extensively in the course of this study.

The investigated samples showed different states of preservation. Finds from Area C appeared fairly well preserved, even if sometimes covered by a substantial layer of sinter that could not be removed without damaging the bone and therefore hampered examination of the surface. The finds from Area B generally showed a worse state of preservation, some specimens were heavily corroded and, additionally, covered with thick layers of sinter. Area D (with Early Bronze Age 1 layers) yielded not a single well-preserved specimen; only one heavily corroded fragment of a scapula, most likely porcine, was found.

Quantification was performed basically by counting the Number of Identified Specimens (NISP), being aware of the unquestionable benefits of an observed measure that is provided by the direct, additive tally of examined specimens. Of course NISP is biased by different methods of collection as well as by patterns of butchery and fragmentation;[18] however, derivative methods like MNI (Minimum Number of Individuals) or MNE (Minimum Number of skeletal Elements) tend to exaggerate the frequency of in fact rarely represented species, are severely affected by limited abilities in determination and, what is more, the derivate is always a function of NISP, consequently reflecting initial biases.[19] The value of MNI, whether performed by the classic method[20] or by means of more sophisticated tools like utilising diagnostic zones of skeletal elements,[21] mainly becomes apparent in order to stress selective patterns that set residuals of specific functions[22] apart from 'normal' domestic waste.

Osteological analysis was performed according to the methodic rules of archaeozoological research. Osteometrical data collection followed the standards of A. Von den Driesch,[23] data on culling ages were obtained by estimating the wear stages of teeth according to the methods of S. Payne,[24] modified by H. Hongo,[25] and by rating the state of epiphyseal closure.[26] All quantitative data as well as discernible bone modifications like traces of butchering, burning, gnawing marks etc. were recorded digitally, using a self-developed input mask that, based on the software package PASW Statistics, allowed the direct application of all current statistical assay methods.

Results

Early Bronze Age Finds

Only Area B yielded a quite small, hardly sufficiently significant sample of faunal remains (Tab. 2) that could be assigned to the chronological stage of Early Bronze Age 2 (EBA 2). Surprisingly, only mammalian species of large and medium size were represented, which should be blamed not merely on the poor preservation state of biogenic remains, as mollusc shells and fragments of tortoise carapaces are also lacking completely.

The species composition of the sample is dominated by cattle bones (51%, NISP), followed by remains of domestic pig (24%) and ovicaprines (21%). As only one ovine humerus could be identified, no preference for sheep or goat is discernible. Additionally, three dog bones and two remains of red deer have been recorded. No significant patterns of skeletal representation are recognisable, which is obviously also due to the small sample size.

---

18 Albarella 1999, 318–320.
19 For comprehensive evaluations of quantitative methods see Lyman 2008 and Peres 2010.
20 White 1953.
21 Albarella 1995.
22 E.g. Forstenpointner 2003, tab. 21.1.
23 Von den Driesch 1996.
24 Payne 1987.
25 Hongo 1997.
26 Noddle 1974; Habermehl 1975.

B – EBA 2	B	O-C	O	S	Cn	Ce	s	m	l	ind	total
Cran. fragm.	11	2		4				31	41		89
Mandibula	4	1		1	1			5			12
Dens sup.	2	1		1							4
Dens inf.		1		1							2
Dens	2	2		1				9	1		15
Vert. cerv.	4							4			8
Vert. thor.				1							1
Vert. lumb.	1										1
Os sacrum	2										2
Vertebra								2	2		4
Costa	5	2				1		30	61		99
Scapula	2	2		4							8
Humerus	3	3	1	1				1	3		12
Radius	2	1									3
Ulna				4							4
Carpus	1										1
Metacarpus	1	1		1							3
Coxa	4	2		1				1	5		13
Femur	3	2		1	1						7
Tibia		3		1	1						5
Talus	1										1
Calcaneus	2										2
Metatarsus	2					1					3
Metapodium				5							5
Phalanx prox.	4										4
Phalanx med.	2										2
Os longum							1	65	74		140
Os planum								4	2		6
Spongiosa								25	24		49
Compacta								284	134	1	419
ind.								22	57	6	85
total	58	23	1	27	3	2	1	483	404	7	1009
total dom +Ce%	50.9	20.2	0.9	23.7	2.6	1.8	114				

Tab. 2 Species composition and skeletal distribution of faunal remains from Early Bronze Age layers in Area B. Abbr.: B – cattle, O-C – ovicaprines, O – sheep, C – goat, S – domestic pig, Cn – dog, Ce – red deer, s – small-sized animal, m – medium-sized, l – large-sized, ind – indeterminable

In terms of culling ages, the vast majority of skeletal finds appeared to represent adult individuals. While in cattle not a single juvenile bone was discernible and only one juvenile and two adolescent pig bones could be identified, in ovicaprines at least four remains represented juvenile lambs or fawns and one humerus came from a neonate. A total of 7 teeth (1 bovine, 3 porcine, 3 ovicaprine) exclusively represented adult individuals. Bone modifications are not frequently present, we recorded 30 charred fragments (3% of the total, comprising 21 black, 7 grey, 1 white

specimen), only two butchering marks and not a single trace of carnivore or rodent gnawing. Obviously, the poor preservation state provides a strong contributory cause for the scarcity of discernible modifications of the bone surface.

Intermediate Layers

In fact, both samples (Tab. 3a,b) are too small to allow more than indistinct attempts at interpretation. Nevertheless, as these finds have been extracted from sandy to clayey soil, underlying the ashy layers of the abandonment horizon in Area C and the uppermost layers in Area B in the fortification ditch,[27] and are believed to reflect domestic consumptive patterns of the Recent Bronze Age or even earlier habitational phases, cautious comparison with the other samples appears feasible. Area C yielded 63 identifiable specimens that show a similar species composition to the EBA 2 finds from Area B with even more dominant bovine remains (54%), again followed by domestic pig (27%), ovicaprines (16%) and red deer (3%). Again similar to the EBA 2 sample, with the exception of two juvenile specimens each from cattle and domestic pig, all identifiable remains represent adult individuals. Unlike the EBA 2 finds from Area B, a total of 20 mollusc shells has been recovered, comprising 12 maybe intrusive land snails (7 Helix sp. and 5 *Rumina decollata*) and 8 marine species (1 *Ostrea edulis*, 2 Bivalvia indet., 4 *Patella caerulea*). One shell of *Erosaria spurca*, the dirty cowry, may have been collected because of its decorative form and colours. 42 fragments of this sample, which is a quarter of the total, have been exposed to fire and appear totally (n=12) or partly (n=30) charred or even calcined. The vast majority of burnt specimens came from one stratigraphic unit (SU 202), which was not an ash layer, but had a silt loam matrix. 16 fragments were charred (10% of the total, comprising 15 black and 1 grey specimen), 6 specimens showed traces of butchering, only one appeared gnawed by carnivores. Application of any other analytical method in terms of detecting patterns of consumption or husbandry appears unfeasible, due to the obviously small sample size.

C – intermediate	B	O-C	S	Ce	Vu	m	l	total
Cran. fragm.	1	1	2			5	1	10
Hyalia	1							1
Mandibula	8	2	2					12
Dens sup.	3							3
Dens inf.		1	3					4
Vert. cerv.	2							2
Vert. thor.			1					1
Costa	8	1	1			3	4	17
Scapula	2	1						3
Humerus		1	1	2	1			5
Radius	4	1						5
Ulna	1							1
Metacarpus			1					1
Femur	2		2					4
Tibia		1						1
Fibula			1					1
Calcaneus			1					1

[27] On the stratigraphy of the fill layers inside the fortification ditch see the contribution by Jung and Pacciarelli, this volume.

C – intermediate	B	O-C	S	Ce	Vu	m	l	total
Metatarsus		1	1					2
Phalanx prox.	1		1					2
Phalanx med.	1							1
Os longum						20	8	28
Compacta						25	30	55
Spongiosa							1	1
total	34	10	17	2	1	53	44	161
total dom + Ce %	54.0	15.9	27.0	3.2				

B – intermediate	B	O-C	O	S	Ce	m	l	total
Cran. Fragm.				1				1
Antler					1			1
Mandibula	1	1		1				3
Dens inf.				1				1
Vert. cerv.	1							1
Costa		1						1
Humerus				1				1
Radius			1					1
Metacarpus	1							1
Os longum						2	1	3
Compacta						2		2
total	3	2	1	4	1	4	1	16
total dom +Ce%	27.3	18.2	9.1	36.4	9.1			

Tab. 3a,b Species composition and skeletal distribution of faunal remains from layers underlying the Recent Bronze Age 2 horizons in areas B and C. Abbr. as for Table 2, additionally Vu – red fox

Recent Bronze Age Finds

Both areas yielded faunal remains that are dated to Recent Bronze Age 2. However, while the small sample from Area B comes from sandy to clayey soil, the huge agglomeration of faunal remains from Area C was recovered from the ashy layers that filled the fortification ditch. The RBA 2 sample from the fortification ditch in Area B (Tab. 4), apart from its small size, shows many similarities to the other finds from Area B as well as to the intermediate sample from Area C. The species composition is again dominated by cattle bones (50%) now followed by ovicaprines (25%), domestic pig (20%) and red deer (3%). Two fragments of equine shin-bones possibly represent the same individual and only one lower canine from a small individual proves the presence of dogs. Not a single avian, reptilian or mollusc remain appeared in the sample. Also, similarly to the aforementioned samples, all assessable teeth represented adult, in the case of bovines even mature, individuals and the state of epiphyseal closure, including a general assessment of bone morphology, indicated only a few animals that had been slaughtered at a juvenile (B: n=1, O-C: n=2, S: n=3) or adolescent age (B, O-C, S: n=1 each). Partial charring was visible in 25 fragments which is an expectable ratio of 6% of the whole sample. 12 specimens (10 bovine, 2 ovicaprine) showed butchering marks; 9 fragments had been gnawed by carnivores.

B – BR 2	B	O-C	O	C	S	Ee	Cn	Ce	m	l	total
Cran. fragm.	4	2	1	1	6				14	1	29
Mandibula	8				5			1		3	17
Dens sup.	1	5									6
Dens inf.		2			3		1				6
Vert. cerv.	2										2
Vert. thor.	6	1									7
Vert. lumb.	4								1		5
Os sacrum		1						1			2
Vertebra									3	1	4
Costa	12	3			1				2		18
Scapula	3	2								1	6
Humerus	3	1			1						5
Radius	2	3									5
Ulna	3										3
Carpus	2										2
Metacarpus		1			1						2
Coxa	2	1	1		2						6
Femur	2	2			3						7
Tibia	5	3			2	2		1			13
Talus	1										1
Tarsus	1										1
Metatarsus	2	1									3
Metapodium	1			1	2						4
Phalanx prox.	2				1			1			4
Phalanx dist.	1										1
Dens	1	2			1						4
Os longum									80	39	119
Compacta									19	65	84
Spongiosa									9	19	28
total	68	30	2	2	28	2	1	4	128	129	394
total dom +Ce%	49.6	21.9	1.5	1.5	20.4	1.5	0.7	2.9			

Tab. 4 Species composition and skeletal distribution of faunal remains from Recent Bronze Age 2 layers in Area B. Abbr. as for Table 2, additionally Ee – domestic horse

The ashy layers of Area C yielded a huge agglomeration of faunal remains that in several respects differs substantially from all other aforementioned samples.

In terms of species composition (Tab. 5a), a slight dominance of ovicaprines (35.2% of domestic animals, including red deer, sheep : goat = 2 : 1) is discernible, followed by domestic pig (31.8%) and cattle (26%) which could be called a balanced livestock economy. While red deer, excluding antler fragments, contribute only a ratio of 1.5% to the remains of economically relevant species, dog bones form 4.2% of this subsample. Horses are represented by only two finds, a lumbar vertebra and a molar tooth of a small individual, proven as *Equus ferus caballus* by a distinct plica cavallina. Other than in the smaller samples, a rather wide range of wild species could be identified, however always proven by only a few fragments, which, together with the low percentages of red deer, indicates a very low importance of hunting in all phases of the settlement.

C – BR 2	B	O-C	O	C	S	Cn	Ee	Ce	Cu	Ca	Ss	Ur	Lu	Vu	Me	Fe	Le	mM	s	m	l	ind	total
Cran. fragm.	89	76	13	8	130	21		5							1				2	449	142		936
Antler								43	7														50
Hyalia	7	2	1																				10
Mandibula	59	49	2		54	7		2										3			1		177
Dens sup.	27	40			46	8	1	1					1					5					129
Dens inf.	39	52	2	1	97	16		1						1				3					212
Dens	13	24			17	3		1										2	2	41	8		111
Dens dec.	3				2																		5
Vert. cerv.	45	14			21	5												1		4			90
Vert. thor.	48	46			25	2		2			1									7	3		134
Vert. lumb.	32	61			28	7	1	4										5		7			145
Vert. caud.	4	3			3	1												8		1			20
Vertebra		3			3													3		61	27		97
Costa	185	286			184	29		7									2	3	1	282	118		1097
Costa cartil.	2																						2
Sternum	1	3			1	1																	6
Scapula	39	35	1		34	2		1								1		3		11	4		131
Humerus	14	52	3	3	41	2		6										6		2	1		130
Radius	17	54	1		26	4		2		1		1	1										107
Ulna	16	23	3		26	2		2							1								73
Carpus	19	3			5															1			28
Metacarpus	24	31	5	1	29	5		7				1		1						1	3		108
Coxa	23	22	6	4	25	1		1										2		8	1		93

C – BR 2	B	O-C	O	C	S	Cn	Ee	Ce	Cu	Ca	Ss	Ur	Lu	Vu	Me	Fe	Le	mM	s	m	l	ind	total
Os sacrum	7	3			2																		12
Femur	22	51			36	4				1						1		2		1	1		119
Patella		1			2																		3
Tibia	31	77	3	3	34			1								1		4			1		155
Fibula					44	2																	46
Talus	5	5	4	1	11																		26
Calcaneus	7	1	1	4	10			1															24
Tarsus	9		2		8																		19
Metatarsus	17	29	3	3	26	9		1		1													89
Metapodium	5	7	3	1	18	2					1	1						4		1			43
Phalanx prox.	23	13	8	1	35	4		1		1	3	1		1				2					93
Phalanx med.	18	6	3		27	1		1			1												57
Phalanx dist.	10	4	3	1	10			2			1	1											32
Os sesamoid.	6	1																					7
Os longum																		1		796	211		1008
Os planum	1																			78	17		96
Compacta																				3688	674		4362
Spongiosa																				320	30		350
ind.																		3	1	303	3	10	320
total	867	1081	63	31	1060	140	2	92	7	4	7	5	2	3	2	3	2	60	6	6062	1245	10	10752
total dom + Ce %	26	32.4	1.9	0.9	31.8	4.2	0.1	2.8															

Tab. 5a Species composition and skeletal distribution of faunal remains from Recent Bronze Age 2 layers in Area C. Abbr. as for Table 2, additionally Ee – domestic horse, Cu – cervid, Ca – roe deer, Ss – wild boar, Ur – brown bear, Lu – grey wolf, Vu – red fox, Me – badger, Fe – wild cat, Le – hare, mM – micromammal

In the case of the brown bear, a specific utilisation may be discernible, as three finds are skeletal elements of the paw: two metapodials and one claw bone. Furs of carnivores are often tanned with paws remaining; the mentioned finds might, therefore, be interpreted as residuals of a bear coat. All other identified mammal game species, like grey wolf, red fox, badger, wild cat and roe deer fit well within the expectable faunal spectrum of the Italian peninsula. The whole sample yielded only 10 avian skeletal remains (Tab. 5b), 6 of which turned out to be identifiable at least up to family level. 4 fragments represent small species like quail (n=2), duck and rail (n=1 each), two remains, however, prove the golden eagle (*Aquila chrysaetos)*. A cervical vertebra and a femur indicate the presence of the whole carcass of the bird in the settlement, not only emblematic parts of it like the head, wings or claws. We did not record any cut marks; nevertheless, consumption of the eagle seems likely and, doubtless, should be interpreted in a meaningful way.

Additionally, skeletal remains of tortoises, mainly fragments of the carapace (Tab. 5b), have also been recorded; more evidence on the herpetofauna, as well as on small mammalian and avian species, is to be expected after completion of the microfaunistic analysis. At present the remains of aquatic resources have also not been analysed completely; consequently we refer to our published preliminary results.[28] In short, very few fish remains are present, mainly representing marine species such as Sparidae and Serranidae, maybe also Nephelidae. The malacological record, roughly comprising 1000 fragments, is vastly dominated by the rayed Mediterranean limpet (*Patella caerulea*).

In terms of skeletal representation, the detailed list of elements (Tab. 5a) shows clearly that all parts of the body appear in expectable ratios. As ever, small elements like basipodials are more or less underrepresented due to their limited findability, but no patterns of intentional selection are discernible.

C – BR 2	Aq	An	Ra	Co	A m	A s	A i	Te	total
Cranial fragm.			1						1
Clavicula								1	1
Vert. thor.	1								1
Humerus								2	2
Coxa								2	2
Femur	1							1	2
Tibiotarsus				2	1				3
Tarsometatarsus					1	1			2
Phalanx		1							1
Carapax								57	57
Os longum					1		1		2
total	2	1	1	2	2	1	1	57	74

Tab. 5b Species composition and skeletal distribution of avian and tortoise remains from Recent Bronze Age 2 layers in Area C. Abbr.: Aq – golden eagle, An – duck (Anatinae), Ra – rail (Rallidae), Co – quail, A m – medium-sized bird, A s – small-sized bird, A i – indeterminable bird, Te – tortoise

The sufficiently large sample size allowed estimation of culling ages by means of assessing the stages of both dental wear and epiphyseal fusion. In cattle (Fig. 1a), dental analysis shows two preferred ages of slaughtering: on the one hand, yearlings, on the other, forming the major peak, adult individuals at the age of 4–6 years. This evidence is corroborated by the epiphyseal data: while almost all calves survived the fusion point of early-closing (during the first year of life) growth plates, a third of the represented animals – the yearlings – were culled before the

[28] Jung et al. 2016, 195–197.

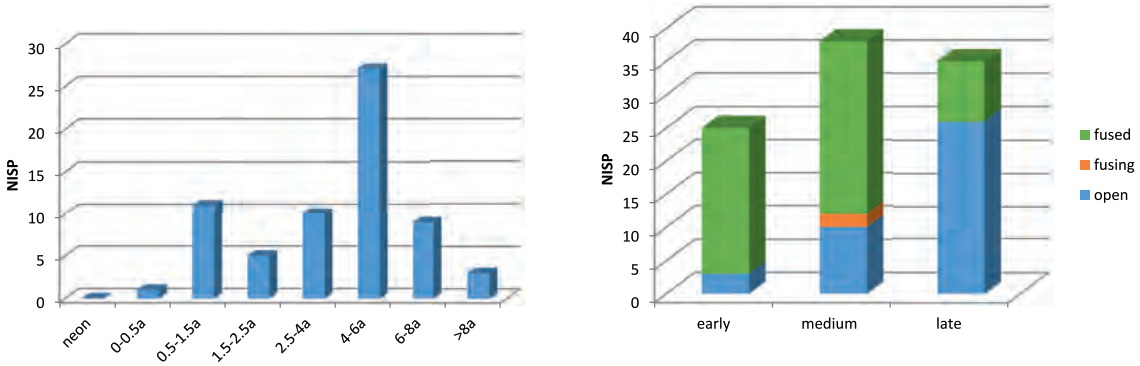


Fig. 1a Area C, RBA 2: Data on preferred culling ages in cattle. Left: age distribution of assessable teeth, right: distribution of epiphyseal fusion stages (graphics: G. Forstenpointner)

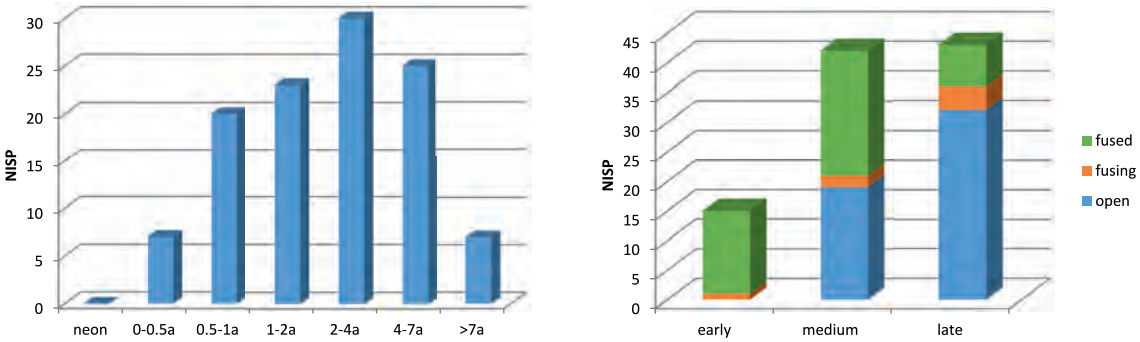


Fig. 1b Area C, RBA 2: Data on preferred culling ages in ovicaprines. Left: age distribution of assessable teeth, right: distribution of epiphyseal fusion stages (graphics: G. Forstenpointner)

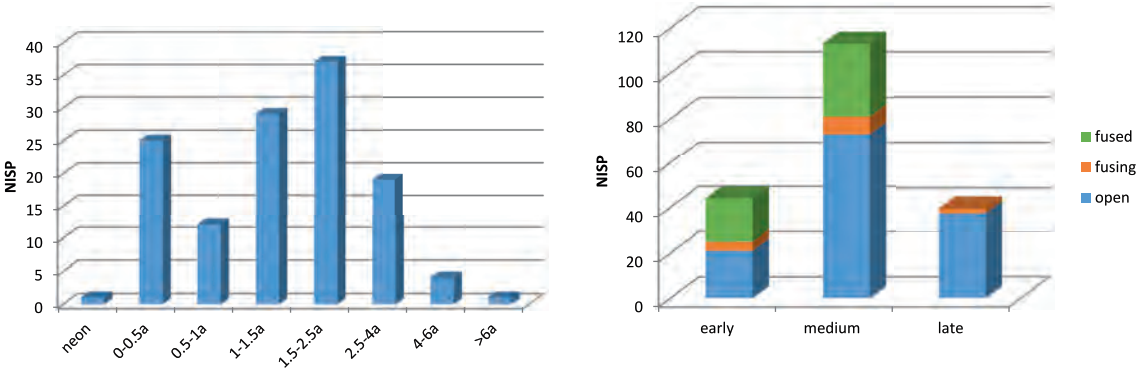


Fig. 1c Area C, RBA 2: Data on preferred culling ages in domestic pigs. Left: age distribution of assessable teeth, right: distribution of epiphyseal fusion stages (graphics: G. Forstenpointner)

epiphyses with intermediate fusion date (at the age of 2–3 years) could close. Another third of the significant subsample comes from older individuals that also survived the closure of late-fusing epiphyses at the age of 4–6 years.

In ovicaprines, slaughtering started at an age of half a year at the low end of the scale, with increasing numbers of adolescent and young adult animals up to 4 years, which most likely mainly comprise young rams or bucks. Adult and mature individuals at ages of more than 7 years are thought to represent females and indicate exploitation of secondary products like wool or milk. In pigs, a first preferential culling age affects piglets at an age of 4–6 months, a second peak is situated at an age of 1.5–2 years, when the animals reached their final body dimensions. Older individuals represent mainly breeding sows, but elder boars have also been proven.

Due to the severe grade of fragmentation, only a few significant skeletal elements permitted proper assessment of sex, obviously not enough to provide sufficient samples for sound statistical analysis. While in cattle only two female hip bones prove two slender cows, in ovicaprines a total of 12 significant finds represent a perfectly balanced ratio of the two sexes with 6 females (3 sheep, 1 goat, 2 indistinct) and 6 males (2 sheep, 1 goat, 3 indistinct)., The dominance of sheep, together with the balanced ratio of sexes, being aware of the very small number of assessed bones, might indicate an economic focus on wool production.

In pigs, taking into account the upper and lower tusks and the adjacent parts of the maxilla and mandible, the Late Bronze Age layers of Area C yielded more male (n=10) than female (n=5) finds, which, in terms of sample size, again is not enough to endorse sustainable interpretations. However, 6 of these male remains represent fully adult individuals, which might perhaps indicate a tradition of castrating boars in order to produce fat stags.

An average of 5.7% (n=190) of identified mammal bones from the ashy layers of Area C show chop marks (Tab. 6). Additionally, butchering is proved by a total of 54 (1.6%) discernible cut marks, this number supposedly corresponding to only a fraction of the real number, due to the masking effect of the ubiquitous sinter. Almost 85% of the chop marks were recorded on elements of the trunk skeleton, such as the ribs, vertebrae and hip bones, while 9% occur on head bones and only 6% on elements of the limbs. The same dominance of chopped fragments of the axial skeleton is discernible in all other samples, but while 6 specimens of a total of 63 identified fragments (9.5%) in the intermediate layers of Area C show traces of heavy butchering, in the EBA 2 sample only two bovine remains, one rib and one cervical vertebra (1.8%) bear chop marks. A possible explanation for this obviously selective occurrence of chopping traces might be offered by the particular morphology of the butchered bones, as ribs and vertebrae are much more fragile than the massive and hard long bones and, therefore, are less harmful to chopping tools made of bronze or stone. In all samples the elements of the appendicular skeleton appear heavily fractured, most likely in order to gain the fatty bone marrow, but the lack of chop marks indicates that blunt tools were used to crush the bone. The high ratio of dog remains in the Recent Bronze Age 2 layers from Area C (n=140, 4.2% of domestic mammals) has previously been pointed out as a specific feature of this sample. In more than 10% of these fragments (n=15) traces of butchering are evident; the regular consumption of dogs and maybe also wolves (Fig. 2) should therefore be assumed.

chopmarks	**B**	**O-C**	**O**	**C**	**S**	**Cn**	**Ce**	**Ee**	**total**
Head	8	1	2	1	4	1			17
Limbs	7	2			3				12
Trunk	32	75			37	14	2	1	161
total	47	78	2	1	44	15	2	1	
cutmarks	**B**	**O-C**	**O**	**C**	**S**	**Cn**	**Ce**	**Fe**	**total**
Head	4	2	1						7
Limbs	4	1		1	4			1	11
Trunk	9	14			11	1	1		36
total	17	17	1	1	15	1	1	1	54

Tab. 6 Species and body part distribution of butchering marks on mammal remains from Recent Bronze Age 2 layers in Area C. Abbr. as for Tables 2–5

One butchered bovine cranial fragment supposedly indicates a purpose other than the mere carving-up of edible carcasses (Fig. 3). As illustrated in the schematic drawing, the frontal and temporal bones have been neatly transected in a transversal direction just in front of the horn



Fig. 2 Area C, RBA 2: Left radius of a grey wolf, proximal part. Arrow heads delimit the edges of a chopmark (photo and graphics: G. E. Weissengruber)

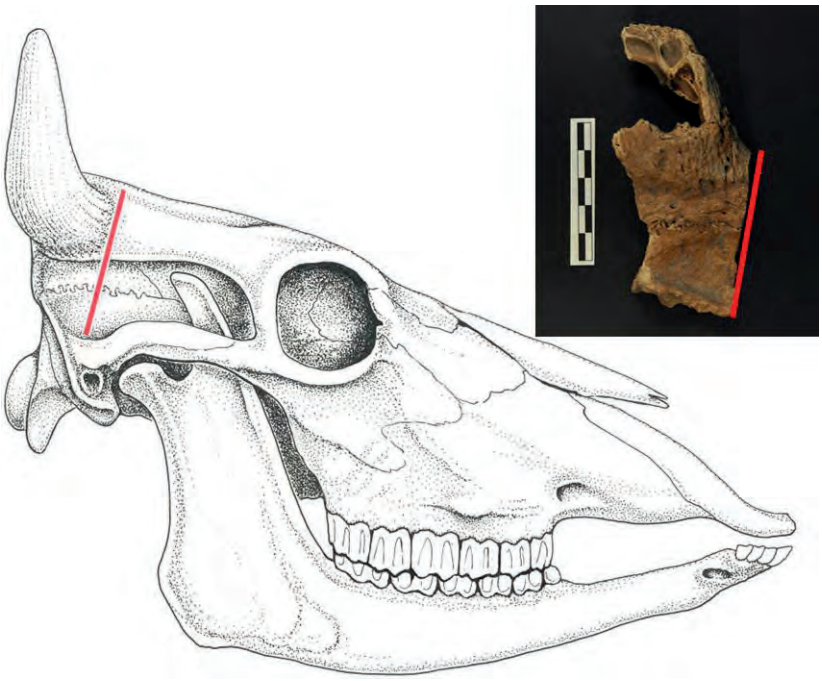


Fig. 3 Area C, RBA 2: Bucranium-like fragment of a bovine skull (photo and graphics: G. E. Weissengruber; drawing: E. Polsterer)

cores, producing a very short but nevertheless significant bucranion which might be interpreted in a similar meaningful way as the aforementioned eagle bones.

Not surprisingly, considering that the faunal remains had been embedded in huge ashy layers that bear witness to a heavy conflagration, an apparently high percentage of the bones (19.3%, n=2070) appeared charred, most of them blackish (n=1409), the rest, due to higher temperatures, grey (n=188) to white (n=473). However, the vast majority of burnt fragments comprise small indeterminable splinters of various osseous substances (79%, n=1636); only 434 definable specimens have been recorded and form a fraction of 12.9% of all identified mammal finds. Taking into account the remarkably high temperatures necessary to generate fine-structured, greyish ashes, we have to assume that most of the bones were not affected by the fire that generated these ashes, but were deposited in the ditch at the same time as the ashes and supposedly together with other waste.

A coarse screening of the osteometric data revealed body dimensions of the relevant domestic animals very similar to published data from Torre Mordillo,[29] Francavilla Marittima (site Timpone de la Motta)[30] and Grotta Cardini[31] in Calabria and from Coppa Nevigata[32] and Torre Castelluccia[33] in Apulia. A comprehensive comparative analysis of the available data will be published in a forthcoming study on growth forms of Bronze Age livestock in Southern Italy.

Conclusions

In terms of species composition, the comparison of the admittedly small sample from Early Bronze Age layers of Area B with available data from the Apulian sites of Coppa Nevigata[34] and Cavallino (site 'insediamento del Bronzo')[35] and from Campanian La Starza and Tufariello shows partly similar as well as highly divergent features (Fig. 4).

Similarly to our finds, the samples from Cavallino and even more from La Starza, comprise quite high percentages of bovine remains; however, in stark contrast to Zambrone, all comparative samples show much higher ratios of ovicaprine and fewer porcine remains. Dog bones do not exceed a ratio of 3% in Zambrone and the two Apulian settlements, but, in contrast to Zambrone and Cavallino, in Coppa Nevigata and La Starza red deer remains contribute roughly 7% of the species that are relevant in terms of exploitation. Taking into account the potentially high random error, due to the scarcity of evidence and the mostly small sample sizes, and given that a direct comparison of Apulian and Calabrian evidence is suitable, an important role of cattle in the Early Bronze Age to early Middle Bronze Age husbandry of at least some settlements in southern Italy might be assumed. Potentially, an emphasis on cattle breeding might be coincident with particular regimes of transhumance that appear most likely, if not proven by a clear isotopic evidence of repeated movement of a bovine individual from the Poro high plain to the settlement.[36] Whether the remarkably low percentage of ovicaprines, diverging from all other Bronze Age finds in southern Italy, is due to a taphonomic bias or to a unique feature of the husbandry of Zambrone cannot be determined with certainty. As the vast majority of remains represents adult individuals, at least for cattle and ovicaprines economic patterns based on secondary products like milk or wool appear likely. The apparently low importance of hunting in Zambrone and Cavallino and the higher number of red deer bones in Coppa Nevigata matches a common feature of southern Italian Bronze Age economies that comprise data sets with very low amounts of game bones as well as samples with abundant percentages of red deer or wild boar remains.[37]

The 'intermediate layers', underlying the RBA 2 deposits from areas B and C and potentially assignable to earlier phases of the Recent Bronze Age yielded even smaller samples than the EBA sample from Area C with, consequently, very restricted significance. Nevertheless, the similarity of the sample from Area C to the EBA 2 finds is obvious in terms of species composition and should therefore not be neglected.

The RBA 2 samples from areas B and C differ strongly in several respects. Unfortunately, comprising a total of 137 identified macromammal finds, the sample from Area B is also very small, but it appears to show a barely sufficient grade of significance. Surprisingly, these finds also present a faunal composition that is very similar to the samples from the EBA 2 and from the intermediate layers of Area C (Fig. 5). The only mentionable differences between the RBA 2

29 Tagliacozzo – Curci 2001, 405–416.
30 Elevelt 2012a, 220–239.
31 Tagliacozzo et al. 1989, 254–256.
32 Siracusano 1995, 192–195.
33 Corridi 1993, 111.
34 Siracusano 1995, 198.
35 Sorrentino 1979, 308.
36 See Pike et al., this volume.
37 Wilkens 1993, 268.

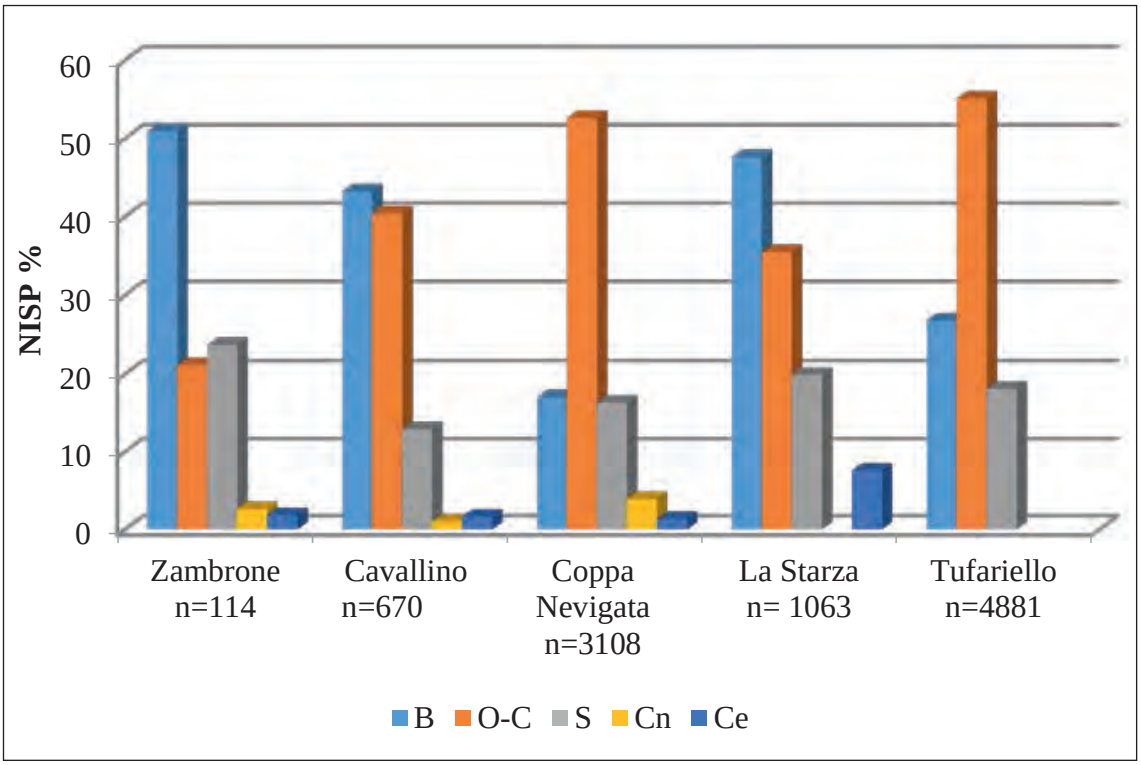


Fig. 4 Area B, EBA 2: Comparison of species distribution with contemporaneous evidence. Abbr. as for Tables 2–5, data for EBA Cavallino (Huts 1, 1a, 2 and 3) by Sorrentino 1979, 308; for EBA 2/MBA 1 Coppa Nevigata by Siracusano 2012, 236; for MBA 1–2 La Starza by Albarella 1999, 321 (ratio of dog bones not available); for EBA 2/MBA 1–2 Tufariello by Barker 1975 (ratios of dog and cervid bones not available) (graphics: G. Forstenpointner)

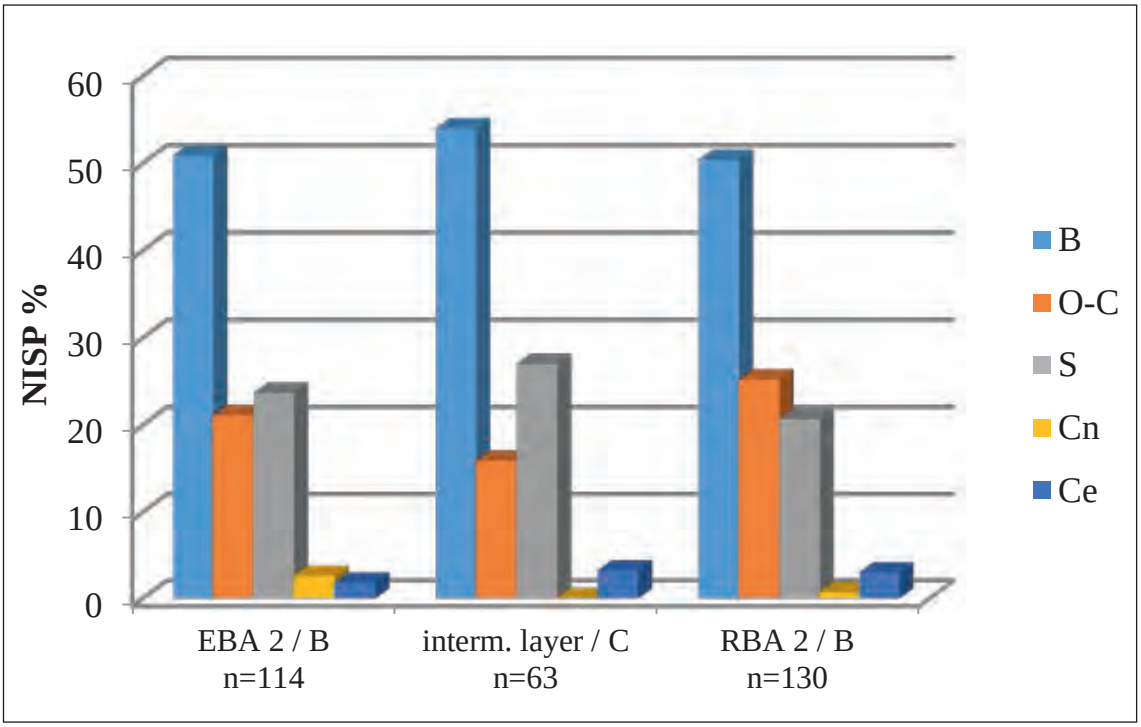


Fig. 5 Comparison of species distribution within samples from Area B, EBA 2 and RBA 2, and from Area C, intermediate layers. Abbr. as for Tables 2–5 (graphics: G. Forstenpointner)

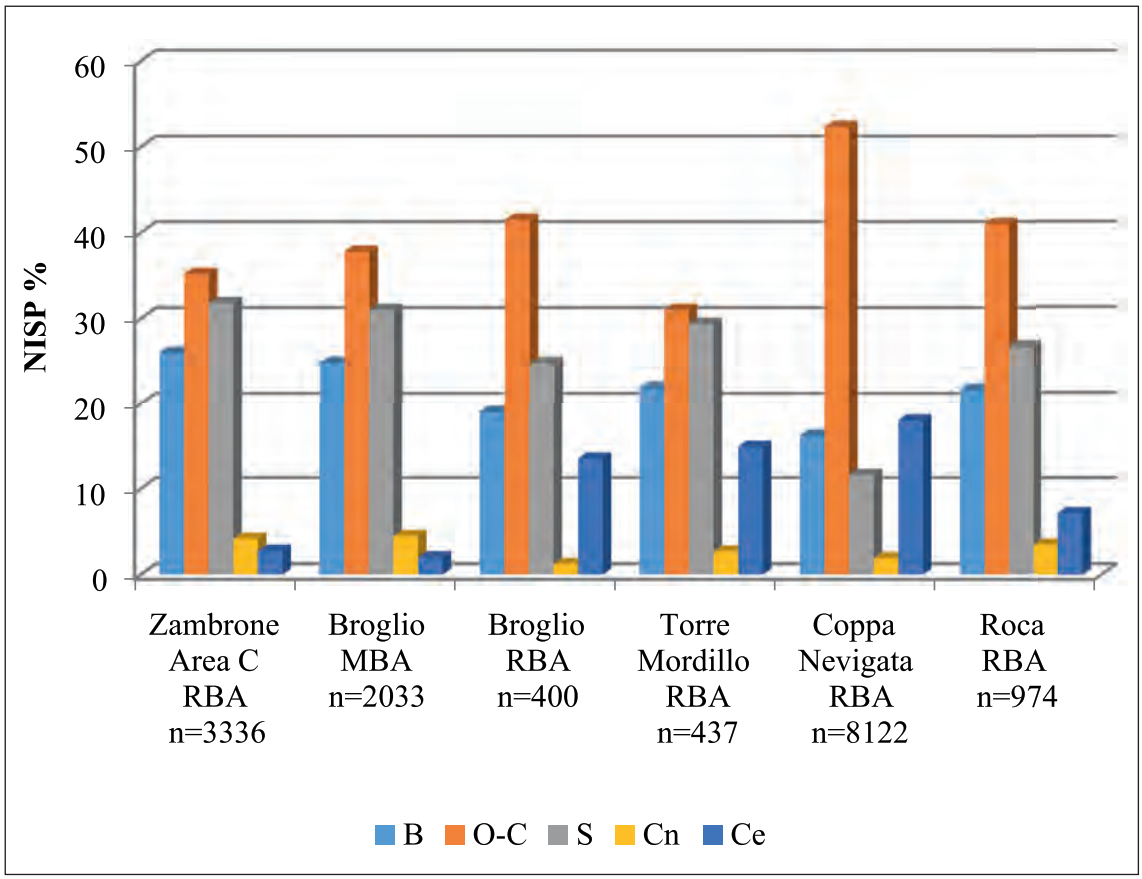


Fig. 6 Area C, RBA 2: Comparison of species distribution with contemporaneous evidence from Calabria and Apulia. Abbr. as for Tables 2–5, data for MBA 2–3 Broglio by Elevelt – Tagliacozzo 2009/10, 444, and RBA Broglio by Tagliacozzo 1994, 602; for Torre Mordillo by Tagliacozzo – Curci 2001, 359; for Coppa Nevigata by Siracusano 2012, 236 and for Roca by Rugge 2008, 269 (graphics: G. Forstenpointner)

assemblage and the earlier samples are a slightly higher percentage of ovicaprine remains and the appearance of two tibial fragments of the horse, quite likely, but not definitely, representing one animal, and not surprising for a RBA 2 site. Concerning the other less frequent species, dog and red deer, both appear in a very low percentage and we did not record any signs of butchery on canine bones. The only available reference sample that shows close resemblances comes from the Apulian EBA site of Cavallino,[38] even bearing in mind that this sample yielded a converse ratio of ovicaprine and porcine remains, compared to the Zambrone finds.

The RBA 2 finds from Area C comprise by far the most abundant subsample of the faunal record from Punta di Zambrone. A total of 3367 identified remains of domestic and wild mammal species doubtless provides a valid data set that represents specific patterns of faunal exploitation. In terms of species composition, this subsample differs strongly from all other aforementioned assemblages; however, it shows proportions of the most relevant exploited species that are quite similar to other Calabrian MBA–RBA sites, yet differ from respective Apulian features like those from Coppa Nevigata and Roca Vecchia (Fig. 6).

While the Calabrian samples consistently show a balanced livestock economy, with almost even ratios of cattle, ovicaprines and pigs, the Apulian assemblages are dominated by remains of sheep and goats. The high percentage of ovicaprines at RBA Coppa Nevigata is mainly represented by sheep remains, which have been recorded almost five times more frequently than goat

[38] Sorrentino 1979, 308.

bones. This evidence might coincide with the coeval production of purple dye that was supposedly also used to stain locally provided textiles. Both Apulian samples and the finds from Torre Mordillo comprise rather high ratios of red deer, illustrating the frequently mentioned importance of red deer hunting in prehistoric Apulia.[39]

In comparison to all other subsamples, the percentage of canine remains is rather high (4.2% vs. 0–2.6%), and more than 10% of these bones show traces of butchering, which is the highest respective percentage of all domesticates. This evidence, together with other features of species composition (Fig. 6), closely resembles the findings from MBA Broglio di Trebisacce with a ratio of 4.3% dog remains, comprising 7% butchered specimens. Therefore, while consumption of dogs in prehistoric Italy has been reported but occasionally,[40] in Bronze Age Calabria and probably also Apulia[41] exploitation of dogs not only as assistants for herding and guarding but also as an alimentary source appears a quite common practice. Surprisingly, data from RBA Broglio di Trebisacce[42] with quite high percentages of ovicaprines and red deer but only few dog bones without traces of butchery more closely resemble the sample composition of Coppa Nevigata than of the preceding local habitation stage.

In terms of skeletal representation, the RBA sample from Area C shows no discernible patterns of selection. Comparable samples are only available from MBA Broglio di Trebisacce und from MBA–RBA Timpone della Motta, the first resembling to a large extent the evidence from Zambrone, the latter, surprisingly, completely lacking ovicaprine vertebrae and ribs in the MBA and RBA subsamples from the area Plateau I, but not in the subsequent Iron Age finds.[43] This obviously selective lack of elements indicates particular slaughtering practices, related only to ovicaprines, and underlines impressively the importance of determining all significant skeletal elements, including ribs and vertebrae.

In conclusion, we have to state that all samples from Area B and also from the intermediate layers of Area C differ substantially from the huge and significant assemblage from the ashy RBA 2 layers of Area C. In terms of the livestock economy, two different regimes appear discernible: in Area B finds indicate an emphasis on cattle-breeding together with a scant regard for herding sheep and goats that seems to be consistent from the Early till the Recent Bronze Age and possibly coincides with transhumant herd management; in the RBA 2 Area C, a balanced livestock with slightly predominating exploitation of ovicaprines is represented that resembles closely patterns of husbandry known from other MBA–RBA Calabrian sites, in particular MBA Broglio di Trebisacce. An additional indication of a potential relationship between this site and the RBA settlement of Punta di Zambrone might be provided by the high percentages of butchered dog bones that distinguish the regular consumption of dogs as a particular characteristic of both sites. However, any interpretative attempt has to bear in mind that the series of ashy layers that had been deposited during RBA 2 at Punta di Zambrone most likely indicate very specific forms of consumption, not necessarily reflecting the regular stock economy of the settlement.

Acknowledgements: The archaeozoological research at Punta di Zambrone was funded by the Austrian Science Fund (FWF, in the framework of project no. P23619-G19).

39 Wilkens 1993, 268; Elevelt 2012b, 10.
40 De Grossi Mazzorin – Tagliacozzo 1997, 437.
41 Punta le Terrare: data not available, quoted by Elevelt – Tagliacozzo 2009/10, 437, referring to Wilkens 1990.
42 Tagliacozzo 1994, 602.
43 Elevelt 2012a, 38 (MBA), 41 (RBA), 44 (IA).

Bibliography

Albarella 1995
U. Albarella, Problemi metodologici nelle correlazioni inter-sito. Esempi da archeofaune dell'Italia Meridionale, in: R. Peretto (ed.), Atti del 1° Convegno Nazionale di Archeozoologia (Rovigo 5–7 marzo 1993), Padusa Quaderni 1, 1995, 15–28.

Albarella 1999
U. Albarella, The animal economy after the eruption of Avellino pumice. The case of La Starza (Avellino, Southern Italy), in: C. Livadie (ed.), L'eruzione Vesuviana delle "'Pomici di Avellino"' e la Facies di Palma Campania (Bronzo antico). Atti del Seminario Internazionale di Ravello, 15–17 luglio 1994 (Bari 1999) 317–330.

Barker 1975
G. Barker, Stock economy, contribution in: R. Ross Holloway – N. P. Nabers – S. S. Lukesh – G. Barker – N. B. Hartmann – E. R. Eaton – H. Mc Kerrell – W. L. Phippen, Buccino. The Early Bronze Age village of Tufariello, Journal of Field Archaeology 2, 1975, 59–72.

Corridi 1993
C. Corridi, Analisi di resti faunistici, contribution in: M. Gorgoglione, La capanna 7 di Torre Castelluccia (Pulsano, Taranto), dalle ultime fasi all'età del Bronzo alla prima età del Ferro, Taras 13, 1–2, 1993, 105–114.

De Grossi Mazzorin – Rugge 2007
J. de Grossi Mazzorin – M. Rugge, I resti ossei animali provenienti dal saggio X (scavi 2005), contribution in: C. Pagliara – G. Maggiulli – T. Scarano – C. Pino – R. Guglielmino – J. de Grossi Mazzorin – M. Rugge – G. Fiorentino – M. Primavera – L. Calcagnile – M. d'Elia – G. Quarta, La sequenza cronostratigrafi ca delle fasi di occupazione dell'insediamento protostorico di Roca (Melendugno, Lecce). Relazione preliminare della campagna di scavo 2005 – Saggio X, Rivista di Scienze Preistoriche 57, 2007, 311–362.

De Grossi Mazzorin – Tagliacozzo 1997
J. De Grossi Mazzorin – A. Tagliacozzo, Dog remains in Italy from the Neolithic to the Roman period, Anthropozoologica 25/26, 1997.

Elevelt 2005
S. Elevelt, Analisi dei resti faunistici di età protostorica rinvenuti sul primo pianoro dell'insediamento di Francavilla Marittima (CS), in: G. Malerba – P. Visentini (ed.), Atti del 4° Convegno Nazionale di Archeozoologia, Quaderni del Museo Archeologico del Friuli Occidentale 6, 2005, 261–266.

Elevelt 2012a
S. Elevelt, Subsistence and social stratification in Northern Ionic Calabria from the Middle Bronze Age until the Early Iron Age (PhD Diss., University Groningen 2012).

Elevelt 2012b
S. Elevelt, Het gebruik van landbouwhuisdieren en wilde dieren in de Bronstijd en Vroege IJzertijd in Zuid-Italië, Tijdschrift voor Mediterrane Archeologie 48, 2012, 7–11.

Elevelt – Tagliacozzo 2009/10
S. Elevelt – A. Tagliacozzo, The faunal remains of Broglio di Trebisacce (southern Italy), Palaeohistoria 51/52, 2009/10, 425–449.

Facciolo – Tagliacozzo 2002
A. Facciolo – A. Tagliacozzo, Dati archeozoologici dai livelli del Bronzo Medio di Grotta della Madonna. Scavi 2002, in: Istituto Italiano di Preistoria e Protostoria (ed.), Atti della XXXVII riunione scientifica "Preistoria e protostoria della Calabria", Scalea, Papasidero, Praia a Mare, Tortora, 29 settembre – 4 ottobre 2002 (Florence 2004) 805–812.

Forstenpointner 2003
G. Forstenpointner, Promethean legacy. Investigations into the ritual procedure of "Olympian" sacrifice, in: E. Kotjabopoulou – Y. Hamilakis – P. Halstead – C. Gamble – P. Elefanti (eds.), Zooarchaeology in Greece. Recent advances, British School at Athens Studies 9 (London 2003) 203–213.

Habermehl 1975
K.-H. Habermehl, Die Altersbestimmung bei Haus- und Labortieren, 2nd edition (Berlin, Hamburg 1975).

Hongo 1997
H. Hongo, Patterns of animal husbandry, environment and ethnicity in central Anatolia in the Ottoman Empire period. Faunal remains from Islamic layers at Kaman-Kalehöyük, Japan Review 8, 1997, 275–307.

Jung et al. 2016
R. Jung – M. Pacciarelli – G. Forstenpointner – G. Slepecki – A. Galik, Funde aus dem Müllhaufen der Geschichte im Befestigungsgraben von Punta di Zambrone. Angeln am spätbronzezeitlichen Mittelmeer, in: M. Bartelheim – B. Horejs – R. Krauß (eds.), Von Baden bis Troja. Ressourcennutzung, Metallurgie und Wissenstransfer, Oriental and European Archaeology 3 (Rahden/Westf. 2016) 175–206.

Lyman 2008
R. L. Lyman, Quantitative Paleozoology (Cambridge 2008).

Minniti 2012
C. Minniti, La raccolta di molluschi marini a Coppa Nevigata nell'età del Bronzo, in: A. Cazzella – M. Moscoloni – G. Recchia, Coppa Nevigata e l'area umida alla foce del Candelaro durante l'età del Bronzo (Foggia 2012) 366–387.

Noddle 1974
B. Noddle, Ages of epiphyseal closure in feral and domestic goats and ages of dental eruption, Journal of Archaeologic Science 1, 1974, 195–204.

Payne 1987
S. Payne, Reference codes for wear states in the mandibular cheek teeth of sheep and goats, Journal of Archaeologic Science 14, 1987, 609–614.

Peres 2010
T. M. Peres, Methodological issues in zooarchaeology, in: A. VanDerwarker – T. M. Peres (eds.), lntegrating Zooarchaeology and Paleoethnobotany. A Consideration of lssues, Methods, and Cases (New York 2010) 15–36.

Rugge 2008
M. Rugge, I resti osteologici animali, in: C. Pagliara – R. Guglielmino – L. Coluccia – I. Malorgio – M. Merico – D. Palmisano – M. Rugge – F. Minnone, Roca Vecchia (Melendugno, Lecce), SAS IX. Relazione stratigrafi ca preliminare sui livelli di occupazione protostorici (campagne di scavo 2005–2006), Rivista di Scienze Preistoriche 58, 2008, 239–280.

Siracusano 1995
G. Siracusano, La Fauna del Bronzo Tardo del sito stratificato di Coppa Nevigata, in: Atti del I° Convegno Nazionale di Archeozoologia, Padusa Quaderni 1, 1995, 185–200.

Siracusano 2001
G. Siracusano, Lo sviluppo sostenibile nel sito die Coppa Nevigata, in: A. Gravina (ed.), Atti del 21° Convegno Nazionale sulla Preistoria – Potostoria – Storia della Daunia, San Severo, 24–26 Novembre 2000 (San Severo 2001) 219–236.

Siracusano 2012
G. Siracusano, La fauna degli scavi in estensione Puglisi-Palmieri 1972–1975 e le scelte nella dieta carnea degli abitanti del villaggio dell'età del Bronzo di Coppa Nevigata, in: A. Cazzella – M. Moscoloni – G. Recchia, Coppa Nevigata e l'area umida alla foce del Candelaro durante l'età del Bronzo (Foggia 2012) 235–243.

Sorrentino 1979
C. Sorrentino, La fauna, in: O. Pancrazzi, Cavallino I. Scavi e ricerche 1964–1967 (Galatina 1979) 295–309.

Tagliacozzo 1994
A. Tagliacozzo, l dati archeozoologici. Economia di allevamento e caccia a Broglio di Trebisacce, in: R. Peroni – F. Trucco (eds.), Enotri e Micenei nella Sibaritide l. Broglio di Trebisacce (Taranto 1994) 587–652.

Tagliacozzo – Curci 2001
A. Tagliacozzo – A. Curci, I dati archeozoologici. Allevamento e caccia nell'età del bronzo, in: F. Trucco – L. Vagnetti (eds.), Torre Mordillo 1987–1990. Le relazioni Egee di una comunità protostorica della Sibaritide, Incunabula Graeca 101 (Rome 2001) 347–418.

Tagliacozzo et al. 1989
A. Tagliacozzo – S. Scali – P. F. Cassoli, La fauna della Grotta Cardini, Memorie dell'Istituto Italiano di Paleontologia Umana 4, 1989, 213–256.

Von den Driesch 1996
A. Von den Driesch, Das Vermessen von Tierknochen aus vor- und frühgeschichtlichen Siedlungen (Munich 1976).

White 1953
T. E. White, A method of calculating the dietary percentage of various food animals utilized by aboriginal peoples, American Antiquity 18, 1953, 396–398.

Wilkens 1990
B. Wilkens, L'età del bronzo in Italia. Resti faunistici ed economia, in: F. Martini – L. Sarti (eds.), La preistoria del Monte Cetona. Materiali e documenti per una guida del Museo civico per la preistoria del Monte Cetona (Florence 1990) 183–186.

Wilkens 1993
B. Wilkens, Etat des données archéozoologiques sur la chasse en Italie centrale et méridionale du Néolithique à l'Âge du Bronze, in: J. Desse – F. Audoin-Rouzeau (eds.), Exploitation des animaux sauvage à travers le temps (Juan-les-Pins 1993) 261–273.

Wilkens 1998
B. Wilkens, Le risorse animali, in: A. Cinquelmi – F. Radina (eds.), Documenti dell'età del Bronzo. Ricerche lungo il versante Adriatico-Pugliese (Fasano di Brindisi 1998) 223–298.

Human Remains from the Filling of the Bronze Age Fortification Ditch of Punta di Zambrone (Italy)

Fabian Kanz[1] – *Jan Cemper-Kiesslich*[2] – *Nora Großschmidt*[3] – *Reinhard Jung*[4] – *Karl Großschmidt*[5]

Abstract: Archaeological excavations at Punta di Zambrone (Calabria, Italy) lead to the recovery of severely fragmented human remains in a fortification ditch (Area C). Besides other findings like animal bones and artefacts, the filling of this ditch also contained a large amount of plant ash, indicative of a prolonged period of fire-related processes, dating back to the 2nd millennium BC. Comprehensive anthropological investigations were carried out to determine the sex and age as well as the health status of the discarded individuals. Apart from this, a set of methods from forensic anthropology were applied to reconstruct the circumstances of death and related taphonomic processes. The reassociation of skeletal fragments from the ditch revealed a minimum number of two individuals. Most of the bone fragments were assigned to an early adult individual of questionable sex. The remaining fragments could be tentatively assigned to a slightly younger (adolescent) individual. However, for the adolescent individual, the low number of associated bone fragments rendered macroscopic sexing elusive. Dental enamel hypoplasias were present on one premolar, indicating stress-induced perturbation of crown formation during childhood for one of the individuals. In addition, the same individual also displayed new bone formation around the external auditory pore (porus acusticus externus) in the tympanic portion of the temporal bone, suggestive of an inflammatory process affecting the external ear. Remarkably, none of the human bone fragments exhibited burn marks. This finding rules out the possibility of a direct link with the assumed burning event. Taphonomic reconstruction of the excavation site suggests that the remains of at least one of the excavated individuals have undergone multiple disturbances after deposition.

Keywords: Punta di Zambrone, human remains, anthropology, taphonomy

Introduction

Several archaeological excavation campaigns at Punta di Zambrone revealed a fortification ditch (Fig. 1, Area C) with numerous human remains. In addition to animal bones and artefacts, the filling of the fortification ditch also contained a large amount of plant ash. This finding is indicative of a prolonged period of fire-related processes dating back to the Recent Bronze Age period (13th to 12th centuries BC).[6] All recovered human remains were located within this massive ash layer.

In Recent Bronze Age Italy as well as in central Europe during the contemporaneous Urnfield Period, cremation was a common burial practice.[7] Accordingly, the discovery of human bones

[1] Center for Forensic Medicine, Medical University of Vienna, Sensengasse 2, 1090, Austria; Fabian.Kanz@meduniwien.ac.at.

[2] University of Salzburg, Interfaculty Department of Legal Medicine, DNA-Unit and Department of Classics, Ignaz-Harrer Straße 79, 5020 Salzburg, Austria; jan.kiesslich@sbg.ac.at (Corresponding Author); CAMAS – Centre of Archaeometry & Applied Molecular Archaeology Salzburg; archaeometrie@sbg.ac.at

[3] Center of Anatomy and Cell Biology, Medical University of Vienna, Schwarzspanierstraße 17, 1090, Austria; nora@reflex.at.

[4] Austrian Archaeological Institute, Austrian Academy of Sciences, Hollandstraße 11–13, 1020 Vienna, Austria; Reinhard.Jung@oeaw.ac.at.

[5] Center of Anatomy and Cell Biology, Medical University of Vienna, Schwarzspanierstraße 17, 1090, Austria; Karl.Grossschmidt@meduniwien.ac.at.

[6] See Jung – Pacciarelli, this volume.

[7] Vanzetti 2009.

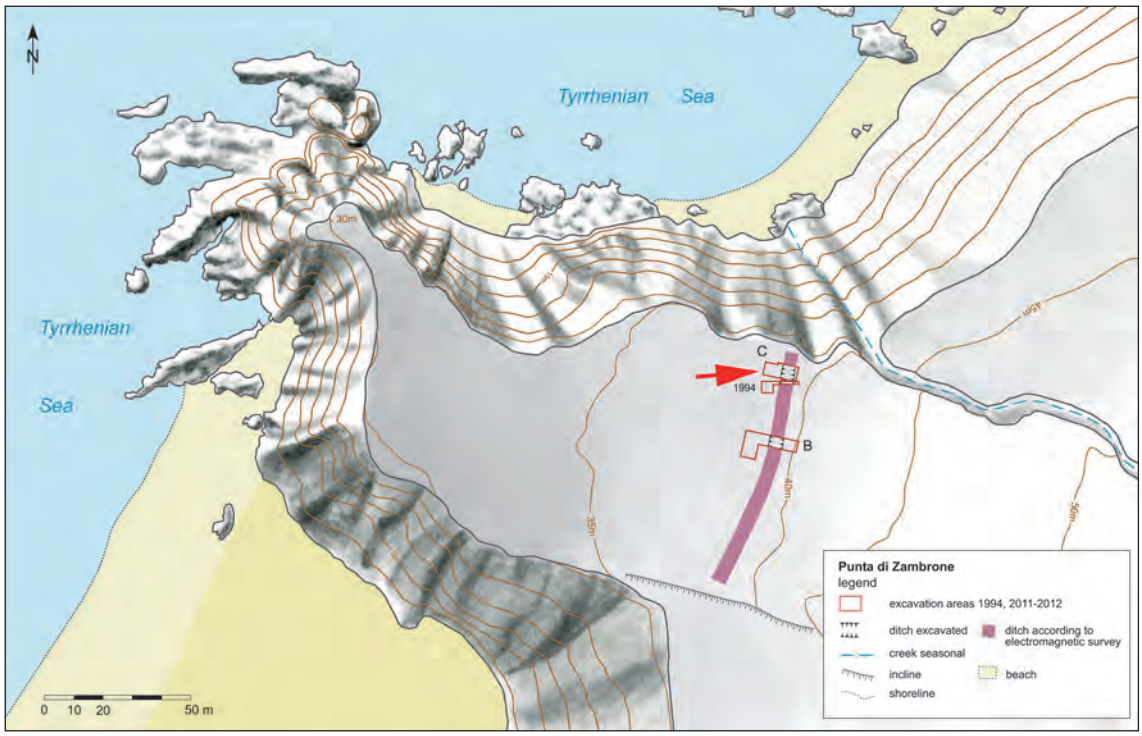


Fig. 1 Location of the excavation areas (C marked by red arrow) and proposed course of the fortification ditch (after Jung et al. 2015)

inside an ash layer might provoke an interpretation of this evidence in terms of cremation as a burial practice at Punta di Zambrone.

Systematic excavation endeavours of Bronze Age settlements in southern Italy, especially south of Naples, are still rare.[8] Therefore, it is not surprising that the number of human specimens unearthed from such settlements is very low. At the excavation site of Ariano Irpino (Campania, Italy) an exceptionally high number of 93 individuals was recovered, but only 13 (4 infants, 2 juveniles and 7 adults) could be clearly dated back to the Recent Bronze Age period referred to in the publication as 'Subappenninico'.[9] More human skeletal material is thus necessary to further extend our knowledge of the past lives of the south Italian settlers.

Material and Method

During several excavation campaigns in Punta di Zambrone a total of 73 human bone and 10 teeth fragments were recovered and were available for anthropological investigations. A comparative morphological minimum number of individuals (MNI) analysis was conducted to determine the number of individuals disposed of in the fortification ditch.[10] The state of preservation of the human remains was documented via photography. Sex and age-at-death analyses were performed following the recommendations of the Conference of Sárospatak.[11] Histological thin sections of the premolar were prepared and subsequently analysed via light microscopy as a complementary

8 Jung et al. 2015.
9 Recchia 2009.
10 Bass 1987; White 2000.
11 Ferembach et al. 1979; Rösing et al. 2007.

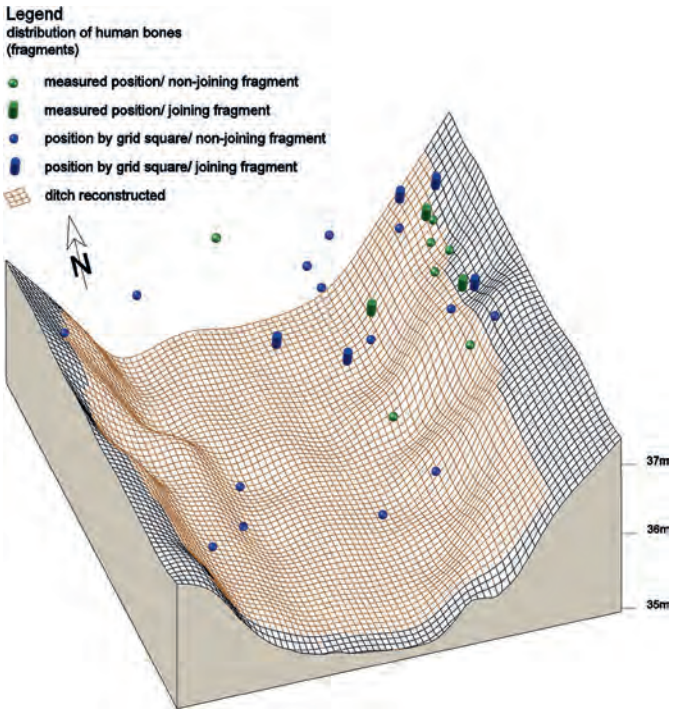


Fig. 2 Distribution of the scattered human remains within the fortification ditch (measurements and graphics: A. Buhlke)

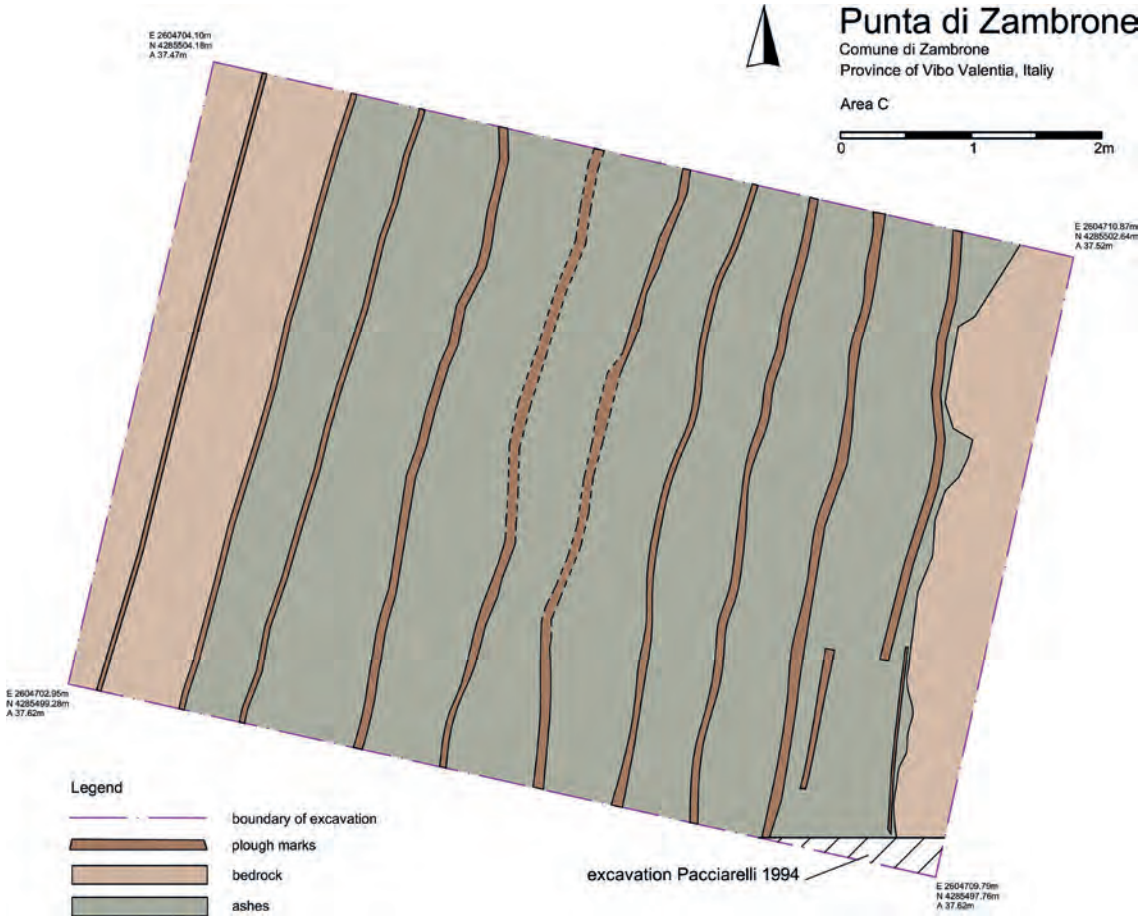


Fig. 3 Stratigraphical Unit (SU) 95, ashy level with plough marks (measurements and graphics: A. Buhlke)

age-at death estimation: the study of the annual growth rates of the dental cement (TCA = tooth cementum annulation) provides added value for age-at-death estimation.[12]

Jaw bone related features like molar abrasion, alveolar bone resorption and dental calculus formation were evaluated according to Brothwell.[13] Documentation of macroscopic osteopathological changes was followed by paleopathological evaluation.[14] All human skeletal remains recovered from the ditch were investigated using a set of decent methods from forensic anthropology to elucidate the circumstances of death and potential postmortem taphonomic processes.[15]

Results

The bone fragments of the two individuals were widely scattered over the ditch. Nevertheless, it was possible to reconstruct their location at the excavation site (Fig. 2). Most of the skeletal elements were situated on the east flank in the filling of the fortification ditch. Some elements were also unearthed at the west flank crossover of the filling. In total, 34 cranial (including one fragment of the mandible) as well as 39 postcranial fragments and 10 teeth were identified. These bones were widely scattered throughout the different ashy fill layers of the ditch, though they were concentrated in the upper levels disturbed by recent ploughing (SU 1 and 95). The fact that they are also present in the deeper undisturbed ash levels (SU 66, 129 and 151) proves that these bones cannot be ascribed to burials deposited in the ash layers and disturbed by ploughing in the 20th century AD (Fig. 3).

Minimum Number of Individuals (MNI)

Twenty-one of the cranial fragments could be reassigned due to direct fitting (Fig. 4). The remaining parts of the cranium did not show any redundancy. Due to their macroscopic features, it can be assumed that all of them originate from the same adult individual (Fig. 5). This stands in sharp contrast to the postcranial elements recovered: a fragment of the right clavicle and one thoracic vertebral body point towards the additional presence of a slightly younger individual. Therefore, it is very probable that the recovered remains represent at least two individuals, hereafter referred to as Individual 1 and Individual 2. The remaining 40 additional, non-redundant post cranial bone fragments could not be assigned reliably to one of the two individuals, because of their small size and their unspecific morphological appearance.

Individual 1

Only a small part of the postcranial skeleton is present: The medial third of a clavicle and one thoracic vertebral body. In total, less than 1% of the individual's entire skeletal inventory could be recovered. Consequently, a comprehensive anthropological study of this individual was rendered very difficult.

The ossification state of the medial end of the clavicle and the body of the vertebra indicates that this individual was between 16 and 20 years of age at the point of death. Neither element shows secondary sexual characteristics – thus sexing of the individual is not possible. None of the fragments displays any evidence of burning, ante- or perimortal trauma or pathologies.

---

12 Wittwer-Backofen et al. 2004.
13 Brothwell 1981.
14 Ortner 2003.
15 Berg et al. 1981; Haglund – Sorg 1996; Brinkmann – Madea 2004; Kanz – Grossschmidt 2006; Byers 2008.



Fig. 4 Reconstruction of the cranial vault of Individual 2 due to direct fitting of 21 bone fragments (photos: F. Kanz)

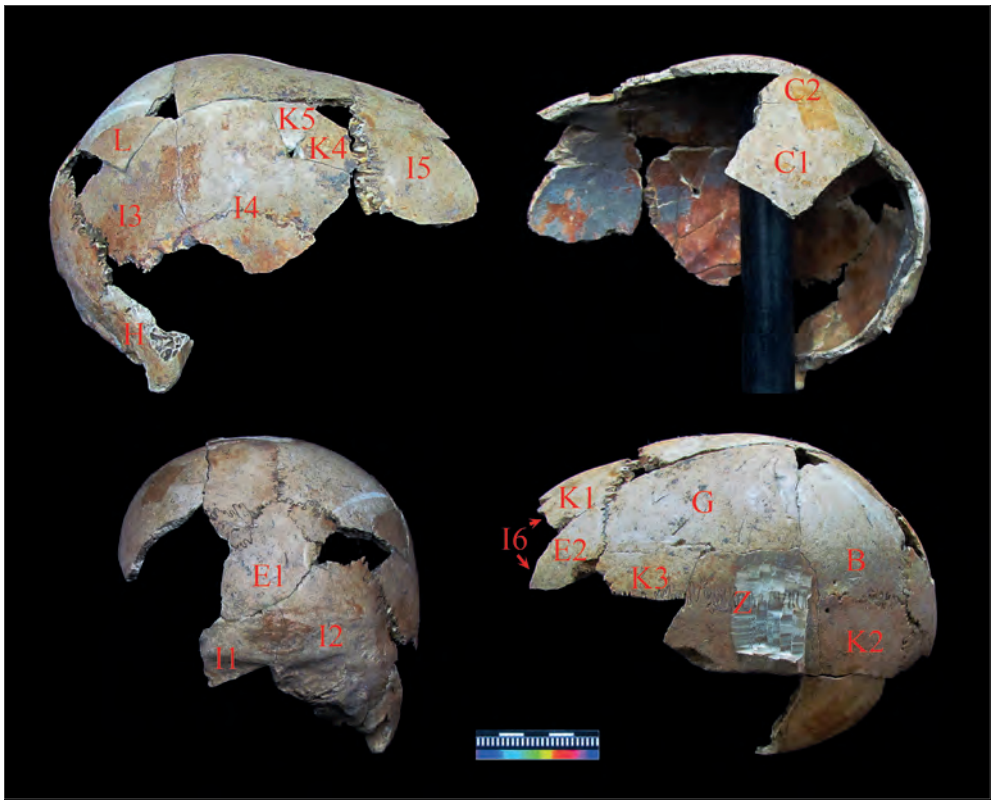


Fig. 5 Reconstruction of the cranial vault of Individual 2 with anthropological ID numbers (cf. Tab. 1) (photos and graphics: F. Kanz)



Fig. 6 Bone fragments and teeth, which most probably also belong to Individual 2. White arrow marks severe cervical caries on a third molar from the lower jaw (photos: F. Kanz)

Individual 2

Compared to Individual 1, the overall preservation of Individual 2 is much better – a partially preserved cranial vault (Fig. 4), 9 additional cranial fragments, 6 isolated teeth and a portion of the left mandible with three molars and one premolar in situ (Fig. 6). Less than 5% of the entire skeletal inventory of the individual is present.

Dental abrasion and closure of the cranial sutures, suggest an age at death of between 20 and 30 years. Osteological age estimation is verified by the results of the TCA analysis of the premolar.

Most features suitable for morphological sex estimation (e.g. the frontal region) are missing. The prominence of the external occipital protuberance, the relatively robust mandibular ramus and the thickness of the cranial vault point towards a male individual. The relatively small mastoid process and the fragile zygomatic bone are more common in female individuals. Concerning

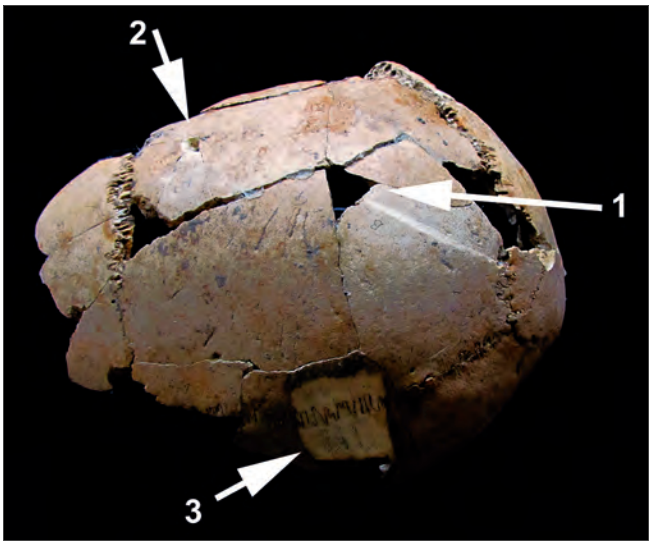


Fig. 7 Reconstruction of the cranial vault of Individual 2 with marked signs of taphonomic changes caused by multiple disturbances (1 … plough; 2 … excavation; 3 … DNA sampling) (photos and graphics: F. Kanz)

the south Italian population, there is a lack of contemporary reference material to understand the variation of the arguably sexually dimorphic features. The sex of this individual has to be classified as ambiguous with a slight tendency towards male.

Individual 2 displays some striking epigenetic variations: there are bilateral ossicles in the lamboid suture[16] (Fig. 4, back view) and variation of the permanent maxillary teeth – a double-rooted premolar and two deformed roots of the third molars.[17] Prevalence rates for this kind of epigenetic feature do exist for Copper Age Italy,[18] but unfortunately, to date, the frequencies in Recent Bronze Age populations are not known. Gross inspection of the premolar revealed two linear enamel hypoplasias, commonly interpreted as markers of unspecific stress. These enamel defects are induced by general developmental perturbations during the time of dental crown formation in early childhood.[19] The changes observed on the third molar are consistent with severe cervical caries (Fig. 6 white arrow). No further features of periodontal or dental disease are present. The outer table of the region around the *porus acusticus externus* presents minor evidence of new bone formation, suggestive of an inflammatory process in the ear region.[20]

Taphonomy

Evidence of burning was analysed by the study of macroscopic changes in colour and texture.[21] Remarkably, none of the human bone fragments exhibited cremation marks, ruling out an immediate context with the assumed burning event. Also, no bite marks were detected, which indicates that the bodies have not been exposed for any considerable time to rodents or other animals. Furthermore, the remains did not exhibit any cut marks and/or combat-inflicted injuries, so a possible dismemberment of the bodies prior to disposal in the fortification ditch can be excluded. Nevertheless, it has to be kept in mind that for both individuals just a minor skeletal inventory (Individual 1 < 1%; Individual 2 < 5%) was available for investigation.

16 Hauser – De Stefano 1989.
17 Alt 1997.
18 Vargiu et al. 2009.
19 Roberts – Manchester 2005.
20 Roberts – Manchester 2005.
21 Shipman et al. 1984; Nicholson 1993.

Anthro-ID	Area	Stratigraphical Unit (SU) and Squares	Find Date	East (m)	North (m)	Height asl (m)	Joints	Classification
	C	PZ95 BBCC8–13	06.09.2012					left lateral cuneiform
	C	PZ95 BBCC8–9	11.09.2012					base of the skull
A	C	PZ95/P32 (DD12–13)	07.09.2012	2604709.079	4285500.481	37.084		fragment of left parietal bone
	C	PZ129/P43 (DD11)	02.09.2013	2604708.098	4285500.451	36.691		3rd molar
B	C	PZ1 EE10	08.09.2011				B=K2, G, E1, Z, L	fragment of right parietal bone
C1; C2	C	PZ95 EE12–13	28.08.2012				C1=C2, K2; C2=C1, K2, Z	2× fragment of left parietal bone (large=C1; small=C2)
D	C	PZ 95EE11	30.08.2012					fragment of left temporal bone
E1; E2	C	P95/P28 (EE 12–13)	07.09.2012	2604709.473	4285500.428	36.984	E1=B, K2, I1, I2; E2=G, K3, I6, K1	fragment of the occipital bone (E1) + fragment of the frontal bone (E2)
F	C	PZ95 EE12–13	07.09.2012					fragment of left parietal bone (F), long bone fragment
G	C	PZ95/P30 (EE12–13)	07.09.2012				G=B, Z, K3, E2, K1,K5, I4	fragment of right parietal bone
X	C	PZ95/P27 (EE12–13)	05.09.2012	2604709.616	4285501.766	36.977		fragment of a parietal bone?
	C	P95/P26 (EE12–13)	05.09.2012	2604709.411	4285501.451	36.993	ULN=ULN	2× fragment of the ulna
H	C	PZ1 FFGG12–13	09.09.2011				H=I2	fragments of mastoid (H), molare fragment, shaft fragment humerus, 3× bone fragments
Y	C	PZ1 FFGG11	13.09.2011					fragment of a parietal bone?, maxilla molar, molar fragment, 2× bone fragments
	C	PZ151 FFGG11	2013					2× fragments of left scapula, 1× terminal finger bone
I1; I2; I3; I4; I5; I6	C	PZ95/P1 (FFGG12–13)	28.08.2012	2604709.729	4285501.996	37.049	I1=I2, E1; I2=I1, E1, I3, H; I3=I2, L, I4; I4=I3, G, K4, K5; I5=K4, G, K1; I6=K1, E2	fragments of: 2× occipital bone (I1+I2), 2× parietal bone incl. temporal bone (I3+I4), the frontal bone (I5+I6)
K1; K2; K3; K4; K5	C	PZ95 FFGG12–13	28.08.2012				K1=I5, G, E2, I6; K2=E1, C1, C2, Z, B; K3=Z, E2, G; K4=K5, I5, I4;K5=I4, G, K4; CLA=CLA	fragments of: right parietal bone (K3+K4+K5), left parietal bone (K2), the frontal bone (K1), 4× skull fragments, 1× long bone fragment (femur?), 3× clavicle, 1× premolar, 1st rib, 2× body of thoracic vertebra
	C	PZ95 FFGG9	31.08.2012					fragment of phalanges bone
	C	PZ95 FFGG8	04.09.2012					bone fragment
	C	PZ66 FFGG11	07.09.2012					TK
L	C	P95/P24 (FFGG12–13)	05.09.2012	2604709.802	4285501.965	36.997	L=I3, B	fragment of right parietal bone
M	C	PZ66/P75 (FFGG10)	10.09.2012	2604707.952	4285503.12	36.315		molar
	C	PZ95 FFGG12–13	04.09.2012 & 28.08.2012 & 30.08.2012					17× bone fragments
Z	C	PZ95 EE 11	29.08.2012				Z=K2, C2, K3, G, B	fragments of both parietal bones incl. Sutura sagittalis
	C	PZ95/P09 (EE 12–13)	30.08.2012					fragment of left mandibula body incl. premolar and molars
	C	PZ95 EE12–13	28.08.2012					skull fragment

Tab. 1 Human remains from Punta di Zambrone, Area C

The bones of Individual 1 were found in close proximity to Individual 2, commingled in the same stratum (SU 95) at quadrant FFGG 12–13 and excavated on the same day.

Taphonomic reconstruction suggests that the remains of Individual 2 have undergone multiple disturbances after death and deposit. The oldest impact on the buried skull is represented by a broad superficial scratch on the left parietal bone ending in a triangular-shaped hole (Fig. 7.1). This massive trauma caused several breaks in the cranial vault, leaving the skull scattered. The most probable cause of this lesion was a strike from an agricultural plough, a commonly used instrument in the region. A more recent lesion on the parietal bone (Fig. 7.2) was most probably caused by digging tools during the excavation process. Finally, there are some superficial signs of drilling from the sampling for DNA analysis (Fig. 7.3).

Conclusion

A close examination of the human remains from the fortification ditch in Punta di Zambrone enabled us to interpret some of the skeletal and dental features. The remains originate from at least two individuals, a younger adult (20–30 yrs.) and an adolescent (16–20 yrs.). A definite sex determination is not possible for either individual. The older individual displays signs of unspecific inflammation of the external ear and caries. Taphonomic investigation revealed disturbance of the burial of at least one of the individuals and several incidents of anthropogenous damage, long after deposition. Even though the remains were buried in ash, no marks of burning could be identified anthropologically. The fact that bones of one and the same individual were scattered through different ash levels is evocative of the similar taphonomic properties of the pottery – showing joints between different ash levels including considerable vertical distances between joining fragments.[22] A second property of the bones resembles the findings of the pottery, i.e. their unburnt character. Similarly, only very few sherds from the ash layers show traces of burning.[23] The position of the human bones in the ditch is thus secondary and only partly the result of recent disturbances. The stratigraphic evidence related to both the bones and the pottery suggests first that neither the bones nor the pots were burnt together with the plant material that produced the ashes, and second, that the ashes must originally have been accumulated elsewhere, before they were heaped inside the fortification ditch, when the settlement was abandoned.

Acknowledgements: We would like to thank the Soprintendenza per i Beni Archeologici della Calabria, Italy and all members of the Punta di Zambrone team for their dedicated work. We are particularly grateful to Reinhard Jung from the OREA Institute and Marco Pacciarelli from the University of Naples Federico II, who have made possible our investigations on the excavated human remains.

Bibliography

Alt 1997
K. W. Alt, Odontologische Verwandtschaftsanalyse. Individuelle Charakteristika der Zähne in ihrer Bedeutung für Anthropologie, Archäologie und Rechtsmedizin (Jena 1997).

Bass 1987
W. M. Bass, Human Osteology. A Laboratory and Field Manual (Columbia, Missouri 1987).

Berg et al. 1981
S. Berg – R. Rolle – H. Seemann, Der Archäologe und der Tod. Archäologie und Gerichtsmedizin (Munich 1981).

Brinkmann – Madea 2004
B. Brinkmann – B. Madea, Handbuch der gerichtlichen Medizin (Berlin, Heidelberg, New York 2004).

[22] See Jung – Pacciarelli, this volume, fig. 19. A 14C-date on one human bone fragment from Individual 2 (PZ95/P1) confirms its RBA date (see Weninger et al., this volume).

[23] Jung et al. 2015, 60.

Brothwell 1981
D. R. Brothwell, Digging up Bones (Oxford 1981).

Byers 2008
S. N. Byers, Introduction to Forensic Anthropology (Boston 2008).

Ferembach et al. 1979
D. Ferembach – I. Schwidetzky – M. Stloukal, Empfehlungen für die Alters- und Geschlechtsdiagnose am Skelett, Homo – Journal of Comparative Human Biology 30, 1979, 1–32.

Haglund – Sorg 1996
W. D. Haglund – M. H. Sorg, Forensic Taphonomy. The Postmortem Fate of Human Remains (Boca Raton, New York, London, Tokyo 1996).

Hauser – De Stefano 1989
G. Hauser – G. F. De Stefano, Epigenetic Variants of the Human Skull (Stuttgart 1989).

Jung et al. 2015
R. Jung – M. Pacciarelli – B. Zach – M. Klee – U. Tanheiser, Punta di Zambrone (Calabria) – a Bronze Age harbour site. First preliminary report on the Recent Bronze Age (2011–2012 campaigns), Archaeologia Austriaca 99, 2015, 23–110.

Kanz – Grossschmidt 2006
F. Kanz – K. Grossschmidt, Head injuries of Roman gladiators, Forensic Science International 160, 2006, 207–216.

Nicholson 1993
R. A. Nicholson, A morphological investigation of burnt animal bone and an evaluation of its utility in archaeology, Journal of Archaeological Science 20, 1993, 411–428.

Ortner 2003
D. J. Ortner, Identification of Pathological Conditions in Human Skeletal Remains (San Diego 2003).

Recchia 2009
G. Recchia, Antenati, «eroi», nemici. Sepolture e resti umani in alcuni abitati dell'età del Bronzo dell'Italia peninsulare, Scienze dell'Antichità 14/2007–2008, 2009, 83–121.

Roberts – Manchester 2005
C. Roberts – K. Manchester, The Archaeology of Disease (Gloucestershire 2005).

Rösing et al. 2007
F. W. Rösing – M. Graw – B. Marre – S. Ritz-Timme – M. A. Rothschild – K. Roetzscher – A. Schmeling – I. Schroeder – G. Geserick, Recommendations for the forensic diagnosis of sex and age from skeletons, Homo – Journal of Comparative Human Biology 58, 2007, 75–89.

Shipman et al. 1984
P. Shipman – G. Foster – M. Schoeninger, Burnt bones and teeth. An experimental study of color, morphology, crystal structure and shrinkage, Journal of Archaeological Science 11, 1984, 301–325.

Vanzetti 2009
A. Vanzetti, Appunti per l'indagine sulle deposizioni umane in abitato durante la protostoria europea, Scienze dell'Antichità. 14/2007–2008, 2009, 745–769.

Vargiu et al. 2009
R. Vargiu – A. Cucina – A. Coppa, Italian Populations During the Copper Age. Assessment of Biological Affinities Through Morphological Dental Traits, Human Biology 81, 2009, 479–493.

White 2000
T. D. White, Human Osteology (New York 2000).

Wittwer-Backofen et al. 2004
U. Wittwer-Backofen – J. Gampe – J. W. Vaupel, Tooth cementum annulation for age estimation. Results from a large known-age validation study, American Journal of Physical Anthropology 123, 2004, 119–129.

Ancient DNA from Punta di Zambrone: Minute Traces of 3000-year-old DNA or 'Much Ado About Nothing'?

Jan Cemper-Kiesslich[1] – *Petra Kralj*[2] – *Reinhard Jung*[3] – *Fabian Kanz*[4] – *Walther Parson*[5]

Abstract: In this study we set out to characterise ancient DNA extracted from human bones unearthed during archaeological excavations in Punta di Zambrone (Calabria, Italy) in the year 2011. Hard tissue remains consisted mainly of animal bones, but also of some human skeletal fragments that were taken for ancient DNA analysis after anthropological investigation: No nuclear DNA was detected but moderate amounts of mitochondrial DNA. Nevertheless, the results enabled allocation of reputed mitochondrial haplotypes and ethno-geographical assignments for each sample analysed. Given that all samples stem from the same individual,[6] by merging single sample results we constructed a (hypothetical) merged/consensual haplotype in order to assess the main objective of this study: were the humans living and dying at the ancient site of Punta di Zambrone locals or did they hail from another area? Additionally, we report the planning and realisation of the Punta di Zambrone excavation and archaeometric investigations, which could serve as a procedural model in molecular archaeology.[7]

Keywords: Molecular archaeology, ancient DNA, mitochondrial DNA, human hard tissue, migration and residence, Punta di Zambrone, Recent Bronze Age, sampling for aDNA, synoptic study design

Introduction

Depending on the state of preservation, human remains may offer a broad variety of 'encrypted' information on the living conditions as well as the circumstances of death of individuals, groups and societies. Naturally, hard tissue remains are available for analysis. When interpreting and discussing the results, one should be aware that the objects under investigation mirror conditions of life that have manifested in and on the bones and teeth at the time of death and may have been modified by post mortem influences during taphonomy and diagenesis.[8]

Aside from material objects and written traditions, biogenic, especially human remains represent a special category of 'historical tradition' for archaeological and historical research. Employment of adapted techniques from physical anthropology, forensics, radiology, analytical chemistry, physics, molecular biology (ancient DNA analysis) etc. allows us to read parameters like sex,

1 University of Salzburg, Interfaculty Department of Legal Medicine, DNA-Unit and Department of Classics, Ignaz-Harrer Straße 79, 5020 Salzburg, Austria; jan.kiesslich@sbg.ac.at (Corresponding Author); CAMAS – Centre of Archaeometry & Applied Molecular Archaeology Salzburg; archaeometrie@sbg.ac.at.

2 Medical University of Innsbruck, Institute of Legal Medicine, Müllerstraße 44, 6020 Innsbruck, Austria; kralj.petra@gmail.com.

3 Austrian Archaeological Institute, Austrian Academy of Sciences, Hollandstraße 11–13, 1020 Vienna, Austria; Reinhard.Jung@oeaw.ac.at.

4 Medical University of Vienna, Center for Forensic Medicine, Unit of Forensic Anthropology, Sensengasse 2, 1090 Vienna, Austria; fabian.kanz@meduniwien.ac.at; CAMAS – Centre of Archaeometry & Applied Molecular Archaeology Salzburg; archaeometrie@sbg.ac.at.

5 Medical University of Innsbruck, Institute of Legal Medicine, Müllerstraße 44, 6020 Innsbruck, Austria; walther.parson@i-med.ac.at; Forensic Science Program, The Pennsylvania State University, 13 Thomas Building, University Park, PA 16802, United States of America; walther.parson@i-med.ac.at.

6 Kanz et al., this volume.

7 Cemper-Kiesslich et al. 2014.

8 Haglund – Sorg 2002, 3–30.



Fig. 1 Excavation of human bones at Punta di Zambrone, Area C (August, 30th 2011): use of facemasks and single-use medical gloves (photo: R. Jung)

age at death, ancestry, provenance, migration and residence, hereditary and infectious diseases, injuries and traumas, traits of medical treatment, sometimes even the cause and manner of death and post mortal incidents.[9] Consequently, a synoptic read-out is to be compared with other written and material sources.[10]

The main objective of this study was to extract and characterise ancient DNA (aDNA) from human remains in order to assess any potential information to be found in the genetic code.

Materials and Methods

All lab work was undertaken in accordance with strict guidelines for aDNA analysis and follows the requirements of the DIN ES ISO/IEC 17025;2005 guideline.[11]

Preliminary Measures

Contamination control and prevention of further DNA decay appear to be the most critical issues in the pre-analytical stage of any aDNA investigation.[12] Hence, a part of the excavation team was briefed on sampling and storage procedures before accessing the excavation site. Contamination by modern DNA from excavators or other personnel in the course of the excavation and/or recovery process on potential sample materials is likely to be avoided by wearing facemasks and single-use medical gloves (Fig. 1).

9 Cemper-Kiesslich et al. 2012.
10 Cemper-Kiesslich et al. 2014.
11 DIN 2005.
12 Kolman – Tuross 2000; Yang – Watt 2005; Roberts – Ingham 2008.

According to our experience there is no need to use sterile medical ware, though recommended by some authors, or to use full body protection. Reducing the number of persons involved in the whole process appears to be another appropriate measure to reduce contamination risks and therefore a team comprising of two students, who attended a lab course on aDNA analysis, were nominated as the 'recovery team' to be deployed as soon as human remains were unearthed.

Additionally, a reference sample for downstream quality control was taken from each person potentially being or having been in contact with the samples.

Several systematic and case studies have shown that the most appropriate method of aDNA-sampling is an on-site process followed by immediate cooling/freezing until further analyses in a dedicated laboratory environment.[13] This recommendable procedure is obviously not suitable – or rarely possible – in regular archaeological excavations due to logistic limitations. Osseous remains of reputed human origin were therefore wrapped in paper and sealed in paper bags to allow evaporation of residual humidity and stored under dry and cool conditions until they arrived at the laboratory. Bones were not washed.[14]

DNA Extraction, Purification and Analysis

Four human bone samples were selected by a physical anthropologist and an archaeozoologist prior to further analysis. Due to the anthropological expertise, all samples are likely to stem from the same individual but were treated separately within the initial data interpretation. One additional sample, most likely a pig tooth, was chosen as a negative control and underwent the same analytical steps as the other samples:

DNA-ID	Excavation-ID	Individual	Sample Type
D041625	PZ95/P9	Individual 2 – sample fragment matches skull reconstruction	Human, part of the left mandible with premolar
D041626	PZ95/P8	Porcine	Pig, left maxilla with Pd3, Pd4, M1 (age at death: 8–10 months)
D041632	PZ95EE12–13	Individual 2 – sample fragment matches skull reconstruction	Human, skull fragment
D041637	PZ95/P1	Individual 2 – sample fragment matches skull reconstruction in photo composition	Human, skull fragment
D041638	PZ95EE 11	Individual 2 – sample fragment matches skull reconstruction	Bone fragment (skull?)

Tab. 1 List of samples from Punta di Zambrone, Area C, disturbed Recent Bronze Age layers (anthropological identification by F. Kanz, zoological assignment by G. Forstenpointner and G. Weissengruber)

After photographic documentation and registration, superficial soil and dirt was removed with a rotating wire brush. Due to the small size, all samples were then treated in an ultrasonic bath utilising 75% v/v Ethanol for 5 minutes. The supernatant was discarded and the sample transferred into a new tube. This step was repeated twice with 100% Ethanol to achieve further cleaning and removal of water. Prior to physical breakdown, the samples were air-dried at approximately 70°C for 2 hours. Whole samples were crushed with DNA-free strong forceps (usually used for construction work) and powdered in a Retsch-200 pebble mill.

Reference samples from potential contaminators were treated with the GenIal First DNA kit according to the manufacturer's guidelines;[15] purified DNA was dissolved in 40µl and diluted to a final concentration of 1ng/µl with buffered TE prior to PCR analysis as described below.

13 Brandt et al. 2010; Alt et al. 2014.
14 Cemper-Kiesslich et al. 2010.
15 Company release July 2013; GenIal 2013.

Approximately 250mg of fine bone powder was added to 650µl of 0.5 M EDTA (Ethylendiamintetraacetic acid) for decalcification (approx. 48 hours). This step was followed by a ProteinaseK-digestion using DTT as an adjuvant in order to set the DNA free in an aqueous solution suitable for DNA-purification done on a Qiagen M48[16] liquid handling platform (for detailed protocol see[17]).

The resulting concentrated DNA solution was analysed using Life Technology's AmpFlSTR Identifiler PLUS-kit[18] with enhanced sensitivity (34 cycle PCR) in order to establish a human nuclear autosomal genotype.

Respective DNA-extracts were additionally investigated for quantity and quality of human mitochondrial DNA (mtDNA) using an already published method.[19] PCR reactions were carried out on ABI 9500 thermal cyclers, post-PCR analysis/capillary electrophoresis employed ABI 3500 or 3130 instruments respectively.

Results

Autosomal DNA

Only 2 out of 4 samples (DNA-ID D041625 and D041637) yielded minute traces of human nuclear DNA (data not shown). The other samples (including the animal sample, DNA ID D041626, see Table 1) were negative for nuclear DNA. Sex identification was also not possible.

Reference Samples

References from samples from each member of the excavation team, laboratory staff as well as from other involved personnel, including those from the DNA-lab, who might have been in contact with the samples, were successfully typed. However, there was no match with the ancient samples since there was almost no nuclear DNA detectable. The nuclear DNA results for samples DNA-ID D041625 and D041637 were poor and non-reproducible; hence a comparison of these results with the reference sample data was not feasible.

Mitochondrial DNA Data, Haplotypes, Haplogroups and Ethnic Estimation

Conventional DNA-sequencing according to Sanger usually covers some 100 bases within a single read, provided that the DNA is well preserved and not too degraded. This is apparently not always the case for ancient samples, hence the sequence information can be accessed by partial regions of interest of the mitochondrial genome. The numbers given in the 'reading range' refer to fixed positions according to the human mitochondrial reference sequence (abbr.: rCRS[19]).

Mitochondrial DNA data as shown above comprises DNA-sequence information that can be displayed simply by the sequential notification of the respective information, i.e. ACTTTGGGATCGATTAGCCGATCGATCGATCGATCGATG...; this, however, has proven to be impracticable for reporting mtDNA sequence data. Hence, there is a convention of displaying differences to the so-called revised Cambridge Reference Sequence (abbr.: ΔrCRS[20]), a well-established, validated and frequently occurring human mitochondrial DNA haplotype. The line 'DNA Sequence (ΔrCRS)' may also be denominated as 'Haplotype', referring to single individuals or samples.

Haplotypes that share a common ancestor form so-called haplogroups. Haplogroups referring to human mtDNA sequence data are the result of human evolution, migration and mutation

16 Company release June 2012; Qiagen 2012.
17 Cemper-Kiesslich et al. 2011.
18 Company release March 2012; Life Technologies 2012.
19 Berger et al. 2009.
20 Andrews et al. 1999.

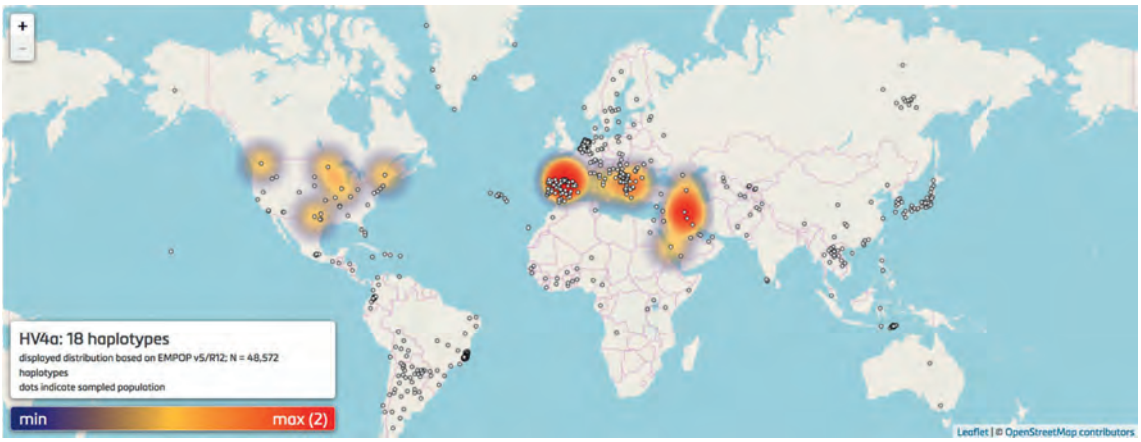


Fig. 2a Distribution of mtDNA haplogroup HV4a in EMPOP (v4, R13) (graphics: W. Parson)



Fig. 2b Distribution of mtDNA haplogroup H10a in EMPOP (v4, R13) (graphics: W. Parson)

reflecting maternal inheritance and spatial or geographical distribution patterns in the human population structure.

Haplotype database queries[21] result in the frequencies as well as spatial, ethno-geographical distribution patterns of human mitochondrial haplogroups ('heat-map', e.g. Figure 2a). These findings may allow a downstream assignment of the lineage under investigation to a certain region and/or ethnic group taking into consideration that this information is restricted to the maternal line. In this case, as with any other historical DNA data, the temporal gap between the geno- or haplotype under investigation and the reference data (recent) have to be taken into account including potential migration and mutational events. Hence, an ethnic assignment for a historical individual based on DNA data has to be treated cautiously.

DNA sequence analysis of the human mitochondrial control region showed unambiguous results for all 4 human samples as well as for the animal control sample (this may be due to interspecies cross reactions with porcine DNA but also due to minimal human DNA contamination) as shown below. Additionally, results for database queries[22] such as frequencies, haplogroups and ethno-geographical allocations are given. At first sight we assume, based on the mtDNA data, that we are dealing with 4 different human individuals:

21 http://empop.online, database readout March, 1st 2016.

22 http://empop.online [Parson – Dür 2007], version 4, release 13, date of query: Jan 24th, 2020.

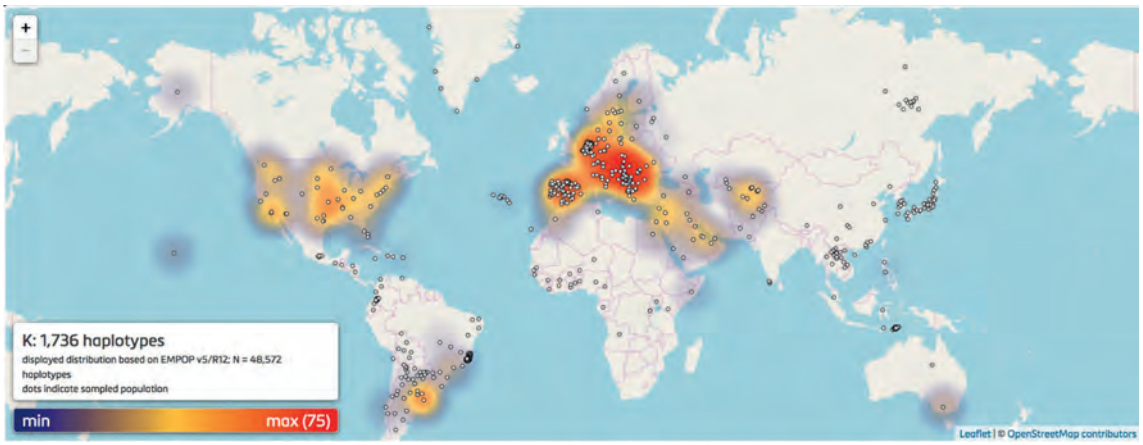


Fig. 3 Distribution of mtDNA haplogroup K in EMPOP (v4, R13) (graphics: W. Parson)

D041625, PZ95/P9, human, part of the left mandible with premolar
Reading ranges: 16024–16248 16410–16510 16562–16569 1–181 213–576
Haplotype / DNA Sequence (ΔrCRS): 16221T 263G 309.1C 315.1C
Frequency: 27 matches in 38,361 mtDNA haplotypes total database (= approx. 1 out of 1,420)
Haplogroup (reputed): HV4a or H10a (see Fig. 2a–b)

D041626, PZ95/P8, animal tooth (pig, left maxilla with Pd3, Pd4, M1; age at death: 8–10 months)
Reading ranges: 16024–16152 16161–16248 16562–16569 1–181 368–390
Haplotype / DNA Sequence (ΔrCRS): 73G 146C
Frequency: 34 matches in 39,404 mtDNA haplotypes (= approx. 1 out of 1,158)
Haplogroup (reputed): L3/M/N

This finding obviously has to be viewed critically. If the data results from interspecies cross reaction with porcine DNA it simply makes no sense. If the result is due to the presence of (contaminating) human DNA, contamination cannot be excluded. The haplotype 73G 146C does not harbour enough resolution to assign useful haplogroup information.

D041632, PZ95EE12–13, human skull fragment
Reading ranges: 16024–16248 16410–16510 16562–16569 1–181 210–433 461–575
Haplotype / DNA Sequence (ΔrCRS): 73G 150Y(C or T) 152Y (C or T) 315.1C 523del 524del
Frequency: 0 matches in 38,361 mtDNA haplotypes (= less than 1 out of 38,361)
Haplogroup (reputed): L3/M/N

D041637, PZ95/P1, human skull fragment
Reading ranges: 16024–16095 16125–16248 16389–16510 16562–16569 1–181 413–576
Haplotype / DNA Sequence (ΔrCRS): 16224C 73R(A or G) 152Y(C or T) 523del 524del
Frequency: 0 matches in 38,409 mtDNA haplotypes (= less than 1 out of 38,409)
Haplogroup (reputed): K (see Fig. 3)

D041638, PZ95EE11, human bone fragment (skull?)
Reading ranges: 16024–16248 16562–16569 1–181 320–576
Haplotype / DNA Sequence (ΔrCRS): 16224C 73G 146C 523del 524del
Frequency: 0 matches in 38,409 mtDNA haplotypes (= less than 1 out of 38,409)
Haplogroup (reputed): K (see Fig. 3)

Discussion and Conclusions

Study Design and Logistics

This study may serve as a best practice example for planning and conducting aDNA analysis in the course of an archaeological project. Molecular genetics but also physical anthropology, archaeobotany, archaeozoology, isotope analysis and other disciplines were included in the preliminary planning, respecting the needs for each scientific approach.[23]

As mentioned above, it seems evident that sampling and sample storage are critical factors for successful aDNA recovery and analysis. Prior to archaeological measures, the whole team was trained in handling alleged human remains and how to store and process these samples in the aftermath of the excavation. Though the primary aim of our efforts was about provenancing the human remains, the central issue was the recovery of individual and authentic aDNA, which has been achieved – at least to some degree. The authors want to point out that for each bone fragment a retention sample is held in readiness for further analyses with more sophisticated methods such as MPS (massive parallel sequencing).

Ancient DNA – Results – Authentication and Ethnic Estimation

Nuclear DNA could not be detected in the analysed remains. Nevertheless, all samples were positive for mtDNA. This appears reasonable since nuclear DNA has been shown to be less stable than mtDNA; additionally the latter occurs in a frequency per cell which is several magnitudes higher (some 1000–10,000) compared to nuclear DNA, which is present in two copies in diploid organisms such as humans.

Since no nuclear DNA was found, we had no opportunity to undertake a comparison with the affiliated personnel in order to exclude recent contamination. (A total of 31 individuals were anonymously genotyped for a small, so-called reference database.) Complete contamination control would, of course, have required mtDNA data from these persons but this was not feasible in the course of this study due to financial and logistical limitations. Moreover, a match between an ancient sample and a potential contaminator does not necessarily constitute proof for a false positive, contaminated sample but may also be the result of a random match and would therefore lead to an erroneous exclusion of an authentic result. The risk of a false exclusion depends on the relative frequency of the haplotype found and may be estimated at approximately 1 in 10,000; the same scenario for nuclear DNA is at least 10 magnitudes lower.

Nevertheless, the mtDNA results appear authentic – at least to some degree, since no nuclear DNA was found within the ancient samples, which would be expected if a modern, user-borne contamination had occurred. As indicated above, the state of preservation of reputed authentic DNA appeared to be quite poor for the samples analysed in this study. Nevertheless two major independent and likely scenarios may be proposed (amongst others), assuming that the mtDNA results do represent the authentic ancient mtDNA from the human skeletal remains unearthed at Punta di Zambrone:

Scenario 1

All (4) human samples yielded authentic ancient mtDNA. Hence we face 4 different female lines represented by 4 different individuals belonging to mtDNA-haplogroups HV4a or H10a and some undeterminable haplogroup due to the lack of indicative variants and 2 individuals from group K (see heat maps as shown in the figures above for a rough idea concerning the ethno-geographical background). The porcine tooth seemed to be contaminated. Including the results of Kanz et al.,[24] scenario 1 appears to be rather unlikely based on the matching pattern of the skull fragments providing evidence of a single individual.

---

[23] Alt 2010.

[24] Kanz et al., this volume.

Scenario 2

Experiences with nuclear DNA employing multiple analogous analyses showed that in cases of so-called 'low copy number' PCRs involving only a few target molecules per reaction, stochastic effects are likely to occur. Due to the minute quantity of template molecules within individual PCR reactions there may be ambiguous but consistent results. In a summarising approach, results from different reactions on different samples from the same individual can be merged to give a resulting geno- or haplotype. The bottom line of Table 2 shows a 'merged' consensus mitochondrial haplotype – given that all samples stem from the same individual (Individual 2).[25] This, of course, has to be viewed especially cautiously, since the single samples can also stem from 2 or more different individuals with the same or even (slightly) different haplotypes. Additionally some results may be due to minute/stochastic contaminations or heteroplasmy.

Sample ID	**ΔrCRS**	**ΔrCRS**	**ΔrCRS**	**ΔrCRS**	**ΔrCRS**	**ΔrCRS**	**ΔrCRS**	**ΔrCRS**	**ΔrCRS**	**ΔrCRS**	**ΔrCRS**
D041625 (human)	16221T						263G	309.1C	315.1C		
D041632 (human)			73G		150Y (C/T)		263G		315.1C	523del	524del
D041637 (human)		16224C	73R (A/G)			152Y (C/T)				523del	524del
D041638 (human)		16224C	73G	146C						523del	524del
merged (human)		**16224C**	**73G**				**263G**		**315.1C**	**523del**	**524del**

Tab. 2 This table gives a summary of mtDNA results for human samples from Punta di Zambrone, Area C (disturbed Recent Bronze Age layers)

Frequency: 0 matches in 38,409 mtDNA haplotypes (= less than 1 out of 38,409)
Haplogroup (reputed): K (see Fig. 3)

Concluding Remarks

In conclusion, the molecular genetic study yielded sparse results due to the low amount and quality of DNA extracted from the remains.

Due to limited resources the current study refers to routinely applied molecular-archaeological methodology. Consequently, and as mentioned above, current developments such as MPS (massive parallel sequencing) may enable more of the genetic information preserved in the osseous remains from Punta di Zambrone to be read in the future.

Additional provenancing data from isotope analyses may (or may not!) align with mtDNA results.

Referring to the initial questionnaire of this study we may cautiously assign an Eastern European background for the female line of the individual(s) found in Punta di Zambrone.

The preliminary procedures in pursuing a multi- and trans-disciplinary approach within the Punta di Zambrone campaigns are to be seen as exemplary. Despite financing and labour, the sample material itself is the limiting factor. For this very reason, any information conceivable – i.e. as shown in this paper – has to be taken into account in order to amend our picture of past societies.

Acknowledgements: This study was supported by the TuBa Private Foundation.

[25] As suggested by Kanz et al., this volume.

Bibliography

Alt 2010
K. W. Alt, Grenzüberschreitungen. Wissenschaft im Dialog um die Vergangenheit, in: H. Meller – K. W. Alt (eds.), Anthropologie, Isotopie und DNA. Biographische Annäherung an namenlose vorgeschichtliche Skelette? 2. Mitteldeutscher Archäologentag vom 08. bis 10. Oktober 2009 in Halle (Saale), Tagungen des Landesmuseums für Vorgeschichte Halle 3 (Halle [Saale] 2010) 9–16.

Alt et al. 2014
K. W. Alt – G. Brandt – C. Knipper – C. Lehn, Recommendations for sampling in forensic anthropology. Ancient DNA and stable isotope analyses, Rechtsmedizin 24, 2014, 179–185.

Andrews et al. 1999
R. M. Andrews – I. Kubacka – P. F. Chinnery – R. N. Lightowlers – D. M. Turnbull – N. Howell, Reanalysis and revision of the Cambridge reference sequence for human mitochondrial DNA, Nature Genetics 23, 1999, 147.

Berger – Parson 2009
C. Berger – W. Parson, Mini-midi-mito. Adapting the amplification and sequencing strategy of mtDNA to the degradation state of crime scene samples, Forensic Sciences International: Genetics 3, 2009, 149–153.

Brandt et al. 2010
G. Brandt – C. Knipper – C. Roth – A. Siebert – K. W. Alt, Beprobungsstrategien für aDNA und Isotopenanalysen an historischem und prähistorischem Skelettmaterial, in: H. Meller – K. W. Alt (eds.), Anthropologie, Isotopie und DNA. Biographische Annäherung an namenlose vorgeschichtliche Skelette? 2. Mitteldeutscher Archäologentag vom 08. bis 10. Oktober 2009 in Halle (Saale), Tagungen des Landesmuseums für Vorgeschichte Halle 3 (Halle [Saale] 2010) 17–32.

Cemper-Kiesslich et al. 2014
J. Cemper-Kiesslich – M. R. Mc Coy – F. Kanz, Antik DNA ve adli tip karsilikli faydalari. Sanal bir antik DNA çalismasi ile ilgili pratik örnekleme ve laboratuvar kilavuzu / Ancient DNA and forensics – mutual benefits. A practical sampling and laboratory guide through a virtual ancient DNA study, Adli Tip Bülteni – The Bulletin of Legal Medicine 19, 2014, 1–14.

Cemper-Kiesslich et al. 2010
J. Cemper-Kiesslich – F. Neuhuber – R. Schwarz, „Gene aus alten Knochen" – Alte DNA & molekulare Archäologie. Ein Überblick über die Methodik der molekularbiologischen Spurenanalytik an biogenen Überresten mit einem praktischen Leitfaden für die Probennahme und Aufbewahrung, in: J. Cemper-Kiesslich – F. Lang – K. Schaller – Ch. Uhlir – M. Unterwurzacher (eds.), Tagungsband zum Ersten Österreichischen Archäometriekongress, 15.–17. Mai 2009 / Primus Conventus Austriacus Archaeometriae Scientiae Naturalis ad Historiam Hominis Antiqui Investigandam – MMIX, Schriften zur Archäologie und Archäometrie an der Paris Lodron Universität Salzburg 1 (Salzburg 2010) 25–41.

Cemper-Kiesslich et al. 2011
J. Cemper-Kiesslich – R. Schwarz – F. Neuhuber, Dialysis vs. Qiagen M48. Two alternative procedures for purifying ancient DNA from bone and teeth extracts, in: J. Cemper-Kiesslich – F. Lang – K. Schaller – Ch. Uhlir – M. Unterwurzacher (eds.), Tagungsband zum Zweiten Österreichischen Archäometriekongress, 13.–14. Mai 2010 / Secundus Conventus Austriacus Archæometriæ Scientiæ Naturalis ad Historiam Hominis Antiqui Investigandam – MMX, Schriften zur Archäologie und Archäometrie an der Paris Lodron Universität Salzburg 2 (Salzburg 2011) 121–124.

DIN 2005
Deutsches Institut für Normung e.V. (ed.), General Requirements for the competence of testing and calibration laboratories (ISO/IEC 17025;2005) (Berlin 2005).

GenIal 2013
Gen-Ial – Institut für Angewandte Laboranalysen GmbH (ed.), All-tissue DNA-Kit, Handbuch für DNA-Extraktionen. 07/2013. Troisdorf.

Haglund – Sorg 2002
W. D. Haglund – M. H. Sorg, Advances in Forensic Taphonomy. Method, Theory, and Archaeological Perspectives (Boca Raton, Fla. 2002).

Kolman – Tuross 2000
C. J. Kolman – N. Tuross, Ancient DNA analysis of human populations, American Journal of Physical Anthropology 111, 2000, 5–23.

Life Technologies 2012
Applied Biosystems by Life Technologies (ed.), AmpFlSTR® Identifiler® Plus PCR Amplification Kit user guide. 03/2012. Carlsbad, CA, USA.

Parson – Dür 2007
W. Parson – A. Dür, EMPOP – a forensic mtDNA database, Forensic Science International Genetics 1, 2, 2007, 88–92.

Qiagen 2012
Qiagen (ed.), MagAttract® DNA Mini M48 Handbook, for DNA purification from soft tissues and cultured cells using the BioRobot® M48 workstation. 06/2012. Hilden.

Roberts – Ingham 2008
C. Roberts – S. Ingham, Using ancient DNA analysis in palaeopathology. A critical analysis of published papers, with recommendations for future work, International Journal of Osteoarchaeology 18, 2008, 600–613.

Yang – Watt 2005
D. Y. Yang – K. Watt, Contamination controls when preparing archaeological remains for ancient DNA analysis, Journal of Archaeological Science 32, 2005, 331–336.

Domesticate Animal Herding and Procurement Strategies, and the Childhood Origin of the Human Mandible (SP1) from the Bronze Age Site of Punta di Zambrone, Calabria, Italy: a Laser Ablation Sr Isotope Study

Alistair W.G. Pike[1] – *Matthew J. Cooper*[2] – *Gerhard Forstenpointner*[3] – *Reinhard Jung*[4] – *J. Andy Milton*[5] – *Marco Pacciarelli*[6]

Abstract: Strontium isotope analysis of human and faunal enamel has the potential to reveal human childhood origins, and herding and other movements of animals. Recent developments have included laser ablation sampling which dramatically increases the spatial resolution at which strontium isotopes can be measured. This allows time series of changes in strontium isotopes to be measured along the growth axis of enamel, giving a highly time-resolved measure of human and animal movement. Here we present the method and some examples of its application including our work attempting to identify the provenance of humans at the Bronze Age harbour site of Punta di Zambrone (possible inhabitants of the settlement or foreigners related to its destruction?) and to identify the extent of the agricultural catchment of this settlement through analysis of cattle, pig and other animal teeth. The Sr isotope results show a faunal catchment of approximately 15km, stretching from the coast to the inland high plain, and suggest that the individual SP1 was most likely local to the region.

Keywords: Animal teeth, human teeth, laser ablation, Early Bronze Age Calabria, Punta di Zambrone, Recent Bronze Age Calabria, Strontium isotope analyses

Introduction and Aims

Here we present the laser ablation Sr isotope analysis of tooth enamel of various fauna and a human mandible (SP1) from the Early and Recent Bronze Age layers at Punta di Zambrone.

The coastal settlement of Punta di Zambrone is located on the Poro promontory in the western part of southern Calabria. Marco Pacciarelli and his local collaborators have investigated this geomorphologically very diverse region for several decades by means of archaeological surveys and excavation campaigns.[7] The results of these activities allow the reconstruction of the settlement history of this specific micro-region in detail and form the background against which we can evaluate the results of the three-year excavation project centred at Punta di Zambrone.[8] In the northern

[1] Department of Archaeology, University of Southampton, Avenue Campus, Southampton, SO17 1BF, United Kingdom; a.w.pike@soton.ac.uk.

[2] Ocean and Earth Science, University of Southampton, National Oceanography Centre Southampton, European Way, Southampton, SO14 3ZH, United Kingdom; M.J.Cooper@soton.ac.uk.

[3] Institute for Topographic Anatomy, Department of Pathobiology, University of Veterinary Medicine Vienna, Veterinaerplatz 1, 1210 Vienna, Austria; Gerhard.Forstenpointner@vetmeduni.ac.at.

[4] Austrian Archaeological Institute, Austrian Academy of Sciences, Hollandstraße 11–13, 1020 Vienna, Austria; Reinhard.Jung@oeaw.ac.at.

[5] Ocean and Earth Science, University of Southampton, National Oceanography Centre Southampton, European Way, Southampton, SO14 3ZH, United Kingdom; james.a.milton@noc.soton.ac.uk.

[6] Dipartimento di Studi Umanistici, University of Naples Federico II, Via Marina 33, 80133 Naples, Italy; marco.pacciarelli@unina.it.

[7] Pacciarelli 2000, 72–85.

[8] For an overview on this project, see Jung and Pacciarelli in the present volume.

section of the Recent Bronze Age (RBA) fortification ditch we excavated a sequence of ashy fill layers very rich in artefacts, animal bones and charred botanical remains. In addition, these layers yielded dispersed human bone fragments that could be partially recomposed and belong to two different individuals, one of which retains its mandible with three molars (M1–M3) and a canine.[9] The find position of these bones is a secondary one, as they had been deposited together with the ashy sediment in the fortification ditch in an intentional backfill at the end of the settlement's use. Earlier, the ashes had accumulated elsewhere – most probably close to the fortification wall, over an extended period while the settlement was inhabited.[10] Consequently, we can use the contents of the ashy layers to reconstruct the Recent Bronze Age history of the site. Early Bronze Age (EBA) finds come from the fill of a long rock-cut feature running close and almost parallel to the RBA ditch.

We aim to determine the animal management strategies of the site (e.g. importation vs local husbandry) and to determine if SP1 was 'local' to his/her place of burial or had spent his/her childhood (to the age of about 14) in an area of differing strontium geology.

Strontium isotopes (measured as $^{87}Sr/^{86}Sr$) are passed unchanged into tooth enamel via the diet, preserving the mean $^{87}Sr/^{86}Sr$ of the parent rocks that form the soils of the dietary catchment. Since ^{87}Sr is radiogenic and is produced from the radioactive decay of ^{87}Rb ($t_{½}$= 48.8 By), regions of older geology (or geologies with high ^{87}Rb) will have higher $^{87}Sr/^{86}Sr$ than areas of younger geology. Hence, tooth enamel that formed from dietary catchments that have different parent geologies will have different $^{87}Sr/^{86}Sr$, enabling the identification of different childhood origins for individuals and fauna.[11]

The most common application of Sr isotope analysis on archaeological material has been to identify individuals who are 'non-local', that is they spent their childhood (when the enamel of their teeth was mineralising) in a different strontium isotope catchment to the location of their burial. The 'local' Sr isotopic range can be estimated from Sr isotopic values of non-migratory fauna, sediments, flora and drinking water from the vicinity of the site where the tooth samples were recovered.[12] Where Sr isotopic values in an individual's teeth lie outside this range, they are deemed to be non-local, and must have migrated to the site sometime between the end of enamel mineralisation (e.g. c.14 years old for M3) and their death. Among many such studies, this technique has been useful in understanding degrees of human mobility in the past,[13] patterns of exogamy and kinship,[14] and animal migration.[15]

However, recent developments in laser ablation sampling allow the measurement of Sr isotopes along the growth axis of tooth enamel at very high spatial resolution.[16] Since enamel forms incrementally, measurements along the enamel provide a time series of Sr isotopes and enable the reconstruction of movement over the time the enamel is mineralising. Intra-tooth sampling of Sr has previously been done by drilling sequential samples from the enamel,[17] though it has rarely produced more than 5 or 6 measurements per tooth. Laser ablation Sr isotope analysis, on the other hand, can produce hundreds of isotopic measurements per millimetre, allowing the detection of movement over far shorter timescales than drilling. It is therefore ideal for detecting movement over shorter (e.g. seasonal) timescales as required to identify certain animal husbandry regimes such as transhumance.

---

9 See Kanz et al., this volume.

10 Pottery sherds and human bones exhibit refitting joins throughout the ash layers. For further information on the character of the ashy layers and their depositional history, see the contribution by Jung and Pacciarelli in the present volume.

11 E.g. Bentley 2006.

12 E.g. Bentley et al. 2004.

13 E.g. Price et al. 2004.

14 E.g. Haak et al. 2008.

15 Pellegrini et al. 2008.

16 De Jong et al. 2010; De Jong 2013; Lewis et al. 2014.

17 E.g. Bentley – Knipper 2005.

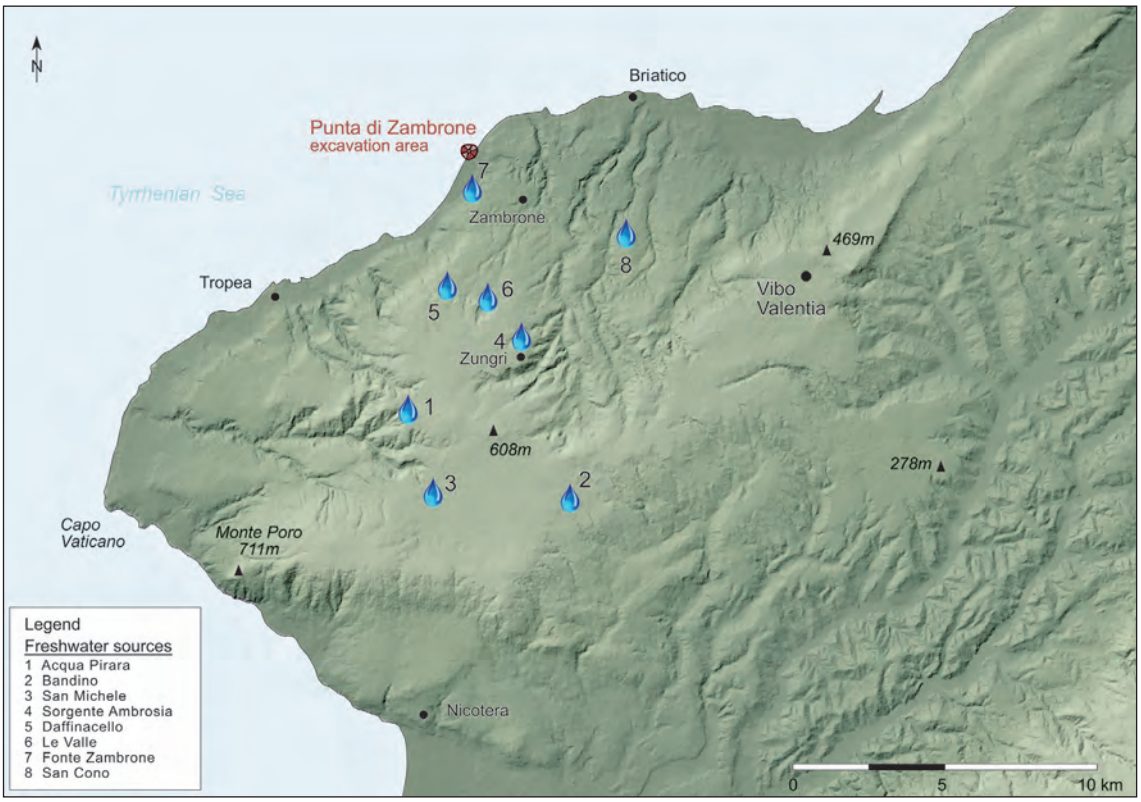


Fig. 1 Location of the water sample in the region of Punta di Zambrone (map: A. Buhlke)

Samples and Sampling

In order to define the 'local' range to the site, enamel from non-migratory archaeological fauna (a dog and a badger[18]) were sampled, along with human and faunal dentine – which in most cases takes up Sr from the burial environment and therefore reflects the $^{87}Sr/^{86}Sr$ of the immediate site. Water samples were collected, both local to the site, and further afield to provide a Sr isotope 'map' of the region (Fig. 1). These also included a small number of water samples from Achaea, Greece (Fig. 2), since Mycenaean pottery found at Punta di Zambrone turned out to be produced in that region and in further regions mainly in western Greece.[19] The human teeth sampled (SP1 – M1, M2 and M3) were mandibular permanent molars and provide a time series of Sr isotopes from approximately birth to about the age of 14 for this individual.[20] A selection of domesticated fauna (pigs, sheep, cattle, horse) were sampled to look at animal procurement strategies (Tab. 1). We especially wanted to test whether the hinterland of the site, rising from the coastal strip and extending over hilly terraces up to the Poro high plain or plateau (with elevations of more than 600m asl), formed an economically integrated system during the different habitation periods of Punta di Zambrone.[21] This would help to understand the role the site may have played as a harbour for an economically and perhaps politically structured system of settlements.

18 Larivière – Jennings 2009, 624.
19 Jung et al. 2015; Jung et al., this volume.
20 AlQahtani et al. 2010.
21 As Pacciarelli (2000, 78–84 with figs. 42–44) has proposed for EBA 2, MBA 1–2 and the RBA.

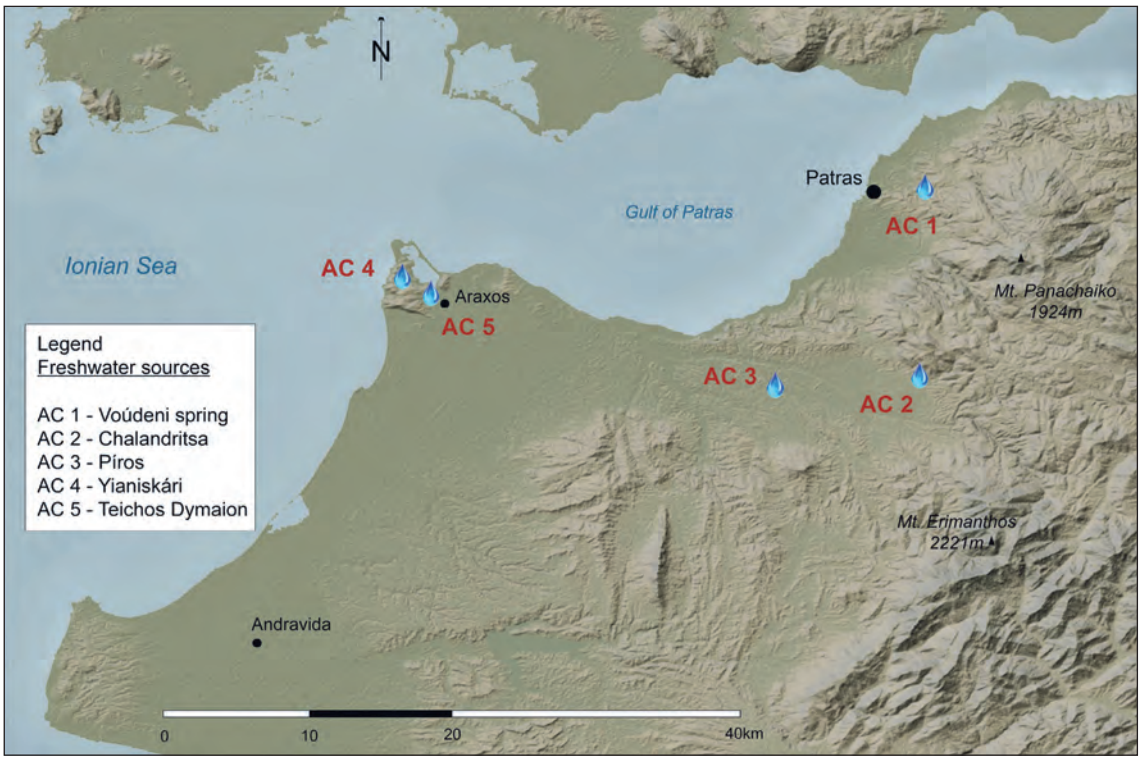


Fig. 2 Water sample locations in the central plain of Achaea (map: A. Buhlke)

Lab ID	Species/age/tooth	Site code(s)	Date	Notes
SP1 (M1, M2, M3)	Human mandible M1, M2 and M3	Area C, PZ95/P9 (= DNA sample D041625)	RBA 2	Early adult 20–30 years. M2 section incomplete
SP2	Pig, left maxilla, M3?	Area C, PZ95/P8	RBA 2	
SP3	Horse, right maxilla, M1	Area C, PZ66FFGG10	RBA 2	
SP4	Red Deer, right mandible, I2	Area C, 66cCC12	RBA 2	
SP5	Pig, right maxilla, M3	Area B, PZ83/P3	EBA 2	
SP6	Probably domestic pig	Area C, PZ66cBB11	RBA 2	
SP7	Badger, c. 1 year, left maxilla, M1	Area C, PZ66DD11	RBA 2	
SP8	Sheep, right mandible, P4	Area C, PZ66EE11	RBA 2	
SP9	Dog, right mandible, M1	Area C, PZ95DD8	RBA 2	
SP12	Bovine, > 2 years, right maxilla, P3	Area B, PZ86cF3	EBA 2	
SP13	Pig, > 1.5 years, 4 teeth, possibly from the same individual	Area B, PZ191I2	EBA 2	
SP14	Pig, > 1.5 years, left mandible, P2	Area C, PZ129BBCC12	RBA 2	
SP15	Sheep/goat, > 4 years, right maxilla, M2	Area C, PZ129bDD11	RBA 2	certainly from an animal other than SP16
SP16	Sheep/goat, right maxilla, M1 or right mandible, M2, both >1 year	Area C, PZ129bDD10	RBA 2	certainly from an animal other than SP15
SP17	Bovine, > 0.5 years, right maxilla, M1	Area C, PZ129bCC10-11	RBA 2	

Tab. 1 List of tooth samples analysed

Longitudinal sections of approximately 1.5mm thick of enamel and some incidental dentine were removed using a hand drill and diamond cutting disk. As far as possible, the samples represent a section of the complete length of the enamel from the crown to the cervix. Samples were cleaned in an ultrasonic bath in 18MΩ H_2O for ten minutes and dried overnight in an oven at 60°C.

Analysis

The samples were mounted in the laser cell by pressing them into pressure-sensitive adhesive putty (Blu-tack). Sr isotopic analysis was performed on a Thermo Fisher Neptune multi collector ICP-MS with a New Wave 193nm ArF homogenised excimer laser, using the oxide reduction technique of De Jong.[22] The measurement of Sr isotopes by laser ablation has only recently been made reliable. The primary difficulty has been the molecular interference on ^{87}Sr of $^{40}Ca^{31}P^{16}O^{+}$ which is the primary constituent of the enamel matrix. Other potential problems come from doubly charged rare earth elements which give mass to charge ratios of between 84 and 88, calcium-calcium and calcium-argide dimers which can interfere with ^{84}Sr, ^{86}Sr and ^{88}Sr, in addition to potential ^{87}Rb and ^{86}Kr interferences. Our approach has been to minimise oxide formation (monitored as $^{254}(UO)^{+}/^{238}U^{+}$) through careful control of plasma conditions, and to monitor and reject teeth that have significant rare earth concentrations which we consider to indicate diagenetic alteration. We correct for the ^{86}Kr using an on peak gas blank and for rubidium interference using the natural $^{87}Rb/^{85}Rb$ ratio of 0.385617. A small positive offset from known values $^{87}Sr/^{86}Sr$ of calcium phosphate standards is usually observed because the oxide interference is not completely eliminated, but it is normally well within the precision of a typical measurement.

Time series of strontium isotopes are obtained as continuous data by moving the tooth along its growth axis (at 15 or 25μms^{-1} depending on the size of the tooth) as the laser pulses with a repetition rate of 10Hz and spot size of 150µm, giving a fluence of c. 8.6Jcm^{-2}, and collecting strontium isotopic data every 2 seconds. Thus a single measurement represents the Sr isotopic signal integrated over 30 or 50µm of tooth enamel, although in practice we present the data as a 5-point moving average. The human (SP1) dentine associated with M1, M2 and M3, the pig dentine (SP2) and the enamel from the badger (SP7) and the dog (SP9) were analysed as 'spots'. The laser, with a spot size of 150µm, was pulsed at 10Hz for 90s without moving the sample, effectively 'drilling' with the laser and sampling a few tens of microns of the tooth orthogonal to the axis of growth. Where appropriate, spots were repeated at different locations on each of the tissues.

Repeat analysis of an in-house ashed bovine pellet standard (BP1) bracketing every third analysis, showed an offset of +89±98ppm (1 sigma) for the laser ablation analyses over TIMS values. This is about the same order as the within-tooth variation for homogenous teeth, but well within the total variation between the teeth of c. 1000ppm, and is therefore considered insignificant to our interpretation of the results.

Water samples were analysed by conventional Thermal Ionisation Mass Spectrometry (TIMS) methods following strontium separation on Sr-Spec columns and loading onto tantalum filaments with a tantalum activator solution. The samples were analysed at a ^{88}Sr beam size of 2V on a Thermo Fisher Triton Plus. The long-term average for NIST987 for the instrument is 0.710244 ± 0.000019 (2 s.d.) on 180 analyses.

Results and Discussion

Table 2 shows the results of the dentine and analyses used to define the local range. Table 3 gives the locations and results of the analyses of the water samples. Water samples from within a radius of about 6km from the site gave Sr isotopic values indistinguishable from the local range defined

[22] De Jong et al. 2010; De Jong 2013; Lewis et al. 2015.

by the dentine and enamel samples. The exception to this is the water taken from a fountain close to the site itself (WP7) which gave the most radiogenic Sr, completely at odds with the dentine measurements. The dentine is very consistent between samples, so it is likely that the water sample is unrepresentative of the local Sr isotopic range, either because of modern contamination of the water source, or because of an error in sampling or analyses.[23] We therefore exclude this sample in our interpretation of the results.

Lab ID	Tissue	$^{87}Sr/^{86}Sr$
SP1	M1 – dentine	0.708770 ± 42
	M1 – dentine	0.708764 ± 26
	M2 – dentine	0.708679 ± 25
	M3 – dentine	0.708715 ± 51
	M3 – dentine	0.708718 ± 40
SP2	Dentine	0.708909 ± 21
SP7	Enamel 1	0.708934 ± 19
	Enamel 2	0.708766 ± 14
	Enamel 3	0.708797 ± 17
SP9	Enamel 1	0.708566 ± 31
	Enamel 2	0.708568 ± 31
	Enamel 3	0.708560 ± 30

Tab. 2 Results of laser 'spot' analyses of Sr isotopes of dentine and enamel. Errors at 2 SE.

Lab ID	Location	$^{87}Sr/^{86}Sr$
WP1	Aqua Pirara	0.708374 ± 0.000014
WP2	Bandino	0.709007 ± 0.000013
WP3	San Michele	0.709264 ± 0.000012
WP4	Sorgente Ambrosia	0.708733 ± 0.000015
WP5	Daffinacello	0.708552 ± 0.000014
WP6	San Giovanni "La Velli"	0.708830 ± 0.000014
WP7	Marina de Zambrone	0.709565 ± 0.000012
WP8	San Cono	0.708904 ± 0.000011
AC1	Spring close to the Mycenaean cemetery of Voúdeni	0.707959 ± 0.000016
AC2	Spring close to the Mycenaean settlement of Chalandrítsa	0.708049 ± 0.000016
AC3	River Píros close to the village Chaikáli	0.708311 ± 0.000016
AC4	Yianiskári, plant sample (not far from the beach)	failed
AC5	Teichos Dymaion, plant sample (close to the Mycenaean citadel)	failed

Tab. 3 Results of the water analyses from around Punta di Zambrone (WP) and from the central plain of Achaea (AC). Errors at 2 SE.

[23] We suppose that the first hypothesis is correct, as this specific fountain has been restructured in recent years by adding modern pipes and installations. All the other water samples come from old fountains used by the local population for decades and retain their traditional layout. We thank Francesco Rombolà for taking us to the different fountains in the region.

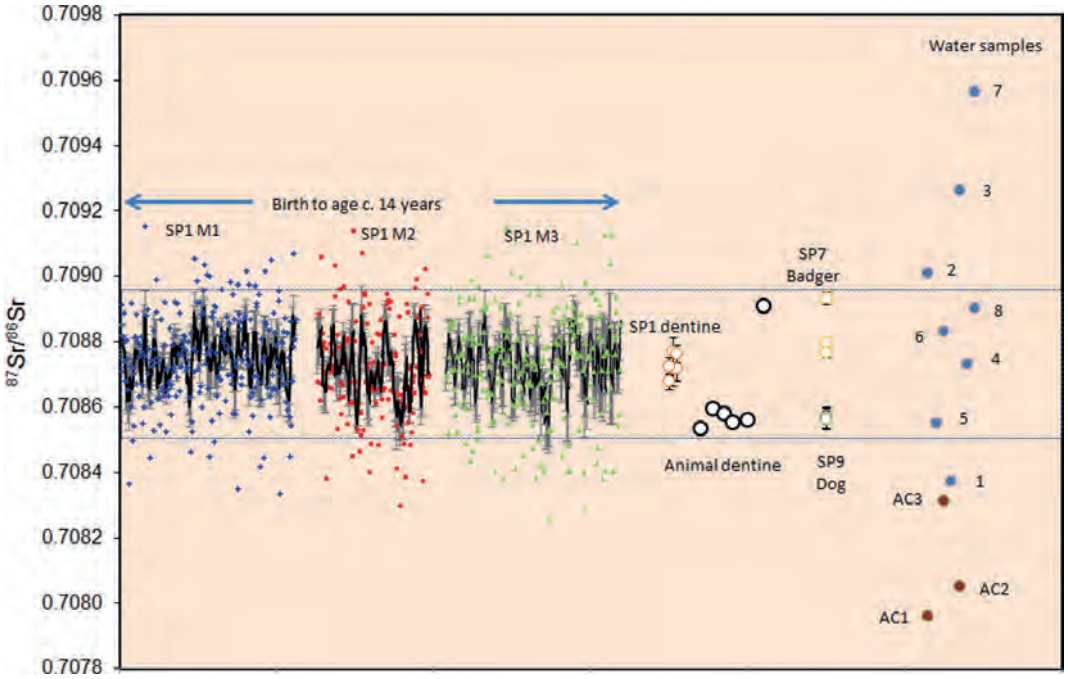


Fig. 3 Results of the Sr isotope analysis of SP1. The black lines represent the 5-point moving mean of individual isotopic measurements, with error bars representing the standard error. The broken lines represent the 'local' Sr isotopic range as defined by the dentine, badger and dog samples. Also shown are the water samples from the region (blue) and from Achaea (red) (graphics: A. W. G. Pike)

Is SP1 a Local?

The laser ablation Sr isotopes of the three molars of individual SP1 are shown in Fig. 3. The molars represent a time series of isotopes from approximately birth to around 14 years of age. There is little variation in Sr isotopic ratios within the three teeth indicating that this individual moved very little during the time of enamel formation (i.e. the first 14 years of life), or if he/she moved he/she did so to an area of similar strontium geology. The human dentine, used as a proxy for the Sr isotopes in the groundwater immediate to the site, cluster tightly around the mean values for the three tooth enamel samples. The strontium isotopic composition in human teeth, however, reflects the strontium of the whole dietary catchment with a smaller input from drinking water. A better estimate of the 'local' strontium isotopic range therefore comes from non-migratory mammals found at the site. Their foraging and scavenging behaviour is likely to sample an area or diet more representative of human subsistence behaviour, and here we use badger and dog enamel to define the local range of strontium isotopes (broken lines on Fig. 3) which gives a broader range than the human dentine. This range neatly brackets all the 5-point running mean isotopic values for the three human teeth. So notwithstanding movement to the site from an identical strontium geology later in life, our most parsimonious explanation is that the individual SP1 is local to the area of his burial. It would not have been surprising, however, if the individual had come from outside the region since Punta di Zambrone is a port with clear connections to elsewhere in the Mediterranean, for example, the pottery link to Achaea, Greece. However, the water samples (AC1–3, Fig. 3) indicate that he did not grow up in this area. The remains were also highly fragmented (a portion of a disarticulated mandible) and lacked a formal grave which may suggest an outsider and/or someone connected to the destruction of the site. However, given the Sr isotope result, and without further evidence, we must conclude at present that the individual was local and the remains represent either a grave disturbed during the Recent Bronze Age (with its contents partially re-deposited in the fortification ditch), or a burial rite that resulted in highly dispersed remains.

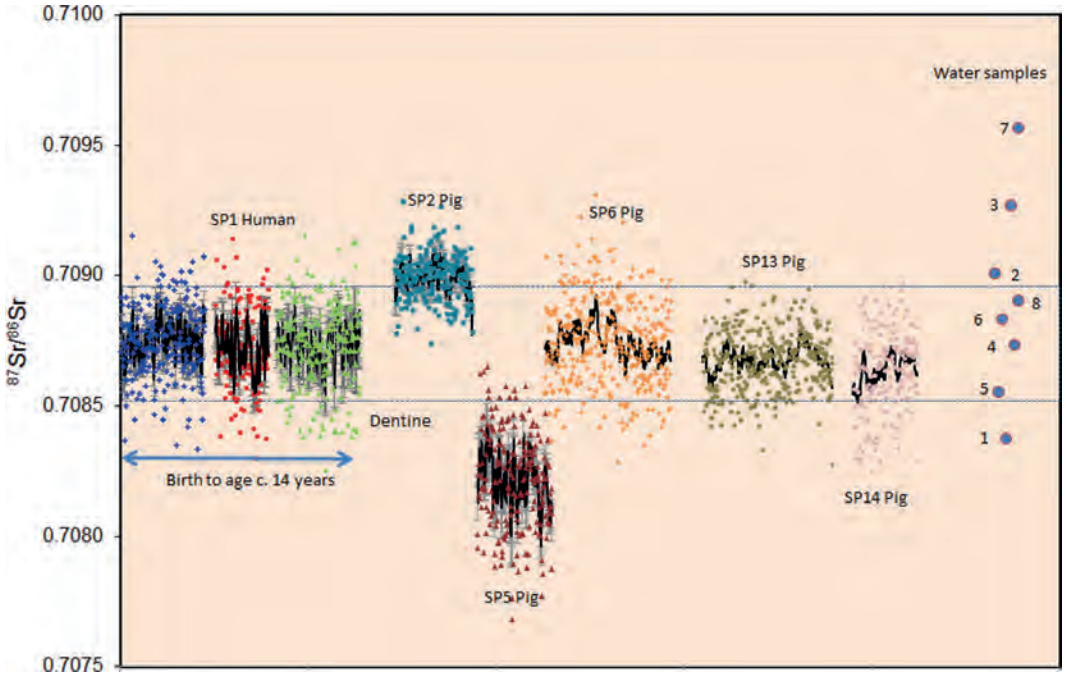


Fig. 4 Results of the Sr isotope analysis of pigs (graphics: A. W. G. Pike)

Animal Herding and Procurement

The fauna show a different pattern with some Sr values falling outside the local range, and matching to water samples taken further afield. Three of the five pigs match the local range and were probably raised within a few km of the site (Fig. 4). The other two match water samples from the Poro high plain rising to the south and southeast of Punta di Zambrone. None of them shows significant variation in Sr isotopes within the enamel, indicating that they were not moved to a different geology during enamel formation. This is not surprising as pigs can consume a wide variety of diets including human food-waste which means the provision of winter fodder or seasonal movement to fresh resources is less of an issue than for cattle.

The sheep and one bovine (SP17) show a similar pattern to the pigs (Fig. 5) with some of them consistent with a local origin, and others from the high plain. However, the horse (SP3) and the other bovine (SP12) show variation in Sr isotopes along the growth axis of the enamel indicating movement during the period when the enamel was mineralising. Both have at least one period where the isotopes are consistent with the local range for the site, though both spent the majority of the time away from the site. For the horse tooth, during its stage of mineralisation, the isotopes suggest movement between the high plain (water sample 1, Fig. 1), the local catchment (water samples WP 4, 5, 6, 8), and a third unknown location with low $^{87}Sr/^{86}Sr$.

The bovine (SP12) moves from the high plain (represented by water sample 3) to the lowland near the site, returns to the high plain, moves again to the lowland and returns again to the high plain, all within the period of mineralisation of its maxillary P3. These results ought to be interpreted in the light of comparative morphology. While carnivores and pigs are characterised by brachydont (short-crowned) teeth with rather short stages of mineralisation (less than a year), herbivores like cattle and horse, at least in parts of their dentition, show proto-hypsodont (high-crowned) teeth. In horses the duration of the mineralisation process varies between 1.5 and 3 years; for the mandibular M1 an average time of 2 years is reported, starting at the age of one month.[24] For cattle, unfortunately, no reliable data on the duration of enamel formation in

[24] Hoppe et al. 2004.

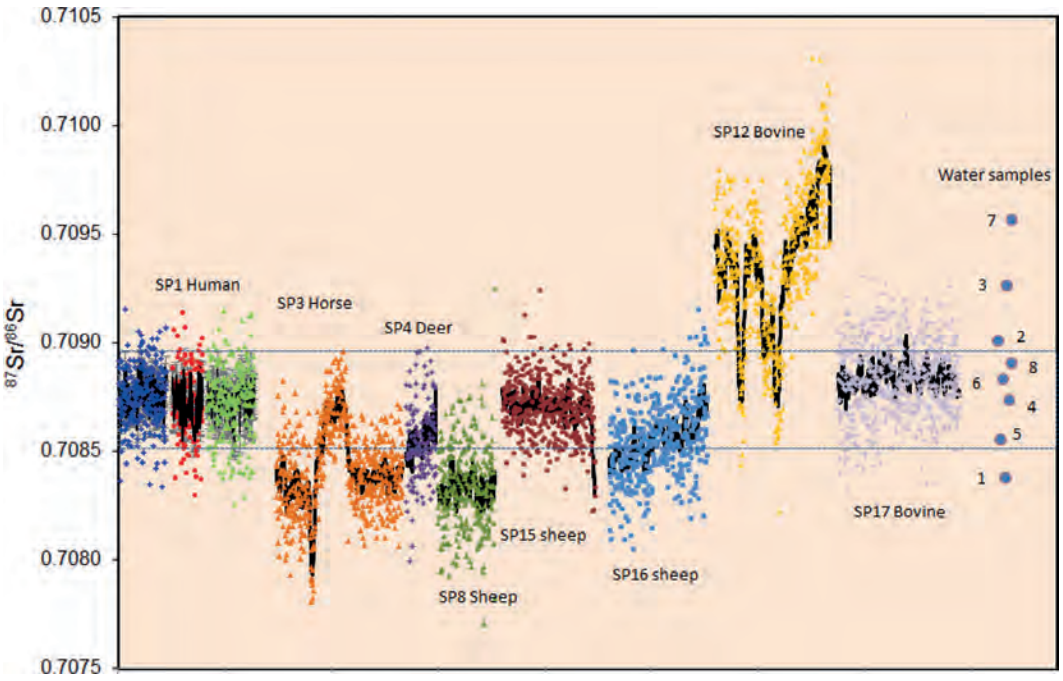


Fig. 5 Results of the Sr isotope analysis of various fauna (graphics: A. W. G. Pike)

P3 is available,[25] but the mineralisation of a maxillary P3 should not be estimated at less than 2 years.

Cattle movement can be explained in several ways. In areas of seasonal climate, transhumance is a strategy of moving cattle (and sheep) to fresh pastures, usually on a seasonal basis. This can be vertically over short distances (e.g. to Alpine pastures), or horizontal transhumance, usually over longer distances.[26] In the case of SP12 the enamel formation process presumably started at an age of 1.5 years, and lasted after its eruption at the age of 2–2.5 years for another 0.5–1 year. The discernible changes of $^{87}Sr/^{86}Sr$ most likely reflect seasonal movements in the context of transhumant herding.

The horse SP3 apparently spent the first 6–8 months of its life at the high plain, then moved to the lowland for a similar span of time and, after a short excursion somewhere else, returned to the high plain at least until the end of its 2nd year of life, which again might be related to the need to find pasture away from the main settlement.

Figure 6 shows a summary of the origins of the fauna based on the best match to the water samples. The results show that while about half of the animals have Sr isotopic ratios consistent with an origin near to Punta di Zambrone, the inland plain is also an important source of domestic fauna found at the site in both the Early and Recent Bronze Age. Without further comparative sites it is not possible to determine if this pattern was the norm for this period, or whether the specialist nature of Punta di Zambrone as a port reduced its capacity to raise animals locally so it relied on farming communities in the hinterland to provide food, either through trade, or through remote land ownership. Interestingly, however, given that Punta di Zambrone is a port, we find no evidence of animals imported from further afield. While we can never rule out distant origins that have similar Sr values, all the animals have values consistent with an origin within about 15km of the site, and the port settlement appears self-sufficient, at a regional level, in domestic animals at least. This is an important result hinting at the economic capacity of a settlement system that

[25] Brown et al. 1960, erroneously also cited by Zazzo et al. 2005, report exclusively on the mineralisation of bovine incisors.

[26] Davies 1941; Bartosiewicz – Greenfield 1999.

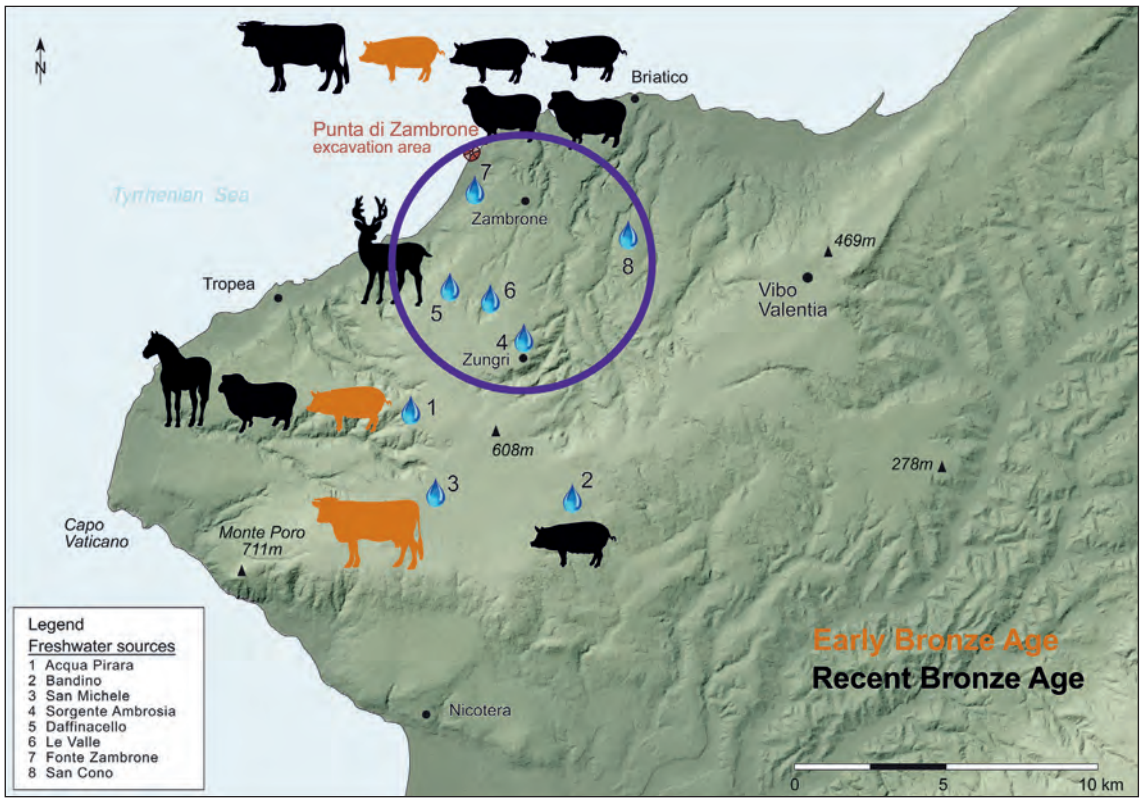


Fig. 6 Sr catchment of the fauna. The Sr isotopes of water samples 4, 5, 6 and 8 (circled) are indistinguishable from the local Sr isotopic range of the site and are considered a single Sr catchment. Water sample 7 has been excluded from the interpretation because it contradicts results from the dentine and non-migratory fauna (see text) (graphics: A. Buhlke and A. W. G. Pike)

extended from the coast up to the Poro high plain, both in EBA 2 and in the later RBA 2. It does indeed seem that settlements had complementary roles depending on their topographical position in the three different geographical zones of this system.[27]

Conclusions

This is the first high-resolution intra-tooth strontium isotope study on Italian archaeological material, and the first in the country to look at domestic animal herding and procurement strategies. Analyses of faunal Sr isotopes reveal a pattern of procurement of animals that includes local (<6km) sources as well as revealing the importance of the inland high plain (6–15km) as a region where animals were reared. Intra-tooth variation in Sr in a horse and bovid suggest movement of animals, possibly as part of a transhumance regime.

A comparison between the strontium isotopes of local non-migratory fauna (a badger and a dog) and dentine samples with the three molars from SP1 suggest the individual spent his/her childhood on similar strontium geology to that local to his burial. The simplest explanation is that he/she grew up close to the location of his/her burial, though we cannot rule out an origin with similar geology elsewhere.

[27] See above with n. 21.

Acknowledgements: The project reported in this article was supported by the Gerda Henkel Stiftung (no. AZ 04/V/13, 'Mobilität von Mensch und Tier: Zum Verständnis von Wirtschaftsweise und historischen Ereignissen in der bronzezeitlichen Hafensiedlung von Punta di Zambrone [Kalabrien]', lead by R. Jung). Two joint excavation and research projects at Punta di Zambrone received funding from the Austrian Science Fund (no. P23619-G19, project led by R. Jung) and the Italian Ministry of Education, Universities and Research (PRIN – *Progetti di Ricerca di Rilevante Interesse Nazionale*, project no. 2009MF87BM, lead by M. Pacciarelli) repectively. Alistair Pike is supported by a Royal Society Wolfson Research Merit Award.

Bibliography

AlQahtani et al. 2010
S. J. AlQahtani – M. P. Hector – H. M. Liversidge, Brief Communication: The London Atlas of Human Tooth Development and Eruption, American Journal of Physical Anthropology 142, 2010, 481–490.

Bartosiewicz – Greenfield 1999
L. Bartosiewicz – H. J. Greenfield, Transhumant Pastoralism in Southern Europe. Recent Perspectives from Archaeology, History and Ethnology (Budapest 1999).

Bentley 2006
R. A. Bentley, Strontium isotopes from the earth to the archaeological skeleton. A review, Journal of Archaeological Method and Theory, 13, 3, 2006, 135–187.

Bentley – Knipper 2005
R. A. Bentley – C. Knipper, Transhumance at the early Neolithic settlement at Vaihingen (Germany), Antiquity 306, 2005, 1–3.

Bentley et al. 2004
R. A. Bentley – T. D. Price – E. Stephan, Determining the 'local' 87Sr/86Sr range for archaeological skeletons. A case study from Neolithic Europe, Journal of Archaeological Science 31, 2004, 365–375.

Brown et al. 1960
W. A. B. Brown – P. V. Christofferson – M. Massler – M. B. Weiss, Postnatal tooth development in cattle, American Journal of Veterinary Research 21, 1960, 7–34.

Davies 1941
E. Davies, The patterns of transhumance in Europe, Geography 26, 1941, 155–168.

De Jong 2013
H. N. De Jong, A Strontium Isotope Perspective on Subsistence Through Intra-tooth and Inter-site Variation by LA-MC-ICP-MS and TIMS (PhD Diss., University of Bristol 2013).

De Jong et al. 2010
H. De Jong – G. Foster – V. Heyd – A. W. G. Pike, Further Sr isotopic studies on the Eulau multiple graves using laser ablation ICP-MS, in: H. Meller – K. Alt (eds.), Anthropologie, Isotopie und DNA. Biografische Annäherung an namenlose vorgeschichtliche Skelette? 2. Mitteldeutscher Archäologentag vom 08. bis 10. Oktober 2009 in Halle (Saale), Tagungen des Landesmuseums für Vorgeschichte Halle 3 (Halle [Saale] 2010) 63–70.

Haak et al. 2008
W. Haak – G. Brandt – H. de Jong – C. Meyer – R. Ganslmeier – V. Heyd – C. Hawkesworth – A. Pike – H. Meller – K. Alt, Ancient DNA, Strontium isotopes and osteological analyses shed light on social and kinship organization of the Later Stone Age, Proceedings of the National Academy of Sciences of the United States of America 105, 2008, 18226–18231.

Hoppe et al. 2004
K. Hoppe – S. Stover – J. Pascoe – R. Amundson, Tooth enamel biomineralization in extant horses. Implications for isotopic microsampling, Palaeogeography, Palaeoclimatology, Palaeoecology 206, 2004, 355–365.

Jung et al. 2015
R. Jung – H. Mommsen – M. Pacciarelli, From west to west. Determining production regions of Mycenaean pottery of Punta di Zambrone (Calabria, Italy), Journal of Archaeological Science Reports 3, 2015, 455–463.

Larivière – Jennings 2009
S. Larivière – A. Jennings, Family mustelidae (weasels and relatives), in: D. Wilson – R. Mittermeier (eds.), Handbook of the Mammals of the World, 1. Carnivores (Barcelona 2009) 564–656.

Lewis et al. 2014
J. Lewis – C. D. Coath – A. W. G. Pike, An improved protocol for 87Sr/86Sr by laser ablation multi-collector inductively coupled plasma mass spectrometry using oxide reduction and a customised plasma interface, Chemical Geology 390, 2014, 173–181.

Pacciarelli 2000
M. Pacciarelli, Dal villaggio alla città. La svolta protourbana del 1000 a.C. nell'Italia tirrenica, Grandi contesti e problemi della Protostoria italiana 4 (Florence 2000).

Pellegrini et al. 2008
M. Pellegrini – R. E. Donahue – C. Chenery – J. Evans – J. Lee-Thorp – J. Montgomery – M. Mussi, Faunal migration in late-glacial central Italy. Implications for human resource exploitation, Rapid Communications in Mass Spectrometry 22, 2008, 1714–1726.

Price et al. 2004
T. D. Price – Knipper – G. Grupe – V. Smrcka, Strontium isotopes and prehistoric human migration. The Bell Beaker period in Central Europe, European Journal of Archaeology 7, 2004, 9–40.

Zazzo et al. 2005
A. Zazzo – M. Balasse – W. Patterson, High-resolution $\delta^{13}C$ intratooth profiles in bovine enamel. Implications for mineralization pattern and isotopic attenuation, Geochimica et Cosmochimica Acta 69, 14, 2005, 3631–3642.

Provenance Determination of Bronze Age Grinding Stones from Punta di Zambrone

Tatjana M. Gluhak[1] – *Christoph Schwall*[2] – *Reinhard Jung*[3] – *Marco Pacciarelli*[4]

Abstract: The present study deals with the analysis of several fragments of grinding stones from excavations at Punta di Zambrone, a coastal site in Calabria, southern Italy, as well as with survey finds in the wider region of this settlement. For all grinding stone fragments a Bronze Age dating is ascertained, or at least very probably. The fragments are made of grey, vesicular lavas which are not available in this region. For the determination of the provenance of the grinding stone fragments geochemical analyses were performed. By comparing the major and trace element composition with the geochemical data of volcanic rocks in the Mediterranean, a provenance from the Aeolian Islands can be assumed. Thus, a procurement of rocks as raw material for the production of grinding stones or the finished tools can be attested as early as the beginning of the 2nd millennium BC.

Keywords: Aeolian Islands, geochemistry, grinding stones, provenance, southern Italy, volcanic rocks

Introduction

The excavations at Punta di Zambrone,[5] a coastal site in Calabria, southern Italy, yielded stratified fragments of grinding stones made of volcanic rocks dating to the Early and Recent Bronze Age periods in this region. Grinding stones are typical grain processing tools and represent common finds in prehistoric settlements. Volcanic rocks offer excellent conditions for the grinding of grain because of their hardness and vesicular structure. This rock type is conspicuous among the finds, as volcanic rocks do not occur in the region of Punta di Zambrone. Despite the small amount of objects and the fragmentary preservation of the grinding stones, it is worth studying the finds in detail, as geochemical analyses offer the opportunity to determine the provenance of the volcanic rocks on the basis of the major and trace element compositions, which will be compared with all published and available geochemical data of the volcanic rock in the Mediterranean. Two more grinding stones from two sites (Biluscia, Torre Sant'Irene) detected in surveys[6] in the wider region of the settlement (Fig. 1), will be analysed in addition to the Punta di Zambrone finds. As no other comparable excavated Bronze Age sites in this region have been published so far,[7] the

1 tami.gluhak@gmail.com.

2 Austrian Archaeological Institute, Austrian Academy of Sciences (ÖAW), Hollandstraße 11–13, 1020 Vienna, Austria; christoph.schwall@oeaw.ac.at.

3 Austrian Archaeological Institute, Austrian Academy of Sciences (ÖAW), Hollandstraße 11–13, 1020 Vienna, Austria; reinhard.jung@oeaw.ac.at.

4 Dipartimento di Studi Umanistici, University of Naples Federico II, Via Marina 33, 80133 Naples, Italy; marco.pacciarelli@unina.it.

5 Jung et al. 2015.

6 The surveys were conducted by M. Pacciarelli, M. R. Varricchio, A. Lo Torto, C. Rombolà, F. Rombolà, F. Staropoli and the Soprintendenza Archeologica della Calabria. The results of these investigations, including the grinding stones (see catalogue below), are part of the unpublished thesis of M. R. Varricchio (cf. Varricchio 1992). We are very grateful to M. R. Varricchio for the permission to use the pictures and drawings.

7 To be sure, the Soprintendenza per i Beni Archeologici della Calabria has carried out rescue excavations in the urban area of Tropea (cf. Pacciarelli 2000, 82). Some of the resulting finds are exhibited at the Museo Diocesano at Tropea, among which, however, there are no grinding stones. Rescue excavations have also been conducted at Torre Sant'Irene, but remain unpublished up to the present day.

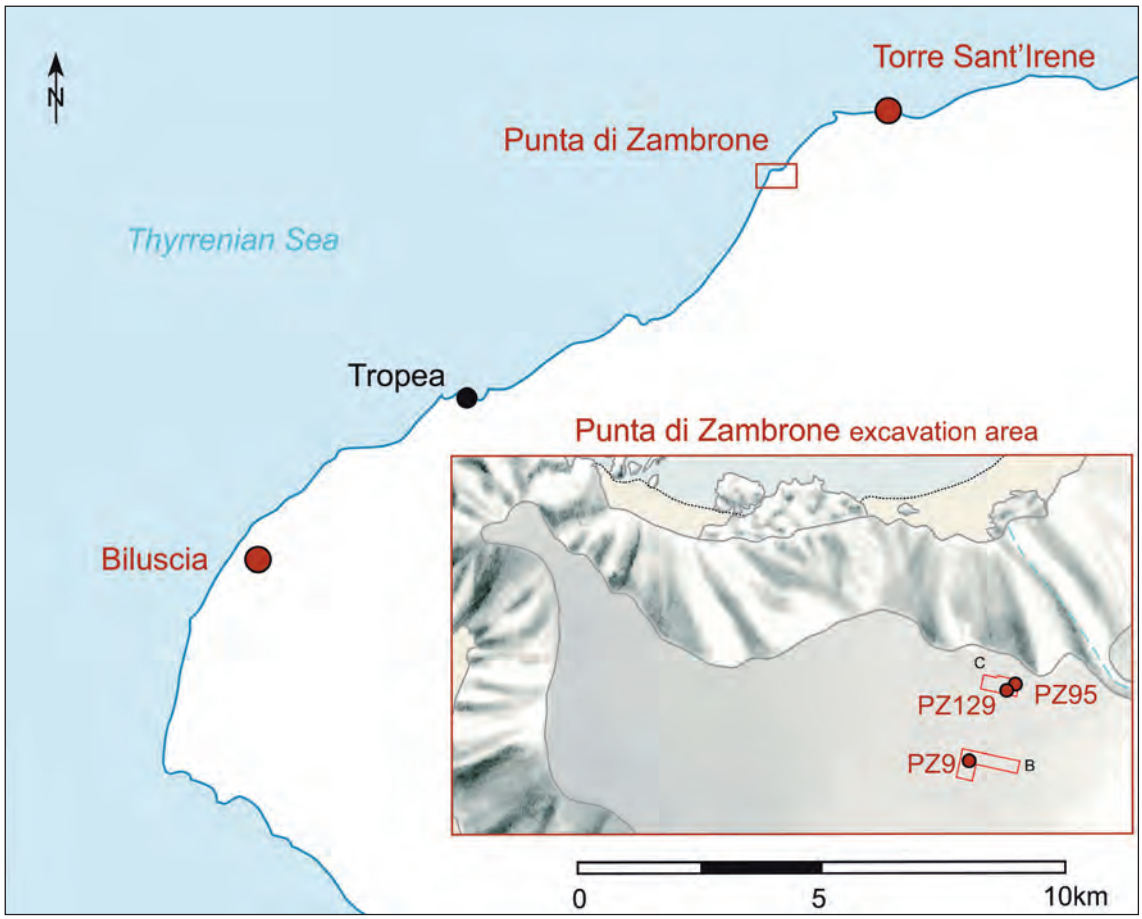


Fig. 1 Map showing the sites of the analysed grinding stones on the Poro promontory in Calabria, southern Italy (map: A. Buhlke)

survey finds, in addition to the finds of the settlement Punta di Zambrone, allow the uncovering of contacts between the entire micro region and volcanic rock sources. Although the question of whether the raw materials for the production of grinding stones or the finished stone tools were brought to the settlement remains open, the geochemical analyses of rather inconspicuous finds like grinding stones allow us to assess the targeted procurement of volcanic rocks and thus highlight regional and supra-regional connections.

Archaeological Background of the Grinding Stone

In total, five fragments of grinding stones were analysed. Three of them were found during the excavations at Punta di Zambrone (from stratigraphic units PZ9, PZ95 and PZ129; Fig. 2–3; see catalogue below: cat. nos. 1–3). The fragmentation of the finds makes an exact determination as to which part of the tool the fragment originally belonged to difficult, but cat. no. 1 from PZ9 and cat. no. 3 from PZ129 can be determined as fragments of an upper part of a grinding stone. The small sizes of cat. no. 2 (PZ95) preclude distinguishing between an upper or lower stone.[8] In general, the contexts of the objects indicate that the fragments represent deposits of ordinary waste products. The

[8] Due to the small size of fragment PZ95, which shows a preserved grinding surface, it cannot be totally excluded that it belongs to another stone tool (e.g. a pounder), even if an affiliation to an upper or lower stone of a grinding stone is most likely because of the plain grinding surface and the vesicular volcanic rock.

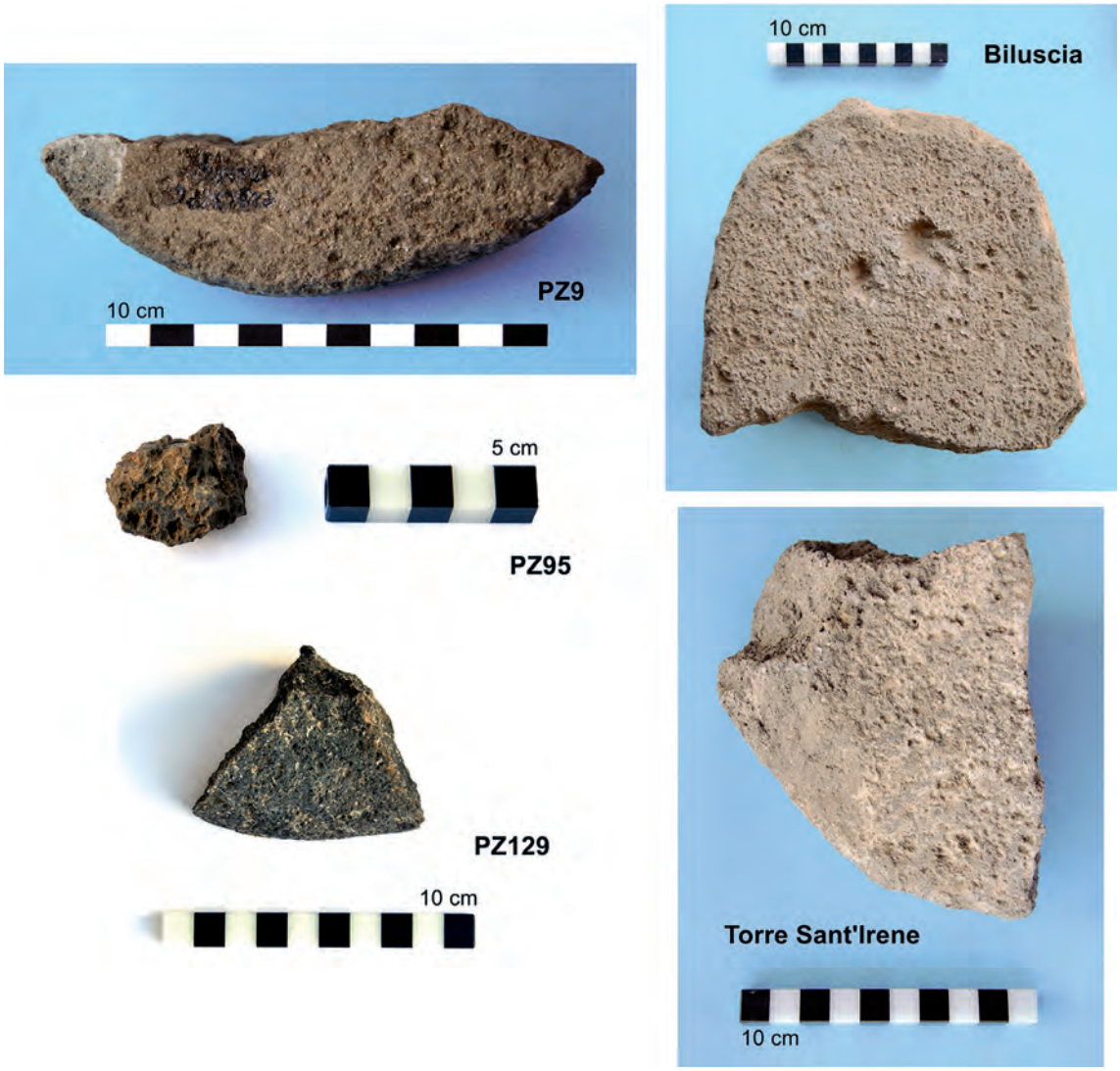


Fig. 2 Pictures of the grinding stone fragments from Punta di Zambrone, Biluscia and Torre Sant'Irene (pictures: R. Jung)

finds cat. nos. 2 (PZ95) and 3 (PZ129) seem to be related to layers of a ditch filling in Area C.[9] Cat. no. 3 (PZ129) was found in an ashy layer deposited as fill in the fortification ditch, whereas the tiny fragment PZ95 was detected in an upper level of the successive fill layers of that ditch. These are secondary deposits of material originating, with high probability, from the interior of the settlement. In the case of stratigraphic unit PZ95, the layer was disturbed by modern agricultural ploughing activities. For both objects (cat. nos. 2 and 3) a dating to Recent Bronze Age 2, around 1200 BC, is assumed.[10] Grinding stone cat. no. 1 (PZ9) was also found in a layer disturbed by modern ploughing activities in Area B above the intact Early Bronze Age 2 occupation layers.[11] Nevertheless, the consistency of the excavated finds of the uppermost layers and the lack of later Recent Bronze Age finds indicate a dating to the Early Bronze Age 2 period between 1900–1700 BC.

9 For an overview of the ditch segment in Area C see: Jung et al. 2015, 61, fig. 5.

10 For a chronological chart of the Bronze Age Period of Tyrrhenian Italy see Pacciarelli 2000, 68, fig. 38; for the absolute chronology of the successive fill layers of the Punta di Zambrone ditch see Weninger et al., this volume.

11 Note, however, that stratigraphic unit PZ9 in Area B was disturbed to a lesser extent than stratigraphic unit PZ95 in Area C.

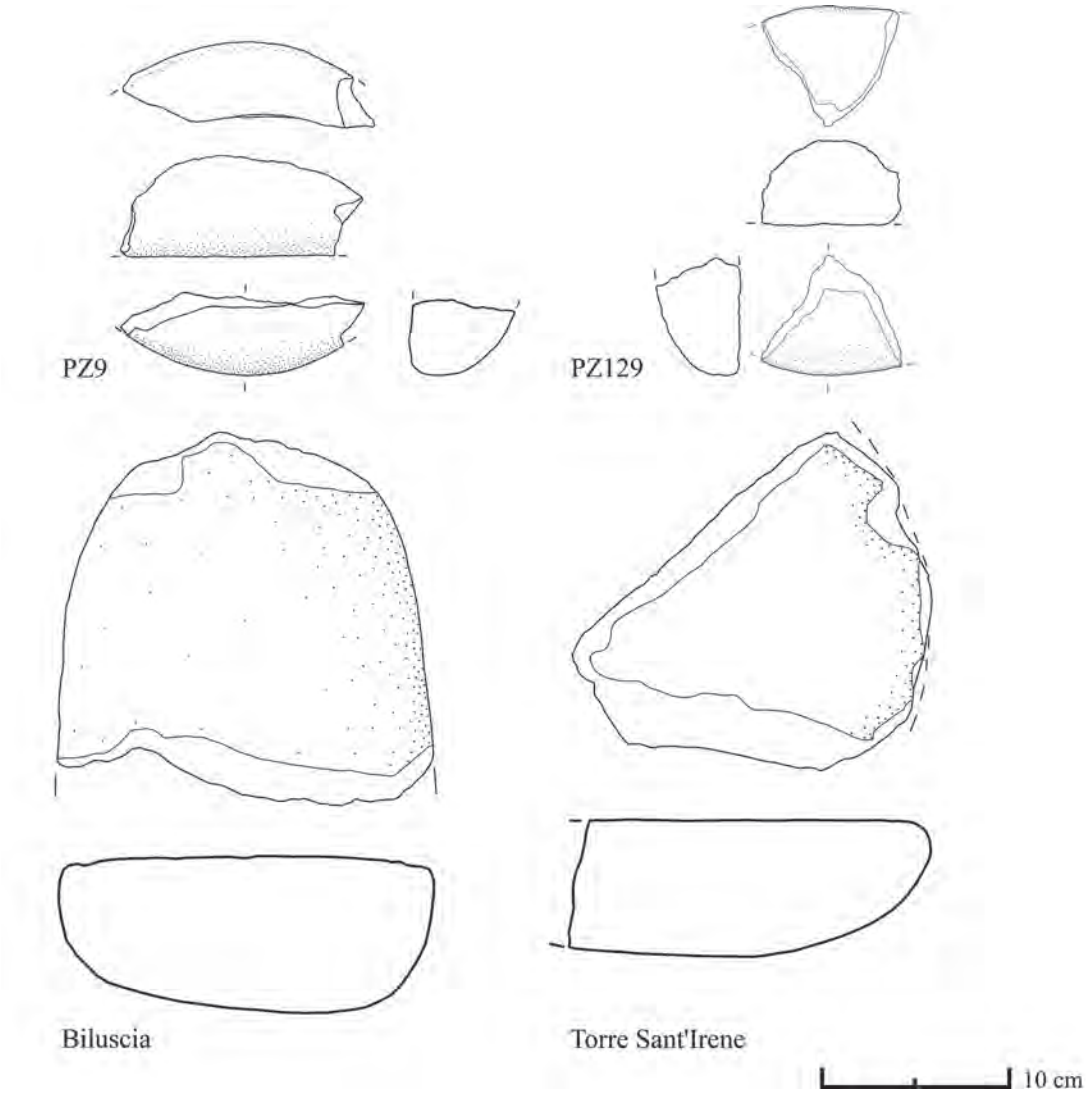


Fig. 3 Drawings of the grinding stone fragments from Punta di Zambrone (1–2), Biluscia (3) and Torre Sant'Irene (4). Scale 1:4 (drawings and design: 1–2 F. Corpaci, N. Insolvibile; 3–4 M. R. Varricchio)

Two fragments of grinding stones from two surveyed coastal sites, Biluscia and Torre Sant'Irene,[12] on the Poro promontory (Fig. 2–3) are included in the present study. Because of its elongated shape and the cross section, the object from Biluscia can be classified as an upper, mobile part of the device. The fragment from Torre Sant'Irene, however, can be determined by the size and longitudinal section as a fragment of a lower part. The finds of both sites indicate a dating particularly to Middle Bronze Age 1–2, whereby several ceramic finds indicate that the sites were already occupied in Early Bronze Age 2.[13] Moreover, in Biluscia the Recent Bronze Age period is also attested by finds.

However, despite the small number of fragments and the fact that two samples are survey finds as well as that the pieces are derived from disturbed layers, it can be assumed that the use of grinding stones made of volcanic rocks appears as early as Early Bronze Age 2 at sites situated on the coastline of the Tyrrhenian Sea.

[12] For more detailed information about the sites see Pacciarelli 2000, 74–85.
[13] Pacciarelli 2000, 77, fig. 41.

Provenance Determination

The provenance determination of volcanic rock grinding stones based on their geochemical composition is a crucial method for revealing regional and supra-regional contacts.

Method

The fragments of the grinding stones were sampled by chipping off rock pieces. Due to the small amount of sampled material, it was not possible to produce thin sections and the analyses had to be constrained to the determination of the geochemical compositions. For this purpose, the sample was cleaned in an ultrasonic bath, dried, crushed and ground to powder in an agate mill. The powder was used to produce lithium tetraborate glass beads for wavelength dispersive X-ray fluorescence (XRF) major element measurements. For analysing the trace elements by laser ablation-ICP-MS, c. 40mg of powder was melted to glass beads on an iridium-strip heater. The major element measurements were conducted in a 2002 model panalytical MagXPRO wavelength-dispersive X-ray spectrometer with a Rh-X-ray tube and a maximum excitation of 3.2kW. The trace element measurements were performed in an Agilent 7500 CE quadrupole Inductively Coupled Plasma Mass Spectrometry (ICP-MS) system, coupled with an ESI New Wave Research NWR193 (ArF-excimer) laser ablation system with 193nm wavelength. Three spots, each with a diameter of 100µm were measured on every glass bead using a pulse-rate of 10Hz and laser energy densities of 6J/cm². The carrier gas was Argon. ^{29}Si served as the internal standard, its values being taken from the XRF measurements. NIST SRM 610, 612 and MPI-DING KL2G were taken as reference materials. The USGS-BCR-2G was measured for quality control purposes. The values of the reference materials were taken from the GeoReM Database published 'preferred values'.[14] The measured values are compiled in Tab. 1.

	PZ9 (Cat. no. 1)	**PZ95 (Cat. no. 2)**	**PZ129 (Cat. no. 3)**	**Biluscia (Cat. no. 4)**	**Torre Sant'Irene (Cat. no. 5)**
SiO_2 (wt%)	55.31	54.93	52.60	52.87	53.34
Al_2O_3	18.41	16.88	17.77	18.49	18.45
Fe_2O_3(t)	8.68	9.11	8.04	9.70	7.50
MnO	0.16	0.16	0.15	0.17	0.15
MgO	3.11	4.43	5.18	4.48	4.24
CaO	8.41	9.17	9.76	10.05	9.09
Na_2O	2.93	2.14	2.54	2.26	2.63
K_2O	1.96	2.20	2.77	1.08	3.34
TiO_2	0.76	0.72	0.83	0.71	0.80
P_2O_5	0.26	0.26	0.35	0.18	0.45
LOI	0.24	0.44	0.06	0.72	0.35
Sc (ppm)	25.00	25.58	23.89	37.26	24.51
V	277.70	230.59	235.92	300.59	232.62
Cr	4.56	13.81	26.60	12.18	35.91
Co	20.32	17.96	18.96	26.28	24.21
Ni	6.43	10.95	19.76	12.49	23.43
Cu	67.19	60.88	41.68	93.21	23.69

[14] Online <http://georem.mpch-mainz.gwdg.de/> (last accessed 23 March 2020).

	PZ9 (Cat. no. 1)	PZ95 (Cat. no. 2)	PZ129 (Cat. no. 3)	Biluscia (Cat. no. 4)	Torre Sant'Irene (Cat. no. 5)
Ga	17.68	16.37	15.48	16.76	16.20
Rb	54.03	73.63	123.90	28.74	99.19
Sr	669.57	782.99	569.62	644.99	776.61
Y	27.75	16.04	23.62	20.31	26.75
Zr	85.99	99.07	176.67	57.42	185.57
Nb	6.56	6.96	21.24	3.91	24.09
Ba	501.34	576.17	1174.33	419.28	1176.89
La	22.28	23.82	41.19	16.65	44.17
Ce	41.65	46.31	80.82	30.61	86.14
Pr	4.84	5.32	9.12	3.81	9.70
Nd	19.61	21.10	34.73	16.15	36.96
Sm	4.23	4.05	6.52	3.62	7.04
Eu	1.18	1.18	1.62	1.05	1.70
Gd	3.76	3.42	5.78	3.32	5.68
Tb	0.52	0.53	0.78	0.48	0.75
Dy	3.23	2.96	4.51	2.95	4.48
Ho	0.65	0.53	0.85	0.58	0.82
Er	1.96	1.69	2.36	1.78	2.44
Tm	0.29	0.21	0.32	0.25	0.32
Yb	1.95	1.53	2.23	1.61	2.19
Lu	0.29	0.25	0.34	0.24	0.34
Hf	2.34	2.44	4.25	1.57	4.34
Ta	0.37	0.39	1.15	0.19	1.24
Th	5.80	6.81	18.63	3.73	19.78
U	1.94	1.85	4.56	0.93	4.91

Tab. 1 Major (LOI-free) and trace element composition of the analysed grinding stone fragments

Results

The provenance determination is based on the procedure of Gluhak – Schwall 2015. All fragments of grinding stones are grey, vesicular volcanic rocks. The volcanic rocks are classified using the 'total alkali silica' (TAS) diagram by their SiO_2 content and the sum of Na_2O and K_2O (Fig. 4). Three grinding stone fragments (PZ9, PZ95, Biluscia) plot in the field of basaltic andesites (field 'E'), the remaining two (PZ129, Torre Sant'Irene) in the field of trachyandesites (field 'B'). In accordance with the Na_2O/K_2O ratios, both can be classified as shoshonites ($Na_2O - 2 \leq K_2O$). The TAS diagram already shows that for the basaltic andesites PZ9, PZ95 and Biluscia a provenance from only the Aeolian Islands, Sardinia or the Hyblean Mountains on Sicily can be assumed. The plotting of both shoshonites within the TAS diagram indicates a provenance from the Aeolian Islands or the island of Ustica (Fig. 4). The Na_2O/K_2O ratios in figure 5 clearly demonstrate that for the grinding stones only a provenance from the Aeolian Islands and Sardinia is possible. Only the fragment from Biluscia could show chemical similarities to lava from the Hyblean Mountains. The comparison of the TiO_2 content of the grinding stones with the values of the Hyblean Mountains (Fig. 6) shows that the Sicilian rock sources of the Hyblean Mountains and Mount Etna have

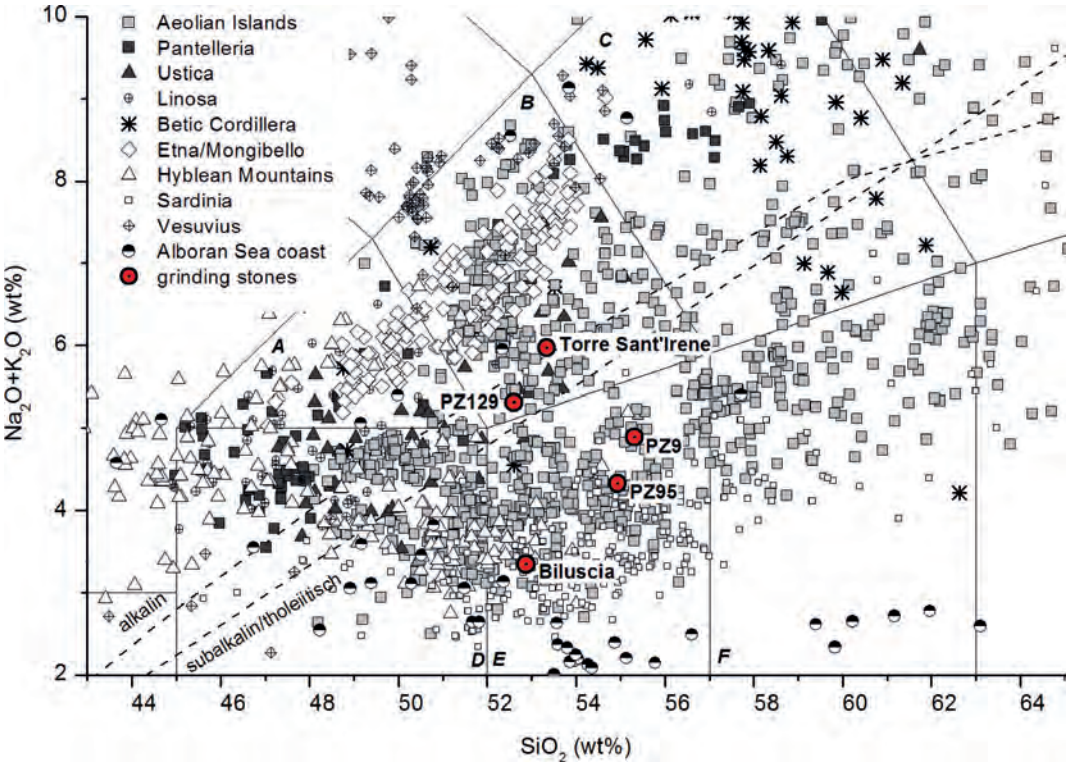


Fig. 4 Classification of the grinding stones in the TAS-diagram. Data for comparison from the Aeolian Islands, Pantelleria, Ustica, Linosa, Betic cordillera, Mount Etna/Mongibello, the Hyblean Mounts, Sardinia, Vesuv and the Alboran Sea compiled from GEOROC. For references see Gluhak – Schwall 2015 (graphics: T. M. Gluhak and Ch. Schwall)

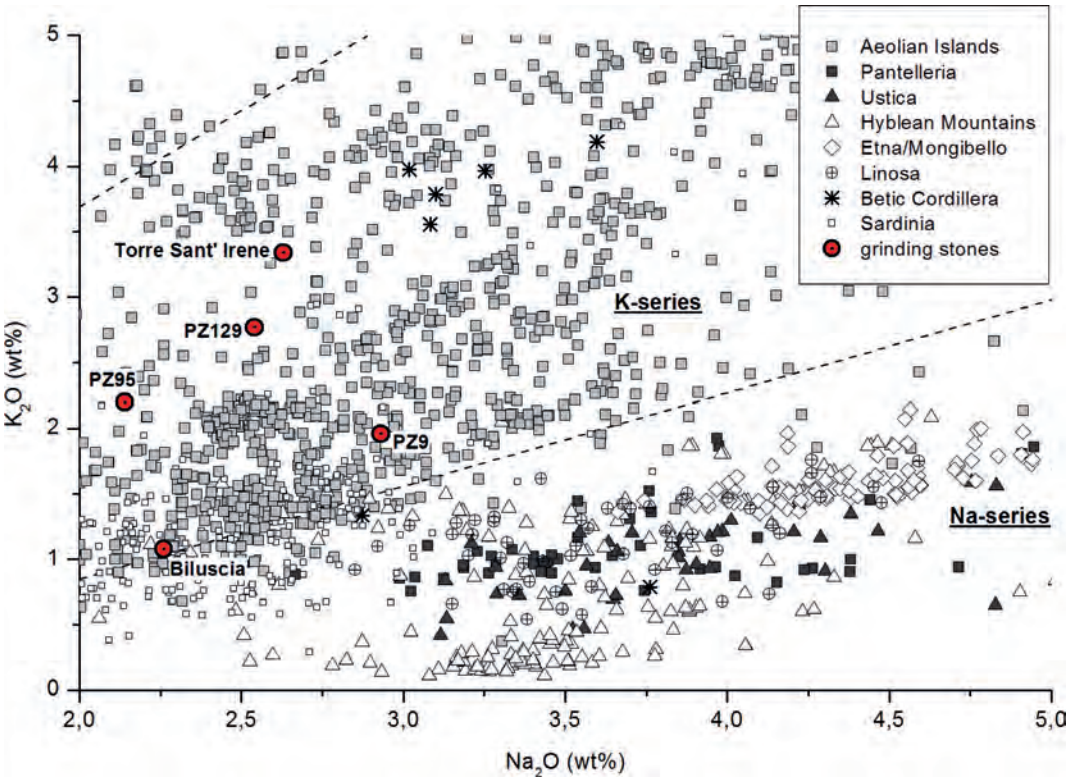


Fig. 5 Na_2O/K_2O diagram of the grinding stones in comparison to the Hyblean Mounts, the Aeolian Islands, Betic Cordillera, Ustica, Pantelleria, Linosa, Sardinia and Mount Etna/Mongibello. For references see Gluhak – Schwall 2015 (graphics: T. M. Gluhak and Ch. Schwall)

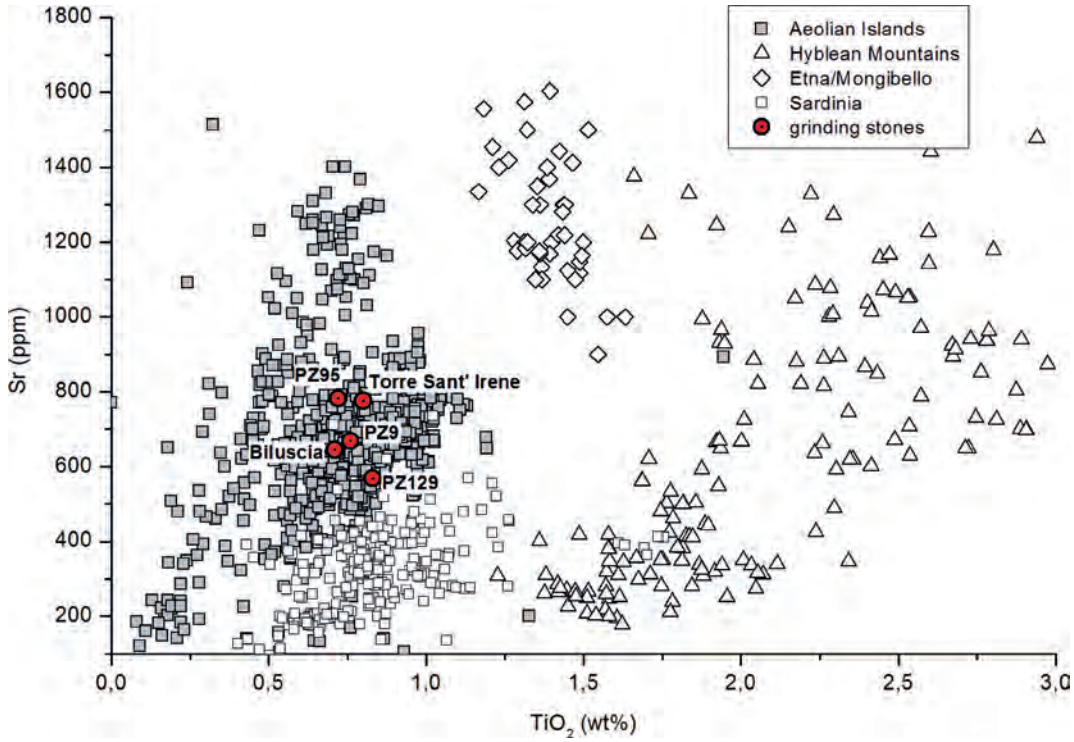


Fig. 6 TiO_2 and Sr content of the grinding stones in comparison to the Aeolian Islands, the Hyblean Mounts, Mount Etna/Mongibello and Sardinia. For references see Gluhak – Schwall 2015 (graphics: T. M. Gluhak and Ch. Schwall)

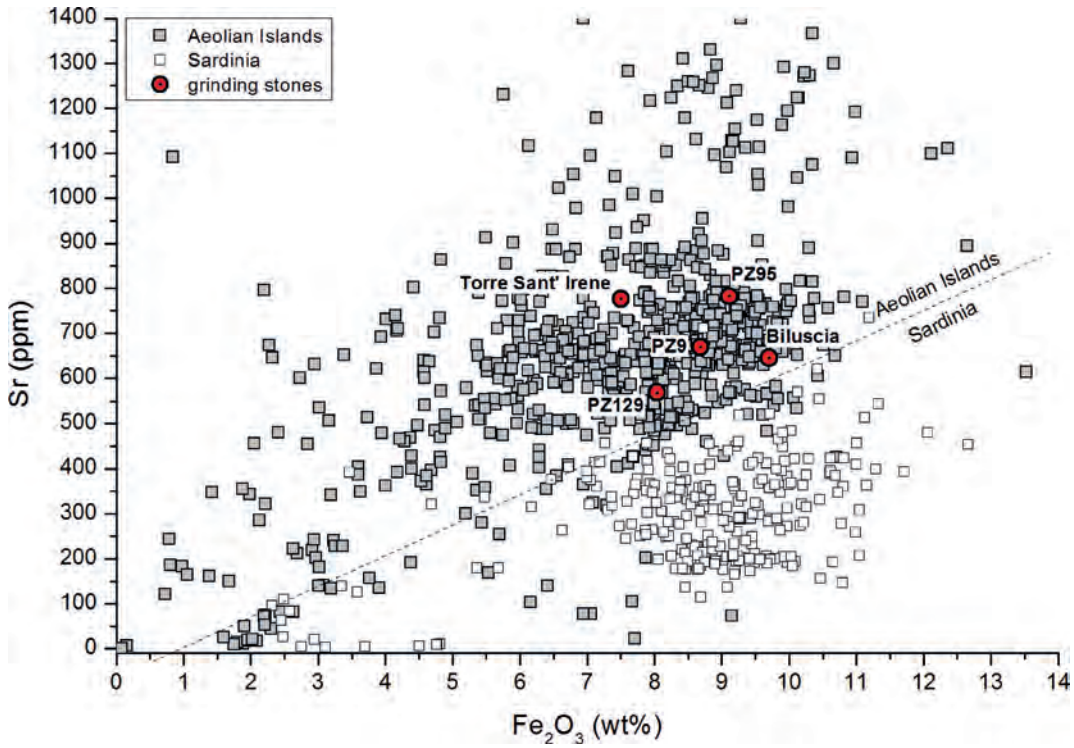


Fig. 7 Fe_2O_3 and Sr content of the grinding stones in comparison to the Aeolian Islands and Sardinia. For references see Gluhak – Schwall 2015 (graphics: T. M. Gluhak and Ch. Schwall)

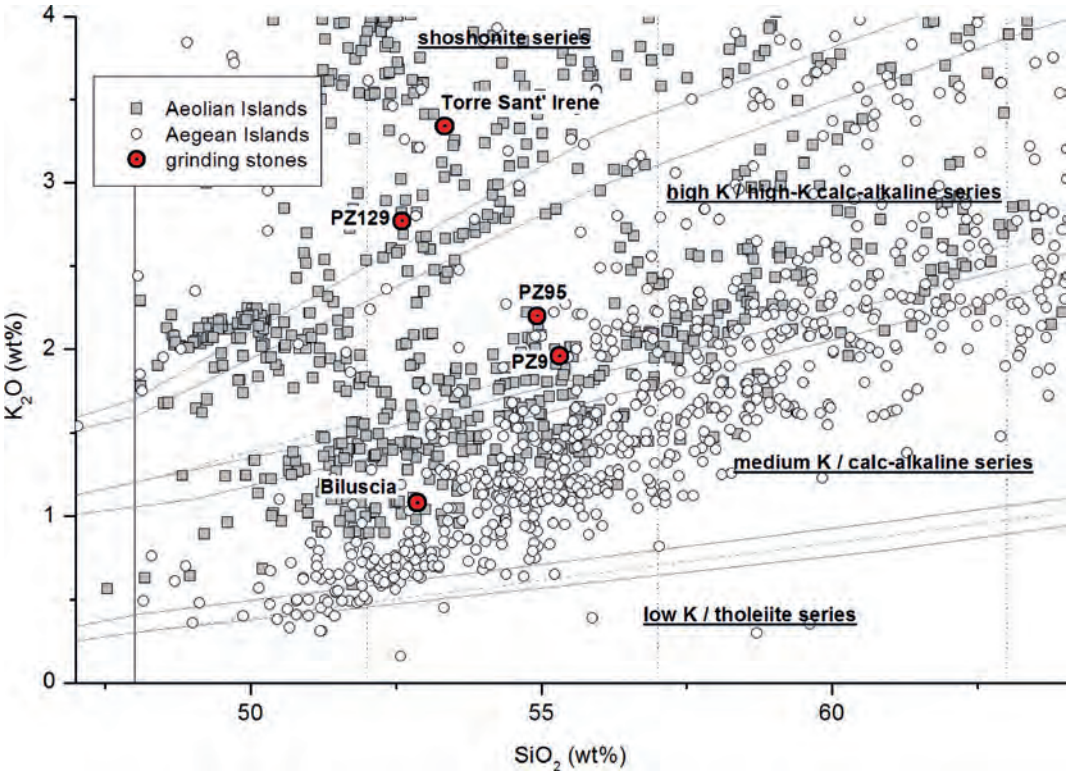


Fig. 8 Comparison of SiO_2/K_2O ratio of the subduction-related rock grinding stones to rocks from the Aeolian and Aegean islands. For references for Aegean and Aeolian rocks see Gluhak – Schwall 2015 (graphics: T. M. Gluhak and Ch. Schwall)

significantly higher titanium values than the analysed grinding stones. Already, figure 6 strongly suggests a provenance from the Aeolian Islands. However, a provenance from Sardinia can be finally excluded based on the Fe_2O_3 and Sr content (Fig. 7).

Gluhak and Schwall describe the problem that the volcanic rocks from the Aeolian Islands cannot be clearly discriminated from the volcanic rocks from the Aegean Islands based on their major and trace element compositions.[15] As an example, the SiO_2/K_2O content of volcanic rocks from the Aeolian and Aegean Islands is shown in Figure 8. Although the rocks of the Aeolian Islands show a trend of a higher K_2O content than the Aegean Islands, the rocks show a large overlap in their composition, which is also true for the other geochemical components. Nevertheless, the fragments of the grinding stones analysed in the present study have K_2O contents which plot in an area dominated by the Aeolian Islands, particularly shown by PZ129 and the fragment from Torre Sant'Irene.

The comparison of the geochemical composition of the fragments with data from volcanic rocks from the Mediterranean region demonstrates that a provenance from the Aeolian Islands can be assumed without much doubt. However, due to the geochemical similarities of the volcanic rocks from the Aeolian Islands, an affiliation to a particular island is not possible.[16]

Discussion of the Provenance Determination

As the grinding stones were in all likelihood derived from the Aeolian Islands, contacts must have existed probably as early as Early Bronze Age 2 and can also be attested for the later Recent

15 Gluhak – Schwall 2015.
16 Gluhak – Schwall 2015.

Bronze Age.[17] Although it is not clear whether the raw material for the production of the devices was imported or the finished grinding stones, the volcanic rocks of the grinding stones show clear contacts between the coastal region of the Poro promontory and the Aeolian Islands.

In general, grinding stones are common devices of everyday activities, which can be expected in prehistoric settlements. Excavations of Early to Recent Bronze Age settlements on the Aeolian Islands show that these devices made of volcanic rocks are attested at several sites. Grinding stones dated to the Middle and Recent Bronze Age periods are known from the acropolis of Lipari[18] on the homonymous island. Middle Bronze Age grinding stones were also found at Milazzese on Panarea[19], Portella on Salina[20], San Vincenzo on Stromboli[21] and Capo Graziano[22] on Filicudi. Furthermore, some grinding stones from Milazzese on Panarea indicate an even earlier date. Two objects were associated with finds dating between the late Aeneolithic and the initial Early Bronze Age Period.[23] Additionally, grinding stones are also recorded from Milazzo, a site on a peninsula situated in the northeast of Sicily. Early Bronze Age objects are mentioned from hut 3 in the excavation area 'Viale dei Cipressi'.[24] Additionally, finds are recorded from the 'Piazza XXV Aprile' dating to the late Early Bronze Age 2 and the beginning of the Middle Bronze Age.[25] In total, 11 objects made of volcanic rocks, including six fragments of grinding stones (MIL3–5, 8–10), one fragment of a mortar (MIL1) and a possible pestle (MIL6), found at the 'Piazza XXV Aprile' have recently been geochemically analysed by wavelength-dispersive XRF.[26] It turned out that the rocks of two grinding stones (MIL3–4) and the possible pestle (MIL6) come from the Aeolian Islands. Only the provenance of the mortar (MIL1) can be assigned to Sicilian rock sources from Mt. Etna. The raw material of one grinding stone (MIL9) is interpreted as procured from the Aegean region, probably from the island of Santorini. This provenance determination is problematic regarding the already discussed difficulties in differentiating clearly between the Aeolian and Aegean volcanic rock sources, especially based on the geochemical data presented.[27]

A further comparable study to determine the provenance of Bronze Age volcanic rock grinding stones was conducted for Apulian finds dating between the 19th and 10th centuries BC.[28] In total, 23 grinding stones from 10 sites, located along the Adriatic and Ionic coast as well as in the region between Apulia and Basilicata, were analysed.[29] The investigations have revealed that the volcanic rocks were procured entirely from the closest volcanic rock sources at Mount Vulture in northern Basilicata.[30] Despite being coastal sites, the procurement of raw materials for grinding stones was obviously restricted to the mainland volcanic rock sources. Nevertheless, the raw material for the grinding stones was transported over long distances, whether travelling over land or using waterways.[31]

---

17 For the following comparisons of different sites on the Aeolian Islands and on Sicily the overall Italian chronological system is used.

18 Capo Graziano 2 *facies* (cultural group) (Bernabò Brea – Cavalier 1980, pl. 139.1); Milazzese *facies* (Bernabò Brea – Cavalier 1980, pl. 190.1–2, 6, 9–10); Ausonian I *facies* (Bernabò Brea – Cavalier 1980, pl. 217.1).

19 Milazzese *facies* (Bernabò Brea – Cavalier 1968, pl. 62.3–17).

20 Milazzese *facies* (Martinelli 2010, 149–150, 159, fig. 82.5; 160, fig. 83.5).

21 Pers. communication S. Levi.

22 Milazzese *facies* (Bernabò Brea – Cavalier 1980, 179–180, pl. 106.6–8). Stone tools, named 'macinelli' (Martinelli et al. 2010, 293), are also recorded from Filo Braccio on Filicudi dating to Early Bronze Age 1 (Capo Graziano 1 *facies*). However, there is no information about the rock type and it is unclear whether these tools are grinding stones or not.

23 Aeneolithic to Capo Graziano 1 *facies* (Bernabò Brea – Cavalier 1968, 43, fig. 22).

24 Capo Graziano 1 *facies* (Levi et al. 2009, 36; pers. communication S. Levi).

25 Facies Messina-Ricadi (Martinelli 2009, 182, cat. no. 20–21; Di Bella et al. 2018).

26 Di Bella et al. 2018, tab. 1.

27 Cf. Gluhak – Schwall 2015, 260, 262–264, fig. 12–13.

28 Lorenzoni et al. 2000.

29 Lorenzoni et al. 2000, 877–879, fig. 1.

30 Lorenzoni et al. 2000, 881.

31 The example given by Lorenzoni et al. (2000, 881) concerning the Middle Bronze Age grinding stones of the western Sicilian settlement Monte Castellazzo di Poggioreale (phase A) has to be excluded. The stones were taken as

In the present case of the grinding stones from the coastal region of the Poro promontory, procurement of volcanic rocks from the Aeolian Islands by water transport was apparently easier than procurement from sources on the southern Italian mainland. As already shown by the distribution of ceramics, contacts between Calabria and the Aeolian Islands can be assumed from as early as the beginning of the 2nd millennium BC.[32] Thus, the analysed fragments of grinding stones provide an important contribution to highlighting contacts of the Bronze Age coastal regions of the Tyrrhenian Sea in southern Italy and, moreover, indicate maritime connectivity, which can be traced presumably as early as the Early Bronze Age 2 phase at the beginning of the 2nd millennium BC.

Catalogue of Finds

Cat. no. 1: find no. **PZ9**/P4 (Fig. 2–3)
Area: B
Square: G3
Description: fragment of an upper part of a grinding stone (form 2 according to Zimmermann 1988, 725); oval shape reconstructable; plano-convex longitudinal section and cross section; abrasion marks on the grinding surface
Measurements: length (max. preserved) 12.5cm; width (max. preserved) 4.5cm; height (max. preserved) 5.2cm
Material: basaltic andesite
Coordinates: East: 2604694.852m; North: 4285478.634m; height asl: 37.371m.
Stratigraphical context: EBA 2 settlement level, partly disturbed by 20th century AD ploughing.

Cat. no. 2: find no. **PZ95**DD12-13/15 (Fig. 2)
Area: C
Squares: DD12–13
Description: fragment of a grinding surface with abrasion marks; not distinguishable if grinding stone (upper or lower part) or part of another stone tool (e.g. pounder); the vesicular structure of the rock indicates use as a grinding stone
Material: basaltic andesite
Measurements: length (max.) 3.4cm; width (max.) 1.8cm
Coordinates: ---
Stratigraphical context: RBA 2 ashy fill of the fortification ditch, severely disturbed by 20th century AD ploughing.

Cat. no. 3: find no. **PZ129**/P62/3 (Fig. 2)
Area: C
Squares: CC10–11
Description: fragment of an upper part of a grinding stone (form 2 according to Zimmermann 1988, 725); shape not reconstructable, possibly oval?; plano-convex longitudinal section and cross section; abrasion marks on the grinding surface

evidence for a long distance procurement system of volcanic rocks from the eastern sources of Mount Etna and the Hyblean Mountains based on the analyses of Ferla et al. 1984. However, no grinding stone dating to the Bronze Age period of Monte Castellazzo di Poggioreale was analysed in this petrographical and geochemically study (cf. Ferla et al. 1984, 28, tab. 1 in comparison to 38, tab. 2). Moreover, a procurement of volcanic rock grinding stones from eastern Sicily is not assumed before the end of the 7th century BC (cf. Ferla et al. 1984, 45; Spatafora 1993, 169).

[32] For the distribution of the Cessaniti pottery see Pacciarelli 2000, 27. – Earlier contacts dating to the Final Neolithic in the 5th millennium BC are attested by the distribution of the Diana *facies* on both, the Aeolian Islands and the Poro promontory (Pacciarelli 2011, 265–266, 285–286).

Material: trachyandesite
Measurements: length (max. preserved) 7.4cm; width (max. preserved) 6.4cm; height (max. preserved) 4.4cm
Coordinates: East: 2604707.540m; North: 4285499.569m; height asl: 36.741m.
Stratigraphical context: RBA 2 ashy fill of the fortification ditch.

Cat. no. 4: Biluscia (Varricchio 1992, cat. no. 2 / Fig. 2–3)
Area: A
Description: fragment of an upper part of a grinding stone (form 2 according to Zimmermann 1988, 725); elongated oval shape reconstructable; plano-convex longitudinal section and cross section; slightly convex-shaped grinding surface with abrasion marks
Material: basaltic andesite
Measurements: length (max. preserved) 19.3cm; width (max. preserved) 19.4cm; height (max. preserved) 8.0cm
Stratigraphical context: surface find of a site dating to EBA 2, MBA 1/2 and RBA.

Cat. no. 5: Torre Sant'Irene (Varricchio 1992, cat. no. 21 / Fig. 2–3)
Area: C
Description: fragment of a lower part of a grinding stone (presumably form 2 according to Zimmermann 1988, 725); presumably oval shape reconstructable; concave-convex longitudinal section; plan-convex cross section; abrasion marks on the grinding surface
Material: trachyandesite
Measurements: length (max. preserved) 18.7cm; width (max. preserved) 17.5cm; height (max. preserved) 7.8cm
Stratigraphical context: surface find of a site dating to EBA 2 and MBA 1/2

Bibliography

Bernabò Brea – Cavalier 1968
L. Bernabò Brea – M. Cavalier, Meligunìs Lipára III. Stazioni preistoriche delle isole Panarea, Salina e Stromboli (Palermo 1968).

Bernabò Brea – Cavalier 1980
L. Bernabò Brea – M. Cavalier, Meligunìs Lipára IV. L'acropoli di Lipari nella preistoria (Palermo 1980).

Bernabò Brea – Cavalier 1991
L. Bernabò Brea – M. Cavalier, Meligunìs Lipára VI. Filicudi insediamenti dell'éta del Bronzo (Palermo 1991).

Di Bella et al. 2018
M. Di Bella – F. Italiano – M. C. Martinelli – P. Mazzoleni – S. Quartieri – G. Tigano – A. Tripodo – G. Sabatino, Archaeometric characterization of prehistoric grindstones from Milazzo Bronze Age settlement (Sicily, Italy), Archaeological and Anthropological Sciences 10, 2018, 1571–1583. doi:10.1007/s12520-017-0483-8

Ferla et al. 1984
P. Ferla – R. Alaimo – G. Falsone – F. Spatafora, Studio petrografico delle macine di età arcaica e classica da Monte Castellazzo di Poggioreale (Sicilia occidentale), Sicilia Archeologica 56, 1984, 25–52.

Gluhak – Schwall 2015
T. M. Gluhak – Ch. Schwall, Provenance analyses of the volcanic rock grinding stones from the Greek colony Selinunte, Sicily (Italy). Constraints and possibilities, Archaeometry 57, 2, 2015, 246–268.

Jung et al. 2015
R. Jung – M. Pacciarelli – B. Zach – M. Klee – U. Thanheiser, Punta di Zambrone (Calabria) – a Bronze Age harbour site. First preliminary report on the Recent Bronze Age (2011–2012 campaigns), Archaeologia Austriaca 99, 2015, 53–110.

Levi et al. 2009
S. T. Levi – B. Prosdocimi – G. Tigano – A. Vanzetti, Il villaggio protostorico di Viale dei Cipressi e la facies Capo Graziano, in: G. Tigano (eds.), Mylai II. Scavi e ricerche nell'area urbana (1996–2005) (Messina 2009) 23–136.

Lorenzoni et al. 2000
S. Lorenzoni – M. Pallara – E. Zanettin, Volcanic rock Bronze Age millstones of Apulia, southern Italy. Lithology and provenance, European Journal of Mineralogy 12, 2000, 877–882.

Martinelli 2009
M. C. Martinelli, L'insediamento specializzato in Piazza XXV Aprile a Milazzo (ME), in: G. Tigano (ed.), Mylai II. Scavi e ricerche nell'area urbana (1996–2005) (Messina 2009) 175–186.

Martinelli 2010
M. C. Martinelli, Archeologia delle Isole Eolie. Il villaggio dell'età del Bronzo Medio di Portella a Salina. Ricerche 2006 e 2008. In omaggio a Luigi Bernabò Brea nel centenario della nascita (Milazzo 2010).

Martinelli et al. 2010
M. C. Martinelli – G. Fiorentino – B. Prosdocimi – C. d'Oronzo – S. T. Levi – G. Mangano – A. Stellati – B. Wolff, Nuove ricerche nell'insediamento sull'istmo di Filo Braccio a Filicudi. Nota preliminare sugli scavi 2009, Origini 32 Nuova Serie IV, 2010, 285–314.

Pacciarelli 2000
M. Pacciarelli, Dal villaggio alla città. La svolta protourbana del 1000 a.C. nell'Italia tirrenica, Grandi contesti e problem della Protostoria italiana 4 (Florence 2000).

Pacciarelli 2011
M. Pacciarelli, L'Eneolitico della Calabria tirrenica. Nuovi dati sull'articolazione cronoculturale, Origini 33 Nuova Serie V, 2011, 249–302.

Spatafora 1993
F. Spatafora, Un gruppo di macine da Monte Castellazzo di Poggioreale, in: Studi sulla Sicilia Occidentale in onore di Vincenzo Tusa (Padua 1993) 165–171.

Varricchio 1992
M. R. Varricchio, L'età del bronzo medio e recente nel Promontorio di Tropea (Tesi di laurea in Lettre, La Sapienza University Rome, Rome 1992).

Zimmermann 1988
A. Zimmermann, Die Funde. Steine, in: U. Boelicke – D. v. Brandt – J. Lüning – P. Stehli – A. Zimmermann (eds.), Der bandkeramische Siedlungsplatz Langeweiler 8. Gemeinde Aldenhoven, Kreis Düren, Beiträge zur Neolithischen Besiedlung der Aldenhovener Platte III.2, Rheinische Ausgrabungen 28 (Cologne 1988) 569–787.

The Impasto Pottery of Punta di Zambrone (Vibo Valentia, Calabria): Production, Use, Function and Exchanges within the South-Italian Recent Bronze Age Scenario

Pamela Fragnoli[1]

Abstract: The *impasto* pottery found in the Recent Bronze Age levels of Punta di Zambrone (Vibo Valentia) is investigated by combining macroscopic and petrographic analyses. Structural remains of clay architecture, baking plates, cooking stands and pottery wasters are considered for comparison and as local reference material. This integrated approach allows for a wide perspective embracing various steps of the *chaîne opératoire*. Clear differences in the supply, paste preparation, finishing and firing procedures have been recognised between open and closed shapes, due to functional aspects and distinct manufacturing traditions. Open shapes with simple profiles could be used in connection with fire, as in the case of a vegetal-tempered bowl with use-wear typical for solid food processing. A few closed shapes are imported, surprisingly never from the opposite Aeolian archipelago.

Keywords: Subapennine pottery, southern Tyrrhenian Sea, organisation of production, exchange networks, functional specialisation, macroscopic classification, petrographic analyses

Introduction

The Bronze Age settlement of Punta di Zambrone[2] is located on the Tropea promontory on the Calabrian Tyrrhenian coast in the province of Vibo Valentia. During the Recent Bronze Age (RBA), Punta di Zambrone certainly represented a key harbour involved in significant maritime goods exchanges, as evidenced by the high amount of Minoan and Mycenaean imports found at the site. The settlement rose up in a strategic position in the southern Tyrrhenian Sea allowing control of the maritime circulation between the Aegean, eastern and western Mediterranean, Sicily and peninsular Italy.

In this paper I consider the RBA *impasto* pottery from Punta di Zambrone that belongs to the Subapennine culture, diffused from the Po plain to southern Calabria, in the Aeolian archipelago (in Lipari, where it is known as the Ausonian culture) as well as in eastern Sicily.[3] Typical of the Subapennine assemblage are carinated cups with a rich variety of raised handles. During the period under investigation, the level of the pottery production organisation increased considerably: pots became functionally more specialised and typologically more standardised.[4] A more marked homogeneity in raw material supply and paste preparation modes as well as a greater control of firing conditions characterise this wide-spread ceramic *facies*.[5]

Many archaeometric analyses have been performed on the RBA pottery production of southern Italy.[6] However, the data from the southern Tyrrhenian area are still scanty. The Tropea promontory, mainly composed of granites, is geologically easily distinguishable from the neigh-

[1] Austrian Archaeological Institute, Austrian Academy of Sciences, Franz-Klein-Gasse 1, 1190 Vienna, Austria; pamela.fragnoli@oeai.at.

[2] Pacciarelli – Jung, this volume.

[3] Pacciarelli 2001, 36; Paciarelli – Varricchio 2004.

[4] Castagna 2003; Castagna 2006; Damiani 2010, 443–445.

[5] Levi 1999; Levi 2010.

[6] Levi 1999; Recchia – Levi 1999; Acquafredda et al. 2006; Williams – Levi 2008.

bouring regions and thus particularly suitable for archaeometric applications aimed at reconstructing large and short goods exchanges.

Among recent studies, NAA analyses carried out on the Aegean-type pottery from Punta di Zambrone further highlight the singularity of this harbour site.[7] The greater part of the analysed sherds is assignable to imports from western Greece, while most of the Aegean-type pottery found in coeval south Italian sites was locally produced.[8] The uniqueness of the Punta di Zambrone ceramic assemblage also lies in the occurrence of Italo-Mycenaean vessels imported from northern Calabria, presumably the Sybaris plain.[9] These first results considerably change the picture as known so far, making it ever more necessary to extend the analyses to this region.

Aims, Materials and Methods

In this paper, the RBA *impasto* pottery from Punta di Zambrone is investigated by means of archaeometric tools in order to identify the paste preparation modes, the raw material procurement patterns and the production places, and eventually to reconstruct the organisation level of the production and identify possible exchange networks. 564 diagnostic and body sherds of *impasto* pottery found in the RBA levels brought to light in areas C and B (east part) of the excavations[10] were considered. The RBA trends were also compared to those obtained from 838 EBA samples from areas D and B (west part) to highlight diachronic patterns. In the discussion, the ceramic production of Punta di Zambrone is then contextualised within the RBA southern Italian scenario.

All sherds were first examined with the aid of magnifying lenses, optical and digital microscopes in order to preliminarily define the techno-compositional variability of the pottery production, paying attention to those features less or not at all visible in thin sections, such as surface treatments, firing conditions and use-wear traces. *Impasto* sherds were described and classified in terms of the surface, clay matrix and inclusion variability.[11] All data were recorded in a ceramic technology form[12] based on forms proposed in the literature[13] but nevertheless adapted to the specific case study.

I then sampled 42 representative *impasto* sherds to be analysed under the polarising microscope (Tab. 1). The main aim was to classify thin sections by their degree of similarity into homogeneous reference groups that ideally should represent the ceramic pastes prepared in a specific way and place. These reference groups were then compared with the macroscopic techno-compositional groups, main typological classes, local reference materials (such as plaster fragments and cooking stands) and geological outcrops.

---

7 Jung et al. 2015.

8 Jones et al. 2014. A similar prevalence of imports among the Aegean-type pottery is known in Sicily and in the Aeolian archipelago (Jones – Levi 2014, 222–241). However, in the Aeolian archipelago these data are still based on very few analysed samples (Jones – Levi 2014, 239–240), only one of which dates to the RBA.

9 Jung et al. 2015.

10 The pottery sherds analysed in this paper were found during a three-year excavation campaign (2011–2013) conducted by Marco Pacciarelli and Reinhard Jung in the framework of a joint project of the University of Naples Federico II, the University of Salzburg and the Institute for Oriental and European Archaeology (OREA, Austrian Academy of Sciences in 2013).

11 External and inner surfaces are described in terms of colours, firing conditions, finishing procedures and use-wear. For the clay matrix, I reported the colour, firing conditions, structure and consistency. Inclusions are defined on the basis of colour, shape, hardness, lustre, frequency, maximal diameter and sorting degree.

12 Fragnoli et al. 2014.

13 Levi 2010.

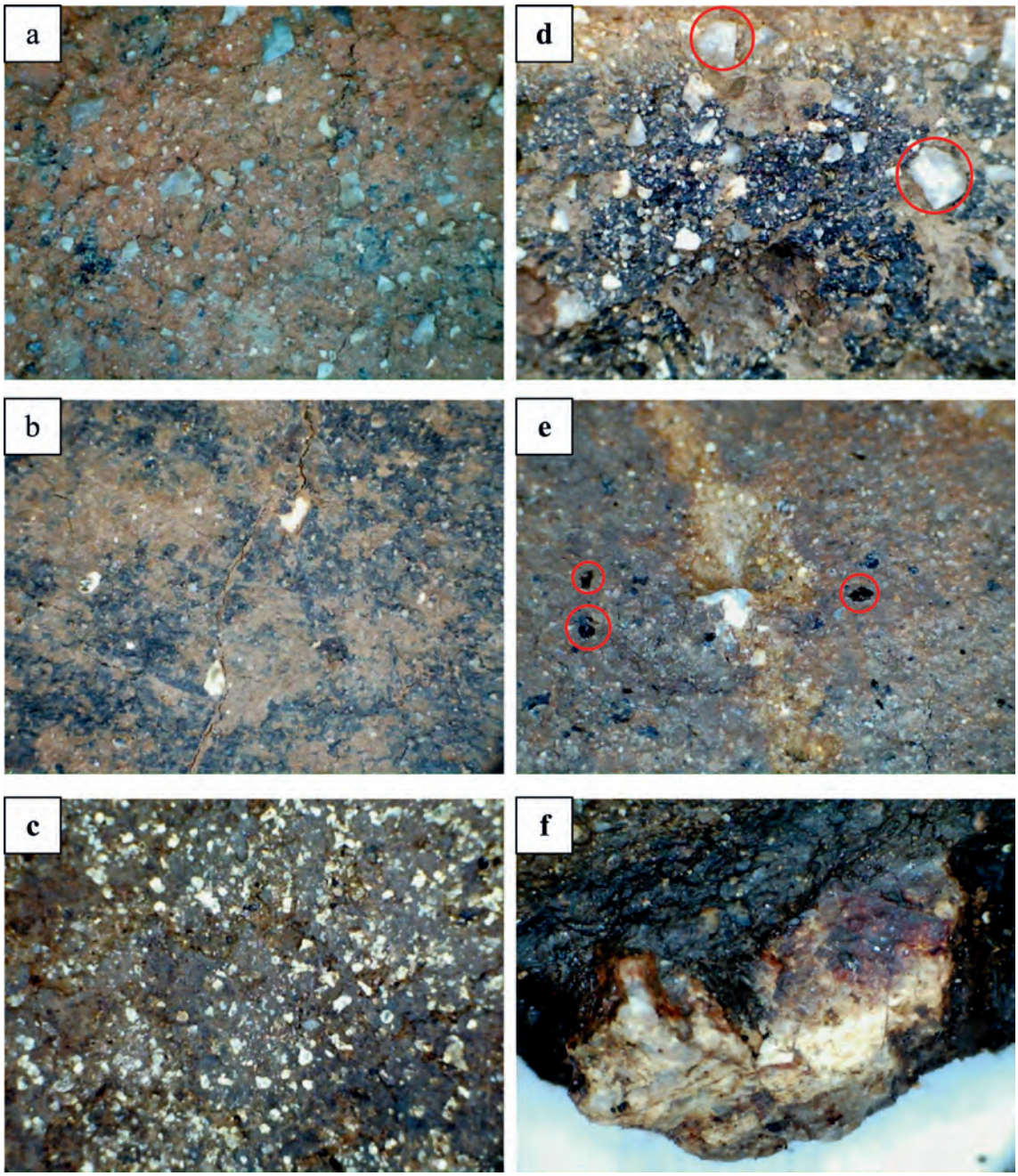


Fig. 1 Local macroscopic fabrics at Punta di Zambrone: a. non-muscovitic paste (35.8%); b. moderately muscovitic paste (43.4%); c. strongly muscovitic paste (20.7%); d. occurrence of quartzites (in red circles); e. occurrence of biotites (in red circles); f. occurrence of granites (photos: P. Fragnoli)

Macroscopic Techno-Compositional Observations

The RBA ceramic finds from Punta di Zambrone were first examined in terms of ceramic temper, whose type, amount and dimension provides information on supply and manufacturing procedures. The sherds differ in the presence/absence and relative amount of muscovitic mica, while quartz is ubiquitous. Accordingly, three main ceramic pastes, i.e. non-muscovitic (Q), moderately muscovitic (Q+M) and strongly muscovitic (M+Q), could be recognised (Fig. 1a–c). Non-muscovitic (35.8%) to moderately muscovitic (43.4%) pastes clearly prevail over the strongly muscovitic ones (20.7%).

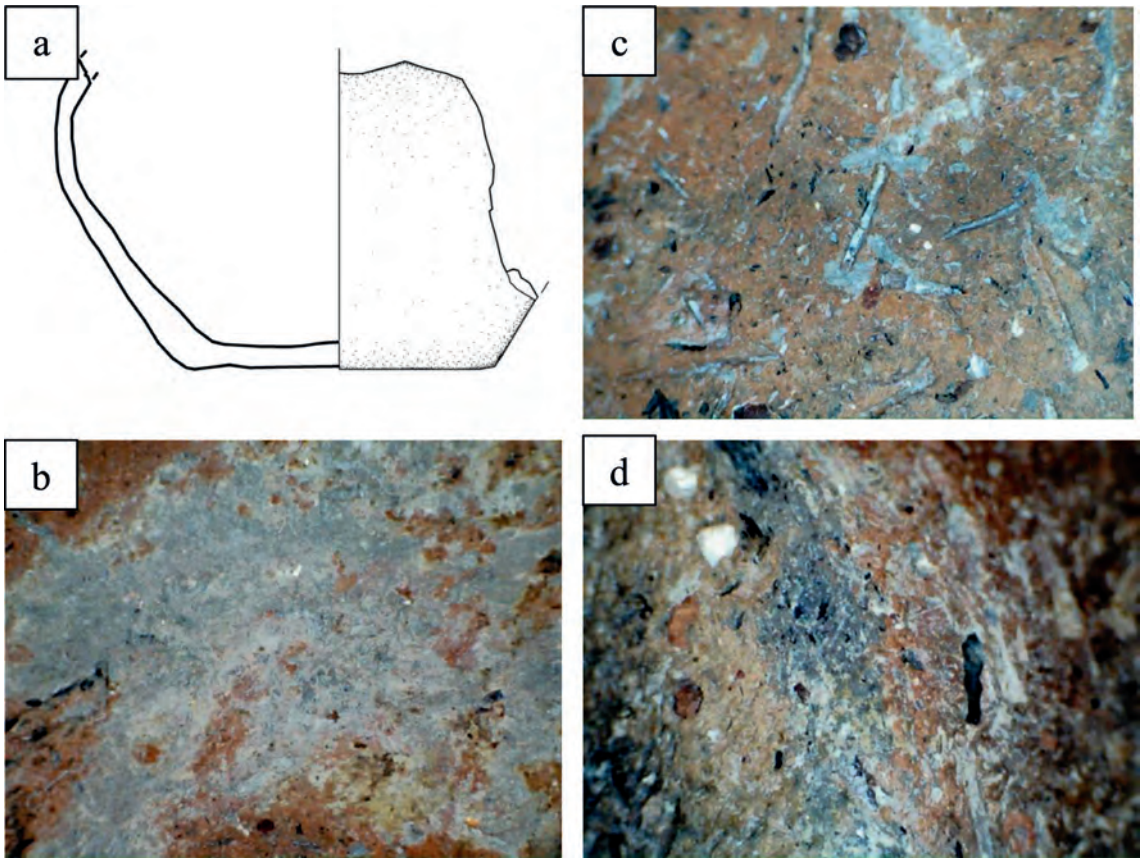


Fig.2 Bowl with inverted rim (a), tempered with vegetal fibres (c) and characterised by internal abrasions (b) and carbon deposits (d) (drawing: C. Capriglione; photos: P. Fragnoli)

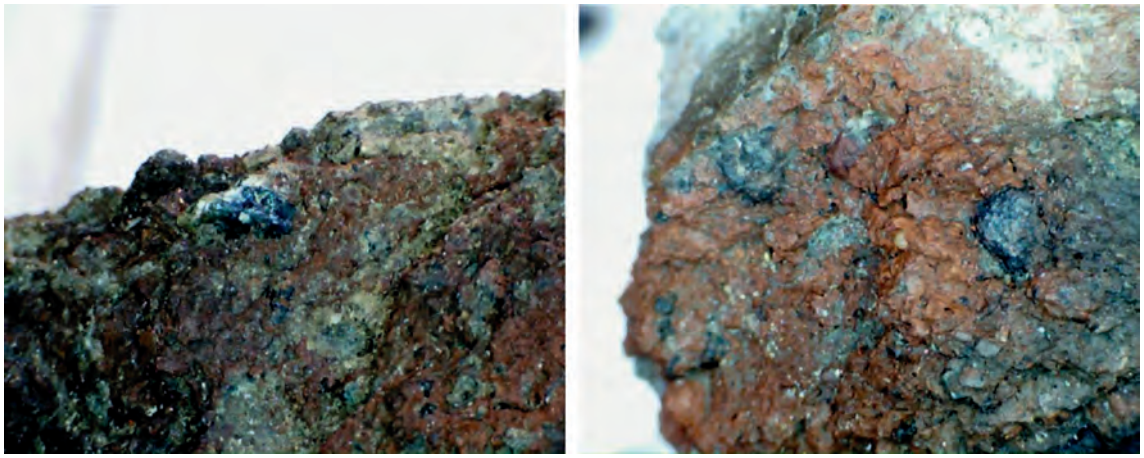


Fig. 3 Occurrence of non-local volcanic inclusions in closed shapes (photos: P. Fragnoli)

At Punta di Zambrone, quartz is translucent, white or pinkish, ranging from fine to coarse angular sand and had been added as temper by potters. Muscovite, which is, by contrast, a natural component of the clay matrix, shows a metallic lustre (silver or gold) and a differentiated grain-size distribution, reflecting different clay depositional energies. Less common components are biotites, appearing as black tabular inclusions with parallel cleavages, and lithic clasts, especially quartzites and granites (Fig. 1d–f). In a few cases vegetal fibres seem to have been used as temper,

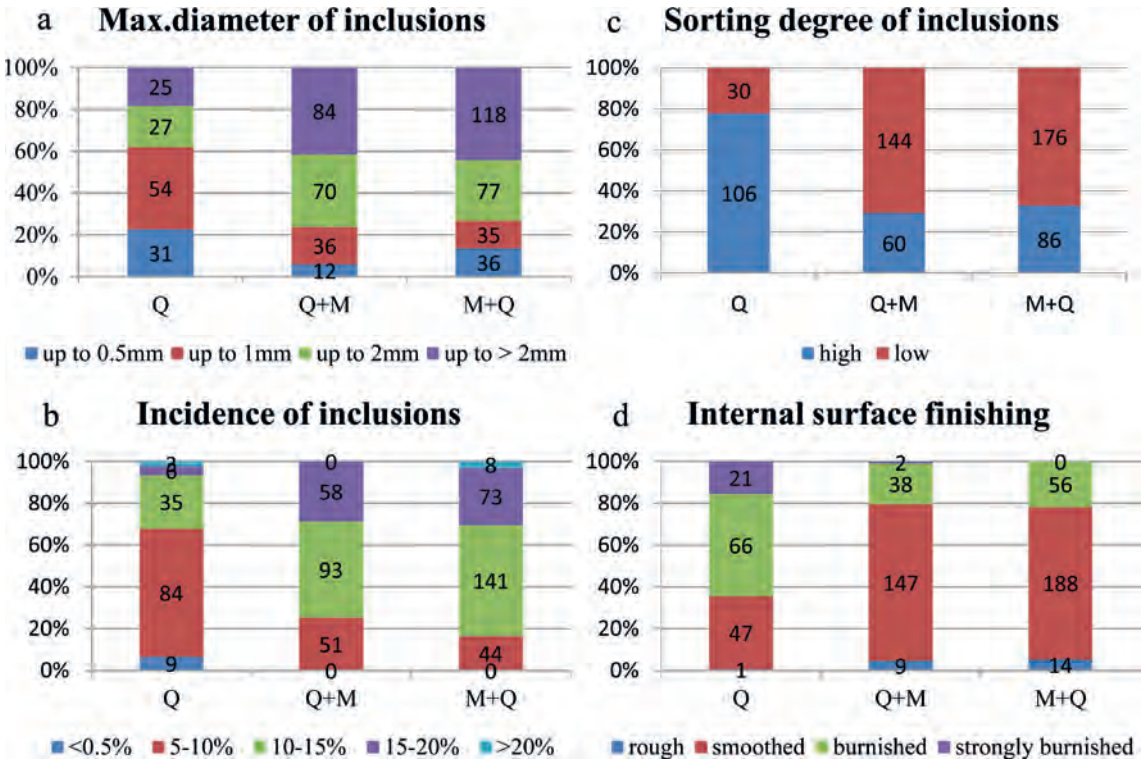


Fig. 4 Correlations between ceramic pastes and technological features: a. ceramic pastes and temper size; b. ceramic pastes and temper percentage; c. ceramic pastes and temper sorting degree; d. ceramic pastes and finishing procedures on pots' internal surfaces (graphics: P. Fragnoli)

as, for instance, in a bowl with an inverted rim and use-ware left by cooking possibly semi-solid foodstuffs (inner abrasions and carbon deposits) (Fig. 2a–d). Last but not least, two pottery sherds belonging to closed shapes, a large vessel and a jar, were certainly imported since they contain volcanic minerals and rocks,[14] not compatible with the granitic local outcrops (Fig. 3).

The different ceramic pastes are correlated with specific technological features, such as the grain-size distribution and surface treatment (Fig. 4a–d). Finer vessels, completely burnished, comprising up to 10% well-sorted inclusions with a diameter up to 2mm, were frequently manufactured with non-muscovitic pastes (Q). Micaceous pastes (Q+M and M+Q) with larger and badly-sorted inclusions were instead used for coarser vessels with rough or just smoothed inner surfaces.

Furthermore, a close correlation between ceramic pastes and formal repertoire can be observed (Fig. 5a–c). Non-muscovitic pastes generally appear in open shapes, including bowls and cups, while closed shapes, such as jars, *pithoi* or *dolia*, are produced with muscovitic clays (Fig. 5a). Typical of open shapes are the striated burnishing traces, probably caused by some fibrous tools, like wooden sticks, on the leather-hard ceramic body. Traces run horizontal and parallel over the rim, while they cross on the body. The broader and deeper finishing traces on closed shapes indicate that they were burnished with some round tools, e.g. pebbles, when the ceramic body was softer. Open and closed shapes also differ in the firing conditions. The former are usually fired under well-controlled reducing atmospheres, while oxidising firing conditions predominate in the latter (Fig. 5b). Some closed shapes range from grey to dark grey in colour, indicating a reducing firing, anyway less intense than that observable on the black open shapes (Fig. 5c).

[14] Such volcanic elements were black, angular, with a vitreous or metallic lustre, thus well distinguishable from the prevailing quartz-micaceous local component.

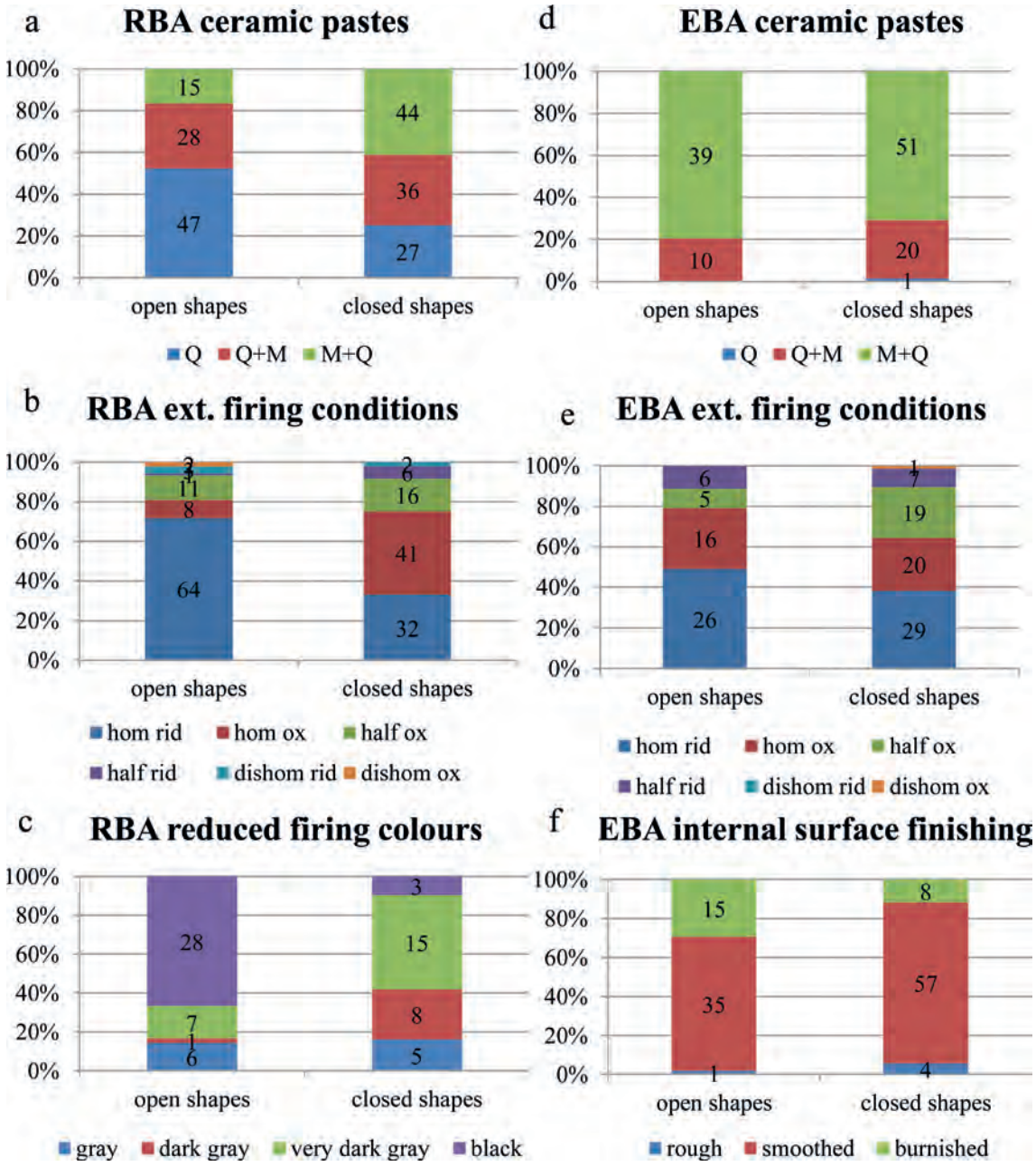


Fig. 5 a. Ceramic pastes in RBA open and closed shapes; b. firing conditions of external surfaces in RBA open and closed shapes; c. colours due to reducing firing conditions in RBA open and closed shapes; d. ceramic pastes in EBA open and closed shapes; e. firing conditions of external surfaces in EBA open and closed shapes; f. finishing procedures of internal surfaces in EBA open and closed shapes (graphics: P. Fragnoli)

Regarding other clay-based materials, cooking stands and baking plates show, as closed vessels, coarse moderately to strongly muscovitic pastes. Pastes used for plaster are instead finer, with some isolated quartz grains, more and less vegetal-tempered, porous and very light coloured.

By comparing the above-mentioned RBA trends with the data collected on the EBA materials found in Areas D and B (west part), I could first assess a diachronic increase in the use of non-muscovitic pastes. Contrary to the RBA evidence, EBA open and closed shapes do not show any clear manufacturing differences, often being characterised by common paste preparation, finishing and firing modes (Fig. 5d–f).

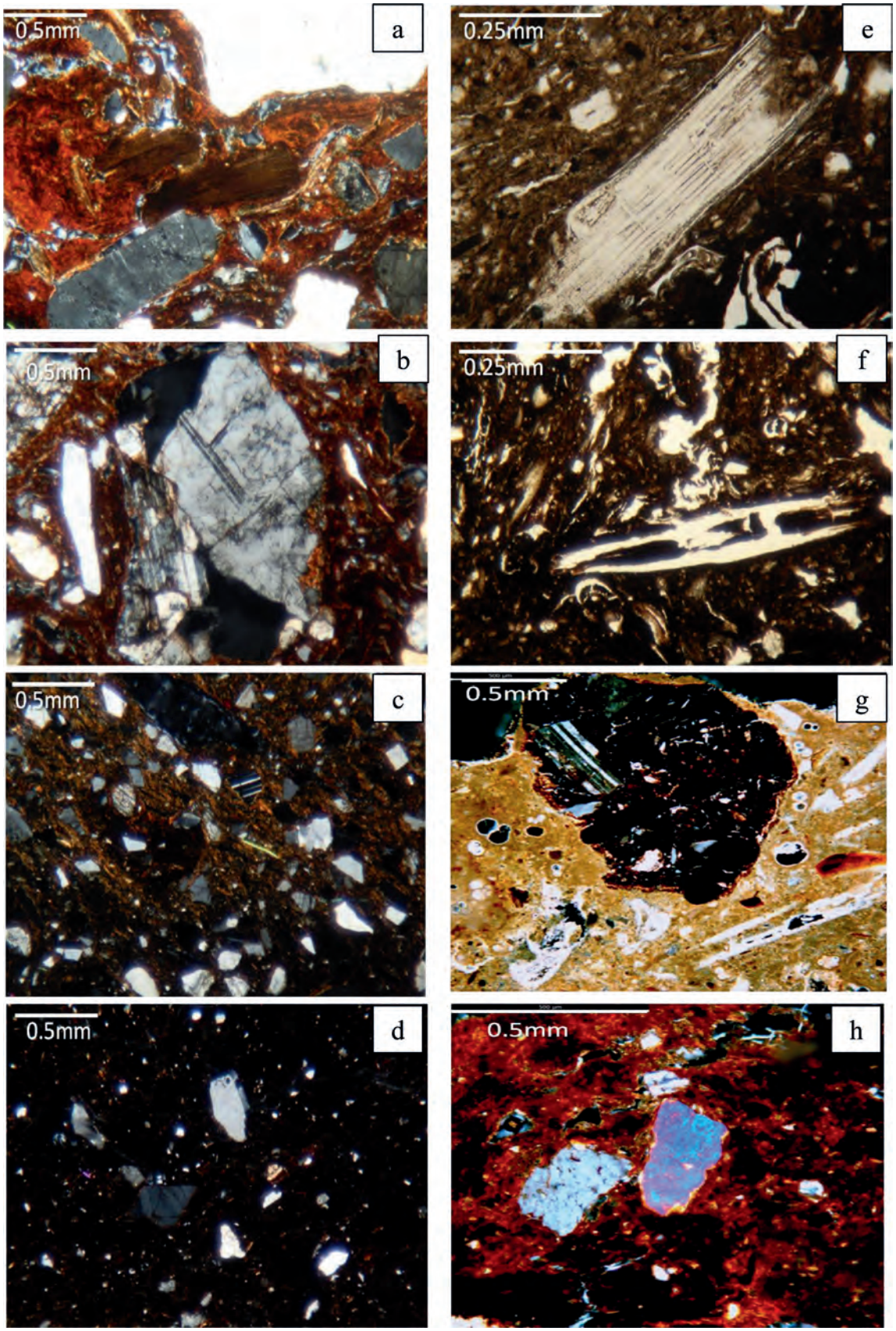


Fig. 6 a–b. Petro group 1 with granites (b) and biotites (a); c–d. petro group 2 with quartzes and feldspars; e–f. vegetal-tempered variant of petro group 2 in handles of carinated cups; g. calcareous-fossiliferous clay tempered with grogs in plaster fragments; h. volcanic fabric in some closed shapes (photos: P. Fragnoli)

Samples	ID marker	Petro group	Variants	Macro group	Pot description
IP1	PZ66cCC9/5	1		M+Q	jar with flared, flattened rim and wall with rib
IP2	PZ66cCC9/6	1		Q+M	jar with flared, rounded rim
IP3	PZ66cCC9/18	1		M+Q	hemispheric bowl with simple rim
IP4	PZ66aBB11/2	1		M+Q	jar with straight, rounded rim and wall with finger-impressed rib
IP5	PZ66dBB10/4	2	vegetal-tempered	Q	flat rim
IP6	PZ66cCC11/16	1	sandstone	Q+M	rounded jar with flared and rounded rim
IP7	PZ66cCC10/8	1		Q+M	deep bowl with non-articulated profile
IP8	PZ66cBBCC9/1	2	vegetal-tempered	Q+M	wall
IP9	PZ66/P118/2	2	grog	Q	horizontal handle
IP10	PZ66bBB9/2	2	muscovite; finer and well sorted	M+Q	small bowl with internally enlarged rim
IP11	PZ66aCC11/1	2	vegetal-tempered	Q	bowl with internally enlarged rim
IP12	PZ66aBBCC10/1	2	vegetal-tempered	M+Q	carinated cup with flared rim, slightly concave shallow wall, slightly rounded carination
IP13	PZ66cCC12/8	1	vegetal-tempered	M+Q	vertical handle
IP14	PZ66cCC12/3	2		Q	carinated cup with sinuous profile and slightly flared rim, concave wall, rounded carination
IP15	PZ66bBB10/9	2	vegetal-tempered	Q+M	fragment of plastic decoration
IP16	PZ66bCC11/3	2		Q	very open and shallow carinated cup with flared rim and shallow body
IP20	PZ111dJK11/1	1	lack of biotites	Q+M	wall
IP22	PZ106JK10/3	1		Q+M	jar with finger-impressed rib
IP32	PZ129/P31	1		Q	jar with very prominent rounded body; beginning of strap handle placed on the belly
IP34	PZ66/P103/1.2	2			wall with metopes surrounded by large incised lines and filled with irregular carved rectangles or triangles with traces of white paste
IP36	PZ161BBCC10–12PUL/5	1		Q+M	pottery waster
IP38	PZ151FFGG10–11/11	volcanic (imported)		lustrous, angular and black inclusions	closed pot

Samples	ID marker	Petro group	Variants	Macro group	Pot description
IP39	PZ151/P24	1	vegetal-tempered	Q	jar with funnel-shaped, rounded rim and globular body
IP40	PZ129DDEE12/1	2	vegetal-tempered	Q	vertical handle with fragmentary configured ending with quadrangular section
IP43	PZ129FFGG12/4	2		Q	horizontal handle of bucket-shaped jar
IP45	PZ129EE10/5	1	vegetal-tempered	Q	cooking stand fragment
IP46	PZ151DD12/1	3		Q+M	daub with smoothed surfaces
IP47	PZ129CC12/3	2		Q	carinated cup with flared rim, shallow slightly concave wall and slightly rounded carination
IP48	PZ151FFGG11/1	1	slightly calcareous-fossiliferous	Q+M	baking plate
IP49	PZ151FFGG10/57	3		Q+M	daub with smoothed surfaces and wood imprints
IP50	PZ151DD10/1	3		Q	daub with wood imprints
IP53	PZ129/P53/1	1			jug with slightly flared rim and rounded body, with vertical strap handle raised on the rim
IP55	PZ176/P17	2	vegetal-tempered	Q+M	bowl with inverted rim
IP56	PZ6A/P8	1	grog	M+Q	horizontal handle of large container
IP57	PZ6A/P7/5	2		M	bowl with internally enlarged rim
IP58	PZ6A/P7/3	1		M	small cup with slightly flared and rounded rim
IP59	PZ6A/P6/5+6	2	vegetal-tempered	M+Q	vertical handle ending with snail horns
IP60	PZ95EE12–13/8	2	vegetal-tempered	Q	carinated cup with slightly flared rim, high straight wall and not very prominent carination
IP64	PZ75FFGG8-9/10	1		Q+M	vertical handle of large container
IP65	PZ80CCPUL/2.3	1		Q+M	small bowl with rounded rim, slightly convex body and bottom with *omphalos*; miniaturistic
IP66	PZ151EE9/43	1	vegetal-tempered	Q+M	wall fragment of *pithos* with high, undecorated plastic band
IP67	PZ151DD10/29	2		M+Q	jar with funnel-shaped rim and ovoidal body

Tab. 1 List of the RBA sherds analysed with the polarising microscope

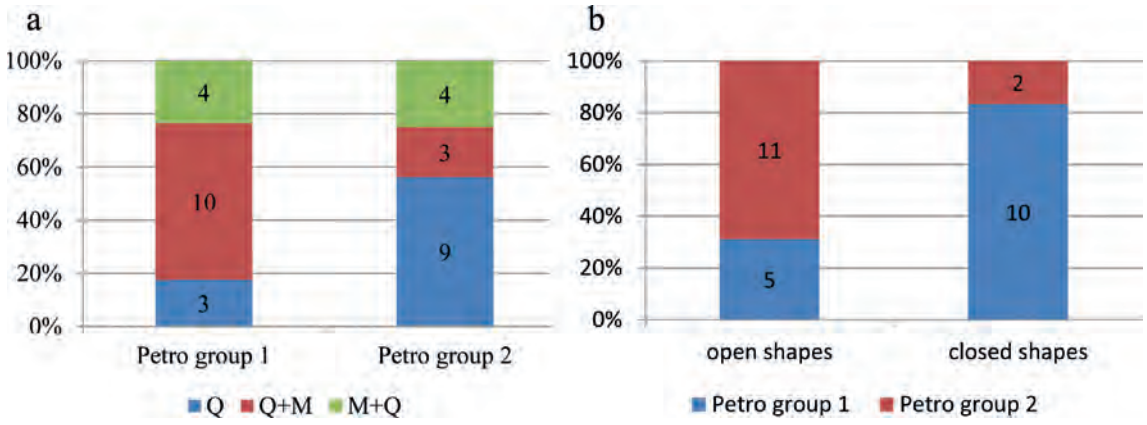


Fig. 7 a–b. Correlation between petro-and macro groups; c. petro groups in RBA open and closed shapes (graphics: P. Fragnoli)

Minero-Petrographic Results

The forty-two analysed thin sections are equally divided into two reference groups (Tab. 1). The inclusions characterising the first petrographic group (Fig. 6a–b) represent up to 25% of the ceramic paste, are badly sorted, angular and consist of quartz, also polycrystalline, granite, K-feldspar (mainly orthoclase), plagioclase and biotite. The coarsest fraction is mainly composed of granite fragments with a maximal diameter up to 3.2mm. Biotites can sometimes be deformed and reach a maximal diameter up to 1.4mm. Less common inclusions are muscovite, epidote, amphibole, metamorphic quartz and gneiss. The clay matrix generally shows a striated birifrengence. Some samples can be considered as variants of petro group 1 since they lack biotites (IP20), or they contain sandstones (IP6), grog (IP56), calcareous-fossiliferous components (IP48) or vegetal fibres (IP66, IP39, IP13, IP45).

In the second petro group (Fig. 6c–d) granites and biotites are lacking; clay pellets and opaque minerals often occur; K-feldspars include both orthoclase and microcline; the sorting degree is higher; inclusions are fewer (10–15%) and finer (up to 1.2mm with a mode < 0.35mm), and the clay matrix is silty, granular and optically inactive. Half of the samples, mainly consisting of the strap handles of carinated cups and carinated cups, are vegetal-tempered. Only one sample, a horizontal handle (IP9), contains grog.

The macro and petro groups correlate well (Fig. 7a). The first petrographic group, with granites and biotites, largely corresponds to the muscovitic macro-groups (Q+M and M+Q). The second petro group, with quartz and feldspars, mostly coincides with the non-muscovitic macro-group (Q). Thus, petro group 1 generally occurs in closed shapes, petro group 2 in open shapes (Fig. 7b). As shown in the histogram in Fig. 7b, about 20% of open shapes nevertheless belong to petro group 1. These are mainly open shapes with simpler profiles, like bowls. By contrast, more articulated shapes such as carinated cups are always part of petro group 2.

The other clay-based materials can be classified into two reference groups. Artefacts used in connection with fire, i.e. cooking stands and baking plates, belong to the petro group with granites and biotites including most of the closed shapes, group 1. By contrast, plaster fragments show a calcareous-fossilifereous clay tempered with angular and badly sorted sands, consisting of quartz, plagioclase, feldspars and biotites, as well as granite and grog (Fig. 6g), a kind of paste (petro group 3) never used for producing pottery at Punta di Zambrone.

By comparing the identified petro groups with the local outcrops reported on geological maps,[15] regular patterns in the raw material procurement can be recognised (Fig. 8). The petro group 1,

[15] Cassa per il Mezzogiorno (ed.), Carta geologica della Calabria (1: 25000), sheet 241 III Southwest (Ercolano 1968).

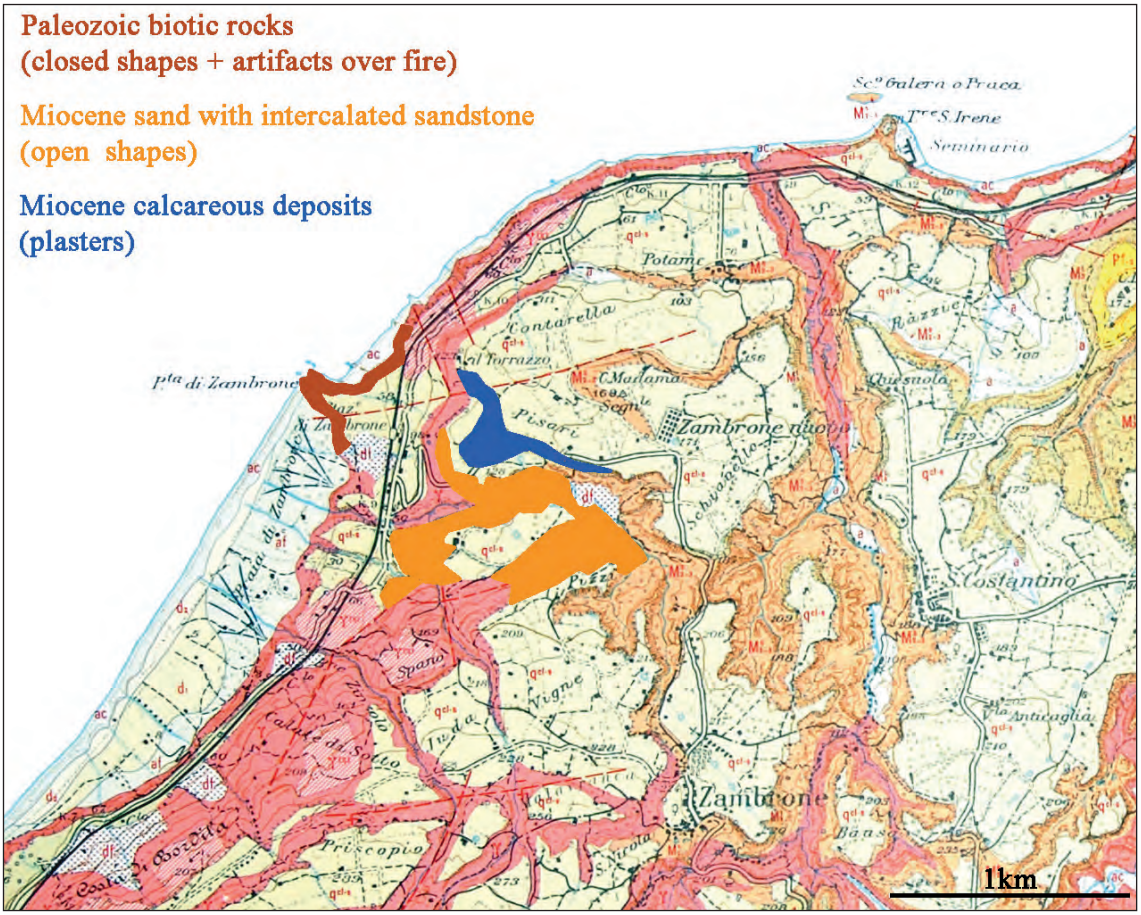


Fig. 8 Geological map slightly modified from Carta Geologica della Calabria 1958–1962, Foglio 241 III, S.O., reporting the different local procurement areas for closed shapes, other clay-based artefacts used over fire (baking plates, cooking stands), plaster and open shapes (graphics: P. Fragnoli)

typical of closed shapes and clay-based artefacts used in connection with fire, is compatible with the Palaeozoic biotitic rocks outcropping in the immediate surroundings of the settlement. The occurrence of petro group 1 in a pottery waster (IP36) further testifies to the local production, presumably quite close to the site, of closed shapes, baking plates and cooking stands. The petro group 2, peculiar or confined to open shapes, shows instead affinities with the Miocene sands available 1km away from the coastline. At a similar distance other Miocene deposits, calcareous and fossiliferous, were exploited to produce plaster.

Regarding the large vessel and the jar macroscopically interpreted as imports from volcanic areas, they are composed of pyroxenes, biotites, quartzes, also polycrystalline, and amphiboles (Fig. 6h). It is possible to exclude any Aeolian provenance since the volcanic temper typically characterising the pottery production from Lipari[16] (e.g. glass sherds, pumices) is lacking.[17] The fabrics rich in basalt and volcaniclastic rocks observed among the pottery assemblages from the Hyblean Mountains and the Etnean region are likewise not present.[18]

16 Williams 1967; Williams 1980; Fragnoli 2012, 90, 92; Brunelli et al. 2013.

17 During the Recent Bronze Age, Lipari was the only inhabited island in the Aeolian archipelago. Most of the pottery was locally made by using imported clay, presumably from northern Sicily. Petrographically, it appears as a hybrid mixture of local volcanic and non-local sedimentary/metamorphic components (Williams – Levi 2008). The volcanic material used for producing pottery remained quite unvaried during the whole pre- and protohistoric sequence of the island (Williams 1967).

18 Fragnoli – Levi 2012.

Compared to the RBA assemblage, EBA samples present a greater petrographic variability represented by five different petro groups. In line with macroscopic observations, EBA open and closed shapes often show common paste preparation modes. The most common paste consists in micaceous clay tempered with quartzes, feldspars and biotites. No evidence of imports has been observed. Campania[19] thus remains the most probable provenance area for this large vessel and the jar. In order to assign these pots to a more precise production area, it would be advisable to perform micro-chemical analyses on the volcanic temper. Through this analysis I was able to identify imports from Campania to Stromboli in the Aeolian archipelago during the Early Bronze Age on the basis of the high LILE/HFSE ratios of hornblendes.[20]

Discussion

The results obtained so far are here discussed according to the three following criteria: first, the presence of vegetal fibres in some ceramic pastes; secondly, the importation of closed shapes and, lastly, the dichotomy in the *chaîne opératoire* between open and closed shapes.

It is commonly assumed that the organic matter sporadically observed in Italian Bronze Age pastes is not the result of manufacturing choices but occurs naturally in the clay deposits. On the contrary, the addition of vegetal temper in the case of a few pottery vessels from Punta di Zambrone appears to have been an intentional choice by potters on the basis of high amounts and low sorting degrees. Though not belonging to an indigenous tradition, cases of organic tempering could be recognised in the handles of carinated cups and in one bowl used for cooking. For the former, often characterised by articulated handle projections, the addition of vegetal fibres could be a means of improving the workability and plasticity of the clay during manufacturing and reducing the weight of the object after firing.[21] The advantage in tempering cooking pots with organic material, making them porous, is not clear in terms of thermal shock resistance and heating conductivity, since most of the data in literature are somehow controversial.[22] In any case, porous vessels with a lower heating conductivity are better suited for simmering than for boiling because their low heating conductivity prevents seepage.[23] The use-wear observed on the inner surface of the vegetal-tempered bowl from Punta di Zambrone seems to further corroborate this observation. Whatever the function, several archaeological and ethnographic studies reported the use of organic temper in cooking pots.[24] For instance, among the Late Archaic assemblage of the southeastern United States, Skibo reported vegetal-tempered vessels used for indirect cooking and simmering.[25] As stressed by Stillborg,[26] who reports cases of functionally 'inappropriate' paste recipes, numerous considerations might lie behind the choice of temper besides functionality, and a good explanation for the existence of chaff-tempered pottery used in connection with fire is still lacking. From a formal point of view, the vegetal-tempered bowl with inverted rim from Punta di Zambrone corresponds to the cooking pots outlined by Henrickson and McDonald[27] in their ethnographic survey on pottery forms and functions: these are short and

19 As is well known, in Campania, apart from the islands of the Naples bay, the most significant volcanic complexes rise along the Tyrrhenian coast in the western part of the region (Mt. Somma-Vesuvius and Phlegraean Fields).

20 To LILE (*Large Ion Lithophile Elements*) belong Rb, Eu, Cs, Ba, Sr, U, Th, K e Pb^{2+}, to HFSE (*High Force Strength Elements*) La, Ce, Nd, Ta, Nb, Zr, Sm, Yb, Hf and Ti. High LILE/HFSE ratios are typical of orogenic volcanoes, such as those of peninsular Italy, while low ratios can be assigned to products of intra-plate volcanoes, occurring, for example, in Sicily and Sardinia (Peccerillo 2005).

21 Rye 1981, 33–34; Skibo et al. 1989.

22 Rye 1976; Reid 1984; Rice 1987, 226–232, 237–242, 347–368; Skibo et al. 1989.

23 Rice 1987, 231; Müller et al. 2013.

24 Linne 1965; Rye 1976; DeBoer – Lathrap 1979; Rye 1981; Smogorzewska 1983; Reid 1984.

25 Skibo 2013, 41–43, 93–95.

26 Stillborg 2001.

27 Henrickson – McDonald 1983.

squat containers with a large basal surface that allows an efficient heat transfer but with a slightly restricted mouth to prevent too rapid evaporation. Long-term simmering appears the most probable cooking practice we can assign to this pot based on its use-wear, physical properties and shape, which, though a bit restricted at the mouth, is large enough to allow for easy access to semi-solid foodstuffs.[28]

The few imports identified among the *impasto* pottery at Punta di Zambrone consist of closed shapes circulating for their contents from volcanic areas (probably from Campania), evidence which is in line with the data collected in coeval peninsular settlements. For instance, at Broglio di Trebisacce on the Ionian Calabrian coast, only 2% of the *impasto* pottery, mainly consisting of medium-large closed vessels, was imported from the southern plain of Sybaris.[29] At Punta di Zambrone, contacts with the opposite Aeolian archipelago could not be archaeometrically proven, not even for the EBA levels, where Capo-Graziano-style pottery was found but it was locally produced. Conversely, 20% of the vessels, mainly open shapes, found in the Capo Graziano settlement of Stromboli were presumably imported from the Tropea promontory.[30] Hence, it seems that this relationship was somehow unidirectional. In my opinion, this high incidence of imports, including functionally differentiated vessels, could have been determined by the scarceness on the volcanic island of the raw materials necessary for pottery production, such as clay and water. To broaden our knowledge about the intensity and nature of interactions occurring by the EBA in the Lower Tyrrhenian Sea, it would be advisable to analyse the Aeolian-type pottery found in other Calabrian contexts, such as Taureana di Palmi (RC),[31] the necropolis of Nicotera (RC)[32] and the Petrosa cave.[33]

Furthermore, the macroscopic and petrographic analyses show that by the RBA open and closed shapes were manufactured in distinct modes that differed in each phase of the *chaîne opératoire*, from raw material procurement to tempering, surface treatment and firing. RBA closed shapes were made with coarse biotitic and granitic pastes, available in the immediate vicinity of the site and fired under oxidising atmospheres. I suppose that the ingredients of this recipe were ultimately selected for their properties in terms of thermal shock resistance and heating conductivity, both increased by the temper coarseness, the tabular shape of micas and the occurrence of granites, to make pots suitable to be used over fire. The use of the same raw material to make cooking stands and baking plates confirms this hypothesis. The occurrence of the same recipe in one pottery waster does not simply corroborate a local pottery production at Punta di Zambrone, but seems also to indicate that closed shapes, cooking stands and baking plates were probably produced closer to the site with respect to open shapes. These latter were produced from finer non-micaceous, quartz-feldspathic pastes, accurately burnished and fired under controlled reducing atmospheres. The coarse micaceous raw material available near the site was presumably not suitable for tableware from the point of view of workability and the aesthetic result. The use of the same paste preparation modes for closed shapes and some bowls with a simple round profile indicates that, in terms of function, the latter cannot be considered as purely tableware. The use-wear, namely abrasions and carbon deposits, visible on the internal surface of the bowl I mentioned above confirm this hypothesis. Experiments demonstrated that the level of the production organisation for open shapes varies greatly depending on the profile complexity, recording a difference in manufacturing times of up to six hours between round and carinated bowls.[34]

The information gained on the organisation of production during the RBA at Punta di Zambrone is consistent with the general evidence reported for the period, marked by an increasing lev-

28 Recchia 2000.
29 Levi 1999, 104–108, 228–232.
30 Fragnoli 2012, 98, fig. 4.2.14; 100–101, 118, 122–123, 125, fig. 5.2.
31 Pacciarelli 2002.
32 Marino – Pacciarelli 1996.
33 Martinelli et al. 2004.
34 Cardarelli – Levi 2004; Brodà et al. 2009.

el of specialisation, as visible in the standardisation of pots' dimensions, functions and typology, especially in the case of tableware.[35] However, at Punta di Zambrone, the functional specialisation is, for the first time, also reflected in the selection of raw materials and in the paste preparation modes, and potters paid particular attention to the thermal properties of clays and tempering materials. By contrast, at other well-known sites of southern Italy, such as Broglio di Trebisacce in Calabria and Coppa Nevigata in Apulia, a general homogenisation of paste recipes regardless of functional shapes is observable.[36]

Moreover, a higher degree of specialisation is distinguishable in the local production of wheelmade Aegean and Aegeanising pottery (Italo-Mycenaean painted pottery, Pseudo-Minyan or Grey Wares, pithoi with grooved bands), principally but not exclusively in the Ionian area. Locally established Aegean artisans manufactured 'display vessels' for the *élites* according to peculiar technological procedures (paste fineness, wheel shaping, painted decoration, high temperature firing), not shared with the local *impasto* pottery that was instead intended for common use.[37] In this sense, the evidence from Punta di Zambrone, where no local Aegean-type pottery was identified but the *impasto* pottery, is assignable to a certain level of complexity, acquires a greater relevance and needs to be further investigated.

Other clues suggest a tendency towards a beginning of specialisation. In this sense we might interpret the well-documented case of the Ausonian pottery of Lipari that was mostly locally produced with imported clay from Sicily.[38] This particular manufacturing choice was determined by the extensive outcropping on the north-eastern Sicilian coast of clay with superior pottery-making qualities when compared to those from volcanic Aeolian sources. Hard and durable pottery fabrics could thus be obtained, which could be improved in terms of thermal properties by adding local volcanic matter. In thin sections these pots appear as a mixture of volcanic and metamorphic/plutonic components, composing respectively the clastic and detrical fractions.[39] Since the earliest phases of occupation, the lack of good quality clay on the archipelago accounts for the procurement of finished artefacts from outside, especially regarding the finer productions, such as, for instance, the painted pottery found in the Neolithic levels of Lipari which was mainly manufactured in Sicily.[40] The practice of importing clay is first recorded during the Middle Bronze Age (Milazzese phase) for making incised Apennine-style pots, but became extremely relevant by the RBA and seems more closely associated with the production of finer quality open forms than with coarse-textured jars and *situla*.[41] Even though much less marked than at Punta di Zambrone, the *impasto* pottery production from the Aeolian archipelago also displays evidence of an increasing complexity revealed by the adoption of different paste recipes for open and closed shapes. In this respect, it is worth mentioning that, as at Punta di Zambrone, no Italo-Mycenaean pottery has so far been identified in the Aeolian archipelago.[42] A correlation between the lack of Italo-Mycenaean wares and the more specialised level of the local *impasto* pottery production seems to take shape.

35 Levi et al. 1994–95; Levi 2004; Castagna 2003; Castagna 2006; Damiani 2010, 443–445.

36 Levi et al. 1994–95; Recchia – Levi 1999; Levi 1999; Levi 2010.

37 Peroni 1996, 6–40; Peroni 2004, 161–174; Pacciarelli 2001, 188; Bettelli 2002; Jones et al. 2014, 445, 463; Vanzetti 2014. Different interpretations are reported in Jung 2005a, 59–60; Cazzella – Recchia 2009; Bietti Sestieri 2010, 165; Cazzella 2010. Based on stylistic and technological features, Jung assigned the Italo-Mycenaean painted production (LH IIIB) from Termitito in Basilicata to an Italian artisan trained in the Argive palatial workshops.

38 Williams – Levi 2008.

39 Williams 1967; Williams – Levi 2008.

40 Williams 1980.

41 Williams – Levi 2008.

42 See fn. 7. However, during the Milazzese phase (Middle Bronze Age 3) at Lipari, similarities have been observed between the patterns painted on a wheelmade closed vessel and those incised on typical local *impasto* wares (Jung 2005b, 477, pls. 105a, b). The wheelmade painted closed vessel from Lipari is still awaiting archaeometric analyses.

Aknowledgements: I would like to thank Marco Pacciarelli and Reinhard Jung for having involved me in the research project of Punta di Zambrone that has been a stimulating, enriching scientific and personal experience. I am grateful to Cristina Capriglione for her collaboration in the sample selection and the elaboration of the ceramic technological form, Veronica Ventorino for her constant support in the sample processing, Maria Bianca D'Anna for her helpful suggestions on cooking pots and practices and Andrea Cardarelli for his precious comments on the production organisation of the Subapennine pottery. I am indebted to all the students and scholars of the Punta di Zambrone project because, for many different reasons, they made this work possible.

Bibliography

Acquafredda et al. 2006
P. Acquafredda – A. Cinquepalmi – R. Laviano – I. M. Muntoni, Analisi comparativa di ceramiche e piastre dell'Età del Bronzo provenienti da Monopoli Piazza Calmieri (BA) e da Masseria Chiancudda (Costernino – BR), in: B. Fabbri – S. Gualtieri – M. Romito (eds.), La ceramica in Italia quando l'Italia non c'era, Atti della 8° Giornata di Archeometria della Ceramica (Vietri sul Mare 2004) 23–34.

Bettelli 2002
M. Bettelli, Italia meridionale e mondo miceneo. Ricerche su dinamiche di acculturazione e aspetti archeologici, con particolare riferimento ai versanti adriatico e ionico della penisola italiana, Grandi contesti e problemi della Protostoria italiana 5 (Firenze 2002).

Bietti Sestieri 2010
A. M. Bietti Sestieri, L'Italia nell'età del Bronzo e del Ferro. Dalle palafitte a Romolo (2200–700 a.C.) (Rome 2010).

Brodà et al. 2009
Y. Brodà – V. Cannavò – E. Govi – S. T. Levi – S. Marchetti Dori – G. Pellacani, Bronze Age Terramare pottery from Northern Italy. Exercises in experimental reproduction, in: K. T. Birò – V. Szilàgyi – A. Kreiter (eds.), Vessels. Inside and outside. Proceedings of the Conference EMAC '07, 9th European Meeting on Ancient Ceramics (Budapest 2007) 103–110.

Brunelli et al. 2013
D. Brunelli – S. T. Levi – P. Fragnoli – A. Renzulli – P. Santi – E. Paganelli – M. C. Martinelli, Bronze Age pottery from the Aeolian Islands. Definition of temper compositional reference units by an integrated mineralogical and microchemical approach, Applied Physics A 113, 2013, 855–863.

Cardarelli – Levi 2004
A. Cardarelli – S. T. Levi, La ceramica della Terramare, Parco Archeologico e Museo all'aperto della Terramara di Montale, Archaeolive (Modena 2004) 83–88.

Castagna 2003
M. A. Castagna, I servizi da simposio in ceramica d'impasto e depurata dalla "casa centrale" di Broglio di Trebisacce, in: Cocchi Genick 2004, 263–267.

Castagna 2006
M. A. Castagna, Variazioni dimensionali e variabilità tipologica del vasellame da mensa del Bronzo Recente in Italia meridionale, in: Studi di Protostoria in onore di Renato Peroni (Florence 2006) 354–360.

Cazzella 2010
A. Cazzella, L'organizzazione delle comunità dell'Italia sud-orientale durante il II millennio a.C., in: F. Radina – G. Recchia (eds.), Ambra per Agamennone. Indigeni e Micenei tra Adriatico, Ionio ed Egeo (Bari 2010) 91–96.

Cazzella – Recchia 2009
A. Cazzella – G. Recchia, The Myceneans in the Central Mediterranean. A comparison between the Adriatic and the Tyrrhenian seaways, Pasiphae 3, 2009, 27–40.

Cocchi Genick 2004
D. Cocchi Genick (ed.), L'età del bronzo recente in Italia. Atti del Congresso Nazionale di Lido di Camaiore, 26–29 ottobre 2000 (Viareggio 2004).

Damiani 2010
I. Damiani, L'età del bronzo recente nell'Italia centro-meridionale, Grandi contesti e problemi della Protostoria italiana 12 (Florence 2010).

DeBoer – Lathrap 1979
W. R. DeBoer – W. D. Lathrap, The making and breaking of Shipibo-Conibo Ceramics, in: C. Kramer (ed.), Ethnoarchaeology (New York 1979) 102–138.

Fragnoli 2012
P. Fragnoli, Circolazione e produzione della ceramica nei contesti Capo Graziano (BA-BM2) delle isole Eolie (PhD Diss., Università di Ferrara, Ferrara 2012).

Fragnoli – Levi 2012
P. Fragnoli – S.T. Levi, Pottery fabric in prehistoric houses at Morgantina, in: R. Leighton (ed.), Excavations on the Cittadella of Morgantina in Sicily (1989–2004) (London 2012) 101–119.

Fragnoli et al. 2014
P. Fragnoli – C. Capriglione – R. Jung – M. Pacciarelli, Before sampling. Systematic procedures of macroscopic pottery classification within the Punta di Zambrone (VV) Research Project, in: G. Greco – L. Cicala (eds.), Archaeometry. Comparing Experiences (Naples) 293–310.

Henrickson – McDonald 1983
E. F. Henrickson – M. M. A. McDonald, Ceramic form and function An ethnographic search and an archaeological application, American Anthropologist 85, 3, 1983, 630–643.

Jones – Levi 2014
R. E. Jones – S. T. Levi, Characterisation and provenance, in: Jones et al. 2014, 101–275.

Jones et al. 2014
R. E. Jones – S. T. Levi – M. Bettelli – L. Vagnetti, Italo-Mycenaean Pottery. The Archaeological and Archaeometric Dimensions, Incunabula Graeca 103 (Rome 2014).

Jung 2005a
R. Jung, Aspekte des mykenischen Handels und Produktenaustauschs, in: B. Horejs – R. Jung – E. Kaiser – B. Terzăn (eds.), Interpretationsraum Bronzezeit. Bernhard Hänsel von seinen Schülern gewidmet, Universitätsforschungen zur prähistorischen Archäologie 121 (Bonn 2005) 45–70.

Jung 2005b
R. Jung, Quando? Wann? Quand? When? Translating Italo-Aegean synchronisms, in: R. Laffineur – E. Greco (eds.), Emporia. Aegeans in Central and Eastern Mediterranean. Proceedings of the 10th International Aegean Conference / 10e Rencontre égéenne internationale, Athens, Italian School of Archaeology, 14–18 April 2004, Aegaeum 25 (Liège 2005) 473–484.

Jung et al. 2015
R. Jung – H. Mommsen – M. Pacciarelli, From west to west. Determining production regions of Mycenaean pottery of Punta di Zambrone (Calabria, Italy), Journal of Archaeological Science Reports 3, 2015, 455–463.

Levi 1999
S. T. Levi, Produzione e circolazione della ceramica nella Sibaritide protostorica I. Impasto e dolii, Grandi contesti e problemi della Protostoria italiana 1 (Florence 1999).

Levi 2004
S. T. Levi, La ceramica. Circolazione dei prodotti e organizzazione della manifattura, in: Cocchi Genick 2004, 233–242.

Levi 2010
S. T. Levi, Dal coccio al vasaio. Manifattura, tecnologia e classificazione della ceramica (Bologna 2010).

Linné 1965
S. Linné, The ethnologist and the American Indian potter, in: R. Matson (ed.), Ceramics and Man, Viking Fund Publications in Anthropology 41 (Chicago 1965) 20–42.

Marino – Pacciarelli 1996
D. Marino – M. Pacciarelli, Calabria, in: D. Cocchi Genick (ed.), L'antica età del bronzo in Italia. Atti del Congresso di Viareggio, 9–12 Gennaio 1995 (Florence 1996) 147–161.

Martinelli et al. 2004
M. C. Martinelli – R. Agostino – G. Fiorentino – G. Mangano, La grotta San Sebastiano a Bagnara Calabra (RC). Primi risultati, in: Istituto Italiano di Preistoria e Protostoria (ed.), Atti della XXXVII Riunione Scientifica "Preistoria e protostoria della Calabria", Scalea, Papasidero, Praia a Mare, Tortora, 29 settembre – 4 ottobre 2002 (Florence 2004) 260–273.

Müller et al. 2013
N. S. Müller – A. Hein – V. Kilikoglou – P. M. Day, Bronze Age cooking pots and cooking methods, Préhistoires Méditerranéennes 4, 2013, 2–10.

Pacciarelli 2001
M. Pacciarelli, Dal villaggio alla città. La svolta protourbana del 1000 a.C. nell'Italia tirrenica, Grandi contesti e problemi della Protostoria italiana 4 (Florence 2001).

Pacciarelli 2002
M. Pacciarelli, L'insediamento dell'età del bronzo di Taureana di Palmi, in: R. Agostino (ed.), Palmi un territorio riscoperto. Revisioni e aggiornamenti. Fonti e ricerca archeologica (Rubettino 2001) 139–152.

Pacciarelli – Varricchio 2004
M. Pacciarelli – M. R. Varricchio, Fasi e facies del Bronzo medio e recente nella Calabria meridionale tirrenica, in: Istituto Italiano di Preistoria e Protostoria (ed.), Atti della XXXVII Riunione Scientifica "Preistoria e protostoria della Calabria", Scalea, Papasidero, Praia a Mare, Tortora, 29 settembre – 4 ottobre 2002 (Florence 2004) 359–379.

Peccerillo 2005
A. Peccerillo, Plio-Quaternary Volcanism in Italy. Petrology, Geochemistry, Geodynamics (Berlin 2005).

Peroni 1996
R. Peroni, L'Italia alle Soglie della Storia (Roma, Bari 1996).

Peroni 2004
R. Peroni, Culti, comunità tribali e gentilizie, caste guerriere e figure di eroi e principi nel secondo millennio in Italia tra Europa Centrale ed Egeo, in: F. Marzatico – P. Gleirscher (eds.), Guerrieri, Principi ed Eroi tra il Danubio e il Po dalla Preistoria all'Alto Medioevo (Trento 2004) 161–174.

Recchia 2000
G. Recchia, La funzione dei contenitori ceramici dell'età del Bronzo nell'Italia meridionale. Una prospettiva etnoarcheologica, Archeologia Postmedievale 4, 2000, 111–122.

Recchia – Levi 1999
G. Recchia – S. T. Levi, Morfologia funzionale e analisi archeometriche. Considerazioni preliminari sulla ceramica dell'età del Bronzo di Coppa Nevigata, in: C. Gravina (ed.), 19° Convegno nazionale sulla Preistoria – Protostoria – Storia della Daunia, San Severo 27–29 novembre 1998. Atti, vol. 1 (San Severo 1999) 157–176.

Reid Kenneth 1984
C. Reid Kenneth, Fire and ice. New evidence for the production and preservation of Late Archaic fiber-tempered pottery in the Middle-Latitude Lowlands, American Antiquity 49/1, 1984, 55–76.

Rice 1987
P. M. Rice, Pottery Analysis. A Sourcebook (Chicago, London 1987).

Rye 1976
O. Rye, Keeping your temper under control. Materials and the manufacture of Papuan pottery, Archaeology and Physical Anthropology in Oceania 1, 1976, 106–137.

Rye 1981
O. Rye, Pottery Technology. Principles and Reconstruction (Washington, DC 1981).

Skibo et al. 1989
J. Skibo – M. Schiffer – K. Reid, Organic-tempered pottery. An experimental study, American Antiquity 54, 1989, 122–146.

Smogorzewska 2011
A. Smogorzewska, Ninevite 5 kitchen ware. Morphology and technological characteristic, Polish Archaeology in the Mediterranean 23, 1, 2011, 471–504.

Stillborg 2001
O. Stillborg, Temper for the sake of coherence. Analyses of bone- and chaff-tempered ceramics from Iron Age Scandinavia, European Journal of Archaeology 4, 2001, 398–404.

Vanzetti 2014
A. Vanzetti, Dall'Età del Bronzo all'Età del Ferro. Il contesto archeologico della più antica Italìa, in: Da Italìa a Italia. Le radici di un'identità, Atti del cinquantesimo convegno di studi sulla Magna Grecia, Taranto 29 settembre – 2 ottobre 2011 (Taranto 2014) 79–106.

Williams 1967
J. L. Willliams, A Petrological Study of The Prehistoric Pottery of the Aeolian Islands, with Special Reference to the Stratigraphical Sequence of the Acropolis of Lipari (PhD Diss., University of London, London 1967).

Williams 1980
J. L. Williams, A petrological examination of the prehistoric pottery from the excavations in the Castello and Diana Plain of Lipari. An interim report, in: L. Bernabò Brea – M. Cavalier, Meligunìs Lipára, IV, L'acropoli di Lipari nella preistoria (Palermo 1980) 847–868.

Williams – Levi 2008
J. L. Williams – S. T. Levi, The Ausonian pottery of Lipari (Aeolian Islands, Sicily). A typological and petrological assessment, Proceedings of the Prehistoric Society 74, 2008, 141–170.

Production Regions and Technology of Pottery at Punta di Zambrone: NAA and Petrography in a Combined Approach

Pamela Fragnoli[1] – *Hans Mommsen*[2] – *Reinhard Jung*[3]

Abstract: We analysed 37 samples of pottery and daub fragments from Punta di Zambrone (province of Vibo Valentia) by combining thin-section petrography and Neutron Activation Analysis (NAA) geochemistry. The aim is to identify possible production areas for some wheelmade vessels of Aegean type and better define raw materials and paste recipes for the local handmade *impasto* ware. By integrating petrographic and NAA results, one reliable group emerged, which refers to the local specialised production of Recent Bronze Age (RBA) open shapes. A filter test allowing larger elemental variances was applied on NAA data in order to identify further groups (named special groups) to be specifically compared with petrographic fabrics. The special NAA group Ul41 and petro group 3, including local reference materials such as daub fragments, correlate well. Furthermore, the concentration pattern of Ul41 is close to that of local clay deposits (Cava Monaca and Fiumara Jona). The RBA closed shapes show a lower correspondence between geochemical and petrographic results, presumably attributable to less standardised production processes.

Keywords: Bronze Age pottery, southern Tyrrhenian Calabria, provenance determination, production technologies, combined analytical approach, NAA geochemistry, thin-section petrography

Introduction

This paper deals with provenance determination of ceramic finds from the southern Calabrian settlement of Punta di Zambrone and methodological issues of the combination of different analytical methods. We are investigating the two major classes of ceramic vessels found at Punta di Zambrone: first, the so-called *impasto* pottery that is handmade and includes medium-coarse to coarse wares and, second, the Aegean-type pottery that is wheelmade and consists of vessels made in fine to medium-coarse fabrics. Both pottery classes have already been analysed independently using two different methodological approaches adapted to the specific technological properties of the two classes. Pamela Fragnoli investigated the coarser *impasto* pottery by using petrographic analyses,[4] while Hans Mommsen analysed Mycenaean- and Minoan-type pottery by means of Neutron Activation Analysis (NAA).[5] The results of both studies provoked us to undertake a further, integrated study combining the two approaches in order to arrive at a greater precision of provenance determination for specific vessels and to learn more about production processes such as the raw material procurement patterns and the paste preparation modes.

[1] Austrian Archaeological Institute, Austrian Academy of Sciences, Franz-Klein-Gasse 1, 1190 Vienna, Austria; pamela.fragnoli@oeai.at.

[2] Helmholtz-Institut für Strahlen- und Kernphysik, University of Bonn, Nussallee 14–16, 53115 Bonn, Germany; mommsen@hiskp.uni-bonn.de.

[3] Austrian Archaeological Institute, Austrian Academy of Sciences, Hollandstraße 11–13, 1020 Vienna, Austria; Reinhard.Jung@oeaw.ac.at.

[4] See Fragnoli, this volume.

[5] Jung et al. 2015a.

Petrographic samples	Find no.	Petro groups	NAA samples	NAA groups, standard evaluation	NAA groups, special evaluation	Chronology	Vessel shape (according to C. Capriglione, M. Pacciarelli and R. Jung)
impasto pottery							
IP1	PZ66cCC9/5	1	KP 48	singleton	Ul94	RBA 2	jar with finger-impressed rib (not included in the typological classification)
IP5	PZ66dBB10/4	2	KP 59	pair with IP36	pair with IP36 (=260)	RBA 2	jar (not included in the typological classification)
IP8	PZ66cBBCC9/1	2	KP 51	ZamB	ZamB	RBA 2	wall sherd (not included in the typological classification)
IP9	PZ66/P118/2	2	KP 49	ZamB	ZamB	RBA 2	large closed shape with horizontal handle (XVIIIb-group 1)
IP11	PZ66aCC11/1	2	KP 53	singleton	Ul78	RBA 2	bowl with enlarged rim (not included in the typological classification; attributable to the typological family IIa2)
IP12	PZ66aBBCC10/1 + PZ151EE11/3	2	KP 50	ZamB	ZamB	RBA 2	shallow carinated cup with short, very concave wall (IVa6-24E)
IP17	PZ86/P61	6	KP 60	singleton	Ul78	EBA 2	jar with short vertical rib
IP18	PZ83/P21/2	1	KP 64	singleton	singleton	EBA 2	jar
IP21	PZ86/P20	6	KP 61	singleton	singleton	EBA 2	Cessaniti style cup
IP23	PZ109/P3	5	KP 69	singleton	Ul78 assoc.	MBA ?	truncated conical foot
IP28	PZ86/P35/2	4	KP 68	singleton	singleton	EBA 2	jar with strap handle
IP29	PZ86/P34	6	KP 62	singleton	Ul78	EBA 2	Capo Graziano-like cup
IP30	PZ86/P43	1	KP 66	singleton	Ul94	EBA 2	baking plate
IP31	PZ140/P1/2	5	KP 54	singleton	Ul78 assoc.	MBA 3	bowl on high foot decorated with ribs (Thapsos-Milazzese style; XXII-A)
IP32	PZ129/P31	1	KP 52	singleton	Ul94	RBA 2	jar with strap handle placed on the maximum expansion point (X22-116)
IP33	PZ6a/P9/1	2	KP 65	ZamB	ZamB	RBA 2	*impasto* vessel with everted rim (XXV-group 3.d)
IP35	PZ83/P26	4	KP 63	singleton	Ul78	EBA 2	Large carinated cup
IP36	PZ161BBCC10-12PUL/5	1	KP 70	pair with IP5	pair with IP5 (=260)	RBA 2	waster/missfired vessel
IP37	PZ86/P110	1	KP 67	singleton	Ul78	EBA 2	deep carinated cup

Petrographic samples	Find no.	Petro groups	NAA samples	NAA groups, standard evaluation	NAA groups, special evaluation	Chronology	Vessel shape (according to C. Capriglione, M. Pacciarelli and R. Jung)
IP39	PZ151/P24 + PZ151FFGG12/21	1	KP 47	ZamB	ZamB	RBA 2	jar with funnel-shaped rim (X22-116)
IP40	PZ129DDEE12/1	2	KP 56	ZamB	ZamB	RBA 2	strap handle with fragmentary configured ending (not included in the typological classification)
IP41	PZ159/P3/1	7	KP 58	singleton	singleton	EBA 1	large jar with finger-impressed rim
IP42	PZ145/P5	7	KP 57	singleton	singleton	EBA 1	vessel with everted neck
IP51	PZ145/P10/10	5	KP 55	singleton	singleton	EBA 1	deep cup with strap handle
IP61	PZ192/P3/2	5	KP 80	singleton	singleton	EBA 1	cup with strap handle
IP64	PZ75FFGG8-9/10 + PZ151DD11/49	1	KP 78	singleton	singleton	RBA 2	*pithos* (XIIb-gripping elements)
IP66	PZ151EE10/43	1	KP 77	singleton	Ul94	RBA 2	*pithos* with high, undecorated plastic band (XIIb-plastic bands A)
clays(c) and structural ceramics							
	PZ166a/P22		KP 34c	singleton	Ul78 assoc.	RBA 2	clay sample
	PZ176FFGG10/180		KP 71	singleton	Ul94	RBA 2	clay bin ?
	PZ176FFGG10/119		KP 75	singleton	singleton	RBA 2	daub
	PZ66bCC11/10		KP 76	singleton	singleton	RBA 2	probable oven fragment (XXIVb-134)
	PZ128FFGG12/9.17		KP 79	singleton	Ul78	RBA 2	large storage vessel with high concave neck (XIIa24-121)
IP46	PZ151DD12/1	3	KP 74	ZamA assoc.	Ul41	RBA 2	daub
IP49	PZ151FFGG10/57	3	KP 73	pair with IP50	Ul41	RBA 2	daub
IP50	PZ151DD10/1	3	KP 72	pair with IP49	Ul41	RBA 2	daub
wheelmade pottery							
KP 35	PZ129aBBCC9/1	loner	KP 35	pair with KP 29		RBA 2	large coarse-ware stirrup jar FT 164
KP 36	PZ151EE10/1	loner	KP 36	singleton		RBA 2	large closed vessel of Mycenaean/Minoan coarse ware

Tab. 1 List of the 37 analysed samples with assignment of the petrographic and NAA groups. The NAA groups were formed using the usual and a special statistical filter procedure (see text). Samples that are only associated may be singletons

NAA Groups

After the petrographic study of the coarse *impasto* pottery from Punta di Zambrone a large number of the fragments were analysed by NAA. This method has been in use in Bonn for more than 25 years with the aim to provenance pottery. The measurement procedure and also the 'filter' statistical data evaluation method were described recently, presenting the NAA results of the Mycenaean and Minoan samples from Punta di Zambrone.[6] The *impasto* and other samples, including local reference material and clay from this site, are treated here and labelled KP 34–36, 47–80.

Impasto Pottery

The measured raw weight concentration data for these samples are listed in appendix 1. The NAA grouping results have been not very satisfactory. According to our standard statistical filter method, we have seen almost exclusively singletons (see Tab. 1). The standard method calculates modified distances between single samples and other single samples or with an already existing group of samples considering dilution and the experimental uncertainties of the samples or the spreads (root mean square deviations) in the case of groups.[7] The value of this modified distance can be transformed into the probability that the samples belong to the same group or that one sample belongs to an existing group. Six samples out of the total of 35 samples marked ZamB in Tab. 1 form a pattern with acceptable small spreads (except for Co: variance 19%, see column 1 in Tab. 2). Furthermore, samples KP 59 and the waster KP 70 (IP5 and IP36) probably form a chemical pair, but the concentrations of some elements are not very close to each other, e.g. Cs varies by 28%. Both samples are well separated from all other material in our database. A 2nd (also bad) pair can be formed by the daub samples KP 72 and 73 (IP50 and IP49, both petro group 3), but values vary in Rb by 33% and in Hf by 20%. The concentration patterns of these probable pairs are also shown in Tab. 2.

Tab. 2 Elemental pattern obtained using the normal routine statistical filter method of the NAA groups ZamB and the sample pairs PZ KP 59+70 and PZ KP 72+73. Given are the average concentration values M in µg/g (ppm), if not indicated otherwise, and the spreads σ (root mean square deviations) in % of M. The individual samples have been multiplied by the best relative fit factor with respect to M (given below)

	ZamB 6 samples factor 1.00			**KP59+70 2 samples factor 1.00**			**KP72+73 2 samples factor 1.00**	
	M	σ(%)		M	σ(%)		M	σ(%)
As	22.9	(35.)		8.23	(10.)		4.73	(29.)
Ba	1708.	(18.)		1088.	(54.)		1080.	(9.0)
Ca\%	2.04	(32.)		2.62	(10.)		19.1	(19.)
Ce	113.	(7.4)		94.0	(6.7)		33.7	(0.9)
Co	15.1	(19.)		13.5	(4.0)		7.97	(4.6)
Cr	46.5	(6.4)		28.1	(4.7)		25.9	(4.9)
Cs	6.02	(5.8)		3.14	(28.)		1.19	(12.)
Eu	1.67	(8.5)		1.49	(5.2)		0.66	(10.)
Fe\%	5.34	(8.1)		4.13	(2.9)		1.89	(4.6)
Ga	21.5	(9.5)		19.8	(14.)		7.85	(20.)

6 Jung et al. 2015a and references therein.

7 Beier – Mommsen 1994a; Beier – Mommsen 1994b.

	ZamB 6 samples factor 1.00			KP59+70 2 samples factor 1.00			KP72+73 2 samples factor 1.00	
Hf	7.36	(4.1)		6.08	(8.7)		2.38	(20.)
K\%	1.23	(6.6)		1.75	(2.8)		0.75	(30.)
La	56.8	(3.6)		48.5	(8.5)		17.6	(1.7)
Lu	0.40	(7.3)		0.29	(9.8)		0.17	(4.5)
Na\%	0.92	(5.5)		1.31	(11.)		0.46	(3.5)
Nd	42.6	(10.)		38.3	(6.3)		12.8	(11.)
Ni	47.5	(54.)		25.3	(88.)		143.	(23.)
Rb	87.2	(8.2)		116.	(4.3)		29.2	(33.)
Sb	0.55	(18.)		0.24	(15.)		0.34	(5.4)
Sc	18.0	(1.7)		17.0	(3.7)		7.35	(3.1)
Sm	7.74	(7.0)		6.40	(1.1)		2.12	(1.2)
Ta	1.79	(7.0)		0.80	(19.)		0.45	(5.7)
Tb	0.90	(14.)		0.61	(7.8)		0.35	(8.8)
Th	21.3	(1.9)		12.5	(10.)		4.90	(0.8)
U	3.56	(12.)		0.78	(33.)		1.14	(24.)
W	2.59	(6.6)		1.69	(17.)		1.02	(11.)
Yb	2.86	(5.8)		1.85	(18.)		1.19	(2.8)
Zn	88.7	(15.)		94.8	(1.8)		112.	(3.4)
Zr	293.	(7.0)		234.	(24.)		109.	(29.)

best relative fit factors for group
ZamB: KP 47(1.06), 49(0.99), 50(1.02), 51(0.93), 56(0.99), 65(1.01)
pair KP59+70: KP 59(1.02), 70F(0.98)
pair KP72+73: KP 72Z(1.03), 73Z(0.97)

If the coarseness of pottery is due to (natural or artificial) admixtures of sand or calcite or some other compounds that do not have high concentrations of the trace elements measured by NAA, the difference in the patterns of fine and coarse ceramic products can be corrected by a best relative fit adjusting 'diluted' or 'concentrated' clays to a common basis and reducing the spreads.[8] But, on the other hand, if the coarse non-plastic parts have a high or varying trace and minor elemental content, more blurred or even different patterns are expected in NAA for pottery samples made of the same clay, but with different admixtures or different amounts of such admixtures.[9] Since petrography did show groups and no loners, a filter test allowing larger modified distances to form groups has been executed to see if the many chemical loners can be allocated to groups. The resulting special group assignments of the former singletons are given in Tab. 1, 6th column.

A special group Ul41 is formed with the former pair of daub samples KP 72 and 73 and the third sample in petro group 3, KP 74. This group, Ul41, is close in concentration space to the group of local clays previously named ZamA (see Tab. 3).[10]

8 Mommsen – Sjöberg 2007; for an extreme case of dilution see Mommsen et al. 2006.
9 Sterba et al. 2009.
10 Jung et al. 2015a.

Tab. 3 Elemental patterns obtained using a special statistical filter method allowing larger variances of the NAA groups ZamA, Ul41, ZamB, Ul78, and Ul94. Given are the average concentration values M in µg/g (ppm), if not indicated otherwise, and the spreads σ (root mean square deviations) in % of M. The individual samples have been multiplied by the best relative fit factor with respect to M (given below). 'factor' is the best relative fit factor for the group Ul41 with respect to group ZamA and for the other groups Ul78 and Ul94 with respect to group ZamB. Note the differences in the variances between the normal NAA groups ZamA and ZamB and the groups formed especially for comparison with the petro groups

	ZamA 4 samples factor 1.00		**Ul41 3 samples factor 0.96**		**ZamB 6 samples factor 1.00**		**Ul78 6 samples factor 1.22**		**Ul94 6 samples factor 1.03**	
	M	σ(%)	M	σ(%)	M	σ(%)	M	σ(%)	M	σ(%)
As	4.47	(45.)	3.82	(47.)	22.9	(35.)	14.7	(50.)	11.6	(44.)
Ba	196.	(31.)	819.	(51.)	1708.	(18.)	1696.	(23.)	1121.	(34.)
Ca\%	34.1	(60.)	18.5	(15.)	2.04	(32.)	2.22	(21.)	--	
Ce	33.7	(7.7)	33.0	(0.7)	113.	(7.4)	113.	(16.)	226.	(23.)
Co	10.6	(8.8)	7.65	(4.6)	15.1	(19.)	12.7	(28.)	14.0	(31.)
Cr	37.0	(8.4)	26.7	(8.7)	46.5	(6.4)	44.4	(8.6)	42.7	(49.)
Cs	2.91	(5.1)	1.61	(48.)	6.02	(5.8)	4.53	(27.)	4.02	(39.)
Eu	0.62	(5.4)	0.64	(6.6)	1.67	(8.5)	1.85	(6.2)	1.87	(18.)
Fe\%	1.72	(9.4)	1.89	(3.4)	5.34	(8.1)	4.92	(7.7)	4.43	(15.)
Ga	8.55	(30.)	8.47	(18.)	21.5	(9.5)	23.9	(11.)	22.3	(17.)
Hf	1.71	(16.)	2.25	(18.)	7.36	(4.1)	8.22	(12.)	6.48	(34.)
K\%	0.93	(8.9)	0.80	(23.)	1.23	(6.6)	2.10	(25.)	1.91	(17.)
La	16.6	(5.5)	17.3	(0.3)	56.8	(3.6)	59.1	(13.)	111.	(28.)
Lu	0.18	(5.1)	0.17	(3.7)	0.40	(7.3)	0.46	(24.)	0.35	(24.)
Na\%	0.31	(34.)	0.40	(25.)	0.92	(5.5)	1.83	(26.)	1.29	(51.)
Nd	11.9	(9.9)	12.5	(11.)	42.6	(10.)	48.8	(18.)	86.9	(19.)
Ni	158.	(53.)	117.	(40.)	47.5	(54.)	68.0	(47.)	65.9	(48.)
Rb	49.7	(5.9)	37.9	(45.)	87.2	(8.2)	114.	(17.)	102.	(24.)
Sb	0.60	(48.)	0.28	(31.)	0.55	(18.)	0.49	(28.)	0.52	(53.)
Sc	6.47	(3.9)	7.32	(2.5)	18.0	(1.7)	17.7	(6.1)	17.0	(14.)
Sm	1.99	(4.2)	2.08	(1.0)	7.74	(7.0)	8.38	(15.)	12.9	(11.)
Ta	0.45	(14.)	0.45	(5.6)	1.79	(7.0)	1.45	(25.)	1.18	(30.)
Tb	0.35	(12.)	0.36	(8.5)	0.90	(14.)	0.99	(12.)	1.03	(17.)
Th	4.70	(4.1)	4.87	(2.0)	21.3	(1.9)	19.2	(18.)	25.2	(26.)
U	1.43	(21.)	1.08	(18.)	3.56	(12.)	2.66	(11.)	2.34	(31.)
W	0.97	(13.)	0.93	(12.)	2.59	(6.6)	1.96	(22.)	1.92	(14.)
Yb	1.20	(6.5)	1.19	(3.8)	2.86	(5.8)	3.23	(25.)	2.48	(23.)
Zn	75.5	(52.)	98.6	(21.)	88.7	(15.)	100.	(15.)	87.9	(21.)
Zr	54.5	(36.)	99.7	(28.)	293.	(7.0)	327.	(14.)	282.	(25.)

best relative fit factors for group
ZamA: KP 23T(1.71), 24T(1.51), 25T(1.06), Gesu 2(0.56) (matching sample from Gela)
ZamB: see Table 2
Ul41: KP 72Z(1.07), 73Z(0.98), 74Z(0.95)
Ul78: KP 53(0.85), 60(1.00), 62(0.97), 63(1.17), 67(1.14), 79(0.91)
Ul94: KP 44(0.80), 48(1.12), 52(0.89), 66(1.27), 71Z(1.06), 77(0.89)

Two further special groups, Ul78 and Ul94, could be formed. They are not very different from one another (Tab. 3) and also close in composition to the pair (=260) KP 59 and KP 70. They are clearly distinguishable from all other groups in our database. Despite the large abundance variations there is no overlap with other samples in our database in this case. This is also true for the groups Ul41 and ZamA. It seems that the clay pastes utilised in the region of Punta di Zambrone have a concentration signature that distinguishes them from all other clays represented in our database.

All the special groups show a large scatter of concentrations for many elements. This points to the fact that the vessels of the special groups do not originate from one single production series with well-homogenised clay paste in a pottery workshop, but have been made with pastes prepared using several different recipes in one or in several different workshops. The special groups have been formed here only to compare them with the petro groups. They should not be used to answer questions of provenance, since there is a not-negligible probability that some pottery sample from somewhere else matches these strongly varying patterns with variations of some elemental concentrations of up to several 10%.[11]

Wheelmade Pottery

The samples KP 27 and 36 have, according to NAA, a different elemental composition and are singletons. The samples KP 29 and 35, probably from the same vessel, form a chemical singleton pair.[12] Given the fact that sample KP 41 (a deep bowl type C) is a member of group LacA and thus a Laconian product, and given the new evidence for Laconian–Italian contacts brought to light by the excavation results at the palace site of Ayios Vasileios,[13] we tried to describe the Laconian connection of Punta di Zambrone with greater precision.

The assignation of LacA to Laconia is based on the geographical distribution of its members and further supported by a clay sample, which is close in composition and was taken from the Menelaion hill.[14] This might suggest that the deep bowl found at Punta di Zambrone comes from a potter's workshop not far from that site. In order to assess the chemical variability of Laconian clay deposits and improve the differentiation between different Laconian production regions, we have now measured one further Laconian clay sample. It was collected at the clay bed of Lefkochoma, 4.3km to the east of the Mycenaean palace of Ayios Vasileios. However, this sample turned out to be a singleton. Its measured raw weight concentration data are listed in Appendix 2, Tab 1.

Petrographic Fabrics

Impasto pottery

Under the microscope, the 67 *impasto* samples from Punta di Zambrone were distributed into seven fabric groups based on different rocks/minerals ratios, muscovite and biotite amounts, variety of K-feldspars, occurrence of volcanic ash and calcareous-fossiliferous components, temper amount and grain size distribution. These fabrics indicate different local supply sources within the region of the Poro promontory and correlate well with the different occupation phases of the site. The petrographic groups 1, 2 and 3 are peculiar to the RBA pottery assemblage and are described elsewhere in this volume (see note 4). The descriptions of the EBA petro groups are reported here below.

---

11 An example is given in Jacobs et al. 2017.

12 Jung et al. 2015a.

13 See Kardamaki – Vasilogamvrou, this volume.

14 Jung et al. 2015a, 458–460, tab. 1.

PETRO GROUP 4 – Granitic with non-micaceous clay matrix and rare fine biotite (Fig. 1a–b)

This fabric includes the samples IP24, IP25, IP26, IP27, IP28, IP30, IP35, IP37, IP54 and shows inclusions with angular to subangular and elongate to equant shapes, a maximal diameter of 3.2mm, an incidence of 15–20%, a polymodal grain size distribution and a weak to moderate alignment.

All the grain size fractions are equally represented. In the coarse one, with grains greater than 1.2mm, granitic rocks predominate, quartzes (also polycrystalline) are common, plagioclase few, K-feldspars (orthoclase, anorthoclase, microcline) rare. Granites are composed of plagioclases, microclines, quartzes and orthoclases and often exhibit pertitic and granophyric structures. The medium and fine fractions, composed of inclusions greater and smaller than 0.6mm, are both characterised by the predominance of quartz and the frequent occurrence of plagioclases and K-feldspars (microcline and orthoclase). Few granites are visible in the medium fraction, while the fine fraction can also include occasional biotites, muscovites and very rare epidotes.

The clay matrix accounts for 73% of the ceramic paste, is neither calcareous nor micaceous, exhibits orange-brownish colours and various degrees of optical activity, from isotropic to anisotropic with striated and speckled b-fabrics. The 7% porosity consists in meso- and macro planar voids aligned to the margins.

PETRO GROUP 5 – Quartz- and feldspar-based well-sorted fabric with micaceous matrix (Fig. 1c–d)

The samples IP19, IP31, IP51, IP52, IP54, IP61, IP62 and IP63 were classified into this group. The inclusions account for 15–20%, reach a maximal diameter of 1.6mm but are generally smaller than 0.8mm, have a unimodal to bimodal grain size distribution, different degrees of roundness/sphericity (angular to subrounded, elongate to equant) and a random or weakly aligned orientation.

The fine fraction (15% inclusions <1mm) clearly prevails over the coarse one (5%) and is composed of predominant quartzes, dominant biotites, frequent plagioclases, common K-feldspars (orthoclase and microcline) and occasional muscovites and epidotes. Quartz also predominates in the coarse fraction, besides a few biotites and granites and rare orthoclases.

The 30% clay matrix is distinguished by a strong optical activity, both under parallel and crossed polarised light (with striated b-fabrics), due to its prevalent biotitic composition. It appears brown in parallel polarised light and brown-yellowish to orange-brownish in crossed polarised light and may display dark or light cores. The porosity is composed of 7–10% meso- and macro planar voids, vughs and vescicles that are oriented parallel to the margins.

PETRO GROUP 6 – Granitic with micaceous matrix and predominant fine biotite, volcanic ashes and frequent muscovites (Fig. 1e–f)

This fabric occurs in the samples IP17, IP21 and IP29 and is composed of 15–20%, angular-shaped, randomly oriented inclusions with a maximal diameter of 2mm and a marked bimodal grain size distribution.

The coarse fraction accounts for 5% and is formed by grains greater than 1.55mm, namely predominant granites, dominant quartzes (also polycrystalline) and rare orthoclases. The fine fraction is represented by 10–15% grains smaller than 0.8mm related, in descending order of incidence, to quartzes (predominant), volcanic ash, biotites (predominant–frequent), plagioclases (dominant), muscovites (frequent–common), orthoclases (frequent), microclines (rare–very rare) and green amphiboles (very rare).

The matrix (70%) is micaceous, optically active with striated b-fabrics and exhibits dark cores with orange (XPL) and orange–yellowish (PPL) margins. The porosity consists in 10% micro- and mesoplanar voids aligned to margins.

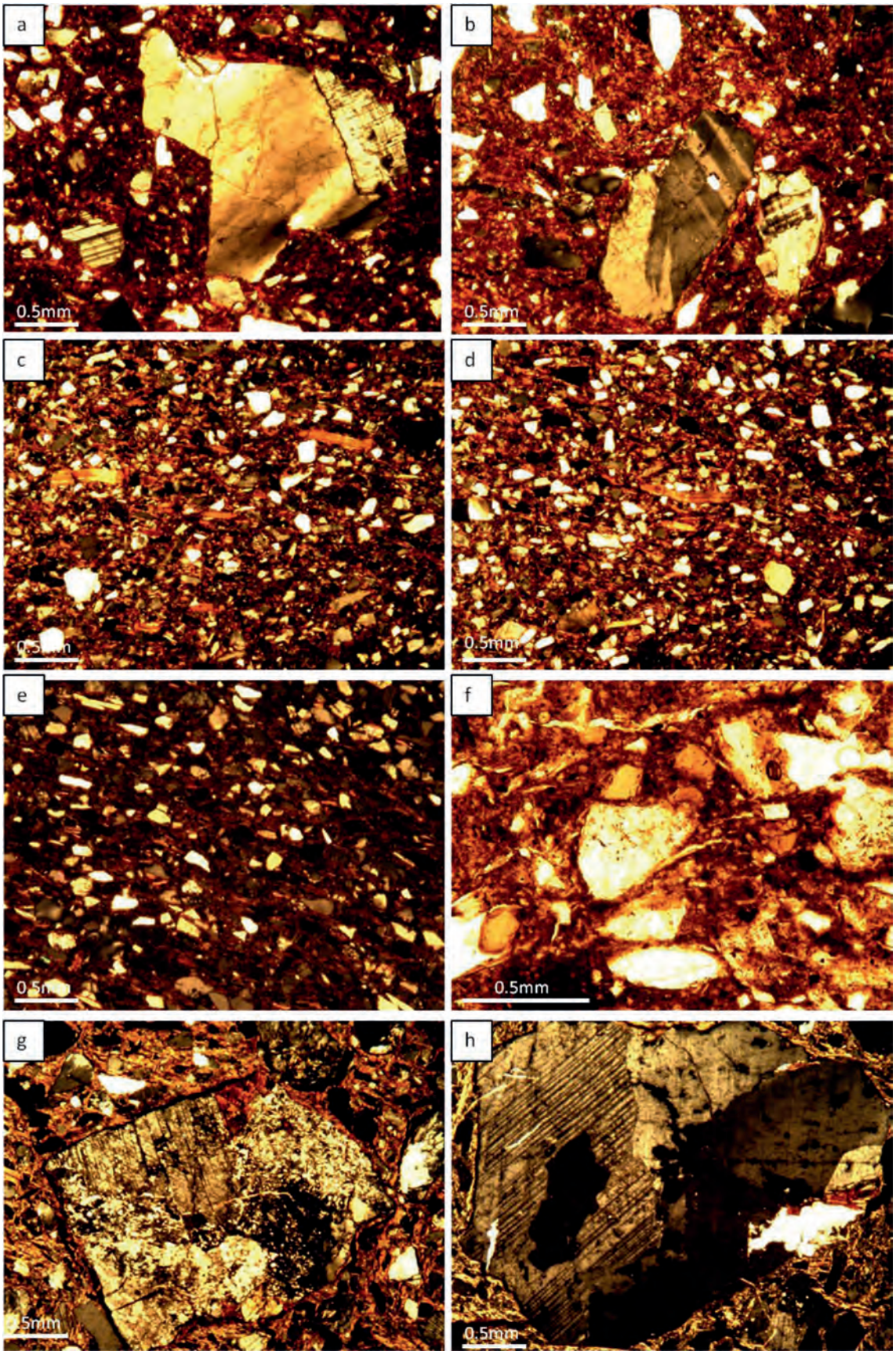


Fig. 1 Microphotographs of EBA petro-groups 4 (a–b), 5 (c–d), 6 (e–f) and 7 (g–h). Except for fig. 1f, all the pictures were taken under crossed polarised light (photos: P. Fragnoli)

PETRO GROUP 7 – Granitic with micaceous matrix and dominant–frequent fine biotites and rare fine muscovite (Fig. 1g–h)

This fabric comprises the samples IP41 and IP42 and is composed of 20% inclusions with a maximal diameter of 5.4mm, angular and elongate–equant shapes, a random orientation and polymodal grain size distribution. The coarse fraction, including grains greater than 1.4mm, clearly prevails over the medium (1.4–0.6mm) and fine fractions (< 0.6mm).

The coarse and medium fractions are composed, in decreasing order of abundance, of granites, quartzes (predominant–dominant), orthoclases (common–few) and microclines (few–rare). Besides predominant quartzes, the fine fraction contains dominant–frequent biotites, frequent–common plagioclases, orthoclases, very few–rare microclines, rare muscovite, granite and very rare epidote. The clay matrix (75%) is micaceous, brown–yellowish in PPL and yellowish in XPL, optically active with striated b-fabrics. Voids are formed by 5% mesovughs randomly distributed within the matrix.

Wheelmade Pottery

In the case of two wheelmade pots (samples KP 35 and KP 36), we chose to supplement the NAA with a petrographic analysis for two specific reasons. First, these two samples belong to the rarer medium–coarse fabrics of wheelmade pottery, for which the probability of finding characteristic inclusions that can be related to specific geographic regions is higher than is the case with the fine fabrics that dominate the Aegean-type ceramics assemblage of Punta di Zambrone. Second, the results of the NAA induced us to look for further methods to narrow down a possible production region for these two vessels.

KP 36 belongs to a wall fragment of a vessel that might be assignable to the same fabric as the false neck fragment of a large stirrup jar, which has already been published.[15] The false neck belongs to a coarse-ware stirrup jar FT 164 – often called ‘transport stirrup jar’, a type that is only very rarely found in southern Italy and Sicily. It was possible to take a sample from the false neck with the corundum drill from the interior wall (sample KP 27), while a petrographic sample would have destroyed the piece to an unjustifiable degree. Therefore, we alternatively sampled the wall sherd KP 36 for petrography. This sherd likewise belongs to a large closed vessel and seemed to show the same fabric characteristics as the false spout fragment. However, the chemical analysis disproved the macroscopic fabric classification, as KP 36 does not form a pair with KP 27, but turned out to be a chemical loner.

KP 35 forms a chemical pair together with KP 29 (see above). Both of the sampled sherds most probably belong to one and the same vessel. This vessel, a large closed shape with a thick whitish slip and a shiny red paint, was classified as macroscopic fabric PZ-M9 and it is the only example at the site. It therefore seemed to be a possible import to Punta di Zambrone and more specifically an import that might attest to contacts with a region that may not be detectable via other evidence from the site. Since its first publication[16] more sherds could be assigned to this vessel. It is also a large coarse-ware stirrup jar. One shoulder fragment with neck attachment and plastic rib, two belly fragments and one fragment from the lower wall are extant.[17]

The samples KP 35 and KP 36 are both petrographic loners among the pottery assemblage from Punta di Zambrone. KP 35 (Fig. 2a) is composed of 20% inclusions showing different sphericity and roundness degrees (angular to subrounded, elongate to equant), a maximal diameter up to 1.25mm, and a polymodal grain size distribution. Quartz mica schists predominate in the coarse and medium fractions, i.e. in the ranges between 1.25–0.75mm and 0.75–0.33mm. Besides

[15] Jung et al. 2015b, 73, fig. 14.13; 75–77, 97 cat. no. 24.

[16] Jung et al. 2015b, 76–77, fig. 16.4, 6; 99 cat. nos. 35 and 37.

[17] The small diameter precludes the identification as any kind of narrow-necked jug. For FT 164 with a plastic rib close to the false neck attachment see Haskell et al. 2011, figs. 3.KN05, 7.MYC45, MYC46, 11.TH03, TH04, 12.TH05, 18.ZYG09.

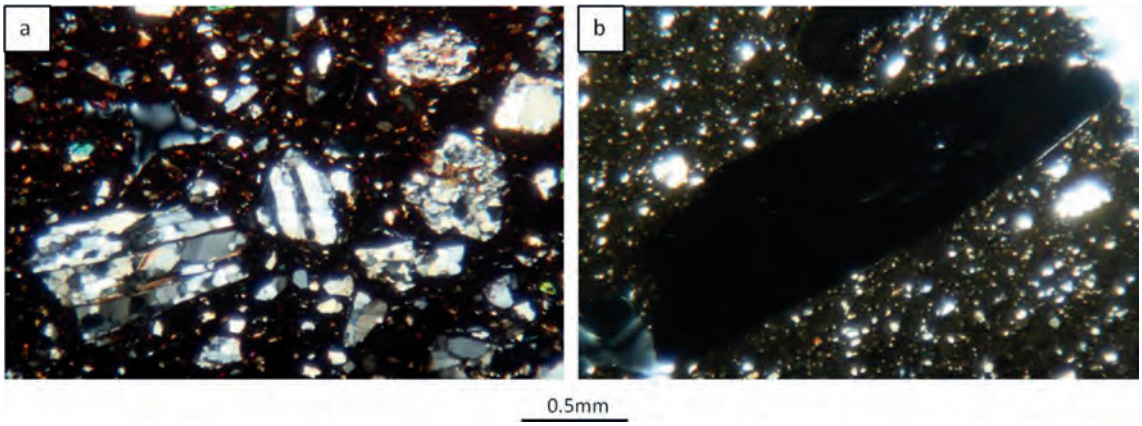


Fig. 2 Microphotographs under crossed polarised light of the wheelmade samples PZ KP35 (a) and PZ KP36 (b) (photos: P. Fragnoli)

quartz mica schists, few inclusions of quartzite occur in the coarse fraction, while the medium fraction also includes common polycrystalline quartzes and rare plagioclases. The inclusions of the fine fraction are smaller than 0.3mm and consist of predominant quartzes, common epidotes, and occasional muscovites. The matrix accounts for 65% of the ceramic paste. It appears as silty, non-calcareous, optically inactive, and exhibits bands of different colours due to different firing horizons. These bands are brown and reddish-brown in plane polarised light and dark red and brown in crossed polarised light. The porosity is composed of 15% micro- and meso-planar voids aligned to margins.

The sample KP 36 (Fig. 2b) is composed of 15% inclusions with angular, equant–elongate shapes, a maximal diameter of 1.6mm, a bimodal grain size distribution dominated by the fine fraction (<0.3mm) and a strong alignment to margins. Dark mudstones greater than 0.65mm predominate in the coarse fraction. The fine fraction consists of predominant quartzes (sometimes polycrystalline or metamorphic), very few biotites, rare muscovites and very rare quartz-mica schists. The matrix is silty, non-calcareous, brown in PPL and dark brown in XPL and optically inactive. The porosity is composed of 5% meso- and macrochannels aligned to margins.

Discussion and Conclusions

Provenancing of pottery by chemical analyses is possible, since the elemental patterns normally characterise the clay pastes used for production that are assumed to stem from local or nearby claybeds. The minor and trace elements of mainly the plastic (clay) parts of the paste dominate the patterns, since the non-plastic admixtures like sand or calcite usually have low trace element concentrations. The minerals of the plastic parts are too small (c. 2µm) to be seen in petrography. There, mainly the non-plastic larger admixtures are investigated and the petro groups formed depend on these admixtures. So an agreement between chemical analyses and petrography is not necessarily expected; both methods look at different parameters stored in pottery. But the formation of ‘special’ NAA groups allowing larger elemental variances has been partly successful in reproducing the petro groups. In Tab. 4 a comparison of the petro groups and the NAA special groups is given. We stress again that the patterns of the special NAA groups are not suited for provenance determinations.

NAA/Petro groups	1	2	3	4	5	6	7	none	totals
ZamB	47	**49,50, 51,56, 65**							6
Ul78	67	53		63	69-	60,62		34-,54-,79	6+3-
Ul94	**48,52, 66,77**							[44],71	5+[1]
Ul41			**72,73, 74**						3
pair =260	70	59							2
singles	64,78			68	55,80	61	57,58	75,76	10
totals	10	7	3	2	3	3	2	5	35

Tab. 4 Comparison of petro groups and NAA groups. Given are the KP Nos. Only associated samples (marked with a 'minus') may be singletons. [44] has been published as a singleton in Jung et al. 2015a

Impasto Pottery

A clear correspondence emerges between petro group 2 and NAA group ZamB. Five of the six members of ZamB belong to the petro group 2. This correspondence should be interpreted not only in terms of provenance since it strongly reflects technological, morphological, functional and chronological aspects as well.[18] Indeed, petro group 2 and NAA group ZamB include the open shapes from the Recent Bronze Age 2 levels, which are characterised by recurrent and distinct raw material procurement patterns, paste preparation modes, finishing techniques and firing procedures.[19] Thus, this combined analytical approach allowed us to clearly identify a petrochemical reference group for the most specialised pottery production of Punta di Zambrone.

A further agreement is seen for the three daub pieces IP 46, 49, and 50 (KP 74, 73, and 72) in petro group 3. They are in NAA special group Ul41. This concentration pattern is close to the pattern ZamA of the local clay deposits of Cava Monaca and Fiumara Jona (see note 2). Although, as already mentioned, the special NAA groups should not be used for provenance determinations, we can assume that the group Ul41 reflects a local signature since it only refers to daub fragments, normally considered as local reference materials, and shows geochemical affinities with a local clay deposit.

The petrographic results evidenced the exploitation of a further local source during the RBA for the production of closed shapes, baking plates and cooking stands. These artefacts belong to the petro group 1 and four of them belong to special NAA group Ul94. A 5th sample, KP 71, most probably belonging to a clay bin,[20] was not analysed petrographically and a sixth Mycenaean sample, KP 44, has been published before as a single item.[21] Other petro group 1 samples do not show a geochemical homogeneity as they are assigned to NAA singletons. The higher variability of petro group 1 with respect to petro group 2 also emerged under the polarising microscope. Though all the samples of petro group 1 are characterised by granite tempering, some of them were considered as variants due to the occurrence of grog, sandstones, fossils, vegetal fibres or the lack of biotite. Closed shapes, baking plates and cooking stands were thus produced with less standardised raw materials and recipes with respect to those used for tablewares (petro group 2 and NAA group ZamB). Nevertheless, these clay-based artefacts used over fire show some re-

18 See Fragnoli, this volume.

19 For a broader discussion of this evidence, see Fragnoli, this volume.

20 Circular clay bins made of unfired clay belong to the fixed installations that are found in many late Mycenaean houses.

21 Jung et al 2015a.

current choices in terms of thermal shock resistance and heating conductivity, such as the temper coarseness, the tabular shape of micas and the occurrence of granites.

The members of the special group Ul78 cannot be assigned to a single petro group. We consider this as an expected result, since petrography and chemical analyses, as already mentioned, look at different parameters and are therefore complementary methods. It is only by chance that the elemental content in the mixture of plastic and non-plastic parts is similar to the visible mineral content in thin-section samples.

As for the petro groups peculiar to the EBA levels, no grouping patterns were evidenced by NAA data. This lack of correspondence could be in part due to the low number of samples for each petro group, i.e. only 12 samples distributed into 4 different petro groups. Future sampling and new sets of analyses will hopefully clarify this point.

Wheelmade Pottery

The mineral and rock association of the sample KP 35 refers to low-grade metamorphic formations that are quite widespread in the Mediterranean area. Similar outcrops occur widely in southern Calabria and in northeastern Sicily.[22] Metamorphic fabrics were also observed in pithoi found at Broglio di Trebisacce and interpreted as imports from the southern Sybaritic plain.[23] However, the chemical composition of sample KP 35 does not match the group SybB, which includes coarse-ware pithoi identified as southern Sybaritic products by means of petrography.[24] Although this does not mean that we can exclude northern Calabria as the production region for KP 35 by archaeometric arguments, such a provenance is nevertheless very improbable. This is due to the fact that so far no large stirrup jar FT 164 has been found at the excavated sites in the plain of Sybaris.[25] The accurate petrographic descriptions provided by Williams on pots found in the Aeolian archipelago but produced in northeastern Sicily from the Middle Neolithic to the Late Bronze Age represent an excellent possibility for fabric comparison.[26] Indeed, Williams identified 8 different petro groups with low-grade metamorphic rocks related to different Sicilian supply sources. However, contrary to what we can observe in KP 35, these groups are quite rich in K-feldspars, do not contain plagioclases or epidotes and show a prevalence of single minerals over rocks.

Low-grade metamorphic rocks also occur in the Aegean environment, in particular in Crete (northern quartzite-phyllite series) and in the Cyclades.[27] Quartz-mica schists and quartzites recur in different fabrics of western and central Crete reported by Day[28] and Boileau.[29] However, the fabric of KP 35 differs from them for the lack of phyllite and serpentinite and for the higher amounts of muscovite, plagioclase and biotite. Quartz-mica schists crop out in many deposits across the Cyclades,[30] including those documented on Naxos, Amorgos, Ios, Schinousa, as well as further west on Seriphos up to Kea and also possibly Melos. One sample from Kavos on Keros exhibits a similar fabric to that of KP 35, which, according to the author, is compatible with the schist deposits of Naxos but also shows similarities with the schist fabrics of the Western

22 Levi 2010, 35.
23 Levi 1999, 105–108.
24 Jung et al. 2015a, 459.
25 There is a false neck of a stirrup jar found at Torre Mordillo in the central plain of Sybaris (Vagnetti 2001, 303–304, fig. 95.28), but its small diameter of only 3cm precludes an ascription to FT 164 (having false neck diameters between 6 and 7cm or more). This small stirrup jar was classified as a local or regional product based on a chemical analysis by AAS (Jones – Levi 2014, 183 sample no. TM9), the measurements of which are not compatible with those of our NAA.
26 Williams 1967; Williams – Levi 2008.
27 Higgins – Higgins 1996.
28 Fabric 1 in Day 2011, 42–43.
29 Fabrics 1, 2 and 3 in D'Agata – Boileau 2009.
30 Jones 1986, 258–267; Wilson 1999, 24.

Cyclades.[31] However, there is so far no evidence suggesting that large coarse-ware stirrup jars FT 164 were produced on the Cyclades.[32] Thus, we consider the identification of the production region of this stirrup jar an unresolved problem.

The sample KP 36 is compositionally (dark mudstones + low-grade metamorphic rocks) and technologically (high temperature firing, bimodal grain size distribution) comparable with Day's fabric 14.[33] This fabric includes coarse-ware stirrup jars FT 164 found at Chania, Malia and Mycenae and refers petrographically[34] and chemically[35] to different production centres located in central and western Crete. Thus, sample KP36 may, in fact, come from a large coarse-ware stirrup jar FT 164 imported to Punta di Zambrone. However, no definite typological assignment is possible due to the fact that we are dealing with an undecorated wall fragment, the chemical composition of which does not match that of the false neck sample KP27.

Summarising our results, we can say that the petrographic and chemical results agree quite well, although the groupings of both methods coincide only in some cases and to various degrees. In general, the fact that the clay pastes of handmade *impasto* pottery have concentration signatures that distinguish them from all other clays represented in the Bonn NAA database, fits well with the assignation of the petro groups to the surroundings of the settlement that was achieved based on the local geology. Regarding technology, we were able to show that during RBA 2, local production of *impasto* pottery at Punta di Zambrone assumed a more standardised character in comparison to the level the production had reached by EBA 2. Both petrography and NAA support this conclusion. The standardisation concerns open tableware shapes, which emphasises also the importance of these vessels on a social level, i.e. their use during different kinds of group or community consumption. This marked standardisation emerges in various steps of the *chaîne opératoire*,[36] reflecting recurrent and specific potters' choices, and indicates a high level of specialisation and organisation of the pottery production. An increased standardisation and specialisation is extensively documented[37] by the RBA, when the Subapennine culture spread through most of the Italian peninsula. However, while in most of the Subapennine sites this phenomenon implies a general homogenisation in the selection of raw materials and in the preparation of paste recipes,[38] at Punta di Zambrone the archaeometric analyses point to a strong functional characterisation of pottery shapes, which might be related to differences in the pottery consumption modes and contexts rather than to a lower or higher degree of specialisation.

We were also able to test some previous hypothesis regarding the provenance of the large coarse-ware stirrup jars found at the site. Those fragments that could be typologically identified as FT 164 with some certainty cannot be ascribed to Cretan production centres – neither by NAA nor by petrographic analysis. Nevertheless, the petrographic analysis suggests in one case of uncertain typological identification that a large wheelmade closed vessel of coarse-ware had indeed been imported from the island of Crete.

Acknowledgements: The NAA and petrographic data reported in this contribution were carried out in the framework of programme P23619-G19 ('Punta di Zambrone – a Bronze Age Fortified Settlement on the Tyrrhenian Coast of Calabria', directed by R. Jung, OREA) of the Austrian Science Fund (FWF) and project no. 2009MF87BM of the Italian Ministry of Education, Universities and Research (PRIN – *Progetti di Ricerca di Rilevante Interesse Nazionale*), run by the University of Naples Federico II and directed by M. Pacciarelli. The analysis of the new Laconian clay sample was carried out in the framework of the FWF project P28023-G25 ('Studies on the new Mycenaean Palace of Ayios Vasileios in Laconia'). The help of the staff of the research reactor of the Reactor Institute Delft irradiating the samples is gratefully acknowledged.

31 Hilditch 2007.
32 Cf. Haskell et al. 2011.
33 Day 2011, 63–65.
34 Day 2011, 64–65.
35 Day 2011, 84.
36 See Fragnoli, this volume.
37 Levi 1999; Castagna 2003; Castagna 2006; Damiani 2010, 443–445; Levi 2010.
38 Levi et al. 1994–1995; Levi 1999; Recchia – Levi 1999; Levi 2010.

Bibliography

Beier – Mommsen 1994a
Th. Beier – H. Mommsen, Modified Mahalanobis filters for grouping pottery by chemical composition, Archaeometry 36, 1994, 287–306.

Beier – Mommsen 1994b
Th. Beier – H. Mommsen, A method for classifying multidimensional data with respect to uncertainties of measurement and its application to archaeometry, Naturwissenschaften 91, 1994, 546–548.

Castagna 2003
M. A. Castagna, I servizi da simposio in ceramica d'impasto e depurata dalla "casa centrale" di Broglio di Trebisacce, in: D. Cocchi Genick (ed.), L'età del bronzo recente in Italia, Atti del congresso nazionale di Lido Camaiore (Lido Camaiore Ottobre 2000) 263–267.

Castagna 2006
M. A. Castagna, Variazioni dimensionali e variabilità tipologica del vasellame da mensa del Bronzo Recente in Italia meridionale, in: Studi di Protostoria in onore di Renato Peroni (Florence 2006) 354–360.

D'Agata – Boileau 2009
A. L. D'Agata – M.-C. Boileau, Pottery production and consumption in Early Iron Age Crete. The case of Thronos Kephala (Ancient Sybrita), Studi Micenei ed Egeo-Anatolici 51, 2009, 165–222.

Damiani 2010
I. Damiani, L'età del bronzo recente nell'Italia centro-meridionale, Grandi contesti e problemi della Protostoria italiana 12 (Florence 2010).

Day 2011
P. M. Day, Petrographic analyses, in: Haskell et al. 2011, 41–78.

Haskell et al. 2011
H. W. Haskell – R. E. Jones – P. M. Day – J. T. Killen, Transport Stirrup Jars of the Bronze Age Aegean and East Mediterranean, Prehistory Monographs 33 (Philadelphia 2011).

Higgins – Higgins 2006
M. D. Higgins – R. Higgins, A Geological Companion to Greece and the Aegean (Ithaca, New York 2006).

Hilditch 2007
J. Hilditch, Petrographic analysis of EBA ceramics from Kavos (Keros), in: C. Renfrew – C. Doumas – L. Marangou – G. Gavalas (eds.), Keros, Dhaskalio Kavos. The Investigations of 1987–1988, Keros 1 (Cambridge 2007) 238–263.

Jacobs et al. 2017
A. Jacobs – B. Borgers – Ch. Makarona – V. Renson – H. Mommsen – P. Fragnoli – R. Jung, Archaeometric studies on plain ware composition and manufacturing techniques, in: S. Hadjisavvas, Alassa. Excavations at the Late Bronze Age Sites of Pano Mantilaris and Paliotaverna 1984–2000 (Nicosia 2017) 539–558.

Jones 1986
R. E. Jones, Greek and Cypriot Pottery. A Review of Scientific Studies, Fitch Laboratory Occasional Paper 1 (Athens 1986).

Jones – Levi 2014
R. E. Jones – S. T. Levi, Characterisation and provenance, in: Jones et al. 2014, 101–275.

Jones et al. 2014
R. E. Jones – S. T. Levi – M. Bettelli – L. Vagnetti, Italo-Mycenaean Pottery. The Archaeological and Archaeometric Dimensions, Incunabula Graeca 103 (Rome 2014).

Jung et al. 2015a
R. Jung – H. Mommsen – M. Pacciarelli, From west to west. Determining production regions of Mycenaean pottery of Punta di Zambrone (Calabria, Italy), Journal of Archaeological Science: Reports 3, 2015, 455–463.

Jung et al. 2015b
R. Jung – M. Pacciarelli – B. Zach – M. Klee – U. Thanheiser, Punta di Zambrone (Calabria) – a Bronze Age harbour site. First preliminary report on the Recent Bronze Age (2011–2012 campaigns), Archaeologia Austriaca 99, 2015, 53–110.

Levi 1999
S. T. Levi, Produzione e circolazione della ceramica nella Sibaritide protostorica I. Impasto e dolii, Grandi contesti della Protostoria italiana 1, Prima di Sibari 1 (Florence 1999).

Levi 2010
S. T. Levi, Dal coccio al vasaio. Manifattura, tecnologia e classificazione della ceramica (Bologna 2010).

Levi et al. 1994–95
S. T. Levi – A. Cazzella – M. Moscoloni – F. Frattini – M. L. Amadori – E. Pecchioni – S. Conticelli – R. Cioni, Analisi archeometrica della ceramica dell'età del bronzo di Coppa Nevigata (FG). Alcune implicazioni archeologiche, Scienze dell'Antichità 8–9, 1994–95, 101–160.

Mommsen et al. 2006
H. Mommsen – A. Bonanno – K. Chetcuti Bonavita – I. Kakoulli – M. Musumeci – C. Sagona – A. Schwedt – N. Vella – N. Zacharias, Characterization of Maltese pottery of the Neolithic, Bronze Age and Punic phases by neutron activation analysis, in: M. Magetti – B. Messiga (eds.), Geomaterials in Cultural Heritage, Geological Society of London, Special Publication 257 (London 2006) 81–89.

Mommsen – Sjöberg 2007
H. Mommsen – B. L. Sjöberg, The importance of the 'best relative fit factor' when evaluating elemental concentration data of pottery demonstrated with Mycenaean sherds from Sinda, Cyprus, Archaeometry 49, 2007, 357–369.

Recchia – Levi 1999
G. Recchia – S. T. Levi, Morfologia funzionale e analisi archeometriche. Considerazioni preliminari sulla ceramica dell'età del Bronzo di Coppa Nevigata, in: C. Gravina (ed.), Atti 19 Convegno nazionale sulla Preistoria – Protostoria – Storia della Daunia, tomo primo (San Severo 1998) 155–176.

Sterba et al. 2009
J. H. Sterba – H. Mommsen – G. Steinhauser – M. Bichler, The influence of different tempers on the composition of pottery, Journal of Archaeological Science 36, 1582–1589.

Vagnetti 2001
L. Vagnetti, Le ceramiche egeo-micenee, in: F. Trucco – L. Vagnetti (eds.), Torre Mordillo 1987–1990. Le relazioni egee di una comunità protostorica della Sibaritide, Incunabula Graeca 101 (Rome 2001) 299–330.

Williams 1967
J. L. Williams, A Petrological Study of the Prehistoric Pottery of the Aeolian Islands, with Special Reference to the Stratigraphical Sequence of the Acropolis of Lipari (PhD Diss, University of London, London 1967).

Williams – Levi 2008
J. L. Williams – S. T. Levi, The Ausonian pottery of Lipari (Aeolian Islands, Sicily). A typological and petrological assessment, Proceedings of the Prehistoric Society 74, 2008, 141–170.

Wilson 1999
D. E. Wilson, Keos IX. Ayia Irini: Periods I–III. The Neolithic and Early Bronze Age Settlements. Part 1. Pottery and Small Finds (Mainz 1999).

Appendix 1: Raw NAA data of *impasto* and clay or other local material from Punta di Zambrone

Given are weight concentration values in µg/g (ppm), if not indicated otherwise. Below average measurement uncertainties (errors) are quoted, also in %. The data are stored for download at the site http://mommsen.hiskp.uni-bonn.de.

Sample	factor	As	Ba	Ca%	Ce	Co	Cr	Cs	Eu	Fe%	Ga
KP 34	1.000	12.6	1137.	1.77	92.7	17.3	38.6	6.32	1.61	5.46	21.6
KP 35	1.000	11.8	379.	2.00	52.5	26.7	186.	3.22	1.29	6.00	19.7
KP 36	1.000	3.80	335.	7.11	73.6	22.1	174.	5.36	1.31	4.44	14.2
KP 47	1.000	17.1	1836.	2.82	109.	15.5	41.7	5.61	1.44	4.76	22.4
KP 48	1.000	6.81	1349.	2.87	165.	14.1	25.4	2.56	1.52	4.36	22.2
KP 49	1.000	28.0	1685.	2.07	112.	19.4	48.8	6.75	1.50	5.25	22.7
KP 50	1.000	29.7	1662.	2.08	110.	14.5	45.3	5.81	1.59	5.91	22.5
KP 51	1.000	16.7	2322.	1.34	134.	17.3	46.4	6.49	1.99	6.20	22.0
KP 52	1.000	20.5	1132.	2.54	250.	17.0	44.1	5.80	2.05	5.10	20.1
KP 53	1.000	28.4	1772.	2.70	141.	16.9	42.4	5.49	1.78	5.11	21.2
KP 54	1.000	7.46	1177.	1.49	91.7	19.6	45.4	5.07	1.19	3.55	21.0
KP 55	1.000	6.83	1272.	2.18	106.	9.89	26.7	2.06	1.96	3.46	22.5
KP 56	1.000	32.1	1283.	2.48	120.	13.4	46.4	5.91	1.78	5.00	20.7
KP 57	1.000	10.8	1095.	1.53	108.	5.17	35.9	1.49	1.56	3.76	31.8
KP 58	1.000	7.67	1103.	1.22	67.4	7.24	15.4	1.55	0.96	3.49	24.0
KP 59	1.000	8.66	1479.	2.76	87.9	12.9	26.7	2.46	1.41	4.14	19.5
KP 60	1.000	8.75	1278.	1.73	84.0	13.4	34.9	3.20	1.52	4.15	17.0
KP 61	1.000	8.05	770.	1.93	82.5	8.54	43.6	2.72	2.26	4.63	21.4
KP 62	1.000	8.03	1230.	1.76	78.5	8.54	37.2	2.57	1.73	3.93	19.3
KP 63	1.000	9.70	1679.	1.12	80.5	6.20	35.9	2.58	1.24	3.11	18.0
KP 64	1.000	8.41	1480.	1.60	74.1	9.16	40.4	4.87	1.05	4.63	22.7
KP 65	1.000	13.8	1520.	1.42	98.1	10.8	50.7	5.65	1.74	5.04	18.2
KP 66	1.000	5.95	892.	1.58	178.	5.21	24.1	1.80	1.21	2.91	19.6
KP 67	1.000	10.1	1219.	1.34	84.7	7.54	32.5	3.37	1.24	3.40	19.5
KP 68	1.000	16.3	1551.	1.04	81.1	10.5	83.0	4.59	1.45	5.94	23.4
KP 69	1.000	7.96	1241.	1.08	92.6	8.32	42.4	2.17	1.06	3.94	22.2
KP 70	1.000	7.79	684.	2.47	100.	14.2	29.6	3.84	1.57	4.12	20.2
KP 71	1.000	8.10	1309.	13.2	296.	11.2	34.2	2.25	1.41	3.17	17.2
KP 72	1.000	5.56	985.	21.0	32.5	7.51	24.3	1.26	0.60	1.78	8.30
KP 73	1.000	3.85	1181.	17.1	34.8	8.45	27.5	1.12	0.73	2.01	7.41
KP 74	1.000	2.34	369.	19.7	36.1	7.98	32.2	2.72	0.69	2.14	10.9
KP 75	1.000	10.2	1123.	3.02	76.3	10.4	29.0	2.39	2.18	5.08	32.2
KP 76	1.000	15.6	1604.	19.0	40.8	8.63	30.7	1.85	0.85	2.84	14.5
KP 77	1.000	9.64	1200.	2.55	193.	14.7	36.5	6.02	2.22	4.92	28.7
KP 78	1.000	6.54	1135.	2.76	92.1	13.1	35.2	2.95	2.05	4.03	30.7
KP 79	1.000	10.1	1141.	2.42	97.0	11.8	36.2	5.63	1.71	4.89	24.1
KP 80	1.000	6.49	829.	1.34	73.3	7.67	58.3	4.80	0.95	4.58	28.4
ave. error		0.14	40.	0.21	0.40	0.084	0.49	0.083	0.021	0.012	2.7
in %		1.2	3.3	4.9	0.4	0.7	1.1	2.2	1.4	0.3	13.

Sample	factor	Hf	K %	La	Lu	Na%	Nd	Ni	Rb	Sb	Sc
KP 34	1.000	6.87	2.10	46.1	0.41	1.03	31.3	--	155.	0.35	18.4
KP 35	1.000	4.44	1.42	21.7	0.50	1.56	21.9	128.	68.9	1.58	26.5
KP 36	1.000	6.12	1.55	39.0	0.45	0.94	17.5	173.	77.9	0.66	16.6
KP 47	1.000	6.44	1.30	53.8	0.34	0.94	40.0	42.0	93.1	0.45	16.9
KP 48	1.000	5.06	2.17	78.6	0.25	1.86	68.8	--	119.	0.39	18.2
KP 49	1.000	7.62	1.16	54.6	0.37	0.89	39.2	74.7	89.1	0.58	18.2
KP 50	1.000	7.07	1.17	53.7	0.41	0.91	38.2	--	88.6	0.67	17.9
KP 51	1.000	8.18	1.27	64.3	0.47	1.01	50.3	31.1	92.0	0.60	18.8
KP 52	1.000	7.12	1.78	123.	0.38	1.33	93.1	27.1	84.5	0.62	18.9
KP 53	1.000	7.31	1.23	68.1	0.40	1.00	52.7	--	92.9	0.52	17.7
KP 54	1.000	8.32	2.54	41.9	0.37	1.51	31.4	--	124.	0.42	12.8
KP 55	1.000	11.5	1.42	51.6	0.50	1.61	48.2	60.7	68.9	0.42	21.8
KP 56	1.000	7.60	1.24	58.8	0.42	0.94	39.6	38.2	84.5	0.61	18.2
KP 57	1.000	6.28	1.23	58.4	0.26	1.36	44.6	30.0	58.1	0.31	17.9
KP 58	1.000	5.35	1.76	33.5	0.44	1.76	30.4	51.8	74.3	0.32	12.4
KP 59	1.000	5.60	1.77	44.8	0.26	1.40	36.8	--	111.	0.21	17.1
KP 60	1.000	7.79	1.64	43.8	0.53	1.38	31.7	--	88.9	0.27	14.8
KP 61	1.000	6.74	1.64	75.7	0.59	1.57	67.8	85.1	81.2	0.32	15.1
KP 62	1.000	8.00	1.79	51.9	0.43	1.66	51.4	84.6	83.2	0.31	14.4
KP 63	1.000	5.06	1.91	44.7	0.23	1.68	36.5	60.7	73.5	0.47	11.1
KP 64	1.000	7.77	1.97	33.6	0.28	1.07	26.6	64.7	145.	0.28	16.7
KP 65	1.000	7.41	1.25	56.9	0.41	0.84	48.5	53.8	76.6	0.40	18.1
KP 66	1.000	7.72	1.46	84.2	0.22	1.35	64.3	39.9	71.8	0.21	13.6
KP 67	1.000	5.49	1.87	38.5	0.30	1.59	29.2	20.5	99.1	0.46	13.6
KP 68	1.000	8.52	1.51	47.9	0.47	0.98	37.2	27.2	103.	0.40	20.9
KP 69	1.000	5.44	1.74	42.6	0.27	1.28	29.2	50.8	72.7	0.44	13.3
KP 70	1.000	6.57	1.76	52.3	0.31	1.23	39.5	25.8	122.	0.27	16.9
KP 71	1.000	3.19	1.50	156.	0.25	0.74	109.	99.0	68.9	0.35	12.5
KP 72	1.000	2.64	0.58	16.9	0.16	0.46	12.9	117.	21.8	0.34	7.00
KP 73	1.000	2.11	0.94	18.3	0.18	0.46	12.6	171.	37.2	0.34	7.72
KP 74	1.000	2.24	1.02	19.0	0.19	0.31	13.6	75.5	61.7	0.20	8.24
KP 75	1.000	5.54	2.26	53.3	0.44	1.77	47.9	34.6	123.	0.27	22.3
KP 76	1.000	3.48	1.21	20.6	0.21	0.67	16.3	101.	71.5	0.39	11.6
KP 77	1.000	8.26	2.13	105.	0.42	1.62	80.9	68.6	124.	0.44	17.8
KP 78	1.000	6.83	2.64	58.6	0.42	1.90	46.4	96.5	111.	0.36	17.1
KP 79	1.000	7.26	1.72	47.1	0.41	1.54	42.1	48.3	127.	0.40	16.3
KP 80	1.000	6.33	2.19	39.1	0.32	1.67	29.8	43.3	109.	0.28	15.2
ave. error		0.053	0.036	0.11	0.010	0.008	2.6	23.	2.0	0.030	0.018
in %		0.8	2.2	0.2	2.7	0.6	6.2	34.	2.2	6.9	0.1

Sample	factor	Sm	Ta	Tb	Th	U	W	Yb	Zn	Zr
KP 34	1.000	5.94	1.52	0.85	14.5	2.08	2.84	2.52	148.	278.
KP 35	1.000	4.39	0.86	0.75	7.38	1.61	3.09	2.76	78.4	165.
KP 36	1.000	2.99	1.33	0.74	11.2	2.73	2.73	3.02	77.1	218.
KP 47	1.000	6.87	1.51	0.65	19.9	2.74	2.25	2.52	101.	253.
KP 48	1.000	10.3	0.85	0.88	19.2	1.20	1.22	1.60	92.3	238.
KP 49	1.000	7.01	1.93	0.83	22.1	3.72	2.69	2.68	93.9	292.
KP 50	1.000	7.72	1.71	0.98	20.7	3.58	2.83	2.82	77.6	287.
KP 51	1.000	9.15	1.94	1.02	22.6	4.29	2.70	3.26	108.	332.
KP 52	1.000	16.2	1.74	1.34	31.4	2.53	2.34	2.93	85.2	325.
KP 53	1.000	9.66	1.50	0.93	23.0	2.66	2.34	2.91	79.6	298.
KP 54	1.000	5.83	1.20	0.76	15.9	2.72	1.62	2.75	96.5	295.
KP 55	1.000	9.42	0.73	1.14	18.8	1.90	1.47	3.39	99.8	464.
KP 56	1.000	8.06	1.75	0.92	21.8	3.99	2.55	3.06	78.3	317.
KP 57	1.000	7.16	0.77	0.58	23.2	2.09	1.70	1.65	40.1	261.
KP 58	1.000	4.98	0.68	0.80	23.5	1.55	1.67	3.22	50.1	198.
KP 59	1.000	6.24	0.68	0.60	11.4	0.96	1.90	1.59	93.4	190.
KP 60	1.000	6.51	1.28	0.91	15.3	2.16	1.87	3.79	73.6	291.
KP 61	1.000	11.7	1.00	1.32	16.2	2.06	1.08	4.23	140.	267.
KP 62	1.000	8.30	0.84	0.97	13.7	1.89	1.29	3.08	94.5	341.
KP 63	1.000	5.82	0.80	0.60	12.0	2.22	1.11	1.59	65.3	199.
KP 64	1.000	4.36	1.37	0.56	16.6	2.44	1.81	1.88	100.	314.
KP 65	1.000	7.85	1.91	1.01	21.1	3.18	2.54	2.90	75.7	281.
KP 66	1.000	9.09	0.84	0.64	25.8	2.27	1.36	1.61	44.8	295.
KP 67	1.000	5.24	1.03	0.65	16.7	2.01	1.18	2.00	75.1	229.
KP 68	1.000	6.26	1.90	0.85	18.2	3.00	2.56	3.27	111.	317.
KP 69	1.000	4.95	0.87	0.60	14.6	2.06	0.92	1.76	80.1	197.
KP 70	1.000	6.57	0.93	0.62	13.6	0.62	1.54	2.12	96.2	278.
KP 71	1.000	13.0	0.58	0.77	26.1	1.49	1.83	1.97	96.5	152.
KP 72	1.000	2.05	0.44	0.33	4.76	0.92	0.95	1.18	112.	129.
KP 73	1.000	2.20	0.47	0.38	5.05	1.38	1.09	1.21	113.	89.3
KP 74	1.000	2.26	0.50	0.42	5.44	1.08	0.89	1.35	82.3	91.8
KP 75	1.000	9.01	0.86	1.06	10.9	0.99	1.55	2.86	109.	270.
KP 76	1.000	2.95	0.56	0.46	5.64	1.73	1.39	1.41	103.	144.
KP 77	1.000	12.2	1.56	1.14	25.0	3.57	2.28	2.94	106.	333.
KP 78	1.000	8.00	0.85	1.13	12.0	1.22	2.31	2.83	92.3	260.
KP 79	1.000	6.34	1.82	0.89	14.6	2.30	2.15	2.75	110.	268.
KP 80	1.000	5.15	1.08	0.60	18.8	2.52	1.79	2.03	84.0	252.
ave. error		0.038	0.039	0.049	0.067	0.20	0.20	0.055	1.7	19.
in %		0.5	3.4	6.1	0.4	9.3	10.	2.2	1.9	7.5

Appendix 2: Elemental Reference Patterns of Laconian Pottery Workshops Measured by Neutron Activation Analysis

To determine the production places of archaeological pottery by an elemental analysis, so-called reference material produced in known workshops of a given geographical location is essential. Only if the composition of a ceramic object is identical to the composition of one such reference piece, is the provenance of this object established with high probability. The reason is that an elemental pattern consisting of 15–20 elemental concentration values – the more the better – measured with high experimental precision has a high probability of being unique in the region considered and characterises clearly the manufacturing workshop or workshops using the same clay pastes. If different clay paste preparation recipes have been used in these workshops, resulting in different elemental patterns, reference pieces for these different production series are needed.

Tab. 1 Concentrations C for the clay samples Lefk-T1 and Mene-T1 and average concentrations M for the group LacA in µg/g (ppm), if not indicated otherwise, and experimental uncertainties δ for the samples and standard deviations σ (spreads) for the group in percent of C or M, respectively. Each individual sample in the group LacA has been corrected using the best relative fit factor with respect to the grouping values M. The factor given for the samples is the best relative fit factor with respect to group LacA

	Lefk-T1 1 sample factor 1.00		**Mene-T1 1 sample factor 0.88**		**LacA 67 samples factor1.00**	
	C	δ(%)	C	δ(%)	M	σ(%)
As	2.86	(2.7)	15.1	(0.4)	10.8	(60.)
Ba	271.	(14.)	401.	(13.)	557.	(25.)
Ca\%	1.05	(22.)	0.78	(16.)	5.53	(48.)
Ce	85.2	(0.4)	81.4	(0.5)	83.5	(4.3)
Co	22.7	(0.5)	14.0	(0.6)	23.3	(13.)
Cr	98.3	(0.6)	173.	(0.5)	191.	(16.)
Cs	4.17	(2.1)	6.33	(1.1)	6.35	(8.3)
Eu	1.49	(1.4)	1.42	(1.7)	1.45	(4.1)
Fe\%	5.17	(0.3)	5.30	(0.3)	4.72	(7.1)
Ga	22.0	(3.8)	24.1	(3.0)	23.3	(22.)
Hf	7.82	(0.7)	5.05	(1.1)	5.76	(12.)
K\%	1.69	(0.5)	2.17	(0.5)	2.42	(7.8)
La	39.8	(0.2)	43.2	(0.1)	40.3	(4.5)
Lu	0.51	(1.8)	0.46	(2.6)	0.48	(5.4)
Na\%	0.99	(0.2)	0.45	(0.4)	0.81	(41.)
Nd	35.9	(9.2)	37.4	(9.4)	33.9	(8.0)
Ni	87.1	(28.)	156.	(5.5)	155.	(25.)
Rb	86.9	(2.2)	125.	(1.5)	131.	(5.7)
Sb	0.76	(3.7)	1.57	(3.9)	1.05	(34.)
Sc	20.3	(.10)	19.8	(0.1)	20.1	(5.1)
Sm	6.20	(3.6)	6.58	(0.5)	6.29	(6.4)
Ta	1.56	(2.6)	1.19	(2.1)	1.15	(9.5)
Tb	1.04	(5.4)	0.82	(4.7)	0.87	(6.4)
Th	12.2	(0.5)	15.3	(0.4)	13.8	(4.9)
U	2.60	(7.2)	2.57	(3.8)	3.29	(27.)
W	1.78	(6.0)	1.79	(3.9)	2.39	(19.)
Yb	3.50	(1.7)	3.15	(1.5)	3.28	(4.3)
Zn	101.	(1.8)	109.	(1.8)	110.	(12.)
Zr	296.	(6.8)	250.	(8.6)	232.	(17.)

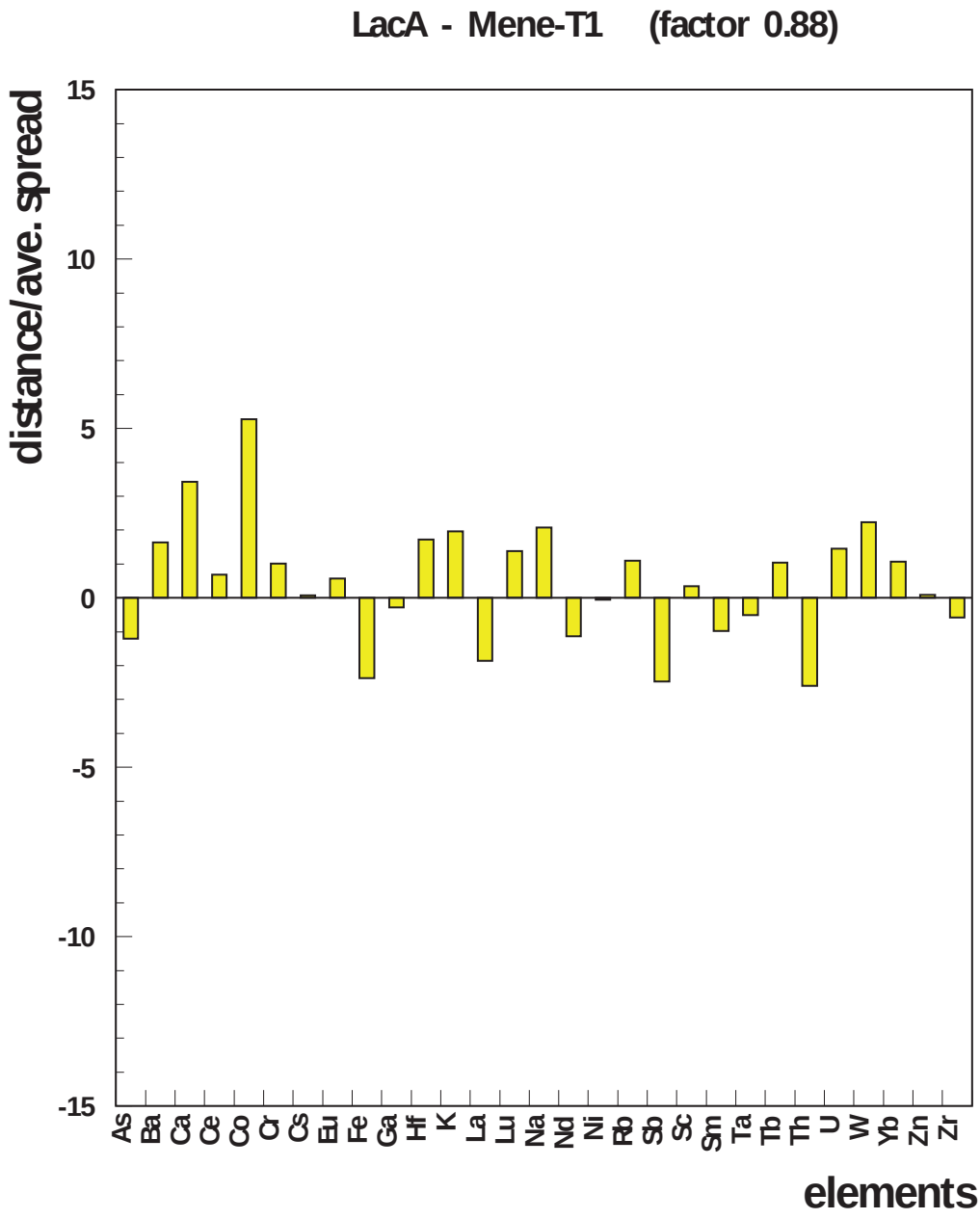


Fig. 1 Graphical comparison of chemical compositions of group LacA and of clay sample Mene-T1. Plotted are the differences in the concentration values normalised by the average of the standard deviations (spreads) of the group and the experimental uncertainties of the single sample. The values of the clay sample have been multiplied first by the best relative fit factor 0.88 with respect to group LacA. The concentrations are statistically similar (except for Co and Ca [see text]) (graphics H. Mommsen)

Good reference pieces are ceramic products which were definitely made in a known workshop such as, e. g., kiln wasters or unfired vessels found at a pottery site. If a raw clay repository in a workshop is excavated, and if it is assumed that this clay was used without any paste preparation techniques, such clays may also be good reference material. The same applies for samples of raw clays from a geological clay deposit. Even if the location of a pottery workshop nearby is not known, it can be assumed that a vessel of unknown origin having a similar elemental pattern as the raw clay is produced somewhere in the close neighbourhood to the clay bed, the distance depending on the transport possibilities of the ancient potters overland or by boat.

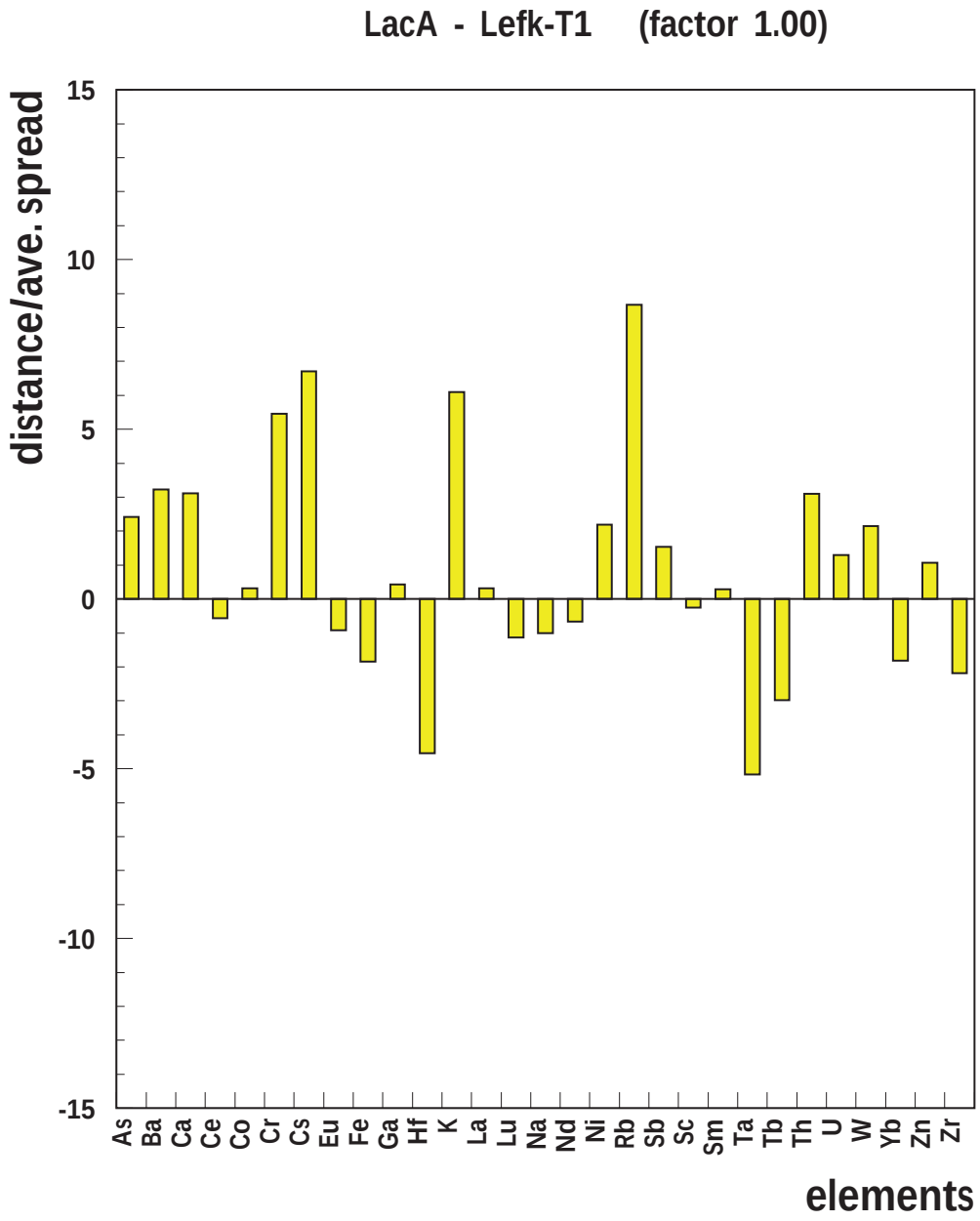


Fig. 2 Graphical comparison of chemical compositions of group LacA and of clay sample Lefk-T1. Plotted are the differences in the concentration values normalised by the average of the standard deviations (spreads) of the group and the experimental uncertainties of the single sample. The values of the clay sample have been multiplied first by the best relative fit factor 1.00 with respect to group LacA. The concentrations are different for many elements (graphics H. Mommsen)

For these reasons, a sample, Lefk-T1, of a clay deposit (36.978958° N; 22.526020° E) near the recently discovered Mycenaean palace Ayios Vasileios, close to the village of Lefkochoma, Laconia, has been analysed by means of Neutron Activation Analysis (NAA) in Bonn.[1] The composition is given in Table 1. It is clearly different from the composition of a clay sample Mene-T1 (37.066580° N; 22.454372° E, also shown in Table 1) taken from the embankment of the access path to the coeval Mycenaean site, the Menelaion, only about 11.5km northwest of Ayios Vasile-

[1] For a recent description see: Gilboa et al. 2017 and references therein.

ios. It turned out that the clay Lefk-T1 is a chemical loner – no similar pattern is stored in our database of about 12,500 samples from the central and eastern Mediterranean. Consequently it remains an open question, whether this clay was already being exploited in Antiquity. By contrast, the composition of the second Laconian clay sample, Mene-T1, is found in many samples in our database, forming the group called LacA, which may point to a production place close to the Menelaion. This pattern LacA[2] is also given in Table 1. It has the highest distribution of members in Laconia itself at the sites Epidauros Limera and Melathria, sampled more than 20 years ago.[3] Apart from the reference clay, only a few pottery vessels in the Bonn database have been published and are members of this group, while they are archaeologically classified as Laconian products, supporting this provenance.[4] The close similarity of the patterns Mene-T1 and LacA is depicted in Fig. 1, showing the average uncertainties/spreads in normalised differences of the concentrations. The largest difference is in Co, followed by Ca, which has probably been added as a dilution to the paste LacA (Ca is very low in the clay, best fit factor 0.88 with respect to LacA). This treatment of the clay Mene-T1 to make the paste LacA might be the reason for the somewhat increased differences of some of the other elements. The comparison of the clay Lefk-T1 with LacA is shown in Fig. 2, with many elemental concentrations having very high differences, pointing to a different clay bed.

References

Demakopoulou et al. 2017
K. Demakopoulou – N. Divari-Valakou – J. Maran – H. Mommsen – S. Prillwitz – G. Walberg, Clay paste characterisation and provenance determination of Middle and Late Helladic vessels from Midea, Opuscula 10, 2017, 7–49.

Forsén et al. 2017
J. Forsén – H. Mommsen – C. Shriner, Some preliminary remarks concerning a Neutron Activation Analysis (NAA) study and fabric correlation of ceramic samples from Asea in Arcadia, Greece, in: E. Κώτσου (ed.), Σπείρα. Επιστημονική συνάντηση προς τιμήν της Αγγέλικας Ντούζουγλη και του Κωνσταντίνου Ζάχου (Athens 2017) 91–108.

Gilboa et al. 2017
A. Gilboa – Y. Shalev – G. Lehmann – H. Mommsen – B. Erickson – E. Nodarou – D. Ben-Shlomo, Cretan pottery in the Levant in the fifth and fourth centuries B.C.E., American Journal of Archaeology 121, 2017, 559–593.

Jung et al. 2015
R. Jung – H. Mommsen – M. Pacciarelli, From west to west Determining production regions of Mycenaean pottery of Punta di Zambrone (Calabria, Italy), Journal of Archaeological Science: Reports 3, 2015, 455–463.

Schlotzhauer 2001
U. Schlotzhauer, Die südionischen Knickrandschalen. Eine chronologische Untersuchung zu den sog. Ionischen Schalen in Milet (PhD Diss., Ruhr-Universität Bochum 2001). Online <http://www-brs.ub.ruhr-uni-bochum.de/netahtml/HSS/Diss/SchlotzhauerUdo/diss.pdf> (last accessed 21 Jan. 2019).

2 Published already in Jung et al. 2015 and in Demakopoulou et al. 2017.

3 Unpublished.

4 Schlotzhauer 2001, 430, 459, fig. 123; 461, fig. 124; 466, fig. 126; 610 appendix VI (sample Mile 88, 6th-century BCE bowl with everted rim, in that publication still classed as unlocated group Ul13); Forsén et al. 2017, 95 fig. 1 (sample Asea 31, MH bowl with everted rim). Unpublished pots include 5 vessels from Selinunte (samples Seli 141 = inv. no. SL 23549a; Seli 144 = inv. no. M86 D266; Seli 145 = inv. no. SL 19242; Seli 146 = inv. no. SL 31188; Seli 147 = inv. no. SL 24605).

The Metal Finds from Punta di Zambrone and Other Sites, and the Bronze Age Metal Supply in Southern Calabria

Reinhard Jung[1] – *Mathias Mehofer*[2] – *Marco Pacciarelli*[3] – *Ernst Pernicka*[4]

Abstract: This is the final publication of all metal objects found during the excavations at Punta di Zambrone, supplemented by other Bronze and Iron Age metal finds from the wider region of southern Calabria. A typo-chronological discussion of all classifiable artefacts is followed by the results and discussion of archaeometric investigations. SEM-EDS analyses surprisingly revealed that one artefact consists of a material resembling copper-iron sulphide. The analytical results further revealed that the origin of the metal in the lead objects can be traced back to the Aegean, in one case specifically to Attica. An Aegean origin is also attested for a silver bracelet from the Middle Bronze Age grave of Gallo di Briatico that yielded other relevant Aegean objects. The bronzes showed a more varied picture. Some of them can clearly be assigned to Cypriot and southern Alpine copper ore deposits (Trentino region) respectively. One cannot exclude a Sardinian provenance of the copper in the case of two further Bronze Age artefacts (and one of Early Iron Age date). These analyses provide a deep insight into the metal supply networks that were in operation in Calabria, especially during the Recent Bronze Age.

Keywords: Bronze Age Calabria, Iron Age Calabria, metal, bronze artefacts, lead artefacts, silver artefacts, swords, copper-iron sulphides, copper supply networks, SEM-EDS, lead isotope analyses, chemical analyses

Introduction

In this contribution we present the metal objects found during the excavations at Punta di Zambrone. We discuss their typology and chronology as well as the results of different analytical methods used to investigate the chemical composition and the provenance of those metal artefacts. We contextualise them by reference to other metal finds from the region of the peninsula of Tropea and southern Calabria in general. We investigate the provenance of different kinds of metal used by the workshops in these areas (Fig. 1).

Typology and Chronology of Metal Objects from Punta di Zambrone and Southern Calabria

In a first macroscopic examination, we classified the metal artefacts from Punta di Zambrone according to the metal of which they are made. Three of them are lead objects (cat. nos. 3, 5 and 9), while 42 consist of copper alloy, and one is a worked piece of a material resembling copper-iron sulphide.[5] The vast majority of these artefacts stem from the ashy fill layers of the fortification

[1] Austrian Archaeological Institute, Austrian Academy of Sciences, Hollandstraße 11–13, 1020 Vienna, Austria; Reinhard.Jung@oeaw.ac.at.

[2] VIAS – Vienna Institute for Archaeological Science, University of Vienna, Franz Klein-Gasse 1, 1190 Vienna, Austria; mathias.mehofer@univie.ac.at.

[3] Dipartimento di Studi Umanistici, University of Naples Federico II, Via Marina 33, 80133 Naples, Italy; marco.pacciarelli@unina.it.

[4] Curt-Engelhorn-Center for Archaeometry gGmbH, D 6,3, 68159 Mannheim, Germany; ernst.pernicka@ceza.de.

[5] Nine of these copper alloy objects are only amorphous fragments. In a few cases, we listed and counted fragments which obviously belonged to one and the same object (or – if amorphous fragments – were found next to each other), as one catalogue entry.

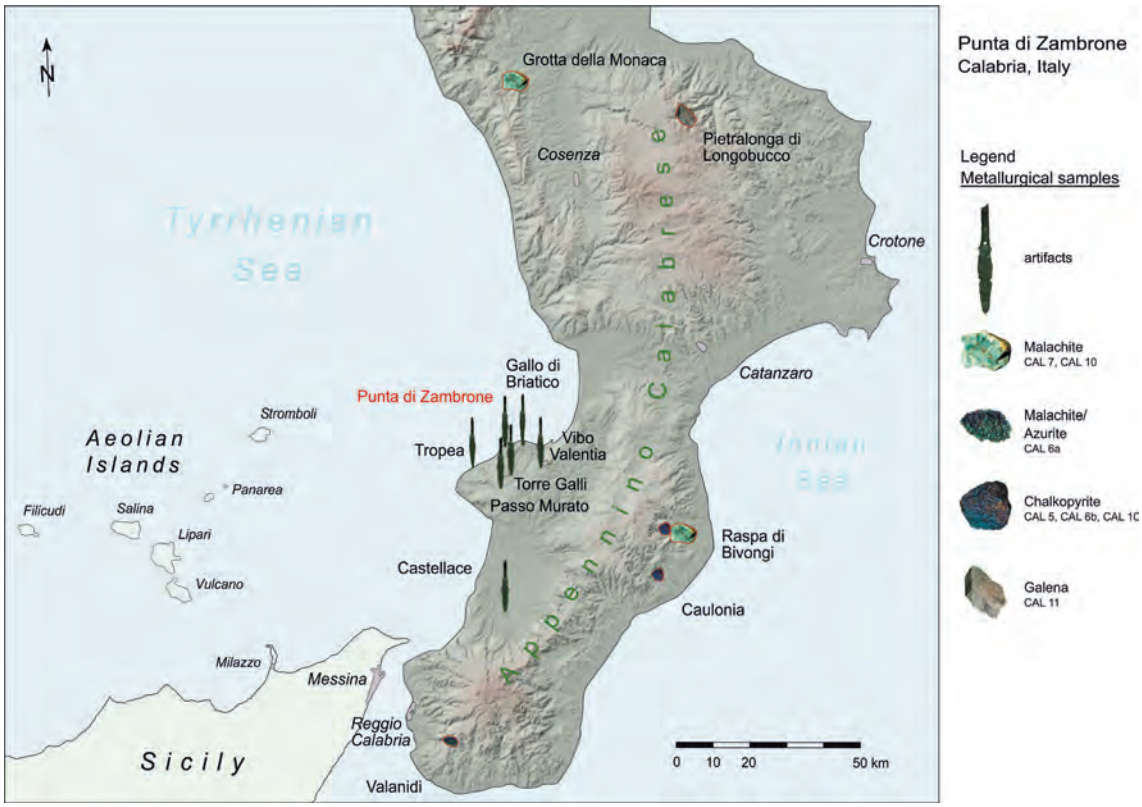


Fig. 1 Find locations of metal artefacts, ore and slag samples analysed for the present study (cartography: A. Buhlke)

ditch in Excavation Area C. One comes from the debris layer that had formed as a result of the collapse of the fortification (cat. no. 42). Only two (cat. nos. 45 and 46) were found in Excavation Area B, where they laid stratified in the upper fill level of the ditch and should thus be contemporary with the ash layers in Area C. As it is rare to find metal artefacts in settlements, we note the surprisingly large number of 43 metal objects found in an excavation area of 35m² (Area C). As for the other artefact classes found in the mentioned ash layers, these metal objects are quite fragmentary.[6] In addition, the copper alloy objects are heavily corroded and did not preserve their metal cores. Based on the stratigraphic evidence, we can ascribe this fact to their deposition in levels with high water permeability.

Other metal artefacts (re-)published and discussed in the present article come from Vibo Valentia, Gallo di Briatico, Passo Murato on the Poro high plain, Torre Galli, Tropea and Castellace. To identify the provenance of metal we sampled and analysed some Calabrian metal ores and slag as well as an ingot from Frattesina in Veneto.

Pins

Three of the fragmentary metal objects from Punta di Zambrone can be securely identified as pins, while there is not a single fragment that indicates the presence of fibulae in the settlement. The first pin has a double spiral head (cat. no. 21, Figs. 2.1; 3). It belongs to type Peschiera according to Carancini, of which it is the southernmost specimen known today.[7] Accepting Carancini's differentiation of varieties based on the cross section of the wire would result in a classification of the

[6] The only fully preserved object is the bronze fishhook that has been fully discussed in another publication (Jung et al. 2016).

[7] For this type of pin see: Carancini 1975, 12–13, 130–133, pl. 18.5a83–588; 19; 20.619–635; 105B; De Marinis – Salzani 2005, 421; Cupitò 2006, 23–25, 124–125, figs. 9–10.

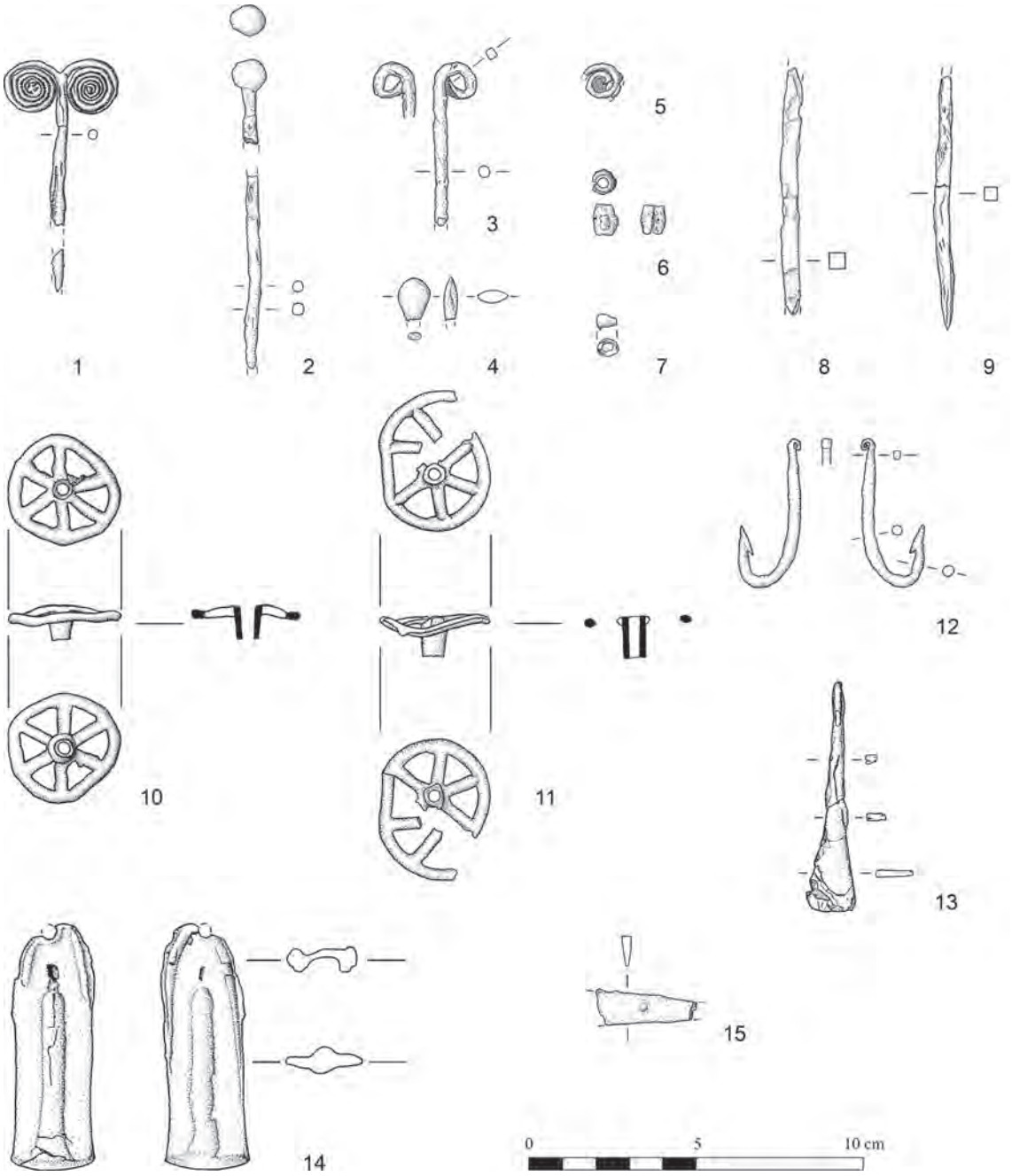


Fig. 2 Punta di Zambrone, Recent Bronze Age, artefacts consisting of bronze (1–3, 5–9, 12–15), copper slag (4) and lead (10–11). Scale 1:2 (drawings: R. Jung and M. Pacciarelli; digitisation: P. Ftaras)

pin from Punta di Zambrone as variety A (with both spirals and shank having a circular section).[8] In northern Italy the double spiral-headed pins of type Peschiera had a production period ranging from MBA 3 to RBA 1.[9] It seems that the size of the spiral pair is chronologically sensitive, with the largest specimens being confined to the Recent Bronze Age.[10] According to its maximum width of 3.45cm, the Zambrone pin belongs to the medium-sized category. There may have been

8 Carancini 1975, 130–132, pl. 18.583–588; 19; 20.619–621.

9 Cupitò 2006, 124–125; Cardarelli et al. 2014b, 616.

10 According to Michele Cupitò (2006, 125), this is true for pins with spirals of a width between 4.0 and 4.4cm. Raffaele De Marinis and Luciano Salzani (2005, 421, 432–433) had proposed a different size classification.



Fig. 3 Punta di Zambrone, Recent Bronze Age, double spiral-headed pin consisting of bronze cat. no. 21 (photo: J. Lipták)

a second specimen of the type at Punta di Zambrone; a spiral fragment (cat. no. 44, Fig. 2.5) is very similar in its dimensions to the well-preserved double spiral-headed pin cat. no. 21 (Fig. 2.1).

The roll-headed pin (cat. no. 34; Fig. 2.3) represents a very simple type appearing in many Bronze Age societies of Europe and the Near East. Consequently, one has to pay special attention to the morphological details. The specimen from Punta di Zambrone has a shank with a circular cross section and a head with only one coil and an opening in the centre. Only in the part of the coil has the wire apparently been hammered out to assume a rectangular cross section. In Italy, roll-headed pins with a similar shape are very common finds,[11] while in Greece they constitute one of the rarer pin types.[12] At Olmo di Nogara in Veneto they appear in one tomb of MBA 3 date and in five tombs dated to the Recent Bronze Age.[13] At Roca Vecchia the type is attested in Phase II of Area X and thus dates to the start of RBA 2. This is contemporary with the latest materials from the ash layers at Punta di Zambrone.[14] The variety of the roll-headed pin present at Punta di Zambrone remained popular throughout the Final Bronze Age and also subsequently, in the Early Iron Age.[15] However, it must be emphasised that although the general form of the piece under

[11] Carancini 1975, 99–110, pls. 6.103–118, 121, 122; 7.159–161; 8.172–186, 190–195, 200–201; 9.213–217, 220–226, 230–235, 241–250, 255–259; 10.263–264, 281–286.

[12] Kilian-Dirlmeier 1984, 50–60, pl. 5.146–147, 149.

[13] Salzani 2005, 104, 171, 191, 201, 232, 239–240, 258, 320–330, 343, pl. 13.Tb129A, C; 348, pl. 18.Tb178B; 349, pl. 19.Tb199A, B; 354, pl. 24Tb287B; 355, pl. 25.Tb304A, Tb305C; 359, pl. 29.Tb353A; 370, pl. 40.Tb493F. – Dimensions (l.): 10.1cm; 11.49cm; 7.8cm (2×); 4cm; 11.5cm; 4.4cm; 4.8cm; 4cm. De Marinis – Salzani 2005, 423.

[14] Pagliara et al. 2007, 330–332, 348–349, fig. 17.II.17.

[15] Carancini 1975, 9, 113–116; further specimens come, e.g., from Pianello di Genga (Peroni 2010, 26, 29, pl. 10B3) in central Italy and from Colombara – Gazzo Veronese in northern Italy (Salzani 2002, 89, 112, fig. 60C3).

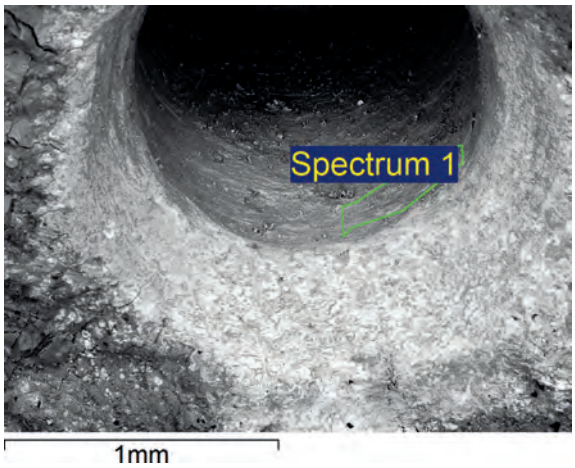


Fig. 4 Cat. no. 12: SEM picture of the drill hole used to obtain material for chemical and isotopic analyses. The green line indicates the region, where the SEM-EDS area measurement (Fig. 5) was carried out (photo: M. Mehofer, VIAS, University of Vienna)

discussion belongs to a very common type, the Punta di Zambrone specimen differs from all the other similar Italian pins in one detail, i.e. the head section, which is not a laminar or much flattened rectangular section, but very thick, almost quadrangular.[16]

The pin with a globular head (cat. no. 24, Fig. 2.2) belongs to a group of types quite widely distributed during the Recent Bronze Age, generally characterised by an incised decoration (the engraved lines may, however, no longer be visible in the Punta di Zambrone pin due to the strong corrosion). One may mention here examples of type Franzine (with a head often larger than that of the Zambrone specimen[17]) from the Casinalbo cemetery in northern Italy,[18] a pair from a cremation tomb at Canosa (Contrada Pozzillo)[19] and another one from a deposit inside a RBA 2 pit at Roca Vecchia[20] in the south. A similar pin, apparently without decoration, was found in the Grotta dei Cervi in southern Apulia.[21]

If one judges solely by its shape, a fragmentary oval object (cat. no. 12, Fig. 2.4) with lentoid cross section might belong to an artefact, perhaps an ornament, not easy to identify in typological terms. For instance, it could theoretically be one end of the cruciform head of a Cogolara-type pin,[22] specimens of which are also known from Ausonian I and Ausonian II levels on the acropolis of Lipari.[23] Although the broken edge at one end might suggest that there had once been a shank,[24] the result of the chemical analysis argues against such a typological identification, as the object does not consist of metal.[25] Moreover, the results of the XRF and lead isotope analyses speak in favour of a Cypriot provenience for this copper-based object (see below).

16 However, the contemporaneous Ausonian I levels at Lipari might offer quite a good parallel for this peculiarity (Bernabò Brea – Cavalier 1980, 583–584, fig. 109g).
17 Carancini 1975, 197–198, pls. 44.1354–1355; 45.1356–1364.
18 Cardarelli et al. 2014a, 560, 563, fig. 357.30–31.
19 Lo Porto 1997, 83, fig. 21.4–5.
20 Maggiulli 2017, 980–981, fig. 3.II.US11650.1–2.
21 Aprile et al. 2017, 102, fig. 20.9; 104.
22 Carancini 1975, 248, pl. 55.1824–1826.
23 Bernabò-Brea – Cavalier 1980, 583, 585, fig. 110b, d; 640–641, fig. 128a, pl. 215.2b–c.
24 Compare, e.g., the detailed drawings of two Cogolara type pins from Monte Battaglia in Romagna: Bermond Montanari 2001, 289, fig. 4.6–7.
25 If there was no shank, it is possible that not much of the original object is missing. It might have been a kind of pendant. A further argument speaking against a classification as a fragmentary Cogolara pin is the sharp edge of the hypothetical pin head. The pins of type Cogolara have depressed globular heads instead (Bermond Montanari 2001, 289, fig. 4.6–7).

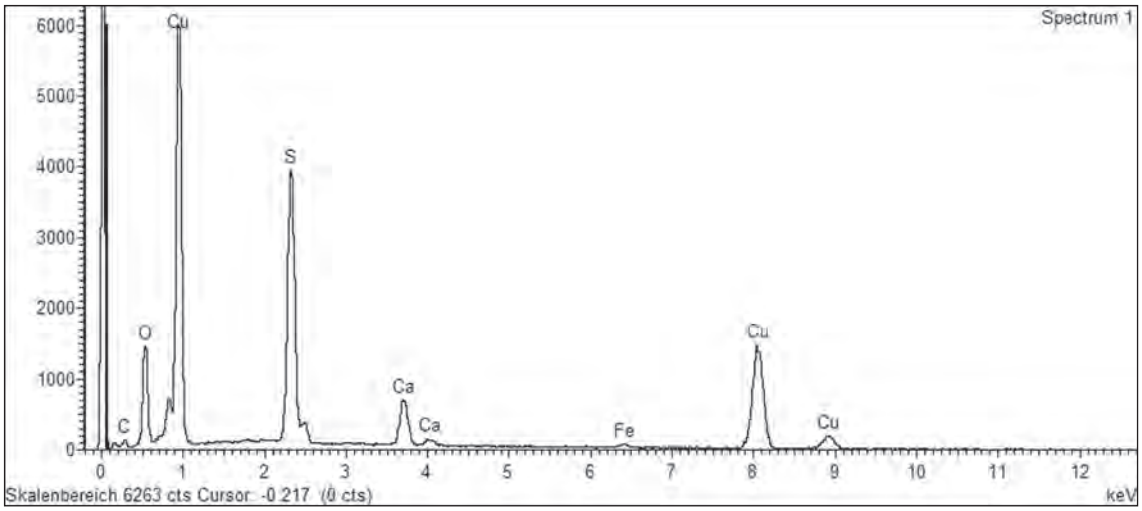


Fig. 5 Cat. no. 12: SEM-EDS spectrum with results of measurements marked in Fig. 4 (M. Mehofer, VIAS, University of Vienna)

During the sampling process (Fig. 4), we already recognised that the material (cat. no. 12) is very hard and has properties which seem unusual for a metal artefact. We decided to bring it to the archaeometallurgical laboratory of the Vienna Institute for Archaeological Science at the University of Vienna for analysis. The examination with a scanning electron microscope (SEM-EDS)[26] surprisingly revealed that it is composed of copper sulphide with low iron and lead concentrations (Fig. 5).

This opens up two possible interpretations. Either the material can be classified as matte, an intermediate product of the copper smelting process or it can be interpreted as copper ore (Fig. 6; Tab. 1). The first option is contradicted by the fact that there is almost no iron present in the material, which would lead to the conclusion that the smelting process happened under extremely oxidising conditions. If that were the case, these smelting conditions would also have led to the oxidation and evaporation of lead and sulphur which are, however, still present in certain amounts. Furthermore, it has to be stated that the Cypriot ore deposits are dominated by chalcopyrite. The resulting intermediary smelting product – the matte – should have an appreciable iron content,[27] which cannot be observed in our case.

Element	C (%)	O (%)	Si(%)	S (%)	Fe (%)	Ca (%)	Cu (%)	Pb (%)	sum
Spectrum 1	4.9	2.2	b.d.l.	20.4	0.2	b.d.l.	72.3	b.d.l.	100
(σ)	0.7	0.6		0.7	0.2		0.9		
Spectrum 2	6.4	25.9	0.6	b.d.l.	b.d.l.	0.3	30.8	36.0	100
(σ)	0.7	0.8	0.4			0.3	0.8	0.5	
Spectrum 3	5.7	2.5	b.d.l.	19.4	0.2	0.2	72.0	b.d.l.	100
(σ)	0.8	0.7		0.8	0.2	0.3	0.9		

Tab. 1 Cat. no. 12: results (rounded) of the measurements displayed in Fig. 4. 'b.d.l.' below the detection limit of the analytical device. All values are given in mass percent

[26] Optical microscope: Olympus BX 51; SEM–EDS: Zeiss EVO 60 XVP with an EDS system produced by Oxford Instruments (INCA 400). Accelerating voltage: 20kV, working distance of 9.5mm, beam current 100µA, dead time between 30 and 40%. The stability of the beam current was verified by cyclical measurements of a cobalt standard. All results were normalised to 100% and are given as mass percentage (Melcher – Schreiner 2004, 332; Mehofer – Kucera 2005).

[27] Mehofer 2014, 72 fig. 16; Van Brempt – Kassianidou 2017, 546 fig. 9.

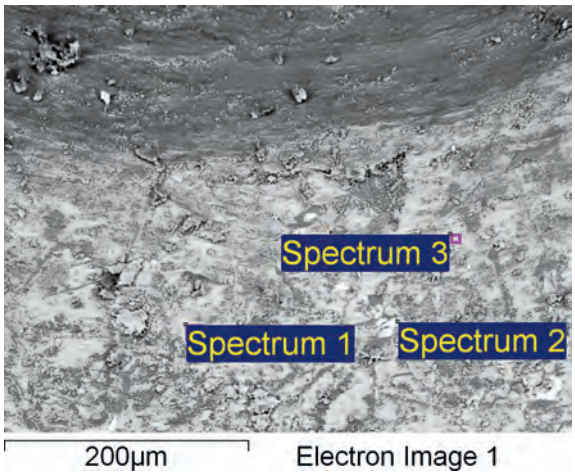


Fig. 6 Cat. no. 12: detail of the region indicated in Fig. 4. It shows the various regions where the point analyses 1–3 (Tab. 1) were carried out. White = lead inclusions; light grey = copper sulphides; dark grey = oxides of copper, iron and lead (photo: M. Mehofer, VIAS, University of Vienna)

These facts speak against an interpretation as a smelting product. We can therefore argue that a piece of copper ore of Cypriot provenience was used for manufacturing this object.[28] The analyses with the SEM-EDS suggest that the material is copper sulphide, possibly a mixture of chalcocite with covellite with very low iron and lead concentrations. Such ores can be found in the cementation and sedimentation zones of copper ore deposits like those found on Cyprus.[29] Its dark blackish shiny colour might have predestined it to for use in the production of precious objects.

In order to test this interpretation, an additional XRD analysis was carried out (Fig. 7) and the mineral phases antlerite ($Cu_3[SO_4][OH]_4$), gypsum ($CaSO_4\ 2H_2O$) and covellite (CuS) were identified. Furthermore, various lead and iron oxides and phosphates were detected. If this object were the product of copper smelting, the gypsum would have decomposed. As gypsum is still present, we can conclude that the object did not undergo a pyrotechnological process. This fact supports the above interpretation as copper ore.

Ornaments and Dress Accessories

Bronze beads such as the two specimens found in the ash layers of Punta di Zambrone (cat. nos. 4 and 36, Fig. 2.6–7) are almost absent in Italian Bronze Age contexts.[30] In Mycenaean Greece, bronze beads could be part of necklaces during the Early Mycenaean phases,[31] while they are rare in Palatial and Post-palatial contexts. The whole LH IIIC chamber tomb cemetery of Peratí yielded only a single example – different in type from the two Zambrone specimens.[32] A chamber tomb at Brauron in Attica contained eight bronze beads almost identical in shape and dimensions to the better-preserved bead from Punta di Zambrone (cat. no. 4, Fig. 2.6).[33] Unfortunately, this tomb

[28] The authors want to thank Dr. J. Lutz (CEZA Mannheim) for his useful remarks and discussions.

[29] Gale et al. 1997, 241–246, tab. 2–6; Stos-Gale et al. 1997, 110–111, tab. 6; Stos-Gale et al. 1998, 122, tab. 3a; OXALID Database <http://oxalid.arch.ox.ac.uk/Cyprus/Cyprus.html> (last accessed 3 June 2018).

[30] Matarese et al. 2017, 468–469, fig. 1c.

[31] Midea, citadel, rock cutting: Walberg 2007, 182–183, 320 cat. no. M99; fig. 235.M99. – Tiryns, child tomb: Kilian 1982, 419–420, fig. 38.4. – Argos, Tumulus Δ tomb I (140): Protonotariou-Deïlaki 2009, 135–136, 550, fig. 5–6. All those Early Mycenaean beads are ring-shaped and smaller than cat. no. 4 from Punta di Zambrone.

[32] Iakovidis 1969/70 vol. I, 122 cat. no. M 198; vol. II, 302 tab.; vol. III, pl. 36α.M 198.

[33] Chamber tomb 2 of the Kakavoyannis excavations: Papadopoulos – Kontorli-Papadopoulou 2014, 113 cat. no. M37, fig. 3.309 (left); 281, pl. 97.M37.

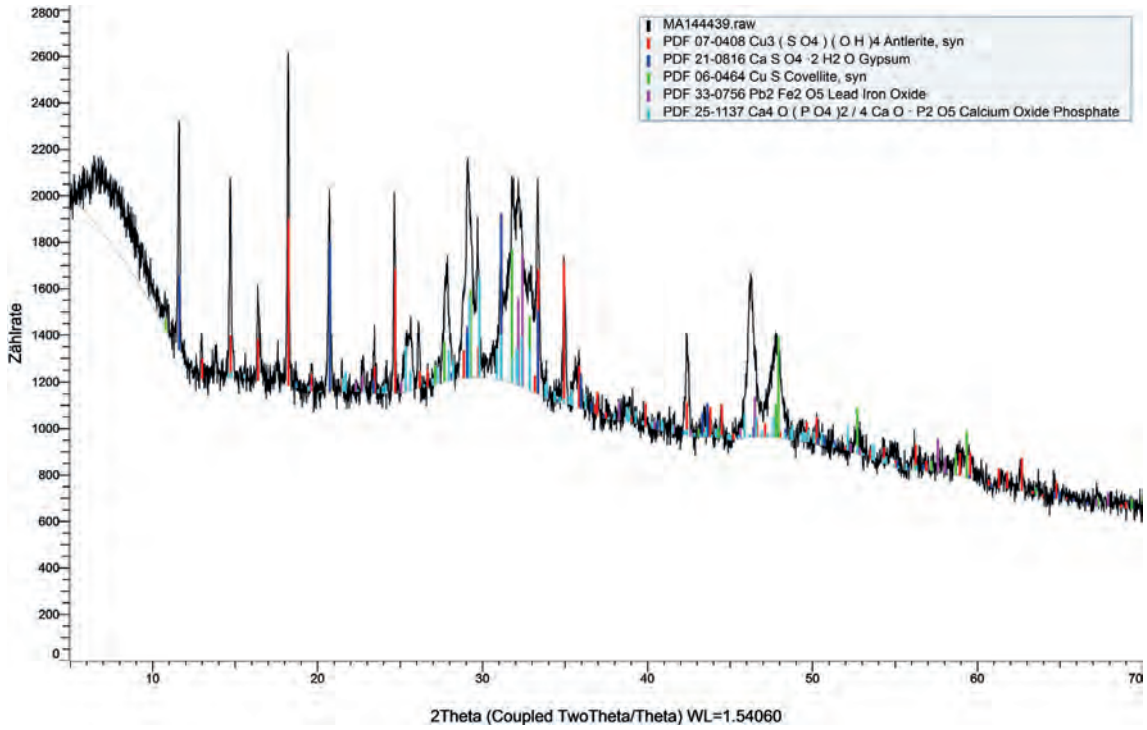


Fig. 7 XRD spectrum showing the crystalline phases present in cat. no. 12 (photo: M. Mehofer, VIAS, University of Vienna)

was disturbed in Antiquity and contained pottery ranging from LH IIIA2 to the Protogeometric period.[34] A further parallel comes from an Early Protogeometric layer at Kalapódhi.[35]

The fragments of silver rings of c. 10cm diameter, probably belonging to a spiraliform bracelet and found inside a MBA 1–2 jar burial at Gallo di Briatico (cat no. 47, Fig. 8.1), c. 6km east of Punta di Zambrone, represent the earliest metal artefacts that we examine here. The fragments formed part of an exceptionally rich burial assemblage including a small amber bead, a green stone bead, a pin head consisting of rock crystal of Early Mycenaean type and – most remarkable of all – a Neopalatial Minoan carnelian seal.[36] In view of its accompanying finds and the lack of exact parallels in Italy, this silver ornament might be an import to the peninsula of Tropea.[37]

The chronologically latest artefact to be discussed here is a bow fibula from Torre Galli on the Poro high plain, c. 8km SE of Punta di Zambrone (cat no. 54, Fig. 8.2). It is a survey find from the area of the Early Iron Age cemetery. Due to the badly preserved incised decoration it is difficult to classify. It may belong to the type Ob2 variety B or to the type Ob5 variety D. Both types are dated to phase I of the Early Iron Age (in terms of absolute chronology end of 10th to 9th century BCE).[38]

34 Papadopoulos – Kontorli-Papadopoulou 2014, 109–113.

35 Kalapodhi, Layer 17: Felsch 2007, 183, 330 cat. no. 1373, pl. 45.1373.

36 Pacciarelli 2000, 185–188, fig. 109.

37 For smaller-sized parallels (diameters 0.7–0.9cm) from Prato di Frabulino see: Casi et al. 1995, 89 cat. nos. 1–3; 107, fig. 7B3, and Pacciarelli 2000, 185. In MH and Early Mycenaean tombs sometimes silver hair- or earrings appear. As an example, one may name a pair of silver rings with diameters of 4.0 and 3.7cm respectively. They lay underneath the skull in shaft grave Y (Grave Circle B) at Mycenae (Mylonas 1972–1973, 228–229, 233 cat. no. Y-332, pl. 209β, upper right). However, none of the better-preserved MH and LH I silver ornaments constitute good parallels for the Calabrian find. Some excavation reports mention silver wire fragments, but the lack of illustrations prevents us from drawing any conclusions regarding possible exact parallels.

38 Pacciarelli 1999b, 129–130, fig. 34.

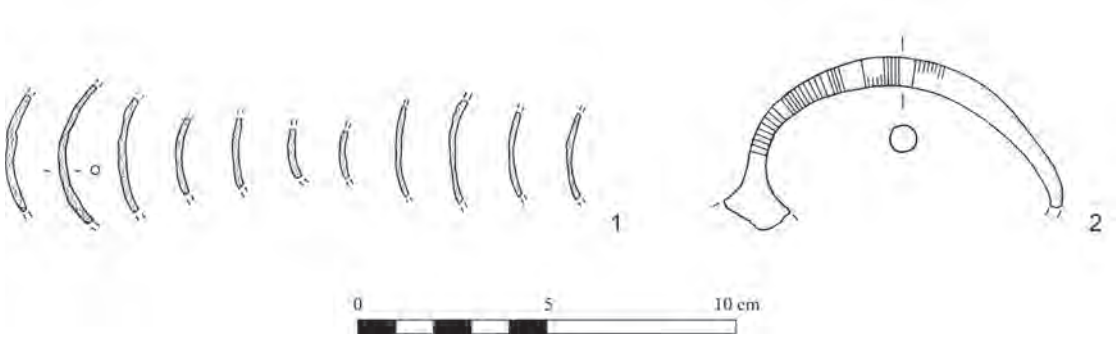


Fig. 8 Gallo di Briatico, Middle Bronze Age 1–2, silver artefact (1); Torre Galli, Early Iron Age I, bronze artefact (2). Scale 1:2 (drawings: M. Pacciarelli)

Implements

Five fragmentary bronze artefacts from Punta di Zambrone belong to implements. The awls with a square section (cat nos. 40 and 42, Fig. 2.8–9) find a good comparison in southern Italy with three specimens from the settlement of Scoglio del Tonno (Taranto).[39] It should be noted that the metal artefacts from Scoglio del Tonno predominantly (though not exclusively) date to the Recent Bronze Age. A further parallel comes from a possible cremation burial deposited inside a jar underneath the floor of the Ausonian I hut β I on the acropolis of Lipari.[40] This one, as well as yet another parallel from a Final Bronze Age (FBA) 1 level at Roca Vecchia, shares the typological detail of the parallel long sides,[41] which seems to be characteristic for awls from continental Italy. By contrast, Mycenaean awls regularly have converging long sides, i.e. sides that taper continuously towards the tip, and they have a short shafting tang as well.[42]

The roughly rectangular bronze blade with a cutting edge on one of its short sides and a high midrib is an unusual object (cat. no. 10, Fig. 2.14). So far, no exact parallel has been published from either the Aegean or Italy, and similar objects seem to be absent from central Europe, too. The morphologically closer class of objects is known from Neopalatial and Mycenaean Crete as well as from the Mycenaean Argolid. They consist of rather thin blades of c. 9 to 15cm length with a more or less curved cutting edge on one short end and one or two rivets close to the other short end.[43] According to *communis opinio* these tools were cutters used by skinners or shoemakers.[44] Some of the longer blades have flanges running along most of the blade's length.[45] One of these comes from Mália, House Zβ, Room V, and dates to LM IB/LH IIA.[46] There is also a very small one measuring only 4cm in length with flanges close to the neck and the rivet.[47] Closest in outline and size to the specimen from Punta di Zambrone is the blade from chamber tomb 4 at Sellópoulo

39 Bietti Sestieri et al. 2010, 461, fig. 4.18, 21, 22.

40 Bernabò Brea – Cavalier 1980, 114, 586, pl. 218.4.

41 Maggiulli in: Pagliara et al. 2007, 348–349, fig. 17.IV.4. In contrast to the better preserved specimen from Punta di Zambrone, the tip of this awl has a circular cross section. See also a fragmentary specimen with square section from a FBA context at Broglio di Trebisacce (Buffa 1994, 572, pl. 120.5; 574).

42 Lazáridhes on Aegina, built chamber tomb A: Evstratiou – Polychronakou-Sgouritsa 2016, 97–98, fig. 109. – Mycenae, Panayía Houses, Area 26: Mylonas Shear 1987, 120, 122, cat. no. 192; pl. 37.192. – Mycenae, Tsountas hoard 1 (LH IIIB Final): Spyropoulos 1972, 9 n. 1; 37–40, figs. 63–71, pl. 13ι. – Mycenae, Mylonas hoard: Spyropoulos 1972, 55, 67, fig. 116.14, 15. – Náfplio-Evanyelístria, chamber tomb K: Piteros 2015, 246–247, fig. 5.

43 Evely 1993/2000, 525–527, pl. 99.6–7.

44 Dawkins 1923, 120, pl. 25U; Deshayes 1959, 69–70, pl. 20.1 (3rd in middle row), 2 (2nd in upper row); 29B1.

45 Evely 1993/2000, 525–527, fig. 216.5–6.

46 Deshayes 1959, 69, pl. 29B1. For the date see Driessen – Macdonald 1997, 189–190.

47 It comes from the Dictaean Cave (Psykhró) and cannot be dated by context (Boardman 1961, 23, cat. no. 81, fig. 7.81, pl. 10.81).

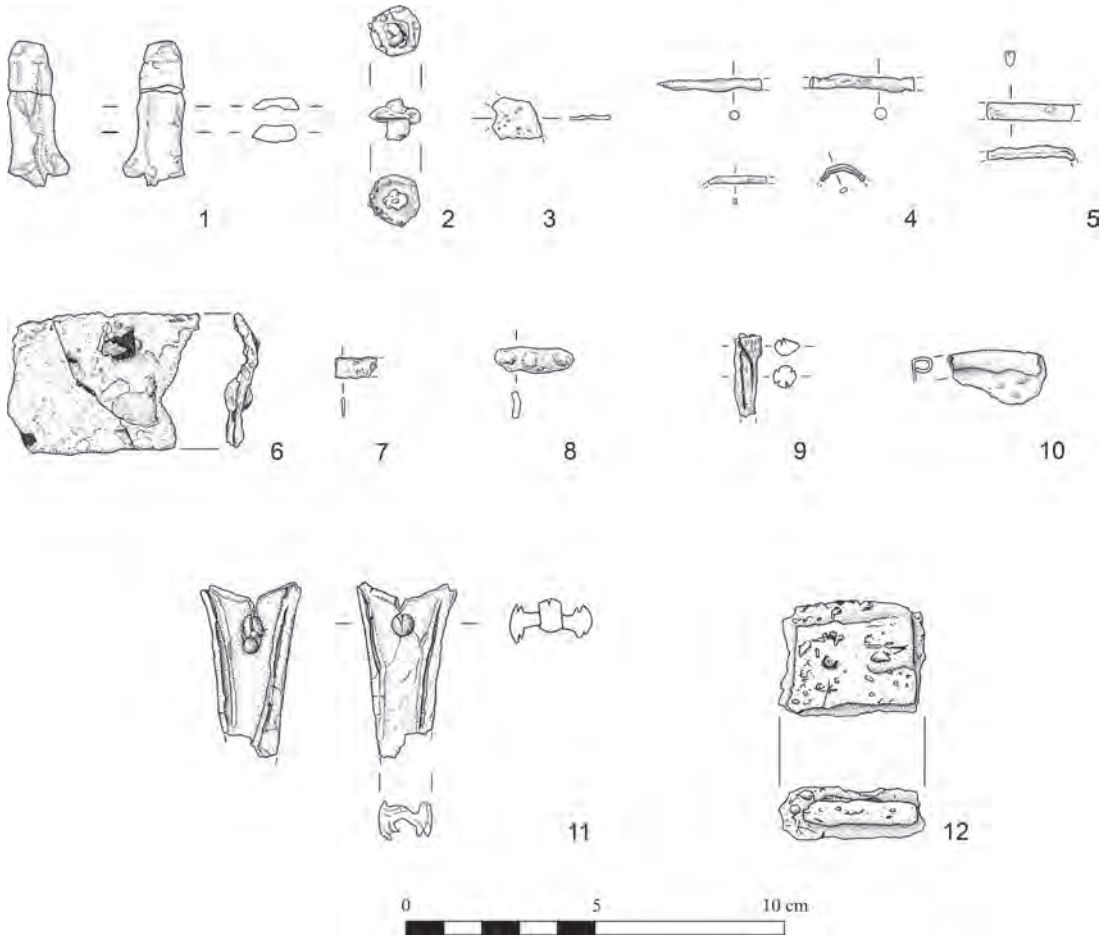


Fig. 9 Punta di Zambrone, Recent Bronze Age, artefacts consisting of bronze (2–12) and lead (1). Scale 1:2 (drawings: R. Jung; digitisation: P. Ftaras)

in central Crete.[48] It measures 9.7cm in length and has a maximum width of 3.6cm (as opposed to the 7.42cm length and 2.4cm width of the Zambrone blade). It has a single rivet hole in the proximal half, as was probably also the case for the Calabrian object. The outline of the two objects is comparable, but the Cretan artefact lacks the flanges and the midrib. It belongs to either burial I or to burial II in the tomb. Both date to LM/LH IIIA1,[49] i.e. about 150 years earlier than the context of the tool from Punta di Zambrone.

The sole cutter known from mainland Greece is perhaps closer in date to the Calabrian artefact. It comes from chamber tomb K at the Evanyelístria site of Náfplio in the southern Argolid and was part of a whole set of bronze and stone tools found in pit 1 in that tomb. This set included two chisels, five awls, a knife, a needle, a kind of large tongue with scissor-like end pieces equipped with teeth, a saw, and several whetstones and millstones.[50] Unfortunately, the accompanying pottery remains unpublished, and the published dating ranges for the assemblage in pit 1 are contradictory: 1450–1400 BCE[51] and LH IIIA–IIIB[52] respectively. In shape and size,

[48] Popham et al. 1974, 229 cat. no. 10; 230, fig. 18.10. It is unclear why Evely (1993/2000, 378–379, fig. 152.2) classed it as a razor.
[49] Popham et al. 1974, 199–206, 226, fig. 15B26.
[50] Deïlaki 1977, 92–93, drawing 6, pl. 91γ–ε; Piteros 2015, 246–247, fig. 5.
[51] Deïlaki 1977, 92.
[52] Piteros 2015, 246.

the tool from Náfplio is quite close to that from Sellópoulo and it also lacks the flanges and midrib.

This means that there may be a functional relationship between the Minoan and Mycenaean cutting tools and cat. no. 10 from Punta di Zambrone, but one cannot establish a strict typological link. On the one hand, this might be due to a research gap, but on the other hand, the corpus of Late Mycenaean hoard finds, mainly consisting of tools and weapons, has not yielded such a tool so far.

As there is no object in Bronze Age Italy that is at least remotely comparable to the tool from Punta di Zambrone, one might explain the latter in terms of an individual creation modelled on the Aegean functional counterparts. Certain morphological details that distinguish this object from the Aegean tools may even reveal how it was made. The dimensions, the outline of the neck, its flanges, the midrib and even the position of the hypothetical rivet hole correspond quite well to the morphological characteristics of grip-tongue daggers classed as type Pertosa by Vera Bianco Peroni.[53] One could hypothesise that this specific tool was produced by cutting off the grip-tongue and the tip of the dagger as a first step. In the second step the craftsperson would have made the cutting edge by hammering and sharpening.

The fragmentary bronze object cat. no. 33 (Fig. 2.13) may be either a spatula or an arm belonging to a pair of tweezers. As preserved, the object is totally straight, while Mycenaean and Late Minoan tweezers regularly have bent arms. According to the position and shape of the bend and the size of the loop, Agni Xenaki-Sakellariou distinguished five types in her discussion of the artefacts from the chamber tombs at Mycenae.[54] Tweezers with straight arms, i.e. without even a bend close to the distal end, are very rare in Mycenaean Greece. One can cite one well-preserved specimen from the already mentioned chamber tomb K at the Evanyelístria site. This pair of tweezers has no bent arms, no offset loop, and it also shares with the Zambrone object the outline of the arm in frontal view.[55] Another pair of tweezers with straight arms from the chamber tomb cemetery at Achaia Clauss in the northwestern Peloponnese is much smaller than the Calabrian find and has more slender arms, widening only slightly at the distal end.[56] A final pair of tweezers with straight arms comes from Mycenae. It was found in the dromos of chamber tomb Δ at the site of Paliomándhri.[57] Unfortunately, none of the three Mycenaean parallels can be closely dated by context. However, they all seem to be of Palatial date. In Bronze Age Italy, tweezers are truly exceptional finds. The earliest ones are two from the MBA 3 phase in the so-called Hypogaeum of the Ivories at Trinitapoli in northern Apulia.[58] They are slightly bent and differ from the fragment cat. no. 33 mainly in the outline of the arms in frontal view. These are much broader in proportion than the Zambrone specimen, which widens only in the distal third of its length. The tweezers from the RBA 2 hoard found at Gualdo Tadino in Umbria retain the basic proportions of the earlier Apulian tweezers, but are decorated in addition.[59] The morphology of the later tweezer types dating to the Final Bronze Age differs even more markedly from the artefact found at Punta di Zambrone.[60] In conclusion, we can classify the tweezer fragment from Punta di Zambrone as

---

53 Bianco Peroni 1994, 149–152, pl. 82, 83.1498–1506. For an updated distribution map of the type see Jung 2009a, 136–138, fig. 4. For the date of the type in Greece and Italy see Jung 2006, 150, 204, pl. 9.3; 10.6; 16.7.

54 Xenaki-Sakellariou 1985, 70 cat. no. Χλ 2386 (1); 145–146 cat. no. Χλ 2385; 200 cat. no. Χλ 2929 (11); 273 cat. no. X 4556, pl. I. For further examples see Spyropoulos 1972, 38–43, fig. 72–76.

55 Deïlaki 1977, 92, pl. 91γ (1st object in bottom row); Piteros 2015, 246, fig. 5 (2nd object in top row).

56 Papadopoulos 1978/79, 148, 225 cat. no. 120, pl. 273, fig. 297c; pl. 306, fig. 330c. Dimensions: l. 5.2cm; maximum width 0.8cm. Papadopoulos suggested a date to 'LH IIIA–IIIB' (Papadopoulos 1978/79, 225 cat. no. 120), but did not explain his reasons.

57 Verdelis 1966, 81 cat. no. 8, pl. 87β (left). Dimensions (l.): 6.3cm. The pottery from the tomb has a dating range from LH IIIA to LH IIIB Early/Middle (cf. Verdelis 1966, 80–81, pl. 86, 87β [right]).

58 Peroni et al. 2003, 296–297, 314, fig. 12.6077, 6085 [correct is: 334]; 317, fig. 15.334, 6077; 319 fig. 17.

59 Peroni 1963, I.6.5-(3) no. 26. – For the date cf. Carancini – Peroni 1999, 18, pl. 29.

60 Cf. Salzani 1989, 14, 17, 34, fig. 12.6; 39, fig. 17.17; Salzani 1990–1991, 126, 151, fig. 4.3.

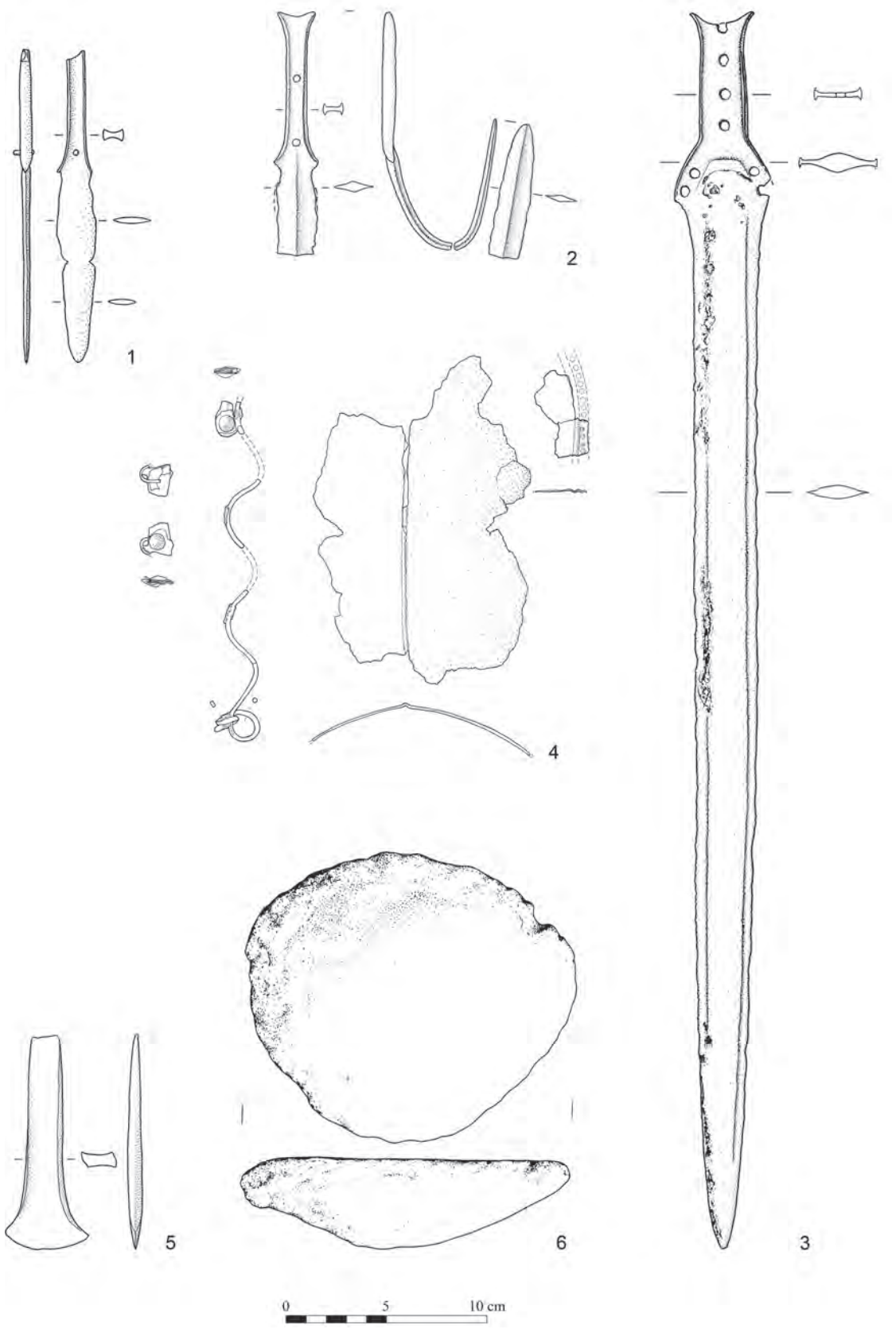


Fig. 10 Tropea, Recent Bronze Age, bronze artefact (1); Vibo Valentia, Recent Bronze Age, bronze artefacts (2–3); Castellace, Final Bronze Age 1–2, bronze artefact (4); Passo Murato, Recent Bronze Age, bronze artefact (5); Frattesina, Final Bronze Age 2, lead artefact (6). Scale 1:3 (1–5 drawings: R. Jung and M. Pacciarelli; digitisation: P. Ftaras and R. Varricchio; 6 after Salzani 2003, 42 fig. 3.16)

Aegean in type. In Bronze Age Italy,[61] as well as in the Late Bronze Age Aegean,[62] tweezers are often associated with weapon burials.

One fragment (cat. no. 43, Fig. 2.15) can probably be identified as the tip of a knife blade, the type of which cannot, however, be determined.

Apart from the bead cat. no. 4, the only fully preserved – although found broken in two pieces – copper-based artefact is a barbed fishhook with a loop at the end of the shank (cat. no. 29, Fig. 2.12). As we have discussed elsewhere,[63] it is a medium-sized hook (comparable to contemporary hook sizes between 2/0 and 3/0) and would have been suitable for fishing quite large groupers (*Epinephelus* Bloch, 1793) or even tunas (*Thunnus* South, 1845), common dentex (*Dentex dentex* Linné, 1758) or larger Atlantic mackerels (*Scomber scombrus* Linné, 1758). The barb and loop are the typologically distinctive elements, which together appear regularly on Bronze Age fish hooks from central Europe, Italy and the Carpathian Basin, but only rarely in the Aegean. It may well be that the few exact Aegean parallels for the Zambrone fish hook were part of the metallurgical innovation packet originating in the central Mediterranean and adopted since the later LH IIIB phases by the Aegean populations. Despite a systematic flotation programme conducted in all excavation areas and during all three seasons, fish remains are quite rare among the find materials from Punta di Zambrone. The archaeozoologists tend to interpret this fact by a predominance of angling among the fishing techniques in use at this coastal settlement. Developed net fishing practices would probably have resulted in higher find densities and also in a different spectrum of fish species.[64]

A flanged axe from the hinterland of Punta di Zambrone was found during banking works on the Poro high plain at Passo Murato (at c. 555m asl) in 1977 (cat. no. 51, Fig. 10.5).[65] The proportions of the slender axe with the broad convex cutting edge widening abruptly in the distal part of body set it apart from Early and Middle Bronze Age axe types of continental Italy.[66] The Sicilian copper workshops provide us with better parallels for such a shape including the rather low flanges. They belong to type R2 (axes with slightly raised flanges), variety B, according to Rosa Maria Albanese Procelli. However, they are all single finds and can therefore not be dated by context.[67] One flat axe with proportions comparable to those of the southern Calabrian specimen (type R1, variety C2, according to Albanese Procelli) comes from the hoard find of Badia Malvagna in the hinterland of Naxos, in the province of Messina opposite southern Calabria.[68] Albanese Procelli dates this hoard complex to the local Pantalica I *facies* (Recent to early Final Bronze Age)[69]. A more specific date within the Recent Bronze Age is surely reliable, considering that the shaft-hole axes of Badia Malvagna have close parallels in the hoard assemblage found underneath Hut α II in the settlement on the acropolis of Lipari.[70] Just like the axe from Passo Murato, the specimen from Badia Malvagna, as well as the similar Sicilian single finds of the R2 B variety, were evidently made in a bipartite mould.[71] The chemical analysis of the Passo Murato axe provides us with an additional dating criterion. The quite high percentage of tin (12%) clearly speaks against an Early

---

61 Salzani 1989, 14, 17, 34, fig. 12.6; 39, fig. 17.17; Peroni et al. 2003, 296–298, 320, fig. 18.

62 Steinmann 2012, 286, 513–518, tab. A1–A5; 521–522, tab. A8–A9. One can add the following LH IIIB warrior burials with tweezers: Voúdeni (Achaea), chamber tomb 21: Moschos 2007, 14, fig. 6; 19–21, fig. 12. – Foúresi (Attica), chamber tomb 1, burial 2 (a man, older than 40 years): Chatzidimitriou et al. 2010, 51, 57–58, 68–69, 76, fig. 8; 77, fig. 10; 79, fig. 24; 80, figs. 26–29.

63 Jung et al. 2016.

64 Forstenpointner, Slepecki, Weissengruber and Galik in: Jung et al. 2016, 197.

65 Cf. Pacciarelli 2011, 270; lo Torto et al. 2011.

66 For those types cf. Carancini – Peroni 1999, pls. 1–15. Another possible coeval flat axe found in southern Calabria is that from the hoard of Gerocarne (Nava 1978, 114, fig. 2; 115, 117), dated to the RBA by Gian Luigi Carancini and Renato Peroni (Carancini – Peroni 1999, pl. 29).

67 Albanese Procelli 1993, 30–33 cat. nos. 4, 10, 12 and 17, figs. 1.4, 10 and 2.12, 17; 72.

68 Albanese Procelli 1993, 50–51, fig. 15.BM 1.

69 Albanese Procelli 1993, 211–212.

70 Bernabò-Brea – Cavalier 1980, 739–740, cat. nos. 1–16, pls. 278–281.

71 Albanese Procelli 1993, 72.



Fig. 11 Punta di Zambrone, Recent Bronze Age, lead wheel cat. no. 3 (photo: J. Lipták)

Bronze or early Middle Bronze Age date. An ideal alloy composition with 8 to 12% Sn was produced by the phase MBA 3, as swords of types Thapsos and Pertosa from southeastern Sicily[72] and from the Aeolian Islands[73] indicate. It is then characteristic for the RBA metallurgy all over Italy.[74] South Italian EBA and MBA 1–2 products often have much lower tin contents or even do not contain any tin at all.[75] If the Passo Murato axe is indeed a product of Sicilian metallurgy, we cannot completely rule out an MBA 3 chronology, as several moulds for flat axes come from the settlement of Ustica-Faraglioni.[76]

The two lead wheels, cat. nos. 3 (Figs. 2.10 and 11) and 9 (Fig. 2.11) – already discussed elsewhere – are almost identical in their dimensions and belong to a type attested multiple times in Mycenaean Greece. The Italian bronze wheel types Redù and Narce – traditionally interpreted as pin heads, but possibly rather spindle whorls – are similar, but not identical to the Aegean finds.[77] One exact parallel for the Zambrone objects, again made of lead, has recently been found in a LH IIIC Developed level in the Lower Town of Tiryns.[78] There is a third lead artefact; an irregular strip (cat. no. 5, Fig. 9.1), which is probably part of a clamp used to mend a vessel. This repair technique was in common use in the Bronze Age Aegean, but only rarely – if ever – applied in contemporary Italy.[79]

---

72 Unpublished data produced at the CEZ Mannheim in the framework of the programme 'Dissemination of War Technology in the Mediterranean at the End of the 2nd Millennium BC – Or Why the Bronze Smith Had to Have some Knowledge about Fighting' conducted by M. Mehofer and R. Jung and financially supported by INSTAP, Philadelphia, USA.

73 Bettelli – Cardarelli 2010, 165–168, fig. 85.1; Mazzucchelli – Giovannini 2010, 171, tab. 1, 3.

74 Cf. de Marinis et al. 2005, 681–686, fig. 1; Hook 2007, 314, tab 1.120, 122, 127; Salzani 2011, 82–87, tab. 4.

75 For continental Italy see Pare 2000, 23–24. For Sicily see Maniscalco 1997, 363; Giardino 1997, 406–407.

76 Albanese Procelli 2000, 77; Vassallo 2004, 34–35, fig. 6.5–7. These moulds, however, do not show the broad, semilunar cutting edge of the Passo Murato specimen.

77 Jung et al. 2015, 79–81.

78 Maran – Papadimitriou 2016, 56, fig. 84.

79 Jung et al. 2015, 81–82, figs. 18a–b.

Weapons and Armour

The only secure weapon from Punta di Zambrone is the grip-tongue fragment of a small sword or large dagger (cat. no. 38, Fig. 9.11). It is not easy to find precise parallels for this fragmentary piece. During the Recent Bronze Age, different types of daggers and swords and also some knives share similar grip-tongue handles.[80] However, the RBA knife handles are always of smaller size (at least regarding the examples known up to now). Even the daggers are almost always smaller. The width[81] of the pommel ears of the specimen from Punta di Zambrone is reached by very few RBA daggers. One of these belongs to the Merlara type[82], a second one to the Tenno type,[83] while another four belong to type Bertarina.[84] None of these specimens, however, has a truly similar shape,[85] and, above all, none has a rivet in such a high position, i.e. close to the proximal end of the grip-tongue. More generally speaking, all grip-tongue daggers have their first (and often single) rivet in a more distal position, close to the blade, while only in a few cases is there a second rivet located not far from the centre of the grip-tongue. A rivet next to the proximal extremity, between the pommel ears, is an exceptional feature, which is present on only less than 5% of the daggers with extant handle.

For the reasons outlined above, it is slightly more likely that cat. no. 38 was part of a small grip-tongue sword. Two swords, assigned by Vera Bianco Peroni to her type Frassineto,[86] belong in essence to a reduced version of the Cetona type (cf. below). Both have a grip-tongue of dimensions compatible with those of the fragment of Punta di Zambrone. One of them – the one with the handle entirely preserved – also has a series of rivet holes, the highest of which is not far from the proximal end of the grip-tongue.[87]

Another peculiarity of the Zambrone fragment is the fact that only a single rivet is preserved. Considering the extant portion of the grip-tongue, one would expect at least one more rivet or rivet hole to be present, if not two – if this was indeed part of a sword. Occasionally, however, there are swords, which, although exhibiting all the characteristics of the Cetona type, have only a single rivet in the grip-tongue.[88] Three of these are very slender with pommel ears of a width even more restricted than in the case of the Zambrone fragment.[89] Therefore, it seems possible to assign the Zambrone grip-tongue to a variety of the Cetona type. Moreover, it seems significant that the geographically closest parallel for cat. no. 38 is part of the Lipari hoard. Unfortunately, this is again just a fragment of a grip-tongue. Bernabò Brea and Cavalier thought it more likely belonged to a sword than to a dagger.[90]

---

80 Bianco Peroni 1976, 14 cat. nos. 16–17; 16–17 cat. nos. 25, 28, 32 and 35, pls. 2.16–17, 23; 3.25, 28, 32; 4.35.

81 The preserved width of the pommel ears is 2.67cm. Considering that some smaller chips are broken off, the original width was a bit larger.

82 Bianco Peroni 1994, 155 cat. no. 1535, pl. 85.1535 (from the settlement of Toscanella Imolese in Emilia-Romagna). A big dagger close to type Merlara was found in Sicily at Sant'Angelo Muxaro (Tomb XV, n. 1: Rizza – Palermo 2004, 111, tav. XXVII).

83 Bianco Peroni 1994, 156 cat. no. 1552, pl. 86.1552 (the eponymous piece from Trentino).

84 Bianco Peroni 1994, 158–160 cat. nos. 1574, 1585, 1595, 1600 (from the settlement Peschiera-Bacino Marina in Veneto, from the *terramare* settlement Casaroldo di Samboseto in Emilia-Romagna and from Castelbonafisso in Lombardy).

85 The grip-tongue of the Punta di Zambrone specimen has concave sides, which expand towards the end very gradually, while the six mentioned daggers (and generally the majority of the daggers) have a real 'swallow-tail' termination, which expands suddenly only at the end of the grip-tongue.

86 Bianco Peroni 1970, 64 cat. nos. 148–149, pl. 21.148–149.

87 Bianco Peroni 1970, 64 cat. no. 149, pl. 21.149.

88 In Italy a sword from Casier in Veneto (described as a variety of type Treviso by Bianco Peroni 1970, 61 cat. no. 134, pl. 18.134), on the western Balkans at least five (singled out as type Marina by Harding 1995, 33–34 cat. nos. 65–69 and 71, pls. 10. 65–69; 11.71), in the Carpathian Basin one (Kemenczei 1988, 54 cat. no. 259, pl. 27.259).

89 Mesić-Špaja (a hoard find of Ha A1 date from the Vojvodina): Harding 1995, 34 cat. no. 67, pl. 10.67 (width 2.55cm). Volosinovo (a chance find from the Vojvodina): Harding 1995, 34 cat. no. 71, pl. 11.71 (width 2.4cm). Nagyrécse (a single find from Hungary): Kemenczei 1988, 54 cat. no. 259, pl. 27.259 (width 2.4cm, but no real pommel ears have been forged out).

90 Bernabò Brea – Cavalier 1980, 746 cat. no. 84, pl. 291.84.

Among the eight fragmentary bronze shanks from Punta di Zambrone, three may in fact be parts of rivets, as they seem to preserve one flattened and slightly thickened end (cat. nos. 2, 32 and 35 [Fig. 9.9]). However, their condition precludes any typological discussion, i.e. a hypothetical assignation to knives, daggers or swords. A further object (cat. no. 18, Fig. 9.2) may also be a rivet. It has an umbrella-shaped head, carried by the rest of a rather thick shank. Functional and decorative rivets with umbrella-shaped heads are present on some Aegean swords of different types and LBA phases up to the late Post-palatial period.[91] By contrast, the heads of functional rivets on swords and daggers in Italy are only slightly broadened by hammering and do not have an umbrella-like cap. However, some MBA swords in northern Italy have additional rivets with umbrella-shaped heads, which seem to have been inserted into the organic hilt plates for decorative reasons and do not penetrate the metal grip-tongue or hilt.[92]

In addition to weapons, the inhabitants of Punta di Zambrone might even have used armour, but a final decision on the function of several sheet bronze artefacts is impossible due to their fragmentary character and thorough corrosion. One is band-shaped, but does not show any signs of rivet or sewing holes (cat. no. 31, Fig. 9.6). A second one has a rolled edge and seems to come from an object with an oval silhouette such as a greave (cat. no. 39, Fig. 9.10).[93]

Two RBA daggers are known from the peninsula of Tropea: one is a chance find from Tropea (cat. no. 48, Fig. 10.1), c. 8km SW of Punta di Zambrone; the other one had been secondarily deposited in an Archaic tomb (no. 156) in the so-called INAM cemetery of Vibo Valentia (cat. no. 50, Fig. 10.2), c. 12.5km SE of Punta di Zambrone. The latter is a characteristic example of the Bertarina type[94] and constitutes the southernmost specimen that is currently known.[95] Probably the one from Tropea belongs to the same type, although a classification as type Tenno cannot be excluded.[96] In northern and central Italy, the Bertarina type is attested for RBA 1 as well as for RBA 2.[97]

The already mentioned Archaic tomb from Vibo Valentia not only contained a dagger, but also a long sword of type Cetona (cat. no. 49, Fig. 10.3) – equivalent to type Reutlingen in central Europe and Naue II type A in Greece. Unlike the dagger, which is bent and broken, this sword is intact, apart from the organic parts of the grip that are missing, as is common among swords of this type found in the Mediterranean. The sword type Cetona is one of the classic representatives of the so-called *koiné metallurgica* (metallurgical koiné),[98] because its geographical distribution

---

91 In the Aegean, such broad rivet heads often served to carry golden caps (Kilian-Dirlmeier 1993, 44 cat. no. 56; 46 cat. no. 75; 59 cat. no. 118; 61 cat. no. 130; 84 cat. no. 201; 85 cat. no. 204; 98 cat. no. 255, pls. 11.56; 14.75; 22.118; 24.130; 31.201; 32.204; 39.255).

92 Salzani 2005, 97, 121, 334, pl. 4.Tb26B; 369, pl. 39.Tb483B.

93 The thickness of the sheet (0.11cm at the flat part) is analogous to the measured thickness (between 0.07 and 0.175cm) of the Pórtes greaves (cf. below n. 102). If this interpretation is correct, it might be a rare attestation of a greave in a RBA context in Italy. Katalin Jankovitz already proposed an interpretation as greave fragments for certain sheet bronze objects from the RBA 2 hoard of Pila del Brancón in the Veneto (Jankovits 1999, 91, 98, fig. 1.4–5; Jankovits 2000, 190, fig. 1.4–5; 198). One detail might speak against the interpretation of cat. no. 39 as part of a greave, i. e. the lack of any repoussé decoration. The earliest specimen of the possibly relevant greave types (see below), the one from skeleton VI inside Enkomi chamber tomb 18 (Swedish excavations), also seems to be undecorated, but the totally corroded surface prevents verification of that suspicion (Catling 1955, 22–25, figs. 1–4).

94 For the Bertarina type see Peroni 1956, 70, 82, pl. 1.2–3; Bianco Peroni 1994, 157–161, pls. 87.1566–1570; 88–89; 90.1600–1607.

95 For the distribution of type Bertarina see Bianco Peroni 1994, 160–161, tav. 121. Today, one can add a few more specimens: one from Olmo di Nogara in Veneto (Salzani 2005, 214–215, fig. 464B; 351, pl. 21.Tb228B); a second one from a RBA deposition at Custoza, also in Veneto (Salzani 1999, 10, 35, pl. 6.6), and a third one from a RBA 2 settlement level at Moscosi di Cingoli in the Marche (Sabbatini – Silvestrini 2005, 650–651, fig. 4.2).

96 For the Tenno type see Bianco Peroni 1994, 156–157, pls. 86.1552–1556; 87.1557–1563; 120B. In fact, types Bertarina and Tenno are not well separated from each other in Bianco Peroni 1994. Peroni had assigned one of Bianco Peroni's type Tenno specimens to his type Bertarina and a second one (close to type Tenno in Bianco Peroni 1994) to his type Vöcklabruck (Peroni 1956, 82 cat. no. 21; 83 cat. no. 44).

97 Damiani 2010, 395–396, fig. 64.18–20.

98 Peroni 1969, 151; Bietti Sesteri 1973, 384; Carancini – Peroni 1997.

extends from Scandinavia to Cyprus and perhaps even to the Syrian coast.[99] The specimens from Vibo Valentia and possibly Punta di Zambrone (see above) as well as Lipari[100] are the southernmost finds known from Italy. So far, no Cetona-type sword has been found on Sicily.

A pair of bronze greaves from pit grave 1929/2 in the small burial ground at Castellace constitute the only evidence for late 2nd-millennium protective armour known today from southern Calabria (cat nos. 52–53, Fig. 10.4). The tomb dates to FBA 1/2[101] and therefore roughly one century later than the abandonment of the settlement at Punta di Zambrone. The specific type of greave is mainly found in Greece. The eastern limit of its distribution is represented by two tombs at Enkomi on Cyprus, while the Calabrian grave assemblage is the westernmost occurrence.[102] The characteristics of the type (1A1 in Clausing's typology) are the s-shaped wire fittings running around the flanged edges and held in place by straps riveted to the main bronze sheet. Apparently, organic strips or cords were attached to them in order to fix the greaves on the warrior's leg. The system of lace fastening is common to many different types of sheet bronze greaves that were in use between France, the Po plain, the Carpathian Basin and the eastern Mediterranean since Bronze D of the central European chronological system. By contrast, the earlier Mycenaean greave from the LH IIB/IIIA1 warrior tomb 12 at Dhendrá follows a totally different fixation principle. A row of small holes running parallel to the non-flanged edges would have served for sewing the greave onto an organic support (or providing it with a lining).[103] This principle can also be seen in other classes of protective armour (hand and arm guards, corselets) of the Mycenaean Palace age.[104] Moreover, those Mycenaean armour pieces of LH IIIA–IIIB date never carry repoussé decoration, which, in turn, is characteristic for later European greaves and protective armour in general. For these reasons, one cannot unequivocally classify the greaves with s-shaped wire fittings as an eastern Mediterranean invention, although their distribution pattern and the early date of the specimen from tomb 18 of the Swedish excavations at Enkomi to LC IIC (contemporary with LH IIIB Late and LH IIIC Early 1)[105] might at first sight suggest just that.

Ingots

A small bronze cuboid, the original weight of which must have been around 40g, might have functioned either as a small ingot or as a balance weight (cat. no. 1, Fig. 9.12). The larger cuboid or brick-shaped ingots weighing 19.450 and 8.835kg from the Lower Citadel (built into a LH IIIB Middle house wall) and the Lower Town at Tiryns (a hoard deposited during the Submycenaean phase) respectively[106] first of all establish that bronze ingots could have this general shape in Late Mycenaean times. However, there are only very few direct parallels for very small-sized bronze cuboids in the Mediterranean. Three of them were found together and again come from Tiryns. They measure between 1.9 and 3.0cm in length, between 1.15 and 1.3cm in width, while their thickness oscillates between 0.53 and 0.65cm. Their masses amount to 7.4, 8.2 and 10.3g respectively.[107] Lorenz Rahmstorf compared them to central European rectangular to amygdaloid

99 For distribution maps see Jung 2011, 201, fig. 1; Pabst 2015, 106, fig. 1; 137–139.

100 For fragments that could belong to the Cetona type see Bernabò Brea – Cavalier 1980, 746 cat. nos. 81, 82, 84; 748 cat. nos. 117–122, pls. 291.81, 82, 84; 294.117; 295.

101 Pacciarelli 2000, 193–194, fig. 112A1.

102 For the definition of the type see Clausing 2002, 163–166, fig. 8.1–6. Further examples are now published from the western Peloponnese (Kolonas 2008, 42 fig. 55 [Pórtes]; Vikatou 2012, 73, fig. 9 [Máyiras]) and from Aetolia-Acarnania (Jung et al. 2017, 88–90, fig. 9 [Kouvarás]).

103 Verdelis 1977, 45–48, fig. 13, pl. 22; Clausing 2002, 170–171, fig. 12.

104 Verdelis 1977, 28–50, pls. 12–21; Xenaki-Sakellariou 1985, 77–78 cat. nos. Χλ 2780 (1. 2) and Χλ 2781 (1) pls. 13.2780 (1), 2780 (2), 2781 (1); IX.2780; Andrikou 2007, 402–403, pls. 100–102.

105 Jung 2009b, 76–77.

106 Kilian 1988, 130, 140, fig. 37.3–4.

107 Rahmstorf 2008, CD-ROM cat. nos. 435, 436 and 438. According to Rahmstorf 2010, 99, these weights refer to their actual state of preservation after drill samples for material analyses had been taken.

weights made of bronze.[108] So far, analogous bronze objects are lacking from Italy. There is a similar object with a mass of 16.78g from the shipwreck of Uluburun,[109] the Mycenaean pottery of which dates to LH IIIA 2.[110] Cemal Pulak called it a loaf-shaped weight – probably because its corners are rounded.[111]

In addition, we decided to include in our analysis programme a lead ingot from Frattesina on the northeastern Po plain (cat. no. 55, Fig. 10.6), because an ingot can provide direct information on lead circulation (as opposed to indirect information available via comparison of analytical data from finished artefacts with those of lead ore deposits, e.g. from Sardinia). The Frattesina lead ingot is part of hoard no. 4, found in the area of the settlement, and dates to FBA 2, i.e. c. one and a half centuries later than the bronzes from Punta di Zambrone.[112] Lead ore deposits are known from the southern (Italian) Alps, i.e. from the same region that provides ample evidence for Bronze Age copper smelting.[113] According to previous research, the metal melted from the Trentino ores found its way to the south of Italy by various exchange mechanisms at least from MBA 3 onwards[114] and up to FBA 2.[115]

Archaeometric Analyses

For a full characterisation and archaeological interpretation of the metal artefacts from the Punta di Zambrone settlement, its hinterland and the wider region of southern Calabria, archaeometric analyses were conducted. As the analysis of the surface is often compromised by corrosive effects,[116] even if visible corrosion material is removed, we opted for a minimally invasive sampling method. In the process of sampling we regularly used a steel drill of 1.0 or 1.2mm diameter. If the object was not entirely corroded, we collected only the drilled material from the metallic core (taken from 3 to 4mm depth) and discarded the uppermost (corroded) layer of usually 1 mm thickness. Sample quantities amounted to c. 30 to 40mg of metal (or corrosion products in the case of the Zambrone objects). In the case of sheet bronze, a non-joining piece of a few square millimetres served as a sample for analysis.

We conducted chemical analyses by EDXRF (Energy Dispersive X-ray Fluorescence)[117] and mass spectrometry by MC-ICP-MS (Multi-Collector Inductively-Coupled Plasma Mass Spectrometry)[118] at the Curt Engelhorn Center for Archaeometry (CEZA) in Mannheim as well as SEM-EDS measurements for some selected samples at the Vienna Institute for Archaeological Science (VIAS)[119]. These analyses serve two main purposes: first, the characterisation of the alloy composition and second, determination of the provenance of the raw material copper (or lead or silver).

---

108 Rahmstorf 2010, 99, fig. 8.7.

109 Pulak 1996, 375 cat. no. W53.

110 Bass 1986, 285, 288, ill. 23; 289, 291, ill. 29; 292–293, ill. 34; Pulak 1988, 13–14, figs. 8–9; Bass et al. 1989, 12, fig. 23.

111 Pulak 1996, 375 cat. no. W53; cf. Ialongo 2018, 9–10, fig. 6.20.

112 Salzani 2003, 40–44. In the original publication it is illustrated with the convex side on top. However, this side once lay in the ingot mould. We therefore opted in our Fig. 10.6 for an orientation which is in line with the casting technology.

113 Cierny 2008, 24, 28, 37.

114 Jung et al. 2011.

115 Jung et al. in press.

116 Pernicka 2010, 720. One of the first to observe this was Angelo Mosso (Mosso 1906, 533–535).

117 For the method cf. Lutz – Pernicka 1996.

118 For the method cf. Niederschlag et al. 2003. However, the measurements were conducted with a Thermo Neptune Multi-Collector ICP-Mass Spectrometer. The in-run precision of measurements falls into a range between 0.02 and 0.05% (2σ), depending on the isotope ratio.

119 Beside secondary electrons and back-scattered electrons, characteristic X-rays are used to identify the composition and measure the concentration of elements in the samples. The SEM used for the project is a Zeiss Evo 60 XVP with an analytical unit made by Oxford Instruments (SiLi detector, INCA 400). For a description of the method see Melcher – Schreiner 2004, 335–338.

As mentioned above, in order to obtain information on the sources of metal used in the region during the different protohistoric periods, we did not confine our archaeometric investigations to artefacts that are strictly contemporary with the Punta di Zambrone settlement phases, but also included some more recent artefacts as well as some earlier ones from other southern Calabrian sites.

As a precondition for discussing the provenance of the analysed metal objects, reference data from ore deposits are needed. The ore deposits taken into consideration in this project on archaeological grounds can be expected to have provided the raw metal for the artefacts in question. In Calabria itself, only one copper mine that was exploited during the Metal Ages is known today. It is the Grotta della Monaca close to Sant'Agata di Esaro in the province of Cosenza. In fact, this is a natural cave, which was entered and used during various prehistoric periods at least from the Neolithic onwards. For the chronological range comprising the Chalcolithic, Early and Middle Bronze Ages, mining is attested because of the occurrence of stone mining tools classified by the excavators as hammer-axes, hammers and picks in the same areas of the innermost galleries of the cave that also yielded datable ceramic vessels.[120] Minerals present in the cave include the iron mineral goethite, as well as malachite and azurite. The mentioned different types of hammer stones found in the cave – in some places together with broken up stalagmites – may have been used for the extraction of copper ores[121]. However, the copper mineralisations in the cave are not sufficiently rich to be intensively exploited for metal production. In fact, there is no real copper mineralisation in the cave but merely some green colouration of the calcite on the walls. Thanks to the excavation director Felice Larocca (University of Bari), we were able to take a sample of malachite from the right (southeastern) terminal gallery of the cave during a visit by our team to the ongoing excavations in 2011.[122]

Furthermore, we sampled some copper mineralisations at other locations in southern Calabria, in order to obtain more comparative data. However, there are, at present, no indications for their exploitation during the Bronze Age (see appendix by Giuseppe Ferraro and Sara Marino). Again for comparative reasons, we conducted a lead isotope analysis of a slag sample that was found at the Greek colony Kaulonia (at present day Monasterace Marina) and kindly provided to us by the director of the Vibo Valentia museum, Maria Teresa Iannelli. Although this slag post-dates the Punta di Zambrone settlement by several centuries, it might be related to local metal production, as Kaulonia itself was located in close proximity to copper and lead ore deposits.[123] Thanks to the kind cooperation of Luciano Salzani, we were also able to analyse a lead ingot found at the Final Bronze Age settlement of Frattesina on the northern Po plain. It provides us with comparative data for assessing Bronze Age lead circulation on the Apennine peninsula.

The state of preservation of the copper alloy objects limits somewhat the explanatory potential of the EDXRF analysis, because of possible changes of the elementary composition resulting from corrosive processes. The lead isotope composition should not have been affected by those processes.[124] This allows us to proceed to a provenance determination not only for the lead objects, but also for those made of copper alloys.

Copper-based artefacts

Beginning with the lead isotope ratios of the copper alloy artefacts, we can define two main groups in the two classical three isotope diagrams. The first group, characterised by higher $^{207}Pb/^{206}Pb$ ratios, can be compared to different degrees with those of copper slags from different Recent to

[120] Geniola – Larocca 2005a, 43 fig. 52; 44–45 fig. 54–56; 47 fig. 60–61; Geniola – Larocca 2005b, 52 fig. 68.
[121] Larocca 2010, 269–270 fig. 3; Marino 2010; Larocca 2011.
[122] Larocca 2005b, 23, pl. 1–2.
[123] Cuteri 2012. For the chronology and settlement history of Kaulonia see Iannelli 2012.
[124] Except for one object, all contained several per mille lead, which is much higher than the typical lead concentration in soil, so that no significant alteration of the lead isotope ratios even in the corroded material is to be expected.

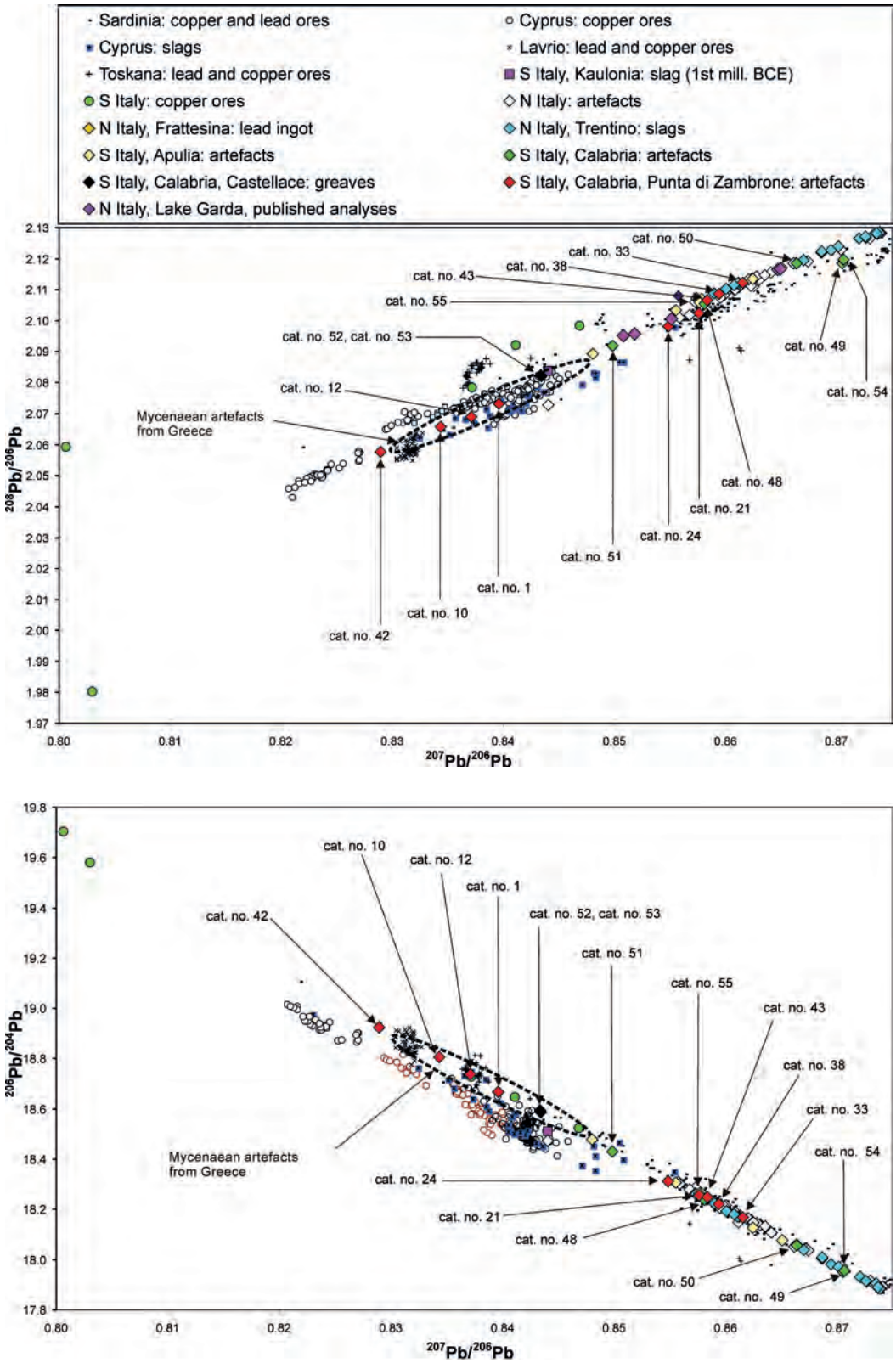


Fig. 12 Lead isotope diagram of the Punta di Zambrone artefacts in combination with the other objects found in southern Italy. The average standard deviation of the artefact analyses of the current research project is smaller than the size of the symbols (artefact, slag [Kaulonia] and ore data from Calabria: this project; slag data from Trentino, artefacts from northern Italy and Apulia by the authors, to be published elsewhere; Stos-Gale – Gale 1992, 339, tab. 2; Stos-Gale et al. 1995, 411–413, tab. 1; Stos-Gale et al. 1996, 384–385 Tab. 2; Gale et al. 1997, 241. tab. 2; 243–244, tab. 4; 246, tab. 6; Gale et al. 1998; Begemann et al. 2001, 75–76, tab. 5; Hauptmann 2011, 199, tab. 19.2; Pernicka – Salzani 2011, 98 Tab. 4; OXALID Database) (graphics: M. Mehofer)

Final Bronze Age smelting sites in the Trentino province of the southern Alps[125] as well as with RBA–FBA bronze artefacts from Veneto and Lombardia.[126] The second group fits with a large group of Mycenaean bronzes (Fig. 12; Tab. 2) as well as with copper smelting slags from different Cypriot Late Bronze Age settlements, which represent the isotopic characteristics of Cypriot and Mycenaean metal circulation.

Cat. no.	Lab code	Site	$^{208}Pb/^{206}Pb$	$^{207}Pb/^{206}Pb$	$^{208}Pb/^{204}Pb$	$^{207}Pb/^{204}Pb$	$^{206}Pb/^{204}Pb$
1	MA-131511	Punta di Zambrone (VV), Calabria	2.0734	0.83958	38.706	15.673	18.668
3	MA-115247	Punta di Zambrone (VV), Calabria	2.0600	0.83132	38.872	15.687	18.870
5	MA-131512	Punta di Zambrone (VV), Calabria	2.0625	0.83240	38.874	15.689	18.848
9	MA-115248	Punta di Zambrone (VV), Calabria	2.0683	0.83438	38.901	15.693	18.808
10	MA-115246	Punta di Zambrone (VV), Calabria	2.0658	0.83433	38.851	15.691	18.807
12	MA-144439	Punta di Zambrone (VV), Calabria	2.0690	0.83709	38.770	15.685	18.738
21	MA-135074	Punta di Zambrone (VV), Calabria	2.1024	0.85762	38.384	15.657	18.257
24	MA-135075	Punta di Zambrone (VV), Calabria	2.0982	0.85484	38.423	15.654	18.312
33	MA-135076	Punta di Zambrone (VV), Calabria	2.1122	0.86153	38.372	15.651	18.167
38	MA-144436	Punta di Zambrone (VV), Calabria	2.1086	0.85939	38.422	15.660	18.222
42	MA-144438	Punta di Zambrone (VV), Calabria	2.0577	0.82892	38.945	15.688	18.926
43	MA-144437	Punta di Zambrone (VV), Calabria	2.1066	0.85836	38.445	15.665	18.250
47	MA-120713	Gallo di Briatico (VV), Calabria	2.0692	0.83296	38.922	15.668	18.810
48	MA-135077	Tropea (VV), Calabria	2.1053	0.85809	38.401	15.652	18.240
49	MA-120711	Vibo Valentia (VV), Calabria	2.1184	0.87052	38.030	15.628	17.952
50	MA-120712	Vibo Valentia (VV), Calabria	2.1184	0.86637	38.252	15.644	18.057
51	MA-146641	Passo Murato (VV), Calabria	2.0918	0.84984	38.554	15.663	18.431
52	MA-146650	Castellace (RC), Calabria	2.0820	0.84342	38.696	15.676	18.586
53	MA-142032	Castellace (RC), Calabria	2.0823	0.84336	38.718	15.681	18.594
54	MA-146639	Torre Galli (VV), Calabria	2.1198	0.87063	38.062	15.633	17.956
55	MA-120714	Frattessina (RO), Veneto	2.1060	0.85725	38.466	15.658	18.265
ores and slag							
chalcopyrite	MA-133263	Kaulonia (RC), Calabria	2.0921	0.84110	39.013	15.685	18.648
malachite, azurite	MA-144441	Valanidi (RC), Calabria	2.0783	0.83715	38.922	15.678	18.728
malachite	MA-144442	Valanidi (RC), Calabria	2.0594	0.80062	40.577	15.775	19.704
malachite	MA-144443	Grotta della Monaca (CS), Calabria	1.9802	0.80299	38.772	15.723	19.580
chalcopyrite	MA-146637	Raspa di Bivongi (RC), Calabria	2.0984	0.84683	38.871	15.687	18.524
galena	MA-146638	Torrente Manna - Pietralonga di Longobucco (CS), Calabria	2.1036	0.85651	38.470	15.663	18.288
copper smelting slag	MA-152007	Monasterace Marina/ Kaulonia (RC), Calabria	2.0838	0.84402	38.573	15.623	18.511

Tab. 2 Lead isotope ratios of 12 artefacts from Punta di Zambrone, 8 artefacts from other Calabrian sites and one artefact from Veneto as well as the lead isotope ratios of 6 ore samples and one slag from Calabria. The precision of measurement is less than ± 0.01% for ratios with ^{206}Pb in the denominator and up to ±0.03% for $^{206}Pb/^{204}Pb$

It is important to remark that the southern Calabrian copper ore samples are clearly different from those groups formed by the bronze artefacts found at Punta di Zambrone and the wider re-

[125] For the smelting sites see Cierny 2008. Thanks to the kind help by Elena Silvestri, in 2010, M. Mehofer and R. Jung were able to sample a number of slag deposits from different sites. The analytical results of those copper slags are going to be published elsewhere.

[126] Cf. Jung et al. 2011.

gion of southern Calabria. This means that they can safely be excluded as sources for the Recent and Final Bronze Age workshops in the region.

The correspondence to the northern Italian slags and bronzes is almost perfect for four out of nine bronze objects from Punta di Zambrone, i.e. the double spiral-headed pin cat. no. 21, the knife fragment cat. no. 43, the hypothetical sword grip-tongue cat. no. 38 and the tweezer fragment cat. no. 33 (Figs. 2.1, 13, 15; 9.11). In addition, there are two contemporary bronzes from the Peninsula of Tropea, which we can assign to the same group: the grip-tongue daggers of type Bertarina from Tropea, cat. no. 48, and Vibo Valentia, cat. no. 50 (Figs. 10.1–2). Based on these results, we can formulate our first working hypothesis, according to which imported copper from the Trentino region served as one basic supply for the local bronze workshops. We still need to test it against the trace element data.

Three further bronze artefacts from Punta di Zambrone and the wider region of the Peninsula of Tropea have similar lead isotope ratios to the first six objects cited above, but in the diagram their $^{208}Pb/^{206}Pb$ ratios are all lower than those of the Trentino ores and the bronzes from the northern Po plain. These artefacts are the pin with a globular head, cat. no. 24, from Punta di Zambrone; the Cetona type sword from Vibo Valentia, cat. no. 49, and the bow fibula from Torre Galli, cat. no. 54 (Figs. 2.2; 8.2; 10.3). The latter two are conspicuously close to some copper and lead ores from Sardinia, while the pin from Punta di Zambrone shows lead isotope ratios very close to an artefact from Lake Garda, which would also suggest the use of Alpine rather than Sardinian copper for this Calabrian object.[127] The results for cat. nos. 49 and 54 could provoke the hypothesis that Sardinian copper was worked in workshops in southern Calabria. One cannot totally exclude this hypothesis for the two RBA objects (cat. nos. 24 and 49), because the Ausonian I settlement on the acropolis of Lipari, which is partly contemporary to the RBA phase of Punta di Zambrone yielded one fragmentary Nuragic amphora.[128] In addition, the trace element composition of cat. nos. 49 and 54 would not contradict the Sardinian provenance of their copper.[129] The lead isotope analyses published by Balassone and her co-authors on three Early Iron Age weapons from Striano in the Sarno valley in Campania might theoretically support such an interpretation for the Torre Galli fibula cat. no. 54, although there is no complete agreement with Sardinian ore data published so far.[130] However, as also pointed out by the authors of that study, there are several copper ore deposits in the Mediterranean area, which are isotopically similar to the Sardinian copper ores. Regarding the possible use of Sardinian copper for the production of the Early Iron Age fibula from Torre Galli, this interpretation is not completely unlikely, considering the recent publication of an artefact of Sardinian type from Torre Galli.[131]

Another group of recently analysed artefacts may be of relevance for interpreting our analytical results for the RBA sword cat. no. 49 and the Iron Age fibula cat. no. 54. These artefacts are three fragments of flat copper ingots that were found at Nuraghe Arrubiu in southern central Sardinia. They had been deposited in the interstices between the stones of a niche inside the lower chamber of tower A, the central tower of the nuraghe. Two were found 60cm above today's chamber floor level, while the third rested at a higher position, at the level of the vault. After being inserted in their deposition places, they had been covered with clay mortar. According to the excavators, one cannot establish a precise stratigraphic link with any of the use phases ranging from Nuragic MBA 3 (the lowest stratigraphic level that contained the well-known LH IIIA2 Mycenaean alabastron) to Nuragic FBA 1 with an additional sporadic use in the Early Iron Age. The excavators propose a chronological assignment of the ingot deposition(s) to the phases of the most intense use, i.e. the Nuragic RBA

127 Pernicka – Salzani 2011, 98, tab. 4 (sample no. MA-073026 taken from a MBA 2–3 flanged axe of type Bacino Marina from the eponymous site); Salzani 2011, 55, 68, pl. 4.4.

128 Bernabò Brea – Cavalier 1980, 568, pl. 218.2.

129 For the chemical composition of copper alloy artefacts from Nuragic Sardinia see Begemann et al. 2001, 60–61, tab. 3.

130 Balassone et al. 2018, 116, fig. 10. The three artefacts in question are Balassone et al. 2018, 106, tab. 1, nos. 9393, 9394A and 9394B; 108, fig. 3b–d).

131 Pacciarelli – Lo Schiavo 2017.

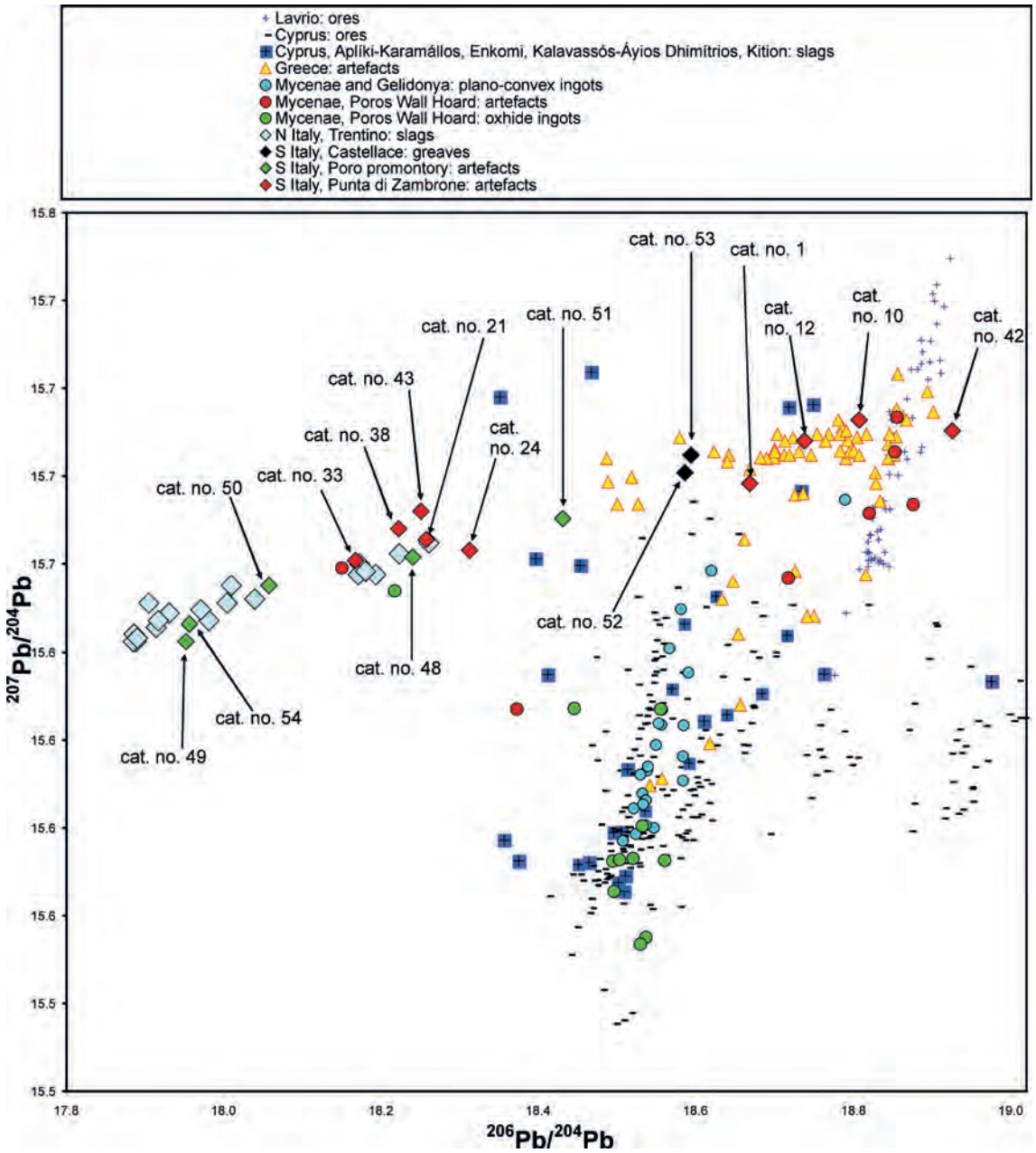


Fig. 13 Lead isotope diagram to show that some of the Punta di Zambrone artefacts (red diamonds) coincide very well with artefacts found in Greece. This suggests a common origin of the copper used. The average standard deviation of the artefact analyses of the current research project is smaller than the size of the symbols (artefact data from Calabria: this project; artefact and slag data from Trentino and Grecce by the authors, to be published elsewhere; Stos-Gale et al. 1996, 384–385, tab. 2; Gale et al. 1997, 241, tab. 2; 243–244, tab. 4; 246, tab. 6; Gale et al. 1998; Hauptmann 2011, 199, tab. 19.2; Mycenae, Gelidonia: OXALID Database) (graphics: M. Mehofer)

and Nuragic FBA 1.[132] According to the results of chemical analyses obtained with a portable XRF device, the three ingots consist of copper with relatively high concentrations of iron and lead. All three have very similar lead isotope ratios.[133] In his discussion of the results, Ignacio Montero-Ruiz relates them to copper from the prehistoric mines in the Wadi Arabah (Timna and Faynan) rather

[132] Perra – Lo Schiavo 2012, 1592–1593, fig. 2; 1594, fig. 2.1–3.
[133] Montero-Ruiz 2018, 169, tabs. 1–2.

than to Sardinian copper ores.[134] However, this interpretation, which would entail far-reaching implications regarding the copper supply of Bronze (or Early Iron) Age Sardinia, seems to us far from certain. Indeed, four ore samples (copper and lead respectively) from the southwestern Sardinian mines Sa Duchessa (Domusnovas) and Zu Zurfuru (Fluminimaggiore) show very similar lead isotope ratios and, indeed, point to a possible Sardinian origin of the metal (Fig. 12).[135] One may also ask how well the extensive ore deposits of southwest Sardinia have been isotopically characterised. In turn, the similarities in the lead isotope ratios between the three ingots from Nuraghe Arrubiu with those of the RBA sword from Vibo Valentia and the Iron Age fibula from Torre Galli may then be taken as supporting evidence for the (possibly limited) use of Sardinian copper in southern Calabria at different times during the metal ages.

The second group of artefacts, which exhibit lead isotope ratios similar to those of Mycenaean bronzes and Cypriot copper slags, may suggest that southern Calabrian workshops also had access to Cypriot copper, most probably imported via the Aegean (Fig. 13). The relevant artefacts from Punta di Zambrone are a possible cuboid bronze ingot of small size (cat. no. 1), the cutting tool (cat. no. 10) and the enigmatic artefact (cat. no. 12) made of copper ore or slag (Figs. 2.4, 14; 9.12). Finally, a bronze awl (cat. no. 42) might be associated with this group (Fig. 2.9). It shows lower $^{208}Pb/^{206}Pb$ and $^{207}Pb/^{206}Pb$ ratios than the bronzes from Mycenaean Greece, but at least one Late Bronze Age slag sample from Enkomi in Cyprus has even lower $^{208}Pb/^{206}Pb$ and $^{207}Pb/^{206}Pb$ ratios. Two of these four objects from Punta di Zambrone have typological traits that do not support the notion that they were imported as finished artefacts from the eastern Mediterranean. The awl has better parallels in Italy than in Greece, while the chisel might be a reworked Pertosa-type grip-tongue dagger. The object cat. no. 12, cut from a piece of copper ore, would, in any case, point to the import of raw material or by-products of copper manufacture from the eastern Mediterranean. Finally, the two samples from one or two bronze greaves from tomb 1929/2 at Castellace (cat. nos. 52 and 53, Fig. 10.4) also fit with the group of Mycenaean bronzes. In this case, however, we may be dealing with imported finished objects rather than with local products made with imported copper. This is a possibility, because the Castellace greaves are the only specimens of their type, which were found in Italy; all the other examples come from Greece and Cyprus (see above). Moreover, tomb 1929/2 also contained another object pointing to the long-distance contacts of the buried person, i.e. a spearhead of type Pazhok with parallels in Albania.[136]

The trace element data of the bronzes can now provide additional and independent parameters to test the mentioned working hypotheses (Tab. 3). In all the relevant trace element diagrams the cutting tool cat. no. 10 (Fig. 2.14) correlates well with the late Mycenaean bronze work and should thus contain copper of the same provenance (Fig. 14). Almost the same can be stated for the bronze cuboid cat. no. 1 and the awl cat. no. 42 (Figs. 2.9; 9.12), but their Ag and Sb concentrations are in the lowermost range of the respective concentrations in the Mycenaean reference group.[137] Our combined analytical evidence suggests that copper was imported to the region (probably from Cyprus via Mycenaean Greece) and subsequently used in local bronze manufacture. In fact, the archaeological evidence from the Tyrrhenian regions of Italy strongly supports such an interpretation, for fragments of copper oxhide ingots are known from Sicily (i.e. from Thapos and Cannatello) and, above all, from the Lipari hoard – probably deposited during the Ausonian I phase.[138] Finally, we may also mention in this context the huge number of complete and fragmentary Cypriot copper oxhide ingots from Sardinia, because they most probably reached

[134] Montero-Ruiz 2018, 170–174, figs. 2–6. A fourth ingot coming from a corridor in the same nuraghe shows diverging lead isotope ratios (Perra – Lo Schiavo 2012, 1592–1593, fig. 2; 1594, fig. 2.4; Montero-Ruiz 2018, 169, tabs. 1–2) and will not be discussed here.

[135] Stos-Gale et al. 1995, 411, tab. 1 (samples nos. SZF1, SZU 100, SZU 101); Begemann et al. 2001, 75, tab. 5 (sample no. SARD 129a).

[136] Pacciarelli 2000, 193–194, fig. 112A2.

[137] Their element concentrations would fit perfectly with those of the chronologically earlier copper oxhide ingots from the Uluburun wreck (not shown in this graph).

[138] Lo Schiavo et al. 2009.

Cat. no.	Lab code	Site	Fe	Co	Ni	Cu	Zn	As	Se	Ag	Sn	Sb	Te	Pb	Bi
1	MA-131511	Punta di Zambrone	0.28	<0.01	0.022	91	<0.1	0.11	0.014	0.003	8.6	0.014	<0.005	0.04	<0.01
3	MA-115247	Punta di Zambrone	0.05	<0.01	<0.02	0.07	1.75	0.53	<0.02	0.027	0.012	0.027	<0.005	97	<0.1
5	MA-131512	Punta di Zambrone	<0.02	<0.02	<0.02	0.13	<0.02	<0.2	<0.02	0.044	0.005	0.025	0.016	100	<0.2
9	MA-115248	Punta di Zambrone	0.07	<0.01	<0.02	0.06	1.10	0.39	<0.02	0.050	0.014	0.27	<0.005	98	<0.1
10	MA-115246	Punta di Zambrone	0.06	0.03	0.03	92	0.50	0.41	<0.01	0.007	7.1	0.009	0.0060	0.16	<0.01
21	MA-135074	Punta di Zambrone	0.073	<0.01	<0.010	94	<0.1	0.23	<0.01	0.004	5.2	0.031	<0.005	0.35	<0.01
24	MA-135075	Punta di Zambrone	1.09	<0.01	0.014	91	<0.1	0.15	<0.01	0.003	7.7	0.056	0.006	0.19	<0.01
33	MA-135076	Punta di Zambrone	0.19	<0.01	0.035	83	0.11	0.12	<0.01	0.104	15.6	0.225	0.008	1.13	0.03
38	MA-144436	Punta di Zambrone	0.15	<0.01	0.03	93	<0.1	0.13	<0.01	0.007	6.7	0.015	<0.005	0.16	<0.01
42	MA-144438	Punta di Zambrone	0.62	<0.01	0.01	89	<0.1	0.32	0.02	0.004	9.6	<0.005	0.013	0.07	<0.01
43	MA-144437	Punta di Zambrone	1.48	<0.01	0.04	78	<0.1	0.12	<0.01	0.012	19.2	0.061	<0.005	0.51	0.02
48	MA-135077	Tropea	0.21	0.03	0.04	77	1.7	0.14	<0.01	0.030	15.7	0.092	0.006	5.3	0.02
49	MA-120711	Vibo Valentia	0.40	0.04	0.03	88	<0.2	0.18	<0.01	0.09	10.7	0.08	<0.01	0.44	0.05
50	MA-120712	Vibo Valentia	0.21	0.02	0.04	90	<0.2	0.12	<0.01	0.05	9.6	0.03	0.01	0.18	0.03
51	MA-146641	Passo Murato	2.3	<0.01	0.04	85	<0.1	0.16	<0.01	0.005	12.0	0.074	<0.005	0.04	0.03
52	MA-146650	Castellace	0.54	<0.01	0.07	78	<0.1	0.34	<0.01	0.038	20.4	0.113	0.011	0.3	0.02
53	MA-142032	Castellace	0.51	0.015	0.11	64	<0.1	0.84	<0.01	0.054	33.9	0.144	<0.005	0.71	0.03
54	MA-146639	Torre Galli	0.45	<0.01	0.05	93	<0.1	0.22	<0.01	0.012	5.3	0.010	0.019	1.20	<0.01
55	MA-120714	Frattessina	0.18	n.a.	n.a.	0.1	n.a.	<0.2	n.a.	0.82	<0.005	<0.005	n.a.	99	0.02

Tab. 3 Chemical composition of the Calabrian artefacts (cf. Tab. 2) as determined with energy-dispersive XRF. All values are given in mass percent, ‘n.a.’ = not analysed

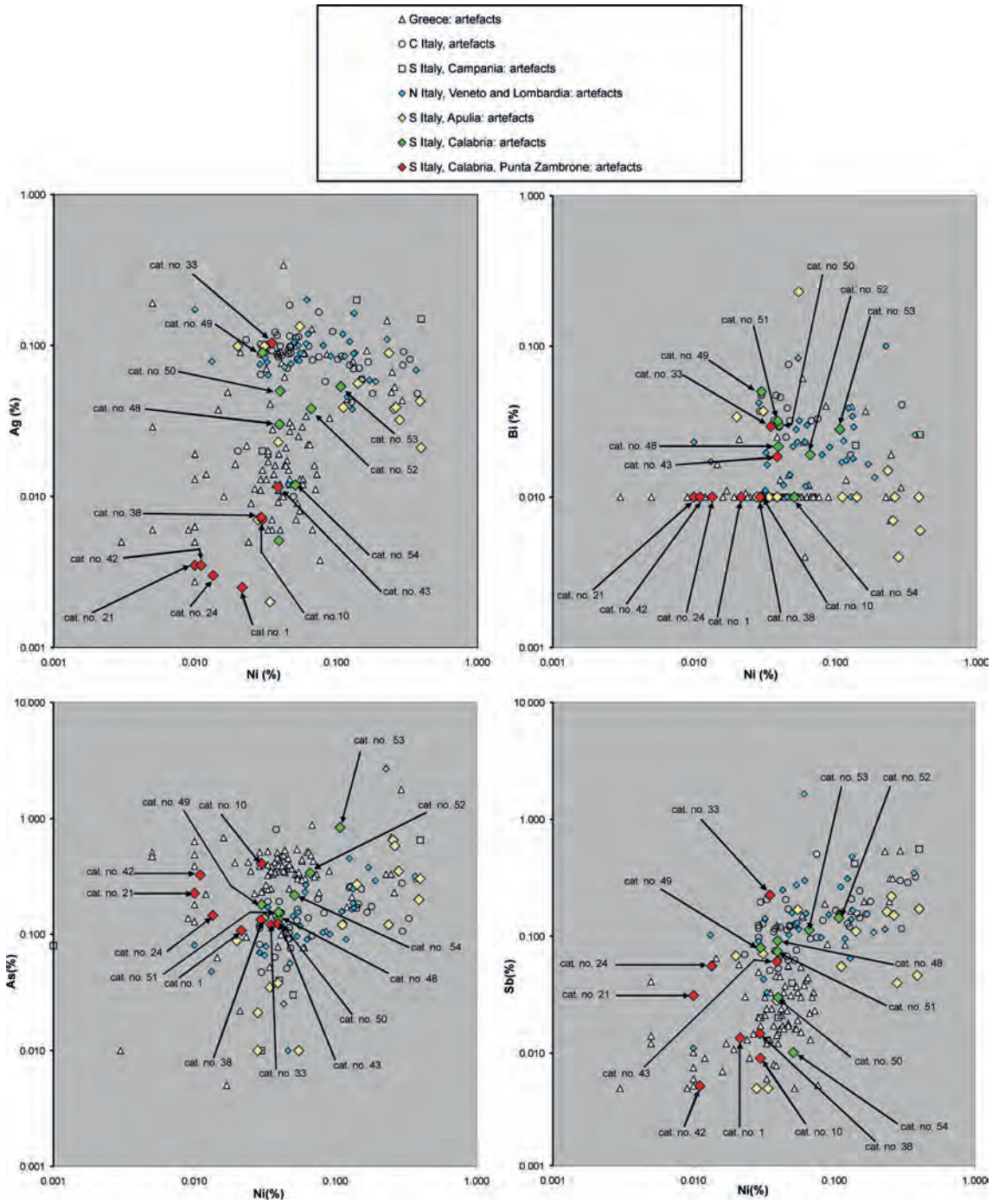


Fig. 14 In double logarithmic diagrams of elemental concentrations artefacts from Apulia and Calabria correlate well with those of northern Italian objects, while those of Punta di Zambrone artefacts that consist of north Italian copper show some differences (artefact data from Calabria: this project; artefacts from northern Italy, Apulia and Greece by the authors, to be published elsewhere; Junghans et al. 1960, 318–319; De Marinis et al. 2005, 681; Hook 2007, 313–316, tab. 1) (graphics: M. Mehofer)

the island on the sea route passing through the Straits of Messina and along the southern Calabrian coast.

In the case of the Castellace greave(s) (cat. nos. 52 and 53, Fig. 10.4), the trace element ratios do not unequivocally support the Cypriot hypothesis, for the Bi and Sb concentrations fit better with the northern Italian bronze artefacts than with the Mycenaean ones. However, the two greave fragments taken as samples were totally corroded, which may have altered their chemical compositions.

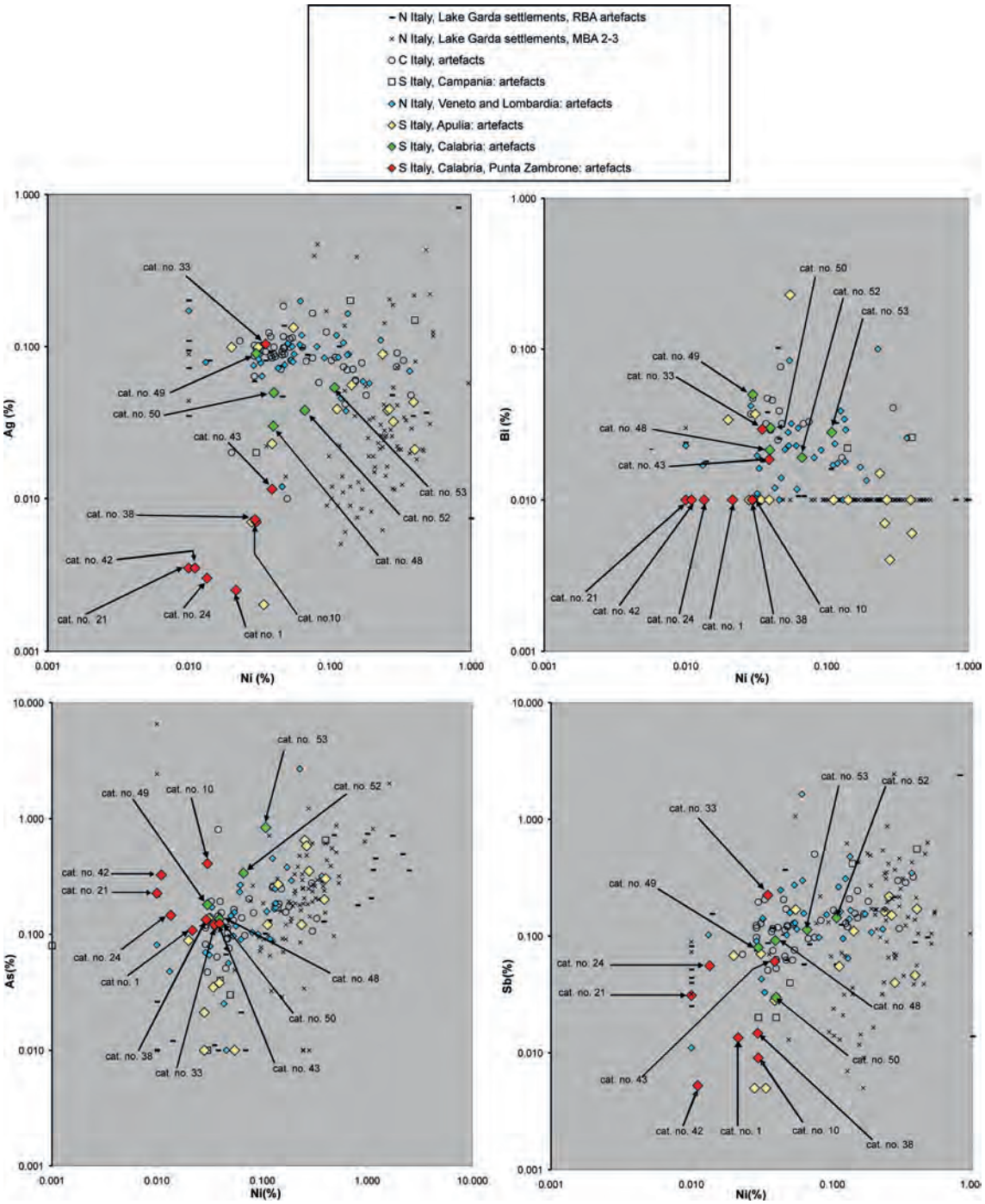


Fig. 15 Double logarithmic diagrams modified from Fig. 14 with data of artefacts from settlements around Lake Garda included (artefact data from Calabria: this project; artefacts from northern Italy, Apulia and Greece by the authors, to the be published elsewhere; Junghans et al. 1960, 318–319; De Marinis et al. 2005, 681; Hook 2007, 313–316, tab. 1; Pernicka – Salzani 2011, 94, tab. 3) (graphics: M. Mehofer)

Apart from the use of Cypriot copper, there is also evidence for the use of southern Alpine copper in the Calabrian workshops (Fig. 15). As stated above, this is suggested by the lead isotope ratios of six bronze objects. However, the interpretation of the trace element ratios of these same objects poses some problems in this respect. First of all, the tweezer fragment cat. no. 33 (Fig. 2.13) is part of the northern Italian bronze group according to all relevant trace element ratios. The same might be said of cat. no. 50 (Fig. 10.2), the grip-tongue dagger from Vibo

Valentia.[139] The trace element concentrations of the remaining four bronze artefacts from Punta di Zambrone and Tropea partly diverge from that northern Italian group. Cat. nos. 21, 38 and 48 have lower Sb concentrations; cat. nos. 21, 38, 43 and 48 contain less Ag than this reference group; the Ni concentrations are lower only in the case of cat. no. 21. Finally, the Bi concentrations of cat. nos. 21 and 38 are lower than those of the northern Italian reference group. The observation that those four Calabrian finds do not show a uniform pattern of deviation from the northern Italian *reference* group, taken together with the fact that they agree perfectly with those northern Italian bronzes in their lead isotope ratios, does not suggest that they contain copper of a different geographical provenance. At this point it cannot be excluded that the mentioned chemical deviations of the three Zambrone artefacts cat. nos. 21, 38 and 43 are due to the strong corrosion of all bronzes from Punta di Zambrone. In fact, with 19.2% Sn cat. no. 43 shows such a high tin content that it must be suspected that this results from corrosive effects. The same applies to the Castellace greave fragments. Moreover, the objects cat. nos. 1 and 42, probably related to Cypriot copper (see above), also show low Ag and Sb concentrations in comparison to their reference group (the bronzes from Mycenaean Greece, see above)[140]. It seems, therefore, that the chemical composition of the objects deposited in the ash levels inside the Zambrone fortification ditch share the same kind of alterations attributable to corrosion, regardless of the metal provenance as indicated by their lead isotope ratios.

The fact that the results of the EDXRF analyses conducted on the dagger from Tropea (cat. no. 48) also shows some trace element deviation warrants another explanation. The zinc (1.72%), tin (15.7%) and lead (5.3%) concentrations of this dagger are unusually elevated, if compared to the results of all the other artefacts analysed within this project. Here it is important to note that in this case the EDXRF analysed a small fragment instead of the powder produced by drill sampling. Although the fragment did have a clearly visible metallic core, a possibly corroded surface as well as the measurement geometry may be responsible for the unusual element values noted.[141] In order to cross-check this result, we carried out SEM-EDS analyses on another fragment of the Tropea dagger. A cross section of the fragment was ground and polished to remove the corrosion. Subsequently the measurements were carried out on the metallic surface prepared in that way (Tab. 4).

Element	Cu	Sn	Pb
Cat. no. 48	89	11	0.3

Tab. 4 Area analysis (rounded) by SEM-EDS of the dagger from Tropea, cat. no. 48. All values are given in mass percent. Measurements were normalised to 100% and afterwards rounded

The SEM-EDS analyses revealed that the tin and lead concentrations of the dagger fall in line with the results of the other analysed artefacts found in southern Italy and did not show unusually high zinc, tin and lead concentrations. It therefore seems that the analysis result of sample no. MA-135077 is compromised by the corrosion.

A single find from southern Calabria does not seem to be related to any of the described groups. It is the axe of Sicilian type cat. no. 51 (Fig. 10.5). Its lead isotope ratios do not correlate with any known and published copper ore deposits of the central or eastern Mediterranean area.

A final issue of the south Italian bronze production to investigate is the tin supply. Some indirect evidence to assess this problem is the tin concentration in the alloys. Given the strong corrosive

[139] The Ag and Sb concentrations of this object are at the lower margin of the northern Italian reference group.

[140] Even regarding cat. no. 10, most Mycenaean bronzes from Greece have higher Ag and Sb concentrations.

[141] A recent publication by G. Balassone and co-authors gives some good insight into the phenomenon of how corrosion processes can change the element concentrations of an artefact. The analyses of artefact no. 8 from Salerno, for instance, show significantly altered tin concentrations. While the analysis of the uncorroded metal reveals a tin concentration of 8.6%, the tin content is remarkably elevated in the corroded surface layer (up to 20%), see Balassone et al. 2018, 111 tab. 4.

effects, we must exclude all the Punta di Zambrone samples from this discussion and can use only the much less corroded objects from the wider region. These are the dagger and sword from Vibo Valentia (cat. nos. 49 and 50), the flat axe from Passo Murato (cat. no. 51) and the dagger from Tropea (cat. no. 48, SEM measurement, Tab. 4), which all date to the Recent Bronze Age. These four objects can serve to calculate the mean and median values of the tin concentration. These do not differ in any significant way from the tin concentrations in roughly contemporary objects from the Marche region in central Adriatic Italy and show an ideal alloy composition (Tab. 5).

By contrast, the Early Iron Age fibula from the Torre Galli necropolis (cat. nos. 54) has a considerably lower tin content of 5.3%, which we can compare with analytical data on weapons and implements from a hoard find deposited in the region of Crotone (northern Calabria). Its constituent elements date from the early Final Bronze to the beginning of the Early Iron Age and have a very variable tin content attesting to difficulties in access to this important raw material at the very end of the 2nd and the beginning of the 1st millennium BCE.

Tin concentration	Peninsula of Tropea, RBA (n = 4)	Marche: Moscosi di Cingoli, Cisterna di Tolentino, MBA 3 – RBA 2 (n = 47)	Crotone, FBA 3 – Iron Age IA (n = 39)
mean value (mass percent)	10.9	9.9	3.2
median value (mass percent)	10.9	9.7	2.8

Tab. 5 Mean and median values of the tin concentrations of bronze artefacts found at various Italian sites (data for the peninsula of Tropea according to Tab. 3 and Tab. 4; for Moscosi di Cingoli and Cisterna di Tolentino according to de Marinis et al. 2005, 681–682; for Crotone according to Palmieri in: Marino – Pizzitutti 2008, 333–334)

Lead and Silver Artefacts

All three lead objects from Punta di Zambrone could be analysed (cat. nos. 3, 5 and 9, Figs. 2.10–11; 9.1). Their lead isotope ratios do not fit with either the main group of lead and copper ores from Sardinia or with lead and copper ores from Tuscany (Fig. 16). The single lead ore from Calabria (Torrente Manna – Pietralonga di Longobucco) that we could sample also shows completely different lead isotope ratios (Fig. 12). Two isolated samples of Sardinian copper ores are somewhat close in their isotope ratios to one of the lead wheels (cat. no. 9), but do not coincide with it. Finally, the lead isotope ratios of a plano-convex lead ingot from the FBA 2 hoard no. 4 at Frattesina (cat. no. 55, Fig. 10.6) position this ingot in the group formed by the Trentino copper slags and set it clearly apart from the Zambrone lead artefacts (Figs. 12; 16).

The typological characteristics of the two lead wheels (cat. nos. 3 and 9; Fig. 2.10–11) point to the Aegean (see above), as does the very fact that they are made of lead. Similar spoked wheels in Italy are almost invariably made of bronze, while LH IIIC Early Dhimíni even provides us with a mould for such a wheel.[142] Indeed, the lead isotope data of the Zambrone lead artefacts confirm their Aegean connections. The lead wheel cat. no. 3 and the lead strip cat. no. 5 can be assigned to the well-known lead deposits in the Lauriōtikē (Attica). The second lead wheel cat. no. 9 finds its best isotopic comparanda among the lead ores from the northern Aegean island of Thasos and the central Aegean island of Euboea. In conclusion, both lead wheels may have reached Punta di Zambrone as imported objects. Indeed, the Mycenaean settlements in which analogous lead wheels have been found (such as Teichos Dymaion, Tiryns and Mycenae) also yielded pottery and bronzes of Subapennine types.[143] In addition, the inhabitants of the settlement at Punta di

[142] Adrimi-Sismani 2006, 14, 23, figs. 10 (on top), 12.BE35699; Adrimi-Sismani 2014, 726–727. The only difference is the ribbed decoration visible on the Dhimíni mould, but this again finds a parallel on a lead wheel from Teichos Dymaion in Achaea (Jung et al. 2015, 80 n. 160).

[143] Cf. Jung 2006, pl. 26; Jung et al. 2015, 80–81.

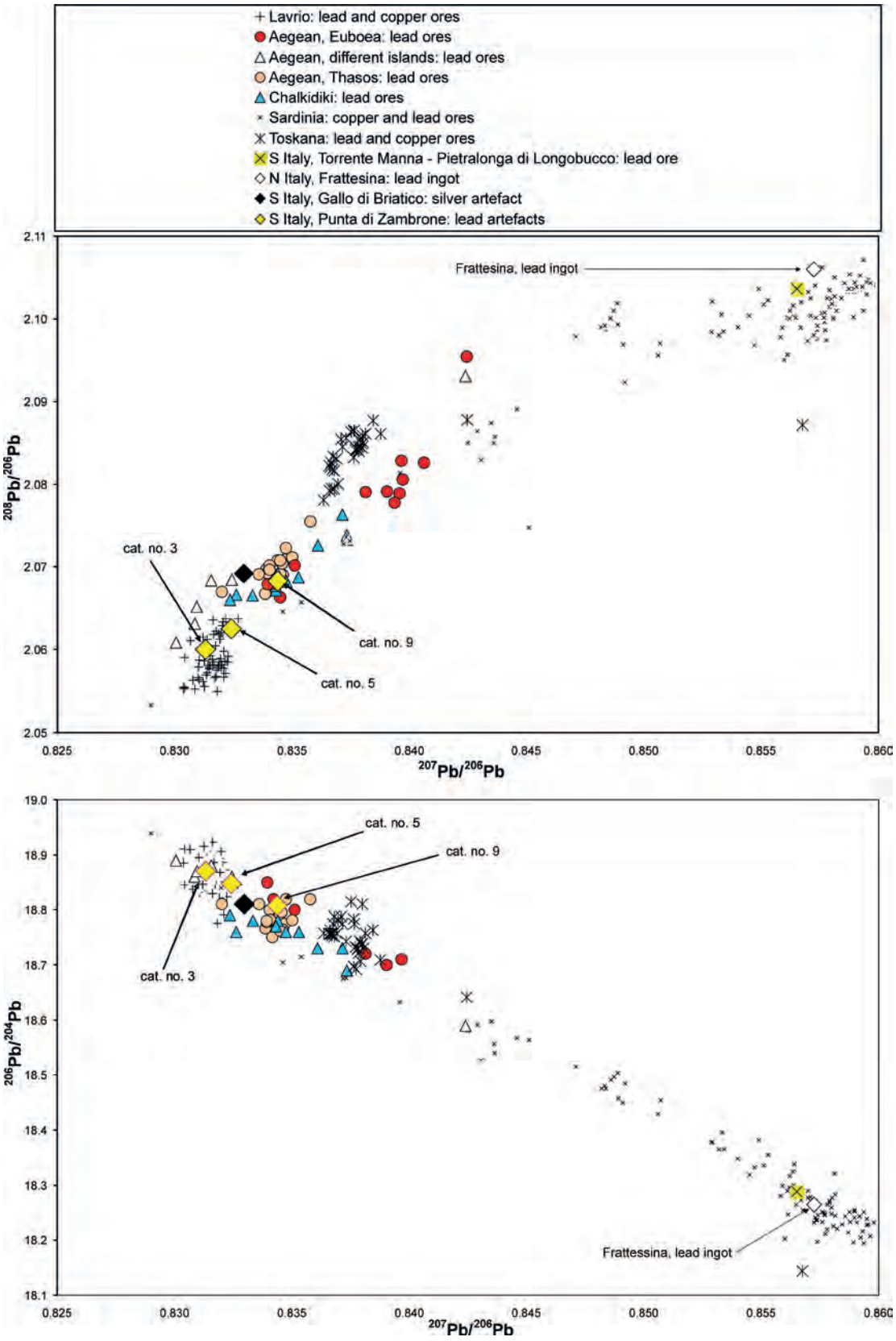


Fig. 16 The lead isotope ratios of lead and silver artefacts found in Punta di Zambrone and Giallo di Briaticao are comparable with those of the island of Thasos and the central Aegean island of Euboea. The average standard deviation of the artefact analyses of the current research project is smaller than the size of the symbols. (artefact and ore data from Calabria and Frattessina: this project; Vavelidis et al. 1985, 77, tab. 6; Stos-Gale – Gale 1992, 339, tab. 2; Stos-Gale et al. 1995, 411–413, tab. 1; Stos-Gale et al. 1996, 384–385, tab. 2; Begemann et al. 2001, 75, tab. 5) (graphics: M. Mehofer)

Zambrone apparently also imported Attic lead as a raw material, if the lead strip did indeed belong to a clamp for mending a pottery vessel.[144]

We did not find any metal objects in the Early Bronze Age levels of Punta di Zambrone, but the Middle Bronze Age 1–2 tomb from Gallo di Briatico provides the opportunity to investigate the metal supply of a period antedating the Recent Bronze Age. The corroded bracelet consists of nearly pure silver (Tab. 3). The lead isotope ratios of this bracelet compare quite well with those of lead ores from Thasos and the Chalkidiki and would thus support its Aegean origin (Fig. 16). This, in turn, would fit nicely with the presence of the Minoan seal and the Early Mycenaean pin head. Recently, Zofia Stos-Gale tried to demonstrate a relationship between the gold-rich silver ores from Romania and the silver of the silver vessels from the shaft graves at Mycenae.[145] In the case of the Gallo di Briatico bracelet the gold concentration of 0.85% excludes such a relationship. Thus, the most convincing provenance of the bracelet (or at least its metal) is the Aegean region.

Conclusions

The metal analyses revealed that in southern Calabria two – and perhaps even three – copper supply networks intersected during the Recent Bronze Age. The first and most relevant is known to have distributed southern Alpine copper from the Trentino region along the Adriatic coasts of Italy,[146] while the data presented here prove that it extended as far southwest as southern Calabria. Moreover, the northern Italian provenance of a large portion of the copper worked in southern Calabria coincides with the northern Italian derivation of the RBA types of weapons, implements and dress accessories, which substituted the earlier MBA 3 bronzes of Sicilian origin in the Lower Tyrrhenian.

The second network is centred on Cyprus and Greece,[147] and reached not only Lipari and Sardinia, but, according to our data, also southern Calabria. More importantly, the results from Punta di Zambrone show that Calabrian bronze workers also used that Cypriot copper for manufacturing implements. Previously, it seemed as if this copper of the oxhide ingots did not enter the regional Tyrrhenian production processes, but remained in ingot form (though largely fragmented).[148]

A possible third network is indicated by the analysis of the Cetona type sword from Vibo Valentia. This artefact, belonging to a type largely produced in Italy during the RBA, might be made of copper from Sardinia, and the same provenance cannot be excluded for another artefact, which comes from the peninsula of Tropea, but dates to the Early Iron Age (see below). This suggests a local production using Sardinian copper, obtained through a maritime connection already attested by exchanges of goods between Sardinia, Lipari and southern Calabria.

Regarding the lead supply of RBA southern Calabria, we only found evidence for Aegean lead. However, one needs to keep in mind that two out of three lead objects almost certainly reached the settlement of Punta di Zambrone as finished objects. The third one, the clamp, might be a local product, but this cannot be stated with certainty.

Moreover, we were able to acquire important new data for other artefacts from Calabria, mostly from older or younger periods. The bracelet from the pithos burial of Gallo di Briatico, datable to MBA 1–2, was composed of silver from Thasos or the Chalkidiki, confirming the predominantly Aegean character of the artefacts found in this tomb. The flat axe from Passo Murato has

144 A lead clamp is known from a RBA 2 context at the settlement of Fosso Vaccina in southern Etruria (Barbaro et al. 2012, 223, 231, fig. 20), but, of course, one cannot exclude the possibility that the Zambrone lead strip was imported with a mended Mycenaean vessel from Greece. This might even be the case for the clamp from Fosso Vaccina, as the settlement also yielded fragments of Mycenaean pots of so far unknown provenance (Barbaro et al. 2012, 213–216, figs. 9–10).

145 Cf. Stos-Gale 2014, 198–199.

146 Jung et al. 2011.

147 The same network also included Apulia, at least in the Final Bronze Age (Jung et al. in press).

148 Cf. Begemann et al. 2001.

a form connected to a Sicilian metallurgical tradition probably of the RBA and contains copper that comes from a still unidentified source. This may suggest that RBA metallurgists in southern Calabria had access to a fourth source of copper, in addition to those from Trentino, Cyprus and Sardinia. The FBA bronze greaves from Castellace were almost certainly produced with Cypriot copper, which is an expected result, since this object belongs to a type predominantly attested in Mycenaean Greece, but also found in Cyprus. The Early Iron Age fibula from Torre Galli also seems to be produced using Sardinian copper. This evidence, isolated but of great interest, must be verified by further analyses.

Catalogue

Cat. no. 1 Fig. 9.12
Find no.: PZ1/P5
Inv. no.: 152269
Object: Bronze cuboid (miniature ingot or balance weight?)
Site and stratigraphical context: Punta di Zambrone, Area C, BB9, SU 1, surface layer of the fortification ditch (September 8th 2011).
Coordinates: East: 2604705.767m; North: 4285499.128m; height asl: 37.413m.
Museum: Vibo Valentia, Calabria, Italy
Dimensions: l.: 3.88cm; width: 3.05cm; max. thickness: 1.41cm.
Mass: 41.8g before restoration; 38.8g after restoration.
Sampling method: Drilling.
Sample no.: PZ MP 5
Lab code: MA-131511
Macroscopic observations:
The cuboid is heavily corroded and split on several sides. Consequently, the sides are now irregular. Originally they seem to have been planar.
Publication: unpublished.

Cat. no. 2
Find no.: PZ1, Area C
Object: Bronze rivet (?)
Site and stratigraphical context: Punta di Zambrone, Area C, SU 1, surface layer of the fortification ditch.
Museum: Vibo Valentia, Calabria, Italy
Dimensions: max. preserved l.: 1.25cm; diameter of the (possible) rivet head: 0.44cm.
Mass: 0.8g
Sampling method: No sample was taken.
Macroscopic observations:
The bronze shank is heavily corroded, slightly bent and shows several splits. One end is broken off, while the other end may be the original rivet head.
Publication: unpublished.

Cat. no. 3 Figs. 2.10 and 11
Find no.: PZ51/P1
Object: Lead wheel
Site and stratigraphical context: Punta di Zambrone, Area C, CC11, SU 51, fill of plough mark disturbing the uppermost RBA ashy fill layers of the fortification ditch (September 16th 2011).
Coordinates: East: 2604707.791m; North: 4285499.516m; height asl: 37.180m.
Museum: Vibo Valentia, Calabria, Italy
Dimensions: diameter: 3.0–3.3cm; l. of the axle: 1.0cm; diameter of the axle at the free end: 0.6cm; thickness of the hoop: 0.25cm.
Mass: 13.0g
Sampling method: Drilling.
Sample no.: PZ MP 3
Lab code: MA-115247
Macroscopic observations:
The wheel-shaped object made of lead is well preserved and only slightly deformed. It consists of a hoop, six spokes and an axle protruding on one side of the wheel. The hoop has a flattened cross section, and the axle is slightly conical, i.e. narrowing down to its free end.
Publication: Jung et al. 2015, 79–81, fig. 17.

Cat. no. 4 Fig. 2.6
Find no.: PZ95/P2
Object: Bronze bead.
Site and stratigraphical context: Punta di Zambrone, Area C, FFGG12–13, SU 95, disturbed uppermost RBA ashy fill layers of the fortification ditch (September 28th 2012).
Coordinates: East: 2604710.019m; North: 4285502.496m; height asl: 37.017m.
Museum: Vibo Valentia, Calabria, Italy
Dimensions: max. l.: 0.9cm; max. diameter: c. 0.7cm; diameter of opening: c. 0.3cm.
Mass: 0.6g.
Sampling method: No sample was taken.
Macroscopic observations:
The bead is corroded. It is made of a rectangular bronze sheet bent into the shape of a small barrel, as the vertical slit clearly indicates.
Publication: Matarese et al. 2017, 468–469, fig. 1c.

Cat. no. 5 Fig. 9.1
Find no.: PZ95 DD8/29
Object: Lead strip.
Site and stratigraphical context: Punta di Zambrone, Area C, DD8, SU 95, disturbed uppermost RBA ashy fill layers of the fortification ditch (September 4th 2012).
Museum: Vibo Valentia, Calabria, Italy
Dimensions: max. preserved l.: 3.9cm; max. preserved width: 1.65cm; thickness: 0.35–0.44cm.

Mass: 12.5g.
Sampling method: Drilling.
Sample no.: PZ MP 6
Lab code: MA-131512
Macroscopic observations:
The lead strip has an irregular outline. It is roughly rectangular, but close to one of its short ends there is a drop-like protrusion. The cross section resembles an irregular trapezoid. One side of the object is rather flat (at some point slightly convex). On the other side there is a longitudinal concavity of irregular outline. This concavity probably formed during the cooling of the metal (*Schrumpfungslunker*).
Publication: Jung et al. 2015, 81–82, fig. 18a, b.

Cat. no. 6
Find no.: PZ95 CC8/7
Object: Amorphous bronze fragment.
Site and stratigraphical context: Punta di Zambrone, Area C, CC8, SU 95, disturbed uppermost RBA ashy fill layers of the fortification ditch.
Museum: Vibo Valentia, Calabria, Italy
Sampling method: No sample was taken.
Macroscopic observations:
The small object is heavily corroded and amorphous.
Publication: unpublished.

Cat. no. 7
Find no.: PZ95 CCDD9/62
Object: Amorphous bronze fragment.
Site and stratigraphical context: Punta di Zambrone, Area C, CCDD9, SU 95, disturbed uppermost RBA ashy fill layers of the fortification ditch.
Museum: Vibo Valentia, Calabria, Italy
Sampling method: No sample was taken.
Macroscopic observations:
The small object is heavily corroded and amorphous.
Publication: unpublished.

Cat. no. 8
Find no.: PZ95 FF12–13/106
Object: Amorphous bronze fragment.
Site and stratigraphical context: Punta di Zambrone, Area C, FF12–13, SU 95, disturbed uppermost RBA ashy fill layers of the fortification ditch.
Museum: Vibo Valentia, Calabria, Italy
Sampling method: No sample was taken.
Macroscopic observations:
The small object is heavily corroded and amorphous; it shows several cracks.
Publication: unpublished.

Cat. no. 9 Fig. 2.11
Find no.: PZ66/P3
Inv. no.: 152247
Object: Lead wheel
Site and stratigraphical context: Punta di Zambrone, Area C, CC10, SU 66a, RBA ashy fill layer of the fortification ditch (September 21st 2011).
Coordinates: East: 2604706.362m; North: 4285499.216m; height asl: 37.01m.
Museum: Vibo Valentia, Calabria, Italy
Dimensions: max. diameter (in deformed state): 4.2cm; min. diameter (in deformed state): 3.3cm; l. of the axle: 1.22cm; diameter of the axle at the free end: 0.62cm; thickness of the hoop: 0.27cm; width of the hoop: 0.39cm; width of the spokes: 0.35cm.
Mass: 13.2g
Sampling method: Drilling.
Sample no.: PZ MP 4
Lab code: MA-115248
Macroscopic observations:
The wheel-shaped object made of lead is deformed and broken. Two of the spokes are detached from the axle. The object consists of a hoop, six spokes and an axle protruding on one side of the wheel. The hoop has a lentoid cross section, and the axle is slightly conical, i.e. narrowing down to its free end. Both the hoop and spokes have sharp edges, which most probably results from the manufacture in a two-piece mould.
Publication: unpublished.

Cat. no. 10 Fig. 2.14
Find no.: PZ66/P5
Object: Partially flanged bronze blade (cutting tool)
Site and stratigraphical context: Punta di Zambrone, Area C, CC11, SU 66a, RBA ashy fill layer of the fortification ditch (September 21st 2011).
Coordinates: East: 2604708.249m; North: 4285499.025m; height asl: 37.054m.
Museum: Vibo Valentia, Calabria, Italy
Dimensions: max. preserved l.: 7.42cm; max. width of the blade: 2.4cm; width of the cutting edge: 2.46cm; l. of the midrib: 5.3–5.4cm; max. thickness of the midrib: 0.84cm; thickness of the blade: c. 0.2–0.3cm.
Mass: 32.0g before restoration; 30.8g after restoration.
Sampling method: Drilling.
Sample no.: PZ MP 2
Lab code: MA-115246
Macroscopic observations:
The fragmentary object is heavily corroded but a metal core is preserved. The corrosion layer preserved a network of mineralised organic fibres (possibly plant fibres) on the surface of the object. There are many cracks in the surface and the edges are partially gone. The cutting edge is split due to corrosion. The blade has an approximately rectangular outline. One end is rounded and flanged. Half of what seems to be a rivet hole is preserved at that end. The other end of the object is made up of a slightly convex cutting edge. On one side of the blade the flanges pass the middle of the length, while on the other, they stop at approximately one third of the length. The blade is strengthened by a narrow midrib that runs down the blade for three quarters of its length. It has a semicircular cross section and widens towards the cutting edge.
Publication: unpublished.

Cat. no. 11
Find no.: PZ66/P168
Object: Bronze shank fragment
Site and stratigraphical context: Punta di Zambrone, Area C, DD11, SU 66, RBA ashy fill layer of the fortification ditch (September 20st 2011).

Coordinates: East: 2604707.962m; North: 4285500.418m; height asl: 36.806m.
Museum: Vibo Valentia, Calabria, Italy
Dimensions: max. preserved l.: 3.95cm; diameter: 0.30–0.46cm.
Mass: 1.8g
Sampling method: No sample was taken.
Macroscopic observations:
The fragment is highly corroded and shows many splits; it is also contorted at the end of the possible tip. At the other end, a part of unknown length is missing. The object has a circular cross section and ends in what might be a pointed tip. Probably, it is the shank of a pin. However, one cannot exclude the possibility that the irregularly pointed shape of one end is only the result of corrosive effects.
Publication: unpublished.

Cat. no. 12 Fig. 2.4
Find no.: PZ66/P173
Object: Lentoid fragment of an object made of copper ore
Site and stratigraphical context: Punta di Zambrone, Area C, CC11, SU 66, RBA ashy fill of the fortification ditch (September 21st 2012).
Coordinates: East: 2604708.338m; North: 4285502.616m; height asl: 36.798m.
Museum: Vibo Valentia, Calabria, Italy
Dimensions: max. preserved l.: 1.29cm; max. width: 0.97cm; thickness in the centre: 0.43cm; width at the broken edge: 0.43cm; thickness at the broken edge: 0.3cm.
Mass: 1.0g (after sampling)
Sampling method: Drilling.
Sample no.: PZ MP 13
Lab code: MA-144439
Macroscopic observations:
The fragmentary object has a roughly lentoid shape. Only its upper half is truly lentoid with a roughly oval silhouette, while the outline of the lower half is conical. At its narrow end, an ancient break is visible. The result of the XRF analysis speaks against the hypothesis that the object could originally have had a shank.
Publication: unpublished.

Cat. no. 13
Find no.: PZ66 EE12/18
Object: Bronze shank fragment.
Site and stratigraphical context: Punta di Zambrone, Area C, EE12, SU 66, RBA ashy fill layer of the fortification ditch.
Museum: Vibo Valentia, Calabria, Italy
Sampling method: No sample was taken.
Macroscopic observations:
The fragment of a bronze shank is heavily corroded and exhibits many fissures. It has slightly bent at one end and has a roughly circular cross section, which is slightly flattened on one side.
Publication: unpublished.

Cat. no. 14
Find no.: PZ66a CC12/1
Object: Fragment of bronze shank.
Site and stratigraphical context: Punta di Zambrone, Area C, CC12, SU 66a, RBA ashy fill layer of the fortification ditch, from botanical sample BP 42 (September 22nd 2011).
Museum: Vibo Valentia, Calabria, Italy
Dimensions: max. preserved l.: 0.84cm; diameter: 0.15cm.
Sampling method: No sample was taken.
Macroscopic observations:
The bronze shank is heavily corroded and has a circular cross section.
Publication: unpublished.

Cat. no. 15
Find no.: PZ66b CC12/2
Object: Two small fragments of bronze wire.
Site and stratigraphical context: Punta di Zambrone, Area C, CC12, SU 66b, RBA ashy fill layer of the fortification ditch.
Museum: Vibo Valentia, Calabria, Italy
Sampling method: No sample was taken.
Macroscopic observations:
The two slightly curved small fragments of bronze wire are heavily corroded and show numerous cracks and deep splits. Possibly, they were part of a pin or needle.
Publication: unpublished.

Cat. no. 16
Find no.: PZ66d CC12/12
Inv. no.: 152252
Object: Amorphous bronze fragment.
Site and stratigraphical context: Punta di Zambrone, Area C, CC12, SU 66d, RBA ashy fill layer of the fortification ditch.
Museum: Vibo Valentia, Calabria, Italy
Dimensions: max. preserved l.: 1.3cm.
Sampling method: No sample was taken.
Macroscopic observations:
The amorphous bronze fragment is heavily corroded.
Publication: unpublished.

Cat. no. 17
Find no.: PZ66f DD10/9
Object: Bronze splinter.
Site and stratigraphical context: Punta di Zambrone, Area C, DD10, SU 66f, RBA ashy fill layer of the fortification ditch.
Museum: Vibo Valentia, Calabria, Italy
Sampling method: No sample was taken.
Macroscopic observations:
The small bronze fragment is heavily corroded and shows some deep cracks. It has an elongated shape of roughly triangular outline.
Publication: unpublished.

Cat. no. 18 Fig. 9.2
Find no.: PZ129/P16
Object: Probable bronze rivet
Site and stratigraphical context: Punta di Zambrone, Area C, DD10, SU 129, RBA ashy fill layer of the fortification ditch (September 4th 2013).

Coordinates: East: 2604708.721m; North: 4285504.333m; height asl: 36.823m.
Museum: Vibo Valentia, Calabria, Italy
Dimensions: max. preserved l.: 1.16cm; diameter of the head: 1.3cm; diameter of the shank (in the middle): 0.5–0.6cm.
Mass: 2.6g
Sampling method: No sample was taken.
Macroscopic observations:
Probably a large rivet with a circular (seemingly umbrella-shaped) head and a short shank (probably fragmentary) with circular cross section. The surface is heavily corroded, which prevents any secure identification of possible decorative elements. Most probably all protruding knobs and bulbs are pure corrosion products.
Publication: unpublished.

Cat. no. 19 Fig. 9.3
Find no.: PZ129/P41
Object: Sheet bronze fragment
Site and stratigraphical context: Punta di Zambrone, Area C, EE11, SU 129, RBA ashy fill layer of the fortification ditch (August 30th 2013).
Coordinates: East: 2604708.109m; North: 4285501.189m; height asl: 36.883m.
Museum: Vibo Valentia, Calabria, Italy
Dimensions: max. dimensions 1.2 × 1.5cm; thickness: 0.06–0.14cm.
Sampling method: No sample was taken.
Macroscopic observations:
The fragment of sheet bronze shows an irregular outline and is entirely corroded. It is not possible to identify original edges with any certainty.
Publication: unpublished.

Cat. no. 20 Fig. 9.4
Find no.: PZ129/P78
Object: Bronze wire fragments (four fragments).
Site and stratigraphical context: Punta di Zambrone, Area C, EE8, SU 129, RBA ashy fill layer of the fortification ditch (September 4th 2013).
Coordinates: East: 2604705.811m; North: 4285501.814m; height asl: 36.860m.
Museum: Vibo Valentia, Calabria, Italy
Dimensions: max. preserved l.: 2.8cm; 2.76cm; 1.55cm; 1.22cm; diameters: 0.26 × 0.27cm; 0.33 × 0.33cm; 0.19 × 0.08cm; 0.18 × 0.14cm.
Mass: 0.8 and 0.4g (two larger fragments); 0.1g (two smaller fragments together).
Sampling method: No sample was taken.
Macroscopic observations:
Four bronze wire fragments, of which the larger two are straight and have a circular cross section, while the smaller ones have rectangular cross sections and are bent to different degrees. One of the two larger fragments ends in a pointed tip.
Publication: unpublished.

Cat. no. 21 Figs. 2.1 and 3
Find no.: PZ129/P79/1, PZ129/P79/2
Object: Bronze double spiral-headed pin (two fragments).
Site and stratigraphical context: Punta di Zambrone, Area C, DD9, SU 129, RBA ashy fill layer of the fortification ditch (September 4th 2013).
Coordinates: East: 2604706.175m; North: 4285500.542m; height asl: 36.752m.
Museum: Vibo Valentia, Calabria, Italy
Dimensions: max. l.: 4.95 and 1.29cm; max. width of spiral pair: 3.45cm.
Mass: 4.4 and 0.4g (after restoration and sampling).
Sampling method: A fragment of the shank was taken as a sample.
Sample no.: PZ MP 7
Lab code: MA-135074
Macroscopic observations:
The pin is broken in two non-joining pieces; the tip is missing. The head consists of two antithetic spirals that spring from the shank. The spirals have five and six coils respectively. The cross section of the shank is circular.
Publication: Jung – Pacciarelli 2017, 316, 323, fig. 5.

Cat. no. 22
Find no.: PZ129/P119
Object: Three amorphous bronze fragments
Site and stratigraphical context: Punta di Zambrone, Area C, DD10, SU 129, RBA ashy fill layer of the fortification ditch (September 9th 2013).
Coordinates: East: 2604706.735m; North: 4285500.792m; height asl: 36.650m.
Museum: Vibo Valentia, Calabria, Italy
Sampling method: No sample was taken.
Macroscopic observations:
The three small and amorphous fragments of bronze are heavily corroded.
Publication: unpublished.

Cat. no. 23
Find no.: PZ129/P146
Object: Amorphous bronze fragment
Site and stratigraphical context: Punta di Zambrone, Area C, EE12, SU 129, RBA ashy fill layer of the fortification ditch (September 10th 2013).
Coordinates: East: 260409.131m; North: 4285501.456m; height asl: 36.716m.
Museum: Vibo Valentia, Calabria, Italy
Dimensions: max. preserved l.: 1.68cm; max. preserved width: 0.48cm.
Mass: 0.2g
Sampling method: No sample was taken.
Macroscopic observations:
The slightly curved object is heavily corroded and shows numerous cracks and deep splits. It is possible that the object consists of two bronze wire fragments held together by corrosion.
Publication: unpublished.

Cat. no. 24 Fig. 2.2
Find no.: PZ129/P150
Object: Bronze pin with globular head.
Site and stratigraphical context: Punta di Zambrone, Area C, DD12, SU 129, RBA ashy fill layer of the fortification ditch (September 10th 2013).

Coordinates: East: 2604709.192m; North: 4285499.603m; height asl: 36.786m.
Museum: Vibo Valentia, Calabria, Italy
Dimensions: total preserved l.: 8.7cm; head diameter: 0.96–1.06cm; shank cross section variable: 0.48, 0.32–0.34, and 0.36–0.39cm.
Mass: 6.4g (after restoration and sampling)
Sampling method: A fragment of the shank was taken as a sample.
Sample no.: PZ MP 8
Lab code: MA-135075
Macroscopic observations:
The pin is broken in two non-joining pieces and is entirely corroded. Its tip is missing. The head has an irregular, roughly globular shape, while the cross section of the shank is circular.
Publication: unpublished.

Cat. no. 25 Fig. 9.5
Find no.: PZ129 DDEE12/2
Object: Fragmentary bronze strip.
Site and stratigraphical context: Punta di Zambrone, Area C, DDEE12, SU 129, RBA ashy fill layer of the fortification ditch (September 9th 2013).
Museum: Vibo Valentia, Calabria, Italy
Dimensions: max. l.: 2.35cm; max. width: 0.25cm; thickness : 0.25cm
Mass: 0.6g.
Sampling method: No sample was taken.
Macroscopic observations:
The bronze strip is entirely corroded. It is narrow and straight, but one end shows a bend – whether primary or secondary cannot be determined. It has a roughly triangular cross section.
Publication: unpublished.

Cat. no. 26
Find no.: PZ129 BBCC12/17
Object: Amorphous bronze fragment.
Site and stratigraphical context: Punta di Zambrone, Area C, BBCC12, SU 129, RBA ashy fill layer of the fortification ditch.
Museum: Vibo Valentia, Calabria, Italy
Sampling method: No sample was taken.
Macroscopic observations:
The very small and amorphous bronze fragment is entirely corroded.
Publication: unpublished.

Cat. no. 27
Find no.: PZ129 EE11/76
Object: Amorphous bronze fragment.
Site and stratigraphical context: Punta di Zambrone, Area C, EE11, SU 129, RBA ashy fill layer of the fortification ditch.
Museum: Vibo Valentia, Calabria, Italy
Sampling method: No sample was taken.
Macroscopic observations:
The very small and amorphous bronze fragment is entirely corroded and shows several fissures.
Publication: unpublished.

Cat. no. 28
Find no.: PZ129a BB9/1
Object: Fragment of a bronze shank.
Site and stratigraphical context: Punta di Zambrone, Area C, BB9, SU 129a, RBA ashy fill layer of the fortification ditch.
Museum: Vibo Valentia, Calabria, Italy
Dimensions: max. preserved l.: 2.1cm; preserved diameter: 0.34cm
Mass: 0.6g.
Sampling method: No sample was taken.
Macroscopic observations:
The bronze fragment is entirely corroded, and both ends are broken off. It has a circular cross section and may be the shank of a bronze pin.
Publication: unpublished.

Cat. no. 29 Fig. 2.12
Find no.: PZ123/P19
Object: Bronze fishhook.
Site and stratigraphical context: Punta di Zambrone, Area C, FF10, SU 123, RBA fill of the fortification ditch (August 13th 2013).
Coordinates: East: 2604707.280m; North: 4285502.738m; height asl: 36.842m.
Museum: Vibo Valentia, Calabria, Italy.
Dimensions: l.: 4.47cm; max. width: 1.84cm; width of the loop 0.29cm; width of the loop in the axis of the hook; l. of the barb: 0.94cm; diameter of the shank: 0.31 (in the middle) and 0.22 × 0.28cm below the loop.
Mass: 1.9g
Sampling method: No sample was taken.
Macroscopic observations:
The object of copper alloy is totally corroded. The fishing hook has a barbed end and a loop for fixing the line. It is made from a single wire, which has a circular diameter for much of its length. Only the last part of the loop and immediately below it has a rectangular cross section.
Publication: Jung et al. 2016, 180, fig. 2–3; 183, fig. 5.1; 194 cat. no. 38.

Cat. no. 30 Fig. 9.7
Find no.: PZ151/P6
Object: Strip of sheet bronze.
Site and stratigraphical context: Punta di Zambrone, Area C, FF11, SU 151, lower RBA ashy fill layer of the fortification ditch (September 12th 2013).
Coordinates: East: 2604708.554m; North: 4285501.842m; height asl: 36.616m.
Museum: Vibo Valentia, Calabria, Italy
Dimensions: max. preserved l.: 1.12cm; width: 0.49cm; thickness: 0.04–0.08cm.
Mass: 0.2g
Sampling method: No sample was taken.
Macroscopic observations:
This corroded sheet bronze fragment belongs to a narrow rectangular strip, one short end of which is preserved.
Publication: unpublished.

Cat. no. 31 Fig. 9.6
Find no.: PZ151/P29/1
Object: Fragmentary bronze sheet.

Site and stratigraphical context: Punta di Zambrone, Area C, DD10, SU 151, lower RBA ashy fill layer of the fortification ditch (September 19th 2013).
Coordinates: East: 2604707.627m; North: 4285500.720m; height asl: 36.568m.
Museum: Vibo Valentia, Calabria, Italy
Dimensions: max. preserved l.: 5.08cm; max. preserved width: 3.7cm; thickness: c. 0.2–0.3cm.
Mass: 11.1g
Sampling method: No sample was taken.
Macroscopic observations:
Corroded fragment of a bronze sheet of rectangular shape. One short end and the long sides seem to be partially preserved. The object is bent and shows on its surface fragments of charcoal and bone held in place by the metal corrosion.
Publication: unpublished.

Cat. no. 32
Find no.: PZ151/P30
Object: Fragmentary bronze shank (rivet?)
Site and stratigraphical context: Punta di Zambrone, Area C, FF11, SU 151, lower RBA ashy fill layer of the fortification ditch (September 20th 2013).
Coordinates: East: 2604708.185m; North: 4285502.686m; height asl: 36.526m.
Museum: Vibo Valentia, Calabria, Italy
Dimensions: max. preserved l.: 1.17cm; diameter of the (possible) rivet head: 0.36cm.
Mass: 0.6g
Sampling method: No sample was taken.
Macroscopic observations:
The corroded fragment of a bronze shank seems to preserve one end, which is flattened, while the other is broken off. The object is heavily corroded and slightly bent. It may be the fragment of a rivet.
Publication: unpublished.

Cat. no. 33 Fig. 2.13
Find no.: PZ151/P38
Object: Fragmentary bronze spatula or tweezer.
Site and stratigraphical context: Punta di Zambrone, Area C, CC11, SU 151, lower RBA ashy fill layer of the fortification ditch (September 23rd 2013).
Coordinates: East: 2604707.457m; North: 4285499.566m; height asl: 36.549m.
Museum: Vibo Valentia, Calabria, Italy
Dimensions: max. preserved l.: 6.9cm; max. preserved width: 1.42cm; thickness: 0.18cm.
Mass: 3.4g
Sampling method: A non-joining fragment was taken as a sample.
Sample no.: PZ MP 9
Lab code: MA-135076
Macroscopic observations:
The object is entirely corroded and shows numerous cracks and splits. It is not certain if the object is preserved in all of its length or if one or both ends are missing. The object is entirely straight and has a flat rectangular cross section. For about two thirds of its length the edges diverge only slightly, while in the distal third they splay more markedly. As a result, one end of the object has an outline resembling an elongated triangle.
Publication: unpublished.

Cat. no. 34 Fig. 2.3
Find no.: PZ151/P43
Object: Roll-headed bronze pin.
Site and stratigraphical context: Punta di Zambrone, Area C, DD10, SU 151, lower RBA ashy fill layer of the fortification ditch (September 25th 2013).
Coordinates: East: 2604707.110m; North: 4285500.559m; height asl: 36.496m.
Museum: Vibo Valentia, Calabria, Italy
Dimensions: max. preserved l.: 4.94cm; width of the flattened (rolled in) end: 0.3cm; width of the opening in the head: 0.4 × 0.6cm; diameter of the shank: c. 0.35cm.
Mass: 3.3g
Sampling method: No sample was taken.
Macroscopic observations:
Fragmentary pin with roll-head. The object is entirely corroded, and part of the shank with the tip is missing. The shank has a circular cross section, while the end has a rectangular, almost square cross section. The latter has been rolled in to form the head with one coil and an opening in the centre.
Publication: unpublished.

Cat. no. 35 Fig. 9.9
Find no.: PZ151 FFGG10/58
Object: Fragmentary bronze shank (rivet?).
Site and stratigraphical context: Punta di Zambrone, Area C, FFGG10, SU 151, lower RBA ashy fill layer of the fortification ditch (September 20th 2013).
Museum: Vibo Valentia, Calabria, Italy
Dimensions: max. preserved l.: 2.26cm; max. diameter: 0.64cm.
Mass: 1.7g
Sampling method: No sample was taken.
Macroscopic observations:
Corroded fragment of a bronze shank with circular cross sections and a flattened end with an irregularly oval cross section.
Publication: unpublished.

Cat. no. 36 Fig. 2.7
Find no.: PZ169/P1
Object: Fragmentary bronze bead.
Site and stratigraphical context: Punta di Zambrone, Area C, FF9, SU 169, RBA sandy fill of the fortification ditch (September 23nd 2013).
Coordinates: East: 2604706.837m; North: 4285502.823m; height asl: 36.545m.
Museum: Vibo Valentia, Calabria, Italy
Dimensions: min. preserved diameter: 0.55cm; max. preserved diameter: 0.63cm; max. preserved height: 0.44cm; thickness of bronze sheet: 0.15–0.18cm.
Sampling method: No sample was taken.
Macroscopic observations:
The fragmentary bead is heavily corroded. It has an oval outline. No slit is visible. Thus, it was made in one piece.
Publication: unpublished.

Cat. no. 37 Fig. 9.8
Find no.: PZ176/P5
Object: Fragmentary bronze strip.
Site and stratigraphical context: Punta di Zambrone, Area C, EE11, SU 176, lower RBA ashy fill layer of the fortification ditch (September 30th 2013).
Coordinates: East: 2604708.629m; North: 4285500.749m; height asl: 36.431m.
Museum: Vibo Valentia, Calabria, Italy
Dimensions: max. preserved l.: 2.07cm; max. preserved width: 0.62cm; thickness: 0.2cm.
Mass: 0.8g.
Sampling method: No sample was taken.
Macroscopic observations:
The fragmentary strip is entirely corroded and has an irregular outline.
Publication: unpublished.

Cat. no. 38 Fig. 9.11
Find no.: PZ176/P15
Object: Flanged bronze grip-tongue.
Site and stratigraphical context: Punta di Zambrone, Area C, GG10, SU 176, lower RBA ashy fill layer of the fortification ditch (October 2nd 2013).
Coordinates: East: 2604707.589m; North: 4285503.148m; height asl: 35.963m.
Museum: Vibo Valentia, Calabria, Italy
Dimensions: max. preserved l.: 4.6cm; width of the pommel ears: 2.67cm; diameter of the rivet: 0.6cm.
Mass: 14.9g (after restoration).
Sampling method: Drilling.
Sample no.: PZ MP 10
Lab code: MA-144436
Macroscopic observations:
The fragmentary grip-tongue is in poor condition. It is highly affected by corrosive processes, which led to numerous cracks and longitudinal splits in the flanges and the grip-tongue. Moreover, the grip-tongue is deformed by a longitudinal bend running down the central axis of its distal part. The pommel ears are preserved, and there is a single rivet hole close to the v-shaped notch between the pommel ears. The rivet is still in place. The surfaces between the flanges show a darker colour, which is most probably due to the former presence of organic hilt plates.
Publication: unpublished.

Cat. no. 39 Fig. 9.10
Find no.: PZ176 FFGG12/1
Object: Bronze sheet fragment.
Site and stratigraphical context: Punta di Zambrone, Area C, FFGG12, SU 176, lower RBA ashy fill layer of the fortification ditch (October 3rd 2013).
Museum: Vibo Valentia, Calabria, Italy
Dimensions: max. preserved l.: 2.64cm; max. width: 1.4cm; thickness: 0.11cm (flat part) and 0.99cm (rolled part).
Mass: 2.8g
Sampling method: No sample was taken.
Macroscopic observations:
Fragment of a bronze sheet. The preserved edge is rolled in. The slightly curved outline of this edge suggests that the whole object had an oval silhouette.
Publication: unpublished.

Cat. no. 40 Fig. 2.8
Find no.: PZ176 EE10/2
Object: Fragmentary bronze awl.
Site and stratigraphical context: Punta di Zambrone, Area C, EE10, SU 176, lower RBA ashy fill layer of the fortification ditch (October 4th 2013).
Museum: Vibo Valentia, Calabria, Italy
Dimensions: max. preserved l.: 7.43cm; dimensions of shank cross section: 0.51 × 0.52cm.
Mass: 7.5g
Sampling method: No sample was taken.
Macroscopic observations:
Fragment of a bronze awl with square section. Neither end is preserved.
Publication: unpublished.

Cat. no. 41
Find no.: PZ176 FFGG11/1
Object: Two fragments of bronze sheet.
Site and stratigraphical context: Punta di Zambrone, Area C, FFGG11, SU 176, lower RBA ashy fill layer of the fortification ditch.
Museum: Vibo Valentia, Calabria, Italy
Dimensions: (frag. 1) max. preserved l.: 1.09cm; max. preserved width: 0.8cm; (frag. 2) max. preserved l.: 1.45cm; max. preserved width: 0.78cm.
Sampling method: No sample was taken.
Macroscopic observations:
The two heavily corroded fragments of bronze sheet do not seem to preserve any original edges. No conclusions regarding the original shape can be drawn.
Publication: unpublished.

Cat. no. 42 Fig. 2.9
Find no.: PZ75 FFGG9/1
Object: Fragmentary bronze awl.
Site and stratigraphical context: Punta di Zambrone, Area C,FFGG9, SU 75, RBA rubble layer of the fortification, fill of the fortification ditch (October 3rd 2013).
Museum: Vibo Valentia, Calabria, Italy
Dimensions: max. preserved l.: 7.61cm; dimensions of shank cross section: 0.43 × 0.43cm.
Mass: 5.8g
Sampling method: Two corroded fragments were taken as samples.
Sample no.: PZ MP 12
Lab code: MA-144438
Macroscopic observations:
The fragmentary bronze awl is totally corroded, the tip is preserved, while the other end is incomplete. The shank has a square diameter and narrows down to a pointed tip.
Publication: unpublished.

Cat. no. 43 Fig. 2.15
Find no.: PZ204/P3/2
Object: Fragment of a bronze knife blade.

Site and stratigraphical context: Punta di Zambrone, Area C, CC12, SU 204, RBA ashy fill of the fortification ditch (October 2nd 2013).
Coordinates: East: 2604708.631m; North: 4285498.774m; height asl: 36.541m.
Museum: Vibo Valentia, Calabria, Italy
Dimensions: max. preserved l.: 3.04cm; max. width of the blade: 1.0cm; width of the back: 0.32cm.
Mass: 1.8g
Sampling method: One corroded fragment was taken as a sample.
Sample no.: PZ MP 11
Lab code: MA-144437
Macroscopic observations:
Only a small blade fragment of the bronze knife is preserved. It is wholly corroded. The back seems to have been slightly curved.
Publication: unpublished.

Cat. no. 44 Fig. 2.5
Find no.: PZ204/P3/1
Object: Fragment of a bronze spiral.
Site and stratigraphical context: Punta di Zambrone, Area C,CC12, SU 204, RBA ashy fill of the fortification ditch (October 2nd 2013).
Coordinates: East: 2604708.631m; North: 4285498.774m; height asl: 36.541m.
Museum: Vibo Valentia, Calabria, Italy
Dimensions: max. preserved diameter: 1.23cm; min. preserved diameter: 1.09cm.
Mass: 0.6g
Sampling method: No sample was taken.
Macroscopic observations:
The fragmentary spiral is entirely corroded. Parts of three coils are preserved. The dimensions compare well with those of the double spiral-headed pin PZ129/P79/1.2.
Publication: unpublished.

Cat. no. 45
Find no.: PZ6/P12
Object: Amorphous bronze fragment
Site and stratigraphical context: Punta di Zambrone, Area B, K7, SU 6, RBA fill layer of the fortification ditch.
Museum: Vibo Valentia, Calabria, Italy
Coordinates: East: 2604703.911m; North: 4285479.300m; height asl:37,126m.
Sampling method: No sample was taken
Macroscopic observations:
It is a small and amorphous fragment bronze.
Publication: unpublished.

Cat. no. 46
Find no.: PZ6I10/14
Inv. no.: 152249
Object: Fragment of a bronze shank
Site and stratigraphical context: Punta di Zambrone, Area B, I10, SU 6, RBA fill layer of the fortification ditch.
Museum: Vibo Valentia, Calabria, Italy
Dimensions: max. preserved length: 1.5cm
Mass: 0.9g
Sampling method: No sample was taken
Macroscopic observations:
The fragment of a bronze shank is entirely corroded. It has a circular cross section.
Publication: unpublished.

Cat. no. 47 Fig. 8.1
Inv. no.: 80462
Object: Fragments of a silver bracelet.
Site and stratigraphical context: Gallo di Briatico, jar burial.
Museum: Vibo Valentia, Calabria, Italy
Dimensions: restored diameter: c. 10cm.
Sampling method: One fragment was taken as a sample.
Sample no.: CAL 3
Lab code: MA-120713
Macroscopic observations:
The preserved fragments of a silver wire with circular cross section are curved. This suggests that they belonged to a piece of ornament, perhaps a spirali-form bracelet with a reconstructed diameter of about 10cm.
Publication: Pacciarelli 2000, 185–186, fig. 109.7.

Cat. no. 48 Fig. 10.1
Inv. no.: 2013/TRP/9150
Object: Bronze grip-tongue dagger, probably of type Bertarina.
Site and stratigraphical context: Tropea, chance find.
Museum: Vibo Valentia, Calabria, Italy
Dimensions: max. preserved l.: 15.6cm; width of the hilt shoulders: 1.8cm; max. thickness of the blade: 0.35cm.
Sampling method: A fragment of the grip-tongue was taken as a sample.
Sample no.: CAL 4c
Lab code: MA-135077
Macroscopic observations:
The dagger is almost complete, but the proximal end of the grip-tongue is missing and the blade has several deep notches resulting from damage, probably due to corrosion. The hilt plates are also missing. The sides of the flanged grip-tongue run almost parallel and widen only in the distal sixth of its length to form the concave shoulders of the hilt. At the proximal end they form two diverging pommel ears. A single rivet in the distal part of the grip-tongue once held the hilt plates in place. The blade must have been leaf-shaped with a convex outline. The cross section of the blade is lentoid. Due to the fragmentary preservation of the cutting edges, it is not certain whether two lateral cuttings just below the grip-tongue were part of the original design of the weapon. Therefore, the assignation of the dagger to the Bertarina type cannot be ascertained.
Publication: Pacciarelli 2000, 83, n. 16; Cardosa 2014, 126–127, 133, fig. 2 (centre).

Cat. no. 49 Fig. 10.3
Inv. no.:1113
Object: Bronze grip-tongue sword of type Cetona / Naue II, type A / Reutlingen

Site and stratigraphical context: Vibo Valentia, INAM necropolis, tomb 156.
Museum: Vibo Valentia, Calabria, Italy
Dimensions: l.: 61.5cm; width of the pommel ears: 3.14cm; max. preserved width of the hilt shoulders: 4.65cm; max. height of the flanges: 0.65cm; max. thickness of the hilt: 0.95cm; max. thickness of the blade: 0.7cm; diameter of the rivet holes in the grip-tongue: 0.4–0.5cm; diameter of the rivet holes in the hilt shoulders: 0.4cm. The balance point lies at 28.2cm as measured from the end of the grip-tongue.
Mass: 504.0g.
Sampling method: Drilling.
Sample no.: CAL 1
Lab code: MA-120711
Macroscopic observations:
The sword is in relatively good condition, but the edge of one hilt shoulder, all of the rivets and the hilt plates are missing. The blade shows damage at several points and is partially split, due to corrosive processes. No ancient notches can be identified. The flanged grip-tongue has parallel sides, which are slightly convex in their central part. The grip-tongue ends in two diverging pommel ears. The hilt shoulders have a conical, slightly convex outline. Four rivet holes were opened in the grip-tongue and four in the hilt shoulders, all from the same side of the sword (the one nowadays carrying the inv. no.). The blade shows a broad thickened central strip set apart from the cutting edges by a step. The width of that central strip accounts for c. 65% of the blade width. It continues well between the hilt shoulders and ends in a step of flattened semicircular outline. The cutting edges run parallel to each other and converge towards the tip in the distal half of the blade (for about 45% of its length up to the tip).
Publication: Bianco Peroni 1974, 3–4 cat. no. 145 A; 15 cat. no. 145 A, pl. 2.145A.b; Arslan 1986, 1044; Pacciarelli 2000, 189–190, fig. 110, right.

Cat. no. 50 Fig. 10.2
Inv. no.: 1194
Object: Bronze grip-tongue dagger of type Bertarina.
Site and stratigraphical context: Vibo Valentia, INAM necropolis, tomb 156.
Museum: Vibo Valentia, Calabria, Italy
Dimensions: max. preserved l. in bent condition: 12.23cm (longer fragment) and 6.8cm (shorter fragment); total l. (straightened): 20.25cm; max. height of the flanges: 0.6cm; width of the pommel ears: 1.9cm; max. width of the hilt shoulders: 2.2cm; max. thickness of the hilt: 0.6cm; max. width of the blade: 2.09cm; max. thickness of the blade: 0.6cm; diameter of the proximal rivet hole: 0.35cm; diameter of the distal rivet hole: 0.4cm.
Mass: 49.0g
Sampling method: Drilling.
Sample no.: CAL 2
Lab code: MA-120712
Macroscopic observations:
The dagger was bent to a ‘v’ and broken in Antiquity. The break occurred in the sharp bend at about the middle of the blade’s length. The hilt plates and both rivets are missing. The cutting edges are damaged.
The sides of the flanged grip-tongue run almost parallel to each other and widen only in the distal sixth of its length to form the concave shoulders of the hilt. At the proximal end the grip-tongue widens and forms two diverging pommel ears with a v-shaped notch in between. Two rivets once held the hilt plates in place, one at the point where the grip-tongue starts to widen, and the other at about 45 % of the grip-tongue’s length. They were opened from opposite sides of the grip-tongue. The blade is set apart from the hilt by two broad concave indentations. It has a rhomboid cross section and its cutting edges ran more or less parallel to each other.
Publication: Bianco Peroni 1974, 3–4 cat. no. 145 A; 15 cat. no. 145 A, pl. 2.145A.a; Arslan 1986, 1044; Bianco Peroni 1994, 159 cat. no. 1592, pl. 89.1592; Pacciarelli 2000, 189–190, fig. 110.left.

Cat. no. 51 Fig. 10.5
Inv. no.: 151464
Object: Bronze flat flanged axe.
Site and stratigraphical context: Passo Murato, chance find.
Museum: Vibo Valentia, Calabria, Italy
Dimensions: max. preserved l.: 10.7cm; width of the neck: 1.3cm; width of the cutting edge: 4.2cm; max. height of the flanges: 0.8cm.
Sampling method: Drilling.
Sample no.: CAL 13b
Lab code: MA-146641
Macroscopic observations:
The flanged axe is almost entirely preserved. Some possible damage seems to have affected the neck, as indicated by its irregular oblique outline. However, the shape of the neck may also be due to a production deficiency. The cutting edge shows some small notches as well as corrosion damage. The blade is slender, the sides run almost parallel to each other. They widen only in the last fifth of its length to form a convex cutting edge that is more than twice as broad as the body of the axe. Apparently, the object was cast in a bipartite mould, while the halves have not been fixed together in a perfectly symmetric way, as the cross section shows.
Publication: Unpublished.

Cat. no. 52 Fig. 10.4
Inv. no.: 6905 (a)
Object: Fragmentary bronze greave.
Site and stratigraphical context: Castellace, tomb 1929/2, pit grave.
Museum: Reggio Calabria, Calabria, Italy
Dimensions of the largest fragment: max. preserved l.: 16.3cm; max. preserved width: 10.9cm; thickness: 0.1cm; diameter of s-shaped wire: 0.2cm.
Sampling method: One fragment was taken as a sample.
Sample no.: CAL 9
Lab code: MA-146650
Macroscopic observations:
The preserved fragments of the first greave consist in a large part of the centre, fragments of the edges, of the wire and the butt straps with rivets. All fragments are corroded. A longitudinal plastic ridge runs down the

central axis of the greave, while the borders are decorated by two plastic ridges framing a row of embossed dots. Butt straps with rivets held in place a bronze wire bent to an s-shape and terminating in a loop.
Publication: Pacciarelli 1999a, 39–41, fig. 32.36–37, 33; Pacciarelli 2000, 193–194, fig. 112A1.

Cat. no. 53 Fig. 10.4
Inv. no.: 6905 (b)
Object: Fragments of a bronze greave.
Site and stratigraphical context: Castellace, tomb 1929/2, pit grave.
Museum: Reggio Calabria, Calabria, Italy
Sampling method: One fragment was taken as a sample.
Sample no.: CAL 8
Lab code: MA-14203
Macroscopic observations:
Only very small and corroded fragments of a possible second greave are preserved.
Publication: unpublished.

Cat. no. 54 Fig. 8.2
Inv. no.: /
Object: Fragmentary bronze bow fibula of type Ob5, variety D.
Site and stratigraphical context: Torre Galli, survey find.
Museum: Vibo Valentia, Calabria, Italy
Dimensions: max. preserved l.: 8.8cm; max. thickness of the bow: 0.8cm.
Sampling method: Drilling.
Sample no.: CAL 12
Lab code: MA-146639
Macroscopic observations:
The bow fibula is in fragmentary condition. The bow is preserved, but part of the catch plate as well as the spring and the pin are missing. The bow is thickened in its central part and getting slender towards the spring. The foot is set apart by a bend in the bow, giving it an almost vertical position. It ends in a triangular catch plate. The bow is decorated with groups of incised parallel lines.
Publication: Unpublished.

Cat. no. 55 Fig. 10.6
Inv. no.: I.G. 297882
Object: Plano-convex lead ingot.
Site and stratigraphical context: Frattesina, hoard find no. 4.
Museum: Verona, Veneto, Italy
Dimensions: max. l.: 16.5cm; max. width: 14.5cm; height: 4.5cm.
Mass: 4530g
Sampling method: Drilling.
Sample no.: Italy sample no. 52.
Lab code: MA-120714
Macroscopic observations:
The ingot has a plano-convex cross section, while its upper face has an irregularly oval outline.
Publication: Salzani 2003, 42, fig. 3.16; 44 cat. no. 16.

Acknowledgements: The excavations at Punta di Zambrone in 2011, 2012 and 2013 brought to light most of the artefacts published in this article. These excavations were conducted as a cooperation of two research projects, one financed by the Austrian Science Fund and directed by R. Jung (FWF, project no. P23619-G19), the other financed by the Italian Ministry of Education, Universities and Research (PRIN: *Progetti di Ricerca di Rilevante Interesse Nazionale*), run by the University of Naples Federico II and directed by M. Pacciarelli. The different metal analyses were part of the mentioned FWF project and additionally financially supported by M. Mehofer, VIAS-Vienna Institute for Archaeological Science, University of Vienna.

Bibliography

Adrimi-Sismani 2006
V. Adrimi-Sismani, Le palais de Iolkos et sa destruction, Bulletin de Correspondance Hellénique 128–129/2004–2005, 2006, 1–54.

Adrimi-Sismani 2014
Β. Αδρύμη-Σισμάνη, Ιωλκός. Η εϋκτισμένη πόλη του Ομήρου. Ένα αστικό κέντρο στο μυχό του Παγασιτικού Κόλπου. Το διοικητικό κέντρο, οι οικίες και το νεκροταφείο (Volos 2014).

Albanese Procelli 1993
R. M. Albanese Procelli, Ripostigli di bronzi della Sicilia nel Museo archeologico di Siracusa (Palermo 1993).

Albanese Procelli 2000
R. M. Albanese Procelli, Bronze metallurgy in protohistoric Sicily. The stone moulds, in: D. Ridgway – F. R. Serra Ridgway – M. Pearce – E. Herring – R. D. Whitehouse – J. B. Wilkins (eds.), Ancient Italy in its Mediterranean Setting. Studies in Honour of Ellen Macnamara (London 2000) 75–90.

Andrikou 2007
E. Andrikou, New evidence on Mycenaean bronze corselets from Thebes in Boeotia and the Bronze Age sequence of corselets in Greece and Europe, in: I. Galanaki – H. Tomas – Y. Galanakis – R. Laffineur (eds.), Between the Aegean

and Baltic Seas. Prehistory Across Borders. Proceedings of the International Conference Bronze and Early Iron Age Interconnections and Contemporary Developments between the Aegean and the Regions of the Balkan Peninsula, Central and Northern Europe. University of Zagreb, 11–14 April 2005, Aegaeum 27 (Eupen 2007) 401–409.

Aprile et al. 2017
G. Aprile – S. Bianco – E. Ingravallo – I. M. Muntoni – I. Tiberi, La Grotta dei Cervi di Porto Badisco. Gli scavi Lo Porto 1970–71, Rivista di Scienze Preistoriche 67, 2017, 59–110.

Arslan 1986
E. A. Arslan, Necropoli «INAM» di Vibo Valentia – Hipponion, Annali della Scuola Normale Superiore di Pisa 16, 1986, 1029–1058.

Åström 1977
P. Åström, The Cuirass Tomb and other Finds at Dendra, Studies in Mediterranean Archaeology IV (Gothenburg 1977).

Balassone et al. 2018
G. Balassone – M. Mercurio – Ch. Germinario – C. Grifa – I. M. Villa – G. Di Maio – S. Scala – R. de Gennaro – C. Petti – M. C. Del Re – A. Langella, Multi-analytical characterization and provenance identification of protohistoric metallic artefacts from Picentia-Pontecagnano and the Sarno valley sites, Campania, Italy, Measurement 128, 2018, 104–118.

Barbaro et al. 2012
B. Barbaro – M. Bettelli – I. Damiani – D. De Angelis – C. Minniti – F. Trucco, Etruria meridionale e Mediterraneo nella tarda età del bronzo, in: V. Bellelli (ed.), Le origini degli Etruschi. Storia – archeologia – antropologia (Rome 2012) 195–247.

Bass 1986
G. F. Bass, A Bronze Age shipwreck at Ulu Burun (Kaş): 1984 campaign, American Journal of Archaeology 90, 1986, 269–296.

Bass et al. 1989
G. F. Bass – C. Pulak – D. Collon – J. Weinstein, The Bronze Age shipwreck at Ulu Burun: 1986 campaign, American Journal of Archaeology 93, 1989, 1–29.

Begemann et al. 2001
F. Begemann – S. Schmitt-Strecker – E. Pernicka – F. Lo Schiavo, Chemical composition and lead isotopy of copper and bronze from Nuragic Sardinia, European Journal of Archaeology 4, 2001, 43–85.

Bermond Montanari 2001
G. Bermond Montanari, Vie di collegamento transappenniniche tra Romagna e Centro-Italia nel Bronzo Finale, in: Istituto Italiano di Preistoria e Protostoria (ed.), Atti della XXXIV Riunione Scientifica “Preistoria e Protostoria della Toscana”, Firenze, 29 settembre – 2 ottobre 1999 (Florence 2001) 283–292.

Bernabò Brea – Cavalier 1980
L. Bernabò-Brea – M. Cavalier, L’acropoli di Lipari nella Preistoria, Meligunis Lipara IV (Palermo 1980).

Bettelli – Cardarelli 2010
M. Bettelli – A. Cardarelli, La spada di bronzo e la grappa di stagno, in: M. C. Martinelli, Archeologia delle Isole Eolie. Il villaggio dell’età del Bronzo medio di Portella a Salina. Ricerche 2006 e 2008 (Milazzo 2010) 165–171.

Bianco Peroni 1970
V. Bianco Peroni, Die Schwerter in Italien / Le spade nell’Italia continentale, Prähistorische Bronzefunde IV, 1 (Munich 1970).

Bianco Peroni 1974
V. Bianco Peroni, Neue Schwerter aus Italien / Altre spade dall’Italia continentale, in: H. Müller-Karpe (ed.), Beiträge zu italienischen und griechischen Bronzefunden, Prähistorische Bronzefunde XX, 1 (Munich 1974) 1–26.

Bianco Peroni 1976
V. Bianco Peroni, Die Messern in Italien / I coltelli nell’Italia continentale, Prähistorische Bronzefunde VII, 2 (Munich 1976).

Bianco Peroni 1994
V. Bianco Peroni, I pugnali nell'Italia Continentale, Prähistorische Bronzefunde VI, 10 (Stuttgart 1994).

Bietti Sestieri 1973
A. M. Bietti Sestieri, The metal industry of continental Italy, 13th to the 11th century BC, and its connections with the Aegean, Proceedings of the Prehistoric Society 39, 1973, 383–424.

Bietti Sestieri et al. 2010
A. M. Bietti Sestieri – C. Giardino – M. Gorgoglione, Metal finds at the Middle and Late Bronze Age settlement of Scoglio del Tonno (Taranto, Apulia). Results of archaeological analyses, Trabajos de Prehistoria 67, 2010, 457–468.

Boardman 1961
J. Boardman, The Cretan Collection in Oxford. The Dictaean Cave and Iron Age Crete (Oxford 1961).

Buffa 1994
V. Buffa, I bronzi, in: R. Peroni – F. Trucco (eds.), Enotri e Micenei nella Sibaritide I. Broglio di Trebisacce (Taranto 1994) 571–574.

Carancini 1975
G. L. Carancini, Die Nadeln in Italien / Gli spilloni nell'Italia continentale, Prähistorische Bronzefunde XIII, 2 (Munich 1975).

Carancini – Peroni 1997
G. L. Carancini – R. Peroni, La koinè metallurgica, in: M. Bernabò Brea – A. Cardarelli – M. Cremaschi (eds.), Le Terramare. La più antica civiltà padana (Milan 1997) 595–601.

Carancini – Peroni 1999
G. L. Carancini – R. Peroni, L'età del bronzo in Italia. Per una cronologia della produzione metallurgica, Quaderni di Protostoria 2 (Città di Castello 1999).

Cardarelli et al. 2014a
A. Cardarelli – G. Pellacani – V. Poli, Classificazione tipologica, in: A. Cardarelli, La necropoli della terramara di Casinalbo, Grandi contesti e problemi della Protostoria italiana 15 (Florence 2014) 437–574.

Cardarelli et al. 2014b
A. Cardarelli – G. Pellacani – V. Poli, Cronologia, in: A. Cardarelli, La necropoli della terramara di Casinalbo, Grandi contesti e problemi della Protostoria italiana 15 (Florence 2014) 575–668.

Cardosa 2014
M. Cardosa, La famiglia Toraldo e la scoperta delle origini di Tropea, Rogerius 17, 1, 2014, 121–138.

Casi et al. 1995
C. Casi – V. d'Ercole – N. Negroni Catacchio – F. Trucco, Prato di Frabulino (Farnese, VT). Tomba a camera dell'età del Bronzo, in: N. Negroni Catacchio (ed.), Preistoria e protostoria in Etruria. Atti del Secondo Incontro di Studi, Farnese 21–23 maggio 1993. Tipologia delle necropoli e rituali di deposizione, ricerche e scavi (Milan 1995) 81–110.

Catling 1955
H. W. Catling, A bronze greave from a 13th century B. C. tomb at Enkomi, Opuscula Atheniensia 2, 1955, 21–36.

Chatzidimitriou et al. 2010
Α. Χατζηδημητρίου – Ε. Βρεττού – Ε. Παπαθωμά – Ι. Μουτάφη, Νέα ευρήματα από το μυκηναϊκό νεκροταφείο στο Φούρεσι του δήμου Γλυκών Νερών, in: Πρακτικά ΙΓ' επιστημονικής συνάντησης ΝΑ. Αττικής, Παιανία, 29–31 Οκτωβρίου & 1–2 Νοεμβρίου 2008 (Kalyvia 2010) 47–80.

Cierny 2008
J. Cierny, Prähistorische Kupferproduktion in den südlichen Alpen, Region Trentino Orientale, Der Anschnitt Beih. 22 (Bochum 2008).

Clausing 2002
Ch. Clausing, Geschnürte Beinschienen der späten Bronze- und älteren Eisenzeit, Jahrbuch des Römisch-Germanischen Zentralmuseums Mainz 49, 2002, 149–187.

Cupitò 2006
M. Cupitò, Tipocronologia del Bronzo medio e recente tra l'Adige e il Mincio sulla base delle evidenze funerarie, Saltuarie dal laboratorio del Piovego 7 (Padua 2006).

Cuteri 2012
F. A. Cuteri, Miniere ed attività metallurgica nell'area dell'antica Caulonia, in: Lombardo 2012, 891–898.

Damiani 2010
I. Damiani, L'età del Bronzo recente nell'Italia centro-meridionale, Grandi contesti e problemi della Protostoria italiana 12 (Florence 2010).

Dawkins 1923
R. M. Dawkins, The bronzes, in: R. C. Bosanquet – R. M. Dawkins, The Unpublished Objects from the Palaikastro Excavations 1902–1906. Part I, The British School at Athens Supplementary Paper 1 (London 1923) 115–124.

De Marinis – Salzani 2005
R. C. De Marinis – L. Salzani, Tipologia e cronologia dei materiali, in: Salzani 2005, 391–448.

de Marinis et al. 2005
G. de Marinis – A. Giumlia-Mair – M. Miccio – P. Pallecchi, Tecnologie produttive nei siti dell'Età del Bronzo di Moscosi di Cingoli e Cisterna di Tolentino, in: Istituto Italiano di Preistoria e Protostoria (ed.), Atti della XXXVIII Riunione Scientifica "Preistoria e Protostoria delle Marche", Portonovo, Abbadia di Fiastra, 1–5 ottobre 2003 (Florence 2005) 679–694.

Deïlaki 1977
E. Δεΐλάκη, Ανασκαφικαί έρευναι εις περιοχήν Ναυπλίας, Αρχαιολογικόν Δελτίον 28B›1/1973, 1977, 90–93.

Deshayes 1959
J. Deshayes, Le quartier «Z», in: J. Deshayes – A. Dessenne, Mallia. Maisons (II), Études Crétoises XI (Paris 1959) 1–89.

Driessen – Macdonald 1997
J. Driessen – C. F. Macdonald, The Troubled Island. Minoan Crete before and after the Santorini Eruption, Aegaeum 17 (Liège 1997).

Evely 1993/2000
R. D. G. Evely, Minoan Crafts. Tools and Techniques. An Introduction, Studies in Mediterranean Archaeology 92, vol. 1 and 2 (Gothenburg, Jonsered 2000).

Evstratiou – Polychronakou-Sgouritsa 2016
K. Ευστρατίου – N. Πολυχρονάκου-Σγουρίτσα, Το μυκηναϊκό νεκροταφείο στους Λαζαρίδες Αίγινας, Αρχαιολογικόν Δελτίον 65–66A′/2010–2011, 2016, 1–134.

Felsch 2007
R. C. S. Felsch, Die Bronzefunde, in: R. C. S. Felsch (ed.), Kalapodi. Ergebnisse der Ausgrabungen im Heiligtum der Artemis und des Apollon von Hyampolis in der antiken Phokis II (Mainz 2007) 28–388.

Gale et al. 1997
N. H. Gale – Z. A. Stos-Gale – G. Maliotis – N. Annetts, Lead Isotope Data from the Isotrace Laboratory, Oxford: Archaeometry Data Base 4, Ores from Cyprus, Archaeometry 39, 1997, 237–246.

Geniola – Larocca 2005a
A. Geniola – F. Larocca, Le ricerche archeologiche. L'area dei cunicoli terminali, in: Larocca 2005, 42–47.

Geniola – Larocca 2005b
A. Geniola – F. Larocca, Le ricerche archeologiche. L'area del cosiddetto "Diaframma", in: Larocca 2005, 48–53.

Giardino 1997
C. Giardino, La metallotecnica nella Sicilia pre-protostorica, in: Tusa 1997, 405–414.

Harding 1995
A. Harding, Die Schwerter im ehemaligen Jugoslawien, Prähistorische Bronzefunde IV, 14 (Stuttgart 1995).

Hauptmann 2011
A. Hauptmann, Slags from the Late Bronze Age metal workshops at Kition and Enkomi, Cyprus, in: Ph. P. Betancourt – S. C. Ferrence (eds.), Metallurgy. Understanding How, Learning Why. Studies in Honor of James D. Muhly, Prehistory Monographs 29 (Philadelphia 2011) 189–202.

Hook 2007
D. Hook, The composition and technology of selected Bronze Age and Early Iron Age copper alloy artefacts from Italy, in: A. M. Bietti Sestieri – E. Macnamara, Prehistoric Metal Artefacts from Italy (3500–720 BC) in the British Museum, British Museum Research Publications 159 (London 2007) 308–323.

Iakovidis 1969/70
S. E. Iakovidis, Περατή. Το νεκροταφείον, Βιβλιοθήκη της εν Αθήναις Αρχαιολογικής Εταιρείας 67, vol. I–III (Athens 1969/70).

Ialongo 2018
N. Ialongo, The earliest balance weights in the west. Towards an independent metrology for Bronze Age Europe, Cambridge Archaeological Journal, 2018, 1–22. doi:10.1017/S0959774318000392

Iannelli 2012
M. T. Iannelli, Hipponion, Medma e Caulonia: nuove evidenze archeologiche a proposito della fondazione, in: Lombardo 2012, 857–878.

Jankovits 1999
K. Jankovits, Studio delle lamine di bronzo del ripostiglio di Pila del Brancón, Nogara (Verona), Padusa 34–35/1998–1999, 1999, 85–107.

Jankovits 2000
K. Jankovits, Neue Angaben zu dem Depotfund von Pila del Brancon, Nogara (Verona), Acta Archaeologica Academiae Scientiarum Hungaricae 51/1999–2000, 189–205.

Jung 2006
R. Jung, Χρονολογία comparata. Vergleichende Chronologie von Südgriechenland und Süditalien von ca. 1700/1600 bis 1000 v. u. Z., Veröffentlichungen der Mykenischen Kommission 26 (Vienna 2006).

Jung 2009a
R. Jung, I “bronzi internazionali” ed il loro contesto sociale fra Adriatico, Penisola balcanica e coste levantine, in: E. Borgna – P. Càssola Guida (eds.), Dall’Egeo all’Adriatico. Organizzazioni sociali, modi di scambio e interazione in età postpalaziale (XII–XI sec. a. C.) / From the Aegean to the Adriatic. Social Organizations, Modes of Exchange and Interaction in Postpalatial Times (12th–11th c. BC). Atti del Seminario internazionale (Udine, 1–2 dicembre 2006), Studi e ricerche di protostoria mediterranea 8 (Rome 2009) 129–157.

Jung 2009b
R. Jung, Pirates of the Aegean. Italy – East Aegean – Cyprus at the end of the second millennium BCE, in: V. Karageorghis – O. Kouka (eds.), Cyprus and the East Aegean. Intercultural Contacts from 3000 to 500 BC. An International Archaeological Symposium held at Pythagoreion, Samos, October 17th–18th 2008 (Nicosia 2009) 72–93.

Jung 2011
R. Jung, Con le armi in pugno. Trasferimento di saperi e scambio di armi tra Mediterraneo ed Europa continentale nel II millennio A.C., in: F. Marzatico – R. Gebhard – P. Gleirscher (eds.), Le grandi vie delle civiltà. Relazioni e scambi fra Mediterraneo e il centro Europa dalla preistoria alla romanità. Exhibition catalogue Trento (Trento 2011) 199–202.

Jung – Pacciarelli 2017
R. Jung – M. Pacciarelli, Gli scavi 2011–2013 a Punta di Zambrone, in: M. Pacciarelli – L. Cicala (eds.), Centri Fortificati della Calabria dalla protostoria all’età ellenistica. Atti del convegno internazionale, Napoli, 16–17 gennaio 2014 (Naples 2017) 313–324.

Jung et al. 2011
R. Jung – M. Mehofer – E. Pernicka, Metal exchange in Italy from the Middle to the Final Bronze Age (14th–11th cent. BCE), in: Ph. P. Betancourt – S. C. Ferrence (eds.), Metallurgy. Understanding How, Learning Why. Studies in Honor of James D. Muhly, Prehistory Monographs 29 (Philadelphia 2011) 231–248.

Jung et al. 2015
R. Jung – M. Pacciarelli – B. Zach – M. Klee – U. Thanheiser, Punta di Zambrone (Calabria) – a Bronze Age harbour site. First preliminary report on the Recent Bronze Age (2011–2012 campaigns), Archaeologia Austriaca 99, 2015, 53–110.

Jung et al. 2016
R. Jung – M. Pacciarelli – G. Forstenpointner – G. Slepecki – G. E. Weissengruber – A. Galik, Funde aus dem Müllhaufen der Geschichte im Befestigungsgraben von Punta di Zambrone. Angeln am spätbronzezeitlichen Mittelmeer, in: M. Bartelheim – B. Horejs – R. Krauß (eds.), Von Baden bis Troia. Ressourcennutzung, Metallurgie und Wissenstransfer. Eine Jubiläumsschrift für Ernst Pernicka, Oriental and Europaean Archaeology 3 (Rahden/Westf. 2016) 175–206.

Jung et al. 2017
R. Jung – M. Mehofer – M. Stavropoulou-Gatsi, Das Kriegergrab des elften Jahrhunderts v. u. Z. von Kouwarás in Ätoloakarnanien, Das Altertum 62, 2017, 81–110.

Jung et al. in press
R. Jung – M. Mehofer – E. Pernicka, Metal exchange in Bronze Age Italy. The Final Bronze Age hoards from Roca Vecchia, Apulia, in: R. Guglielmino – F. Iacono (eds), Roca. A Bronze Age Port on the Adriatic Sea. Aegean Type Pottery and Late Bronze Age Sequence of Area IX (in press).

Junghans et al. 1960
S. Junghans – E. Sangmeister – M. Schröder, Metallanalysen kupferzeitlicher und frühbronzezeitlicher Bodenfunde aus Europa, Studien zu den Anfängen der Metallurgie 1 (Berlin 1960).

Kemenczei 1988
T. Kemenczei, Die Schwerter in Ungarn I (Griffplatten-, Griffangel- und Griffzungenschwerter), Prähistorische Bronzefunde IV, 6 (Munich 1988).

Kilian 1982
K. Kilian, Ausgrabungen in Tiryns 1980. Bericht zu den Grabungen, Archäologischer Anzeiger 1982, 393–430.

Kilian 1988
K. Kilian, Ausgrabungen in Tiryns 1982/83. Bericht zu den Grabungen, Archäologischer Anzeiger 1988, 105–151.

Kilian-Dirlmeier 1984
I. Kilian-Dirlmeier, Nadeln der frühhelladischen bis archaischen Zeit von der Peloponnes, Prähistorische Bronzefunde XIII, 8 (Munich 1984).

Kilian-Dirlmeier 1993
I. Kilian-Dirlmeier, Die Schwerter in Griechenland (außerhalb der Peloponnes), Bulgarien und Albanien, Prähistorische Bronzefunde IV, 12 (Stuttgart 1993).

Kolonas 2008
Λ. Κολώνας, Δίκτυο επισκέψιμων μυκηναϊκών οικισμών και νεκροταφείων επαρχείας Πατρών. Χαλανδρίτσα, Καταρράκτης, Μιτόπολη, Σπαλιαρέϊκα, Ελαιοχώρι, Πόρτες (Athens 2008).

Larocca 2005a
F. Larocca (ed.), La miniera pre-protostorica di Grotta della Monaca (Sant'Agata di Esaro – Cosenza) (Bari 2005).

Larocca 2005b
F. Larocca, Il sistema sotterraneo. Cenni descrittivi, in: Larocca 2005a, 16–23.

Larocca 2010
F. Larocca, Grotta della Monaca. A prehistoric copper and iron mine in the Calabria Region (Italy), in: P. Anreiter – G. Goldenberg – K. Hanke – R. Krause – W. Leitner – F. Mathis – K. Nicolussi – K. Oeggl – E. Pernicka – M. Prast – J. Schibler – I. Schneider – H. Stadler – Th. Stöllner – G. Tomedi – P. Tropper (ed.), Mining in European History and its Impact on Environment and Human Societies. Proceedings for the 1st Mining in European History-Conference of the SFB-HIMAT, 12.–15. November 2009, Innsbruck (Innsbruck 2010) 267–270.

Larocca 2011
F. Larocca, Grotta della Monaca (Sant'Agata di Esaro – Cosenza). Utensili e tecniche estrattive di età eneolitica per l'acquisizione di minerali di rame, in: Istituto Italiano di Preistoria e Protostoria: Atti della XLIII Riunione scientifica "L'età del rame in Italia", Bologna, 26–29 novembre 2008 (Florence 2011) 663–668.

Lo Porto 1997
F. G. Lo Porto, Kanysion 1. La necropoli protostorica a cremazione di contrada Pozzillo, Scienze dell'Antichità 10, 1997, 71–118.

Lo Schiavo et al. 2009
F. Lo Schiavo – R. M. Albanese Procelli – A. Giumlia-Mair, Oxhide ingots in Sicily, in: F. Lo Schiavo – J. D. Muhly – R. Maddin – A. Giumlia-Mair (eds.), Oxhide Ingots in the Central Mediterranean, Biblioteca di Antichità Cipriote 8 (Rome 2009) 135–221.

lo Torto et al. 2011
A. lo Torto – C. Rombolà – F. Rombolà – F. Staropoli, Il giacimento di Passo Murato. Scoperta, rilevamento, recupero e segnalazione, in: Pacciarelli 2011, 293–294.

Lombardo 2012
M. Lombardo (ed.), Alle origini della Magna Grecia. Mobilità, migrazioni, fondazioni. Atti del cinquantesimo convegno di studi sulla Magna Grecia, Taranto 1–4 ottobre 2010 (Taranto 2012).

Lutz – Pernicka 1996
J. Lutz – E. Pernicka, Energy dispersive X-ray fluorescence analysis of ancient copper alloys. Empirical values for precision and accuracy, Archaeometry 38, 1996, 313–323.

Maggiulli 2007
G. Maggiulli, I manufatti metallici, contribution in: Pagliara et al. 2007.

Maggiulli 2017
G. Maggiulli, I manufatti metallici dai livelli dell'età del Bronzo del SAS IX di Roca (LE), in: F. Radina (ed.), Preistoria e Protostoria della Puglia, Studi di Preistoria e Protostoria 4 (Florence 2017) 977–982.

Maniscalco 1997
L. Maniscalco, L'insediamento castellucciano delle coste di Santa Febronia (Palagonia), in: Tusa 1997, 359–404.

Maran – Papadimitriou 2016
J. Maran – A. Papadimitriou, Gegen den Strom der Geschichte. Die nördliche Unterstadt von Tiryns: ein gescheitertes Urbanisierungsprojekt der mykenischen Nachpalastzeit, Archäologischer Anzeiger 2016/2, 19–118.

Marino 2010
S. Marino, Stone-tools with hafting groove and prehistoric mining exploitation in Calabria (Italy), in: P. Anreiter – G. Goldenberg – K. Hanke – R. Krause – W. Leitner – F. Mathis – K. Nicolussi – K. Oeggl – E. Pernicka – M. Prast – J. Schibler – I. Schneider – H. Stadler – Th. Stöllner – G. Tomedi – P. Tropper (ed.), Mining in European History and its Impact on Environment and Human Societies. Proceedings for the 1st Mining in European History-Conference of the SFB-HIMAT, 12.–15. November 2009, Innsbruck (Innsbruck 2010) 321–327.

Marino – Pizzitutti 2008
D. Marino – G. Pizzitutti, Un ripostiglio di bronzi dal territorio a sud di Crotone (Calabria centro-orientale), Rivista di Scienze Preistoriche 58, 2008, 321–336.

Matarese et al. 2017
I. Matarese – S. Conte – R. Jung – M. Pacciarelli, Vaghi di provenienza egea da Punta di Zambrone (VV). Una riflessione crono-tipologica, in: L. Cicala – M. Pacciarelli (eds.), Centri Fortificati della Calabria dalla protostoria all'età ellenistica. Atti del convegno (Naples 2017) 467–469.

Mazzucchelli – Giovannini 2010
M. Mazzucchelli – S. Giovannini, Appendice: Analisi archeometallurgiche, in: Bettelli – Cardarelli 2010, 171.

Mehofer 2014
M. Mehofer, A note on the copper working remains from Stratum 2 at Hala Sultan Tekke, Cyprus, Opuscula 7, 2014, 75.

Mehofer – Kucera 2005
M. Mehofer – M. Kucera, Rasterelektronenmikroskopie in der Archäologie. Zum Einsatz naturwissenschaftlicher Methoden in der archäologischen Forschung – Teil 1, Archäologie Österreichs 16, 1, 2005, 56–63.

Mehofer – Schreiner 2004
M. Melcher – M. Schreiner, Materialanalytische Untersuchungen von Silberproben des Schatzfundes von Fuchsenhof mittels energiedispersiver Elektronenstrahlmikroanalyse im Rasterelektronenmikroskop, in: B. Prokisch – T. Kühtreiber (eds.), Der Schatzfund von Fuchsenhof, Studien zur Kulturgeschichte von Oberösterreich 15, 2004, 325–345.

Montero-Ruiz 2018
I. Montero-Ruiz, Copper ingots from the Nuraghe Arrubiu at Orroli, in: A. Giumlia-Mair – F. Lo Schiavo (eds.), Bronze Age Metallurgy on Mediterranean Islands. Volume in Honor of Robert Maddin and Vassos Karageorghis, Monographies Instrumentum 56 (Drémil-Lafage 2018) 167–175.

Moschos 2007
I. Moschos, Οι μυκηναίοι στην Αχαΐα / The Mycenaeans in Achaia, Φαίδιμος 1 (Patras 2007).

Mosso 1906
A. Mosso, Le armi più antiche di rame e di bronzo, Atti della R. Accademia Lincei, Anno 303, Ser. V, Vol. XII, 1906, 479–582.

Mylonas 1972–1973
G. E. Mylonas, Ο ταφικός κύκλος Β των Μυκηνών, Βιβλιοθήκη της εν Αθήναις Αρχαιολογικής Εταιρείας 73 (Athens 1972–1973).

Mylonas Shear 1987
I. Mylonas Shear, The Panagia Houses at Mycenae, University Museum Monograph 68 (Philadelphia 1987).

Nava 1978
M. L. Nava, Ripostiglio di bronzi da Gerocarne (Catanzaro), Klearchos 20, 1978, 113–119.

Niederschlag et al. 2003
E. Niederschlag – E. Pernicka – T. Seifert – M. Bartelheim, Determination of lead isotope ratios by Multiple Collector ICP-MS. A case study of Early Bronze Age artefacts and their possible relation with ore deposits of the Erzgebirge, Archaeometry 45, 2003, 61–100.

OXALID database
Z. A. Stos-Gale, OXALID – Oxford Archaeological Lead Isotope Database. Online <http://oxalid.arch.ox.ac.uk/TheDatabase/TheDatabase.htm> (last accessed 22 Nov. 2018).

Pabst 2015
S. Pabst, Naue-II-Schwerter mit Knaufzunge und die Außenbeziehungen der mykenischen Kriegerelite in postpalatialer Zeit, Jahrbuch des Römisch-Germanischen Zentralmuseums Mainz 60/2013, 2015, 105–152.

Pacciarelli 1999a
M. Pacciarelli, La necropoli protostorica di Castellace e considerazioni sui processi culturali dei secoli XII–X a.C., in: L. Costamagna – P. Visonà (eds.), Oppido Mamertina, Calabria – Italia. Ricerche archeologiche nel territorio e in contrada Mella (Rome 1999) 35–80.

Pacciarelli 1999b
M. Pacciarelli, Torre Galli. La necropoli della prima età del ferro (scavi Paolo Orsi 1922–23) (Catanzaro 1999).

Pacciarelli 2000
M. Pacciarelli, Dal villaggio alla città. La svolta protourbana del 1000 a.C. nell'Italia tirrenica, Grandi contesti e problemi della Protostoria italiana 4 (Florence 2000).

Pacciarelli 2011
M. Pacciarelli, L'Eneolitico della Calabria tirrenica. Nuovi dati sull'articolazione cronoculturale, Origini 33, 2011, 249–302.

Pacciarelli – Lo Schiavo 2017
M. Pacciarelli – F. Lo Schiavo, A proposito di interazione culturale. Una piccola protome bronzea di stile nuragico da Torre Galli, in: L. Cicala – B. Ferrara (eds.), «Kithon Lydios». Studi di storia e archeologia con Giovanna Greco (Naples 2017) 703–725.

Pagliara et al. 2007
C. Pagliara – G. Maggiulli – T. Scarano – C. Pino – R. Guglielmino – J. De Grossi Mazzorin – M. Rugge – G. Fiorentino – M. Primavera – L. Calcagnile – M. D'Elia – G. Quarta, La sequenza cronostratigrafica delle fasi di occupazione dell'insediamento protostorico di Roca (Melendugno, Lecce). Relazione preliminare della campagna di scavo 2005 – Saggio X, Rivista di Scienze Preistoriche 57, 2007, 311–362.

Papadopoulos 1978/79
Th. J. Papadopoulos, Mycenaean Achaea, Studies in Mediterranean Archaeology 55 (Gothenburg 1978/79).

Papadopoulos – Kontorli-Papadopoulou 2014
Th. I. Papadopoulos – L. Kontorli-Papadopoulou, Vravron. The Mycenaean Cemetery, Studies in Mediterranean Archaeology 142 (Uppsala 2014).

Pare 2000
Ch. Pare, Bronze and the Bronze Age, in: Ch. F. E. Pare (ed.), Metals Make The World Go Round. The Supply and Circulation of Metals in Bronze Age Europe. Proceedings of a Conference Held at the University of Birmingham in June 1997 (Oxford 2000) 1–38.

Pernicka 2010
E. Pernicka, Archäometallurgische Untersuchungen am und zum Hortfund von Nebra, in: H. Meller – F. Bertemes (eds.), Der Griff nach den Sternen. Wie Europas Eliten zu Macht und Reichtum kamen. Internationales Symposium in Halle (Saale), 16.–21. Februar 2005, Tagungen des Landesmuseums für Vorgeschichte 5 (Halle 2010) 719–734.

Pernicka – Salzani 2011
E. Pernicka – P. Salzani, Remarks on the analyses and future prospects, in: A. Aspes (ed.), I bronzi del Garda. Valorizzazione delle collezioni di bronzi preistorici di uno dei più importanti centri metallurgici dell'Europa del IIo millennio a. C. Memorie del Museo Civico di Storia Naturale di Verona, 2. Serie Sezione Scienze dell'Uomo 11 (Verona 2011) 89–98.

Peroni 1956
R. Peroni, Zur Gruppierung mitteleuropäischer Griffzungendolche der späten Bronzezeit, Badische Fundberichte 20, 1956, 69–92.

Peroni 1963
R. Peroni, Ripostiglio Gualdo Tadino, in: Inventaria Archaeologica, Italia. Ripostigli delle età dei metalli, Fascicolo 3: I 6 (Florence 1963).

Peroni 1969
R. Peroni, Per uno studio dell'economia di scambio in Italia nel quadro dell'ambiente culturale dei secoli intorno al mille a.C., La Parola del Passato 125, 1969, 134–160.

Peroni 2010
R. Peroni, Elenco dei reperti 1962, in: V. Bianco Peroni – R. Peroni– A. Vanzetti, La necropoli del Bronzo finale di Pianello di Genga, Grandi contesti e problemi della Protostoria italiana 13 (Florence 2010) 17–42.

Peroni et al. 2003
R. Peroni – B. Barbaro – A. Vanzetti, I materiali del nuovo ipogeo di Trinitapoli, in: A. Gravina (ed.), 23° Convegno Nazionale sulla Preistoria – Protostoria – Storia della Daunia, San Severo, 23–24 Novembre 2002 (San Severo 2003) 287–320.

Perra – Lo Schiavo 2012
M. Perra – F. Lo Schiavo, I ripostigli del nuraghe Arrubiu di Orroli (Nuoro), in: Istituto Italiano di Preistoria e Protostoria (ed.), Atti della XLIV Riunione Scientifica "La Preistoria e Protostoria della Sardegna", Cagliari, Barumini, Sassari, 23–28 novembre 2009 (Florence 2012) 1591–1594.

Piteros 2015
Ch. Piteros, Mycenaean Nauplion, in: A.-L. Schallin – I. Tournavitou (eds.), Mycenaeans Up to Date: The Archaeology of the Northeastern Peloponnese – Current Concepts and New Directions (Stockholm 2015) 79–97.

Popham et al. 1974
M. R. Popham – E. A. Catling – H. W. Catling, Sellopoulo tombs 3 and 4, two Late Minoan Graves near Knossos, The Annual of the British School at Athens 69, 1974, 195–257.

Protonotariou-Deïlaki 2009
Ε. Πρωτονοταρίου-Δεϊλάκη, Οι τύμβοι του Άργους. Διατριβή επί διδακτορία, Άργος I (Athens 2009).

Pulak 1988
C. Pulak, The Bronze Age shipwreck at Ulu Burun, Turkey: 1985 campaign, American Journal of Archaeology 92, 1988, 1–37.

Pulak 1996
C. M. Pulak, Analysis of the weight assemblages from the Late Bronze Age shipwrecks at Uluburun and Cape Gelidonya, Turkey (PhD Diss., Texas A&M University, College Station 1996). Online <https://anthropology.tamu.edu/wp-content/uploads/sites/11/2016/07/Pulak-PhD1996.pdf> (last accessed 12 Oct. 2018).

Rahmstorf 2008
L. Rahmstorf, Kleinfunde aus Tiryns, Tiryns XVI (Wiesbaden 2008).

Rahmstorf 2010
L. Rahmstorf, The concept of weighing during the Bronze Age in the Aegean, the Near East and Europe, in: I. Morley – C. Renfrew (eds.), The Archaeology of Measurement. Comprehending Heaven, Earth and Time in Ancient Societies (Cambridge 2010) 8–105.

Rizza – Palermo 2004
G. Rizza – D. Palermo (eds.), La necropoli di Sant'Angelo Muxaro. Scavi Orsi Zanotti-Bianco 1931–32 (Catania 2004).

Sabbatini – Silvestrini 2005
T. Sabbatini – M. Silvestrini, Piano di Fonte Marcosa, Moscosi di Cingoli. Un sito pluristratificato dell'Appennino marchegiano. Le fasi del Bronzo Recente, in: Istituto Italiano di Preistoria e Protostoria (ed.), Atti della XXXVIII Riunione Scientifica "Preistoria e Protostoria delle Marche", Portonovo, Abbadia di Fiastra, 1–5 ottobre 2003 (Florence 2005) 639–657.

Salzani 1989
L. Salzani, Necropoli dell'Età del Bronzo Finale alle Narde di Fratta Polesine. Prima nota, Padusa 25, 1989, 5–42.

Salzani 1990–1991
L. Salzani, Necropoli dell'Età del Bronzo Finale alle Narde di Fratta Polesine. Seconda nota, Padusa 26–27, 1990–1991, 125–206.

Salzani 1999
L. Salzani, Il sito protostorico di Custoza (Sommacampagna – Verona), Padusa 32–33/1996–1997, 1999, 7–45.

Salzani 2002
L. Salzani, Tombe preistoriche dalla necropoli della Colombara (Gazzo Veronese), Padusa 37/2001, 2002, 83–135.

Salzani 2003
L. Salzani, Fratta Polesine. Il "ripostiglio" n. 4 e altri reperti da Frattesina, Quaderni di Archeologia del Veneto 19, 2003, 40–45.

Salzani 2005
L. Salzani, La necropoli dell'età del Bronzo all'Olmo di Nogara, Memorie del Museo Civico di Storia Naturale di Verona, 2. Serie, Sezioni Scienze Dell'Uomo 8 (Verona 2005).

Salzani 2011
P. Salzani, I metalli del progetto I bronzi del Garda. Primi risultati e prospettive future, in: A. Aspes (ed.), I bronzi del Garda. Valorizzazione delle collezioni di bronzi preistorici di uno dei più importanti centri metallurgici dell'Europa del II° millennio a. C., Memorie del Museo Civico di Storia Naturale di Verona, 2. Serie Sezione Scienze dell'Uomo 11 (Verona 2011: CD-ROM) 47–87.

Spyropoulos 1972
Θ. Γ. Σπυρόπουλος, Υστερομυκηναϊκοί ελλαδικοί θησαυροί, Βιβλιοθήκη της εν Αθήναις Αρχαιολογικής Εταιρείας 72 (Athens 1972).

Steinmann 2012
B. F. Steinmann, Die Waffengräber der ägäischen Bronzezeit. Waffenbeigaben, soziale Selbstdarstellung und Adelsethos in der minoisch-mykenischen Kultur, Philippika 52 (Wiesbaden 2012).

Stos-Gale 2014
Z. A. Stos-Gale, Silver Vessels in the Mycenaean shaft graves and their origin in the context of the metal supply in the Bronze Age Aegean, in: H. Meller – R. Risch – E. Pernicka (eds.), Metalle der Macht. Frühes Gold und Silber. 6. Mit-

teldeutscher Archäologentag vom 17. bis 19. Oktober 2013 in Halle (Saale) / Metals of Power. Early Gold and Silver. 6th Archaeological Conference of Central Germany, October 17–19, 2013 in Halle (Saale), Tagungen des Landesmuseums für Vorgeschichte Halle 11 (Halle [Saale] 2014) 183–208.

Stos-Gale – Gale 1992
Z. A. Stos-Gale – N. Gale, New light on the provenience of the copper oxhide ingots found on Sardinia, in: A. B. Knapp (ed.), Sardinia in the Mediterranean. A Footprint in the Sea. Studies in Sardinian Archaeology Presented to Miriam S. Balmuth, Monographs in Mediterranean Archaeology 3 (Sheffield 1992) 317–346.

Stos-Gale et al. 1995
Z. Stos-Gale – N. Gale – J. Houghton – R. Speakman, Lead isotope data from the Isotrace Laboratory, Oxford: Archaeometry Data Base 1, Ores from the Western Mediterranean, Archaeometry 37, 1995, 407–415.

Stos-Gale et al. 1996
Z. A. Stos-Gale – N. H. Gale – N. Annetts, Lead isotope data from the Isotrace Laboratory, Oxford: Archaeometry Data Base 3, Ores from the Aegean, Part 1, Archaeometry 38, 1996, 381–390.

Stos-Gale et al. 1997
Z. A. Stos-Gale – G. Maliotis – N. H. Gale – N. Annetts, Lead isotope characteristics of the Cyprus copper ore deposits applied to provenance studies of copper oxhide ingots, Archaeometry 39, 1997, 83–123.

Stos-Gale et al. 1998
Z. A. Stos-Gale – N. H. Gale – G. Bass – C. Pulak – E. Galili – J. Sharvit, The copper and tin ingots of the Late Bronze Age Mediterranean. New scientific evidence, in: Proceedings of the Fourth International Conference on the Beginning of the Use of Metals and Alloys (BUMA IV), May 25–27, 1998, Matsue, Shimane, Japan (without place or year) 115–126.

Tusa 1997
S. Tusa (ed.), Prima Sicilia. Alle origini della società siciliana. Exhibition Palermo, accompanying text volume (Palermo 1997).

Van Brempt – Kassianidou 2016
L. Van Brempt – V. Kassianidou, Facing the complexity of copper-sulphide ore smelting and assessing the role of copper in south-central Cyprus. A comparative study of the slag assemblage from Late Bronze Age Kalavasos-Ayios Dhimitrios, Journal of Archaeological Science Reports 7, 2016, 539–553.

Vassallo 2004
St. Vassallo, The stone casting moulds from Colle Madore. Evidence of metallurgy in Sikane, Ancient East and West 3, 2004, 20–37.

Vavelidis et al. 1985
M. Vavelidis – I. Bassiakos – F. Begemann – K. Patriarcheas – E. Pernicka – S. Schmitt-Strecker – G. A. Wagner, Geologie und Erzvorkommen, in: G. A. Wagner –G. Weisgerber (eds.), Silber, Blei und Gold auf Sifnos. Prähistorische und antike Metallproduktion, Der Anschnitt Beih. 3 (Bochum 1985) 59–80.

Verdelis 1966
N. M.Βερδελής, Ανασκαφή Μυκηνών, Πρακτικά της εν Αθήναις Αρχαιολογικής Εταιρείας 1962, 1966, 67–89.

Verdelis 1977
N. M. Verdelis, The metal finds, in: Åström 1977, 28–65.

Viaktou 2012
O. Vikatou, Olympia und sein Umfeld während der mykenischen Zeit, in: W.-D. Heilmeyer – N. Kaltsas – H.-J. Gehrke – G. E. Hatzi – S. Bocher (eds.), Mythos Olympia. Kult und Spiele (Munich, London, New York 2012) 68–73.

Walberg 2007
G. Walberg, Midea. The Megaron Complex and Shrine Area. Excavations on the Lower Terraces 1994–1997, Prehistory Monographs 20 (Philadelphia 2007).

Xenaki-Sakellariou 1985
A. Xenaki-Sakellariou, Οι θαλαμωτοί τάφοι των Μυκηνών – ανασκαφές Χρ. Τσούντα (1887–1898) / Les tombes à chambre de Mycènes – fouilles de Chr. Tsountas (1887–1898) (Athens 1985).

Appendix

Giuseppe Ferraro[1] *– Sara Marino*[2]

The geological structure that includes all of Calabria to the south of the Sybaris plain up to the northernmost tip of Sicily is known as the Calabro-Peloritano arc. This stretch is clearly different from the rest of the Apennines, since in terms of its landscape and the nature of the rocks it shows a strong affinity with the Alps. In fact, magmatic intrusive-type rocks (granitoids) and low-grade metamorphic (schists) to high-grade metamorphic rocks (gneiss) are emerging. The landscape of an igneous-metamorphic nature with a rare Calabro-Peloritano arc sedimentary cover was largely formed in orogenic cycles (presumably Hercynian) prior to those of the Alps and deformed again during the Alpine orogeny. On the subject of the vicissitudes that brought the Calabro-Peloritano arc to its current position,[3] there is a substantial uniformity of views.[4] It can be related to the stage of subduction during the oceanic crust convergence of Tethys towards the European plate, forming a back-arc basin (proto-Tyrrhenian) and resulting in the detachment of the Sardo-Corso block around 30 Ma ago, with its counterclockwise rotation linked to the unwinding of the Tyrrhenian basin. However, about 10 Ma ago, a further phase of detente within the rotation block caused the separation of the Calabro-Peloritano arc from the Sardo-Corso block, with this rapidly traversing towards the east due to the Southern Tyrrhenian opening. This led to an overlap with the land mass of the Apennines, already deformed in the Alpine orogeny (Fig. 1). Regarding this process, a striking observation was made by the Head of the Royal Italian Mining Corps, who first, in the second half of the 19th century, empirically noted the strong similarities between some Alpine mineralised rocks with those of southern Calabria, sampled and analysed in this contribution:

"[…] trovate poco a sud di Reggio, le vestigia di una fonderia di rame;[…] furono scoperte delle gallerie strettissime, capaci di dar passaggio ad un solo uomo, scavate a scalpello. In esse si trova del carbonato di rame verde, depositato da acque che vengono dal di sotto dei sovrastanti terrazzi dell'Aspromonte […]; il deposito e le gallerie sono identici a quelli trovati a Caserme (Kasern) nella Valle Aurina dell'Alto Adige, che scende dalla Vetta d'Italia, e le gallerie sono, certo, della stessa epoca."[5]

It is, in fact, known that the accumulations of natural metallic elements relevant for mining, such as lead and copper (items sampled for this study), are located in specific areas of the earth's crust, where special geodynamic processes have occurred. The minerals containing the elements in question, generally sulphides, are enriched during the stages of progressive cooling of magmas, the crystallisation of which results in a geochemical differentiation, which in many cases leads to the enrichment of mineralogical phases of mining relevance. The areas affected by gradual cooling of magmatic masses are present in the axial areas of the mountain ranges, where the layers of land stacked on top of each other and subject to compressive forces (convergent margins) reach great depths. Only the final lifting of the chain, with subsequent erosion, can therefore lead to outcrops of these masses that were first melted and then recrystallised (clusters of granitoids) in those areas where the mineralisation relating to them occurred. They are found in many of these genetic environments, relating to Alpine mineralisation as well as to most of that in central and northern Europe, but they relate to geodynamic processes from very different ages (belonging to different orogenic cycles). The mineralisation of the island of Elba and the Tuscan mining district are also related to this category. Other important processes of ore enrichment may be due to hydrothermal circulation near areas with a high thermal gradient; in extensional areas of the earth's crust, such as oceanic ridges, or areas of continental rifting, characterised by the

[1] Geologist, Geofisica Misure s.n.c. Trebisacce, Viale della Libertà 132, 87075 Trebisacce, Italy; geofisica@alice.it.
[2] PhD in Prehistoric Archaeology, marino.sara84@gmail.com.
[3] Amodio Morelli et al. 1976.
[4] Scandone 1979.
[5] Dipartimento Urbanistica 2013, 31–32.

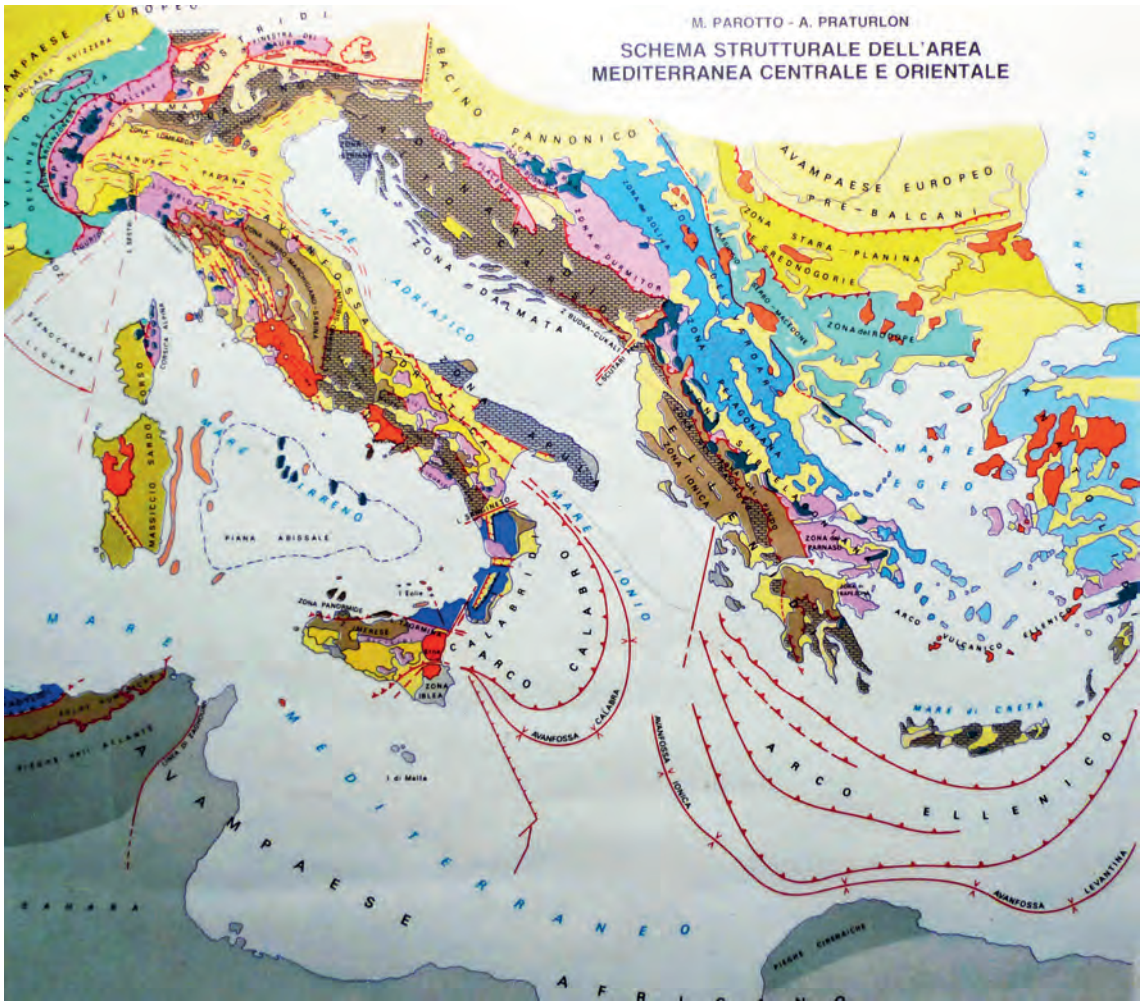


Fig. 1 Structural model of the Central-Eastern Mediterranean Sea (editorial board: G. Bigi, D. Cosentino, M. Parotto, R. Sartori, P. Scandone; regional coordinators: L. Carmignani [Hercynian Sardinia], A. Cherchi [Alpine Sardinia], R. Sartori [marine areas] CNR 1983- SELCA 1991). It is known as the igneous-metamorphic land of the Calabro-Peloritano arc (in blue), is of Hercynian age, but was deformed during the Alpine orogeny, differing from the sedimentary Mesozoic and Tertiary rest of the Apennines (grey and brown). Recent vulcanites and batholiths (Tertiary-Quaternary) are indicated in red; post-orogenic formations in yellow. The red arched arrows show the former direction of rotation of the Sardo-Corso block, that was detached from mainland Europe about 35 Ma ago, due to the opening of the Provencal basin, and Calabro-Peloritano arc later, connected with the opening of the Tyrrhenian Sea

emplacement of volcanic rocks and intrusions of basic magmas. For this genesis, one may refer to both the major copper mines of Cyprus, and those of Val Aurina, the eastern Alps (the Tauern Window) and Liguria (Monte Loreto and Libiola); these are all connected to the Alpine orogenic cycle. The physical appearance caused by the geodynamic processes described above greatly influences not only the landscape, but also the socio-economic aspects of community life in that territory.[6] In this sense the mineral potential of Calabria has long played an important role. The mineralisation of the region was certainly exploited continuously from the Middle Ages up to modern times[7] (Figs. 2; 3).

Until the middle of the last century the mining industry conducted research in the region, in order to examine the possibility of a resumption of mining activities. However, this has not taken place, because it was then considered not to be very advantageous for production

6 Bonardi et al. 1982.

7 Pipino 2003; Cuteri 2009; Clemente 2011.



Fig. 2 Copper ore mineralisation at Valanidi Torrent (photo: G. Ferraro)



Fig. 3 Copper ore mineralisation at Valanidi Torrent (photo: G. Ferraro)

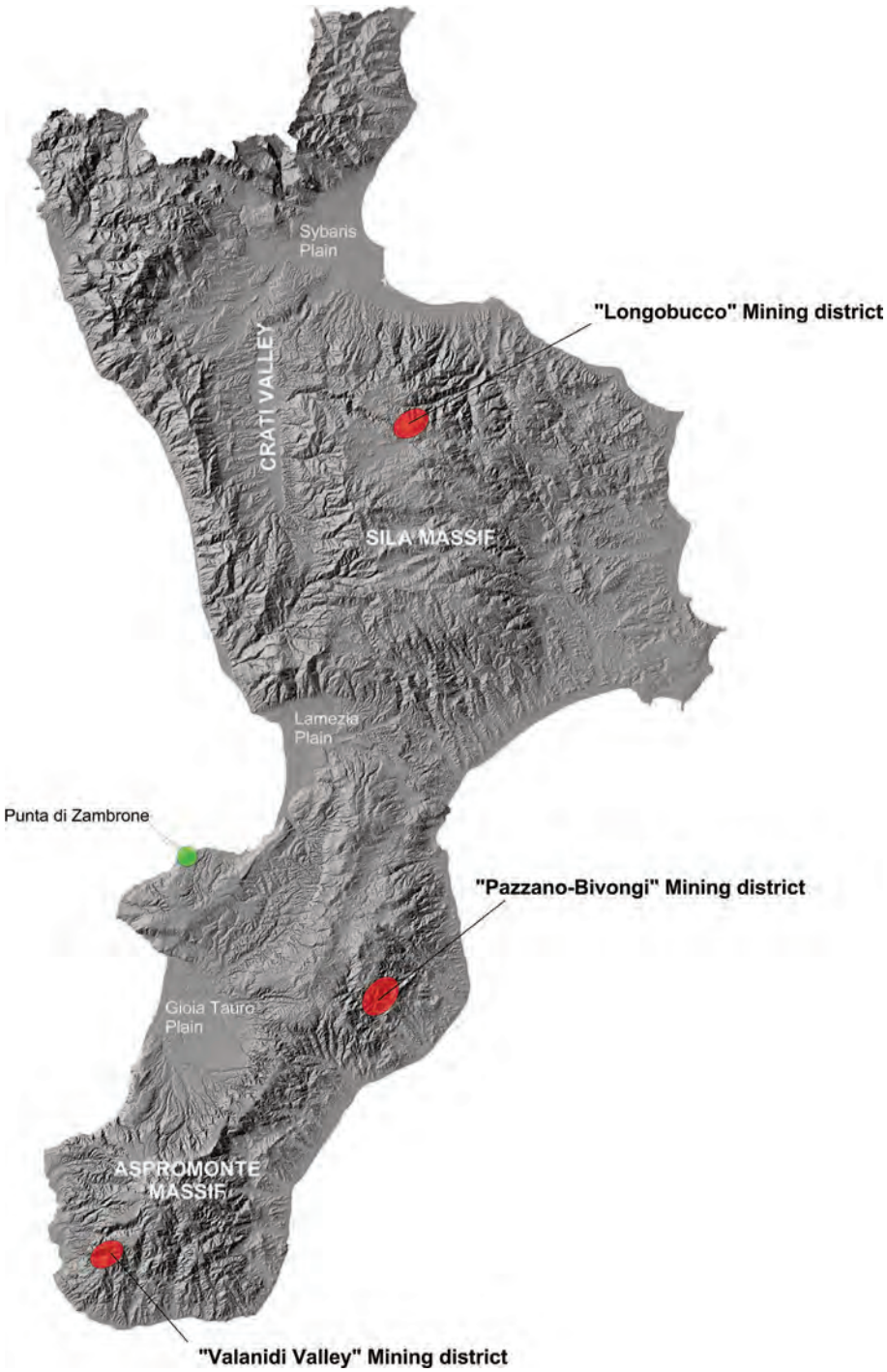


Fig. 4 Map of the sampling carried out for this study (graphics: S. Marino)

contemporaries.[8] In a purely archaeological sense, however, although there are claims of mining up to the Middle Ages,[9] today no clear traces of activities related to the mining of minerals for metallurgical purposes in previous eras exist. The historical mining districts are located in central-southern Calabria and mostly involve mineralisation in sulphides of copper, iron and lead (chalcopyrite, pyrite and galena) (Tab. 1; Fig. 4).

8 Mercati 1969; De Vivo – Ippolito 1984.
9 Clemente 2012.

Mining district	Main ore mined	Ore sampled	Sample description
Valanidi valley (RC)	Cu Ag Pb	Chalcopyrite Malachite Azurite Chrysocolla	Chalcopyrite mineralised veins; Malachite and Azurite concrections
Pazzano-Bivongi (RC)	Mo Cu Pb Ag	Chalcopyrite	Small layers in mica-schist formation (stratabound)
Longobucco (Cs)	Ag Pb Fe Mn	Galena	Mining wastes in outside of historical mines

Tab. 1 Table listing the mining districts with the main ores mined and description of ores sampled for this study

Bibliography

Amodio Morelli et al. 1976
L. Amodio Morelli – G. Bonardi – V. Colonna – D. Djetrich – G. Giunta – F. Ippolito – V. Liguori – S. Lorenzoni – A. Paglionico – V. Perrone – G. Piccarreta – M. Russo – P. Scandone – E. Zanettin Lorenzoni – A. Zuppetta, L'arco Calabro-Peloritano nell'orogene appenninico-maghrebide. Memorie della Società Geologica Italiana 17, 1976, 1–60.

Bonardi et al. 1982
G. Bonardi – B. De Vivo – G. Giunta – A. Lima – V. Perrone – A. Zuppetta, Mineralizzazioni dell'Arco Calabro-Peloritano. Ipotesi genetiche e quadro evolutivo, Bollettino della Società Geologica Italiana 101, 1982, 141–155.

Clemente 2011
G. Clemente, Archeologia mineraria di età borbonica nella Calabria meridionale. Le miniere del Valanidi a Reggio Calabria e Motta San Giovanni tra Settecento e Ottocento, Archeologia Postmedievale 15, 2011, 81–90.

Clemente 2012
G. Clemente, Archeologia mineraria nella Calabria meridionale tra Medioevo e età contemporanea. Dati preliminari sulle miniere del Valanidi nei Comuni di Reggio Calabria e Motta San Giovanni (RC), in: F. Redi – A. Forgione (eds.), Atti del VI Congresso Nazionale di Archeologia Medievale, L'Aquila, 12–15 settembre 2012 (Florence 2012) 666–671.

Cuteri 2009
F. A. Cuteri, La metallurgia di Età medievale in Calabria. Nuovi dati archeologici, in: G. Volpe – P. Favia (eds.), Atti del V Congresso Nazionale di Archeologia Medievale, Palazzo della Dogana, Salone del Tribunale (Foggia); Palazzo dei Celestini, Auditorium (Manfredonia), 30 settembre – 3 ottobre 2009 (Florence 2009) 651–655.

De Vivo – Ippolito 1984
B. De Vivo – F. Ippolito, Mineralizzazioni metallifere italiane ed elementi di prospezione (Naples 1984).

Dipartimento Urbanistica 2013
Dipartimento Urbanistica e Governo del Territorio della Regione Calabria, Quadro Territoriale Regionale Paesaggistico della Regione Calabria vol. 1 (Catanzaro 2013).

Mercati 1969
F. Mercati, Le risorse minerarie della Calabria (Rome 1969).

Pipino 2003
G. Pipino, Oro, miniere, storia. Miscellanea di giacimentologia e storia mineraria italiana (Pratalborato Alessandria 2003).

Scandone 1979
P. Scandone, Origin of the Tyrrenian Sea and Calabrian Arc, Bollettino della Società Geologica Italiana 98, 1979, 27–34.

Analysis of a Recent Bronze Age Amber Bead Fragment from the Site Punta di Zambrone

Christian-Heinrich Wunderlich[1]

Abstract: A fragment of an amber bead from the Punta di Zambrone site was analysed to find out the geographic origin of the raw material. The material was identified as succinite, a material, which in prehistory, could only be found on the coast of the Baltic Sea. Sicilian amber (Simetite) can be ruled out. Using fluorescence microscopy, corroded surfaces, which are a result of stratification in the soil, could be distinguished from modern fracture surfaces.

Keywords: Baltic amber, infrared spectroscopy, Punta di Zambrone, succinite

Three samples of one amber bead fragment (PZ66/P34, PZ66/P35)[2] were taken by using a scalpel. The weight of each fragment was not more than about 0.1–0.2mg. One part was taken from the outer corrosion zone, two samples from a supposed modern fraction plane, meaning the former inner, non-corroded material, the bead.

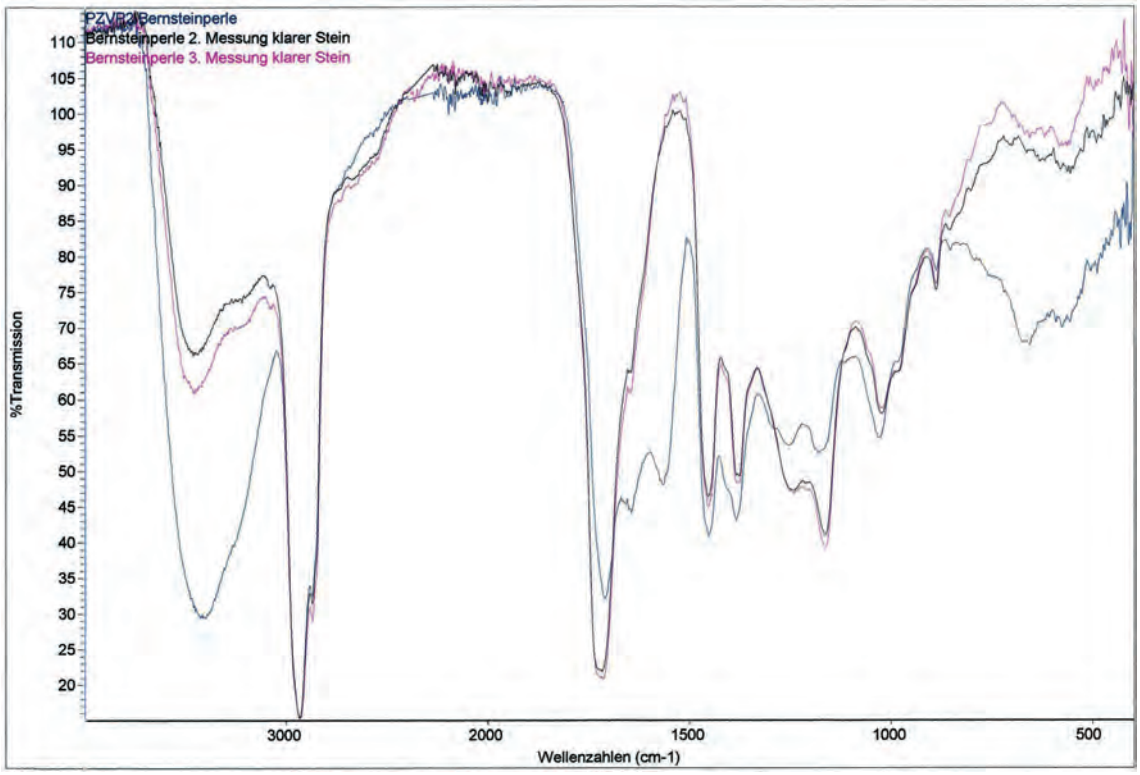


Fig. 1 Infrared spectra of the bead material (PZ66/P34, PZ66/P35). Blue curve: sample taken from the corroded surface; black: sample taken from the fraction plane; pink: sample taken from the fraction plane (graphics: D. Hirschfelder)

[1] Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt, Landesmuseum für Vorgeschichte, Richard-Wagner-Straße 9, 06114 Halle (Saale), Germany; chwunderlich@lda.stk.sachsen-anhalt.de.

[2] For the bead PZ66/P34, PZ66/P35 see Jung – Pacciarelli, this volume, fig. 25.

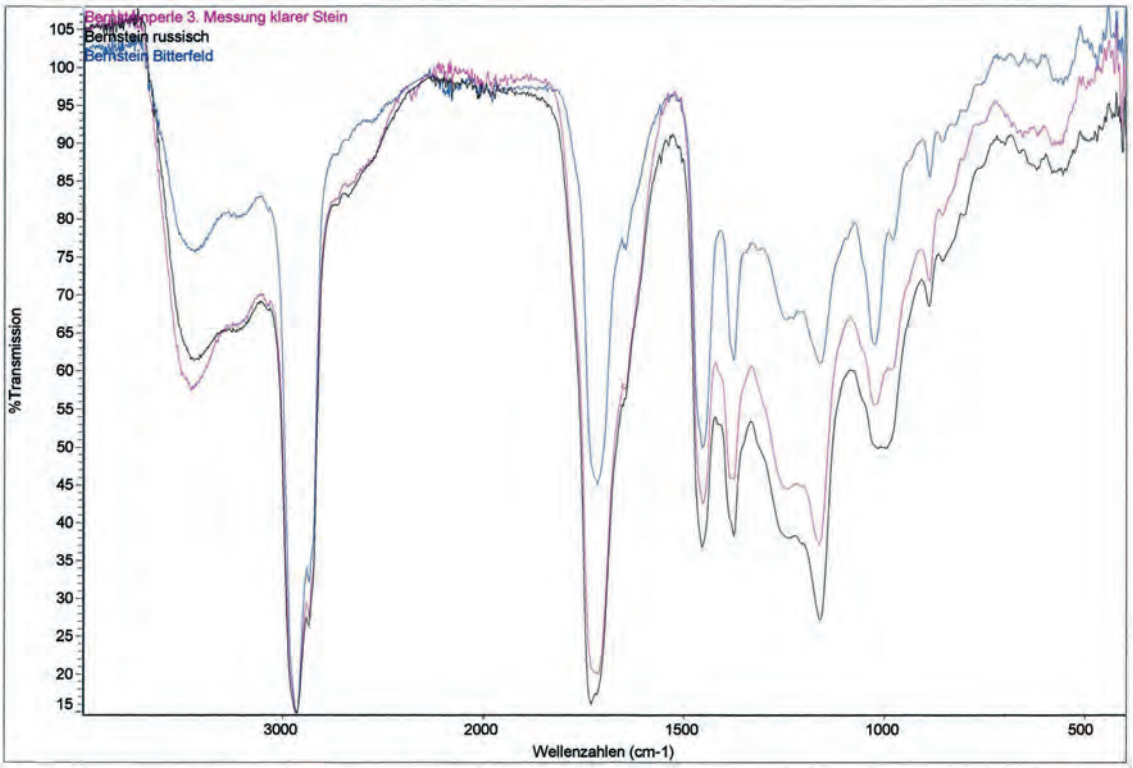


Fig. 2 Infrared spectra of amber from the Baltic Sea (black curve), amber from the mine of Goitsche (Bitterfeld) (blue curve), and sample material of non-corroded fraction plane of the bead PZ66/P34, PZ66/P35 from Punta di Zambrone (graphics: D. Hirschfelder)

The most frequently applied method for identifying different sorts of amber is infrared spectroscopy (IR).[3] The amber fragments were placed on the surface of an infrared diamond window, flattened under high pressure and analysed using a transmitted infrared beam.

The transmitted infrared light was split by the spectrometer using a grid, giving a wavelength-dispersed spectrum, and this was measured by an infrared-sensitive detector.

Each of the three samples was measured in this way. The resulting infrared spectra are shown in Fig. 1.[4]

In addition, reference material was measured in the same way. The reference material came from the Baltic Sea (sold by Kremer-Pigmente, Aichstedten) and from the amber-mine 'Goitsche' near Bitterfeld/Germany (the author's collection). With regard to geological aspects, both ambers are the same, i.e. the so-called succinite or 'Baltic amber' (Fig 2).

Infrared spectra of Baltic amber (succinite) can easily be identified through the so-called 'Baltic shoulder' in the region of 1150–12101/cm wavenumbers. No other fossil resin shows this characteristic absorption.[5]

As visible in Fig. 2, the spectra of the intact, non-corroded bead material of Punta di Zambrone is identical with succinite (Baltic amber). One can also see in Fig. 1 that the outer, corroded zone of the bead differs in its composition from the intact, non-corroded material. This is important for the method of analysing prehistoric amber: it is not possible to carry out 'non-destructive IR'-analysis on the corroded surface of archaeological amber artefacts.

[3] Beck 1986.

[4] The infrared spectroscopy was carried out by Dr. Detlev Hirschfelder, Landeskriminalamt Sachsen-Anhalt, Magdeburg. The author thanks him for his excellent cooperation.

[5] Beck 1986.

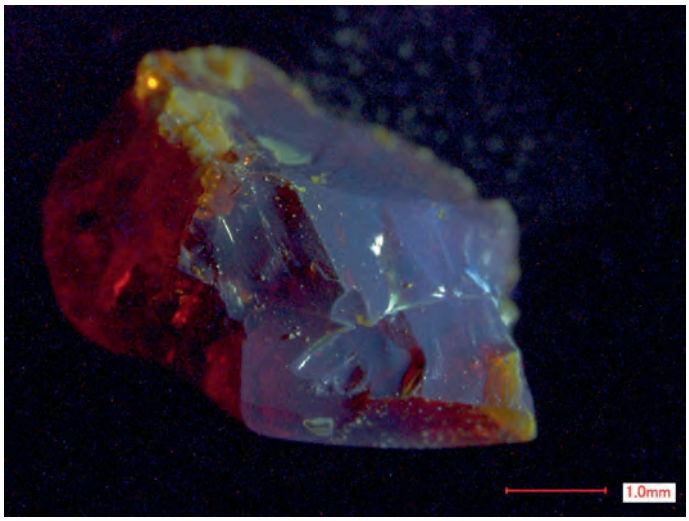


Fig. 3 The amber fragment from Punta di Zambrone (PZ66/P34, PZ66/P35) seen under ultraviolet light (365nm) (photo: Ch.-H. Wunderlich)

During corrosion processes in the soil, amber corrodes in nearly every case, losing water-soluble and/or evaporating volatile substances. The difference between non-corroded, modern (*post excavationem*) and broken archaeological amber can simply be detected in ultraviolet light. Fig. 3 shows the fragment of the amber bead under ultraviolet light (365nm). The modern, fresh broken parts show a pale blueish-turquoise fluorescence, while the corroded surface does not show any effect (It is also a simple method for finding hints of modern forgery or handling 'accidents').

Succinite is a fossil tree resin, which fossilised in geological times (about 40 million years ago) in the area of the recent Baltic Sea. It was transported by fluvial and glacial processes around the whole Baltic Sea, where it can still be found along the coast.

In addition, amber mining is still practised in the region of Yantarny (near Königsberg [Kaliningrad]), where it can be found embedded in so-called 'blue earth'.

Succinite does not occur in any other regions of the world, and in prehistoric times succinite could only be found on the coast of the Baltic Sea, because the modern amber mines of Bitterfeld did not exist and amber in this region is covered with a layer of glacial sediment of 70–100m in thickness. Prehistoric people did not have any way of reaching the amber of the Bitterfeld region.

The exact composition of succinite is not known, due to its high oligomeric constitution, nor do we know the exact botanical species of the amber-producing tree. While former researchers supposed that the resin came from a tree of the *pinus* family, Wolfe et al. suggested species from the conifer family *Sciadopityaceae* ('Umbrella pine').[6]

Although amber can be found in Sicily, the idea that the amber beads from Punta di Zambrone were made of local material can be excluded. The Sicilian amber is a fossil resin called 'simetite', which does not show the Baltic shoulder in its infrared spectra.[7] The amber of Punta di Zambrone must have been imported from the Baltic Sea coast, following the European amber trade route to Calabria.

6 Wolfe et al. 2009.

7 Murillo Borroso – Martinón-Torres 2012, 192, fig. 3.

Bibliography

Beck 1986
C. Beck, Spectroscopic investigations of amber, Applied Spectroscopy Reviews 22, 1, 1986, 57–110.

Murillo Borroso – Martinón-Torres 2012
M. Murillo-Borroso – M. Martinón-Torres, Amber sources and trade in the prehistory of the Iberian peninsula, European Journal of Archaeology 15, 2, 2012, 187–216.

Wolfe et al. 2009
A. Wolfe – R. Tappert – K. Mühlenbachs – M. Moudreau – R. C. McKellar – J. F. Basinger – A. Garret, A new proposal concerning the botanical origin of Baltic amber, Proceedings of the Royal Society B: Biological Sciences, 276, 2009, 3403–3412.

Section 2: The Central and Eastern Mediterranean

Animal Exploitation and Forms of Economic Interaction in Southern and Central Italy during the 13th and 12th Centuries BC

Claudia Minniti[1]

Abstract: The animal remains from a number of sites located in southern and central Italy and dated to the 13th and 12th centuries BC are discussed in view of our understanding of the dynamics of animal consumption and exploitation during the Recent Bronze Age. The interest in the period is linked to the relationships of Italian Bronze Age sites with the Late Bronze Age seafarers coming from the eastern Mediterranean. The archaeological evidence suggests that different levels of contact, from exchange of raw materials and luxury items to circulation of technology and models of production did stimulate changes in social organisation and the economy. Changes in husbandry practices and livestock types, the role of hunting, the exploitation of particular animal resources and the appearance of exotic animals are investigated in order to understand to what extent the main economic, social and political developments that occurred in Italy during the Late Bronze Age are reflected in animal management and diet; in addition, it is investigated whether changes in animal exploitation eventually concerned only part of the peninsula, and particularly those sites that were active in the exchange network within the Mediterranean. The resulting pattern shows a complete self-sufficiency in activities of subsistence through the entire Bronze Age; such self-sufficiency relied on the contributions from agricultural and husbandry practices. Hunting must have been of secondary importance to the economies and the communities examined, although fluctuations probably reflecting local choices have been observed. A substantial increase in sheep/goat frequency at the expense of cattle characterised the economy of Recent Bronze Age sites. Mortality data suggest that pork and mutton production and the use of cattle for ploughing were the main outputs of husbandry practices during the Bronze Age. A trend towards a more diversified exploitation and a major use of secondary products is observed for the Late Bronze Age. The appearance of exotic animals and the exploitation of exotic animals and exotic raw material of likely eastern Mediterranean origin also represent significant evidence for economic change resulting from the relationship between the Aegean area and communities located in Italy.

Keywords: Husbandry, livestock, purple dye, ivory, donkey, central and southern Italy, Bronze Age

Introduction

The animal remains from a number of sites located in southern and central Italy and dated to the 13th and 12th centuries BC are discussed in view of our understanding of the dynamics of animal consumption and exploitation during the Recent Bronze Age. The interest in the period is linked to the relationships of Italian Bronze Age sites with the Late Bronze Age seafarers coming from the eastern Mediterranean. The archaeological evidence suggests that different levels of contact, from exchange of raw materials and luxury items to circulation of technology and models of production, did stimulate changes in social organisation and the economy.[2] The aim of this paper is to investigate to what extent the main economic, social and political changes that occurred in Italy during the Late Bronze Age are reflected in animal management and diet, and whether changes in animal exploitation eventually concerned only part of the peninsula. Although the paper will focus on the Recent Bronze Age, a wider view on the previous and following phases of the Bronze Age is necessary in order to better understand the effects of trade and exchange within the Mediterranean on Bronze Age Italian sites.

1 Dip. Beni Culturali, University of Salento, Lecce, Italy; claudia.minniti@unisalento.it.

2 See Cazzella – Recchia 2009, and references therein.

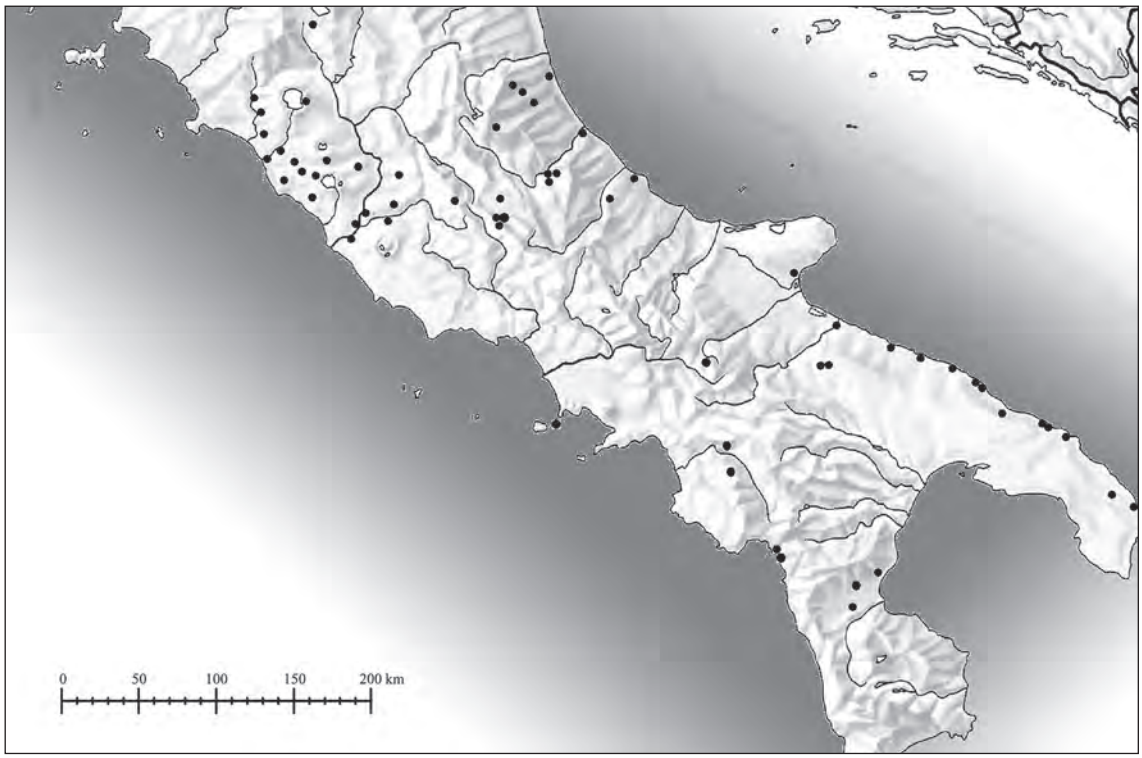


Fig. 1 Distribution map of Bronze Age sites with studied faunal assemblages within the central and southern Italy (graphics: C. Minniti)

To answer these questions, particular attention is paid to changes in husbandry practices and livestock types, to the role of hunting, to the exploitation of particular animal resources and to the appearance of exotic animals.

Different frequencies of the three main domestic species – cattle, sheep/goats and pigs - can reflect changes in the organisation of communities. However, the comparison between sites based only on quantification counts could become less extreme, making less visible possible forms of interaction between communities.[3] Different models of husbandry practices reflected by mortality data can contribute to a better understanding of the dynamics of change in animal exploitation. There are two main purposes which cattle husbandry can fulfil: as traction animals, mainly for ploughing the fields, and meat production. Similarly, caprines can be exploited for meat and for their secondary products, namely milk and wool. A prevalence of one of these purposes could indicate forms of specialisation and, therefore, interaction between sites. Pigs are, by contrast, exclusively meat producers, but changes in pig mortality patterns may indicate different levels of management control.

A more general identification of interactions between communities and higher social and economic complexity can also be presumed from the exploitation of new animal resources and the appearance of exotic animals that could have been a vehicle of social prestige due to their rarity.

In southern Italy, studies of animal remains mainly concern the sites that are located on the Adriatic coast of Apulia, while the hinterland is only represented by two sites located close to Minervino Murge (Fig. 1).[4] Most sites have small or medium-sized assemblages, although exceptionally large animal bone and shell samples have been recovered from the multi-phase settlement

[3] G. Clark has already demonstrated that the study of animal remains from Bronze Age sites may, in fact, seem like an insignificant exercise, as they generally come from already known animal species (Clark 1985).

[4] Pizzarelli 2011–2012.

of Coppa Nevigata.[5] The other large site of the region is Roca Vecchia; however, zooarchaeological data were obtained only from areas and features with particular functions, which, therefore, could have produced an assemblage unrepresentative of the whole site.[6]

In Calabria, the two main settlements on the alluvial coastal plain of Sybaris with large faunal assemblages are Broglio di Trebisacce[7] and Torre Mordillo[8] (Fig. 1). In the same area, the site of Timpone della Motta provided only small samples from Bronze Age contexts.[9] Other studies on animal remains concern two caves located on the Tyrrhenian coast of Calabria: Grotta della Madonna and Grotta Cardini (Praia a Mare). At these sites, a complex stratigraphic sequence has been analysed, which included layers dated to Middle Bronze Age 2 and 3.[10] The rest of the region remains poorly represented. More recent data from Punta di Zambrone discussed in this volume contribute to increasing the information on animal management and diet in Italy during the Recent Bronze Age.[11] The scenario depicted for southern Italy thus shows that the evidence is unevenly distributed geographically; the main factors affecting such distribution are probably represented by the history of the excavations and the small number of reports on animal bone assemblages that are currently available.

Concerning the regions immediately north of Apulia and Calabria, some data cover the Subapennine site of Oratino, near Campobasso,[12] the Protoapennine sites of La Starza, near Ariano Irpino,[13] and the long-lived Bronze Age site of Tufariello, near Buccino;[14] other data could be obtained from the Middle Bronze Age settlement of Vivara-Punta d'Alaca[15] and, more recently, from the Apennine site of Cornaleto.[16] Other data come from central Italy, more precisely from the area corresponding to the modern regions of Abruzzi, Tuscany and Latium (Fig. 1). Zooarchaeological studies here are particularly affected by the history of the excavations and the difficulty of discriminating animal remains from different chronological phases, in contrast with what occurs with other categories of material culture.[17] This is the case for the site of Luni sul Mignone, data from which were originally grouped according to a chronology defined by the correlations between layers that emerged in areas and trenches physically separated from each other, or for the settlement at Narce, where it is no longer possible to discriminate the Recent Bronze Age faunal material from that of the Middle and Final Bronze Ages. However, new important evidence comes from the two recently excavated sites at Fosso Vaccina[18] and in Rome, Capitoline Hill[19], dated to the Recent Bronze Age.

Quantification methods are fundamental to the investigation of animal economies as they allow comparison within and between faunal assemblages. To evaluate the importance of any animal species, many methods are used in a zooarchaeological analysis; most common are the number of identified specimens (NISP) and the minimum number of individuals (MNI), the last interpreting the original number of animals represented per species in an assemblage. The NISP count uses primary data (observable and measurable properties); the MNI count uses secondary data (derived through mathematical manipulation of primary data). All quantification methods

---

5 De Grossi Mazzorin 2010, and references therein; Minniti 2012b; Siracusano 2012, and references therein.
6 Pagliara – Rugge 2005; Pagliara et al. 2005; Pagliara et al. 2007; Pagliara et al. 2008; De Grossi Mazzorin et al. 2010.
7 Cassoli 1984; Gliozzi 1984; Tagliacozzo 1994; Elevelt-Tagliacozzo 2009/2010; Elevelt 2012.
8 Tagliacozzo – Curci 2001.
9 Elevelt 2005.
10 Tagliacozzo et al. 1989; Tagliacozzo 2000.
11 Forstenpointner et al., this volume.
12 Buglione – De Venuto 2008.
13 Albarella 1999.
14 Barker 1975.
15 Carannante et al. 2005.
16 Fiore et al. 2015.
17 Minniti 2012a, and references therein.
18 Barbaro et al. 2012.
19 Minniti 2008; Minniti 2012a.

are flawed: the NISP count can be influenced by a number of factors such as differential anatomy between or within taxa, fragmentation and preservation state; the MNI count can seriously depend on the level of data aggregation, whether estimates are calculated by context, area, period or entire sites.[20]

Although it is often recommended that more than one quantification method be used to allow a balanced consideration of data, this paper will discuss results basing them only on the NISP count, as the MNI count is not available for all the sites examined here.

Another important point to bear in mind here is that samples are extremely different in size and some of them are small. Assemblage size used in any comparative data must be considered, as statistical significance can often become a limiting factor when dealing with sites that have provided assemblages of small size, i.e. with fewer than a hundred identified specimens. Therefore, the variability of sample size necessarily demands caution when interpreting chronological and regional trends.

Hunting and Husbandry

Cattle, sheep, goats and pigs provided for most of the animal proteins throughout the entire Bronze Age at Apulian sites (Tab. 1). Among the four main domesticates, caprines prevail in terms of number of remains in the Middle Bronze Age 1-2A (Protoapennine – 17th–16th century BC) and the Middle Bronze Age 2B–3 (late Apennine – 15th–14th century BC) sites, followed in order of importance by cattle. Pigs are instead the most represented taxon in the Punta Le Terrare site. During Recent Bronze Age 2 (Subapennine – 12th–11th century BC), and in the Final Bronze Age (Protogeometric – 11th–10th century BC) sheep/goats again prevail. Although caprines are dominant in all periods at Coppa Nevigata, a change in species frequency is apparent from Recent Bronze Age 1 (early Subapennine – 13th century BC) with a further increased importance of sheep and goats (from 50% to 64%) at the expense of the cattle (from 37% to 20%).[21]

The kill-off pattern for cattle shows a general use of this animal for traction. Caprines were instead reared mainly for meat production, as most of them were slaughtered at juvenile and subadult stages. Pigs were mainly culled once they had reached their optimum weight. At Coppa Nevigata, cattle were kept alive for longer in Middle Bronze Age 3 and Recent Bronze Age 1. The high proportion of young cattle culled before 12 months of age in Middle Bronze Age 2B and in some features dated to Recent Bronze Age 1 is interpreted by G. Siracusano[22] as a proof of cows' milk consumption.

Hunting must have been of secondary importance in the economies of all sites during the Bronze Age. However, the exploitation of wild animal species by populations that occupied Apulia in the 2nd millennium BC is likely to have been more intense than in other regions.[23] In all chronological phases red deer, roe deer and wild boar are the most attested wild animals. In particular, red deer is the most hunted animal overall over time. Quantification of deer remains may be complicated by the presence of antler in fragment counts, including the shed pieces that may not be derived from hunted animals but collected once loose, and in some reports the numbers of different deer skeletal elements are not given. However, more specific analyses of the samples of deer remains from Mola di Bari and Chiancudda show that all anatomical elements are present, not only fragments of antlers.[24] Elements that bear little or no meat such as limb extremities

[20] For a complete description of quantification analysis in zooarchaeological studies see Baker – Worley 2014.
[21] Data combined from Siracusano 1990; Siracusano 1990–1991; Siracusano 2012.
[22] Siracusano 2012.
[23] De Grossi Mazzorin et al. 2017.
[24] Pizzarelli 2011–2012.

are common, but bones that would have been included in the most important meat cuts such as the humerus, radius, femur and tibia are also well represented. Although we cannot rule out the possibility that collection of the shed antlers was practised, the distribution of other anatomical elements provides evidence of deer hunting.

Site	Period	cattle %	caprines %	pig %	NISP
Coppa Nevigata	MBA 1–2A	20	61	19	2687
Masseria Caterina	EBA – MBA 1	15	59	27	472
Giovinazzo level 2	EBA – MBA 2A	29	41	31	49
Bari – S. Maria	EBA – MBA 2A	38	35	27	194
Monopoli	MBA 1-2A	26	37	37	146
Cavallino	EBA – MBA 1	45	42	13	652
Egnazia liv. VII–VI and IV	EBA – MBA 2A e MBA 2B–3	15	40	46	83
Mola di Bari	MBA 2A–2B	24	44	32	626
Coppa Nevigata	MBA 2B–3	26	62	13	8232
Giovinazzo level 4	MBA 3	39	25	36	36
Monopoli	MBA 2B–3	15	44	41	240
Mass. Chiancudda	MBA 2B–3	37	25	38	609
Punta Le Terrare	MBA 2B–3	12	19	68	493
Coppa Nevigata	RBA 1–2	20	65	15	7796
Monopoli	RBA 2	21	37	42	123
Roca SAS IX	RBA 2	24	46	30	870
Roca SAS X	RBA 2	34	34	32	329
T.re S. Sabina	RBA 2/FBA	24	51	25	273
Madonna del Petto	FBA	40	36	25	222

Tab. 1 Bronze Age sites of Apulia with the proportion of the main domesticates. The NISP (Number of Identified Specimens) count shown is that of the three main domesticates, combined. The chronology of sites refers to Cazzella 2010. (EBA = Early Bronze Age; MBA = Middle Bronze Age, RBA = Recent Bronze Age, FBA = Final Bronze Age)

The large assemblage from Coppa Nevigata shows a certain variety of wild animal species in all periods, with wolf, fox, wild cat, mustelids and hare being represented in addition to deer and wild boar (Tab. 2).[25] The increasing importance of red and roe deer over time is particularly evident.[26] There is no doubt that venison was also eaten, as postcranial bones have also been found in corresponding quantities. However, antlers were certainly used as a working material. According to a more detailed chronology, data seem to suggest that the increase mainly concerned the frequency of roe deer (Tab. 3).[27] The increase in the proportion of roe deer might indicate a higher social complexity, as it should have been more difficult to hunt roe deer due to its habits – roe deer are shier than red deer and usually live in solitude in dense deciduous and coniferous forests.

25 Siracusano 2012.
26 Siracusano 2010.
27 Siracusano 1990–1991; Siracusano 2012.

Period	red deer	roe deer	wild boar	fox	hare	mustelids	wolf	wildcat
	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP
MBA 1–2A	40	4	4	26	4	3	2	-
MBA 2B–3	401	25	12	74	30	23	10	-
RBA 1–2	2015	212	42	40	28	19	9	2

Tab. 2 Number of identified specimens (NISP) of main wild taxa documented at Coppa Nevigata. Combined data from 1955–1975 and 1983–1999 excavations (Siracusano 2012)

Period	red deer		roe deer		wild boar	
	NISP	%	NISP	%	NISP	%
MBA 1–2A	33	92	2	6	1	3
MBA 2B	230	94	7	3	8	3
MBA 3	123	84	18	12	5	3
RBA 1	170	84	27	13	6	3
RBA 2	299	88	92	12	7	1

Tab. 3 NISP and percentages of the three main wild taxa documented at Coppa Nevigata per period. Combined data from 1972–1975 and 1983–1991 excavations (Siracusano 1990–1991; Siracusano 2012)

Domestic species are also predominant at the sites located in the Sybaris plain. Caprines are the most represented domesticates in all periods (Tab. 4).

Site	Period	cattle %	caprines %	pig %	NISP
Broglio di Trebisacce	MBA*	27	41	33	2190
Broglio di Trebisacce	RBA	30	44	26	673
Broglio di Trebisacce	FBA	26	40	34	199
Broglio di Trebisacce	FBA/EIA	23	45	32	107
Torre Mordillo	MBA 3	19	42	38	151
Torre Mordillo	RBA	29	39	32	953
Torre Mordillo	FBA	32	32	35	884
Timpone della Motta	MBA	37	43	21	117
Timpone della Motta	RBA/FBA	42	38	21	149

Tab. 4 Bronze Age sites of Sibaritide, Calabria with the proportion of the main domesticates. The NISP count shown is that of the three main domesticates, combined. (MBA = Middle Bronze Age, RBA = Recent Bronze Age, FBA = Final Bronze Age; EIA = Early Iron Age; * = combined data from sector 10 (phases 1/2 and 3) and sectors B-D-E (Cassoli 1984; Gliozzi 1984; Tagliacozzo 1994; Elevelt – Tagliacozzo 2009/2010; Elevelt 2012)

No particularly significant change can be observed in the proportion of the three main domesticates from the Middle to the Final Bronze Age at Torre Mordillo, while at Broglio di Trebisacce a more detailed chronology shows that sheep and goats become more important from Middle Bronze Age 3 onwards (Tab. 5).

	cattle %	caprines %	pig %
MBA 2	29	35	35
MBA 3	24	46	30

Tab. 5 Percentages of the three main domesticates at Broglio di Trebisacce in the Middle Bronze Age

The mortality data from Broglio di Trebisacce demonstrates that in the Recent Bronze Age cattle were slaughtered as adults far more often than in previous periods. This suggests a more specialised economy, probably geared towards the use of cattle as traction animals for ploughing. Sheep and goats were probably mainly kept for a range of purposes, but a general comparison of the kill-off patterns by period shows that caprine husbandry became more specialised in the exploitation of secondary products – remains from neonate and adult/elderly individuals increase – from Middle Bronze Age 3 onwards.

Concerning pig husbandry, a higher degree of control of animals in the later periods is proved by the increase of juvenile and sub-adult individuals.

At Torre Mordillo, some changes in kill-off patterns mainly concern cattle that in the Recent Bronze Age were killed at a younger age than in previous periods; caprines, on the other hand, continue to be exploited for meat.

The proportion of wild species is low, although characterised by a certain variety (Tab. 6). The presence of the chamois at Broglio di Trebisacce is considered clear evidence that hunting activity was practised in the mountainous hinterland of the site.[28] Red deer remains the dominant species; furthermore, its frequency increases in the later periods in both the sites of Broglio di Trebisacce and Torre Mordillo (Tab. 7). Deer hunting still seems oriented to both meat consumption and the use of antlers as a working material.

Site	Period	red deer	roe deer	cha-moix	wild boar	bear	wolf	fox	wild-cat	badger	mar-ten	pole-cat	hare
		NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP
Broglio Trebi-sacce sct. 10	MBA 1–2	17	12	3	4	1	1	1		2			1
Broglio Trebi-sacce sct. 10	MBA 3	23		1	4	1	1	3					3
Broglio Trebi-sacce 1979–85	MBA	31								1	1		
Broglio Trebi-sacce 1979–85	RBA	74	2			2			1		1		
Broglio Trebi-sacce 1979–85	RBA/FBA	14											
Broglio Trebi-sacce 1979–85	FBA	246			1						1		
Broglio Trebi-sacce 1979–85	FBA/EIA	51	1										
Torre Mordillo	MBA	16	1									5	
Torre Mordillo	RBA	232	1		3		1					2	
Torre Mordillo	FBA	84						3					
Timpone della Motta	MBA	4											
Timpone della Motta	RBA/FBA	1				1							

Tab. 6 NISP of main wild taxa documented in the sites of Sibaritide

[28] Elevelt – Tagliacozzo 2009/2010.

Site	Period	red deer		other wild taxa	
		NISP	%	NISP	%
Broglio di Trebisacce	MBA	71	70	31	30
	RBA	74	91	7	9
	FBA	246	99	2	1
Torre Mordillo	MBA	16	73	6	27
	RBA	232	94	16	6
	FBA	84	90	9	10

Tab. 7 Percentages of red deer remains in comparison with those of other wild taxa documented at Broglio di Trebisacce and Torre Mordillo

Sheep and goats are the most common taxa in the Middle Bronze Age layers documented at Grotta Cardini (54–53% of the four main domesticates), Grotta della Madonna (48%) and at the Subapennine site of Oratino (46%). Meat production was the main aim of livestock husbandry, together with the exploitation of secondary products (in particular, milk and wool in the two caves and wool at Oratino). Red deer represents the main wild species hunted by the inhabitants of the caves, despite the great variety of taxa attested that include roe deer, wild boar, bear, wolf, wild-cat, fox, badger, marten, hare and a certain number of birds.

Caprines also dominate the faunal samples from Tufariello, Cornaleto and perhaps from La Starza, where a number of taphonomic biases might affect the frequency of species and representation of body parts. At La Starza, sheep and goats appear to be slaughtered mainly for mutton production and there is no evidence of seasonal culling.

In central Italy, the frequencies of the three main domestic categories show that cattle was the most common species during the Early and the Middle Bronze Age, although caprines prevail in the Late Bronze Age (Tab. 8).[29] However, a more refined analysis seems to suggest that the increase in sheep and goats starts in Middle Bronze Age 3, corresponding to the Apennine period, and continues into the Recent Bronze Age.[30]

Site	Period	NISP	cattle %	caprines %	pig %
S. Lorenzo a Greve	MBA 1–2	91	18	27	55
Pitigliano Mulino Rossi	MBA 1–2	7	57	14	29
Luni sul Mignone	MBA 1–2	1947	49	27	25
Villaggio delle Macine	MBA 1–2	88	13	61	26
Torre dei Passeri	MBA 2	70	56	24	20
Gonfienti	MBA 2–3	3662	24	46	30
Coccioli	MBA 3	267	36	40	24
Cerchio La Ripa	MBA 3	155	37	43	20
Radicicoli	MBA 3	21	48	29	24
Castiglione	MBA 3	265	46	39	15
Vejano Borgo	MBA 3 / RBA 2	263	32	37	31
Narce	MBA 3 / RBA 2	379	31	53	16
Trasacco	RBA	258	24	67	8

[29] De Grossi Mazzorin 2001.
[30] Minniti 2012a.

Site	Period	NISP	cattle %	caprines %	pig %
Mezzana-Perfetti Ricasoli	RBA 1	290	53	22	25
Banditella	RBA 2	82	50	37	13
M. Rovello	RBA 2	137	42	39	20
Fosso Vaccina	RBA 2	448	21	52	26
Roma Campidoglio	RBA 2	474	31	47	21
Pitigliano Mulino Rossi	RBA/FBA 1–2	19	47	37	16
S. Giovenale	RBA/FBA 1–2	165	18	53	29
Narce	RBA/FBA 1–2	994	27	50	23
Torrionaccio	RBA/FBA 1–2	219	20	74	6
Luni sul Mignone	RBA/FBA 1–2	45	38	33	29
Luni sul Mignone	RBA/FBA 1–2	162	33	60	6
Monte S. Elia	RBA/FBA 1–2	36	31	58	11
Ficana	RBA/FBA 1–2	932	34	40	26
Poggio Buco	FBA 3	456	30	51	19
Sorg. della Nova	FBA 3	375	24	33	42
Sorg. della Nova	FBA	42	24	36	40
Elceto	FBA 3	236	34	54	11
M. Rovello	FBA 3	215	53	33	13
Celano Le Paludi	FBA	954	30	40	31

Tab. 8 Bronze Age sites of central Italy with the proportion of the main domesticates. The NISP count shown is that of the three main domesticates, combined. (MBA = Middle Bronze Age; RBA = Recent Bronze Age; FBA = Final Bronze Age)

Focusing on the economies of the Recent Bronze Age settlements, the animal remains from Fosso Vaccina can be compared to those from Rome, Capitoline Hill, since the dominant role of caprines characterises both sites; however, cattle is more abundant at Monte Rovello, though data from this last site could be affected by the smaller size of the sample. Pigs remain the least important species at all sites except for Vejano Borgo, where Middle Bronze Age and Recent Bronze Age material is mixed.

Cattle were mainly used for traction in the Bronze Age, being slaughtered at either adult or senile age-stages. The trend is documented in the Middle Bronze Age and continues through the Recent Bronze Age with the only exception of Rome, Capitoline Hill, where cattle were specifically exploited for meat (most animals were aged to between two and three years). However, it is important to note that selection of prime animals at Rome, Capitoline Hill may have been specific to the context analysed, and may not reflect the age-structure of local herds. At Fosso Vaccina, cattle were kept for traction, since animals slaughtered in adult and senile age-stages represent about 75% of the sample. However, a significant proportion of the animals (24%) were reared for meat production, being slaughtered before 36 months of age.

The importance of cattle for beef production seems to increase in sites dated to the Final Bronze Age.

Caprine kill-off patterns show that, until the Recent Bronze Age, livestock husbandry was mainly targeted at mutton production, and only secondarily at wool production; on the other hand, milk production became more important from the Final Bronze Age.

Hunting must have been of secondary importance to the economies of all sites throughout the Bronze Age (Tab. 9). Slight fluctuations seem to reflect local choices. At Vejano Borgo, wild species are well represented with a certain variety, though the red deer is the most hunted animal overall. The proportion of antlers is high, but other body parts are clearly represented, suggesting

Site	Period	auroch	red deer	roe deer	ibex	wild boar	bear	wolf	wildcat	lynx	fox	badger	marten	otter	hare
		NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP
S. Lorenzo a Greve	MBA 1–2		4(2)	1		1									
Pitigliano Mulino Rossi	MBA 1–2		3			2									
Luni sul Mignone	MBA 1–2		4	3				1	6		4				2
Villaggio delle Macine	MBA 1–2		178	12		10	1	1	1		4	1			1
Torre dei Passeri	MBA 2														
Gonfienti	MBA 2–3		228(20)	7(2)					4			1	6		7
Coccioli	MBA 3		1			1									
Cerchio La Ripa	MBA 3		6(4)	(1)		1					1				
Radicicoli	MBA 3														
Castiglione	MBA 3		5	1		1									
Vejano Borgo	MBA 3 / RBA 2		33(8)			11	2					4			
Narce	MBA 3 / RBA 2		1					1							
Trasacco	RBA		34	2		3				1		1			1
Mezzana-Perfetti Ricasoli	RBA 1		57(4)		2										
Banditella	RBA 2														
M. Rovello	RBA 2		1	3(2)		1									
Fosso Vaccina	RBA 2														3

Site	Period	auroch	red deer	roe deer	ibex	wild boar	bear	wolf	wildcat	lynx	fox	badger	marten	otter	hare
		NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP
Roma Campidoglio	RBA 2		2(1)	2(1)											
Pitigliano Mulino Rossi	RBA FBA 1–2		5			2									
S. Giovenale	RBA FBA 1–2		3	1											
Narce	RBA FBA 1–2		1	1				1							
Torrionaccio	RBA FBA 1–2														
Luni sul Mignone	RBA FBA 1–2	1	1												
Luni sul Mignone	RBA FBA 1–2		50(41)			1						1			
Monte S. Elia	RBA FBA 1–2														
Ficana zona 2	FBA		8(1)			2								1	2
Poggio Buco	FBA 3		7(4)	(1)											
Sorg. della Nova	FBA 3		38(10)	8											1
Sorg. della Nova	FBA							1				1			
Elceto	FBA 3														
M. Rovello	FBA 3		2	1											
Celano Le Paludi	FBA		93	5		5	19	1		1	3				

Tab. 9 NISP of main wild taxa documented in the Bronze Age sites of central Italy. In parentheses antler fragments

that venison was eaten. At Mezzana-Perfetti Ricasoli the presence of a species from the mountainous hinterland, the ibex, is documented.[31] The proportion of wild species is high in the Final Bronze Age site of Sorgenti della Nova, though only in the sample from feature Va-Ve.[32] When a diachronic trend can be observed, an increase of wild species is visible from the Middle to the Recent/Final Bronze Age (for example, at Luni sul Mignone and at Monte Rovello).

Exploitation of Particular Animal Sources and the Appearance of Exotic Animals in Southern Italy

A particular aspect of the economy at Coppa Nevigata is the exploitation of murex shells for purple dye production.[33] The large quantity and the high state of fragmentation of murex shell remains, which relates to a high number of molluscs in terms of a minimum number of individuals,[34] provide the only, though sufficient indication of their use; indeed, no evidence of basins or installations was recorded, and a secondary use of the shells as building material is documented.

The processing of purple dye could have started in the Early Bronze Age, reached its highest peak in Middle Bronze Age 3 and decreased strongly in the Recent Bronze Age.[35] More than six hundred shell fragments were found in the pre-wall hut dating to the 18th century BC and murex shell heaps were found under the eastern tower of the huge walls and are dated to Middle Bronze Age 2B.[36] During Middle Bronze Age 3, mud layers particularly rich in murex shells, probably carried from the border of the lagoon, filled the area between the two towers of the huge walls, obstructing the previous entrance to the town. It appears that no particularly large heaps of murex shells were found in the Recent Bronze Age settlement.

The occurrence of murex shells from different periods and the variation of frequencies through time may be linked to the exchange network with the Aegean area, where purple dye production is believed to originate and is widely attested since the 18th century BC, albeit with mechanisms that still escape our understanding.[37] The relationship of murex shell frequencies with Mycenaean pottery at Coppa Nevigata appears particularly significant; the fluctuation of murex shells shows a trend opposite to that of Mycenean pottery. This is rarely attested in the Middle Bronze Age layers; while locally-produced Mycenaean-like pottery largely appears during the Recent Bronze Age.[38]

Despite sporadic occurrences of the horse in Italy dated to the Chalcolithic, the majority of reports from the Bronze Age seem to suggest that a certain cultural appropriation of this animal should rather be ascribed to the Middle and Final Bronze Age. The presence of the horse at several sites located in central and southern Italy and dated from the Middle Bronze Age just confirms this hypothesis.[39] An exotic species that makes its first appearance during the Bronze Age is instead the donkey. This animal seems to appear for the first time in Italy in the Recent Bronze Age, becoming more common and spreading from the Final Bronze Age on. The original hypothesis of its provenance from the eastern Mediterranean is still accepted. In southern Italy the donkey is documented at several Final Bronze Age sites (Madonna del Petto, Broglio di Trebisacce and

31 Fonzo – Perazzi 2012. I thank Ornella Fonzo for discussing the preliminary data from the sites of Gonfienti-Scalo Merci (PO) e Mezzana-Perfetti Ricasoli (FI) and confirming the identification of ibex (*Capra ibex* L.).

32 Minniti 2012a, 12, and references therein.

33 Minniti 2005; Minniti 2012, and references therein.

34 See Minniti 2012b, 376, tab. 6.

35 Recent studies clearly show that recovery and preservation biases do not affect the fluctuation of murex frequency through time, despite the fact that the extension and volume of the deposits explored per period vary considerably (Minniti – Recchia 2018).

36 Cazzella et al. 2006.

37 Karali 1999; Minniti 1999; Alberti 2008; Cazzella – Recchia 2009.

38 Recchia 2009.

39 De Grossi Mazzorin et al. 2004.

Timpone della Motta), but it seems to appear earlier at Coppa Nevigata in layers dated to the Subapennine period.[40]

The early appearance of the donkey at Coppa Nevigata seems likely, considering the scenario of exchange network linking the site to the eastern Mediterranean; however, these data are currently being verified and supported by new discoveries. The three teeth previously identified as donkey by S. Bökönyi and G. Siracusano seem, in fact, to have all the characteristics that several studies have shown to be typical of the horse.[41]

Hippopotamus and elephant ivory represent another category of exotic animal material that first occurred in Italy during the Bronze Age. Ivory could have come from the hippopotamus, which lived in the area between the Nile delta and southern Anatolia, from the Asian elephant that lived in the Euphrates valley and in various regions of eastern Asia, and from the African elephant that populated the regions of North Africa. Apart from some ivory objects found in Roca Vecchia, of interest are some fragments of hippopotamus canines that attest the on-site processing of ivory in the Recent Bronze Age.[42] The statuette recently discovered at Punta di Zambrone (southern Calabria) and dated to Recent Bronze Age 2, by contrast, is made from elephant ivory.[43]

Conclusion

Although the overall picture is far from complete and definitive, changes in animal exploitation occurred in central and southern Italy throughout the Recent and Final Bronze Ages.

A general impression seems to indicate that the Late Bronze Age pattern was the result of a process which started in the previous Middle Bronze Age. Nevertheless, there are regional differences in the timing and grade of change.

A diachronic overview suggests that a substantial increase in sheep/goat frequency at the expense of cattle characterised the economy of several sites. At Coppa Nevigata the caprine increase and the cattle decline coincided with the Recent Bronze Age, while in Sibaritide, as well as in most sites located in central Italy, it started earlier, in the later Middle Bronze Age.

Changes in husbandry strategies occurred in the Late Bronze Age, but this trend was not universal. At Coppa Nevigata no particular change occurred except for cattle husbandry. The scenario is one where fewer cattle are used for more diversified purposes.

More evident changes in the kill-off patterns occurred instead at Broglio di Trebisacce and Torre Mordillo, though this does not coincide with the change in species frequency. At Broglio di Trebisacce, mortality data suggest caprine husbandry was geared towards secondary products from the Recent Bronze Age on. In central Italy, husbandry strategies do not seem to change until the Final Bronze Age.

Evidence for the exploitation of particular or exotic animals comes from Coppa Nevigata and Roca Vecchia. The processing of purple dye, well-documented in the entire Mediterranean, at Coppa Nevigata reached its maximum peak in the Middle Bronze Age; it subsequently declined significantly in the Recent Bronze Age, the same period as the crisis of the Mycenaean palatial system. Evidence for local ivory processing is attested at Roca Vecchia in the Recent Bronze Age, the material presumably arriving from the eastern Mediterranean.

The cattle decline and consequent caprine increase could have resulted from an over-exploitation of the land surrounding the sites, leading to nutritional problems for the animals and environmental degradation due to overgrazing; in turn, this could have driven communities to search for new land to exploit, to practise transhumance, to collect and preserve forage and, finally, to

---

40 Bökönyi – Siracusano 1987. Few remains of donkey were recently identified at the sites of Bovolone and Fondo Paviani, in northern Italy, both dated to the Recent Bronze Age (Bertolini et al. in press).

41 According to taxa characters described by Davis 1980; Eisenmann 1986; Uerpmann 2002; Johnstone 2004.

42 Guglielmino et al. 2012.

43 Jung – Pacciarelli 2016; see also Jung – Pacciarelli, this volume.

reduce the size of cattle herds. The increase in the hunting of red and roe deer over time seems to be consistent with the widening of the territory exploited by communities. However, an emphasis on caprine husbandry can also reflect the development of a higher complexity in social structure, with a differentiation of roles within the community (e.g. shepherds engaged in seasonal transhumance, craftsmen engaged in the processing of ivory and purple dye) or the emergence of surplus production and storage,[44] possibly to be used within the exchange network of Mediterranean area.[45]

Acknowledgements: I am very grateful to Reinhard Jung for giving me the opportunity to contribute to this book.

Bibliography

Albarella 1999
U. Albarella, The animal economy after the eruption of Avellino pumice: the case of La Starza (Avellino southern Italy), in: C. Albore Livadie (ed.), L'eruzione Vesuviana delle Pomici di Avellino e la facies di Palma Campania (Bronzo antico). Atti del Seminario Internazionale di Ravello, 15–17 luglio 1994, Territorio Storico ed Ambiente 2 (Bari 1999) 317–330.

Alberti 2008
M. E. Alberti, Murex shells as raw material. The purple-dye industry and its by-products. Interpreting the archaeological record, Kaskal 5, 2008, 73–90.

Baker – Worley 2014
P. Baker – F. Worley, Animal Bones and Archaeology. Guidelines for Best Practice (Swindon 2014).

Barbaro et al. 2012
B. Barbaro – M. Bettelli – I. Damiani – D. De Angelis – C. Minniti – F. Trucco, Etruria meridionale e Mediterraneo nella tarda Età del Bronzo, in: V. Belelli (ed.), Le origini degli Etruschi. Storia, Archeologia, Antropologia (Rome 2012) 195–248.

Barker 1975
G. Barker, Stock economy, contribution in: R. Ross Holloway – N. P. Nabers – S. S. Lukesh – G. Barker – N. B. Hartmann – E. R. Eaton – H. Mc Kerrell – W. L. Phippen, Buccino. The Early Bronze Age village of Tufariello, Journal of Field Archaeology 2, 1975, 59–72.

Bertolini et al. in press
M. Bertolini – A. Curci – J. De Grossi Mazzorin – V. Depellegrin – E. Maini – C. Minniti – U. Tecchiati – U. Thun Hohenstein, Carne, latte e derivati. Gli animali come fonte di cibo nell'età del Bronzo italiana, in: C. Belardelli – J. De Grossi Mazzorin (eds.), Preistoria del Cibo. 50ma Riunione Scientifica dell'Istituto Italiano di Preistoria e Protostoria, Roma, 5–9 ottobre 2015 (in press).

Bökönyi – Siracusano 1987
S. Bökönyi – G. Siracusano, Reperti Faunistici dell'Età del Bronzo del sito di Coppa Nevigata. Un commento preliminare, in: S. M. Cassano – A. Cazzella – A. Manfredini – M. Moscoloni (eds.), Coppa Nevigata e il suo territorio (Rome 1987) 205–210.

Buglione – De Venuto 2008
A. Buglione – G. De Venuto, Analisi preliminare del campione faunistico dal sito dell'età del Bronzo di Oratino (Cb), loc. La Rocca, in: A. Gravina (ed.), Atti del 28 Convegno Nazionale di Preistoria – Protostoria – Storia della Daunia San Severo, 25–26 novembre 1998 (San Severo 2008) 299–310.

Carannante et al. 2005
A. Carannante – S. Chilardi – A. Nappi – C. Pepe – F. Santo, Indagini Archeozoologiche sul Sito dell'Età del Bronzo di Vivara-Punta d'Alaca, Procida (NA). Risultati preliminari, in: G. Malerba – P. Visentini (eds.), Atti del 4º Convegno Nazionale di Archeozoologia (Pordenone 2005) 215–222.

44 De Grossi Mazzorin 2001.
45 Cazzella – Recchia 2008.

Cassoli 1984
P. F. Cassoli, La Fauna, in: G. Bergonzi – V. Buffa – B. Capoferri (eds.), Ricerche sulla Protostoria della Sibaritide 3 (Rome 1984) 232–259.

Cazzella 2010
A. Cazzella, Introduzione, in: F. Radina – G. Recchia (eds.), Ambra per Agamennone. Indigeni e Micenei tra Adriatico, Ionio ed Egeo (Bari 2010) 29–32.

Cazzella – Recchia 2008
A. Cazzella – G. Recchia, A view from the Apennine. The Role of the inland sites in southern Italy during the Bronze Age, in: S. Grimaldi – T. Perrin – J. Guilaine (eds.), Mountains Environment in Prehistoric Europe. Settlement and Mobility Strategies from Palaeolithic to the Early Bronze Age, British Archaeological Reports International Series 1885 (Oxford 2008) 137–143.

Cazzella – Recchia 2009
A. Cazzella – G. Recchia, The 'Mycenaeans' in the Central Mediterranean. A Comparison between the Adriatic and the Tyrrhenian Seaways, Pasiphae 3, 2009, 27–40.

Cazzella et al. 2006
A. Cazzella – C. Minniti – M. Moscoloni – G. Recchia, L'Insediamento dell'Età del Bronzo di Coppa Nevigata e la più Antica Attestazione della Produzione della Porpora in Italia, Preistoria Alpina 40 Suppl. 1 (Trento 2006) 177–182.

Clark 1985
G. Clark, Beyond Subsistence reconstruction. The potential of faunal remains in the study of social and economic complexity, in: C. Malone – S. Stoddart (eds.), Papers in Italian Archaeology IV, British Archaeological Reports International Series 245 (Oxford 1985) 252–270.

Davis 1980
S. J. Davis, Late Pleistocene and Holocene equid remains from Israel, Zoological Journal of the Linnean Society 70, 1980, 289–312.

De Grossi Mazzorin 2001
J. De Grossi Mazzorin, Archaeozoology and habitation models. From a subsistence to a productive economy in central Italy, in: J. R. Brandt – L. Karlsson (eds.), From Huts to Houses. Transformations of Ancient Societies, Proceedings of an International Seminar (Rome 2001) 323–330.

De Grossi Mazzorin 2010
J. De Grossi Mazzorin, L'utilizzazione degli animali nella documentazione archeozoologica dell'età del Bronzo in Puglia, in: F. Radina – G. Recchia (eds.), Ambra per Agamennone. Indigeni e Micenei tra Adriatico, Ionio ed Egeo, Catalogo della Mostra Bari, 28 maggio – 16 ottobre 2010 (Bari 2010) 69–72.

De Grossi Mazzorin et al. 2004
J. De Grossi Mazzorin – A. Riedel – A. Tagliacozzo, L'evoluzione delle popolazioni animali e dell'economia nell'età del bronzo recente, in: D. Cocchi Genick (ed.), L'età del bronzo recente in Italia. Atti del Congresso Nazionale di Lido di Camaiore, 26–29 ottobre 2000 (Viareggio 2004) 227–232.

De Grossi Mazzorin et al. 2010
J. De Grossi Mazzorin – C. Pagliara – M. Rugge, Testimonianze di utilizzazione del Carapace di Caretta caretta nell'Insediamento dell'età del Bronzo di Roca (Lecce), in: A. Tagliacozzo – I. Fiore – S. Marconi – U. Tecchiati (eds.), Atti del 5° Convegno Nazionale di Archeozoologia, Rovereto, 10–12 novembre 2006 (Rovereto 2010) 169–172.

De Grossi Mazzorin et al. 2017
J. De Grossi Mazzorin – C. Minniti – A. Pizzarelli – G. Siracusano, Dinamiche di sfruttamento ambientale e animale in Puglia nell'età del Bronzo, in: F. Radina (ed.), Preistoria e Protostoria della Puglia, Studi di Preistoria e Protostoria 4 (Florence 2017) 449–456.

Eisenmann 1986
V. Eisenmann, Comparative osteology of modern and fossil horses, half-asses and asses, in: R. H. Meadow – H.-P. Uerpmann (eds.), Equids in the Ancient World (Wiesbaden 1986) 67–116.

Elevelt 2005
S. C. Elevelt, Analisi dei Resti Faunistici di Età Protostorica rinvenuti sul Primo Pianoro dell'Insediamento di Francavilla Marittima (CS), in: G. Malerba – P. Visentini (eds.), Atti del 4 Convegno Nazionale di Archeozoologia (Pordenone 2005) 261–266.

Elevelt 2012
S. C. Elevelt, Subsistence and Social Stratification in northern Ionic Calabria from the Middle Bronze Age until the Early Iron Age (PhD Diss., University of Groningen, Groningen 2012).

Elevelt – Tagliacozzo 2009/2010
S. C. Elevelt – A. Tagliacozzo, The Faunal Remains of Broglio di Trebisacce (southern Italy), Palaeohistoria 51/52, 2009/2010, 425–449.

Fiore et al. 2015
I. Fiore – F. Nomi – M. Truffi, i resti faunistici dell'abitato appennininco del Cornaleto (Sant'Arsenio, SA), in: M. Cremaschi – A. M. Mercuri – A. Revedin (eds.), Preistoria del Cibo. 50ma Riunione Scientifica dell'Istituto Italiano di Preistoria e Protostoria, Roma, 5–9 ottobre 2015. Sessione 2: L'ambiente fonte di risorse alimentari. Condizionamenti e impatto ambientale in funzione dell'acquisizione delle risorse alimentari. Online <http://preistoriadelcibo.iipp.it/sessione2-download.html> (last accessed 19 Feb. 2019).

Fonzo-Perazzi 2012
O. Fonzo – P. Perazzi, La Fauna del Bronzo Medio e Recente dagli Insediamenti di Gonfienti-Scalo Merci (PO) e Mezzana-Perfetti Ricasoli (FI), in: N. Negroni Catacchio (ed.), Preistoria e protostoria in Etruria. L'Etruria dal Paleolitico al Primo Ferro. Lo stato delle ricerche. Atti del decimo incontro di studi, Valentano (VT) – Pitigliano (GR), 10–12 settembre 2010 (Milano 2012) 341–351.

Gliozzi 1984
E. Gliozzi, Dati Paleozoologici in Broglio, in: R. Peroni (ed.), Nuove Ricerche sulla Protostoria della Sibaritide (Rome 1984) 285–304.

Guglielmino et al. 2012
R. Guglielmino – F. Iacono – M. Rugge, Brevi Cenni sulla Diffusione dell'Avorio nel Mediterraneo dell'Età del Bronzo, in: J. De Grossi Mazzorin, Artigiani dell'Osso, Avorio e Palco. Ornamenti, Utensili e Giochi dalla Preistoria al Medioevo, Catalogo della Mostra (Lecce 2012) 71–75.

Johnstone 2004
C. J. Johnstone, A Biometric Study of Equids in the Roman World (PhD Diss., University of York, York 2004).

Jung – Pacciarelli 2016
R. Jung – M. Pacciarelli, A Minoan statuette from Punta di Zambrone in southern Calabria, in: E. Alram-Stern – F. Blakolmer – S. Deger-Jalkotzy – R. Laffineur – J. Weilhartner (eds.), Metaphysis. Ritual, Myth and Symbolism in the Aegean Bronze Age. Proceedings of the 15th International Aegean Conference, Vienna, Institute for Oriental and European Archaeology, Aegean and Anatolia Department, Austrian Academy of Sciences, and Institute of Classical Archaeology, University of Vienna, 22–25 April 2014, Aegaeum 39 (Leuven, Liège 2016) 29–36.

Karali 1999
I. Karali, Shells in Aegean Prehistory, British Archaeological Reports International Series 761 (Oxford 1999).

Minniti 1999
C. Minniti, L'utilizzazione dei molluschi nell'età del Bronzo di Coppa Nevigata, in: A. Gravina (ed.), Atti del 19o Convegno Nazionale sulla Preistoria – Protostoria – Storia della Daunia, San Severo, 27–29 novembre 1998, vol. I (San Severo 1999) 177–197.

Minniti 2005
C. Minniti, Shells at the Bronze Age settlement of Coppa Nevigata (Apulia – Italy), in: D. E. Bar-Yosef Mayer (ed.), Archaeomalacology. Molluscs in former Environments of Human Behaviour, Proceedings of the 9th Conference of International Council of Archaeozoology (Oxford 2005) 71–81.

Minniti 2008
C. Minniti, Resti di animali, in M. Albertoni – I. Damiani (eds.), Il Tempio di Giove e le origini del colle Capitolino (Rome 2008) 46–47.

Minniti 2012a
C. Minniti, Ambiente, sussistenza e articolazione sociale nell'Italia centrale tra Bronzo medio e Primo Ferro, British Archaeological Reports International Series 2394 (Oxford 2012).

Minniti 2012b
C. Minniti, La raccolta dei molluschi marini a Coppa Nevigata nell'età del Bronzo, in: A. Cazzella – M. Moscoloni – G. Recchia (eds.), Coppa Nevigata e l'area umida alla foce del Candelaro durante l'età del Bronzo (Foggia 2012) 367–388.

Minniti – Recchia 2018
C. Minniti – G. Recchia, New evidence on purple-dye production from the Bronze Age settlement of Coppa Nevigata (Apulia, Italy), in: M. S. Busana – M. Gleba – F. Meo – A. R. Tricomi (eds.), Textiles and Dyes in the Mediterranean Economy and Society, Proceedings of VI Purpurae Vestes International Symposium, 17–20 Ottobre 2016 (Zaragoza 2018) 87–98.

Pagliara – Rugge 2005
C. Pagliara – M. Rugge, Il Rinvenimento di tre Scheletri di Sus scrofa nell'Insediamento del Bronzo Finale di Roca (Melendugno – LE), in: G. Malerba – P. Visentini (eds.), Atti del 4º Convegno Nazionale di Archeozoologia (Pordenone 2005) 249–252.

Pagliara et al. 2005
C. Pagliara – M. Rugge – G. Marzano, I testudinati e l'Uomo nel Salento – Puglia, in: G. Malerba – P. Visentini (eds.), Atti del 4º Convegno Nazionale di Archeozoologia (Pordenone 2005) 267–272.

Pagliara et al. 2007
C. Pagliara – G. Maggiulli – T. Scarano – C. Pino – R. Guglielmino – J. De Grossi Mazzorin – M. Rugge – G. Fiorentino – M. Primavera – L. Calcagnile – M. D'Elia – G. Quarta, La sequenza cronostratigrafica delle fasi di occupazione dell'insediamento protostorico di Roca (Melendugno, Lecce). Relazione preliminare della campagna di scavo 2005 – Saggio SAS X, Rivista di Scienze Preistoriche 57, 2007, 311–362.

Pagliara et al. 2008
C. Pagliara – R. Guglielmino – L. Coluccia – I. Malorgio – M. Merico – D. Palmisano – M. Rugge – Minnone F., Roca Vecchia (Melendugno, Lecce), SAS IX. Relazione stratigrafica preliminare sui livelli di occupazione protostorici (campagne di scavo 2005–2006), Rivista di Scienze Preistoriche 58, 2008, 239–280.

Pizzarelli 2011–2012
A. Pizzarelli, Interazione uomo – ambiente nelle regioni del basso versante Adriatico della penisola italiana nel II millennio a.C. L'analisi archeozoologica come contributo alla ricostruzione dei paesaggi dell'età del Bronzo (PhD Diss., Università di Foggia, Foggia 2011–2012).

Recchia 2009
G. Recchia, Attività di scambio e sviluppi sociali a Coppa Nevigata (manfredonia-Puglia) durante la tarda età del Bronzo, in: E. Borgna – P. Càssola Guida (eds.), Dall'Egeo all'Adriatico. Organizzazioni sociali, modi di scambio e interazione in età postpalaziale (XII–XI sec. a. C.) / From the Aegean to the Adriatic. Social Organizations, Modes of Exchange and Interaction in Postpalatial Times (12th–11th c. BC), Atti del Seminario internazionale (Udine, 1–2 dicembre 2006), Studi e ricerche di protostoria mediterranea 8 (Rome 2009) 219–234.

Siracusano 1990
G. Siracusano, Un commento sugli ultimi Ritrovamenti Faunistici del Subappenninico di Coppa Nevigata, in: A. Gravina (ed.), Atti del 11 Convegno Nazionale sulla Preistoria – Protostoria – Storia della Daunia, San Severo, 2–3 Dicembre 1989 (San Severo 1990) 117–127.

Siracusano 1990–1991
G. Siracusano, Le Indagine Archeozoologiche nel Sito Stratificato di Coppa Nevigata. Una Visione d'Insieme, Origini 15, 1990–1991, 201–218.

Siracusano 2010
G. Siracusano, Agli Albori della Transumanza, in: G. Volpe – A. Buglione – G. De Venuto (eds.), Vie degli Uomini, Vie degli Animali. Transumanza e altri spostamenti di animali nell'Europa tardoantica e medievale (Foggia 2010) 37–50.

Siracusano 2012
G. Siracusano, La fauna degli scavi in estensione Puglisi-Palmieri 1972–1975 e le scelte nella dieta carnea degli abitanti del villaggio dell'età del Bronzo di Coppa Nevigata, in: A. Cazzella – M. Moscoloni – G. Recchia (eds.), Coppa Nevigata e l'area umida alla foce del Candelaro durante l'età del Bronzo (Foggia 2012) 235–243.

Tagliacozzo 1994
A. Tagliacozzo, I dati archeozoologici. Economia di Allevamento e Caccia a Broglio di Trebisacce, in: R. Peroni – F. Trucco (eds.), Enotri e Micenei nella Sibaritide l. Broglio di Trebisacce (Taranto 1994) 587–652.

Tagliacozzo 2000
A. Tagliacozzo, I dati archeozoologici, strategie di allevamento e caccia a Grotta della Madonna di Praia a Mare (CS) nel quadro del Neolitico, Eneolitico e Età del Bronzo dell'Italia Meridionale, Memorie dell'Istituto Italiano di Paleontologia Umana 6, 2000, 101–150.

Tagliacozzo – Curci 2001
A. Tagliacozzo – A. Curci, I Dati Archeozoologici: Allevamento e Caccia nell'Età del Bronzo, in: F. Trucco – L. Vagnetti (eds.), Torre Mordillo 1987–1990. Le relazioni egee di una comunità protostorica della Sibaritide, Incunabula Graeca 101 (Rome 2001) 347–418.

Tagliacozzo et al. 1989
A. Tagliacozzo – S. Scali – P. F. Cassoli, La Fauna della Grotta Cardini, Memorie dell'Istituto Italiano di Paleontologia Umana 4, 1989, 213–257.

Uerpmann 2002
H.-P. Uerpmann, Dental morphology of horses, donkeys and mules. Contribution to the workshop entitled 'Horse, Donkey and Co.' held in Basel, Switzerland 23rd–24th January 2002.

Coping with Changes: Social and Economic Developments at Coppa Nevigata during the 12th Century BC

Alberto Cazzella[1] *– Giulia Recchia*[2]

Abstract: The fortified settlement of Coppa Nevigata was mostly devoted to transmarine and overland exchange throughout the whole Bronze Age. Craft activities, such as the production of purple dye, were developed early at the site, possibly in relation with these external trades. Wider transformations in the Late Bronze Age Mediterranean scenario impacted on the Adriatic networks, yet Coppa Nevigata maintained an active role in the local and transmarine trades. During the Recent Bronze Age, particularly in the 12th century BC, the site experienced major changes concerning both the settlement's plan and the rise of specialised craft production, such as the flourishing of the locally based production of Aegean–Mycenaean-type pottery. These changes were doubtless related to deep socio-economic transformations of the resident community. Evidence from the extensive excavations at the site points to the emergence of an elite in this period, which was possibly responsible for the reshaping of the settlement's organisation.

Keywords: Coppa Nevigata, Late Bronze Age, transmarine exchange, craft production, emerging elites

Introduction

At the dawn of the 12th century BC, the Coppa Nevigata settlement already had a long history as a centre devoted to overland and transmarine exchange (Fig. 1).[3] According to our proposal for a phase sequence of the settlement, 1200 BC would approximately correspond to the passage between the Early and Late Subapennine (Recent Bronze Age 1 and 2).[4] In that period the settlement's plan was significantly reshaped, probably in response to ongoing socio-economic transformations of the resident community, which are also indicated by the increase in specialised craft production at the site.

We will examine old and fresh evidence from the settlement that points to these significant transformations.[5] Moreover, we will consider the extent to which major changes at a Mediterranean level affected the role played by Coppa Nevigata within the Adriatic exchange network.

Changes in the Settlement Organisation Possibly Related to the Arising of Social Inequalities

Starting from the late 13th century BC (RBA 1), the settlement layout underwent significant modifications in both the areas of the site that have been extensively explored: the northwest area (Puglisi's excavations 1972–1975) and the northeast area (current excavations).

1 'Sapienza' University of Rome, Department of Ancient World Studies, Italy; alberto.cazzella@uniroma1.it.

2 'Sapienza' University of Rome, Department of Ancient World Studies, Italy; giulia.recchia@uniroma1.it.

3 Apart from the occupancies preceding the Bronze Age, the long-lasting occupation of the site began around 1800 BC; Cazzella – Recchia 2012a.

4 Then it would indicatively correspond to the transition between LH IIIB and LH IIIC. The possible back-dating of this transition in the Aegean recently proposed by Wardle et al. 2014, which entails consequences for the South Italian Bronze Age chronology, appears at present to be inconsistent.

5 The manuscript of this paper was submitted in 2015 and discusses data acquired until then. Excavations at the site have continued, providing new pieces of evidence, some of which are briefly mentioned in the footnotes.

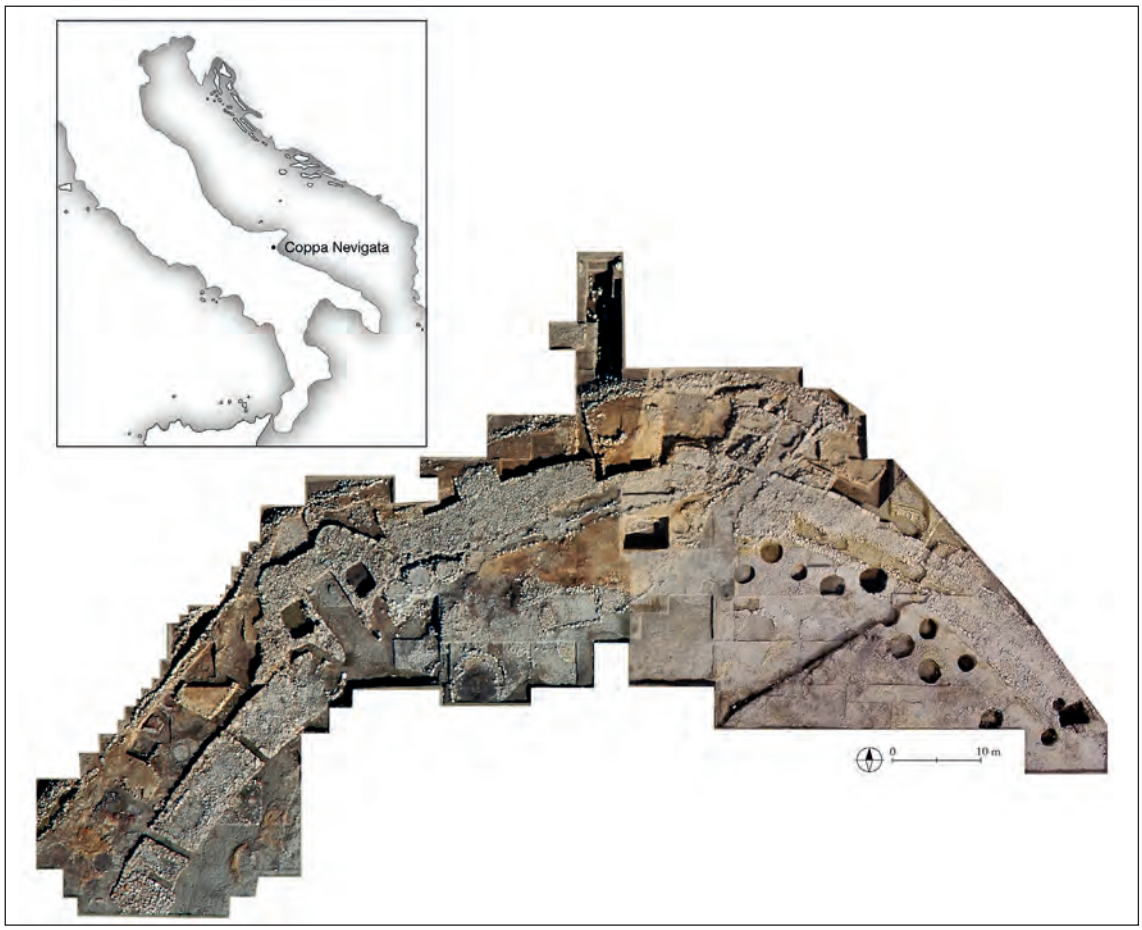


Fig. 1 The site of Coppa Nevigata at the end of the 2015 excavation season (aerial photos: A. V. Romano 2006, F. Nomi 2010 and B. Mandelli 2015)

Alas, at present there is no way to stratigraphically correlate the deposits unearthed during these two seasons of excavations, due to the destructive action perpetrated in 1979, when the landlord dug deep trenches in different parts of the site with the precise purpose of erasing the archaeological remains. This action resulted in the clearing of all the structures that had been brought to light up until then and the destruction of the archaeological deposits at different parts of the site.

Northwest Area

During the Late Subapennine (RBA 2) the northwest area of the settlement was characterised by a series of structures and open spaces neatly arranged along the south side of a narrow path running above the remains of the preceding defensive Apennine (MBA 3) dry-stone wall.

The most notable structure was constituted by two adjacent quadrangular rooms, probably pertaining to the same building, which dated to an early phase of the Late Subapennine (early 12th century BC, RBA 2A). Having been sealed up by a collapse resulting from a fire, these have yielded significant evidence, although they were only partially exposed.[6] The spatial distribution analysis has shown that each room was probably intended for different purposes: the northern for the storage of goods, and the southern for food processing and cooking.[7] The south room has yielded a large quantity of burned seeds, whose spatial distribution suggests that they were kept

6 These rooms were excavated in 1975; Cazzella – Recchia 2012a, 308, fig. 105.

7 Moscoloni et al. 2002.

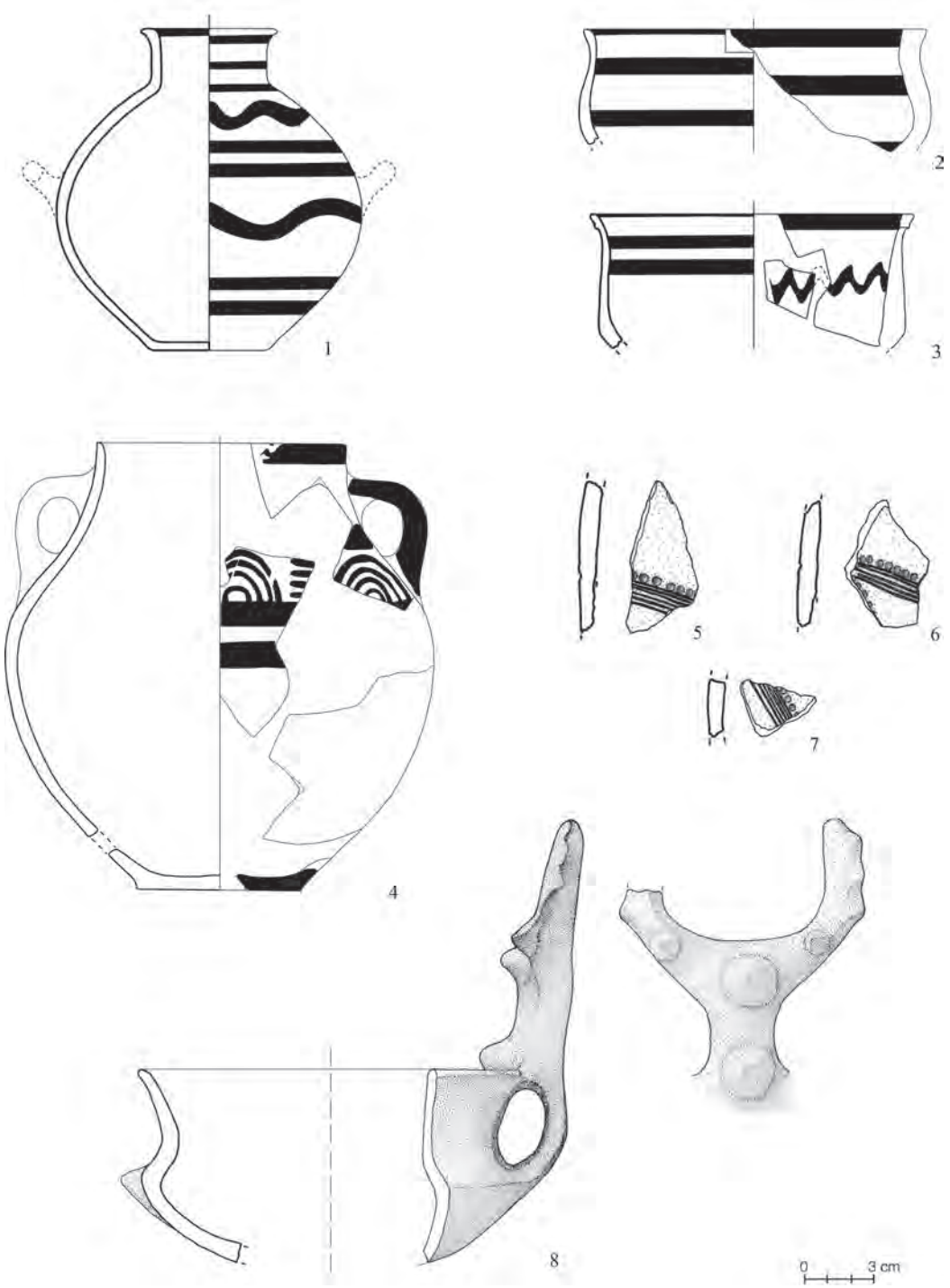


Fig. 2 Coppa Nevigata, pottery from the Recent Bronze Age layers. 1–4. Aegean–Mycenaean-type pottery; 5–7. local *impasto* pottery with Proto-Villanovan-type decorations; 8. local Late Subapennine bowl. Scale 1:3 (drawings: 1–4 M. Bettelli and L. Vagnetti; 5–8 G. Recchia)

in sacks and possibly stored in a loft.[8] Inside the same room three Mycenaean-type sherds have been found and a fourth was just outside it.[9] Given their fragmentary status in contrast with the occurrence of several local vessels broken on the spot, these sherds are most likely residual.

8 Coccolini 1987; Moscoloni et al. 2002.

9 Recchia 2012a, 438, fig. 7; Vagnetti et al. 2012, nos. 29–32.

A cobbled open space was revealed in the excavation trench located a few metres to the south of the one yielding the two-room structure. This open space, which appears to be slightly later than the structure itself, was provided with a clay oven located on the eastern edge of the trench and was bounded on the northwest side by the abovementioned narrow path and on the southeast side by an earthen floor, possibly pertaining to a hut.[10]

The spatial analysis has indicated that the space was mostly used for the consumption of food, while the faunal remains scattered around the clay oven possibly resulted from carcass processing.[11] The area has yielded some Mycenaean-type sherds and close to the oven there was a LH IIIC amphora broken on the spot (Fig. 2.4).[12] According to the results of archaeometric analyses, this was possibly imported from the Peloponnese,[13] although Lucia Vagnetti has argued that it may well be a local production considering its characteristics, such as the fabric, the poor rendering of the decoration and the matt quality of the painting.[14]

All in all, it seems probable that the open space was intended for 'feasting', involving more than one nuclear family, which also entailed the use of 'fine' pottery such as the Mycenaean-like vessels.

Northeast Area

Extensive excavations in the northeast area of the settlement, which began in 1983, have been providing critical data about the Recent Bronze Age Coppa Nevigata. It is now clear that substantial changes occurred starting from the second half of the 13th century BC (RBA 1B) that not only involved the settlement layout, but also the way in which resources were managed within the community.

Corroborative indication as regards this latter aspect is the evidence of household grain crop storage that recurs in various cases from the final phase of the Early Subapennine (RBA 1B) onwards. In fact, besides the abovementioned Late Subapennine (RBA 2A) two-room structure unearthed by Puglisi, large amounts of charred seeds have also been found in two domestic structures belonging to this phase, one located in the western sector of the northeast area[15] and the other, discovered in 2015, in the southern sector (Fig. 3). This evidence contrasts with that of collective storage in silos, which could supply the needs of more than one extended family, prevailing in the previous periods (between 16th and early 13th centuries BC, MBA 2–RBA 1A)[16] and appears to epitomise one of the symptomatic transformations of the Subapennine community.

As far as the spatial organisation of the settlement is concerned, it underwent substantial reshaping starting from the 13th century BC (RBA 1). The massive defensive dry-stone wall of the 14th century BC (MBA 3) seems to have lost most of its functionality, yet the entrance gate (the only gate to the settlement we know for these periods) was rebuilt just above the predating entrance. It is probable that a new defensive line of a different kind was built on the top of the predating wall's remains, as is also suggested by the pair of stone door sockets discovered at the sides of the doorway, meaning that the gate was inserted into a fence of some sort (either wooden and earth or dry-stone).

Deposits of crushed yellow limestone mixed with soil were intentionally accumulated against the inner face of the predating wall, forming two heaps, one to the east and one to the west of the gate. On the basis of the stratigraphic evidence, these appear to have been piled up in at least three stages, starting from the 13th century BC (RBA 1). Between the first and the second stages, a cur-

10 Moscoloni – Recchia 2012, 30, fig. 8; Moffa – Simei 2012.
11 Moscoloni et al. 2002.
12 Vagnetti et al. 2012, nos. 33, 38, 39.
13 Jones – Levi 2012; Jones et al. 2014, 139–142.
14 Vagnetti 2012, 425.
15 Cazzella – Recchia 2012a, 295.
16 Cazzella – Recchia 2013, 198.

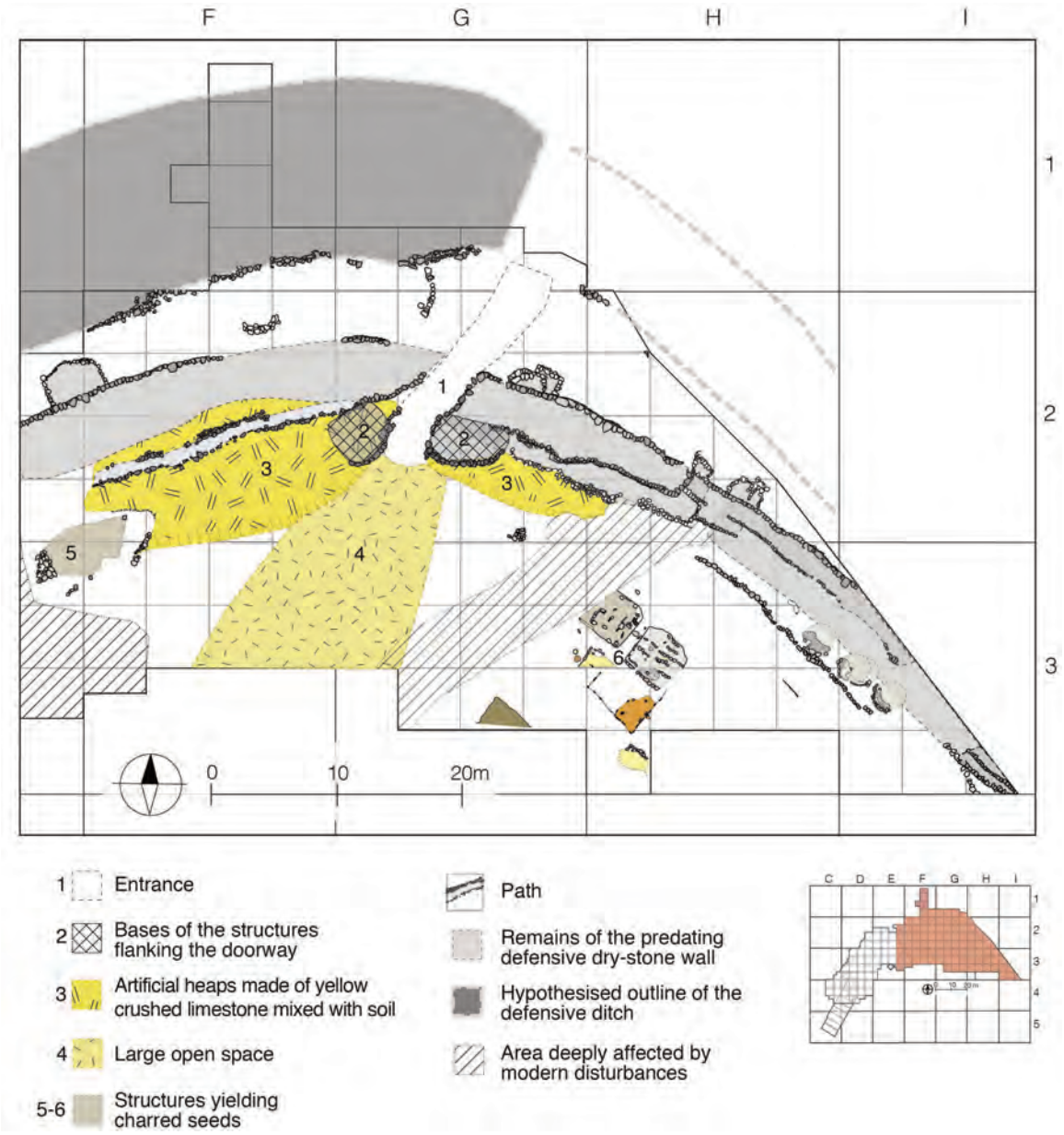


Fig. 3 Coppa Nevigata, map of the Subapennine (13th–12th centuries BC, RBA) features brought to light in the north-eastern area of the settlement – lower strata (graphics: G. Recchia)

vilinear wall constituted by a single line of stones, probably the base of a structure, was built near the gate on the top of the eastern heap and was then enlarged after the second stage, reaching a final extension of more than 20m². This structure, located as it was on a high spot close to the gate (or one of the gates) might have had a defensive purpose, yet it protrudes towards the settlement rather than outwards. The topmost layers of the western heap were wiped out by the destructive event in 1979, but some traces indicate that a corresponding building was probably located there and it is therefore likely that this pair of buildings was intended to monitor the entry to the settlement or, in any case, connected to it.

The western pile of limestone mixed with soil is quite extensive, forming an artificial mound whose northern side was bordered by a narrow path. It overlooked a large open space of more than 150m², located in front of the entrance gate and directly approachable from the little road crossing it. It is difficult to tell whether the mound had actually been settled by a specific kin group at this stage or if it was just used for communal purposes, along with the nearby open space. This latter,

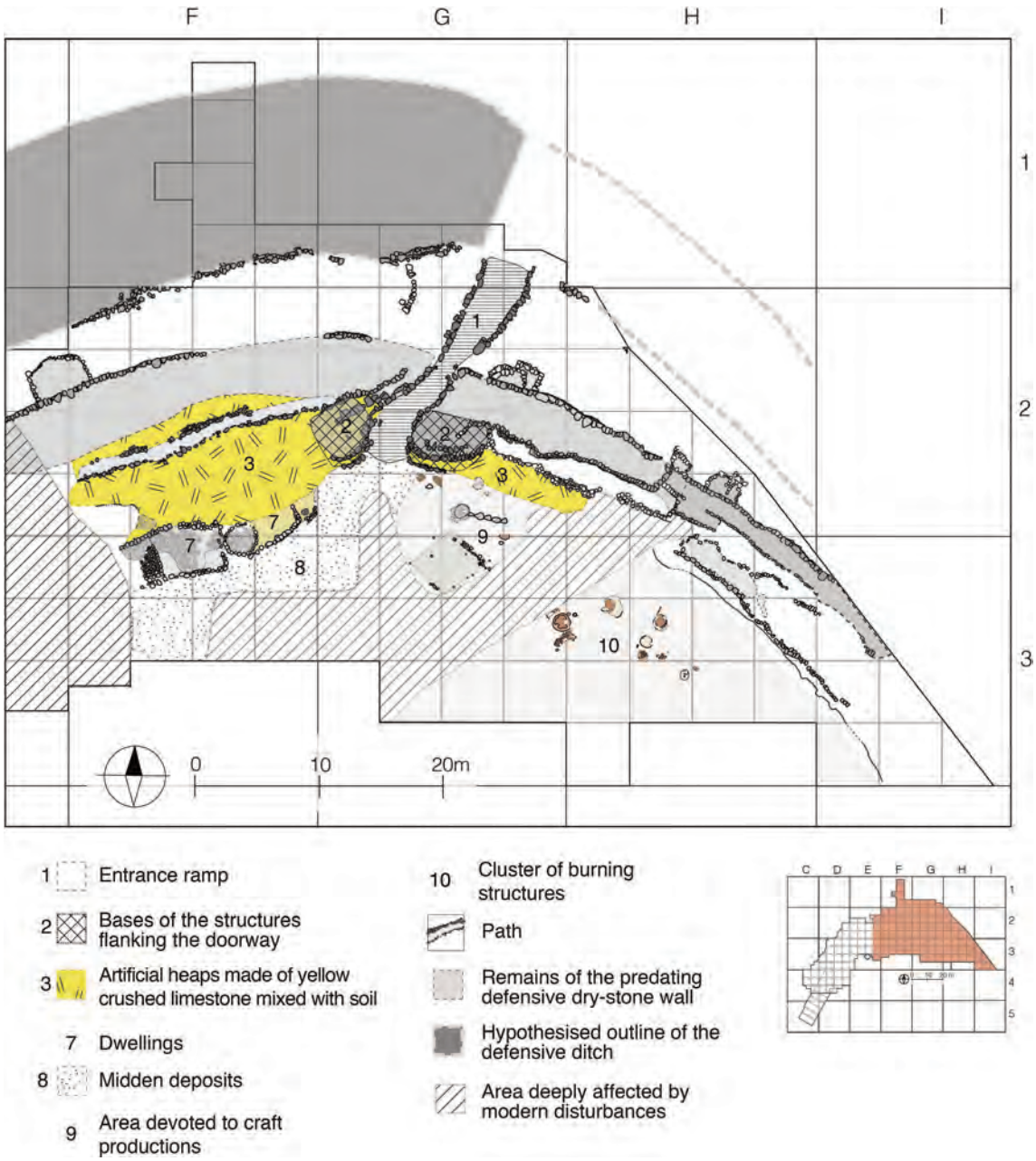


Fig. 4 Coppa Nevigata, map of the Subapennine (12th century BC, RBA 2) features brought to light on the north-eastern area of the settlement – upper strata (graphics: G. Recchia)

resembling a kind of 'square', was created in the late 15th century BC (MBA 3) and remained in use until the late 13th century BC (RBA 1B). It was floored several times,[17] yet it was kept 'empty' (or at least free of detectable structures) throughout two centuries of use and its level remained lower than that of the surrounding areas. The actual function of this space is difficult to figure out. Quite possibly it served for collective purposes, perhaps related to exchange activities or symbolic practices, if not to both.[18]

17 The techniques adopted for the floorings differed through time. During the Apennine (14th century BC, MBA 3) these were made of cobbled layers, while in the Early Subapennine (13th century BC, RBA 1) they were made of layers of the same crushed yellow limestone mixed with soil that was used for the artificial accumulations near the gate.

18 Cazzella – Recchia 2015, 63.

On the southern slope of the western artificial 'mound' some structures were built during the final stage of the piling up process, approximately at the beginning of the Late Subapennine era (early 12th century BC, RBA 2A). In particular, two joined rectangular rooms and a small hearth located just outside the eastern room are recognisable (Fig. 4.7).[19] We tend to think that these were part of the same building, which, given its distinctive location, was probably the residence of an emerging kin group. In any case, at this stage the mound seems to have definitely become a dwelling place. As mentioned above, the topmost layers of the 'mound' are not preserved, so we have no data about the existence of further buildings on this spot, which is nonetheless conceivable.

We would suggest a scenario in which a specific kin group took possession of an area of the settlement that was strategic on both a practical and a symbolical level, with the purpose of emphasising their prominent social position. The hypothesis that the Late Subapennine mound's dwellers also occupied the abovementioned couple of structures flanking the gate is tempting, but unfortunately there is no supporting evidence for it.

To the south of the eastern pile of crushed yellow limestone there is an area provided with some facilities that were likely intended for craft activities. This, in fact, has yielded both complete artefacts, especially adornments, and in-work antler and bone objects (see next paragraph).

From the early 12th century BC onwards (RBA 2A), concurrently with the dwelling on the slope of the 'mound', the large open space (or 'square') began to be filled up with extended deposits characterised by burnt patches, probably deriving from dumping. These, in fact, are kind of midden deposits, containing a lot of organic remains (charcoals, seeds and animal bones) possibly resulting from the preparation and consumption of food, as well as ceramic sherds, among which a number of pieces of locally produced Aegean-Mycenaean-type pottery stand out (e.g. Fig. 2.1–3).

The deposition process of the midden layers, whose precise duration is difficult to determine but did not extend beyond the 12th century, eventually resulted in the complete filling of the gap between the ground level of the 'square' and that of the contiguous areas, with a stratigraphic depth of c. 0.50m.

The drastic shift in the pattern of use of the 'square', or rather its complete obliteration, is perhaps the major change that occurred in the 12th century BC (RBA 2), entailing not only a transformation in the topographic organisation of the settlement, but also a socio-ideological turning point.

Having said that, although garbage disposal inside the settlement might not have been perceived as bothersome as it is today, the occurrence of deposits related to dumping activities near the entrance of the settlement, 'invading' a former communal space, deserves more thorough investigation.

In all likelihood, these deposits resulted from both the activities carried out in the close vicinity of the abovementioned two-rooms building[20] and reiterated disposals of 'waste' coming from repeated activities,[21] implying the use of fire and probably food consumption.

A cluster of burning structures has been revealed in an area located to the southeast of the former open space filled up by midden deposits (Fig. 4.10). The cluster, covering a space of c. 80m², includes the remains of eight sub-circular clay hearths and a small clay oven, which are spatially divided into two groups according to their size (and possibly specific function): four medium-sized clay hearths (with diameters of c. 1.5m) to the west, and four small-sized ones

---

19 Cazzella – Recchia 2012a, 296–298, figs. 87–89. Recently the spatial analysis of this area has been carried out taking into consideration the spatial distribution of both artefacts and ecofacts. This has provided precious information on the patterns of activities performed there (Recchia et al. in press).

20 See above n. 19.

21 It is worth noticing that these midden deposits have also yielded five human bones that pertain to different individuals, as they differ in age and gender, showing traces of post-mortem manipulation (namely one burned pelvis fragment of a female, one burned cranium fragment of a young male with fresh traces of cuts, one cranium fragment of an adult male, one metatarsal of a juvenile and one metacarpal of an adult). We tend to think that these were related to symbolic practices entailing the manipulation of skeletal parts, which had a long tradition at Coppa Nevigata (Recchia 2012b).

(with diameters of c. 0.90m) plus the small oven (1.2m in diameter) to the east. The clay hearths of both sizes are made of a layer of potsherds resting on a pure clay bed and enclosed by a whitish clay kerb. In various cases, a new structure was superimposed directly over a pre-existing one.[22]

Despite these structures testifying to a set of actions related to food preparation and perhaps consumption, the deposits extending over and near this cluster were far less rich in both organic remains and ceramic sherds (including Italo-Mycenaean sherds) than the abovementioned midden deposits.

Unfortunately, a direct stratigraphic correlation between the two areas has been made impossible owing to the gap caused by the destructive action perpetrated in 1979. Nevertheless, on the grounds of the pottery types occurring in both areas these are likely to be coeval.

From an interpretive point of view, the two situations appear to be somehow complementary. In fact, the cluster of burning structures exemplifies a place devoted to the collective preparation and consumption of food and drink, perhaps related to feasting.[23] On the other hand, the relatively small presence of organic remains and sherds may imply that the resulting waste was disposed of somewhere else.

In any case, the functional shift of the former large open space also implies that the patterns of activities that were once carried out there were moved elsewhere and/or managed differently. Had these activities encompassed collectively managed exchange, this latter would no longer have taken place on this spot and perhaps would have become controlled by specific kin groups.

Following this hypothesis, the concurrence between the building of (private) dwellings on the artificial mound and the functional shift of the large open space might not have happened by chance, as it might have entailed a synchronicity between the emergence of a specific kin group and the end of exchange activities in a collective area. In this scenario, a distinctive kin group, whose power was increasing, settled on the artificial mound and 'privatised' a former communal area of the settlement. From then on, exchange within the community and with external partners would have been progressively controlled by this group, which, at the same time would have promoted feasting in order to enhance its own power. (G. R.)

Changing Organisation and Scale of Craft Production

Some kinds of production that required specific knowledge of the process appear to have occurred at Coppa Nevigata over the preceding centuries, yet these developed decisively from the 12th century BC (RBA 2) onwards.

A production that seems to distinguish Coppa Nevigata from the coeval southern Italian sites is that of purple dye, which requires not only the local availability of Murex shells but also some technical knowledge. This production, which possibly involved the whole community rather than a few specialised individuals, emerged at the site as far back as the 18th century BC (late Early Bronze Age), had its peak in the 15th–14th centuries BC (MBA 2–3) and then a sharp decrease from the 13th century BC (RBA 1) onwards (Fig. 5A).[24] At present, it is difficult to say whether this trend is affected by a bias in the archaeological record (for instance, during the RBA crushed Murex shells could have been disposed of in some areas of the settlement that have yet to be excavated), or whether it reflects an actual decline in this production, possibly due to a decreasing demand for purple dye from the Mycenaeans.[25]

---

22 In 2017 a peculiar structure has been brought to light to the south-east of this cluster of burning structures. It is horseshoe-shaped and defined by a clay bench with a series of raw clay rings. Inside the semicircle, the structure was provided with a clay hearth. Various fragments of portable clay ovens lay on the surface of this installation (Cazzella – Recchia 2018a). In all likelihood, this structure too was devoted to the preparation of collective meals.

23 Hayden 2001.

24 Minniti 2012; Minniti – Recchia 2018; Minniti, this volume.

25 Cazzella et. al. 2004.

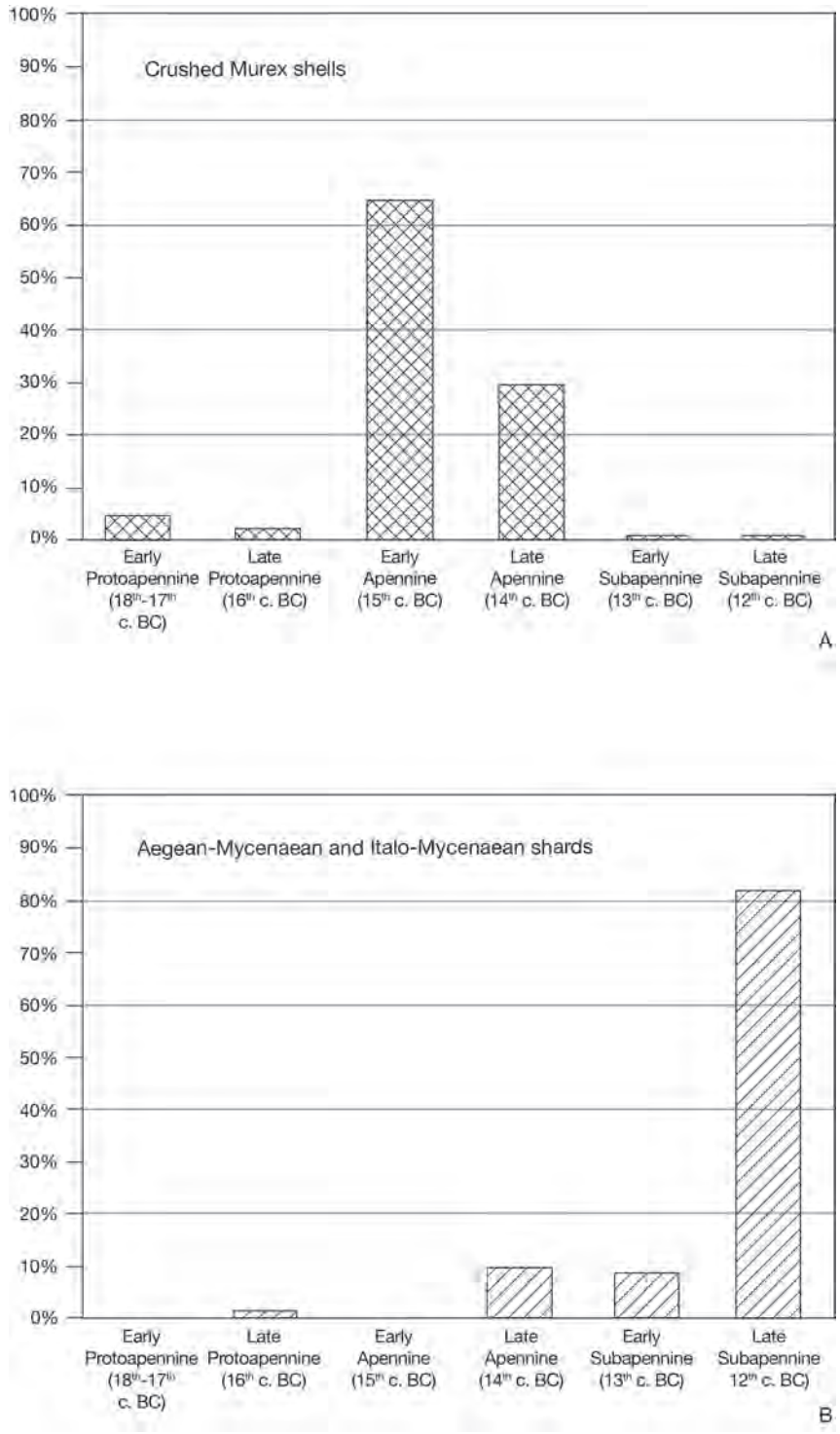


Fig. 5 Coppa Nevigata, frequency distribution of crushed murex shells (A) and Aegean–Mycenaenan-type pottery (B) across the various periods (graphics: C. Minniti, G. Recchia)

By contrast, the production of Italo-Mycenaean pottery at the site appears to take off in the late Recent Bronze Age (Fig. 5B).[26] As is well known, the local production of Italo-Mycenaean pottery, which started in MBA 3, spread over the whole of southern Italy and beyond during the RBA, and

[26] Vagnetti 2012; Vagnetti et al. 2012.

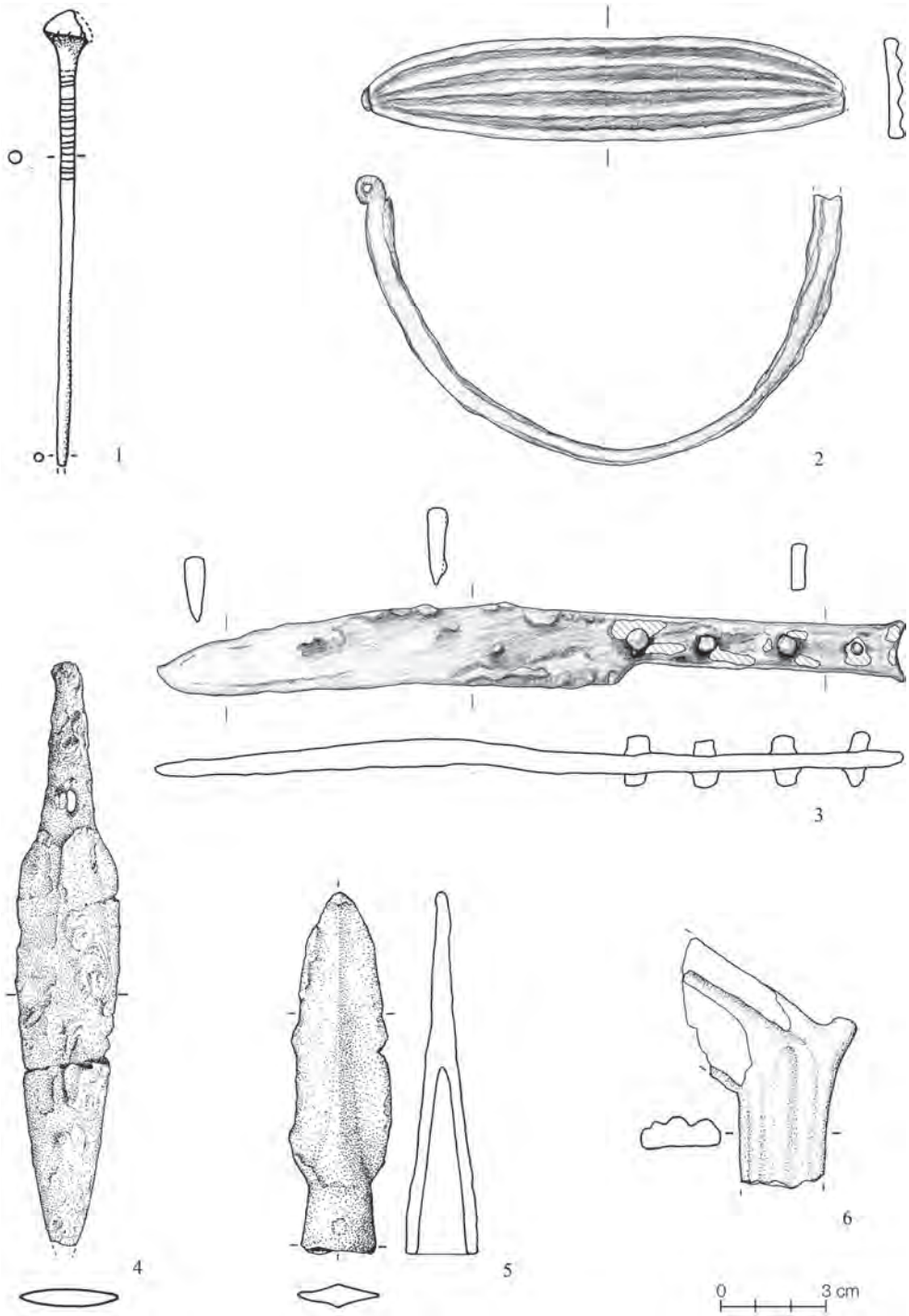


Fig. 6 Coppa Nevigata, Recent Bronze Age bronze artefacts. 1. Biandronno-type pin (Naples museum); 2. necklace decorated with a series of parallel ribs from the ongoing excavations in the northeastern area; 3. knife of type Scoglio del Tonno from the ongoing excavations in the northeastern area; 4. dagger of type Torre Castelluccia from Puglisi's excavations; 5. spearhead of type Pila del Brancòn from the ongoing excavations in the northeastern area, 6. Muscoli-type sickle from Quagliati's excavations. Scale 1:2 (drawings: 1, 6 modified from Belardelli 2004; 2–3 G. Recchia; 4–5 C. Placidi)

therefore Coppa Nevigata does not represent an exception in that respect.[27] Yet, the southern Apulian sites where this local production flourished generally had a prior well-established tradition of

[27] Jones et al. 2014, 15–16.

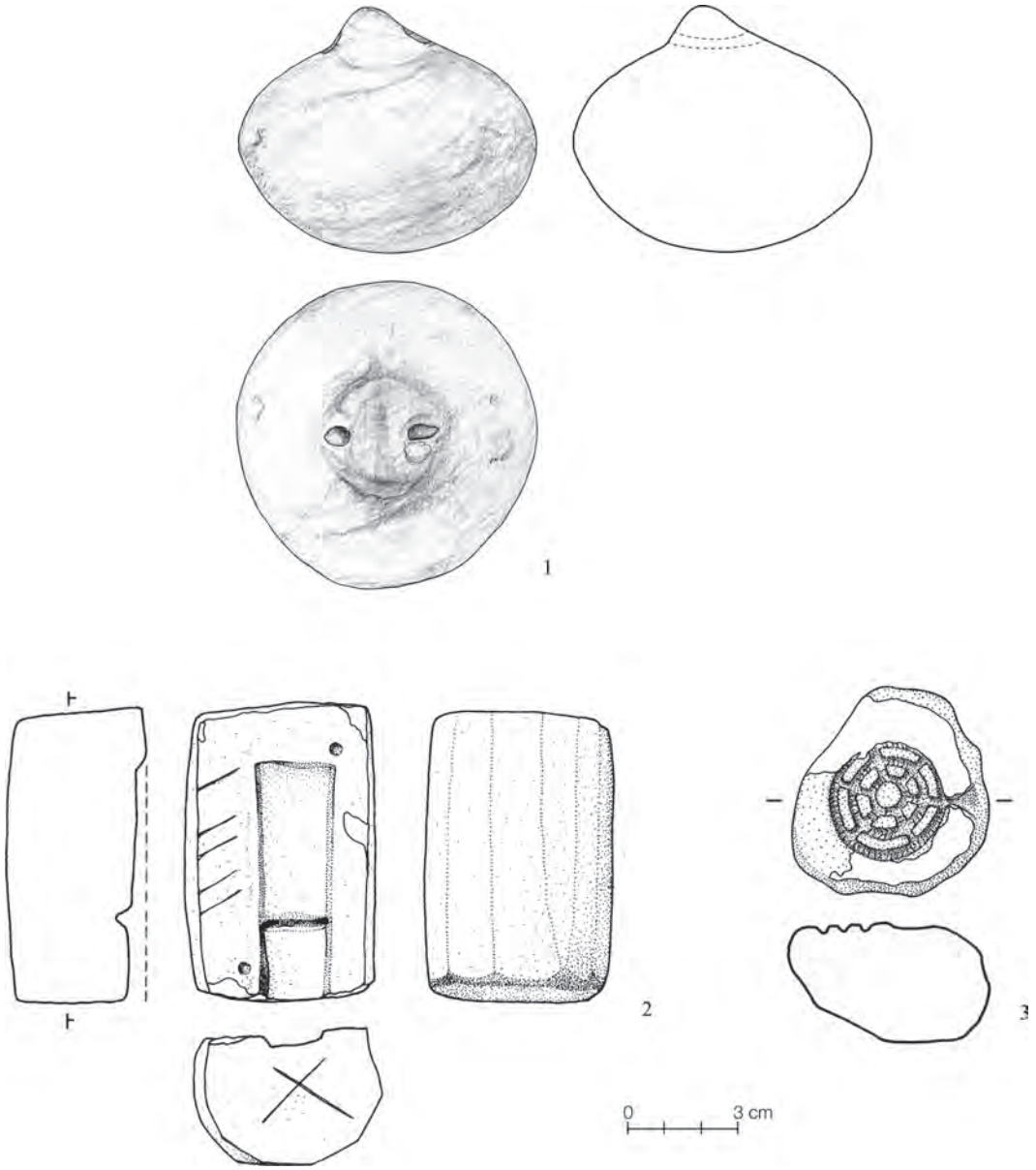


Fig. 7 Coppa Nevigata, Recent Bronze Age stone weight and stone moulds. 1. rounded stone weight perforated for suspension at the top from the ongoing excavations on the northeastern area; 2. stone mould from Mosso's excavations; 3. stone mould from the ongoing research. Scale 1:2 (drawings: 1, 3 G. Recchia; 2 modified from Belardelli 2004)

Aegean-Mycenaean pottery imports,[28] whereas, at Coppa Nevigata (and in northern Apulia in general) only a few sherds of this kind occur in Apennine–Early Subapennine layers (MBA 3–RBA 1),[29] as if the communities of this area had little interest in this exotic pottery.[30] This might imply that at the dawn of the 12th century something changed, as the demand for this alluring item rose sharply. The local manufacturing of wheelmade figulina pottery is strictly related to the vexed question of how local potters acquired the knowledge to produce such refined pottery. Given the absence of any evidence related to stable foreign presences at Coppa Nevigata, we tend to think that, at least in this case, no Aegean potters settled there. Indigenous craftsmen might well have mastered the

28 E.g. Roca Vecchia, S. Sabina and Scoglio del Tonno: Jones et al. 2014, 144, 146–147, 153–158.
29 Recchia 2012a.
30 Radina – Recchia 2006.

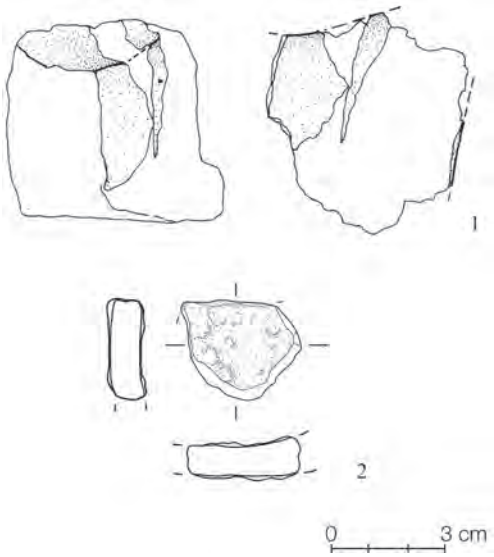


Fig. 8 Coppa Nevigata, metal fragments possibly pertaining to ingots. 1. Fragment that may be interpreted as part of an ox-hide ingot, coming from the dig related to the reclaiming of the lagoon; 2. fragment from Puglisi's excavations in the northwest area of the settlement. Scale 1:2 (1 modified from Belardelli 2004; 2 drawing G. Recchia)

production of Italo-Mycenaean vessels and over time become full-time specialised potters. R. Jung has recently suggested a specific model of interaction between indigenous and Aegean potters.[31]

The occurrence of bronze artefacts becomes substantial in the late Recent Bronze Age deposits (Fig. 6).[32] Moreover, it is to this period that pieces of evidence pointing to the local production of metal objects can be dated, such as the presence of both limestone moulds (Fig. 7.2–3) and metal fragments possibly pertaining to ingots (Fig. 8; a peculiar fragment possibly pertaining to an ox-hide ingot is discussed in detail in the next paragraph).[33] These traces also refer to the presence at the site of locally based specialised bronze workers.

Bone and antler manufacturing possibly developed into a specialised activity in this period as well (Fig. 9). For instance, as mentioned above, the area localised just to the south of the eastern pile of crushed yellow limestone has yielded a group of semi-finished bones showing traces of metal saw cuts. In the same area, various types of ornaments made of different raw materials (metal, rock crystal quartz and perhaps ivory) and a rounded stone weight have also been found (Figs. 7.1; 9.4; 10),[34] which lead to the hypothesis that composite adornments were manufactured and/or assembled there, as probably happened at other coeval or slightly later sites, such as Roca, Moscosi di Cingoli, Scarceta and Maccarese.[35]

This overall increase in craft production at the site may well be related to an upsurge in the role Coppa Nevigata played as a functionally distinct centre devoted to these activities. The rise of a social hierarchy within the community could have favoured this trend, yet this does not necessarily imply that the site had established political territorial control. In fact, at present there is no evidence in Recent Bronze Age northern Apulia of a settlement pattern based on central places surrounded by satellite settlements. On the contrary, long-lasting major settlements, usually located on the coast or at high spots overlooking trade routes, appear to be topographically separated from clusters of hamlets, commonly located inland.[36]

31 Jung 2005, 59–60.
32 Cazzella 2012.
33 Recchia 2009; Cazzella 2012.
34 Cazzella – Recchia 2016.
35 Poggiani Keller et al. 2002; Sabbatini – Silvestrini 2005; Bietti Sestieri 2008, 32–33; Pagliara et al. 2008, 267–268; Maggiulli 2009; Ruggeri et al. 2010.
36 Cazzella – Recchia 2017b.

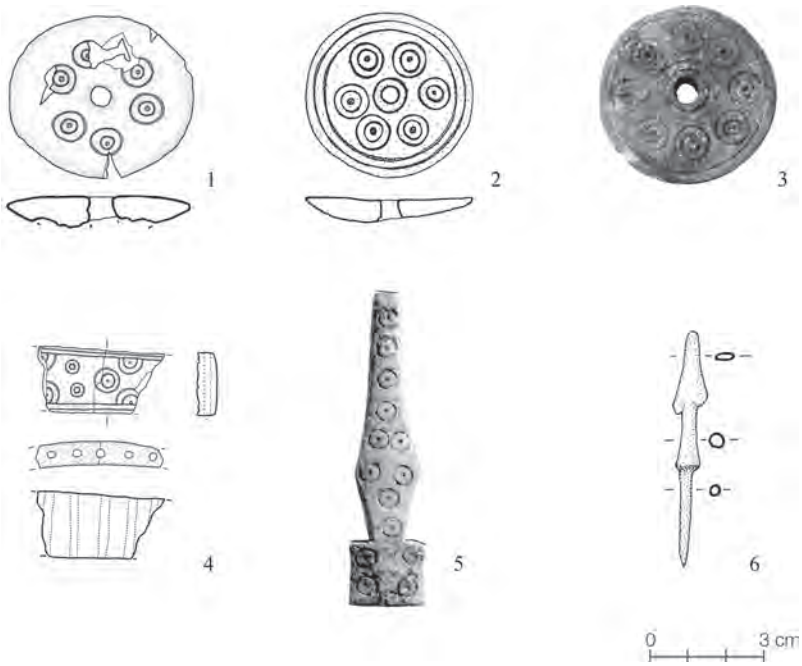


Fig. 9 Coppa Nevigata, Recent Bronze Age antler and bone artefacts. 1–3. incised round-shaped ornaments from the ongoing excavations on the northeastern area; 4. decorated necklace spacer, possibly made of ivory, from the ongoing excavations in the northeastern area; 5. decorated grip from Puglisi's excavations, 6. arrowhead with elongated stem from Puglisi's excavations. Scale 1:2 (1–2, 4, 6 drawings G. Recchia; 3 photo G. Recchia; 5 photo F. Scarpelli)

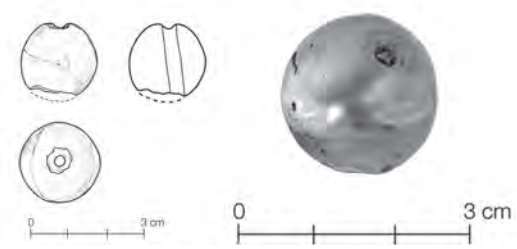


Fig. 10 Coppa Nevigata, Recent Bronze Age rock crystal bead from the ongoing excavations on the northeastern area (drawing and photo: G. Recchia)

Exchange Activities

The role played by Coppa Nevigata in managing external exchange has a long history too, and in this respect the site might not have actually grown in importance after 1200 BC.

The site maintained exchanges with various cultural and geographic regions that are indicated by the circulation of artefacts and raw materials, besides the stylistic similarities with pottery productions across quite an extended territory.

As far as metallurgic production is concerned, the rise of a 'metallurgical koiné' encompassing the Italian peninsula and the eastern Mediterranean is a well-known phenomenon. Nevertheless, on closer investigation some regional differences are detectable for the circulation of specific models and objects, which suggest that preferential contacts were established between certain areas.[37]

[37] Some discussions of the relationships between northeastern Italy and the eastern Mediterranean are presented in Cassola Guida 1999 and Jung 2009, 73–74, 89 fig. 1.

As for pottery production, close comparisons can, in particular, be drawn with pottery assemblages from Recent Bronze Age sites in Molise and southern Apulia/the Ionic gulf, such as Oratino, [38] Porto Perone and Termitito, whereas the similarities with pottery from sites such as Canosa and Roca appear to be limited, but this might be due to the patchy distribution of sites sharing similar cultural traits that characterise southeastern Italy during the late 13th–12th centuries BC (RBA 1 and 2).[39] Some of the metal artefacts occurring at Coppa Nevigata, namely Scoglio del Tonno-type knives and Torre Castelluccia-type daggers (Fig. 6.3–4), also exemplify connections with southern Apulian centres.

Differentiated exchanges with further regions are testified to by an array of goods. Tight relationships with the *terramare* area and Marche are illustrated by antler and bone artefacts, such as incised round-shaped ornaments and grips and arrowheads with elongated stems (Fig. 9),[40] and the abovementioned sub-spherical stone weight perforated for suspension at the top (Fig. 7.1).[41] Amber and amber beads (i.e. the Tiryns-type bead)[42] were possibly acquired from Veneto (perhaps via *terramare*). Metal weapons (i.e. the Pila del Brancòn-type spearhead, Fig. 6.5) and ornaments (i.e. Biandronno-type pin, Fig. 6.1)[43] are also related to contacts (direct or mediated) with Veneto and Lombardia. Moreover, the Proto-Villanovan-type decoration occurred at Coppa Nevigata as far back as the 12th century BC (RBA 2) (Fig. 2.5–7)[44] and was possibly conveyed here through the mediation of the Italian northeastern or central-eastern centres with which the site was in contact.

Connections with the eastern Adriatic coast were still flourishing during the Late Bronze Age too, as parallels between various metal artefacts from Coppa Nevigata and northeastern Adriatic and Balkan sites, ranging from ornaments to tools and weapons (Fig. 6.2, 6), would indicate.[45]

In addition to the small number of Aegean–Mycenaean vessels that are likely to have been imported, other goods, including rock crystal and perhaps ivory and copper,[46] possibly came from the Eastern Mediterranean.

It is now widely accepted that from the 12th century BC onwards (if not earlier), Cypriot–Levantine sailors ventured into the Adriatic corridor and directly reached the northwestern Adriatic centres (i.e. Fondo Paviani, Frattesina and perhaps Campestrin di Grignano Polesine – where Tiryns-type amber beads were manufactured).[47] This might imply, however, that southwestern Adriatic settlements decreased in importance as intermediary centres in the exchange network between eastern Italy and the eastern Mediterranean,[48] a role they certainly played within the Mycenaean connection. This notwithstanding, coastal Apulian settlements doubtless maintained an active role in transmarine exchange, and Cypriot–Levantine sailors probably visited them. A possible piece of evidence supporting this hypothesis is a fragment of a peculiar metal object coming from the dig carried out at Coppa Nevigata in relation to the reclaiming of the lagoon[49] that may be interpreted as part of an oxhide ingot (Fig. 8.1).[50]

---

38 Copat – Danesi 2017.

39 Cazzella – Recchia 2017a, 460–463, fig. 3.

40 Bernabò Brea – Cardarelli 1997, figs. 190.14, 195.5, 204.2; Provenzano 1997, 531, figs. 295.13, 298.9; Pasquini 2005; Cupitò 2006, fig. 22; Recchia et al. 2010, 302.

41 Cardarelli et al. 1997, 636.

42 Bellintani 2010, 145.

43 Belardelli 2004, 98, fig. 34.1; Jung – Mehofer 2012.

44 Cazzella – Recchia 2012b, pls. 19.9–17; 36A.

45 In particular, a bronze necklace decorated with a series of parallel ribs, a bracelet with spiral-shaped end, a Muscoli-type bronze sickle and a Pazhok-type spearhead all belonging to the Recent Bronze Age occur at Coppa Nevigata. Cazzella – Recchia 2016; Cazzella – Recchia 2018b.

46 Cazzella – Recchia 2016.

47 Cassola Guida 1999; Bettelli et al. 2015; Bellintani et al. 2015; Bietti Sestieri et al. 2015.

48 Cazzella 2009; Borgna 2013, 137–138.

49 C. Belardelli suggested that this was a fragment of an anvil (Belardelli 2004, 101, fig. 35.21).

50 Cazzella 2012, 190.

What still remains an open problem is the provenance of the metal used at Coppa Nevigata. Lead isotope analysis carried out on a Pila del Brancòn-type spearhead (Fig. 6.5)[51] has indicated that the raw material is not compatible with Trentino sources,[52] while it is close to Cypriot copper, although not completely compatible with it because of its trace element pattern.

Concluding Remarks

Ongoing socio-economic transformations of the community inhabiting Coppa Nevigata during the RBA left good archaeological traces. The settlement layout was significantly reshaped over this period and in the 12th century BC it appears to have been definitely renovated with the complete conversion of the former large open space that had probably served public purposes and the construction of domestic building(s) on the artificial mound piled up near the gate.

The settlement plan now included some areas possibly intended for feasting (or in any case for food preparation/consumption involving a number of inhabitants), which differ in size and position. In one case (the northwestern sector of the settlement), a relatively small space of this kind interposes the dwellings and could have been related to the family units living in this specific area, while in the northeastern sector a far wider space seems devoted to these activities, possibly fostered by the elite group. It is in this period, in fact, that the establishing of a social hierarchy at the site is conspicuous.

One of the symptomatic transformations of the RBA community is the evidence of crop storage inside domestic structures rather than in communal spaces, which took place from the late 13th century BC onwards. We are inclined to think that the tendency towards an increasing social relevance of nuclear families might have been correlative to the gradual emergence of elite groups.[53] In fact, a growing division within kin groups can be associated with the rising of economic inequality between families. Both demographic 'success', related to the number of children and the longevity of family members, and economic 'success', deriving from harvest and breeding fluctuations, might well result in an imbalance between the various families. Nevertheless, the demographic/economic factor in itself may not suffice to explain a phenomenon such as the 'privatisation' of critical areas of the settlement (i.e. the artificial mound close to the settlement's gate and the adjoining open space). It is likely that the emerging family group (or kin group) that was allowed to inhabit the artificial mound and possibly to manage the activities carried out in the surrounding spaces had achieved social recognition. Moreover, this group might have stood out from the rest because its size was larger than that of average families.

Wider transformations that were taking place in the Mediterranean during the 12th century BC (RBA 2) apparently did not negatively affect Coppa Nevigata, or, at least, they did not hamper the rise of a social hierarchy and the flourishing of specialised craft production. Nevertheless, the mutated scenario of transmarine networks must have caused the site to adapt to new equilibriums. The possible direct arrival of Cypriot–Levantine sailors in the northern Adriatic, for instance, might have resulted in the site losing its role as a hub between the northern and the southern Adriatic centres. Yet, it appears that Coppa Nevigata maintained an active role in exchange activities at both overland and transmarine levels, as testified by the occurrence of artefacts and raw materials of different kinds and origins encompassing various cultural and geographic regions, besides the affinities with pottery productions covering a more extended area. (A.C.)

Acknowledgements: We are indebted to R. Jung for his useful comments on the draft of this paper.

[51] Jung et al. 2011, 242; Jung – Mehofer 2012.

[52] Therefore, this spearhead was manufactured at the site, rather than imported from northern Italy.

[53] Cazzella – Recchia 2013, 203.

Bibliography

Belardelli 2004
C. Belardelli, Coppa Nevigata. Materiali da scavi e rinvenimenti 1903–1909, Grandi contesti e problemi della Protostoria italiana 8 (Florence 2004).

Bellintani 2010
P. Bellintani, Ambra, una materia prima dal Nord (ma non solo), in: Radina – Recchia 2010, 141–146.

Bellintani et al. 2015
P. Bellintani – L. Salzani – G. de Zuccato – M. Leis – C. Vaccaro – I. Angelini – C. Soffritti – M. Bertolini – U. Thun Hohenstein, L'ambra dell'insediamento della tarda Età del bronzo di Campestrin di Grignano Polesine (Rovigo), in: Leonardi – Tinè 2015, 419–426.

Bernabò Brea – Cardarelli 1997
M. Bernabò Brea – A. Cardarelli, Le terramare nel tempo, in: Bernabò Brea et al. 1997, 295–378.

Bernabò Brea et al. 1997
M. Bernabò Brea – A. Cardarelli – M. Cremaschi (eds.), Le Terramare. La più antica civiltà padana (Milan 1997).

Bettelli et al. 2015
M. Bettelli – M. Cupitò – S. T. Levi – R. Jones – G. Leonardi, Tempi e modi della connessione tra mondo egeo e area padano-veneta. Una riconsiderazione della problematica alla luce delle nuove ceramiche di tipo miceneo di Fondo Paviani (Legnago, Verona), in: Leonardi – Tinè 2015, 377–387.

Bietti Sestieri 2008
A. M. Bietti Sestieri, L'età del Bronzo finale nella penisola italiana, Padusa 44, 2008, 7–54.

Bietti Sestieri et al. 2015
A. M. Bietti Sestieri – P. Bellintani – L. Salzani – I. Angelini – B. Chiaffoni – J. De Grossi Mazzorin – C. Giardino – M. Saracino – F. Soriano, Frattesina. Un centro internazionale di produzione e di scambio nell'Età del bronzo del Veneto, in: Leonardi – Tinè 2015, 427–436.

Borgna 2013
E. Borgna, Di periferia in periferia. Italia, Egeo e Mediterraneo orientale ai tempi della koinè metallurgica. Una proposta di lettura diacronica, Rivista di Scienze Preistoriche 63, 2013, 125–153.

Borgna – Càssola Guida 2009
E. Borgna – P. Càssola Guida (eds.), Dall'Egeo all'Adriatico. Organizzazioni sociali, modi di scambio e interazione in età postpalaziale (XII–XI sec. a. C.) / From the Aegean to the Adriatic. Social Organizations, Modes of Exchange and Interaction in Postpalatial Times (12th–11th c. BC), Atti del Seminario internazionale (Udine, 1–2 dicembre 2006), Studi e ricerche di protostoria mediterranea 8 (Rome 2009).

Cardarelli et al. 1997
A. Cardarelli – M. Pacciarelli – P. Pallante, Pesi da bilancia nell'età del Bronzo?, in: Bernabò Brea et al. 1997, 629–642.

Cassola Guida 1999
P. Cassola Guida, Indizi di presenze egeo-orientali nell'Alto Adriatico alla fine dell'età del bronzo, in: V. La Rosa – D. Palermo – L. Vagnetti (eds.), επί πόντον πλαζόμενοι. Simposio Italiano di Studi Egei dedicato a L. Bernabò Brea e G. Pugliese Carratelli, Roma, 18–20 febbraio 1998 (Rome 1999) 487–497.

Cazzella 2009
A. Cazzella, Exchange Systems and Social Interaction during the Late Bronze Age in the Southern Adriatic, in: Borgna – Càssola Guida 2009, 159–169.

Cazzella 2012
A. Cazzella, I manufatti in metallo dagli scavi in estensione 1972–75 a Coppa Nevigata, in: Cazzella et al. 2012, 185–192.

Cazzella – Recchia 2012a
A. Cazzella – G. Recchia, Un trentennio di nuove ricerche a Coppa Nevigata. L'organizzazione dell'abitato e i sistemi di difesa durante le varie fasi dell'età del Bronzo, in: Cazzella et al. 2012, 246–318.

Cazzella – Recchia 2012b
A. Cazzella – G. Recchia, La ceramica d'impasto degli scavi in estensione 1972–1975. Analisi tipologica e confronto con i dati dagli scavi 1955–1971, in: Cazzella et al. 2012, 47–157.

Cazzella – Recchia 2013
A. Cazzella – G. Recchia, The human factor in the transformation of southern Italian Bronze Age societies. Agency Theory and Marxism reconsidered, Origini 35, 2013, 191–209.

Cazzella – Recchia 2015
A. Cazzella – G. Recchia, Spazi aperti e strade a Coppa Nevigata durante l'età del Bronzo alla luce delle più recenti scoperte, Scienze dell'Antichità 21, 1, 2015, 49–67.

Cazzella – Recchia 2016
A. Cazzella – G. Recchia, Elementi di ornamento dall'abitato dell'età del Bronzo di Coppa Nevigata, in: N. Negroni Catacchio (ed.), Atti del XII Incontro di Studi 'Preistoria e Protostoria in Etruria', Valentano (VT) – Pitigliano (GR) – Manciano (GR), 12–14 settembre 2014. Ornarsi per comunicare con gli uomini e con gli Dei. Gli oggetti di ornamento come status symbol, amuleti, richiesta di protezione. Ricerche e scavi (Milan 2016) 359–372.

Cazzella – Recchia 2017a
A. Cazzella – G. Recchia, Confini geografici e temporanei permeabili fra Bronzo Recente e Bronzo Finale nell'Italia centro-meridionale adriatica, in: A. Angelini – M. Cupitò – M. Vidale – V. Donadel (eds.), Beyond Limits. Studi in Onore di Giovanni Leonardi, Antenor Quaderni 39 (Padua 2017) 457–468.

Cazzella – Recchia 2017b
A. Cazzella – G. Recchia, L'abitato fortificato di Coppa Nevigata e il suo ruolo nel sistema economico e politico della Puglia settentrionale, in: F. Radina (ed.), Preistoria e Protostoria della Puglia, Studi di Preistoria e Protostoria 4 (Florence 2017) 465–471.

Cazzella – Recchia 2018a
A. Cazzella – G. Recchia, Una struttura connessa con attività di *feasting* a Coppa Nevigata?, Scienze dell'Antichità 24, 1, 2018, 219–230.

Cazzella – Recchia 2018b
A. Cazzella – G. Recchia, Coppa Nevigata e i suoi rapporti con la *facies* dei Castellieri, in: E. Borgna – P. Càssola Guida – S. Corazza (eds.), Preistoria e Protostoria del *Caput Adriae*, Studi di Preistoria e Protostoria 5 (Florence 2018) 289–300.

Cazzella et al. 2004
A. Cazzella – C. Minniti – M. Moscoloni – G. Recchia, L'insediamento dell'età del Bronzo di Coppa Nevigata e la più antica attestazione della produzione della porpora in Italia, Preistoria Alpina 40 Suppl. 1, 2004, 177–182.

Cazzella et al. 2012
A. Cazzella – M. Moscoloni – G. Recchia (eds.), Coppa Nevigata e l'area umida alla foce del Candelaro (Foggia 2012).

Coccolini 1987
G. Coccolini, Studi sui resti vegetali di un abitato dell'età del Bronzo, in: S. M. Cassano – A. Cazzella – A. Manfredini – M. Moscoloni (eds.), Coppa Nevigata e il suo territorio (Rome 1987) 197–199.

Copat – Danesi 2017
V. Copat – M. Danesi, Il sito della Rocca di Oratino (CB) nel contesto del versante Adriatico meridionale, in: F. Radina (ed.), Preistoria e Protostoria della Puglia, Studi di Preistoria e Protostoria 4 (Florence 2017) 1005–1009.

Cupitò 2006
M. Cupitò, Tipocronologia del Bronzo medio e recente tra l'Adige e il Mincio sulla base delle evidenze funerarie, Saltuarie dal laboratorio del Piovego 7 (Padua 2006).

Hayden 2001
B. Hayden, Fabulous feasts. A prolegomenon to the importance of feasting, in: M. Dietler – B. Hayden (eds.), Feasts. Archaeological and Ethnographic Perspectives on Food, Politics and Power (Washington, London 2001) 23–64.

Jones – Levi 2012
R. E. Jones – S. T. Levi, Nuove analisi archeometriche della ceramica di tipo egeo-miceneo di Coppa Nevigata, in: Cazzella et al. 2012, 445–452.

Jones et al. 2014
R. E. Jones – S. T. Levi – M. Bettelli – L. Vagnetti, Italo-Mycenaean Pottery. The Archaeological and Archaeometric Dimensions, Incunabula Graeca 103 (Rome 2014).

Jung 2005
R. Jung, Aspekte des mykenischen Handels und Produktenaustauschs, in: B. Horejs – R. Jung – E. Kaiser – B. Teržan (eds.), Interpretationsraum Bronzezeit. Bernhard Hänsel von seinen Schülern gewidmet, Universitätsforschungen zur prähistorischen Archäologie 121 (Bonn 2005) 45–70.

Jung 2009
R. Jung, Pirates of the Aegean. Italy – East Aegean – Cyprus at the end of the second millennium BCE, in: V. Karageorghis – O. Kouka (eds.), Cyprus and the East Aegean. Intercultural Contacts from 3000 to 500 BC. An International Archaeological Symposium held at Pythagoreion, Samos, October 17th–18th 2008 (Nicosia 2009) 72–93.

Jung – Mehofer 2012
R. Jung – M. Mehofer, Analisi archeologiche ed archeometriche di una punta di giavellotto del Bronzo Recente da Coppa Nevigata, in: Cazzella et al. 2012, 453–456.

Jung et al. 2011
R. Jung – M. Mehofer – E. Pernicka, Metal exchange in Italy from the Middle to the Final Bronze Age (14th–11th century B.C.E., in: P. P. Betancourt – S. C. Ferrence (eds.), Metallurgy. Understanding How, Learning Why. Studies in Honor of James D. Muhly, Prehistory Monographs 29 (Philadelphia 2011) 231–248.

Leonardi – Tinè 2015
G. Leonardi – V. Tinè (eds.), Studi di Preistoria e Protostoria 2, Preistoria e Protostoria del Veneto (Florence 2015).

Maggiulli 2009
G. Maggiulli, Metallurgia e produzioni metallurgiche a Roca (Lecce). I ripostigli del Bronzo Finale, Rivista di Scienze Preistoriche 59, 2009, 307–334.

Minniti 2012
C. Minniti, La raccolta di molluschi marini a Coppa Nevigata nell'età del Bronzo, in: Cazzella et al. 2012, 367–387.

Minniti – Recchia 2018
C. Minniti – G. Recchia, New evidence on purple dye production from the Bronze Age settlement of Coppa Nevigata (Apulia, Italy), in: M. S. Busana – M. Gleba – F. Meo – A. R. Tricomi (eds.), Textiles and Dyes in the Mediterranean Economy and Societies. Proceedings of the VIth International Symposium on Textiles and Dyes in the Ancient Mediterranean World, Purpureae Vestes VI (Zaragoza 2018) 87–97.

Moffa – Simei 2012
C. Moffa – S. Simei, Analisi dei frammenti di intonaco di capanna dagli scavi in estensione 1972–75 a Coppa Nevigata, in: Cazzella et al. 2012, 229–234.

Moscoloni – Recchia 2012
M. Moscoloni – G. Recchia, Gli scavi Puglisi-Palmieri in estensione 1972–1975 a Coppa Nevigata, in: Cazzella et al. 2012, 27–46.

Moscoloni et al. 2002
M. Moscoloni – G. Recchia – I. Baroni – C. Minniti, Coppa Nevigata. Analisi funzionale delle strutture subappenniniche dei settori E4 e D5 (scavi Puglisi – Palmieri in estensione), in: C. Peretto (ed.), Analisi informatizzata e trattamento dati delle strutture di abitato di età preistorica e protostorica in Italia (Florence 2002) 443–465.

Pagliara et al. 2008
C. Pagliara – R. Guglielmino – L. Coluccia – I. Malorgio – M. Merico – D. Palmisano – M. Rugge – F. Minnonne, Roca Vecchia (Melendugno, Lecce), SAS IX. Relazione stratigrafica preliminare sui livelli di occupazione protostorici (campagne di scavo 2005–2006), Rivista di Scienze Preistoriche 58, 2008, 239–280.

Pasquini 2005
M. Pasquini, L'industria su corno di Moscosi di Cingoli. Forme principali e loro diffusione, in: Istituto Italiano di Preistoria e Protostoria (ed.), Atti della XXXVIII Riunione Scientifica "Preistoria e Protostoria delle Marche", Portonovo, Abbadia di Fiastra, 1–5 ottobre 2003 (Florence 2005) 985–991.

Poggiani Keller et al. 2002
R. Poggiani Keller – I. Baroni – C. Minniti – G. Recchia, Scarceta (Manciano – GR). Analisi dell'uso dello spazio nella struttura del Bronzo finale relativa al settore D, in: C. Peretto (ed.), Analisi informatizzata e trattameno dati delle strutture di abitato di età preistorica e protostorica in Italia (Florence 2002) 355–367.

Provenzano 1997
N. Provenzano, Produzione in osso e corno delle terramare emiliane, in: Bernabò Brea et al. 1997, 524–544.

Radina – Recchia 2006
F. Radina – G. Recchia, Scambi senza ceramica: ambra, avorio e pasta vitrea nei rapporti tra Italia sud-orientale e mondo egeo, in: Istituto Italiano di Preistoria e Protostoria (ed.), Atti della XXXIX Riunione Scientifica "Materie prime e scambi nella preistoria italiana", Firenze, 25–27 novembre 2004 (Florence 2006) 1555–1566.

Radina – Recchia 2010
F. Radina – G. Recchia (eds.), Ambra per Agamennone. Indigeni e Micenei tra Adriatico, Ionio ed Egeo (Bari 2010).

Recchia 2009
G. Recchia, Attività di scambio e sviluppi sociali a Coppa Nevigata (Manfredonia – Puglia) durante la tarda età del Bronzo, in: Borgna – Càssola Guida 2009, 219–234.

Recchia 2012a
G. Recchia, Distribuzione spaziale della ceramica di tipo egeo-miceneo nei diversi livelli di frequentazione dell'abitato dell'età del Bronzo di Coppa Nevigata, in: Cazzella et al. 2012, 431–444.

Recchia 2012b
G. Recchia, Sepolture e resti umani nelle varie fasi dell'abitato dell'età del Bronzo di Coppa Nevigata, in: Cazzella et al. 2012, 389–409.

Recchia et al. 2010
G. Recchia – E. Cristiani – C. Lemorini – V. Copat – M. Bettelli – C. Ruggini, Coppa Nevigata, Manfredonia (Foggia), in Radina – Recchia 2010, 270–302.

Recchia et al. in press
G. Recchia – E. Lucci – G. Fiorentino – C. Minniti – V. Mironti – M. Primavera – G. Siracusano – M. Vilmercati, Interpreting long-lived-in dwelling spaces. Integrated spatial analysis of a Late Bronze Age area at Coppa Nevigata (south-eastern Italy), in: L. Jallot – A. Peinetti, Lieux de vie et espaces domestiques. Organisations fonctionnelles et stratégies sociales / Use of Space and Domestic Areas. Functional Organisation and Social Strategies, UISPP Proceedings Series (in press).

Ruggeri et al. 2010
D. Ruggeri – M. Gala – A. Facciolo – M. C. Grossi – C. Morelli – M. L. Rinaldi – S. Sivilli – E. Carrisi – D. Citro – F. R. De Castro, Località Le Vignole – Maccarese (Fiumicino, Roma). Risultati preliminari dello scavo protostorico, in: Atti del IX Incontro di Studi Preistoria e Protostoria in Etruria (Milan 2010) 327–338.

Sabbatini – Silvestrini 2005
T. Sabbatini – M. Silvestrini, Piano di Fonte Marcosa, Moscosi di Cingoli. Un sito pluristratificato dell'Appennino marchigiano. Le fasi del Bronzo Recente, in: Istituto Italiano di Preistoria e Protostoria (ed.), Atti della XXXVIII Riunione Scientifica "Preistoria e Protostoria delle Marche", Portonovo, Abbadia di Fiastra, 1–5 ottobre 2003 (Florence 2005) 639–657.

Vagnetti 2012
L. Vagnetti, Osservazioni sulle ceramiche di tipo egeo-miceneo da Coppa Nevigata, in: Cazzella et al. 2012, 423–426.

Vagnetti et al. 2012
L. Vagnetti – M. Bettelli – G. Recchia, Catalogo delle ceramiche di tipo egeo-miceneo dall'abitato dell'età del Bronzo di Coppa Nevigata, in: Cazzella et al. 2012, 411–422.

Wardle et al. 2014
K. Wardle – Th. Higham – B. Kromer, Dating the end of the Greek Bronze Age. A robust radiocarbon-based chronology from Assiros Toumba, PLoS ONE, 9, 9, 2014, e106672. doi:101371/journal.pone.0106672

Roca and its Aegean Contacts in the Recent Bronze Age

Riccardo Guglielmino[1]

Abstract: The archaeological exploration of the peninsula of Roca (Lecce), carried out by the University of Salento, has brought to light one of the most important prehistoric settlements in the central Mediterranean. During recent years, an important stratigraphic sequence was explored in the northwest sector of the settlement (Area IX), near the internal front of the protohistoric fortification walls, and this had seven distinct occupation phases from the beginning of Recent Bronze Age 2 to Final Bronze Age 2. A large quantity of Aegean-type ceramics, both imported and locally made, were found in the Recent Bonze Age levels; moreover, the presence of many faunal remains led us to hypothesise celebrations of sacrifices and ritual meals. Various archaeological data converge to suggest that in this period Roca became an important node in a large-scale Mediterranean trade network and acquired the character of a community colony, with a significant group of Aegean immigrants.

Keywords: Roca, Recent Bronze Age, Aegean contacts, Aegean-type pottery, Aegean immigrants

Our knowledge of the Recent Bronze Age at Roca has increased considerably during the last decade. Excavations confirmed that in this period new fortifications, characterised by inclined or stepped walls, were mostly constructed with squared limestone blocks. Both the materials and building techniques reveal a sudden change and a clear improvement compared to the fortifications of the Middle Bronze Age, when the walls were constructed using mainly raw or roughly worked slabs[2] (Fig. 1).

After a possible brief period of abandonment,[3] these new fortifications incorporated the ruins of the monumental defensive structures destroyed during Middle Bronze Age 3. Detailed analysis of their remains revealed an intense building activity, concentrated in a relatively short period of time, with traces of partial destructions, reconstructions, enlargements and an increase in the elevations of the structures.

In addition to the rebuilding of the fortifications, the evidence indicates a process of spatial reorganisation within the settlement, with the creation of a zone dedicated to ritual and cultic practices (that we have sometimes described as a kind of 'Cult Centre') in the northwestern sector of the settlement.

In this area (Area IX) a thick stratigraphy revealed a rich sequence of occupation levels, which allowed us to detect seven distinct occupation phases, datable between the Recent Bronze Age (phases I–V) and the Final Bronze Age (phases VI–VII),[4] and to bring to light remains of several structures. The most recent and best preserved of them is the monumental building (nick-named Temple-Hut), which has been partially published.[5]

In this stratigraphic sequence the deepest levels, pertaining to phases I and II, were mainly composed of large layers of ash and charcoal and contained abundant ceramics and large quantities of animal bones, partly blackened by contact with fire and with clear signs of butchering. As

1 Dipartimento di Beni Culturali, Università del Salento, Edificio ex INAPLI, Via Dalmazio Birago 64, 73100 Lecce, Italy; riccardo.guglielmino@unisalento.it.

2 Guglielmino – Pagliara 2004, 567–568; Scarano 2012.

3 Guglielmino 2005, 639.

4 Pagliara et al. 2008.

5 Malorgio – Maggiulli 2011; Maggiulli – Malorgio 2012; Maggiulli – Malorgio 2017.



Fig. 1 Roca (Lecce). Recent Bronze Age. Inner front of the fortification wall (photo: R. Guglielmino)

regards the formation of these deposits, the nature and disposition of the finds led to the hypothesis of an iteration of public ritual activities, which likely included the celebration of bloody sacrifices and libations, the lighting of fires, the consumption of communal meals and probably the intentional breakage of vessels.[6] The traces connected to such practices were located in a shallow natural depression, which in all probability was previously cleared of older deposits, because of the almost complete absence of traces of previous Middle Bronze Age occupation.[7]

In Area IX the entire stratigraphic sequence yielded large quantities of indigenous *impasto* and Aegean-type pottery (both imported and of local imitation);[8] in some strata the latter exceeded ten percent of the total number of vessels.[9] This abundance is exceptional for an extra-Aegean settlement context, not only in the central Mediterranean,[10] and is likely to be connected with the particular function of the area, since until now it has not been observed in other sectors of the site. In this regard, it is worth mentioning how the recovery of abundant fine and exotic ceramics is a widespread phenomenon in cultic contexts documented in many areas and periods. In addition to the abundance, the richness and the multiplicity of fabrics, forms and decorative motifs, the Aegean-type pottery stands out because it is highly reconstructable, an unusual feature in material coming from a settlement.

In the lower levels of phases I and II, the large number of deep bowls (Fig. 2), the good quantity of kraters and dippers (Fig. 3) among the attested shapes and the presence of some mineralised grape pips, analysed by Milena Primavera, led to speculation that wine was one of the beverages that were consumed in Area IX.[11]

6 Guglielmino 2009a, 188–189.
7 Pagliara et al. 2008.
8 Guglielmino et al. 2010.
9 Iacono 2015.
10 Cf. Blake 2008.
11 Primavera 2018, 46–51. It is worth recalling that in Mycenaean Greece dippers, kraters and deep bowls are almost always attested together in feasting contexts and are probably to be associated with wine consumption. Cf. Borgna 2004, 268.

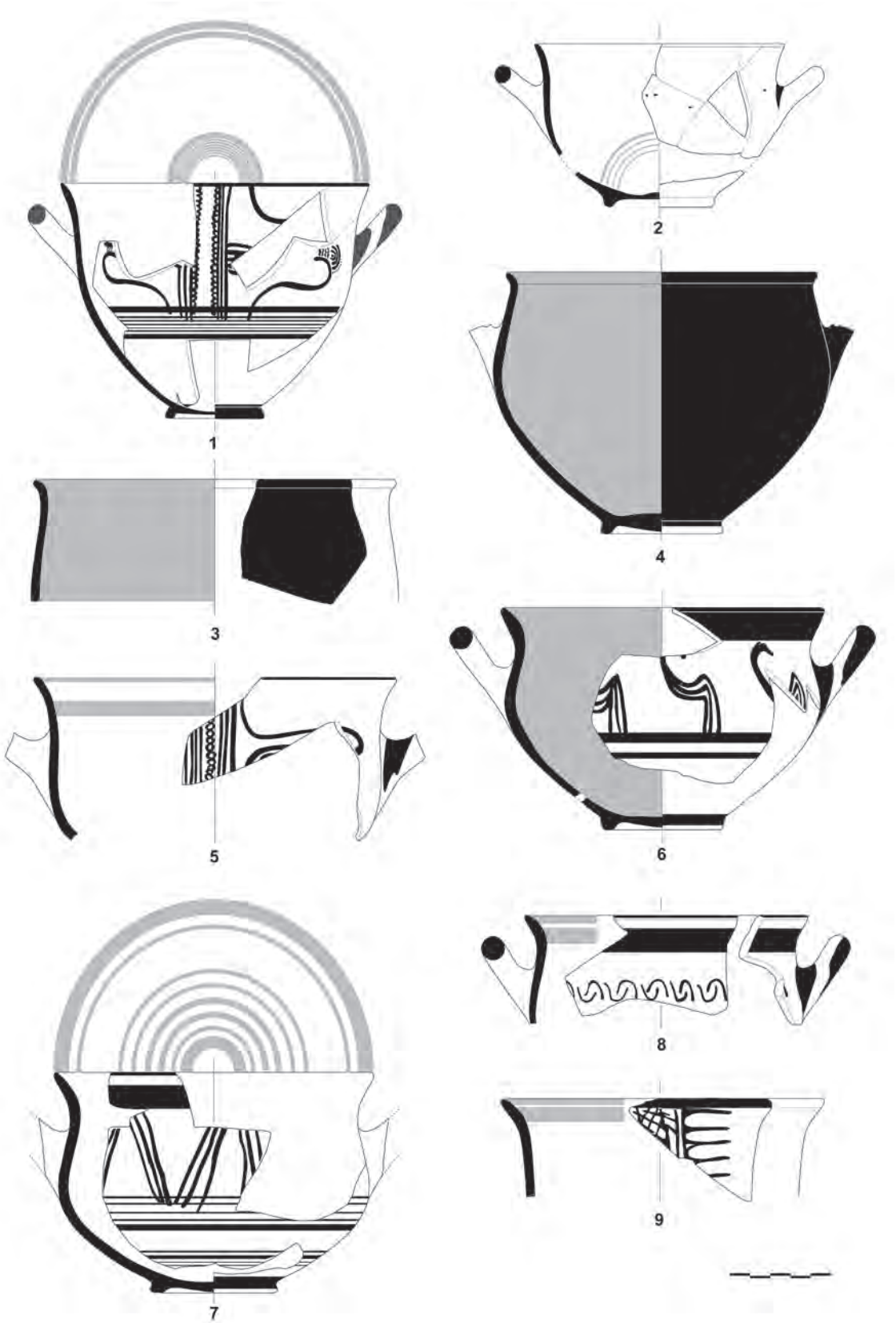


Fig. 2 Roca (Lecce). Recent Bronze Age. Area IX. Aegean-type pottery: 1–4. Phase I; 5–9. Phase II. Scale 1:3 (drawings: R. Guglielmino, L. Coluccia, F. Iacono)

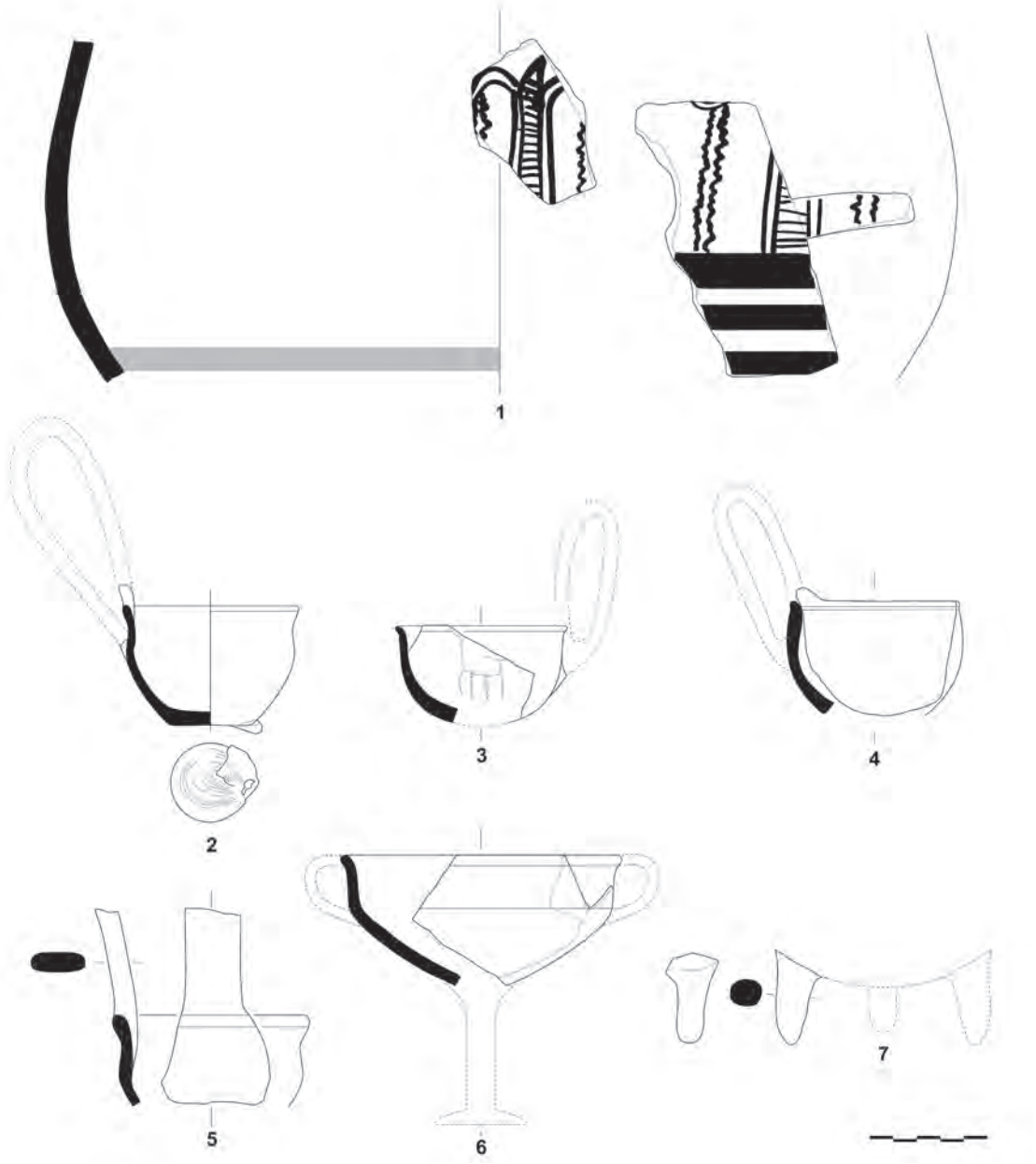


Fig. 3 Roca (Lecce). Recent Bronze Age. Area IX. Aegean-type pottery: 1, 5. Phase II; 2–4, 6–7. Phase I. Scale 1:3 (drawings: R. Guglielmino, L. Coluccia, F. Iacono)

Moreover, at the end of phase II, big selected parts and entire quarters of large animals rich in meat (oxen, goats and pigs) were deposited together with vegetable offerings (wheat sheaves, branches of oak and myrtle) and large amounts of pottery and then buried under a thick layer of crushed limestone. The taphonomic and osteological study conducted by Michela Rugge revealed that the animal parts, found in anatomical connection (Fig. 4), were neither burnt nor defleshed for meat consumption, but were deposited with all their soft tissues intact.[12] These rich offerings may perhaps be interpreted as part of a foundation ritual, since the limestone layer marks a major urban reorganisation of this settlement area; the plant elements may belong to garlands or wreaths that

[12] Pagliara et al. 2008.



Fig. 4 Roca (Lecce). Recent Bronze Age. Area IX. Phase II. Ox bones in anatomical connection (photo: R. Guglielmino)

were worn by those performing the sacrifice or may have adorned the victims, something similar to what probably happened in the Aegean world.[13]

The rich mixed assemblages of local handmade *impasto* and Aegean-type wheel-turned pottery coming from Area IX certainly contribute to establishing an interregional comparative chronology in order to link the local south Italian sequence to the Mycenaean and Minoan ones.[14] The great majority of Aegean and Aegean-type vessels coming from the bottom levels date to the period between LH IIIB2 and IIIC Early, that is to decades around and immediately after 1200 BC, which are the chronological core of this meeting. Nevertheless, the historical framework is complicated by the occasional presence of residual materials and by the fact that Italo-Mycenaean products do not always follow the same standards as the genuine Mycenaean ones. They show, in fact, some evident oddities, hybridisations and chronological delays.[15]

From the same levels of phases I and II come also numerous fragments of coarse-ware stirrup jars.[16] These transport jars are very scarce in the central Mediterranean and, just as we suspected, chemical analyses seem to confirm that they came from western Crete, which all authors recognise as the main production area.[17] We supposed that they were possibly used to carry some kind of scented oils.[18]

In addition to Lustrous Decorated Ware, a fair amount of Mycenaean unpainted ware was also found. It includes both closed and open shapes (Figs. 3, 5) and offers some of the most interesting data concerning the relationship with the Aegean world. Open shapes are represented by *kylikes* and chiefly by dippers, which have semi-globular or slightly carinated bowls. One of our dippers has incised parallel lines at the lower handle attachment, as do some examples from Laconia.[19] Closed shapes (apparently jugs, amphorae and hydriai) have rather thin walls and do not seem

13 Cf. Warren 1985; Warren 2005, 148; Rehak 1995, 446; Younger 1995, 509–510.
14 Cf. Jung 2006, 145–148; Jones et al. 2014, 75–83.
15 Cf. Jones et al. 2014, 67; Jung, Guglielmino, Iacono and Mommsen, this volume.
16 The exact number of these large vessels can hardly be determined with certainty by simple autopsy, because their fabrics are very similar.
17 Guglielmino et al. 2010.
18 Guglielmino 2009b, 487. We are planning gas chromatographic analyses on a selection of fragments.
19 Catling 2009, figs. 168, 241, 305.

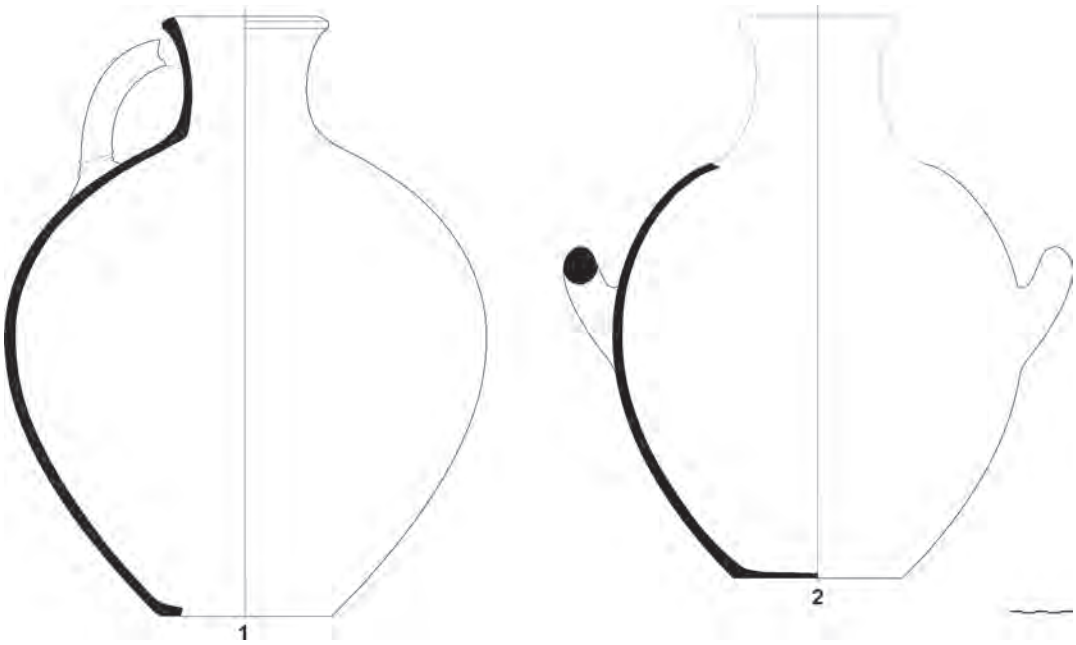


Fig. 5 Roca (Lecce). Recent Bronze Age. Area IX. Phase I. Aegean-type pottery. Scale 1:6 (drawings: R. Guglielmino, L. Coluccia, F. Iacono)

well-suited for transport over long distances. Another fragment seems to be a leg of a small tripod pot or brazier.

So far, the only unpainted vessel selected for chemical analysis was found to be imported (Fig. 5.1).[20] However, regardless of whether the unpainted vessels are imported or not, we must keep in mind that wherever plain and domestic pottery has been found outside the Aegean, as at Miletus and Iasos on the Anatolian coasts and Tell Kazel in Syria, it has been considered as evidence for a high degree of Aegean influence and for a probable presence of Aegean immigrants.[21]

In fact, when compared to other Italian centres, Roca provides rich evidence in favour of the presence of an exogenous minority among the indigenous population; in this regard, one of the most eloquent data is certainly constituted by the discovery in a context of phase III of a purple steatite lentoid seal, unfortunately very worn, which shows a schematic representation of a quadruped.[22] The find belongs, in fact, to a category of artefacts which is extraneous to the indigenous culture, is usually excluded from commercial channels and is almost unknown in the central Mediterranean.

It is attributable to a group defined by Younger as the 'Mainland Popular Group', which is documented by a large number of examples in soft stone. These seals were produced by workshops operating in Mycenaean Greece between LH IIIA2 and IIIB and have been found mainly in non-palatial centres;[23] two examples even come from the Uluburun wreck.[24] It is assumed that the seals of this group, which were not used for administrative purposes,[25] functioned mainly as identity markers and were transmitted from generation to generation among the other *keimelia*.[26]

---

20 Jung, Guglielmino, Iacono and Mommsen, this volume.

21 Mee 1998; van Wijngaarden 2002; Kaiser 2005; Niemeier 2005 with bibl.; Jung 2011.

22 Pagliara et al. 2008, 266–267; Iacono 2010.

23 Guglielmino 2013, 148–149 with bibl. The seal was attributed to this group by Olga Krzyszkowska (personal communication to Francesco Iacono).

24 Pulak 2005, 305.

25 A clay nodule from Thebes, which bears the impression of a seal of this group is, so far, a unique exception (Eder 2007, 38; Flouda 2010, 63).

26 Moschos 2009, 379, n. 148 with bibl.

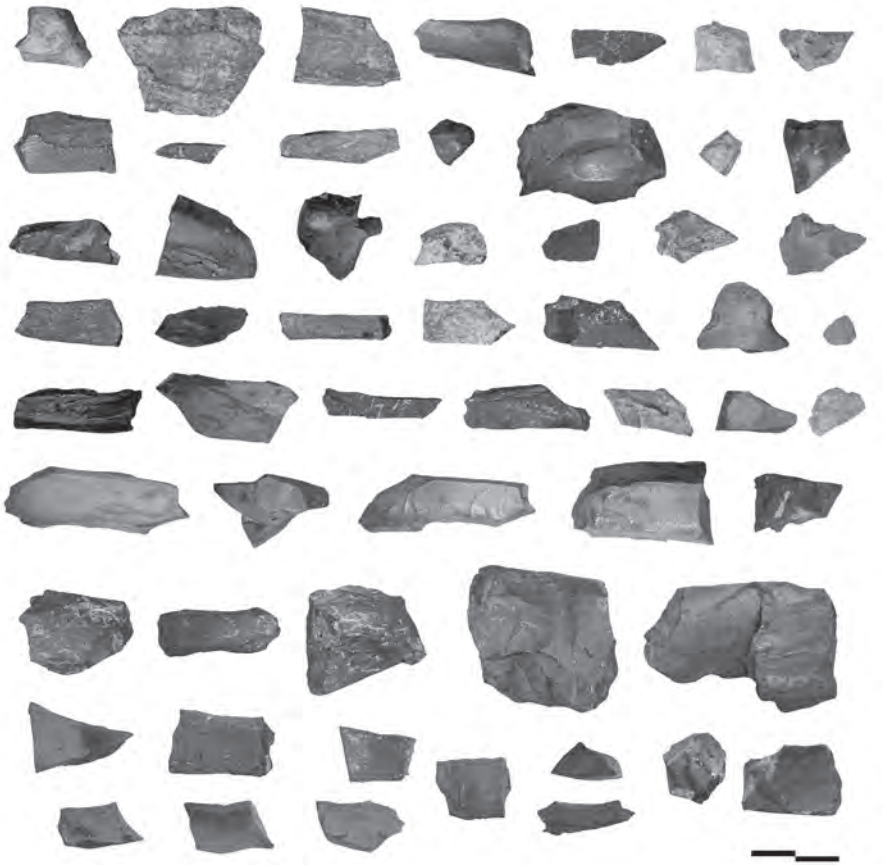


Fig. 6 Roca (Lecce). Recent Bronze Age. Area X. Phase III. Fragments of hippopotamus ivory (photo: R. Guglielmino)

The seal from Roca is the only one of this type found in Italy and it is hard to imagine that it belonged to an indigenous owner.

A few dozen metres south of Area IX, part of a Recent Bronze Age 2 structure has been explored in Area X. Although its size does not seem impressive, there are good reasons not to attribute a merely dwelling function to this construction. In fact, it had a wing destined for craft activities related to the processing of bone and similar materials.[27] Such materials present various steps of the *chaîne opératoire*, including several semi-worked fragments of turtle shell (*Caretta caretta*) and raw hippopotamus ivory (many fragments of lower incisors and canines) (Fig. 6), which is 'more challenging to work than elephant tusks'.[28]

The turtle shell fragments are the sole evidence in Bronze Age Italy for a luxury craft activity which acquired greater importance and diffusion in later Antiquity, mainly for the manufacture of inlay for furniture (Plin., *HN*, 9.12.35–39); among them a marginal carapace scute was worked to produce a thin rhomboid plate (Fig. 7).

Ivory is a raw material of great value that could be designated ultra-exotic in Italy, because it was already exotic in Mycenaean Greece, from where it was probably imported. Roca's evidence constitutes the most ancient attestation of ivory-working in Italy;[29] it seems not unlikely that the introduction of the precious substance and of the specialised and sophisticated technology related to its processing[30] is to be attributed to resident Aegean immigrants. Furthermore, the short

27 Pagliara et al. 2007.
28 Burns 1999, 118 with bibl.
29 Guglielmino et al. 2011.
30 Cf. Barnett 1982; Evely 1993, 219–256.

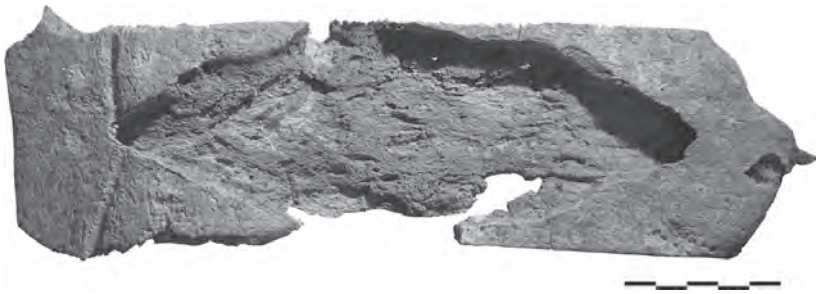


Fig. 7 Roca (Lecce). Recent Bronze Age. Area X. Phase III. Worked turtle shell fragment (photo: R. Guglielmino)

distance of this workshop from the cultic area could not be accidental; evidence for ivory carving, in fact, has been found in the Cult Centre of Mycenae and has been considered possible evidence for a 'workshop-shrine association'.[31]

Moreover, in Mycenaean Greece ivory working was mainly a palace-sponsored craft,[32] as we can clearly infer from some Pylos and Knossos tablets.[33] The Ta series from Pylos, for example, is an inventory of luxurious furniture and deals with tables, thrones and footstools decorated with ivory elements, which were probably used on the occasion of a major commensal and sacrificial ceremony.[34] In this regard, one must also consider that the Ivory Houses at Mycenae, where we have by far the highest concentration of manufactured and semi-finished ivory pieces and where many Linear B tablets were brought to light, have been identified as residences of palace officials.[35]

Therefore, it is very likely that the ivory craft would operate primarily for an elite and palatial clientele, as seems confirmed by its rapid decline in the immediate aftermath of the Mycenaean palaces collapse.[36] In light of these data and of their evident social implications, it is difficult to imagine that at Roca, a few decades after the fall of the Mycenaean palaces,[37] the oldest on-site working of ivory started in an ordinary hut through the initiative of an anonymous craftsman to satisfy the demands of equally anonymous customers.

Perhaps more than anywhere else in the central Mediterranean, it is hard to believe that at Roca the Aegean immigrants were exclusively potters. It seems probable that they included also other figures, not unlike what is supposed for the Italian immigrants who settled in various places in the Aegean.[38] I think that the model that seems to fit best with the cultural profile of Roca in this period is the 'community colony', as delineated by Branigan, which implies the presence of a group of Aegean immigrants; a group numerically not calculable, but certainly neither the majority nor the dominant component of the population living in this centre.[39] It is reasonable to assume, however, that this minority contributed significantly to the technological and socio-economic development of the indigenous community.

In conclusion we can say that at Roca many archaeological data have been collected which clearly testify to strong and frequent contacts with the Aegean world. These contacts seem to reach their greatest intensity around 1200 BC, when we register the highest percentages of Aege-

31 Lupack 2008, 19–43, 141–142.
32 Burns 1999, 144–146; Bachhuber 2006, 351, n. 63 with bibl.
33 Palaima 1991; Shelmerdine 1998, 291; Burns 2010, 108.
34 Ventris – Chadwick 1956, 342–344; Palaima 2004.
35 Voutsaki 2010, 603 with bibl.
36 Rehak – Younger 1998, 252–254.
37 Radiometric dates for our workshop are published in Pagliara et al. 2007, 356–357.
38 It has been supposed that these immigrants included metalworkers, mercenaries, slaves and *clientes* (cf. Bettelli 2002, 130–132; Hallager – Hallager 2003a, 287–288; Hallager 2003, 257; Bettelli 2006, 140–157; Bettelli 2009, 96; Bettelli 2010, 122–123; Jung – Mehofer 2013).
39 Guglielmino 2013 with bibl.; in this regard, cf. Bettelli 2002, 14.

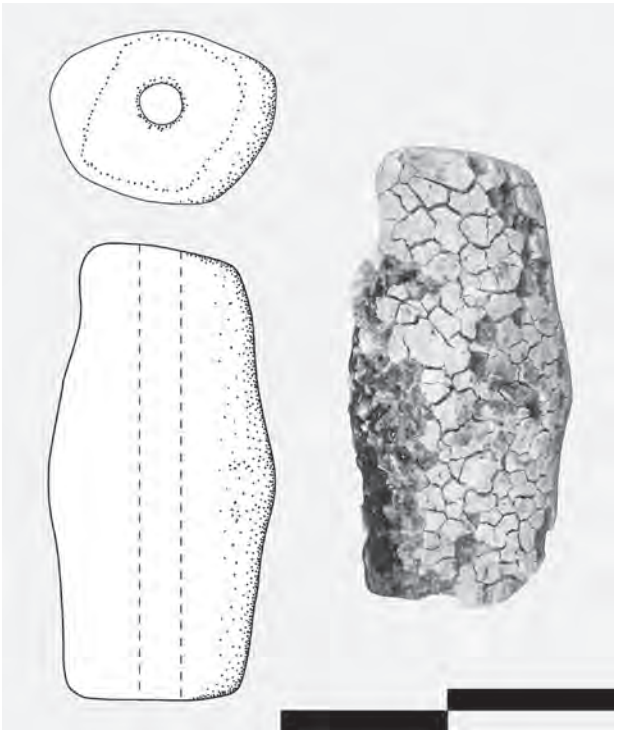


Fig. 8 Roca (Lecce). Recent Bronze Age. Area IX. Phase II. Amber bead of Tiryns type (drawing and photo: R. Guglielmino)

an-type ceramics, both imported and made locally, which clearly include Minoan and Minoanising products. In this period Roca probably served as an important node in a large-scale Mediterranean trade network.

Among other notable evidence for this role during Recent Bronze Age 2, we must also number two large bronze pins with spherical heads of the Italian Franzine type coming from phase I,[40] a Tiryns-type amber bead from phase II, which is one of the most ancient examples in Italy (Fig. 8), and a ring-handled knife close to the central European Baierdorf type from phase V.[41] The local *impasto* decoration also shows close contacts with the *terramare* area in northern Italy.[42]

As we have seen, various data converge to suggest the presence of resident foreigners, probably coming from different Aegean regions; this presence probably dates back to Middle Bronze Age 3, when production of Italo-Aegean ceramics starts. It seems reasonable to assume that the long coexistence and association at the same site, which continued for many generations, may have triggered profound integration and reciprocal influence processes, including, but certainly not limited to, the handicraft sphere.

Bibliography

Bachhuber 2006
C. Bachhuber, Aegean interest on the Uluburun ship, American Journal of Archaeology 110, 2006, 345–361.

Barnett 1982
R. D. Barnett, Ancient Ivories in the Middle East (Jerusalem 1982).

40 Maggiulli 2017. Pins of this type were not attested so far south of the Po valley (Carancini 1975, 197–198).
41 Pagliara et al. 2008, 264, fig. 15B.V.2; 267.
42 Pagliara et al. 2008.

Bettelli 2002
M. Bettelli, Italia meridionale e mondo miceneo. Ricerche su dinamiche di acculturazione e aspetti archeologici, con particolare riferimento ai versanti adriatico e ionico della penisola italiana, Grandi contesti e problemi della Protostoria italiana 5 (Florence 2002).

Bettelli 2006
M. Bettelli, Offerte votive e simboli di culto dall'Italia in Egeo nel secondo millennio a.C., in: A. Naso (ed.), Stranieri e non cittadini nei santuari del Mediterraneo Antico. Atti del Convegno Internazionale, Udine, 20.–22.11.2003 (Florence 2006) 140–157.

Bettelli 2009
M. Bettelli, Handmade Burnished Ware e ceramica grigia tornita in Egeo nella tarda età del bronzo: una messa a punto, Studi Micenei ed Egeo-Anatolici 51, 2009, 95–121.

Bettelli 2010
M. Bettelli, Italia ed Egeo prima e dopo il crollo dei palazzi micenei. Le ceramiche d'impasto e grigia tornita in Grecia e a Creta alla luce delle più recenti scoperte, in: Radina – Recchia 2010, 119–127.

Blake 2008
E. Blake, The Mycenaeans in Italy. A minimalist position, Papers of the British School at Rome 76, 2008, 1–34.

Borgna 2004
E. Borgna, Aegean feasting. A Minoan perspective, Hesperia 73, 2, 2004, 247–279.

Borgna – Cassola Guida 2009
E. Borgna – P. Càssola Guida (eds.), Dall'Egeo all'Adriatico. Organizzazioni sociali, modi di scambio e interazione in età postpalaziale (XII–XI sec. a. C.) / From the Aegean to the Adriatic. Social Organizations, Modes of Exchange and Interaction in Postpalatial Times (12th–11th c. BC), Atti del Seminario internazionale (Udine, 1–2 dicembre 2006), Studi e ricerche di protostoria mediterranea 8 (Rome 2009).

Burns 1999
B. E. Burns, Import Consumption in the Bronze Age Argolid (Greece). Effects of Mediterranean Trade on Mycenaean Society (PhD Diss., University of Michigan, Ann Arbor 1999).

Burns 2010
B. E. Burns, Mycenaean Greece, Mediterranean Commerce, and the Formation of Identity (New York 2010).

Carancini 1975
G. L. Carancini, Die Nadeln in Italien / Gli spilloni nell'Italia continentale, Prähistorische Bronzefunde XIII, 2 (Munich 1975).

Catling 2009
H. W. Catling, Sparta: Menelaion I. The Bronze Age, The British School at Athens, Suppl. 45 (London 2009).

Cline – Harris-Cline 1998
E. H. Cline – D. Harris-Cline (eds.), The Aegean and the Orient in the Second Millennium. Proceedings of the 50th Anniversary Symposium, Cincinnati, 18–20 April 1997, Aegaeum 18 (Liège 1998).

Eder 2007
B. Eder, The power of seals. Palaces, peripheries and territorial control in the Mycenaean world, in: I. Galanaki – H. Tomas – Y. Galanakis – R. Laffineur (eds.), Between the Aegean and Baltic Seas: Prehistory Across Borders. Proceedings of the International Conference Bronze and Early Iron Age Interconnections and Contemporary Developments between the Aegean and the Regions of the Balkan Peninsula, Central and Northern Europe. University of Zagreb, 11–14 April 2005, Aegaeum 27 (Eupen 2007) 35–45.

Evely 1993
R. D. G. Evely, Minoan Crafts: Tools and Techniques. An Introduction, Studies in Mediterranean Archaeology 92, 1 (Gothenburg 1993).

Flouda 2010
G. Flouda, Agency matters. Seal-users in Pylian administration, Oxford Journal of Archaeology 59, 2010, 57–88.

Guglielmino 2005
R. Guglielmino, Rocavecchia (Lecce). Nuove testimonianze di relazioni con l'Egeo e il Mediterraneo orientale nell'età del bronzo, in: Laffineur – Greco 2005, 637–651.

Guglielmino 2009a
R. Guglielmino, Le relazioni tra l'Adriatico e l'Egeo nel Bronzo recente e finale. La testimonianza di Roca, in: Borgna – Cassola Guida 2009, 185–204.

Guglielmino 2009b
R. Guglielmino, Presenze minoiche nel Salento. Roca e la saga di Minosse, in: C. Ampolo (ed.), Immagine e immagini della Sicilia e di altre isole del Mediterraneo antico. Atti delle Seste Giornate Internazionali di Studio sull'area elima e la Sicilia occidentale nel contesto mediterraneo (Pisa 2009) 481–505.

Guglielmino 2013
R. Guglielmino, I rapporti tra l'Italia e l'Egeo nell'età del bronzo e il ruolo di Roca. Alcuni spunti di riflessione, Annali della Scuola Normale Superiore di Pisa serie 5, 5/2 Suppl., 2013, 131–151.

Guglielmino – Pagliara 2004
R. Guglielmino – C. Pagliara, Nuove ricerche a Roca, Annali della Scuola Normale Superiore di Pisa serie 4, 9, 2, 2004, 560–581.

Guglielmino et al. 2010
R. Guglielmino – R. E. Jones – S. T. Levi, Relations between Aegean and Apulia in the Late Bronze Age. The evidence from an archaeometric study of the pottery at Roca (Lecce), Rivista di Scienze Preistoriche 60, 2010, 257–282.

Guglielmino et al. 2011
R. Guglielmino – F. Iacono – M. Rugge, Before the stream. The social and economic role of exotica in the central Mediterranean. The case of the ivories from Roca, in: A. Vianello (ed.), Exotica in the Prehistoric Mediterranean (Oxford 2011) 172–185.

Hallager 2003
B. P. Hallager, The Late Minoan IIIB:2 pottery, in: Hallager – Hallager 2003b, 197–265.

Hallager – Hallager 2003a
E. Hallager – B. P. Hallager, General conclusions, in: Hallager – Hallager 2003b, 286–288.

Hallager – Hallager 2003b
E. Hallager – B. P.Hallager (eds.), The Greek-Swedish Excavations at the Agia Aikaterini Square. Kastelli, Khania 1979–1987 and 2001 (Stockholm 2003).

Iacono 2010
F. Iacono, Sigillo miceneo, in: Radina – Recchia 2010, 371.

Iacono 2015
F. Iacono, Feasting at Roca. Cross-cultural encounters and society in the southern Adriatic during the Late Bronze Age, European Journal of Archaeology 18, 2015, 259–281.

Jones et al. 2014
R. Jones – S. T. Levi – M. Bettelli – L. Vagnetti, Italo-Mycenaean Pottery. The Archaeological and Archaeometric Dimensions, Incunabula Graeca 103 (Rome 2014).

Jung 2006
R. Jung, *Χρονολογία* Comparata. Vergleichende Chronologie von Südgriechenland und Süditalien von ca. 1700/1600 bis 1000 v.u.Z., Veröffentlichungen der Mykenischen Kommission 26 (Vienna 2006).

Jung 2011
R. Jung, Mycenaean vending cups in Syria? Thoughts about the unpainted Mycenaean pottery from Tell Kazel, in: W. Gauß – M. Lindblom – R. A. K. Smith – J. C. Wright (eds.), Our Cups Are Full. Pottery and Society in the Aegean Bronze Age. Papers Presented to Jeremy B. Rutter on the Occasion of his 65th Birthday (Oxford 2005) 121–132.

Jung – Mehofer 2013
R. Jung – M. Mehofer, Mycenaean Greece and Bronze Age Italy. Cooperation, trade or war?, Archäologisches Korrespondenzblatt 43, 2013, 175–193.

Kaiser 2005
I. Kaiser, Minoan Miletus. A view from the kitchen, in: Laffineur – Greco 2005, 193–197.

Laffineur – Greco 2005
R. Laffineur – E. Greco (eds.), Emporia. Aegeans in the Central and Eastern Mediterranean. Proceedings of the 10th International Aegean Conference / 10e Rencontre égéenne internationale, Athens, Italian School of Archaeology, 14–18 April 2004, Aegaeum 25 (Liège 2005).

Laffineur – Niemeier 1995
R. Laffineur – W.-D. Niemeier (eds.), Politeia. Society and State in the Aegean Bronze Age. Proceedings of the 5th International Aegean Conference / 5e Rencontre égéenne internationale, University of Heidelberg, Archäologisches Institut, 10–13 April 1994, Aegaeum 12 (Liège 1995).

Lupack 2008
S. M. Lupack, The Role of the Religious Sector in the Economy of Late Bronze Age Mycenaean Greece (Oxford 2008).

Maggiulli 2017
G. Maggiulli, I manufatti metallici dai livelli dell'età del Bronzo del SAS IX di Roca (LE), in: Radina 2017, 977–982.

Maggiulli – Malorgio 2012
G. Maggiulli – I. Malorgio, Nuovi dati dal settore SudEst della «capanna tempio», Annali della Scuola Normale Superiore di Pisa serie 5, 4/2 suppl., 2012, 88–98.

Maggiulli – Malorgio 2017
G. Maggiulli – I. Malorgio, La grande struttura incendiata dell'età del Bronzo Finale di Roca (SAS IX). Nuovi dati dall'area N, in: Radina 2017, 539–547.

Malorgio – Maggiulli 2011
I. Malorgio – G. Maggiulli, Roca (Le), SAS IX. La struttura incendiata dell'età del bronzo finale. Scavo e analisi del contesto, Rivista di Scienze Preistoriche 61, 2011, 125–158.

Mee 1998
C. Mee, Anatolia and the Aegean in the Late Bronze Age, in: Cline – Harris-Cline 1998, 137–148.

Moschos 2009
I. Moschos, Evidence of social re-organization and reconstruction in Late Helladic IIIC Achaea and modes of contacts and exchange via the Ionian and Adriatic Sea, in: Borgna – Cassola Guida 2009, 345–414.

Niemeier 2005
W-D. Niemeier, The Minoans and Mycenaeans in Western Asia Minor. Settlement, emporia or acculturation, in: Laffineur – Greco 2005, 199–204.

Pagliara et al. 2007
C. Pagliara – G. Maggiulli – T. Scarano – C. Pino – R. Guglielmino – J. De Grossi Mazzorin – M. Rugge – G. Fiorentino – M. Primavera – L. Calcagnile – M. D'Elia – G. Quarta, La sequenza cronostratigrafica delle fasi di occupazione dell'insediamento protostorico di Roca (Melendugno, Lecce). Relazione preliminare della campagna di scavo 2005 – Saggio X, Rivista di Scienze Preistoriche 57, 2007, 311–362.

Pagliara et al. 2008
C. Pagliara – R. Guglielmino – L. Coluccia – I. Malorgio – M. Merico – D. Palmisano – M. Rugge – F. Minnonne, Roca Vecchia (Melendugno, Lecce), SAS IX. Relazione stratigrafica preliminare sui livelli di occupazione protostorici (campagne di scavo 2005–2006), Rivista di Scienze Preistoriche 58, 2008, 239–280.

Palaima 1991
T. G. Palaima, Maritime matters on the Linear B tablets, in: R. Laffineur – L. Basch (eds.), Thalassa. L'Egée préhistorique et la mer. Actes de la troisième Rencontre égéenne internationale de l'Université de Liège, Station de recherches sous-marines et océanographiques (StaReSO), Calvi, Corse (23–25 avril 1990), Aegaeum 7 (Liège 1991) 273–310.

Palaima 2004
T. G. Palaima, Sacrificial feasting in the Linear B documents, Hesperia 73, 2, 2004, 217–246.

Primavera 2018
M. Primavera, Roca e le dinamiche uomo-ambiente in Puglia durante l'età del bronzo (Monteroni di Lecce 2018).

Pulak 2005
C. Pulak, Who were the Mycenaeans aboard the Uluburun ship?, in: Laffineur – Greco 2005, 295–310.

Radina 2017
F. Radina (ed.), Preistoria e Protostoria della Puglia, Studi di Preistoria e Protostoria 4 (Florence 2017).

Radina – Recchia 2010
F. Radina – G. Recchia (eds.), Ambra per Agamennone (Bari 2010).

Rehak 1995
P. Rehak, The use and destruction of Minoan stone bull's head rhyta, in: Laffineur – Niemeier 1995, 435–460.

Rehak – Younger 1998
P. Rehak – J. G. Younger, International styles in ivory carving in the Bronze Age, in: Cline – Harris-Cline 1998, 229–256.

Scarano 2012
T. Scarano, Roca I. Le fortificazioni della media età del Bronzo. Strutture, contesti, materiali (Foggia 2012).

Shelmerdine 1998
C. W. Shelmerdine, Where do we go from here? And how can the Linear B tablets help us get there?, in: Cline – Harris-Cline 1998, 291–299.

Ventris – Chadwick 1956
M. Ventris – J. Chadwick, Documents in Mycenaean Greek (Cambridge 1956).

Voutsaki 2010
S. Voutsaki, Argolid, in: E. H. Cline (ed.), The Oxford Handbook of the Bronze Age Aegean (ca. 3000–1000 BCE) (Oxford 2010) 599–613.

Warren 1985
P. Warren, The Fresco of the Garlands from Knossos, in: P. Darcque – J.-C. Poursat (eds.), L'iconographie minoenne. Actes de la Table Ronde d'Athènes (21–22 avril 1983), Bulletin de Correspondance Hellénique Suppl. 11 (Paris 1985) 187–208.

Warren 2005
P. Warren, Flowers for the goddess? New fragments of wall paintings from Knossos, in: L. Morgan (ed.), Aegean Wall Painting. A Tribute to Mark Cameron, British School at Athens Studies 13 (London 2005) 131–148.

van Wijngaarden 2002
G. J. van Wijngaarden, Use and Appreciation of Mycenaean Pottery in the Levant, Cyprus and Italy (1600–1200 B.C.) (Amsterdam 2002).

Younger 1995
J. G. Younger, Bronze Age representations of Aegean bull-games, III, in: Laffineur – Niemeier 1995, 507–545.

Neutron Activation Analysis of Aegean and Aegeanising Ceramics from Roca Vecchia and the Circulation of Pottery in Southern Italy

Reinhard Jung[1] – *Riccardo Guglielmino*[2] – *Francesco Iacono*[3] – *Hans Mommsen*[4]

Abstract: This article reports the results of an archaeometric study using NAA on 20 samples of wheelmade fine-ware pottery and one pithos from Roca Vecchia in Apulia. The study aims at elucidating the circulation of Mycenaean-type and Italo-Mycenaean-type vessels across southern Italy. For comparison with Punta di Zambrone, we have focused on ceramics from the RBA levels of Roca Vecchia, as this is a coastal settlement, which, according to previous studies, yielded both Aegean imports and local or regional Italo-Mycenaean products, all well-stratified in a continuous vertical settlement sequence. The chemical analysis identified a few imports from Greece (mainly from Achaea/Elis) and many Apulian products (forming two chemical groups), some of which adhere closely to the Mycenaean style, while others are of Italo-Mycenaean type. These Apulian chemical groups are absent from the previously analysed pots from Punta di Zambrone. One medium coarse pithos from Roca Vecchia turned out to be an import from the southern plain of Sybaris, i.e. the same region that is represented with a few Mycenaean fine-ware vessels at Punta di Zambrone.

Keywords: Aegean-type pottery, Italo-Mycenaean pottery, Mycenaean pottery, Neutron Activation Analysis (NAA), pithos, Punta di Zambrone, Roca Vecchia, Sybaris plain

The Research Questions

During the second half of the 2nd millennium BCE in southern Italy we are mainly dealing with a rather wide spectrum of wheelmade ceramics that were either imported from the Aegean or produced under the variable influence of Aegean technological knowhow and typological as well as stylistic influences. Regarding the local products, we can differentiate between two typological/stylistic traditions followed by the potters in the southern Italian workshops. The first tradition is a Mycenaean one and follows quite closely the rules of Mycenaean Greece in terms of shapes, motifs and decorations as well as the regular combinations of these traits. By contrast, the second tradition combines typological and stylistic traits from different regions of origin including Mycenaean Greece, Late Minoan Crete and southern Italy to variable degrees. In this way, the potters created specific Italo-Mycenaean products that remained geographically restricted. Such local pot-making practices, which eclectically combined elements of different manufacturing traditions, are known from all over the central and eastern Mediterranean. Using an overarching typological category, the products of these decidedly local products can be classified as Aegeanising ceramics as opposed to Aegean-type ceramics. The latter were also locally produced in

[1] Austrian Archaeological Institute, Austrian Academy of Sciences, Hollandstr. 11–13, 1020 Vienna, Austria; Reinhard.Jung@oeaw.ac.at.

[2] Dipartimento di Beni Culturali, University of Salento, Edificio ex INAPLI, Via Dalmazio Birago 64, 73100 Lecce, Italy; riccardo.guglielmino@unisalento.it.

[3] Dipartimento di Storia Culture Civiltà, University of Bologna, Piazza S. Giovanni in Monte 4, 40124, Bologna, Italy; francesco.iacono5@unibo.it.

[4] Helmholtz-Institut für Strahlen- und Kernphysik, University of Bonn, Nussalle 14–16, 53115 Bonn, Germany; mommsen@hiskp.uni-bonn.de.

many areas around the Mediterranean, but they closely reproduced either Mycenaean or Minoan prototypes and sometimes – especially in the case of high-quality products – can only be recognised as local products made outside of the Aegean by means of chemical analyses.[5] The results of archaeometric provenance analyses should be compared to those of typological and stylistic examination, in order to arrive at a comprehensive historical interpretation of the phenomenon of wheelmade pottery in Middle to Final Bronze Age southern Italy.

The problem of pottery circulation in southern Italy during the later 2nd millennium BCE has often been discussed with reference to both archaeological and archaeometric data. Richard Jones and Sara Levi recently used discriminant analyses of Italo-Mycenaean pots in order to differentiate between regional production series. Separate discriminant analyses of ICP-ES and AAS results showed broadly comparable results for Apulia alone (ICP-ES data of Torre Santa Sabina, Roca Vecchia and Coppa Nevigata) and Apulia, Basilicata and Calabria in combination (AAS data of Porto Perone, Termitito and Broglio di Trebisacce). The different sites appear quite well separated from each other in the discriminant analysis plots.[6] This supports in principal an interpretation assuming many different production centres for Italo-Mycenaean pottery, an interpretation that is also based on the specific, regionally restricted distribution patterns of some Italo-Mycenaean types.[7] However, in both published discriminant analyses plots, some single samples appear inside the borders of a different local group, which suggests some limited circulation of these pottery products within southern Italy.[8]

The problem of inter-regional transport of Italo-Mycenaean pottery resurfaced when we were looking for an explanation for the composition of the Mycenaean- and Minoan-type pottery assemblage found at Punta di Zambrone in southwestern Calabria.[9] Based on NAA results and in contrast to the picture offered by several other Recent Bronze Age (RBA) settlements, the Zambrone assemblage is exclusively composed of imports. For the time being, we are disregarding the chemical loners that at the moment cannot be assigned to any provenance region. However, we could exclude with high probability a local production at Punta di Zambrone on the basis of chemical comparison with local and regional claybeds. Interestingly, the imports at Punta di Zambrone predominantly come from various regions in western Greece and on Crete, but one chemical group found its match in southern Italy. This is group SybB that can be assigned to the southern plain of Sybaris by petrographic analyses of two chemical group members found at Broglio di Trebisacce[10] (see also below).

The presence of northern Calabrian pottery products (SybB) opened up the possibility that the population in other southern Italian regions might also have contributed to the composition of the assemblage at this southern Calabrian site (Punta di Zambrone). We can formulate two hypotheses on the main role that the southern Italian communities played in the inter-regional distribution of Aegean-type ceramics. Either they were exporting their own products to other harbour sites such as Punta di Zambrone by means of direct exchange contacts of whatever type, or their harbours functioned as stop-over ports and exchange places for Aegean products on the route from Greece to the Tyrrhenian Sea. Of course, a combination of the two possibilities would be a third plausible hypothesis.

If the first hypothesis reflects the Bronze Age reality to a larger degree, we would expect to find pots of different southern Italian regions at Punta di Zambrone. However, a larger scale inter-

5 We thus underline the need to differentiate clearly between local and regional Italo-Mycenaean types (and typological elements) on the one hand, and Minoan and Mycenaean types on the other (Guglielmino 2005, 641–642, pls. 65d–e, 66c; Jung 2006a, 16–19), in contrast to other proposals, in which all wheelmade Aegean-type and Aegeanising pottery vessels made in Italy are united in the same typology without differentiation of the different traditions they depend on (Bettelli 2014).

6 Jones – Levi 2014, 271–272, fig. 4.39–4.40.

7 Bettelli 2002, 64–68, fig. 22B; cf., however, Jung 2006b, 418 n. 83.

8 Cf. Jones – Levi 2014, 271–272, fig. 4.39–4.40.

9 Jung et al. 2015a.

10 Jung et al. 2015a, 459.

regional exchange of Italo-Mycenaean ceramics does not seem to be indicated by the published analytical results of the Jones and Levi team. At Punta di Zambrone the only other Italian region represented by their Mycenaean-type products is the southern plain of Sybaris (see above). Their products amount to 9% of the analysed vessels.[11] The Bonn database includes 850 samples taken from vessels found in southern Italy and Sicily. Nevertheless, some products of other Italian regions might be hidden among the 20% of so far non-assignable vessels of the Zambrone sample.

If the second of the possibilities mentioned above illustrates the predominant way of transporting pottery, the Mycenaean-type pots produced in the Sybaris plain that reached Punta di Zambrone might have been added in Calabria to the pottery imports that were shipped from Greece and were the main products of interest for the community in the southern Tyrrhenian. In this case we may expect to find a similar spectrum of Greek imports in port settlements lying on the route between Greece and Tyrrhenian Calabria. When searching for such intermediate stations, a first region to look at would, of course, be northern Calabria and, specifically, the southern plain of Sybaris, from where some of the Aegean-type vessels found at Punta di Zambrone originated. Analytical results (obtained with different analytical techniques) exist for two sites on the Sybaris plain. These are Torre del Mordillo, located on the central plain and probably controlling most of the plain in the Middle and Recent Bronze Age,[12] and Broglio di Trebisacce, on the northern fringe of the plain. In both cases, the analysed Aegean-type and Aegeanising ceramics mainly come from RBA and specifically from RBA 2 contexts[13], yet they are not strictly contemporaneous with the RBA 2 contexts excavated at Punta di Zambrone. Most of the relevant layers from the Sybaris plain post-date the deposits from the fortification ditch of Punta di Zambrone.[14] In both of the northern Calabrian settlements, Jones, Bettelli, Levi and Vagnetti classified the wheelmade fine-ware pots as predominantly Italo-Mycenaean, i.e. as of local/regional origin. This applies to all chronological phases examined by those authors.[15] Thus, the resulting picture of quantitative relations between local and imported wheelmade ceramics is exactly the reverse of the one we obtained at Punta di Zambrone. This means the northern Calabrian imports at Punta di Zambrone most probably did not reach this southern Calabrian port together with Greek imports in the framework of down-the-line exchanges between harbours positioned along the southern Italian coasts. However, this conclusion is necessarily a preliminary one, and Mycenaean-type material from other southern Italian sites located on the coastal route between western Greece and southern Italy needs to be examined in order to further scrutinise it.

We have to turn to Apulia in order to find a coastal site of the Recent Bronze Age located to the east of Punta di Zambrone, on the route to Greece, and at the same time yielding a similar Aegean pottery assemblage that is dominated by Greek imports. Torre Santa Sabina, Scoglio del Tonno and Roca Vecchia are sites that show a high percentage of Aegean imports, at least for part of the periods LH IIIB and IIIC.[16] Torre Santa Sabina offers an interesting case, as the material comes from RBA 2 habitation structures,[17] and the Aegean pots may best be dated to LH IIIC Early – thus being roughly contemporary with the Zambrone evidence. However, the quantity of Aegean-type pottery is rather restricted and not all of it comes from closed stratigraphic contexts.[18] The early excavations at Scoglio del Tonno brought to light one of the largest assemblages of Aegean-type

11 Four vessels out of 44 (Jung et al. 2015a, 459, fig. 2).

12 According to Peroni's territorial model (Peroni 1994, 840–841, fig. 227; 850–851, fig. 229).

13 Vagnetti – Panichelli 1994; Vagnetti 2001a.

14 The typologically most recent pots from both the rampart layers at Torre Mordillo and from the Central Hut at Broglio di Trebisacce date to LH IIIC Advanced (Jung 2006a, 104–137), while the latest Mycenaean pots from the fortification ditch at Punta di Zambrone fall into LH IIIC Early (Jung et al. 2015b, 68–79).

15 Jones et al. 2014b, 411–413, fig. 6.3.

16 Jones et al. 2014b, 411–413, fig. 6.3.

17 Cinquepalmi – Coppola 1998.

18 13 Aegean-type fragments from the settlement and one from tomb 5 have been analysed and are listed by Jones and Levi (Jones – Levi 2014, 144). 23 sherds are published from the settlement, three from tombs 3 and 12 (Cinquepalmi – Coppola 1998).

pottery in southern Italy. Elizabeth Fisher catalogued 205 vessels and sherds and estimated that another 100–200 sherds should be added.[19] 48 pieces from Scoglio del Tonno were analysed by Richard Jones using different analytical techniques. Unfortunately, no contextual information is available for these finds, which are mainly of Palatial and Post-palatial date (LH IIIA Late – LH IIIC). According to the interpretation of the data by Jones and Levi, imports clearly dominate over local/regional products.[20] However, the repertoire differs from the one attested at Punta di Zambrone in several respects including date[21] and type frequencies.[22]

Under these conditions Roca Vecchia seemed to be the most promising site to execute more chemical analyses on Aegean and Aegeanising ceramics by using NAA, in order to produce new data that are compatible with those from Punta di Zambrone and could serve to test the above-mentioned hypotheses. The ongoing excavations of Roca Vecchia offer the best conditions for such an endeavour, first because of the long vertical stratigraphic sequence and second because of the huge quantities of Aegean-type pottery finds recovered in closed stratigraphic contexts.[23] Third, previous chemical analyses by Jones using ICP have already suggested the existence of a high percentage of Aegean imports, especially among late Palatial and early Post-palatial products.[24]

On this basis, our project was designed to pose some specific questions rather than seeking to reconstruct the full range of Aegean pottery production and consumption at Roca Vecchia. We wanted to focus on the late Palatial and early Post-palatial period, later LH IIIB and LH IIIC Early, the same time period to which the Aegean-type pots from Punta di Zambrone are dated (represented at Roca Vecchia by the two earliest stratigraphic phases of the RBA). For analysis we have selected vessels that resemble those found at Punta di Zambrone on the basis of both type and style as well as macroscopic fabric criteria. Here, we preferred types that are attested at both sites with several specimens and can be taken as representative for the period. In addition, we sampled vessels that are characteristic for Roca Vecchia itself, both in terms of type (specific types with restricted geographical distribution in southern Italy: RocV 5 and 8 and perhaps also RocV 19) and in terms of fabric (RocV 5, 6, 8, 11, 12, 16 and 20). This twofold strategy should allow us to find (1) pots produced in the same Aegean workshops and then exported to Roca Vecchia and Punta di Zambrone, respectively, and (2) to identify possible exports from the Salento region to southern Calabria.

Results of the Chemical Analyses

The 20 vessels selected, including the 8 pieces characteristic for Roca Vecchia, were analysed in Bonn using the routine Neutron Activation Analysis (NAA) procedure as described before,[25] and recently in Jung et al. 2015a. Tab. 1 gives the list and description of these samples. The results, if 20 samples are considered to be meaningful, oppose the findings for the site of Punta di Zambrone. Here the locally made, i.e. in southern Italy, Italo-Mycenaean vessels prevail: 8 out

19 Fisher 1988, 26, 206–251, figs. 4–32. However, only a complete study of all the finds from Scoglio del Tonno kept at the National Archaeological Museum of Taranto may clarify the matter.

20 Jones – Levi 2014, 154–162. One should note that some of the analysed fragments seem to post-date the Bronze Age (Jung 2016, 285).

21 Many vessels date to LH IIIA Late and LH IIIB Early–Middle and are thus earlier than the finds from Punta di Zambrone.

22 In general there are more types attested at Scoglio del Tonno than at Punta di Zambrone, which may only partly be explained by the higher degree of fragmentation of the Zambrone finds (cf. the statistics by Bettelli 2002, 63, fig. 15; 65, fig. 16).

23 See Guglielmino, this volume.

24 Of 35 analysed Aegean or Aegeanising vessels, 18 were classed as imports (mainly assigned to the northern Peloponnese as well as western and central Crete), while 17 were interpreted as local or probably local/regional (Jones – Levi 2014, 146–149, 258–260, 271).

25 Mommsen et al. 1991.

of the 20 pieces from Roca Vecchia belong to a new group temporarily named X115, assigned with high probability to the region of southeastern Italy (Salento), maybe even to workshops close to Roca Vecchia, since group X115 comprises exclusively samples from Roca Vecchia, while kiln wasters from L'Amastuola,[26] close to Taranto, are members of a group named TaIA and this group is not very different in composition to group X115 (with slightly lower values in Hf and Zn and higher values in Fe, if multiplied with the best relative fit factor of 0.93 with respect to TaIA). In addition, a new group, X116, with only 4 samples from Roca Vecchia could be formed, which is close in composition to group X115 except for lower K and Rb values (best relative fit factor 0.99 for X116 with respect to X115), a deviation encountered frequently before.[27] Like X115, it is of still unknown origin, but these 4 pieces were certainly also made at or somewhere in the region of the X115 workshops. A further vessel shows composition SybB, assigned to workshops in the southern Sybaritic plain.[28] This increases the number of southern Italian vessels out of 20 to 13, more than 50%. Only 5 vessels were imported from Greece: 3 from the Western Peloponnese (Achaea, Elis); 1 probably from Arcadia, a member of group Ul54 assigned to the site Asea there,[29] and 1 probably from Boeotia, group X120. The raw concentration data of the 20 samples are given in Tab. 2 and Tab. 3 lists the average concentration values of the groups mentioned. The concentration patterns of groups Ul54 and OlyA were published recently.[30]

Sample no.	Area and Stratigraphical Unit	Area and Stratigraphical Phase	Type	Linear Decoration	Motif	Color of Paint	Chemical Group [fit factor]
RocV 1	SAS IX: 11352, 11350, 9298, 10307	Area IX, Phase I	deep bowl FT 284/285	11.0	0	dark	singleton
RocV 2	SAS IX: 11349	Area IX, Phase II	krater FT 281/282	1 lower band, 2 interior bands	panelled pattern FM 75 or tricurved arch FM 62 with vertical chevrons FM 58	dark	X116 (close to X115) [1.00]
RocV 3	SAS X: 4082	Area X, Phase V	deep bowl FT 284/285	11.0	0	dark	X120 (Boeotia) [0.81]
RocV 4	SAS IX: 11379, 11349	Area IX, Phase I	deep bowl FT 284/285	9.3/16 + 2 lower bands	horizontal zigzag FM 61 in added white paint	dark	OlyA (Achaea/ Elis) [0.97]
RocV 5	SAS IX: 11718, 11331, 9287, 9247, 3324	Area IX, Phase V	Italo-Mycenaean open vessel	exterior rim band 2.1, 1 lower band	pannelled pattern FM 75 and isolated semicircles FM 43	red	X115 [0.94]
RocV 6	SAS IX: 11553	Area IX, Phase II	deep bowl FT 284/285	9.1	0	red	X115 [1.18]
RocV 7	SAS IX: 11349, 11348, 11347, 11093	Area IX, Phase II	neck-handled amphora FT 67	exterior band below rim 2.1, lower interior band 2.1, belly band 2.3, lower bands 2.3	spiraliform motif (cf. FM 49), joining semicircles FM 42	dark	X115 [1.03]

26 Geißler et al. forthcoming.
27 See e.g. Mountjoy – Mommsen 2001.
28 Jung et al. 2015a.
29 Forsén et al. 2017.
30 Ul54: Forsén et al. 2017; OlyA: Jung et al. 2015a; Mommsen et al. 2016.

Sample no.	Area and Stratigraphical Unit	Area and Stratigraphical Phase	Type	Linear Decoration	Motif	Color of Paint	Chemical Group [fit factor]
RocV 8	SAS IX: 11379, 11349, 10306, 9850, 9276, 11245, 9630, 11347, 11346, 10990, 11718	Area IX, Phase I	Italo-Aegean hydria	1.2 + band 7.1 around neck attachment, shoulder bands 2.3, lower bands 2.3, 2 lower bands	linked whorl-shell pattern FM 24	dark	X115 [1.07]
RocV 9	SAS IX: 11379, 11349, 9298, 9961	Area IX, Phase I	deep bowl FT 284/285	11.0	0	dark	Ul54 (with further members from Asea, Arcadia) [0.95]
RocV 10	SAS IX: 11349, 11408, 12277	Area IX, Phase II	krater FT 281/282	3 broad lower bands, 1 broad interior band	triglyph-like palm trees FM 15 or hybrid flowers FM 18	dark	X115 [0.91]
RocV 11	SAS IX: 11349, 10939	Area IX, Phase II	deep bowl FT 284/285	16 + lower band 2.1	multiple stems FM 19,37/38	dark	X116 (close to X115) [1.01]
RocV 12	SAS IX: 11349, 10768, 11347, 11084, 10306, 9295	Area IX, Phase II	krater FT 281/282	1.3	panelled pattern FM 75 with antithetic loops FM 50	red	X115 [1.01]
RocV 13	SAS IX: 11349, 11347	Area IX, Phase II	large closed vessel	belly bands 2.3, 2 broad lower bands	0	dark and red	not measured
RocV 14	SAS IX: 11349	Area IX, Phase II	deep bowl FT 284/285	5.1	panelled pattern FM 75	dark	X116 (close to X115) [1.09]
RocV 15	SAS IX: 11379, 11349, 11718	Area IX, Phase I	stirrup jar	2 bands across false neck	0	red	not measured
RocV 16	SAS IX: 11349	Area IX, Phase II	closed vessel	3 bands on neck-shoulder junction, 1 broad belly band	multiple stems FM 19,37/38	dark	X116 (close to X115) [0.91]
RocV 17	SAS IX: 11379	Area IX, Phase I	mug FT 226	belly bands 2.2, base decoration 3.2	curved stripes FM 67?	red and dark	OlyA (Achaea/ Elis) [0.89]
RocV 18	SAS IX: 11341	Area IX, Phase V	pithos	0	0	unpainted	SybB [0.87]
RocV 19	SAS IX: 10762	Area IX, phase uncertain	Italo-Mycenaean carinated bowl	15	broad wavy line FM 53,25	red	X115 [0.92]
RocV 20	SAS IX: 11379, 10306, 11349, 11675, 11289, 11718, 9276, 9630, 9250	Area IX, Phase I	krater FT 281/282	1.3	panneled pattern FM 75 and isolated semicircles FM 43	red	X115 [0.97]
RocV 21	SAS IX: 11379, 11349, 11408, 10306	Area IX, Phase I	Italo-Mycenaean large closed vessel	belly bands 2.3	curvolinear pattern	dark	singleton
RocV 22	SAS IX: 11379, 11408, 11763, 11349,9276, 5741	Area IX, Phase I	jug FT 105 or hydria FT 128	0	0	unpainted	OlyA (Achaea/ Elis) [1.22]

Tab. 1 Analysed samples from Roca Vecchia: wheelmade Mycenaean and Mycenaeanising pottery (for the decoration codes cf. Jung 2002, 575–580); one pithos

Sample	As	Ba	Ca%	Ce	Co	Cr	Cs	Eu	Fe%	Ga
RocV 1	6.94	486.	9.21	65.3	30.0	248.	7.39	1.28	4.59	20.9
RocV 2	15.5	472.	8.61	58.5	13.2	154.	6.17	0.98	3.44	12.0
RocV 3	4.48	483.	2.80	63.6	36.6	636.	5.86	1.24	5.01	19.2
RocV 4	8.02	453.	8.34	66.4	28.4	246.	7.78	1.34	5.43	25.9
RocV 5	23.3	362.	11.3	60.6	14.3	138.	5.67	1.04	3.45	15.3
RocV 6	9.41	421.	12.2	48.6	9.91	115.	4.43	0.85	2.68	18.2
RocV 7	11.5	409.	8.95	56.5	10.5	98.8	5.23	1.06	2.97	11.2
RocV 8	13.6	436.	11.9	52.6	11.6	130.	4.93	0.97	3.08	–
RocV 9	6.19	363.	9.23	57.7	30.9	257.	5.28	1.06	4.68	19.2
RocV 10	6.76	450.	9.87	63.3	14.1	176.	5.65	1.18	3.47	14.2
RocV 11	17.5	560.	13.2	60.9	11.6	137.	5.85	1.01	3.25	16.2
RocV 12	14.8	562.	12.1	55.0	13.4	135.	5.52	0.98	3.18	17.4
RocV 14	14.7	525.	16.0	50.7	11.4	143.	5.09	0.87	2.87	10.5
RocV 16	10.00	524.	11.5	68.8	14.3	164.	6.75	1.18	3.90	18.3
RocV 17	4.69	438.	4.46	75.6	32.5	282.	7.92	1.28	5.46	22.9
RocV 18	4.15	535.	6.56	85.8	19.0	124.	9.26	1.32	4.83	28.0
RocV 19	5.03	436.	10.8	62.4	20.9	125.	6.11	1.07	3.57	20.8
RocV 20	13.7	634.	10.9	58.0	15.2	143.	5.91	0.99	3.33	21.5
RocV 21	6.48	434.	8.38	66.1	14.4	211.	6.59	1.01	3.66	16.0
RocV 22	4.45	342.	8.77	52.1	24.7	214.	6.07	0.96	4.32	13.5
ave. error	0.14	43.	0.28	0.49	0.15	1.0	0.12	0.024	0.014	2.4
in%	1.4	9.2	2.8	0.8	0.8	0.5	1.9	2.2	0.4	13.

Sample	Hf	K%	La	Lu	Na%	Nd	Ni	Rb	Sb	Sc
RocV 1	4.30	2.14	31.5	0.41	0.75	28.8	175.	127.	1.30	18.0
RocV 2	4.52	1.34	28.2	0.33	1.57	23.1	113.	95.5	0.48	13.3
RocV 3	6.20	1.91	31.1	0.47	1.21	27.9	306.	116.	0.76	18.6
RocV 4	3.78	2.64	31.9	0.43	0.83	19.1	276.	162.	0.62	23.0
RocV 5	5.02	1.87	29.3	0.39	1.08	24.6	114.	115.	0.86	12.9
RocV 6	3.93	1.54	23.8	0.30	0.94	17.5	119.	97.3	0.44	10.6
RocV 7	3.98	1.80	27.3	0.34	0.79	25.3	62.6	105.	0.36	12.2
RocV 8	4.46	1.62	25.3	0.30	0.85	18.5	118.	106.	0.52	11.9
RocV 9	3.56	1.60	27.8	0.39	1.32	24.4	239.	101.	0.84	19.1
RocV 10	4.85	1.93	31.7	0.37	1.39	24.0	135.	113.	0.41	13.3
RocV 11	4.94	1.09	30.2	0.35	1.32	22.3	138.	85.8	0.68	12.0
RocV 12	4.38	1.81	26.5	0.33	0.96	20.6	123.	115.	0.65	12.4
RocV 14	4.65	1.11	25.4	0.32	1.22	18.5	102.	87.4	0.54	11.2
RocV 16	5.36	1.43	33.4	0.37	1.54	22.8	146.	81.0	0.59	14.7
RocV 17	5.13	2.68	36.3	0.49	1.00	27.3	227.	156.	0.59	21.5
RocV 18	5.47	3.12	42.7	0.47	1.07	31.8	96.8	161.	1.03	19.1

Sample	Hf	K%	La	Lu	Na%	Nd	Ni	Rb	Sb	Sc
RocV 19	4.16	2.06	30.6	0.35	0.78	26.3	118.	136.	0.39	14.0
RocV 20	4.25	1.86	27.9	0.35	0.99	20.7	103.	118.	0.65	12.9
RocV 21	5.25	2.06	31.9	0.30	1.15	27.5	114.	129.	0.47	13.2
RocV 22	3.75	2.06	25.5	0.35	0.85	20.0	215.	123.	0.32	17.1
ave. error	0.066	0.030	0.099	0.013	0.007	2.9	33.	2.9	0.035	0.023
in%	1.4	1.6	0.3	3.6	0.6	12.	22.	2.5	5.7	0.2

Sample	Sm	Ta	Tb	Th	U	W	Yb	Zn	Zr	
RocV 1	5.54	0.87	0.74	10.3	5.21	1.41	2.85	134.	230.	
RocV 2	4.04	0.89	0.60	9.67	3.73	2.20	2.41	69.8	161.	
RocV 3	5.19	0.90	0.79	10.5	2.21	2.35	3.26	117.	246.	
RocV 4	5.14	0.74	0.85	11.4	2.01	2.40	2.87	109.	170.	
RocV 5	4.40	0.78	0.71	10.1	3.33	2.06	2.69	115.	190.	
RocV 6	3.37	0.67	0.60	7.86	2.50	1.68	2.13	74.5	165.	
RocV 7	4.20	0.85	0.65	8.94	2.01	2.41	2.36	84.0	165.	
RocV 8	3.71	0.81	0.63	8.73	3.04	1.87	2.19	104.	184.	
RocV 9	4.24	0.64	0.79	9.21	1.96	2.03	2.67	121.	154.	
RocV 10	5.14	0.88	0.79	10.7	2.86	1.58	2.79	144.	185.	
RocV 11	4.54	0.93	0.69	10.2	2.80	1.29	2.50	73.1	177.	
RocV 12	3.85	0.87	0.66	9.07	3.32	2.08	2.48	105.	170.	
RocV 14	3.63	0.88	0.68	8.83	2.16	1.48	2.24	75.8	158.	
RocV 16	5.12	1.08	0.74	11.1	3.48	1.68	2.77	89.2	232.	
RocV 17	5.36	1.13	0.80	12.6	2.75	2.55	3.18	119.	238.	
RocV 18	5.91	1.36	0.87	14.1	4.79	2.08	3.40	141.	175.	
RocV 19	4.24	0.90	0.68	10.4	3.15	1.78	2.28	118.	157.	
RocV 20	4.24	0.93	0.67	9.49	3.19	2.12	2.34	106.	162.	
RocV 21	4.82	0.96	0.57	11.5	2.19	1.62	2.06	73.2	215.	
RocV 22	3.98	0.61	0.60	8.64	1.90	1.51	2.37	73.7	174.	
ave. error	0.051	0.053	0.059	0.078	0.25	0.20	0.068	2.6	23.	
in%	1.1	6.0	8.5	0.8	8.4	10.	2.6	2.5	13.	

Tab. 2 Raw data of the 20 samples from sherds found at Roca Vecchia. Given are the concentrations C of 29 elements in µg/g (ppm), if not indicated otherwise, and below, the average experimental uncertainties (errors), also in % of C

	TaIA 34 samples factor 1.00		X115 8 samples factor 0.93		X116 4 samples factor 0.95		SybB 51 samples factor 1.20		X120 11 samples factor 1.00	
	M	σ(%)	M	σ(%)	M	σ(%)	M	σ(%)	M	σ(%)
As	10.5	(32.)	11.4	(44.)	13.8	(26.)	10.8	(69.)	8.40	(64.)
Ba	429.	(21.)	433.	(19.)	486.	(11.)	791.	(56.)	374.	(46.)
Ca\%	11.4	(17.)	10.3	(17.)	11.8	(31.)	8.55	(33.)	5.44	(51.)
Ce	61.1	(1.9)	53.0	(1.5)	56.5	(5.6)	94.5	(4.5)	54.5	(3.6)
Co	15.2	(11.)	12.6	(19.)	11.9	(5.1)	19.0	(7.5)	29.7	(13.)
Cr	145.	(10.)	123.	(13.)	142.	(5.0)	131.	(7.2)	474.	(13.)
Cs	5.89	(5.7)	5.03	(4.1)	5.65	(4.8)	8.10	(9.2)	3.74	(15.)
Eu	1.10	(2.0)	0.95	(4.5)	0.96	(5.1)	1.57	(4.5)	1.03	(3.2)
Fe\%	3.82	(4.9)	2.98	(2.5)	3.18	(5.5)	5.41	(5.0)	4.39	(6.3)
Ga	18.2	(15.)	15.4	(21.)	14.3	(18.)	27.5	(17.)	15.3	(9.8)
Hf	3.87	(5.5)	4.07	(7.5)	4.62	(4.9)	5.90	(6.7)	4.72	(7.8)
K\%	1.94	(3.8)	1.68	(3.1)	1.17	(8.4)	2.95	(10.)	1.61	(13.)
La	29.9	(1.5)	25.8	(2.6)	27.7	(5.2)	45.5	(4.1)	25.5	(4.0)
Lu	0.37	(3.6)	0.32	(4.7)	0.33	(3.4)	0.51	(4.1)	0.38	(3.8)
Na\%	0.76	(12.)	0.90	(17.)	1.34	(7.8)	1.03	(17.)	0.85	(40.)
Nd	26.2	(6.1)	20.5	(12.)	20.7	(13.)	39.2	(6.2)	22.1	(6.2)
Ni	134.	(19.)	101.	(25.)	121.	(23.)	100.	(35.)	357.	(20.)
Rb	113.	(5.1)	105.	(5.9)	83.2	(12.)	159.	(7.1)	81.0	(6.5)
Sb	0.49	(20.)	0.50	(30.)	0.54	(16.)	0.77	(25.)	0.57	(27.)
Sc	14.3	(3.8)	11.6	(2.2)	12.1	(5.1)	19.3	(3.1)	16.2	(6.2)
Sm	4.90	(3.0)	3.84	(6.4)	4.09	(8.6)	7.16	(3.9)	4.26	(3.6)
Ta	0.88	(5.2)	0.78	(6.8)	0.90	(5.1)	1.42	(7.2)	0.76	(4.4)
Tb	0.67	(6.7)	0.63	(7.6)	0.65	(8.0)	0.95	(6.9)	0.64	(8.5)
Th	9.80	(1.9)	8.71	(2.2)	9.42	(3.5)	15.5	(4.4)	8.76	(5.5)
U	2.62	(14.)	2.70	(15.)	2.88	(19.)	3.40	(15.)	1.62	(7.8)
W	2.26	(16.)	1.80	(16.)	1.54	(22.)	2.92	(16.)	1.66	(12.)
Yb	2.45	(2.3)	2.23	(6.3)	2.35	(2.6)	3.46	(3.2)	2.51	(3.2)
Zn	90.7	(7.4)	97.9	(13.)	72.9	(7.5)	140.	(13.)	88.9	(8.7)
Zr	165.	(14.)	161.	(12.)	174.	(12.)	213.	(23.)	179.	(16.)

Tab. 3 Average concentrations M and spreads (root mean square deviations = standard deviations) σ of the formed groups: TaIA: region of L'Amastuola/Taranto, X115 and X116: unknown, probably Salento, SybB: southern Sybaritic plane, X120: unknown, probably Boeotia. The groups X115, X116, and SybB are multiplied with the best relative fit factor with respect to the group TaIA

These provenance determinations contradict the results of Jones and Levi for the same site of Roca Vecchia.[31] They report a large contingent of about 50% of Aegean imports, whereas in our set of 20 samples only 25% were imported from Greece and the local 'Italo-Mycenaean' wares contribute 65%.[32] The case of Punta di Zambrone, with the high percentage of Aegean imports, is a peculiar, so far rare, result among southern Italian settlements. We can exclude having missed local products in the extensive sampling strategies, in which only very small pieces were not sampled.

[31] See n. 24.

[32] Note, however, that the analysis programme by Jones and Levi also included samples from earlier as well as later stratigraphic phases. Our project focused on the earliest levels of the Recent Bronze Age, in order to collect evidence contemporaneous with that of Punta di Zambrone (see above).

A preliminary assessment of fabric groups at Roca conducted by Iacono has allowed us to identify two main (read 'typical') groups within the Roca material. These have been identified as 'local' on the basis of Jones and Levi's analyses,[33] but their definition was not purely visual/macroscopic, as it was aided by the analysis of about 100 vessels/sherds through p-XRF. The two groups can be briefly characterised as one rich in Iron and another rich in Calcium. This is not unusual in sets of lustrous decorated pottery, but the overlap of some of the members of the groups with local southern Italian productions identified by means of NAA is extremely interesting. The Fe-rich samples had reddish paint, pink to brownish fabric and were often micaceous and slightly softer. The Ca-rich group, on the other hand, usually had a dark brown to black paint, cream to buff fabric, was normally harder than the iron-rich material, and almost always non-micaceous. Within the sample from Roca Vecchia the samples RocV 5, 6, 12, 20 (all belonging to X115) can be put under the Fe-rich 'label' and RocV 8, 11, and 16 in the Ca-rich one (which possibly overlaps with X116) (but compare Tab. 3 for the NAA concentration results).

Detailed Discussion of the Results with Reference to Single Vessels

Imports from Greece

Two of the analysed monochrome deep bowls FT 284/285 (RocV 1 and RocV 9[34]), both found in early RBA 2 layers (area SAS IX, Phase I), show the everted rim that is found on monochrome deep bowls from the last phase of the Pylos palace, the destruction level dated to LH IIIC Early 1.[35] The first of these deep bowls from Roca turned out to be a singleton (RocV 1), while the second one originated in Arcadia,[36] central Peloponnese (RocV 9). The same morphological variety of the monochrome deep bowl is represented with three specimens in the RBA 2 ashy fill layers in the fortification ditch at Punta di Zambrone.[37] Two of them were produced in western Greece (chemical group OlyA from Achaea or Elis), while the third one also seems to be a Peloponnesian product.[38] These analytical results prove that the monochrome deep bowl with everted rim was produced in several areas of the Peloponnese. They furthermore suggest that such products may have reached southern Italy via different routes at the beginning of LH IIIC Early.

The third deep bowl FT 284/285 with monochrome decoration is also an import, but unlike RocV 9 it was not produced in the Peloponnese. The NAA result indicates a probable Boeotian workshop (RocV 3, Fig. 1.RocV 3). The rim of this deep bowl is flaring, the painted decoration partially diluted with clearly visible brush traces. These characteristics hint at a later production period than that of the first two monochrome deep bowls (RocV 1 and 9), and, in fact, the stratigraphic context of RocV 3 belongs to the last Bronze Age settlement phase (area SAS X, Phase V) dating to Final Bronze Age 2 (FBA 2).

Two sampled sherds (RocV 4, Fig. 1.RocV 4, and RocV 11) belong to deep bowls FT 284/285 of type C according to Kardamaki, a decoration type (decoration 16, with rim band between 1.5 and 2.49cm of width) that was common in both LH IIIB Final and IIIC Early.[39] The first sampled specimen (RocV 4) is a Peloponnesian import according to the NAA results. It shows an everted rim similar to that of the two monochrome deep bowls, but even more articulated than in the

33 Jones – Levi 2014, 146–149, 258–260, 271.

34 Guglielmino, this volume, fig. 2.3 (RocV 1), 4 (RocV 4).

35 Blegen – Rawson 1966, 110, 189–190, 308, 398, figs. 385.594, 1172, 1176; 386.594; Mountjoy 1999, 352, cat. nos. 116 and 117, fig. 110.117. For the discussion of these parallels see: Guglielmino 2009a, 191, 193, fig. 3.1, 2. – For the date of the palace destruction see: Vitale 2006, 200, tab. 2.

36 Forsén et al. 2017.

37 Jung et al. 2015b, 69–70, fig. 13.4; 95–96, cat. no. 4.

38 Jung et al. 2015a, 458, tab. 1: sample nos. Zamb 1, 39 and 40.

39 Kardamaki 2009, 204–206, 228–231. However, the rim band of RocV4 bifurcates, which leads to the decoration type 9.3.

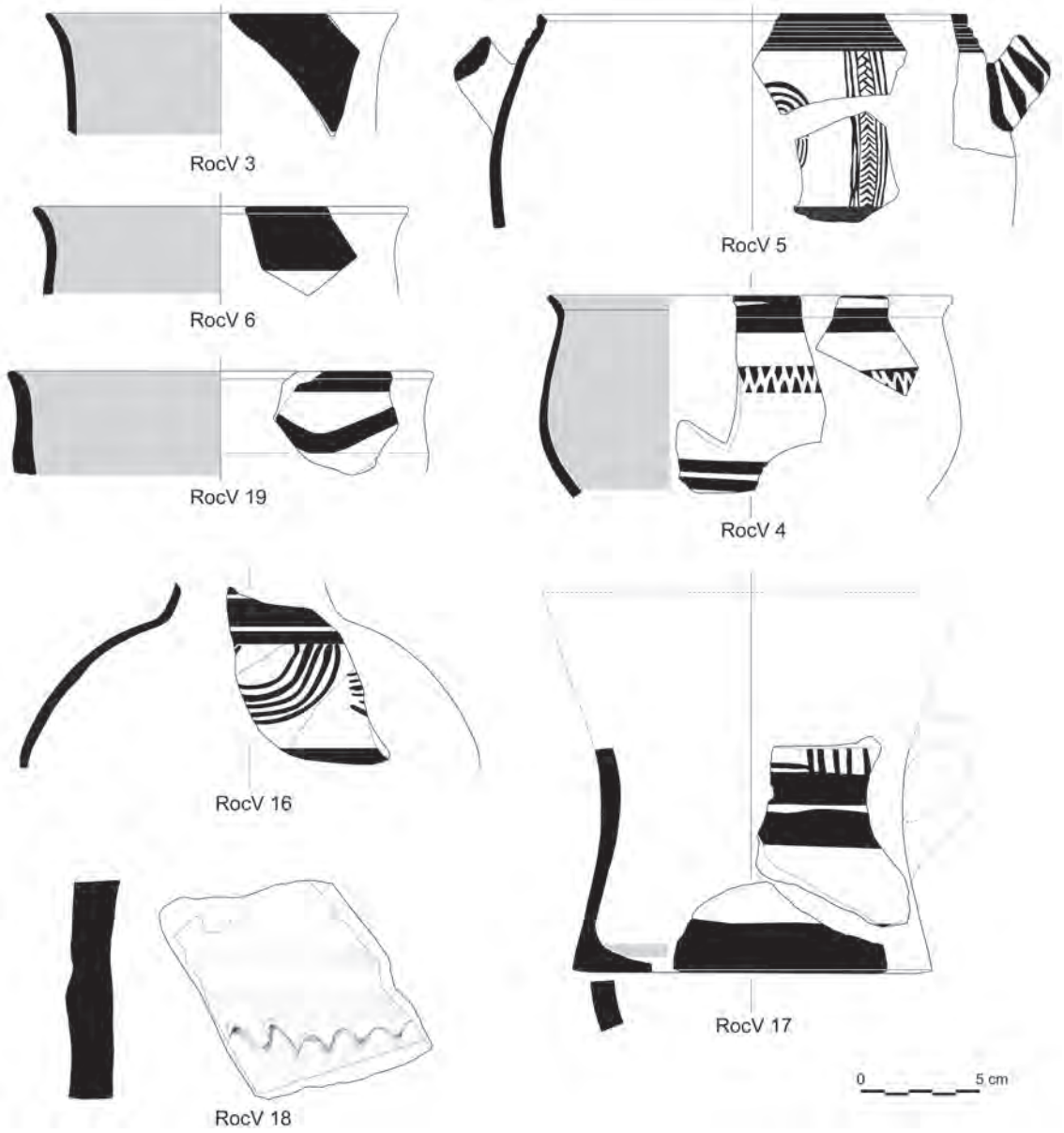


Fig. 1 Mycenaean and Mycenaeanising vessels and one pithos (RocV 18) from Roca Vecchia, analysed with NAA. Scale 1:3 (drawings: R. Guglielmino, L. Coluccia and F. Iacono)

monochrome specimens. It was found in the same early RBA 2 layers as two of the mentioned monochrome deep bowls. Its most characteristic feature is the horizontal zig-zag executed in added white paint on top of a horizontal band in the decorative zone. The rare light-on-dark technique finds several parallels in Post-palatial Greece. In our case the most significant ones are deep bowls from Teichos Dymaion on Cape Araxos in western Achaea,[40] because the NAA result indicates a production place in this region or in Elis, immediately to the south (chemical group OlyA). Added white paint was also used in the Voúdeni workshop, a western Achaean workshop active in the middle of LH IIIC and known for its pictorial products.[41] Published examples from Voúdeni itself include a monochrome krater FT 281/282 with pictorial decoration in the reserved handle zone (white paint on the animal bodies), a monochrome kalathos FT 290/291 with added white zigzag

40 Mastrokostas 1966, 64, pl. 61α; Mastrokostas 1967a, pl. 165.9.
41 Moschos 2009a, 360–361; Moschos 2009b, 257 n. 171.

bands and dotted lines below the reserved handle zone, and three fragments of pictorial kraters with warriors, rowers and birds.[42]

A further vessel produced in the Peloponnese and exported to Roca Vecchia during the first RBA 2 phase (area SAS IX, phase I) is a mug, FT 226 (RocV 17, Fig. 1.RocV 17). Again the chemical group OlyA indicates an Elian or Achaean workshop. Due to the rarity of settlement excavations in these northwestern Peloponnesian regions, few specimens are published. There is one parallel for the combination of shape and motif (curved stripes FM 67) from chamber tomb 15 in the Trípes cemetery at Kladhéos.[43]

Surprisingly, another Peloponnesian import found in the same early RBA 2 layers as most of the analysed deep bowls (Area SAS IX, Phase I) is an unpainted pot (RocV 22[44]). It is a large one-handled closed vessel, either a jug FT 105 or a hydria FT 128.[45] Unpainted Mycenaean vessels are a rarity in southern Italy. Two rather small wall fragments from the fortification ditch of Punta di Zambrone come from a large jug (FT 105) or a neck-handled amphora (FT 70) and from a belly-handled amphora (FT 58) or a hydria (FT 128) respectively.[46] Both were probably entirely unpainted vessels, but the fragmentary preservation prevents a 100% certain classification. In all three cases (RocV 22, Zamb 32, Zamb 38) the NAA shows that we are dealing with imports from the northwestern Peloponnese, i.e. from Achaea or Elis (chemical group OlyA). The fact that only very few settlement finds are published from these regions impedes the search for parallels, but one can cite a hydria found at Dhrakótripa in western Achaea.[47]

Apulian Products

Based on the assignation of chemical groups X115 and X116 to workshops located in Apulia, we can confirm the above-mentioned existence of two pot making traditions, a first one that includes Mycenaean-type products and a second one, the products of which are Aegeanising and combine typological and stylistic traits of different provenance.

Eight vessels of the analysed sample are local products of Mycenaean type. A deep bowl FT 284/285 of type A with the rim decoration 5.1 characteristic for this type[48] is decorated with a triglyph motif FM 75 consisting of a central net pattern FM 57 and lateral arrows (RocV 14, from SAS IX, Phase II, early in RBA 2).[49] One deep bowl A from a LH IIIB layer at Thebes shows a triglyph with the same combination of motif elements.[50] In general, arrows as a fringe motif of triglyphs on deep bowls A are attested in LH IIIB Middle at Mycenae[51] as well as in LH IIIB Final

42 Kolonas 2008, 16–17, fig. 18; 19, fig. 23; I. Moschos in: Badisches Landesmuseum Karlsruhe 2018, 356, cat. no. 297; 362–363, cat. nos. 311–313. Two krateriskoi and two spouted kraters FT 298 from Delphi and Kirrha in Phocis show decorations with an outer band carrying quirk motifs FM 48 in added white paint similar to the deep bowl from Roca Vecchia, but the vessels from Phocis are much larger (Mountjoy 1999, 759–762, fig. 295.743).

43 O. Vikatou in: Heilmeyer et al. 2012, 325, cat. no. 106. The horizontal line starting to the left of the motif might suggest a classification of the motif as a panelled pattern FM 75.5/75.18, but that regularly has wavy lines rather than straight lines as central fill elements (cf. Voigtländer 2003, pl. 99.S115; 100.S197; 104.HS12–20; 107.HS54–63; 121.Si4–8; 122.Si9–17 [the latter perhaps an exception with straight lines]). Furthermore, curved stripes are more common on mugs than panelled patterns. Therefore, the horizontal straight line might be an irregularity of the lower band bordering the motif at the bottom.

44 Guglielmino, this volume, fig. 5.1.

45 Guglielmino 2013, 149, 279, fig. 105.

46 Jung et al. 2015a, 458, tab. 1, samples Zamb 32 and Zamb 38; Jung et al. 2015b, 73, fig. 14.17; 98, cat. no. 28.

47 Zapheiropoulos 1965, 169, 175, cat. no. 4, pl. 136β; Papadopoulos 1978/1979, 105, 216, cat. no. 734, pl. 147, fig. 171a, pl. 238, fig. 262a.

48 Podzuweit 2007, 24, Beil. 1.

49 Iacono 2015, 268–269, fig. 4; Guglielmino, this volume, fig. 2.9.

50 Thebes, Oedipus Street 14, Room B, beneath the floor: Symeonoglou 1973, 20, pl. 24, fig. 35.14. The only difference is the rim decoration, as the Boeotian deep bowl shows decoration 1.1.

51 South House, construction fill: Mountjoy 1976, 89, fig. 7.51. Prehistoric Cemetery, Central: French 1966, 232–233, fig. 8.22–23. For a further specimen from Mycenae see Iakovidis 2013b, 257, pl. 56α6.

at Tiryns[52] and Thebes.[53] Further examples come from Kopréza in Attica[54] and Áyios Stéphanos in Laconia.[55] The sherd from Roca Vecchia belongs to chemical group X116, which most probably represents regional products, but is the smaller of the two identified groups that can be ascribed to Apulia. No typological or stylistic element of this fragment diverges from the pottery making traditions of Late Mycenaean Greece.

A further deep bowl fragment belongs to FT 284/285 type B (RocV 6, Fig. 1.RocV 6). In the Argive sequences this type with its monochrome interior decoration and the rim band of 2.5–3cm width is characteristic for the last phases of the Palatial period, i.e. LH IIIB Developed and Final, while it is already a rare type by LH IIIC Early 1.[56] The stratigraphic context of the sampled specimen from Roca Vecchia indicates a rather early stage of RBA 2 (Area SAS IX, Phase II). The vessel is a member of the larger chemical group of Apulian origin, group X115. One may wonder if this is a case of secondary deposition of a 13th-century product – considering also the size of the fragment and its partially worn surface.

One of two analysed deep bowls FT 284/285 of type C is a locally made Mycenaean pot belonging to the same chemical group X115 (RocV 11) as the deep bowl B. Deep bowl C RocV 11 has the s-profile characteristic of Post-palatial deep bowls on the Greek mainland, while the tongue-shaped multiple stem motif FM 19,37/38 is rather characteristic for the palace period.[57] This deep bowl was found in the second building phase of RBA 2 (Area SAS IX, Phase II), which rules out a LH IIIB date. Being a member of the small NAA group X116, it is an Apulian product, but in view of the fact that other vessels from the RBA 2 levels at Roca are imports from Achaea, a deep bowl from Teichos Dymaion seems to be a relevant parallel.[58] It was found inside the secret passageway of the citadel wall and shows the same motif (although in a more curved execution) and the same lower bands as the Apulian vessel, but it belongs to the deep bowl type A without monochrome interior. Its pottery context is LH IIIC Early 1 in date and therefore either contemporary or slightly later than that of RocV 11.[59]

The fragment of a krater FT 281/282 (RocV 2, Fig. 2.RocV 2) shows a banded interior and a motif which is either a panelled pattern FM 75 or – because of the diverging lateral lines – a tricurved arch FM 62 combined with vertical chevrons FM 58. In Greece, panelled patterns such as the one on the krater from Roca Vecchia are characteristic for deep bowls rather than for kraters,[60] while the panelled pattern is found on a krater from the *Epichosis* (West Wall) material from Tiryns and thus in LH IIIB Final (–LH IIIC Early 1).[61] A second fragmentary krater FT 281/282 shows antithetic loops flanking a central triglyph filled with a net pattern (RocV 12, Fig. 2.RocV 12). A very similar motif appears on a deep bowl FT 284/285 from the destruction level in the palace of Pylos (LH IIIC Early 1[62]). A third krater FT 281/282, apart from a triglyph, shows a concentric semicircle motif that is positioned on top of a horizontal line (RocV 20, Fig. 2.RocV

52 Tiryns, Lower Citadel, Building III, LH IIIB Final destruction layer: Grossmann – Schäfer 1975, 74–75, fig. 21, pl. 51.99.

53 Pelopídhou Street, Linear B archive, Deposit 2b: Andrikou 2006, 72, cat. no. 155; 110, pl. 10.155; 140, pl. 40, fig. 51.155.

54 Mountjoy 1999, 551, fig. 200.251.

55 Mountjoy 2008, 318, fig. 6.12.3182.

56 Kardamaki 2009, 395, 399.

57 Guglielmino 2009a, 192–193, fig. 3.4; Guglielmino, this volume, fig. 2.6.

58 Mastrokostas 1967b, 159–160, fig. 187β; Papadopoulos 1978/1979, 112, 215, cat. no. 679, pl. 153, fig. 177b.

59 The profile of the Achaean deep bowl shows the straight upper part and slight carination of the lower part characteristic for type 3 of Mountjoy's LH IIIB2/IIIC Early transitional phase (Mountjoy 1999, 37). The other two deep bowls – one with regular triglyphs of type A, one with running spiral – and the krater FT 281/282 with linked running spirals argue in favour of a very early Post-palatial date (cf. Mastrokostas 1967b, 159–160, figs. 186–187). A further deep bowl A with motif FM 19,37/38 comes from Mine no. 3 at Thorikós in Attica, which is not a closed context (Mountjoy 1995, 207–208, fig. 6.67).

60 Voigtländer 2003, 85, cat. no. Si 1, pls. 60.Si1; 121.Si1.

61 Voigtländer 2003, 77, cat. no. K 20, pl. 114.K20.

62 Blegen – Rawson 1966, 398, figs. 339 (right) and 385.808; Mountjoy 1999, 351–352, fig. 120.111.

20). This arrangement of the motif seems to be without parallel in Mycenaean Greece, where in LH IIIB Final and IIIC Early concentric semicircles are regularly found flanking triglyphs, but in an antithetic arrangement, in which the one semicircle group is hanging from a rim band, the other standing on a lower band.[63] In view of the remarkable variability and freedom that potters had to create and combine motifs on kraters, especially during LH IIIC Early, one may not use the surprising motif combination on the Roca krater to classify this pot as Aegeanising and not as Mycenaean in style.

All three kraters belong to chemical group X115. One fragment of RocV 12 had already been analysed in the earlier programme by Jones, and was also classified as a local product.[64] One of the three local kraters comes from the lowest RBA 2 level (Area SAS IX, Phase I: RocV 20), while two were found stratified in levels of the following settlement phase of RBA 2 (Area SAS IX, Phase II: RocV 2 and RocV 12). They are thus contemporary or slightly more recent in date than the quoted Peloponnesian parallels.

Finally, a fourth krater fragment (FT 281/282) is also a member of the larger Apulian group X115 (RocV 10[65]) and comes from a rather early level of RBA 2 (Area SAS IX, Phase II). Its linear decoration with (at least) three broad bands framing the lower end of the motif zone and (at least) one broad interior band conforms to common decorative schemes of Mycenaean kraters,[66] but it is difficult to find close parallels for the motif, a series of triglyph-like palm trees FM 15 or hybrid flowers FM 18.

The shoulder fragment of a closed vessel belonging to group X116 shows a row of hook-shaped multiple stems FM 19,37/38 pending from a shoulder band beneath the monochrome neck (RocV 16, Fig. 1.RocV 16). This motif rarely appears on shoulders of Mycenaean closed vessels. A narrow-necked jug FT 120/121 or a jug with cutaway neck from a LH IIIB Final context at Mycenae provides a reasonable parallel.[67] Another fragment from a LH IIIB Final context shows a similar motif, but in this case with standing multiple stems.[68] The closed vessel RocV 16 was found in a context of developed RBA 2 (Area SAS IX, Phase II) and should therefore be of Post-palatial date. According to the NAA it is a member of the smaller Apulian group X116. It might be that a prolonged use of the Palatial Mycenaean style in the Apulian workshops of wheel-made pottery was the reason for the chronological distance to the named parallels.

The neck-handled amphora (RocV 7, Fig. 2.RocV 7) coming from a RBA 2 context (Area SAS IX, Phase II) and belonging to chemical group X115 might be assigned to the Mycenaean FT 67 characterised by a broad flaring neck, rounded lip and two vertical handles from neck to shoulder. Although its size (height: 23.5cm; rim diameter: 10cm) is only slightly bigger than that of known FT 67 specimens, its proportions and profile – especially the conical lower body – are rarely paralleled among vessels found in Greece. The cemetery of Prósimna in the Argolid offers the best morphological comparison for the high shoulder and conical lower body, as opposed to the more baggy or rounded specimens quoted by Furumark, most of which are unpainted.[69] In addition, the Prósimna vessel also resembles the Roca Vecchia specimen as regards the neck decoration with

---

63 Midea, West Gate (LH IIIB Final): Demakopoulou et al. 2008, 20, fig. 36. Menelaion, Profitis Elis erosion gully (LH IIIB Final – IIIC Early): Catling 2009, 171, cat. no. PE 39; fig. 228.PE 39. Tiryns, Northeastern Lower Town, Phase 1 (LH IIIC Early): Stockhammer 2007 vol. II, 19 cat. no. 248, pl. 13.248.

64 Guglielmino et al. 2010, 258, tab. 1.101; 263, tab. 3 (cluster 2); 275–276, fig. 10.101.

65 Guglielmino, this volume, fig. 3.1.

66 Cf. Podzuweit 2007, 59, pls. 30.1; 33.1–2.

67 Plákes House, Basement 10: Iakovidis 2013a, 135, pl. 50α.7. However, the Roca fragment shows a shoulder band beneath the junction of shoulder and neck, which diverges from the classic decoration of narrow-necked jugs and jugs with a cutaway neck.

68 'Causeway Deposit': Wardle 1973, 308, fig. 6.7. For the date of that deposit see the last comments by Kardamaki 2009, 335–341. See also a narrow-necked jug FT 120/121 from Selinia on Salamis, burial C (ca. LH IIIB Middle–Final), see Tzavella-Evjen 1993, 70, 83–84, fig. 14.

69 Furumark 1941, 595. For an unpainted and stratified specimen see e.g.: Mycenae, Plákes House, Basement 8, LH IIIB Final: Iakovidis 2013a, 109, pl. 36β.

one broad band right above the upper handle attachment and one band at the base of the neck.[70] The only difference lies in the triangular lip profile of that Argive specimen. Unfortunately, no other pot accompanied the amphora and remnants of a skeleton deposited inside a pit in chamber tomb XXVI. However, a very similar, but unpainted amphora was found in another chamber tomb of the same cemetery (tomb VIII) in context with a stirrup jar FT 182 indicating a date in the first half of LH IIIB.[71] Another painted specimen of FT 67 comes from the LH IIIB Final destruction level of the Tirynthian Lower Citadel, but its proportions differ from the Roca Vecchia vessel.[72]

There are no handmade types among the contemporary *Subapennine* pottery from Apulia, which could offer closer morphological parallels than the vessels from the Argolid. In addition, the vessel shape does not seem to be the result of combining characteristics taken from different Mycenaean or Minoan types. Therefore, the wide-necked amphora from Roca Vecchia may well be classified as Mycenaean in type (as opposed to Mycenaeanising). The spiraliform motif with multiple stems (in its general aspect comparable to curved-stemmed spirals FM 49) and two rows of joining semicircles FM 42 used as fringes resembles an elaborately stylised argonaut.[73] The same motif of a double row of FM 42 is hanging from the broad band at the base of the neck. Its assignation to chemical group X115 confirms its local production in Apulia.

Four of the Apulian products are clearly Aegeanising vessels that differ to variable degrees from Minoan and/or Mycenaean ceramics. The first one is a hydria, which belongs to chemical group X115. Its sherds were found scattered throughout several levels in excavation Area SAS IX (RocV 8, Fig. 2.RocV 8). Initially, they were assigned to different phases.[74] This was also due to chromatic differences between the sherds, but these later proved to be of post-depositional origin. The deepest level from which fragments of the vessel were retrieved is Level I, dating to an early phase of RBA 2. This must be the original use context of the vessel, while the vertical dispersion of the sherds finds an easy explanation if seen against the many pits that had been opened in the levels of this area during the succeeding Final Bronze Age (FBA) phases.[75]

This vessel in all its typological and stylistic details reveals the eclectic combination technique of the Apulian potters. The presence of a vertical handle from lip to shoulder and of at least one horizontal handle on the belly leaves no doubt about the classification as a hydria. However, the Roca Vecchia specimen diverges from regular Mycenaean hydriae of FT 129. The lip is flat and horizontal rather than rounded or hollowed and the vertical handle is band-shaped rather than of circular or oval cross section.[76] A fragmentary large closed vessel found at Tris Langádhes on Ithaca, in House TL, has the same flat vertical handle decorated in a very similar way with net pattern FM 57,[77] while other fragments exhibit similar lip profiles (some even with the conspicuous slight ridge directly underneath the lip[78]). In addition, one of these fragmentary closed vessels from Ithaca shows a horizontal wavy line,[79] which appears on mainland Mycenaean vessels only by LH

---

70 Prósimna, chamber tomb XXVI, pit in front of the west wall: Blegen 1937, 94, 437, pl. 46, fig. 203.432: height 21.7cm; rim diameter: 11.4cm; base diameter: 7.9cm; maximum diameter: 16.9cm. Differences in decoration between the Prósimna and the Roca Vecchia vessels lie in the additional rim band of the Prósimna vessel and the two groups of three bands on belly and lower body.

71 Prósimna, chamber tomb VIII, bone heap with one skull in the northern corner: Blegen 1937, 161, 452, pl. 95, fig. 399.831, 833; Shelton 1996, 17, nos. 831 (incorrectly assigned to FT 183) and 833 (with strap handles, raised base, unpainted). For the production period of the stirrup jar type see Jung et al. 2015b, 75.

72 Tiryns, Lower Citadel, Building III, LH IIIB Final destruction: Grossmann – Schäfer 1975, 67, no. 40, pl. 46.40; Podzuweit 2007, 182, pl. 96.5.

73 Guglielmino 2008, 261–262, fig. 14.II.2; Guglielmino 2009a, 194, 199, fig. 5.4.

74 Guglielmino 2005, 639, 643, pls. 165c1; 166f1.

75 Cf. Pagliara et al. 2008, 242–243, figs. 3–4.

76 Sometimes rather flat handle cross sections occur (Mountjoy 1999, 177–178, fig. 51.390), but the band-shaped version of the Roca Vecchia specimen is singular.

77 Benton – Waterhouse 1973, 10, cat. no. 120; 11, fig. 6.120, pl. 3a120.

78 Benton – Waterhouse 1973, 10, cat. nos. 105–107; 11, fig. 6.105–107.

79 Benton – Waterhouse 1973, 10, cat. no. 105; 11, fig. 6.105.

IIIC Advanced,[80] but on Minoan jugs and amphorae already earlier.[81] House TL at Tris Langádhes is not a closed context, but it predominantly yielded LH IIIA2 pottery as well as some vessels of LH IIIB date.[82] The loop around the attachment of the vertical handle is reminiscent of the loops around Late Minoan IIIA cup handles,[83] while the loops around the attachments of the horizontal handle reappear on Late Minoan IIIA bowls.[84] The shoulder motif of the hydria from Roca Vecchia has already been identified as linked whorl-shell pattern FM 24 with the best parallels in LM IIIA2.[85] The hydria is a very rare shape in Minoan Crete. There is one unpainted example found as part of a LM IIIA1 floor deposit at Khamalévri.[86]

Taken together, the typological and stylistic elements of this hydria show an intense Minoan influence, but also traits of mainland and western Greek origin. The chronological indicators seem to point to a palace period date and even to LM/LH IIIA2, while the stratigraphical context indicates an early Post-palatial date. The fact that it belongs to the chemical group X115, the larger one of the two new Apulian groups, which consists exclusively of samples from Roca Vecchia, strongly supports local production. One fragment had already been analysed in the earlier ICP-ES programme by Jones, who also interpreted the result in terms of local production. In fact, the fragment was a member of the same cluster that included also a duplicate sample of our RocV 12 vessel (see above).[87]

In this context it is important to note that another vessel, which is a clear reproduction of a Minoan prototype, had also been included in that very ICP-ES cluster.[88] It is a small open vessel, most probably a cup with good LM IIIA2 parallels, and comes from a MBA 2–3 context.[89] This cup and the hydria RocV 8 would suggest that a local pottery manufacturing tradition for Minoan and Minoanising vessels existed at Roca Vecchia from Middle Bronze Age 3 (MBA 3) and continued into RBA 2.

A second clear Italo-Mycenaean shape is that of sample RocV 19, which is again a member of NAA group X115 (Fig. 1.RocV 19). It is a large carinated bowl with a rim diameter of 18cm, and it was found in a mixed context with pottery dating from MBA 3 to FBA 1. The interior is monochrome, while the preserved exterior decoration consists of a narrow rim band. The motif on the upper part is a broad wavy line with wide swings. The preserved portion of the lower part of the vessel is undecorated. If one compares this sherd with Mycenaean open vessels, the differences to carinated kylikes FT 267,[90] carinated cups FT 240[91] and shallow angular bowls FT 295[92] become apparent. The upper part is only slightly concave, the carination is not very articulated, the part below the carination is very straight, and the wall is of considerable thickness – in contrast to the three mentioned Mycenaean types. Carinated bowls belong to the most characteristic Italo-Mycenaean shapes in many southern Italian regions.[93] Therefore, it is not easy to decide whether the fragment RocV 19 represents a type or variety, the geographic distribution of which was restricted to Apulia.

---

80 Jung 2006a, 164.

81 LM IIIB2 Khaniá: Hallager – Hallager 2003, pls. 60.84-P0629; 61.84-P1308, 70-P0951(+01-P0410); Hallager 2003, 220–221.

82 Mountjoy 1999, 469.

83 Popham 1970, 18, pl. 13c,f; Hallager – Hallager 2011, 218, cat. no. 82-P0513+, pl. 196g1.

84 Popham 1970, 32, 61, pls. 23d; 40a.

85 Guglielmino 2005, 639; Guglielmino 2009b, 490, fig. 206.

86 Andreadaki-Vlasaki – Papadopoulou 1997, 132–133, figs. 47 and 49. Usually, Late Minoan hydriae have just one horizontal handle, which is positioned on the lower part of the vessel on the same side as the vertical handle (see examples quoted by Andreadaki-Vlasaki – Papadopoulou 1997, 133).

87 Guglielmino et al. 2010, 258, tab. 1.55; 263, tab. 3 (cluster 2); 273–274, fig. 9.55.

88 Guglielmino et al. 2010, 258, tab. 1.74; 263, tab. 3 (cluster 2); 274–276, fig. 10.74.

89 Guglielmino et al. 2010, 274–276, sample no. 74.

90 Apart from the differences in profile, carinated kylikes never reach a rim diameter of 18cm, cf. Podzuweit 2007, 109, pls. 55.15–19; 56.1–4.

91 Popham et al. 2006, 139, fig. 2.1.1–5; 154, fig. 2.7.3; Andrikou 2006, 119, pl. 19.304–305; Podzuweit 2007, pls. 59.4–9; 60; 61.1–11; Stockhammer 2007, vol. II, pls. 11.196–201. 204–208; 12.211; 76.1689–1693.

92 Podzuweit 2007, pls. 42.8–18; 43.1–12; Stockhammer 2007, vol. II, pls. 43.1066; 73.1568.

93 On their differentiation from Mycenaean types and on the problem of their genesis see Jung 2006a, 110, pl. 6.1, 2.

A third undoubtedly Italo-Mycenaean shape is the globular open vessel with horizontal strap-handles on the shoulder and four grooves right beneath the lip (RocV 5, Fig. 1.RocV 5). It has been reconstructed from fragments coming from a large number of contexts that belong to the latest RBA 2 settlement phase of Roca Vecchia (Area IX, Phase V: RBA 2 final or beginning of FBA 1). Seen in a broader functional perspective, the vessel can be considered akin to a krater because of its morphological features, but with a rim diameter of 18cm it would rather fit a stemmed bowl FT 304/305. Unfortunately, its internal surface appears to be almost completely worn off. The vessel presents an interesting mixture of stylistic elements. The decoration and general syntax is undoubtedly of Aegean ancestry.

Triglyphs (panelled patterns FM 75) consisting of three lateral lines to the right and left and either vertical zigzag FM 61 or chevron FM 58 as a central element alternate with opposed isolated semicircles FM 43. These motifs are positioned in a zone between a broad rim band and at least one broad lower band. The decorative syntax is therefore close to that employed on deep bowls, stemmed bowls and kraters during the late palace period. All the motifs find good parallels among these vessel classes. One may quote deep bowls A from Mycenae[94], deep bowls B from Mycenae[95] and Tiryns,[96] stemmed bowls from Mycenae[97] and kraters FT 281/282 from Mycenae[98] and Tiryns.[99] The handle decoration, consisting of eight vertical splashes and one across each handle attachment, also follows Mycenaean prototypes. They appear on rosette deep bowls dating again to the late palace period,[100] but also on deep bowls with Close Style or linear decoration dating to the LH IIIC Advanced phase and on kraters of the same date[101] and thus roughly contemporary with the stratigraphic context of the Italo-Mycenaean vessel RocV 5.[102] However, one can find even closer parallels for the strap handles with multiple splashes. These are amphoriskoi FT 59 from LH IIIC Advanced and Late contexts,[103] which not only provide parallels for the painted decoration, but also for the peculiar handle shape (strap handles or handles with a flattened oval section) that is not attested on Mycenaean deep bowls and kraters in Greece.

In general, the shape of RocV 5 is particularly unusual. It has an in-turned upper body with a short everted rim and three parallel grooves directly below. The shape finds no precise parallel in the Aegean world but could echo ovoid jars of the southern Italian *impasto* production. In RBA 2 and throughout the FBA these often have plastic bands underneath the rim.[104] In short, the vessel

---

94 House of the Idols, Corridor (LH IIIB Middle): Wardle 1969, 274–275, cat. nos. 50 and 52, fig. 6.50 (narrow triglyph with vertical zigzag and three lateral lines on both sides), pl. 62c2 (with opposed semicircles). South House, construction fill (LH IIIB Middle): Mountjoy 1976, 88–89, cat. no. 47, fig. 6.47 (narrow triglyph with chevron and three lateral lines on both sides).

95 'Causeway Deposit' (LH IIIB Final): Wardle 1973, 316–317, cat. nos. 72 and 79, fig. 11.72, 79 (narrow triglyph with three lateral lines on both sides and with central elements consisting of zigzag and chevron respectively).

96 'Epichosis' (LH IIIB Final [–LH IIIC Early 1]): Voigtländer 2003, 85, cat. no. Si 1, pls. 60.Si1; 121.Si1 (narrow triglyph with chevron and three lateral lines on both sides).

97 South House, construction fill (LH IIIB Middle): Mountjoy 1976, 90–91, cat. no. 68, fig. 8.68 (opposed semicircles).

98 Citadel House Area, Room XXXII, Phase IX (LH IIIC Early 1): Mountjoy 1999, 156–157, fig. 41.314; French 2011, 39, fig. 12.69-1531 (narrow triglyph with vertical zigzag and three lateral lines on both sides).

99 Northeastern Lower Town, Phase 1 (LH IIIC Early): Stockhammer 2007 vol. II, pl. 14.257 (narrow triglyph with vertical zigzag and three lateral lines on both sides).

100 Cf. rosette deep bowls from Mycenae: Cult Centre, Area 36, Phase VII (LH IIIB Middle): French – Taylour 2007, CD-ROM, 333–334, no. 66-528. 'Causeway Deposit' (LH IIIB Final): Wardle 1973, 329, cat. no. 162 and fig. 18.162.

101 Tiryns, Lower Citadel: Podzuweit 2007, 57–58, 67–68, pl. 23.2; 114.3. Mycenae, Granary: French 2007, 177–178, 184, fig. 6.1–2.

102 A Close Style deep bowl was found in Phase VI of Area IX, see Guglielmino 2008, 260–261, fig. 14.VI.1; 263.

103 Peratí, chamber tomb 148, in situ burial in front of W wall (Phase II, LH IIIC Advanced): Iakovidis 1969/70 vol. I, 129, 131 no. 1123; vol. II, 400; vol. III, pl. 39β.1123; Mountjoy 1999, 581–582, fig. 215.398. – Mycenae, chamber tomb 502, stone enclosure – perhaps belonging to the last interment no. III (LH IIIC Late): Wace 1932, 5, 8 no. 12; pl. 11.12; Mountjoy 1999, 175–176, fig. 50.372.

104 E.g. Giardino 1994, 209, 212, pl. 48.1; Pagliara et al. 2007, 333, fig. 11.III.25; 338, fig. 13.IV.33.

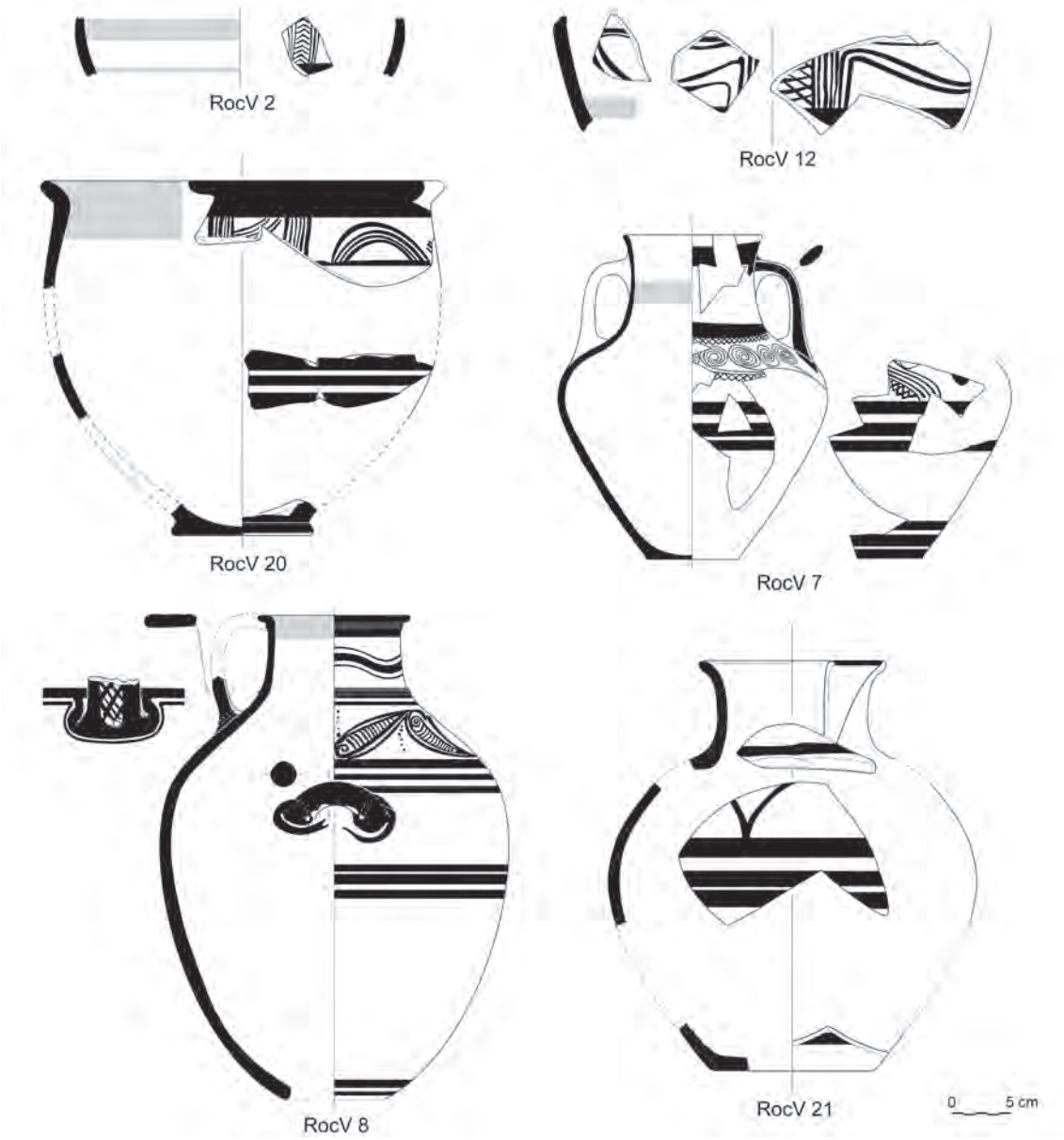


Fig. 2 Mycenaean and Mycenaeanising vessels from Roca Vecchia, analysed with NAA. Scale 1:6 (drawings: R. Guglielmino, L. Coluccia and F. Iacono)

from Roca represents a mixture of Aegean elements with local ones, while the latter were adapted to the Mycenaean style.[105]

Finally, there is a closed vessel with a profile that would suit a Mycenaean jug FT 105/106 or a hydria FT 129, but its proportions are so broad (rim diameter 16cm, base diameter 14cm, height 34cm) that it cannot be considered a regular Mycenaean type (RocV 21, Fig. 2.RocV 21). In view of the fact that 11 fragments are preserved and that these were all found in levels of an early stage of RBA 2 (Area SAS IX, Phase I), it should not be compared to vessels from the Central Hut of Broglio di Trebisacce representing a late stage of RBA 2. One may rather compare it to Italo-Mycenaean vessels from Termitito, as these show the influence of late Palatial Mycenaean workshops

[105] The plastic bands are transformed into grooves common on specific Mycenaean types during the Palatial and Post-palatial period (Mountjoy 1976, 86, fig. 5.24–26; Popham et al. 2006, 183, fig. 2.16.11; 192, fig. 2.23.4; 194, fig. 2.24.1–2).

datable to LH IIIB Middle–Developed.[106] At this site in the Basilicata we find a neck-handled amphora with a broad, flaring neck and simple (not thickened) rounded lip. Its rim diameter is larger (24cm), but its general proportions fit with the specimen from Roca Vecchia. It is decorated with different motifs of the Mycenaean palace period.[107] The Roca Vecchia vessel is overfired and moreover has a deformed rim. It might therefore be a misfired product. If this was right, one would have expected a membership in chemical group X115 or X116, but the piece is a chemical singleton. Unfortunately, the curvilinear shoulder motif is too fragmentary to be identified.

Products from Other Regions in Italy

Finally, we have analysed a single pithos sherd (RocV 18, Fig. 1.RocV 18, Fig. 3), which stratigraphically precedes the well-known fine-ware pithoi of the last FBA phase of the site (FBA 2).[108] The fragment was part of a sherd layer underneath a clay platform dating to the very end of RBA 2 or the start of FBA 1 (Area SAS IX, Phase V).[109] Being a medium coarse vessel and having a plastic cordon on the exterior, it belongs to a different class than the later, FBA 2 specimens. The shallow plastic band is decorated with an incised zig-zag line. So far, this decoration of the applied plastic band finds only a single parallel among the pithoi produced in southern Italy.[110] In the Aegean it is also rare, and, moreover, the zigzag lines on late Palatial and Post-palatial Mycenaean pithoi are not tight, but stretched.[111]

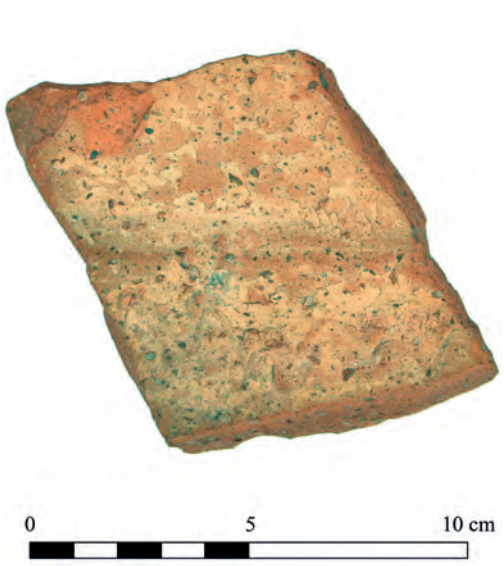


Fig. 3 Imported pithos with incised plastic band (photo: R. Jung)

The mentioned good parallel from southern Italy was found at Torre Mordillo, in a layer dating to FBA 2.[112] According to the published description, the fabric seems to differ from that of the Roca specimen.[113] Nevertheless, the plain of Sybaris is the geographical region where we should search for the workshop of the decorated pithos found at Roca Vecchia. According to the NAA, RocV 18 is a member of the group SybB with a somewhat enhanced Cs value (see Tab. 2). Three members of this group have been found at Broglio di Trebisacce, but are not local to that northern part of the Sybaris plain. Sara Levi and Maurizio Sonnino have been able to show this based on their petrographic analyses of two of those sherds.[114] The first one is a pithos sherd with a plastic band carrying a double zigzag line. Its petrographic characteristics allow an assignation to the southeastern part of the Sybaris plain (Tab. 4: sample Brog 15).[115] The

[106] Protome Painter A and Pieridis Painter A, see Güntner 2000, 228, 236, 350, 367–369; Vagnetti 2001b, 108–110, figs. 2–5; Jung 2005, 59–60.
[107] De Siena 1986, 52, fig. 11; Bettelli – Levi 2014, 321, pl. 4.62.T43. The size of this fragmentary vessel from Termitito exclude a classification as FT 67.
[108] Guglielmino 1999.
[109] For the context see: Pagliara et al. 2008, 247.
[110] Schiappelli 2015, 238, fig. 6a.
[111] Tiryns, Lower Citadel, LH IIIB floor of 'Building 4': Grossmann – Schäfer 1975, 63, no. 3, pl. 44.3. – Tiryns, Northeastern Lower Town, Phase 2 (LH IIIC Early 2): Stockhammer 2007, vol. II, 89, pl. 63.1371. – Lefkandí, Phase 2b (LH IIIC Advanced – Late): Popham et al. 2006, 211, pl. 42.9.
[112] Arancio et al. 2001a, 135–136, fig. 73,20; Arancio et al. 2001b, 203–204.
[113] Arancio et al. 2001b, 203–204: wheelmade, with very few inclusions.
[114] Jung et al. 2015a, 459.
[115] Levi – Sonnino 1999, 67, fig. 27 (zone F); 69; 105; 123, fig. 79.BT932.

Bonn sample number	Sample number in Jones – Levi 2014, 182, tab. 4.7d; Jones 2014, 544, tab. 10; 546, tab. 11	Sample number in Levi 1999	Type	Publication of the sherd/vessel	NAA group	Comments	Petrographic group
Brog 1	BTA001, A13, BT706		belly-handled amphoroid krater of Italo-Mycenaean type, pattern-decorated	Bettelli – Levi 2014, 285, 326, fig. 4.67.A13; Bettelli, this volume, fig. 3.2	SybA		
Brog 2	BTA003, A48, A49, BT704		large closed Mycenaean vessel, monochrome	Bettelli – Levi 2014, 285, 322 fig. 4.63.A48	generally Greek (AkaR, TheB, …)		
Brog 3	BTA004, A9, A65, BT705		belly-handled amphoroid krater of Italo-Mycenaean type, pattern-decorated	Bettelli – Levi 2014, 285, 325, fig. 4.66.A9; Jung 2006a, 105, fig. 11, pl. 6.3; Bettelli, this volume, fig. 3.3	SybA	Jones – Levi 2014, 188: 'local … overfired'	
Brog 4	BTA005, A8, A33		belly-handled amphoroid krater of Italo-Mycenaean type, pattern-decorated	Bettelli – Levi 2014, 285, 323, fig. 4.65,A8; Jung 2006a, 106, fig. 11, pl. 7.2; Bettelli, this volume, fig. 3.1	SybA		
Brog 5	BTA068, A63		vessel of Mycenaean or Italo-Mycenaean type	unpublished	Early MYBE		
Brog 6	BTA069, A 69		vessel of Mycenaean or Italo-Mycenaean type	unpublished	SybA		
Brog 7	BTG025		wheelmade Grey Ware vessel	unpublished	SybA		
Brog 8	BTD034		pithos	unpublished	SybB (= old BroC)		
Brog 9	BTF043		matt painted fine-ware vessel	unpublished	Singleton		
Brog 10	BTI070, I 11		impasto vessel	unpublished	BroD	Middle Bronze Age	
Brog 11	60A	BT 60	large impasto cup	Levi 1999, 122, fig. 78.BT60 ['BT960' is a printing error]; elenco 4g(2)	BroD		southern plain of Sybaris

Bonn sample number	Sample number in Jones – Levi 2014, 182, tab. 4.7d; Jones 2014, 544, tab. 10; 546, tab. 11	Sample number in Levi 1999	Type	Publication of the sherd/vessel	NAA group	Comments	Petrographic group
Brog 12	BT 219A	BT 219	carinated impasto bowl	Levi 1999, 167, fig. 142. BT219; elenco 2b(1)	singleton (but generally Sicily)		KX2
Brog 13	BT 904A	BT 404	if 'BT 404' is correct: impasto jar	if 'BT 404' is correct: Levi 1999, 121, fig. 77.BT404	HimA / SybB	according to Levi 'BT 404' is possibly correct	if 'BT 404' is correct: southern plain of Sybaris
Brog 14	BT 919A	BT 919	pithos base	Levi 1999, 171, fig. 146. BT919; elenco 2c	HimA / SybB		A2
Brog 15	BT 932A	BT 932	pithos with incised plastic cordon	Levi 1999, 105, 123, fig. 79.BT932; elenco 2c	SybB (= old BroC)	coarse-ware pithos	southeastern plain of Sybaris
Brog 16	BT 941A	BT 941	pithos with channelled decoration	Tenaglia 1994, 355, pl. 65.2; Levi 1999, 172, fig. 147. BT941; elenco 2c	SybA		AF3-2
Brog 17	BT 962A	BT 962	pithos with channelled decoration	Levi 1999, 105, 124, fig. 80.BT962; elenco 2c	SybB (= old BroC)	coarse-ware pithos	southern-central and southern plain of Sybaris
Brog 18	BT 978A	BT 978	pithos	Levi 1999, elenco 2c (not illustrated)	HimA / SybB		A4
Brog 19	BT 989A	/	pithos	unpublished	Singleton		

Tab. 4 Group assignations of 19 samples from sherds and vessels found at Broglio di Trebisacce (northern plain of Sybaris) analysed in Bonn. For raw data see Jones 2014, 544, tab. 10; 546, tab. 11; for group SybB (= old BroC) see Mommsen 2014, 19, 25, tab. 6; for group SybA see Mommsen 2018–2019, 111–112, tab. 1; for group HimA see Edel forthcoming

second one is a pithos fragment with grooved decoration (close in type to the FBA 2 pithoi from Roca Vecchia, Tab. 4: sample Brog 17). This sherd has petrographic characteristics that point to the southern-central and southern plain of Sybaris (including the region of Torre Mordillo).[116]

Unfortunately, the pithos sherd with incised zigzag found at Torre Mordillo has not been analysed – neither with chemical nor with petrographic methods. According to the published description it is less coarse than the vessel RocV 18. However, this does not necessarily preclude that both pithoi were produced with clay from the same clay deposits, for the Mycenaean-type members of group SybB from Punta di Zambrone likewise have far fewer and much finer inclusions than the pithos sherd from Roca Vecchia.[117] Furthermore, the results of petrographic research in the Sybaris plain indicate that, in general, pithoi with plastic bands carrying incised decoration were a typical product of the southern regions in the plain.[118] They reached the northern regions, sites such as Broglio di Trebisacce, as imports from the Recent Bronze Age onwards. Almost 50% of the pithoi from the late RBA 2 layers of the so-called Central Hut at Broglio consist of imports from the southern plain.[119]

In view of these comparative data it is possible that the pithos from the southern plain of Sybaris reached Roca Vecchia during a late stage of RBA 2, when, for the first time, larger quantities of such pithoi were not only produced, but also exported to other areas of southern Italy.[120]

Conclusions

The NAA results of the Roca Vecchia Aegean and Aegeanising pottery offer new and valuable insights into the considerable variability of ceramic production and exchange processes during the Recent Bronze Age. First of all, it is important to note that a smaller number of imports from the Aegean is opposed to a larger quantity of most probably local products, which exhibit two different clay recipes. In the earlier analytical programme using ICP-ES only one local group of Aegean pottery was formed by principal component analysis.[121]

A second important point to make is the high quality of several most probably local products that are members of NAA group X115 – be they Mycenaeanising, such as RocV 5 (Fig. 1.RocV 5), or of Mycenaean type, such as RocV 20 (Fig. 2.RocV 20). Both of these vessels are fired very hard and were produced with rather well levigated clay with only a few fine to medium white inclusions and carry lustrous red paint (cf. above for more details of macroscopic observations: Ferich group). The neck-handled amphora RocV 7 (Fig. 2.RocV 7) has only very few white inclusions of coarse size and is fired ‘clinky’ hard, while the paint is dull to slightly lustrous. Third, not only the technology transfer was successful, but the linear and monochrome decoration as well as the adoption of motifs also attest to close contact with Aegean workshops. Even on the Aegeanising shapes, motifs of Mycenaean and Minoan origin were used and integrated into a decorative

116 Levi – Sonnino 1999, 67, fig. 27 (zones D and E); 69; 105; 124, fig. 80.BT962.

117 PZ129/P30 (sample Zamb 20): very few fine, white particles (large closed vessel, no fabric assignation). – PZ1B-BCC8/1, PZ95FFGG10/1, PZ1/44.45 Area C (Zamb 18): very few fine to medium inclusions, white particles and perhaps mica (small open vessel, fabric PZ-M4). – PZ1FFGG10/3 (Zamb 31): much fine mica, very few white particles of medium size (krater, fabric PZ-MU4). – PZ176/P16 (Zamb 42): few fine mica particles (small open vessel, fabric PZ-M18).

118 Levi – Sonnino 1999, 105–106.

119 Levi 1999, 106–107, fig. 65. Most of the fragments with incised cordons come from FBA levels or were stray finds, but the undecorated cordons are characteristic of the RBA levels at Broglio (Tabò 1998, 160–162, 172, pl. 6.1–3; Levi 1999, 123, fig. 79.BT932, BT966, BT958, BT982).

120 So far, the pithos RocV 18 is one of two of its type found at Roca Vecchia, which might suggest that exported pithoi from the southern plain of Sybaris first and foremost reached sites located at a smaller distance from their production region.

121 Guglielmino et al. 2010, 262–265.

syntax of Aegean derivation suited to the relative vessel shape (judged from an Aegean point of view). Fourth, the Mycenaean-type vessels outnumber the Aegeanising vessels among the local products. Furthermore, the predominance of deep bowls FT 284/285 and kraters FT 281/282 accompanied by large closed vessels and stirrup jars is reminiscent of contemporary Mycenaean settlement assemblages.[122] One gets the impression that the Apulian workshops producing for consumers at Roca Vecchia wanted to create a repertory of Aegean style – even in those cases, where they decided to create new shapes and shape variants. They drew heavily on late Palatial prototypes that are attested until LH IIIB Final and also used those palace period motifs in the second RBA settlement phase.[123] Fewer local products (e.g. RocV 11[124] and 12, Fig. 2.RocV 12) and most of the Mycenaean imports exhibit traits of early Post-palatial style.

According to a common explanatory model, the local production of Mycenaean pottery and Aegeanising pottery in southern Italy is due to either immigrant[125] or itinerant[126] Aegean potters. This model has been criticised on various occasions with reference to the results of previous archaeometric studies.[127]

One of the problems resulting from this approach would be the apparent isolation of the foreign potters, who, once settled in a place, would have worked quasi in isolation, i.e. without exchange and dialogue with workshops in other southern Italian settlements, which is especially astonishing during a time of increased trans-Mediterranean mobility such as the later 13th and earlier 12th centuries BCE. Moreover, since the local production of wheelmade and painted pottery started by the Italian MBA, one would have to imagine that only imported Mycenaean pottery circulated among the Italian settlements, not the local products, which are sometimes even difficult to differentiate from imports without chemical analyses (especially in cases such as Roca, where the products of group X115 are of very good quality). At the same time, throughout the last centuries of the 2nd millennium BCE Italian relations to the Aegean would have been continuous, as the evolution of the Italo-Mycenaean styles demonstrates that new typological and stylistic features were regularly taken up by the local workshops.[128] This critical reasoning is reinforced by the analytical results we present here, for none of the 44 analysed Aegean-type vessels from Punta di Zambrone belongs to any chemical group representing workshops in Apulia. Thus, the hypothesis according to which Italo-Mycenaean pottery was transported in limited quantities together with the main import products from Greece seems to be excluded for the case of Punta di Zambrone.

We briefly note that these seemingly contradictory elements of historical reconstruction can also not be explained by a recent model according to which two different kinds of exchange and contact networks existed in southern Italy. The first would have been an indigenous one that is said to be archaeologically visible by means of bronze objects of Subapennine type. The second one would have been a maritime one that can be traced via Aegean pottery (both imported and local). While the first network should have been run by the populations of southern Italy, the second one should have been in the hands of Aegean merchants, who were temporary residents in the Italian coastal sites.[129] Even if we disregard for a moment the severe methodological flaws

---

122 For shape frequencies in phases I and II of Area SAS IX see Iacono 2015, 266–268 with fig. 3 and tab. 2. Cf. the statistics of settlement pottery from the Argolid: Podzuweit 2007, 189–205, Beil. 44a–b, 47, 65–68; Kardamaki 2009, 455, tab. 5; 460, tab. 22; 461–462, tab. 27.

123 This is also true for the stemmed bowl FT 304/305, a Peloponnesian import according to the first analysis programme (Guglielmino et al. 2010, 258, tab. 1.49; 263, tab. 3 [cluster 2]; 273–274, fig. 9.49), for there are three almost exact parallels among the *Epichosis* material of Tiryns (LH IIIB Final [–LH IIIC Early 1]). They show the same combination of tricurved arch FM 62 with FM 43 and in one case also with triglyph FM 75, see Voigtländer 2003, 69–70, cat. nos. HS77–79, pls. 44.HS77, HS78; 45.HS79.

124 Guglielmino, this volume, fig. 2.6.

125 Immigrating on the basis of political contacts between the Mycenaean state and clientele chiefs in Italy: Peroni 1996, 25–34, 281–288.

126 In the economic context of a hypothetical free market: Bettelli 2011, 112–117.

127 Jung 2005, 59–60; Guglielmino 2013, 146–147; Jung 2017, 54–55.

128 Guglielmino 2013, 146–147.

129 Blake 2014, 219–227.

in the use of the archaeological evidence,[130] this proposal is unable to explain many problems. One is the question of why such hypothetical Aegean 'merchants' seem to have delivered proportionally fewer imports to the coastal settlement of Roca Vecchia, situated at the point of the shortest distance to the eastern Adriatic coast, while proportionally more Aegean pots reached Punta di Zambrone on the southwestern coast of Calabria during the beginning of RBA 2. There is obviously an issue of sample size that does not escape our attention, in that the sample from Roca is considerably larger than that of Punta Zambrone and more analyses are needed for the Apulian site. Yet at present the situation seems to confirm this general trend. One might argue that at that time the Aegean 'merchants' found some desirable goods in the Tyrrhenian and therefore concentrated on the western regions. However, even the distribution of imported and locally produced Aegean and Aegeanising pottery in the southeast of Italy is very uneven. Thus, what we see cannot have been a single network 'not only supplied, but run by an outside group'[131] of Aegean 'merchants', who would have brought similar products to all consumers along the Italian coasts. In such a case we should expect evidence comparable to that in the eastern Mediterranean and Cyprus with Aegean exports from some recurrent production regions with similar type repertoires oscillating inside some quantitative margins set by the economic and political importance of each importing community.[132] By contrast, in Italy, we see a remarkable variability from site to site, if we just focus on the middle and late phases of LH IIIB and compare typological and archaeometric evidence. Scoglio del Tonno predominantly received Mycenaean imports. Potters at Termitito produced predominantly Italo-Mycenaean shapes while using Mycenaean palatial motifs (pictorial and non-pictorial).[133] At Roca Vecchia imports arrived, while local potters reproduced many Mycenaean vessel types with Mycenaean decorations and motifs and created a few new Italo-Mycenaean types.

A model better suited to this variability of the late 13th and the 12th centuries BCE would be one that seeks the initiative for the establishment of exchange relations more on the side of the Italian communities than on the side of the Mycenaean and Minoan communities.[134] Such an approach accords with the small scale settlement systems of the time[135] and could also better explain the new NAA results for Punta di Zambrone and Roca Vecchia. Most probably, the population of each coastal settlement developed its own mechanisms for acquiring Aegean products – be it through different types of exchange; through emigrated craftsmen, who became trained specialists in Greece and subsequently returned; or through war and piracy.[136] The distribution of ceramics from the southern Sybaris plain (members of group SybB) easily fits such a model. Apparently, at the onset of RBA 2 peasants and craftsmen in this region were able to generate a product surplus large enough to enter into targeted exchange relations with other settlements both in the Tyrrhenian and in the Adriatic. The production of agricultural surplus unfolded, augmented throughout the RBA

130 Blake stresses the impression that Aegean pottery and Italian bronzes do not appear at the same sites and to a certain degree seem to exclude each other (Blake 2014, 226–227 with fig. 8.4). She misses the decisive factors responsible for the described artefact distribution, i.e. that bronzes have only rarely been found in southern Italian settlements, and bronze hoards as well as tombs equipped with bronze objects are a rarity in southern Italy. This means she did not take into account the filters shaping the archaeological record and created by burial customs, deposition rituals and recovery of bronzes from abandoned settlements. Archaeologically visible distribution of object types does not directly translate into the regions, in which those types were used. Apart from that, she did not even mention the large hoard from the acropolis of Lipari (Bernabò Brea – Cavalier 1980, 733–789) nor the bronze objects from the RBA levels of Roca Vecchia (published in Pagliara et al. 2007 and Pagliara et al. 2008). Both are cases of settlements, in which much Aegean-type pottery and a variety of Subapennine bronzes have been found and which therefore contradict her thesis.

131 Blake 2014, 227.

132 For a discussion of Aegean pottery exported to the eastern Mediterranean see: Jung 2015.

133 For a more detailed discussion of the Termitito and Scoglio del Tonno evidence see: Jung 2005, 58–60 and Jung 2017, 54–56.

134 Jung et al. 2015b, 92–93; Iacono 2016, 135.

135 Cf. Jung et al. 2015a, 460.

136 Jung 2017.

and reached a peak at the end of RBA 2, when products from the southern plain of Sybaris were exported by means of pithoi on an unprecedented scale – as shown by the Broglio evidence, but now also by the rather long distance transport of such pithoi to Roca Vecchia in Adriatic Apulia.

Finally, the decentralised model mainly based on an Italian initiative can also account for the good attestation of products from western Greek regions and the absence (or possibly scarce attestation among non-analysed pieces) of Argive imports at both Punta di Zambrone and Roca Vecchia for two main reasons. First, the western Greek regions (Ionian Islands, Acarnania, Achaea and Elis) were simply the closest ones to reach for ships coming from the Adriatic or from the Tyrrhenian Sea via the Adriatic. Probably vessels produced in western Greece – especially in the northwestern Peloponnese (in Achaea and Elis) – are also hidden in the group of imports identified by Jones in the first programme of provenance analyses applied to Roca Vecchia ceramics.[137] Southern Italian communities were mostly interested in painted products, but occasionally also received unpainted fine-ware pots – again of western Greek origin –, both at Roca Vecchia and at Punta di Zambrone. Second, it appears that the Palatial pottery workshops in the Argolid did not produce any specific ceramics for those Italian consumers,[138] who apparently were not able or interested in producing for exchange purposes sufficient surplus to have been of particular interest to the Aegean palatial economy.[139] This is borne out by the NAA evidence from Roca Vecchia and Punta di Zambrone and further confirmed by the fact that at Termitito the Argive pictorial motifs are only found on locally produced Italo-Mycenaean pots, not on imports.

We have to note, in addition, that a smaller portion of the imports at Punta di Zambrone could be assigned to western Crete, for which a longer sea route had to be taken.[140] Likewise, it has been proposed that certain imports found at Roca Vecchia[141] originated in western Crete. Especially some coarse ware stirrup jars have been assigned a provenance from this island. However, the archaeometric data base presented for such a conclusion seems to be rather weak for a positive assignation.[142] The typology of those stirrup jar fragments is comparable with Cretan coarse-ware stirrup jars, and there is the mentioned Minoan influence present in the local Aegean pottery production at Roca Vecchia (see above).

To sum up, the picture that can be reconstructed based on the new analytical evidence from Punta di Zambrone and Roca Vecchia is one of small-scale communities with variable economic capacities and independent, targeted exchange relationships established with other communities along the coasts of southern Italy as well as with specific sites in the Aegean that were predominantly situated in its western regions.

Acknowledgements: The analyses reported in this contribution were funded by the programme ‘Punta di Zambrone – a Bronze Age Fortified Settlement on the Tyrrhenian Coast of Calabria’ (P23619-G19) of the Austrian Science Fund (FWF). The authors wish to thank the staff of the research reactor of the Reactor Institute Delft, Delft University of Technology, for their technical support.

137 See especially some samples assigned to the northern Peloponnese, because they show a lower Ca content than the Mycenae/Berbati group (Guglielmino et al. 2010, 263–264, fig. 4). A. Hein, A. Tsolakidou and H. Mommsen observed that samples of the Mycenae/Berbati group have a higher Ca content than the group ACH-a assigned to the regions Achaea and Elis (Hein et al. 2002). This group has now increased to over 400 samples and was renamed OlyA (Jung et al. 2015a; Mommsen et al. 2016), since several clay samples with Ca content of about 10–12% from the region of Olympia match this pattern (s. sample Kata in Hein et al. 2002). Both low and high (2–12%) Ca weight concentrations occur in the samples of this group, presumably reflecting recipe variations of clay preparation. This is the reason that Ca is now not taken in Bonn during statistical grouping calculations. The pattern OlyA and MYBE can be distinguished mainly by the lower Cs and Rb values in Achaea/Elis.

138 In contrast to what they did until LH IIIB Middle on a large scale for partners in the eastern Mediterranean.

139 Iacono 2015, 260; Jung et al. 2015a, 460.

140 Jung et al. 2015a, 459.

141 In the same Recent Bronze Age deposits at Roca from which the samples analysed in this paper derive.

142 Guglielmino et al. 2010, 259–261, tab. 2. 364, 430 (531 no data given); 264; 277–278, fig. 11.364, 439, 531. The composition of only the lanthanides is compared to the composition of a group from Chaniá from the Berkeley/Bonn laboratories without an interlaboratory data calibration.

Bibliography

Andreadaki-Vlasaki – Papadopoulou 1997
M. Andreadaki-Vlasaki – E. Papadopoulou, LM IIIA:1 pottery from Khamalevri, Rethymnon, in: E. Hallager – B. P. Hallager (eds), Late Minoan III Pottery Chronology and Terminology. Acts of a Meeting held at the Danish Institute at Athens, August 12–14, 1994, Monographs of the Danish Institute at Athens 1 (Athens 1997) 111–151.

Andrikou 2006
E. Andrikou, The Late Helladic III pottery, in: E. Andrikou – V. L. Aravantinos – L. Godart – A. Sacconi – J. Vroom, Thèbes. Fouilles de la Cadmée II.2. Les tablettes en linéaire B de la Odos Pelopidou. Le contexte archéologique. La céramique de la Odos Pelopidou et la chronologie du linéaire B (Rome 2006) 11–179.

Arancio et al. 2001a
M. L. Arancio – V. Buffa – I. Damiani – F. Trucco, Catalogo delle unità stratigrafiche e dei reperti, in: Trucco – Vagnetti 2001, 61–153.

Arancio et al. 2001b
M. L. Arancio – V. Buffa – I. Damiani – F. Trucco, La classificazione tipologica, in: Trucco – Vagnetti 2001, 155–214.

Badisches Landesmuseum Karlsruhe 2018
Badisches Landesmuseum Karlsruhe (ed.), Mykene. Die sagenhafte Welt des Agamemnon (Darmstadt 2018).

Benton – Waterhouse 1973
S. Benton – H. Waterhouse, Excavations in Ithaca. Tris Langadas, Annual of the British School at Athens 68, 1973, 1–24.

Bernabò Brea – Cavalier 1980
L. Bernabò Brea – M. Cavalier, L'acropoli di Lipari nella preistoria, Meligunìs Lipára IV (Palermo 1980).

Bettelli 2002
M. Bettelli, Italia meridionale e mondo miceneo. Ricerche su dinamiche di acculturazione e aspetti archeologici, con particolare riferimento ai versanti adriatico e ionico della penisola italiana, Grandi contesti e problemi della Protostoria italiana 5 (Florence 2002).

Bettelli 2011
M. Bettelli, Interaction and acculturation. The Aegean and the Central Mediterranean in the Late Bronze Age, in: H. Matthäus – N. Oettinger – St. Schröder (eds), Der Orient und die Anfänge Europas. Kulturelle Beziehungen von der Späten Bronzezeit bis zur Frühen Eisenzeit, Philippika 42 (Wiesbaden 2011) 109–126.

Bettelli 2014
M. Bettelli, Typological classification of Italo-Mycenaean pottery, in: Jones et al. 2014a, 426–444.

Bettelli – Levi 2014
M. Bettelli – S. T. Levi, Archaeological overview. Aegean summary and illustration of samples, in: Jones et al. 2014a, 275–362.

Blake 2014
E. Blake, Social Networks and Regional Identity in Bronze Age Italy (Cambridge 2014).

Blegen 1937
C. W. Blegen, Prosymna. The Helladic Settlement Preceding the Argive Heraeum (Cambridge 1937).

Blegen – Rawson 1966
C. W. Blegen – M. Rawson, The Palace of Nestor at Pylos in Western Messenia (Princeton 1966).

Catling 2009
H. W. Catling, Sparta: Menelaion I. The Bronze Age, The British School at Athens Suppl. 45 (London 2009).

Cinquepalmi – Coppola 1998
A. Cinquepalmi – D. Coppola, Torre Santa Sabina, in: A. Cinquepalmi – F. Radina (eds.), Documenti dell'età del Bronzo. Ricerche lungo il versante adriatico pugliese (Fasano di Brindisi 1998) 147–162; 280–284.

De Siena 1986
A. De Siena, Termitito, in: M. Marazzi – S. Tusa – L. Vagnetti (eds), Traffici micenei nel Mediterraneo. Problemi storici e documentazione archeologica. Atti del convegno di Palermo (11–12 maggio e 3–6 dicembre 1984), Magna Grecia 3 (Taranto 1986) 41–54.

Demakopoulou et al. 2008
K. Demakopoulou – N. Divari-Valakou – M. Nilsson – A.-L. Schallin, Excavations in Midea 2005, Opuscula Atheniensia 31–32/2006–2007, 2008, 7–29.

Edel forthcoming
M. Edel, Eine Terrakotta-Werkstatt in Himera. Untersuchung zur Koroplastik in westgriechischen *apoikiai* ausgehend von den Neufunden vom Piano del Tamburino (PhD Diss., Universität Bern forthcoming).

Fisher 1988
E. A. Fisher, A Comparison of Mycenaean Pottery from Apulia with Mycenaean Pottery from Western Greece (Ann Arbor 1988).

Forsén et al. 2017
J. Forsén – H. Mommsen – C. Shriner, Some preliminary remarks concerning a Neutron Activation Analysis (NAA) study and fabric correlation of ceramic samples from Asea in Arcadia, Greece, in: E. Κώτσου (ed.), Σπείρα. Επιστημονική συνάντηση προς τιμήν της Αγγέλικας Ντούζουγλη και του Κωνσταντίνου Ζάχου (Athens 2017) 91–108.

French 1966
E. French, A Group of Late Helladic IIIB 1 pottery from Mycenae, Annual of the British School at Athens 61, 1966, 216–238.

French 2007
E. French, Late Helladic III C Middle at Mycenae, in: S. Deger-Jalkotzy – M. Zavadil (eds.), LH IIIC Chronology and Synchronisms II. LH IIIC Middle. Proceedings of the International Workshop Held at the Austrian Academy of Sciences at Vienna, October 29th and 30th, 2004, Veröffentlichungen der Mykenischen Kommission 28 (Vienna 2007) 175–187.

French 2011
E. B. French, The LH IIIC structures and associated finds, in: E. B. French – G. Hillman – S. Sherratt, The Post-Palatial Levels, Well Built Mycenae Fasc. 16/17 (Oxford 2011) 1–58.

French – Taylour 2007
E. B. French – W. D. Taylour, The Service Areas of the Cult Centre, Well Built Mycenae Fasc. 13 (Oxford 2007).

Furumark 1941
A. Furumark, The Mycenaean Pottery. Analysis and Classification (Stockholm 1941).

Geißler forthcoming
L. R. Geißler – H. Mommsen – R. Posamentir – K. Riehle, Ionians east and west. Differences according to pottery evidence, in: Ancient West and East, suppl. Colloquia Antiqua, Proceedings of the International Conference Ionians in the East and West, Ampurias, 26–29. Oct. 2015 (forthcoming).

Giardino 1994
C. Giardino, I materiali dell'età del Bronzo recente, in: R. Peroni – F. Trucco (eds.), Enotri e Micenei nella Sibaritide I. Broglio di Trebisacce (Taranto 1994) 185–264.

Grossmann – Schäfer 1975
P. Grossmann – J. Schäfer, Tiryns: Unterburg 1968. Grabungen im Bereich der Bauten 3 und „4", in: Tiryns VIII (Mainz 1975) 55–96.

Guglielmino 1999
R. Guglielmino, I dolii cordonati di Roca Vecchia (LE) e il problema della loro derivazione egea, in: V. La Rosa – D. Palermo – L. Vagnetti (eds.), επί πόντον πλαζόμενοι. Simposio italiano di studi Egei dedicato a Luigi Bernabò Brea e Giovanni Pugliese Carratelli, Roma, 18–20 febbraio 1998 (Rome 1999) 475–486.

Guglielmino 2005
R. Guglielmino, Rocavecchia. Nuove testimonianze di relazioni con l'Egeo e il mediterraneo orientale nell'età del Bronzo, in: R. Laffineur – E. Greco (eds.), Emporia. Aegeans in Central and Eastern Mediterranean. Proceedings of the

10th International Aegean Conference / 10e Rencontre égéenne internationale, Athens, Italian School of Archaeology, 14–18 April 2004, Aegaeum 25 (Liège 2005) 637–651.

Guglielmino 2008
R. Guglielmino, I materiali di tipo egeo, contribution in: Pagliara et al. 2008.

Guglielmino 2009a
R. Guglielmino, Le relazioni tra l'Adriatico e l'Egeo nel Bronzo recente e finale. La testimonianza di Roca, in: E. Borgna – P. Càssola Guida (eds.), Dall'Egeo all'Adriatico. Organizzazioni sociali, modi di scambio e interazione in età postpalaziale (XII–XI sec. a. C.) / From the Aegean to the Adriatic. Social Organizations, Modes of Exchange and Interaction in Postpalatial Times (12th–11th c. BC), Atti del Seminario internazionale (Udine, 1–2 dicembre 2006), Studi e ricerche di protostoria mediterranea 8 (Rome 2009) 185–204.

Guglielmino 2009b
R. Guglielmino, Presenze minoiche nel Salento. Roca e la saga di Minosse, in: C. Ampolo (ed.), Immagine e immagini della Sicilia e di altre isole del Mediterraneo antico, vol. I. Atti delle seste giornate internazionali di studi sull'area elima e la Sicilia occidentale nel contesto mediterraneo, Erice, 12–16 ottobre 2006 (Pisa 2009) 481–505.

Guglielmino 2013
R. Guglielmino, I rapporti tra l'Italia e l'Egeo nell'età del bronzo e il ruolo di Roca. Alcuni spunti di riflessione, Annali della Scuola Normale Superiore di Pisa serie 5, 5/2 Suppl., 2013, 131–151.

Guglielmino et al. 2010
R. Guglielmino – S. T. Levi – R. Jones, Relations between the Aegean and Apulia in the Late Bronze Age. The evidence from an archaeometric study of the pottery at Roca (Lecce), Rivista di Scienze Preistoriche 60, 2010, 257–282.

Güntner 2000
W. Güntner, Figürlich bemalte mykenische Keramik aus Tiryns, Tiryns XII (Mainz 2000).

Hallager 2003
B. P. Hallager, The Late Minoan IIIB:2 pottery, in: Hallager – Hallager 2003, 197–265.

Hallager – Hallager 2003
E. Hallager – B. P. Hallager (eds.), The Greek-Swedish Excavations at the Agia Aikaterini Square, Kastelli, Khania 1970–1987 and 2001 III. The Late Minoan IIIB:2 Settlement (Stockholm 2003).

Hallager – Hallager 2011
E. Hallager – B. P. Hallager (eds.), The Greek-Swedish Excavations at the Agia Aikaterini Square, Kastelli, Khania 1970–1987 and 2001 IV. The Late Minoan IIIB:1 and IIIA:2 Settlements (Stockholm 2011).

Heilmeyer et al. 2012
W. D. Heilmeyer – N. Kaltsas – H.-J. Gehrke – G. E. Hatzi – S. Bocher (eds.), Mythos Olympia. Kult und Spiele, Exhibition catalogue Berlin (Munich 2012).

Hein et al. 2002
A. Hein – A. Tsolakidou – H. Mommsen, Mycenaean pottery from the Argolid and Achaia. A mineralogical approach where chemistry leaves unanswered questions, Archaeometry 44, 2002, 177–186.

Iacono 2015
F. Iacono, Feasting at Roca. Cross-cultural encounters and society in the southern Adriatic during the Late Bronze Age, European Journal of Archaeology 18, 2015, 259–281.

Iacono 2016
F. Iacono, From network to society. Pottery style and hegemony in Bronze Age southern Italy, Cambridge Archaeological Journal 26, 2016, 121–140.

Iakovidis 1969/1970
Σ. Ε. Ιακωβίδης, Περατή. Το νεκροταφείον, Βιβλιοθήκη της εν Αθήναις Αρχαιολογικής Εταιρείας 67 (Athens 1969/1970).

Iakovidis 2013a
Σ. Ε. Ιακωβίδης, Ανασκαφές Μυκηνών IV. Η Οικία στις Πλάκες, Βιβλιοθήκη της εν Αθήναις Αρχαιολογικής Εταιρείας 288 (Athens 2013).

Iakovidis 2013b
Σ. Ε. Ιακωβίδης, Ανασκαφές Μυκηνών ΙΙΙ. Η Νοτιοδυτική Συνοικία, Βιβλιοθήκη της εν Αθήναις Αρχαιολογικής Εταιρείας 278 (Athens 2013).

Jones 2014
R. Jones, Appendix, in: Jones et al. 2014a, 525–550.

Jones – Levi 2014
R. Jones – S. T. Levi, Characterisation and provenance, in: Jones et al. 2014a, 101–275.

Jones et al. 2014a
R. Jones – S. T. Levi – M. Bettelli – L. Vagnetti, Italo-Mycenaean Pottery: the Archaeological and Archaeometric Dimensions, Incunabula Graeca 103 (Rome 2014).

Jones et al. 2014b
R. Jones – M. Bettelli – S. T. Levi – L. Vagnetti, Discussion and perspectives, in: Jones et al. 2014a, 407–463.

Jung 2002
R. Jung, Kastanas. Ausgrabungen in einem Siedlungshügel der Bronze- und Eisenzeit Makedoniens 1975–1979. Die Drehscheibenkeramik der Schichten 19–11, Prähistorische Archäologie in Südosteuropa 18 (Kiel 2002).

Jung 2005
R. Jung, Aspekte des mykenischen Handels und Produktenaustauschs, in: B. Horejs – R. Jung – E. Kaiser – B. Teržan (eds.), Interpretationsraum Bronzezeit. Festschrift Bernhard Hänsel, Universitätsforschungen zur prähistorischen Archäologie 121 (Bonn 2005) 45–70.

Jung 2006a
R. Jung, Χρονολογία comparata. Vergleichende Chronologie von Südgriechenland und Süditalien von ca. 1700/1600 bis 1000 v. u. Z., Veröffentlichungen der Mykenischen Kommission 26 (Vienna 2006).

Jung 2006b
R. Jung, Ευποτον Ποτεριον. Mykenische Keramik und mykenische Trinksitten in der Ägäis, in Syrien und Italien, in: Studi di protostoria in onore di Renato Peroni (Florence 2006) 407–423.

Jung 2015
R. Jung, Imported Mycenaean pottery in the east. Distribution, context and interpretation, in: B. Eder – R. Pruzsinszky (eds.), Policies of Exchange. Political Systems and Modes of Interaction in the Aegean and the Near East in the 2nd Millennium B.C.E. Proceedings of the International Symposium at the University of Freiburg, Institute for Archaeological Studies, 30th May – 2nd June 2012, Oriental and European Archaeology 2 (Vienna 2015) 243–275.

Jung 2016
R. Jung, Review of Jones et al. 2014a, Archaeologia Austriaca 100, 2016, 281–287.

Jung 2017
R. Jung, Le relazioni egee degli insediamenti calabresi e del basso Tirreno durante l'età del Bronzo, in: L. Cicala – M. Pacciarelli (eds.), Centri fortificati indigeni della Calabria dalla protostoria all'età ellenistica. Atti del convegno internazionale, Napoli, 16–17 gennaio 2014, Archeologie. Temi, contesti, materiali 1 (Naples 2017) 51–68.

Jung et al. 2015a
R. Jung – H. Mommsen – M. Pacciarelli, From west to west. Determining production regions of Mycenaean pottery of Punta di Zambrone (Calabria, Italy), Journal of Archaeological Science Reports 3, 2015, 455–463.

Jung et al. 2015b
R. Jung – M. Pacciarelli – B. Zach – M. Klee – U. Thanheiser, Punta di Zambrone (Calabria) – a Bronze Age harbour site. First preliminary report on the Recent Bronze Age (2011–2012 campaigns), Archaeologia Austriaca 99, 2015, 53–110.

Kardamaki 2009
E. Kardamaki, Ein neuer Keramikfund aus dem Bereich der Westtreppe von Tiryns. Bemalte mykenische Keramik aus dem auf der Westtreppenanlage deponierten Palastschutt (PhD Diss., Ruprecht-Karls-Universität Heidelberg 2009). Online <http://archiv.ub.uni-heidelberg.de/volltextserver/14756/> (last accessed 16 Nov. 2016).

Kolonas 2008
Λ. Κολώνας, Βούντενη. Μια σημαντική εγκατάσταση της μυκηναϊκής Αχαΐας (Athens 2008).

Levi 1999
S. T. Levi, Produzione e circolazione della ceramica nella Sibaritide protostorica I. Impasto e dolii, Prima di Sibari 1, Grandi contesti e problemi della Protostoria italiana 1 (Florence 1999).

Levi – Sonnino 1999
S. T. Levi – M. Sonnino, Analisi petrografica, in: Levi 1999, 63–69.

Mastrokostas 1966
E. Μαστροκώστας, Ανασκαφή του Τείχους Δυμαίων – αρχιτεκτονικά λείψανα, στρωματογραφία, Πρακτικά της εν Αθήναις Αρχαιολογικής Εταιρείας 1964, 1966, 60–67.

Mastrokostas 1967a
E. Μαστροκώστας, Ανασκαφή του Τείχους Δυμαίων, Πρακτικά της εν Αθήναις Αρχαιολογικής Εταιρείας 1965, 1967, 121–136.

Mastrokostas 1967b
E. Μαστροκώστας, Τείχος Δυμαίων, Έργον 1966, 1967, 156–165.

Mommsen 2014
H. Mommsen, Provenance by Neutron Activation Analyses and results of Euboean and Euboean related pottery, in: M. Kerschner – I. Lemos (eds.), Archaeometric Analyses of Euboean and Euboean Related Pottery. New Results and their Interpretations. Proceedings of the Round Table Conference held at the Austrian Archaeological Institute in Athens, 15 and 16 April 2011, Ergänzungshefte zu den Jahresheften des Österreichischen Archäologischen Instituts in Wien 15 (Vienna 2014) 13–36.

Mommsen 2018–2019
H. Mommsen, Late Bronze Age Trojan Grey Ware pottery from Sidon. Neutron Activation Analysis (NAA), method and results, Archaeology and History in the Lebanon 48–49, 2018–2019, 110–116.

Mommsen et al. 1991
H. Mommsen – A. Kreuser – E. Lewandowski – J. Weber, Provenancing of pottery. A status report on Neutron Activation Analysis and classification, in: M. Hughes – M. Cowell – D. Hook (eds.), Neutron Activation and Plasma Emission Spectrometric Analysis in Archaeology, British Museum Occasional Paper 82 (London 1991) 57–65.

Mommsen et al. 2016
H. Mommsen – M. Bentz – A. Boix, Provenance of red-figured pottery of the classical period excavated at Olympia, Archaeometry 58, 2016, 371–379.

Moschos 2009a
I. Moschos, Evidence of social re-organization and reconstruction in Late Helladic IIIC Achaea and modes of contacts and exchange via the Ionian and Adriatic Sea, in: E. Borgna – P. Càssola Guida (eds.), Dall'Egeo all'Adriatico. Organizzazioni sociali, modi di scambio e interazione in età postpalaziale (XII–XI sec. a. C.) / From the Aegean to the Adriatic. Social Organizations, Modes of Exchange and Interaction in Postpalatial Times (12th–11th c. BC). Atti del Seminario internazionale (Udine, 1–2 dicembre 2006), Studi e ricerche protostoria mediterranea 8 (Rome 2009) 345–414.

Moschos 2009b
I. Moschos, Western Achaea during the succeeding LH IIIC Late period. The final Mycenaean phase and the Submycenaean period, in: S. Deger-Jalkotzy – A. Bächle (eds.), LH IIIC Chronology and Synchronisms III. LH IIIC Late and the Transition to the Early Iron Age. Proceedings of the International Workshop at the Austrian Academy of Sciences at Vienna, February 23rd and 24th, 2007, Veröffentlichungen der Mykenischen Kommission 30 (Vienna 2009) 235–288.

Mountjoy 1976
P. A. Mountjoy, Late Helladic IIIB 1 pottery dating the construction of the South House at Mycenae, Annual of the British School at Athens 71, 1976, 77–111.

Mountjoy 1995
P. A. Mountjoy, Thorikos Mine no. 3. The Mycenaean pottery, Annual of the British School at Athens 90, 1995, 195–227.

Mountjoy 1999
P. A. Mountjoy, Regional Mycenaean Decorated Pottery (Rahden/Westf. 1999).

Mountjoy 2008
P. A. Mountjoy, The Late Helladic pottery, in: W. D. Taylour – R. Janko – D. Fortenberry – M. J. Goalen – T. Wallace (eds), Ayios Stephanos. Excavations at a Bronze Age and Medieval Settlement in Southern Laconia. The British School at Athens Suppl. 44 (London 2008) 299–387.

Mountjoy – Mommsen 2001
P. A. Mountjoy – H. Mommsen, Mycenaean pottery from Qantir-Piramesse, Egypt. Annual of the British School at Athens 96, 2001, 123–156.

Pagliara et al. 2007
C. Pagliara – G. Maggiulli – T. Scarano – C. Pino – R. Guglielmino – J. De Grossi Mazzorin – M. Rugge – G. Fiorentino – M. Primavera – L. Calcagnile – M. D'Elia – G. Quarta, La sequenza cronostratigrafica delle fasi di occupazione dell'insediamento protostorico di Roca (Melendugno, Lecce). Relazione preliminare della campagna di scavo 2005 – Saggio X, Rivista di Scienze Preistoriche 57, 2007, 311–362.

Pagliara et al. 2008
C. Pagliara – R. Guglielmino – G. Coluccia – I. Malorgio – M. Merico – D. Palmisano – M. Rugge – M. Minonne, Roca Vecchia (Melendugno, Lecce), SAS IX. Relazione stratigrafica preliminare sui livelli di occupazione protostorici (campagne di scavo 2005–2006), Rivista di Scienze Preistoriche 58, 2008, 239–280.

Papadopoulos 1978/79
Th. J. Papadopoulos, Mycenaean Achaea, Studies in Mediterranean Archaeology LV (Gothenburg 1978/79).

Peroni 1994
R. Peroni, Le comunità enotrie della Sibaritide ed i loro rapporti con i navigatori egei, in: R. Peroni – F. Trucco (eds.), Enotri e Micenei nella Sibaritide II. Altri siti della Sibaritide (Taranto 1994) 831–879.

Peroni 1996
R. Peroni, L'Italia alle soglie della storia (Rome, Bari 1996).

Podzuweit 2007
Ch. Podzuweit, Studien zur spätmykenischen Keramik, Tiryns XIV (Wiesbaden 2007).

Popham 1970
M. R. Popham, The Destruction of the Palace at Knossos, Studies in Mediterranean Archaeology XII (Gothenburg 1970).

Popham et al. 2006
M. Popham – E. Schofield – S. Sherratt, The pottery, in: D. Evely (ed.), Lefkandi IV. The Bronze Age. The Late Helladic IIIC Settlement at Xeropolis, The British School at Athens Suppl. 39 (London 2006) 137–231.

Schiappelli 2015
A. Schiappelli, Along the routes of pithoi in the Late Bronze Age, in: A. Babbi – F. Bubenheimer-Erhart – B. Marín-Aguilera – S. Mühl (eds.), The Mediterranean Mirror. Cultural Contacts in the Mediterranean Sea between 1200 and 750 B.C. (Mainz 2015) 231–243.

Shelton 1996
K. S. Shelton, The Late Helladic pottery from Prosymna, Studies in Mediterranean Archaeology and Literature Pocket-Book 138 (Gothenburg 1996).

Stockhammer 2007
Ph. Stockhammer, Die Keramik der Nachpalastzeit aus der Unterstadt von Tiryns (PhD Diss., Ruprecht-Karls-Universität Heidelberg 2007). Online <http://archiv.ub.uni-heidelberg.de/volltextserver/8612> (last accessed 16 Nov. 2016).

Symeonologou 1973
S. Symeonologou, Kadmeia I. Mycenaean finds from Thebes, Greece. Excavations at 14 Oedipus St., Studies in Mediterranean Archaeology XXXV (Gothenburg 1973).

Tabò 1998
D. Tabò, I nuovi dolii dell'età del bronzo recente, in: R. Peroni – A. Vanzetti (eds), Broglio di Trebisacce 1990–1994. Elementi e problemi nuovi dalle recenti campagne di scavo (Soveria Mannelli 1998) 157–173.

Tenaglia 1994
P. Tenaglia, I dolii cordonati, in: Peroni – Trucco (eds.), Enotri e Micenei nella Sibaritide I. Broglio di Trebisacce (Taranto 1994) 347–371.

Trucco – Vagnetti 2001
F. Trucco – L. Vagnetti (eds), Torre Mordillo 1987–1990. Le relazioni egee di una comunità protostorica della Sibaritide, Incunabula Graeca 101 (Rome 2001).

Tzavella-Evjen 1993
H. Tzavella-Evjen, A Mycenaean tomb near Selinia at Salamis, Αρχαιολογική Εφημερίς 131/1992, 1993, 67–93.

Vagnetti 2001a
L. Vagnetti, Le ceramice egeo-micenee, in: Trucco – Vagnetti 2001, 299–328.

Vagnetti 2001b
L. Vagnetti, Preliminary remarks on Mycenaean pictorial pottery from the central Mediterranean, Opuscula Atheniensia, 25–26/2000–2001, 2001, 107–115.

Vagnetti – Panichelli 1994
L. Vagnetti – St. Panichelli, Ceramica egea importata e di produzione locale, in: R. Peroni – F. Trucco (eds.), Enotri e Micenei nella Sibaritide I. Broglio di Trebisacce (Taranto 1994) 373–413.

Vitale 2006
S. Vitale, The LH IIIB – LH IIIC transition on the Mycenaean mainland. Ceramic phases and terminology, Hesperia 75, 2006, 177–204.

Voigtländer 2003
W. Voigtländer, Die Palastkeramik, Tiryns X (Mainz 2003).

Wace 1932
A. J. B. Wace, Chamber Tombs at Mycenae, Archaeologia 82 (Oxford 1932).

Wardle 1969
K. A. Wardle, A group of Late Helladic IIIB 1 pottery from within the citadel at Mycenae, Annual of the British School at Athens 64, 1969, 261–297.

Wardle 1973
K. A. Wardle, A group of Late Helladic IIIB 2 pottery from within the citadel at Mycenae. “The Causeway Deposit”, Annual of the British School at Athens 68, 1973, 297–348.

Zapheiropoulos 1965
N. Ζαφειρόπουλος, Ανασκαφή εν Φάραις, Πρακτικά της εν Αθήναις Αρχαιολογικής Εταιρείας 1958, 1965, 167–176.

From the Aegean to the Ionian Sea: Pottery, Technology and People in the Plain of Sybaris in the Late Bronze Age

Marco Bettelli[1]

Abstract: The Plain of Sybaris, in north-eastern Calabria, is one of the most important regions in Italy where it is possible to study the interactions between local people and Aegean-area traders and craftsmen in the Middle and Late Bronze Age. The combined use of systematic archaeological and archaeometric analyses, carried out especially on pottery from Broglio di Trebisacce and Torre Mordillo, has been fundamental for the investigation into the development of a local production of Mycenaean-type pottery. This Italo-Mycenaean production is oriented towards tableware that is often organised in sets of drinking vessels. There is no doubt that this is a specialised type of pottery production; one of the most controversial and challenging issues is how to connect the development of this specialised craftsmanship to the general organisation of local communities. Many studies concerning the introduction of technological novelties and craft specialisation, especially in the field of pottery production, propose that they arose not for practical or techno-economical convenience but for symbolic and social reasons connected to demand from the elite. It therefore seems necessary to analyse the phenomenon of Italo-Mycenaean pottery – and other Aegean-inspired wares – within a discussion which takes into account the political economy of local communities.

Keywords: Late Bronze Age; Aegean; central Mediterranean; pottery; technology transfer; specialisation; political economy

Introduction

The Plain of Sybaris is located in the northeastern part of Calabria, facing the Ionian Sea, close to the border with Basilicata (Fig. 1). It is one of the most important regions in the central Mediterranean where it is possible to observe the development of Mediterranean interrelations between the local Middle and Final Bronze Age (MBA, FBA) (17th–11th centuries BC). Thanks to the pioneering work of Renato Peroni, Lucia Vagnetti and Richard Jones, carried out since the early eighties of the last century[2] – and continued in the field by Alessandro Vanzetti and Flavia Trucco,[3] we now have an appropriate framework within which to place various pieces of archaeological evidence.

The combined use of systematic archaeological and archaeometric analyses has undoubtedly been fundamental; these analyses have been performed on different classes of pottery of Aegean origin or Aegean type substantially from Broglio di Trebisacce and Torre Mordillo, the two sites in which systematic and long-lasting excavations have been carried out.[4]

As is known, these settlements occupied small plateaus with steep sides, spreading over several hectares, which offered a commanding view over the coastal plain and the Gulf of Sybaris.[5]

[1] Consiglio Nazionale delle Ricerche – Istituto di Scienze del Patrimonio Culturale, Rome, Italy; marco.bettelli@cnr.it.

[2] Peroni – Trucco 1994; Vagnetti – Panichelli 1994; Jones et al. 2014a.

[3] Peroni – Vanzetti 1998; Trucco – Vagnetti 2001.

[4] Jones et al. 1994; Jones 2001; Jones et al. 2014a.

[5] The settled area is calculated on the basis of the naturally defended geomorphological unit, Peroni 1994, 835. According to this parameter, the extension of the Bronze Age site at Broglio should correspond to approximately 11ha. The geomorphological unit is composed of a system of well-isolated terraces, placed at different levels, facing the plain and separate from the hills behind. Archaeological remains of a Bronze Age village are on the highest terrace,

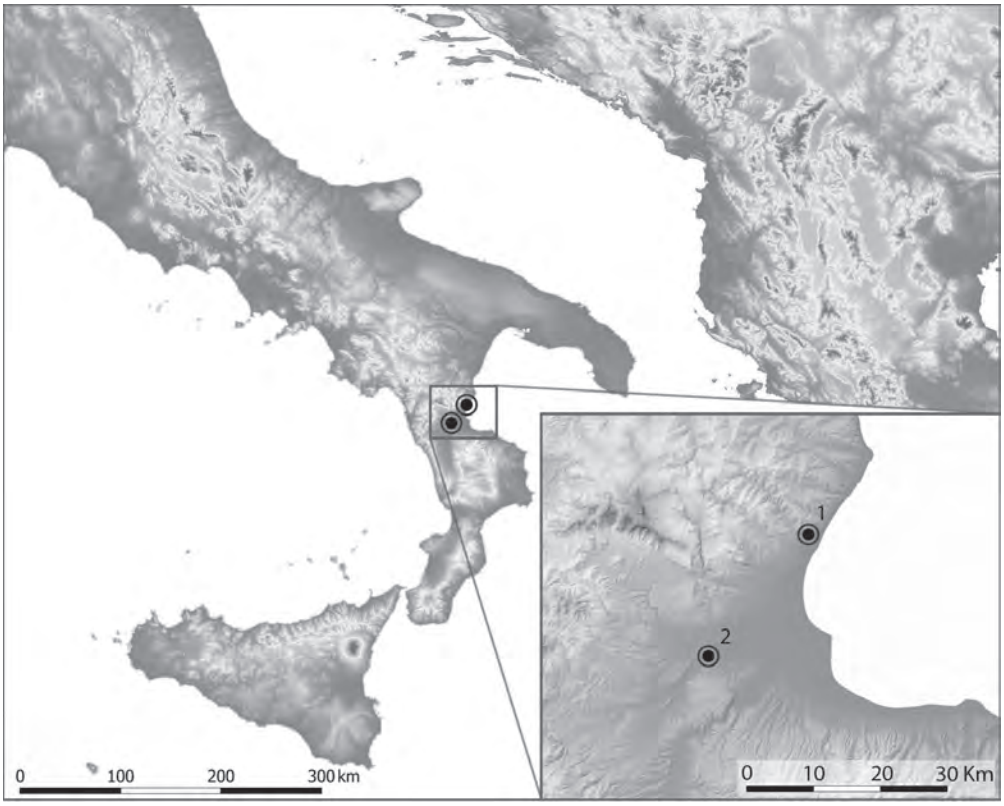


Fig. 1 The Plain of Sybaris with the location of the Broglio di Trebisacce (1) and Torre Mordillo (2) sites (graphics: A. Di Renzoni)

They were part of a larger and complex system characterised by human occupation of the first line of hills surrounding the plain. The life cycle of these villages began from an early stage of the MBA (17th–16th centuries BC) and developed without apparent interruptions, but with important changes, until the Early Iron Age, just before the foundation of the Achaean colony of Sybaris at the end of the 8th century BC.[6] Within this very long timespan interrelations with the Aegean took place, giving rise, over centuries, to significant phenomena that went beyond the simple exchange of goods.

Aegean Pottery in the Plain of Sybaris: Imports and Local Products

According to Lucia Vagnetti, the earliest examples of Aegean pottery in the Plain of Sybaris are a few sherds from Torre Mordillo, dating to LH I–II.[7] They belong to both open and closed shapes: two cups and the shoulder of a closed vessel. One fragment, a cup handle, was analysed and determined to be an import from the Aegean, probably from the Peloponnese[8] (Fig. 2.1). It is worth noting that the other, earlier sherds have also been identified as probable imports by Lucia Vagnetti, considering the high quality of their fabric[9] (Fig. 2.2–3). Despite the amplitude

the so-called 'acropolis' (1.5ha), and on a little hill, the so-called 'castle', which forms the southeastern edge of the same system; less consistent traces of human activities have been found on the remaining areas, consisting of a large terrace behind the 'acropolis', later occupied by a Hellenistic farm.

6 Peroni 1994.

7 Vagnetti 2001b, figs. 95.36; 98.99; 100.121.

8 Jones et al. 2014a, fig. 4.76.TM15.

9 Vagnetti 2001b, 323.

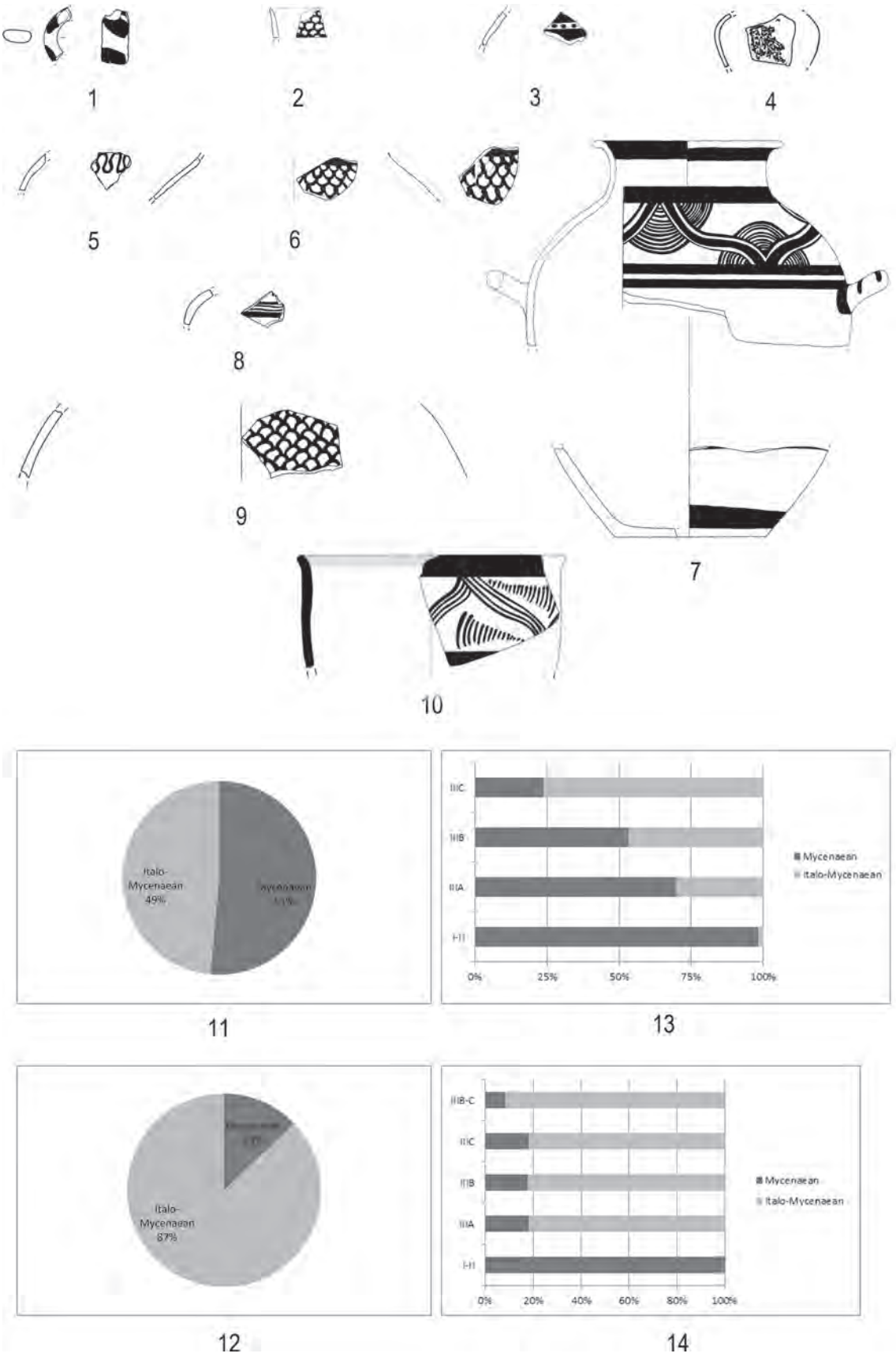


Fig. 2 LH I–II Mycenaean pottery from Torre Mordillo (1–3); LH/LM IIIA Italo-Mycenaean pottery from Broglio di Trebisacce and Torre Mordillo (4–9); LM IIIA cup from Rocavecchia, locally produced (10); ratio between imports and local products at Roca Vecchia (11) and in the Plain of Sybaris (12); proportion of imports and local products in the periods LH I–II, IIIA, IIIB and IIIC in the central Mediterranean (13) and in the Plain of Sybaris (14). 1–5, 8–10 scale 1:4; 6–7 scale 1:6 (after Vagnetti 1982; Vagnetti 1984; Vagnetti 2001b; Bettelli 2002; Guglielmino et al. 2010; Bettelli – Levi 2014)

and intensity of research in Broglio di Trebisacce, it has not yet been possible to identify Aegean pottery of such early dating.

One of the characterising points of the Plain of Sybaris in the history of relations between the central Mediterranean and the Aegean is the early beginning of the local production of Aegean-type pottery. Chemical analyses have pointed out that local clay was used to model Aegean-type vases starting from MBA 3. Findings in MBA levels, both Italo-Mycenaean and wheelmade Grey Ware which are not necessarily typologically diagnostic,[10] must be distinguished from vessels exhibiting stylistic traits of the period LH/LM IIIA which have been found in later layers, together with Aegean pottery LH/LM IIIB or IIIC in date as well[11] (Fig. 2.7). These last cases – in addition to the possibility that several examples might be residual – could be interpreted as precious items preserved through the years or as the lingering of decorations belonging to an older tradition in peripheral contexts, marginal to the creative and productive 'core' of this type of ware. This last hypothesis, although possible, seems less credible considering, on the one hand, the continuity of direct relationships between local communities and traders and craftsmen from the Aegean, shown by imports, and, on the other hand, the constant updating of the formal and especially decorative repertoire of Italo-Mycenaean pottery.

Among the oldest local products, dating from LH IIIA1, there is a jar FS 77, decorated with a stipple pattern[12] (Fig. 2.4), the shoulder of a closed vessel decorated with wavy line from Broglio di Trebisacce[13] (Fig. 2.5), and – even if typologically more ambiguous – a fragment of small closed vessel from Torre Mordillo, possibly decorated with a version of foliate band[14] (Fig. 2.8). Other elements that may be datable to the same phase are two closed vessels from Broglio and Torre Mordillo decorated with a scale pattern[15] (Fig. 2.6, 9). This decorative motif, although not unknown in subsequent periods, is undoubtedly very common during LH IIIA.

The same may also be true regarding Grey Ware. As Clarissa Belardelli and Isabella Damiani have proposed, in both Broglio and Torre Mordillo it is possible to recognise some open and closed Grey Ware shapes similar to *impasto* types datable to a final stage of the MBA, or Grey Ware vessels painted with motifs popular in LH IIIA2.[16] Besides this, as mentioned above, we must not forget the presence of plain and undiagnostic sherds of Italo-Mycenaean pottery and wheelmade Grey Ware from layers dating to the end of the MBA at Broglio di Trebisacce. These are locally produced and, according to their stratigraphic position, may help to date the beginning of the local production of Aegean-type pottery in the Plain of Sybaris towards the end of the MBA.[17]

Moreover, such a phenomenon also seems to apply for Roca Vecchia, in southern Apulia, in the same period. The earliest example of Aegean-type pottery locally produced at this site is, in fact, a cup which finds excellent correlations in the LM IIIA repertoire[18] (Fig. 2.10). The sherd comes from one of the hypogean cavities at least in part coeval to the earliest settlement walls, which are datable towards the end of the MBA.[19]

---

10 Broglio BW 3B; DE 3B1b, Belardelli 1994, pl. 52.1–2; Vagnetti – Panichelli 1994, 377, 27.

11 Broglio DW 3, Vagnetti – Panichelli 1994, pl. 76.1; Jones et al. 2014, fig. 4.70.A30.

12 Vagnetti 1982, pl. 24.2; Jones et al. 2014a, fig. 4.64.A3–BT702.

13 Vagnetti 1984, pl. 47.8; Jones et al. 2014a, fig. 4.68.A22.

14 Vagnetti 2001b, fig. 95.38; Jones et al. 2014a, fig. 4.76.TM21.

15 Jones et al. 2014a, figs. 4.74.BT 714; 4.76.TM70.

16 Belardelli 1994, 319, fig. 109.1–2; Damiani 2001, 255, figs. 47.20; 58.14.

17 Peroni 1994, 838.

18 Guglielmino et al. 2010, fig. 10.74; Jones et al. 2014a, fig. 4.50.RO74. A further, possible, evidence for the beginning of a local production of Mycenaean pottery in southern Italy in the MBA 3 is a sherd from Porto Perone, with pictorial decoration (Taylour 1958, 140, 7; Lo Porto 1963, fig. 69.2; Jones et al. 2014a, fig. 4.52.PP20). Taylour provided a dating of this sherd to LH IIIC, but a LH IIIA2 chronology can't be ruled out; see a fragment, possibly from a krater, from Termitito with a similar decoration (Vagnetti 2001a, 108, fig. 1). Important observations about this topic have also been made by R. Jung, who convincingly proposed, on stylistic grounds, a possible 'local' production for two Aegean-type vessels from Milazzese levels at Lipari (MBA3): Jung 2005a, 477, pl. CV a–b; Jung 2006a, 75, taf. 1.7.

19 Pagliara 2003, 88; Guglielmino et al. 2010, 274–275; Guglielmino 2012; Scarano 2012, 38, 377–383; Guglielmino et al. 2017, 550.

The similarities between the Plain of Sybaris and Roca Vecchia stop here. Unlike the Apulian settlement, in the Plain of Sybaris we have a very scarce presence of imports from the Aegean, even if they are distributed throughout all phases until LH IIIC, as in the case of Torre Mordillo[20] (Fig. 2.11–12).

This phenomenon is even more remarkable if compared to the general trend of the ratio between imports and local production in the central Mediterranean considering all phases (Fig. 2.13–14). Starting from LH/LM IIIA, Italo-Mycenaean pottery continues and increases progressively over time, although its precise evaluation is hampered by the difficulty in many cases of distinguishing LH IIIB from IIIC sherds. In any case, while we can see the high level of local production in LH IIIC, there is the same proportional increase between LH IIIA, IIIB and IIIC: c. 20%.[21] Such a gradual progressive increase from the time of its first appearance undermines the traditional view that connects the increase in local production during LH IIIC to the collapse of the Mycenaean palace economy, but rather considers the phenomenon as linked to the dynamics of what was taking place within Italy.

Thus the interests of the palatial elites may have played a role in the earliest phase of local production, but over time other different actors sought to expand their spheres of action. It also seems clear that the importance of the role of local communities and their demand for specialised and valuable ceramics increased over time.[22]

It is worth noting that at Broglio and Torre Mordillo tableware is the majority among both imports and local products, with very few exceptions;[23] for instance, among local products, the presence, albeit scarce, of vases for storage/transport such as stirrup jars or alabastra must be mentioned.[24] As was already pointed out, especially in the Recent Bronze Age (RBA) and FBA (13th–11th centuries BC), Italo-Mycenaean production is oriented towards tableware, dominated by drinking vessels, but includes storage/pouring and pouring; there is a scarcity of transport vessels (Fig. 3.8).[25] The manner in which these three functions – drinking, storage/pouring and pouring – continue in much the same proportions throughout LH IIIB to IIIC[26] suggests the existence of a strong, definable tradition of specific standardised shapes inspired by Aegean models, but with several local characteristics.[27] This trend concerns not only the Plain of Sybaris, but is confirmed for other areas as well, such as Apulia and Basilicata.[28]

Such a standardisation in the field of pottery production is highlighted by specific and repetitive shapes, inspired by Aegean models but with some major local innovations. A good example is the two-handled necked jars widespread in the Plain of Sybaris (Fig. 3.1–3). They are extraneous to the Mycenaean tradition, and although they can find some prototypes in several Late Minoan necked jars, as Lucia Vagnetti has suggested,[29] a local legacy connected to some specific closed shapes of the local *impasto* pottery and also adopted in wheelmade Grey Ware cannot be ruled out.[30]. These vases have a shoulder decorated with motifs belonging to Cretan and Mycenaean repertoires. If we consider that the earliest decorative motifs on these vases date back to LM IIIA,[31] the hypothesis of a possible derivation from Late Minoan models becomes more plausible. This Cretan legacy in the Plain of Sybaris is well attested only among Italo-Mycenaean productions; differently from Roca

---

20 Bettelli – Levi 2014, 411–413, figs. 6.3 a–d.
21 Bettelli – Levi 2014, 407–408, figs. 6.1a–b.
22 Jones et al. 2014b, 452–453.
23 Bettelli 2002, 58–72; Jones et al. 2005.
24 Jones at al. 2014a, fig. 4.68.A22; 4.74.BT714; 4.76.TM 21, TM 43, TM70.
25 Bettelli – Levi 2014, 415–416.
26 Both not considering the sherds of uncertain chronology and subdividing them between LH IIIB and IIIC.
27 Jones et al. 2005.
28 Bettelli – Levi 2014, 415–416.
29 Vagnetti – Panichelli 1994, 407–408. See also Preve 2011, figs. 5–6.
30 Bettelli 2002, 100–104; Castagna 2002; Castagna 2004; Castagna 2006; Bettelli et al. 2015, 16, 21. R. Jung has proposed interesting comparisons with Achaean specimens for this shape: Jung 2005a, 477; Jung 2006a, 18, taf. 7.1.
31 Jones et al. 2014a, fig. 4.70, A30.

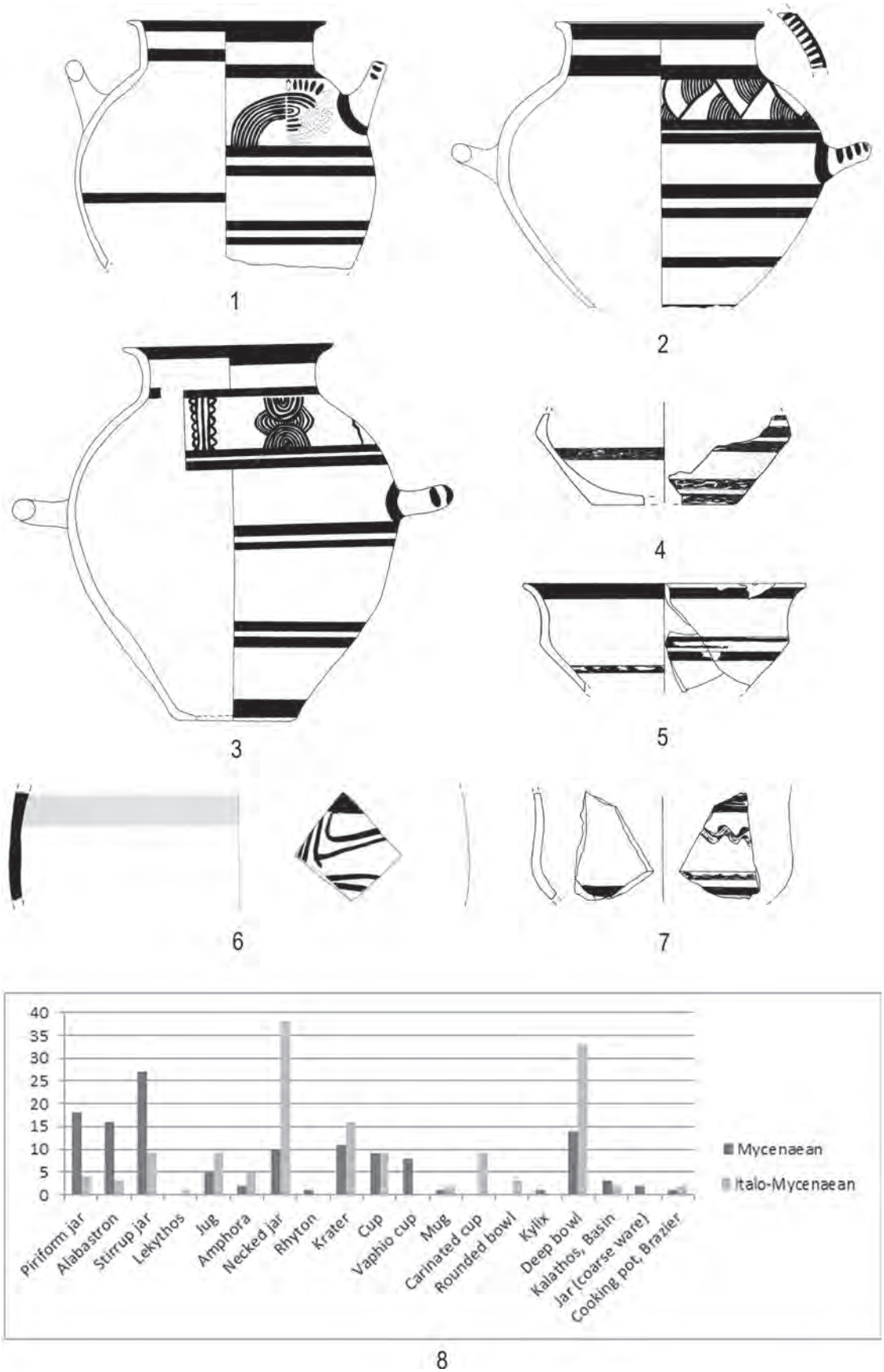


Fig. 3 LH/LM IIIB and IIIC Italo-Mycenaean tableware from the *Casa Centrale* at Broglio di Trebisacce (1–5, 7); Italo-Mycenaean krater from Rocavecchia (6); number of examples of Mycenaean and Italo-Mycenaean pottery according to shapes in the central Mediterranean (only analysed vessels) (8); 1–3, 6 scale 1:6: 4–7 scale 1:4 (after Vagnetti 1982; Vagnetti 1984; Guglielmino et al. 2010)

Vecchia, where Late Minoan elements are equally present among imports and local products, even though the former, according to the present state of knowledge, are not in the form of tableware.[32] This could mean that, on the one hand, traders and craftsmen circulated along different routes[33] while, on the other, we must consider the different functions of sites like Roca Vecchia and Broglio or Torre Mordillo. It is clear that the geography and morphology of the site at Roca promoted its role of trade port suitable for the interception of important routes within the Late Bronze Age international networks.

In the Plain of Sybaris, at present, there is no comparable situation in terms of imports. In this region an important phenomenon of technology transfer in the field of pottery production took place, which soon introduced new techniques of ceramic production and, to some extent, styles; this technological package of Aegean legacy will never be abandoned by the local communities.[34] This kind of technology transfer and its scale must necessarily have required the presence of experienced potters from the Aegean, at least in the beginning. The new technologies – fine clay, wheel-throwing or wheel-fashioning, complex firing structures, painting – were complex enough to require the presence in Italy, if only temporarily, of craftsmen who were in a position to offer training.[35] That was surely the case in contemporary Macedonia or during the introduction of the potter's wheel from the Levant to Cyprus at the beginning of the Late Bronze Age, as many studies suggest.[36]

Of course, it is possible that, over time, native artisans also joined them.[37] This last idea is further strengthened by the consideration that Italo-Mycenaean pottery is often stylistically inconsistent with the Aegean repertoire, with the introduction of a number of novelties in shapes and decorative patterns. Moreover, the strong variability observed among the ceramic *corpora* of the various sites where local production is predominant must be taken into account.[38]

Towards a Political Model

So, as we have seen, contrary to several comparable situations which arose in other regions of the Mediterranean and the Near East even in much earlier periods,[39] in the Plain of Sybaris the potter's wheel was not a local invention. One of the most controversial and challenging issues is how to connect the development of this specialised craftsmanship to the general organisation of the local communities, namely at what level of social interaction Aegean or Aegean-trained potters were acting. Differently from other historical or archaeological contexts, in fact, regarding the central Mediterranean Bronze Age it is still difficult to infer precise relationships between specialisation, exchange and social complexity according to the current models elaborated by anthropology and social archaeology.[40]

According to Elizabeth Brumfiel and Timothy Earle, specialisation can be expected when natural resources are unevenly distributed or when the production process involves some gradually acquired skills. Specialisation involves economic differentiation and interdependence: the existence of individuals who produce goods or services for a broader consumer population. It involves a number of dimensions: the affiliation of the specialist (independent or attached); the nature of the product (subsistence goods, luxury items or services); the intensity of specialisation (part-time

32 Guglielmino et al. 2010; Jones et al. 2014a, figs. 4.46–50.
33 Bettelli 2002, 71.
34 Levi 1999.
35 Jones – Vagnetti 1991; Levi – Jones 2014, 363–405, Jones et al. 2014b, 453–460. A different modality, not necessarily contrasting with this one, was proposed by R. Jung (2005b, 60).
36 Mommsen et al. 1989; Kiriatzi et al. 1997; Jung 2002a; Buxeda i Garrigos et al. 2003; Crewe 2007; Andreou 2009.
37 Peroni 1994, 852; Peroni et al. 2004, 169; Levi – Jones 2014, 404.
38 Jones et al. 2014b, 454.
39 Roux 2010.
40 Brumfiel – Earle 1987b; Roux 2010.

or full-time); the scale of the production unit (individual industry, household industry, workshop industry, village industry or large-scale industry).

The results of our research suggest some answers and considerations: the local production of Italo-Mycenaean pottery, as we have seen, implies the introduction of new and sophisticated skills from the Aegean which were probably acquired gradually by local people as well; the innovative character of Italo-Mycenaean pottery in comparison to the motherland repertoire could be an indication of this.

It is reasonable to assume that, because of its technological complexity, sophistication and exoticism, Italo-Mycenaean pottery belonged to the category of luxury items.

Sara Levi and Richard Jones propose a consideration of this kind of production at the level of workshop industry,[41] and this is an important notion as it implies relationships between masters and apprentices,[42] again with the very probable inclusion of local people in the manufacturing cycle.

Some points remain to be clarified: even where the socio-economic structures able to maintain specialised craft productions exist, part-time or full-time intensity of specialisation may depend on the fluctuations in supply and demand, so it is difficult to consider it as *a priori*. It is even more difficult to establish the specialists' affiliation. According to the models proposed in the above-mentioned studies, independent specialists produce goods or services for a broad crowd of consumers that vary according to economic, social, and political conditions. They operate within a framework with an increasing population density, in which urbanisation and market development can also be present. Attached specialists, instead, usually produce goods for a patron, either a social elite or a government. In this case specialisation arises from the explicit desire of the ruling elites to control the production and distribution of certain politically significant commodities. Attached specialisation develops largely as a function of elite coercive control and elite income.[43]

It seems that the figure of a specialised potter who, either full-time or part-time, produced Italo-Mycenaean pottery doesn't fit well with this very general classification of specialists. It is difficult, if not impossible, to consider them as independent specialists in the sense described above, given that the socio-political and socio-economic framework of the Late Bronze Age Plain of Sybaris was far from concepts such as 'market' or 'urban society'. The definition of attached specialists working for the needs of a patron member of the social elite is undoubtedly more fitting, although it would need to be further clarified in the light of specific socio-economic contexts.

So, what we really can observe is the existence of a specialised pottery production, realistically the result of the work of specialised artisans. There is an almost general agreement in considering this pottery as used for social display purposes.[44] Despite this, it is still controversial to define the specific character of the segment of the community – possibly the socially emerging groups – that acted as a customer for this commodity.[45] It is also difficult to determine whether and to what extent there were relationships of dependence between producers and consumers, especially at the beginning of the local production of this pottery, when the craftsmen came from the Aegean and were therefore not integrated in the native social systems.

It is worth noting that in terms of the acquisition of prestige goods, patron/client relationships may also be formed in simple societies, not necessarily in the presence of specialisation, as ethnographic studies suggest[46]. That is to say, that structures of patronage of this type may also exist in societies which are not extremely hierarchical, or in which a process of social stratification has only recently begun.

---

41 Levi 1999, 259–260; Levi – Jones 2014, 363–405.

42 Roux 2010, 223–224, with quoted literature.

43 Brumfiel – Earle 1987b. See also Roux 2010.

44 Peroni 1994, 847; Levi 1999; Cazzella – Recchia 2009, 32; Jones et al. 2014b, 456.

45 See, for example, Bietti Sestieri 2008, 22–27; according to this scholar, Italo-Mycenaean pottery would have been produced by Aegean craftsmen who moved to the central Mediterranean and settled in the local communities, for their personal consumption only. For a critical discussion of this issue see Bettelli 2011, 113–114; Jones et al. 2014b, 453–454.

46 Douglas 1967, cited in Brumfiel – Earle 1987b, 7.

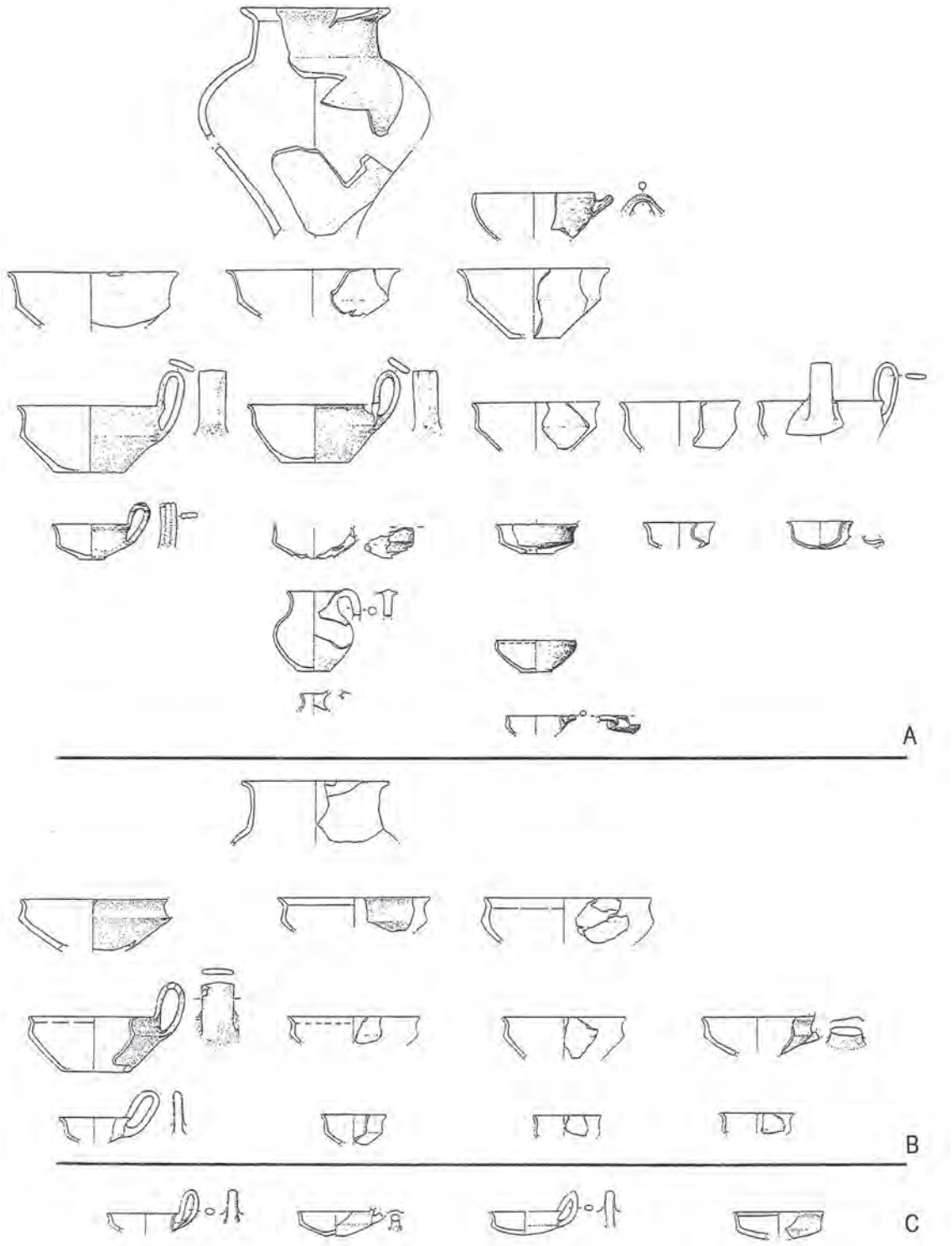


Fig. 4 Grey Ware (A) and *impasto* pottery (B–C), possibly organised in tableware sets, from the *Casa Centrale* at Broglio di Trebisacce. Scale 1:10 after Castagna 2004)

The link between technological innovations and social organisation has also been suggested by other studies concerning pottery production. Valentine Roux proposes that, in traditional societies, discontinuous innovations – such as the wheel-coiling and the wheel-throwing techniques – are promoted by individuals having some form of religious, political or financial power; they are actualised not for practical or techno-economical convenience but for symbolic and social

reasons connected to the elite's demand. In other words, these kinds of technological innovations take place in an elitarian context and only later may spread to other social components; this is because only elites can have the material margins necessary to face the possible failure which a new practice always implies.[47]

A possible example of the so-called 'attached specialisation' in Bronze Age Europe could, as suggested by Kristian Kristiansen, be the Nordic *facies*[48]. In this region local elites would have regulated metallurgy and the production of metal artefacts in order to control access to their social entourage. According to Kristiansen, the circulation of swords, daggers and metal vessels were restricted to a small segment of the population. Within the elite stratum, wealth, power and prestige were concentrated in a few key positions; these key positions were the subject of intense rivalry among the elite. To be successful in such a competition the formation of coalitions and alliances between elites was necessary, and it is probable that elite wealth mediated many of these relationships. According to Kristiansen, ritual and feasting were probably central to the creation of alliances, as attested by a number of archaeological sources of the Nordic Bronze Age, such as imported bronze vessels and golden drinking cups.

A similar phenomenon may have taken place among the Late Bronze Age elites in the Plain of Sybaris and beyond: the high incidence of tableware in Italo-Mycenaean pottery and Grey Ware – especially the former, which varies according to different local styles – can be explained as necessary equipment for ceremonies and feasting in which common drinking between members of the elite, and possibly their followers, took place.[49] Antonia Castagna has proposed the presence at Broglio of true ceramic sets in Italo-Mycenaean pottery and Grey Ware probably used to this end, at least in an advanced phase of the RBA[50] (Fig. 4). Wealth and prestige in the Nordic Bronze Age were obviously focused on precious or strategic metal artefacts. In the Plain of Sybaris – as well as in other regions where Italo-Mycenaean pottery is attested – the same could be true for this new, sophisticated pottery technology, used to produce exotic-type vessels.

At Roca Vecchia a RBA ritual context was recently identified, with the presence of LH IIIC kraters, dippers and deep bowls together with sacrificed animals.[51] It is worth noting that in this case the assemblage of kraters and deep bowls which forms the Aegean drinking set typical of the period is attested.[52] Francesco Iacono, who has studied this important context at Roca, highlights the difference between this context and the above-mentioned, more or less contemporary, drinking assemblages discovered in the *Casa Centrale* at Broglio. In that case, as already mentioned, pottery sets included large-necked jars together with cups and bowls of different sizes, mostly carinated, in Italo-Mycenaean pottery, Grey Ware and *impasto* pottery (Figs. 3.1–5, 7; 4).

The different behaviour adopted by native groups in the use of Mycenaean- or Aegean-inspired pottery, including that witnessed in coeval sites which shared many characteristics, such as Roca Vecchia and Broglio di Trebisacce, may also be justified by the constant construction and negotiation of identities which took place among local communities, or even just in certain sectors of those communities. This is even more important as it happened in a period in which local communities had come into possession of exotic artefacts, technologies and socio-ritual practices. All of these features may have had a restricted circulation, but certainly no community in the regions under consideration could boast – in this late phase of the Bronze Age – an exclusive knowledge and use.

---

47 Roux 2010, 225–228. In this regard, see also the important considerations by R. Peroni concerning the production of Italo-Mycenaean pottery and Grey Ware in the Plain of Sybaris (Peroni 1994, 846–847).

48 Kristiansen 1987.

49 Peroni et al. 2004, 169, 175.

50 Castagna 2002; Castagna 2004; Castagna 2006.

51 Iacono 2015.

52 On the central role of the krater in Mycenaean feasting, the composition of Mycenaean drinking sets and their change in the time, see: Jung 2002b; Borgna 2004; Steel 2004; Wright 2004b; Jung 2006b; Podzuweit 2007, 57–69, 191–197.

In the Plain of Sybaris, the use of Italo-Mycenaean vases, possibly inspired by local tradition (e.g. necked jars and carinated cups), together with the large amount of Grey Ware also presenting a strongly local appearance in terms of shapes, suggests the firmly entrenched presence of a well-structured local identity which could almost be called conservative[53] (Fig. 4). This appears even more clearly in comparison with other sites, such as Roca Vecchia and Scoglio del Tonno in Apulia, where – as we have seen, especially in the first case – the reception, use and manipulation of Aegean vessels and, to some extent, of symbolic and ideological attitudes, suggest a much more dynamic and fluid situation, both at the level of the whole community and of specific segments thereof.[54]

Final Remarks

A version of the so-called 'political model' in explaining relationships between specialisation, exchange and social complexity, suggests that both the control and the manipulation of wealth can come into play in the initial stages of social ranking, and an individual may establish superior social rank by displaying the symbols associated with a foreign, already established elite.[55] From this point of view, we can imagine that the communities in the Plain of Sybaris, starting at least from the end of the MBA, had undertaken a process of social hierarchy, as suggested by R. Peroni,[56] with the establishment of structures able to manage relationships with people from overseas and in faraway countries. At a certain stage in their relationship with the Aegean they started to be interested not only in imported vases, but more and more in their production technology.[57] In this way local elites could be increasingly able to directly control the production, circulation and consumption of this specific sign of social distinction without depending on the fluctuation in supply that might occur when relying exclusively on overseas trade. This model – based primarily on acquisition of exotic technologies for the production of specialised fine ceramics, according to a neo-evolutionary perspective[58] – is consistent with the general reconstruction proposed by R. Peroni and A. Vanzetti concerning the organisation of local communities in the Plain of Sybaris, according to which social structures based on leading families and client followers were present by the Late Bronze Age.[59] Such a reconstruction is founded on the thorough, combined, analysis of a large spectrum of archaeological evidence including settlement patterns, the primary economy, exchange networks, socio-cultural aspects and, of course, major changes in strategic craft production. In this field the development of a local production of specialised pottery of Aegean legacy is considered strictly linked to the elites' social strategies.

The possibility of an early involvement of native potters in the productive chain of Italo-Mycenaean pottery suggested here, but already proposed,[60] does not necessarily contrast with the

53 See also Jung 2006b, 417–418; Borgna 2012, 145.

54 Bettelli et al. 2015. In order to explain these phenomena, the concept of the 'contact zone' may be also introduced (Maran 2012, with quoted literature). In times of intense intercultural entanglement such as the Mediterranean Late Bronze Age, the presence not only of objects from abroad but also of people originating from more or less distant areas must be considered, as is the case of Aegean traders and craftsmen in the central Mediterranean. The appropriation by local people of objects, technologies and, to some extent, lifestyles proposed by foreign groups didn't necessarily follow identical trajectories in all the sites concerned. As Joseph Maran writes '…in a contact zone identities, values, and meanings were negotiated between groups of different origin, the forms and the content of appropriation must have differed significantly from group to group.' (Maran 2012, 121).

55 Brumfiel – Earle 1987b, 3.

56 Peroni 1994, 838, 842.

57 Peroni 1994, 847; Vanzetti 2000, 153.

58 Earle 1987. See also Levi – Vanzetti 1999, 264, note 160.

59 Peroni 1994; Vanzetti 2000; Vanzetti 2014.

60 Peroni 1994, 852; Levi – Vanzetti 1999, 260–265; Peroni et al. 2004, 169; Levi – Jones 2014, 403–404. The possibility of a predominant presence of local potters in producing Italo-Mycenaean vases was suggested also by A. Cazzella and G. Recchia, even if within a different interpretative framework, Cazzella et al. 2006, 153–156; Cazzella – Recchia 2009, 36; Cazzella – Recchia 2018, 25.

previously proposed model of Aegean craftsmen transferred, even temporarily, to central Mediterranean communities.[61] As mentioned above, this obviously must have happened at the beginning of the technology transfer phenomenon; but also, in the course of the long-lasting production of Italo-Mycenaean pottery, the continuous updating of shapes and decorative motifs – although in certain cases locally 'interpreted' – as well as the development of a pictorial style in local productions,[62] suggest a steady exchange of information between Aegean craftsmen and specialised potters operating in the central Mediterranean.[63] On the other hand, a major role of local potters with an Aegean training in workshops producing Italo-Mycenaean pottery may also better explain the well-rooted and long-lasting relations of production that were at work within local communities in the field of specialised pottery production and beyond.[64]

The scarce or very restricted circulation of Italo-Mycenaean pottery,[65] together with the development of specific local styles, may also be explained as an attempt to avoid procuring said pottery through local exchange networks, which could be managed by rival elitarian groups.[66]

Moreover, the elites' interests rapidly went beyond this kind of social display: the new technological knowledge in the field of pottery production was soon also used to manufacture large ceramic containers, inspired by Aegean models, able to meet more efficiently the needs of a new, incipient, productive economy based on specialised arboriculture.[67]

Acknowledgements: I wish to express my gratitude to the organisers of the Conference for inviting me to participate in the discussion of this important topic. I am particularly grateful to Reinhard Jung for his useful comments and suggestions. I also owe a great debt of gratitude to Richard Jones, Sara T. Levi and Lucia Vagnetti, who shared with me their knowledge and experience during a long-lasting collaboration. The author remains responsible for the opinions expressed in this paper.

Bibliography

Andreou 2009
S. Andreou, Stratified wheel made pottery deposits and absolute chronology of the LBA to the EIA transition at Thessaloniki Toumba, in: S. Deger-Jalkotzy – A. E. Bächle (eds.), LH IIIC Chronology and Synchronisms III. LH IIIC Late and the Transition to the Early Iron Age. Proceedings of the International Workshop at the Austrian Academy of Sciences at Vienna, February 23rd and 24th, 2007, Veröffentlichungen der Mykenischen Kommission 30 (Vienna 2009) 15–40.

Belardelli 1994
C. Belardelli, La ceramica grigia, in: Peroni – Trucco 1994, 265–346.

61 Jones – Vagnetti 1991; Jones et al. 1994, 452–453; Peroni 1994, 852–853; Levi – Jones 2014, 403–404.

62 Vagnetti – Panichelli 1994, pl. 74.4; Vagnetti 2001a, figs. 3, 7, 18, 20; Vagnetti 2006; Vagnetti et al. 2009, 178, fig. 11.4–5; Jones et al. 2014a, figs. 4.59.ST 22, 62; 4.61.T39–40; 4.68.A20. In this regard, see also the important considerations in Jung 2005b, 60.

63 Peroni 1994, 853; Vagnetti 1999; Jones et al. 2014b, 452.

64 Peroni 1994, 846–847.

65 The important results of chemical analyses of the Aegean pottery from the Bronze Age site of Punta di Zambrone (Vibo Valentia) suggest the presence at this site, located in Tyrrhenian Calabria, of Italo-Mycenaean vases possibly produced in the southern Plain of Sybaris. This should be the first case in which a circulation of Italo-Mycenaean pottery outside the production area is well attested (Jung et al. 2015, 459–460, fig. 2). Actually, the few sherds from northern and central Italy previously considered as possible imports from the southern Italian peninsula (Jones et al. 2002, 233–242; Bettelli et al. 2006, 403; Salzani et al. 2006, 1156) are now viewed as probable local products (Jones – Levi 2014, 273–275).

66 According to R. Peroni the production of Italo-Mycenaean pottery was promoted by local elites in order to better manage the complex dependence relationships with other social groups of lower rank (Peroni 1994, 847, 852).

67 Peroni 1983, 250–251; Peroni 1994, 845–846, 852, 855–856; Guglielmino 1999; Levi 1999; Vanzetti 2000, 147–149, 154–156; Terral et al. 2004; Schiappelli 2006; Bettelli 2011, 115; Vanzetti 2014, 89–97; Schiappelli 2015; Primavera – Fiorentino 2015.

Bettelli 2002
M. Bettelli, Italia meridionale e mondo miceneo. Ricerche su dinamiche di acculturazione e aspetti archeologici, con particolare riferimento ai versanti adriatico e ionico della penisola italiana, Grandi contesti e problemi della Protostoria italiana 5 (Florence 2002).

Bettelli 2011
M. Bettelli, Interaction and acculturation. The Aegean and the Central Mediterranean in the Late Bronze Age, in: H. Matthäus – N. Oettinger – S. Schröder (eds.), Der Orient und die Anfänge Europas. Kulturelle Beziehungen von der Späten Bronzezeit bis zur Frühen Eisenzeit, Philippika 42 (Wiesbaden 2011) 109–126.

Bettelli – Levi 2014
M. Bettelli – S. T. Levi, 6.1. Assessment of archaeological and archaeometric results, in: Jones et al. 2014a, 407–425.

Bettelli et al. 2006
M. Bettelli – S. T. Levi – R. E. Jones – L. Vagnetti, Le ceramiche micenee in area medio tirrenica: nuove prospettive, in: Studi di Protostoria in onore di Renato Peroni (Florence 2006) 399–406.

Bettelli et al. 2015
M. Bettelli – A. Castagna – I. Damiani – A. Di Renzoni, 4.10. Spunti per la ricostruzione dei modi del bere e del mangiare nelle comunità protostoriche dell'Italia meridionale ionica e tirrenica, in: I. Damiani – M. Pacciarelli (eds.), Preistoria del Cibo. 50ma Riunione Scientifica dell'Istituto Italiano di Preistoria e Protostoria, Roma, 5–9 ottobre 2015. Sessione 4: Tra ritualità e potere. Gli aspetti sociali della produzione, acquisizione conservazione e consumo del cibo e delle bevande. Online <http://preistoriadelcibo.iipp.it/sessione4-download.html> (last accessed 16 Feb. 2019).

Bietti Sestieri 2008
A. M. Bietti Sestieri, L'età del Bronzo finale nella penisola italiana, Padusa 44, 2008, 7–54.

Borgna 2004
E. Borgna, Aegean feasting. A Minoan perspective, in: Wright 2004a, 127–159.

Borgna 2012
E. Borgna, From Minoan Crete to Mycenaean Greece and beyond. The dissemination of ritual practices and their material correlates in ceremonial architecture, in: J. Maran – P. Stockhammer (eds.), Materiality and Social Practice. Transformative Capacities of Intercultural Encounters (Oxford 2012) 137–151.

Brumfiel – Earle 1987a
E. M. Brumfiel – T. K. Earle (eds.), Specialization, Exchange, and Complex Societies (Cambridge 1987).

Brumfiel – Earle 1987b
E. M. Brumfiel – T. K. Earle, Specialization, exchange, and complex societies. An introduction, in: Brumfiel – Earle 1987a, 1–9.

Buxeda i Garrigos et al. 2003
J. Buxeda i Garrigos – R. E. Jones – V. Kilikoglou – S. T. Levi –Y. Maniatis – L. Vagnetti – K. A. Wardle – S. Andreou, Technology transfer on the periphery of the Mycenaean world: the case of Mycenaean pottery found in central Macedonia and the Plain of Sybaris (Italy), Archaeometry 45, 2003, 263–284.

Castagna 2002
M. A. Castagna, La ceramica grigia tornita dalla "casa centrale" (campagne di scavo 1980–1982). Una messa a punto, in: Bettelli 2002, 233–249.

Castagna 2004
M. A. Castagna, I servizi da simposio in ceramica d'impasto e depurata dalla "casa centrale" di Broglio di Trebisacce, in: Cocchi Genick 2004, 263–267.

Castagna 2006
M. A. Castagna, Variazioni dimensionali e variabilità tipologica del vasellame da mensa del Bronzo recente in Italia meridionale, in: Studi di Protostoria in onore di Renato Peroni (Florence 2006) 354–360.

Cazzella – Recchia 2009
A. Cazzella – G. Recchia, The 'Mycenaeans' in the central Mediterranean. A comparison between the Adriatic and the Tyrrhenian seaways, Pasiphae 3, 2009, 27–40.

Cazzella – Recchia 2018
A. Cazzella – G. Recchia, Local networks and Aegean-Mycenaean connectivity in the Tyrrhenian and Adriatic Seas, in: M. Bettelli – M. Del Freo – G. J. van Wijngaarden (eds.), Mediterranea Itinera. Studies in Honour of Lucia Vagnetti, Incunabula Graeca 106 (Rome 2018) 11–31.

Cazzella et al. 2006
A. Cazzella – G. Cofini – G. Recchia, Scambio alla pari, scambio ineguale. La documentazione archeologica e il contributo dell'Etnoarcheologia, in: Istituto Italiano di Preistoria e Protostoria (ed.), Atti della XXXIX Riunione Scientifica "Materie prime e scambi nella preistoria italiana", Firenze, 25–27 novembre 2004 (Florence 2006) 145–168.

Cocchi Genick 2004
D. Cocchi Genick (ed.), L'età del bronzo recente in Italia. Atti del Congresso Nazionale di Lido di Camaiore, 26–29 ottobre 2000 (Viareggio 2004).

Crewe 2007
L. Crewe, Sophistication in simplicity. The first production of wheelmade pottery on LBA Cyprus, Journal of Mediterranean Archaeology 20, 2007, 209–238.

Damiani 2001
I. Damiani, L'età del bronzo recente, in: Trucco – Vagnetti 2001, 235–257.

Douglas 1967
M. Douglas, Primitive rationing. A study in controlled exchange, in: R. Firth (ed.), Themes in Economic Anthropology (London 1967) 119–147.

Earle 1987
T. K. Earle, Chiefdoms in archaeological and ethnohistorical perspectives, Annual Review of Anthropology 16, 1987, 279–308.

Guglielmino 1999
R. Guglielmino, I dolii cordonati di Roca Vecchia (LE) e il problema della loro derivazione egea, in: V. La Rosa – D. Palermo – L. Vagnetti (eds.), Ἐπί πόντον πλαζόμενοι. Simposio italiano di studi Egei dedicato a Luigi Bernabò Brea e Giovanni Pugliese Carratelli, Roma, 18–20 febbraio 1998 (Rome 1999) 475–486.

Guglielmino 2012
R. Guglielmino, La ceramica di tipo egeo, in: Scarano 2012, 374–377.

Guglielmino et al. 2010
R. Guglielmino – S.T. Levi – R. Jones, Relations between the Aegean and Apulia in the Late Bronze Age. The evidence from an archaeometric study of the pottery at Roca (Lecce), Rivista di Scienze Preistoriche 60, 2010, 257–282.

Guglielmino et al. 2017
R. Guglielmino – F. Iacono – L. Coluccia, Roca e il mondo egeo tra il XVI e l'XI sec. a.C. Una messa a punto, in: F. Radina (ed.), Preistoria e Protostoria della Puglia, Studi di Preistoria e Protostoria 4 (Florence 2017) 549–555.

Iacono 2015
F. Iacono, Feasting at Roca. Cross-cultural encounters and society in the southern Adriatic during the Late Bronze Age, European Journal of Archaeology 18, 2015, 259–281.

Jones 2001
R. E. Jones, A provenance study of the Aegean-type and other pottery by chemical analysis, in: Trucco – Vagnetti 2001, 331–338.

Jones – Levi 2014
R. E. Jones – S. T. Levi, Characterisation and provenance, in: Jones et al. 2014a, 101–275.

Jones – Vagnetti 1991
R. E. Jones – L. Vagnetti, Traders and craftsmen in central Mediterranean. Archaeological evidence and archaeometric research, in: N. H. Gale (ed.), Bronze Age Trade in the Mediterranean. Papers Presented at the Conference held at Rewley House, Oxford, in December 1989, Studies in Mediterranean Archaeology 90 (Jonsered 1991) 127–147.

Jones et al. 1994
R. E. Jones – L. Lazzarini – M. Mariottini – E. Orvini, Studio minero-petrografico e chimico di ceramiche protostoriche da Broglio di Trebisacce (Sibari), in: Peroni – Trucco 1994, 413–454.

Jones et al. 2002
R. E. Jones – L. Vagnetti – S. T. Levi – J. Williams – D. Jenkins – A. De Guio, Mycenaean and Aegean-type pottery from northern Italy. Archaeological and Archaeometric Studies, Studi Micenei ed Egeo-Anatolici 44, 2002, 221–261.

Jones et al. 2005
R. E. Jones – S. T. Levi – M. Bettelli, Mycenaean pottery in the central Mediterranean. Imports, imitations and derivatives, in: Laffineur – Greco 2005, 539–545.

Jones et al. 2014a
R. E. Jones – S. T. Levi – M. Bettelli – L. Vagnetti, Italo-Mycenaean Pottery. The archaeological and archaeometric dimensions, Incunabula Graeca 103 (Rome 2014).

Jones et al. 2014b
R.E. Jones – M. Bettelli – S.T. Levi – L. Vagnetti, Discussion and perspectives, in: Jones et al. 2014a, 407–463.

Jung 2002a
R. Jung, Kastanas. Ausgrabungen in einem Siedlungshügel der Bronze- und Eisenzeit Makedoniens 1975–1979. Die Drehscheibenkeramik der Schichten 19–11, Prähistorische Archäologie in Südosteuropa 18 (Kiel 2002).

Jung 2002b
R. Jung, Η χρήση της μυκηναϊκής και πρωτογεωμετρικής κεραμικής στη Μακεδονία, Το Αρχαιολογικό Έργο στη Μακεδονία και στη Θράκη 16/2002, 2004, 35–46.

Jung 2005a
R. Jung, Πότε; Quando? Wann? Quand? When? – Translating Italo-Aegean synchronisms, in: Laffineur – Greco 2005, 473–483.

Jung 2005b
R. Jung, Aspekte des mykenischen Handels und Produktenaustauschs, in: B. Horejs – R. Jung – E. Kaiser – B. Teržan (eds.), Interpretationsraum Bronzezeit. Bernhard Hänsel von seinen Schülern gewidmet, Universitätsforschungen zur Prähistorischen Archäologie 121 (Bonn 2005) 45–70.

Jung 2006a
R. Jung, Χρονολογία comparata. Vergleichende Chronologie von Südgriechenland und Süditalien von ca. 1700/1600 bis 1000 v. u. Z., Veröffentlichungen der Mykenischen Kommission 26 (Vienna 2006).

Jung 2006b
R. Jung, Εὔποτον ποτέριον. Mykenische Keramik und mykenische Trinksitten in der Ägäis, in Syrien, Makedonien und Italien, in: Studi di Protostoria in onore di Renato Peroni (Florence 2006) 407–423.

Jung et al. 2015
R. Jung – H. Mommsen – M. Pacciarelli, From west to west. Determining production regions of Mycenaean pottery of Punta di Zambrone (Calabria, Italy), Journal of Archaeological Science Reports 3, 2015, 455–463.

Kiriatzi et al. 1997
E. Kiriatzi – S. Andreou – S. Dimitriadis – K. Kotsakis, Coexisting traditions. Handmade and wheelmade pottery in Late Bronze Age Central Macedonia, in: R. Laffineur – P. P. Betancourt (eds.), TEXNH. Craftsmen, Craftswomen and Craftsmanship in the Aegean Bronze Age. Proceedings of the 6th International Aegean Conference / 6e Rencontre égéenne internationale, Philadelphia, Temple University, 18–21 April 1996, Aegaeum 16 (Liège 1997) 361–367.

Kristiansen 1987
K. Kristiansen, From stone to bronze: the evolution of social complexity in Northern Europe, 2300–1200 BC, in: Brumfiel – Earle 1987a, 30–51.

Laffineur – Greco 2005
R. Laffineur – E. Greco (eds.), Emporia. Aegeans in Central and Eastern Mediterranean. Proceedings of the 10th International Aegean Conference/10e Rencontre égéenne internationale, Athens, Italian School of Archaeology, 14–18 April 2004, Aegaeum 25 (Liège 2005).

Levi 1999
S. T. Levi, Produzione e circolazione della ceramica nella Sibaritide protostorica I. Impasto e dolii, Grandi contesti e problemi della Protostoria Italiana 1, Prima di Sibari 1 (Florence 1999).

Levi – Jones 2014
S. T. Levi – R.E. Jones, Technological investigations, in: Jones et al. 2014a, 363–405.

Levi – Vanzetti 1999
S. T. Levi – A. Vanzetti, Una panoramica generale, in: Levi 1999, 260–265.

Lo Porto 1963
F. G. Lo Porto, Leporano (Taranto). La stazione protostorica di Porto Perone, Notizie degli Scavi di Antichità 17, 1963, 280–380.

Maran 2012
J. Maran, Ceremonial feasting equipment, social space and interculturality in Post-Palatial Tiryns, in: J. Maran – P. Stockhammer (eds.), Materiality and Social Practice. Transformative Capacities of Intercultural Encounters (Oxford 2012) 121–136.

Mommsen et al. 1989
H. Mommsen – A. Kreuser – J. Weber – Ch. Podzuweit, Classification of Mycenaean pottery from Kastanas by Neutron Activation Analysis, in: Archaeometry. Proceedings of the 25th International Symposium, Athens 19–22 May 1986 (Amsterdam, Oxford, New York, Tokyo 1989) 515–523.

Pagliara 2003
C. Pagliara, Il sito di Roca Vecchia nell'età del Bronzo, in: F. Lenzi (ed.), L'Archeologia dell'Adriatico dalla Preistoria al Medioevo. Atti del convegno internazionale, Ravenna, 7–8–9 giugno 2001 (Bologna 2003) 74–90.

Peroni 1983
R. Peroni, Presenze micenee e forme socio-economiche nell'Italia protostorica, in: G. Pugliese Carratelli (ed.), Magna Grecia e mondo miceneo. Atti del XXII Convegno di studi sulla Magna Grecia, Taranto, 7–11 ottobre 1982 (Taranto 1983) 211–284.

Peroni 1994
R. Peroni, Le comunità enotrie della Sibaritide ed i loro rapporti con i navigatori Egei, in: R. Peroni – F. Trucco (eds.), Enotri e Micenei nella Sibaritide II. Altri siti della Sibaritide (Taranto 1994) 832–879.

Peroni – Trucco 1994
R. Peroni – F. Trucco (eds.), Enotri e Micenei nella Sibaritide I. Broglio di Trebisacce (Taranto 1994).

Peroni – Vanzetti 1998
R. Peroni – A. Vanzetti (eds.), Broglio di Trebisacce 1990–1994. Elementi e problemi nuovi dalle recenti campagne di scavo (Soveria Mannelli 1998).

Peroni et al. 2004
R. Peroni – A. Vanzetti – C. Bartoli – M. Bettelli – I. Cassetta – M. A. Castagna – A. Di Renzoni – F. Ferranti – D. Gatti – S. T. Levi – A. Schiappelli, Broglio di Trebisacce (Cosenza), in: Cocchi Genick 2004, 167–176.

Podzuweit 2007
Ch. Podzuweit, Studien zur spätmykenischen Keramik, Tiryns XIV (Wiesbaden 2007).

Preve 2011
S. Preve, South enclosure of the Holy Church of Apostles Peter and Paul excavation (69–71, Igoumenou Gabriel St.), in: M. Andreadaki-Vlazaki (ed.), Khania (Kydonia). A Tour to Sites of Ancient Memory (Chania 2011) 166–171.

Primavera – Fiorentino 2015
M. Primavera – G. Fiorentino, 3.28. Lo sfruttamento dei frutti arborei spontanei e l'arboricoltura in Puglia durante l'età del bronzo, in: C. Belardelli – J. De Grossi Mazzorin (eds.), Preistoria del Cibo. 50ma Riunione Scientifica dell'Istituto Italiano di Preistoria e Protostoria, Roma, 5–9 ottobre 2015. Sessione 3: Manipolare e conservare. Gli aspetti technici ed economici della gestione delle risorse. Online <http://preistoriadelcibo.iipp.it/sessione3-download.html> (last accessed 14 Feb. 2019).

Roux 2010
V. Roux, Technological innovations and developmental trajectories: social factors as evolutionary forces, in: M. J. O'Brien – S. J. Shennan (eds.), Innovation in cultural systems. Contributions from evolutionary anthropology (Cambridge [Massachusetts], London 2010) 217–233.

Salzani et al. 2006
L. Salzani – L. Vagnetti – R. E. Jones – S. T. Levi, Nuovi ritrovamenti di ceramiche di tipo egeo dall'area veronese. Lovara, Bovolone e Terranegra, in: Istituto Italiano di Preistoria e Protostoria (ed.), Atti della XXXIX Riunione Scientifica "Materie prime e scambi nella preistoria italiana", Firenze, 25–27 novembre 2004 (Florence 2006) 1145–1157.

Scarano 2012
T. Scarano, Roca I. Le fortificazioni della media età del Bronzo. Strutture, contesti, materiali (Foggia 2012).

Schiappelli 2006
A. Schiappelli, Dolii e magazzini tra tardo Bronzo e primo Ferro. Una panoramica tra Italia meridionale e mondo egeo-mediterraneo, in: Studi di Protostoria in onore di Renato Peroni (Firenze 2006) 393–398.

Schiappelli 2015
A. Schiappelli, Along the routes of pithoi in the Late Bronze Age, in: A. Babbi – F. Bubenheimer-Erhart – B. Marín-Aguilera – S. Mühl (eds.), The Mediterranean Mirror. Cultural Contacts in the Mediterranean Sea between 1200 and 750 B.C., International Post-doc and Young Researchers Conference, Heidelberg, 6th–8th October 2012 (Mainz 2015) 231–243.

Steel 2004
L. Steel, A goodly feast … a cup of mellow wine. Feasting in Bronze Age Cyprus, in: Wright 2004a, 161–180.

Taylour 1958
W. Taylour, Mycenean Pottery in Italy and Adjacent Areas (Cambridge 1958).

Terral et al. 2004
J.-F. Terral – N. Alonso – R. Buxó i Capdevila – N. Chatti – L. Fabre – G. Fiorentino – P. Marinval – G. Pérez Jordá – B. Pradat – N. Rovira – P. Alibert, Historical biogeography of olive domestication (*Olea europaea* L.) as revealed by geometrical morphometry applied to biological and archaeological material, Journal of Biogeography 31, 2004, 63–77.

Trucco – Vagnetti 2001
F. Trucco – L. Vagnetti (eds.), Torre Mordillo 1987–1990. Le relazioni egee di una comunità protostorica della Sibaritide, Incunabula Graeca 101 (Rome 2001).

Vagnetti 1982
L. Vagnetti, Ceramica micenea e ceramica dipinta dell'età del bronzo, in: G. Bergonzi – V. Buffa – A. Cardarelli – C. Giardino – R. Peroni – L. Vagnetti, Ricerche sulla Protostoria della Sibaritide 2, Cahiers du Centre Jean Bérard VIII (Naples 1982) 99–113.

Vagnetti 1984
L. Vagnetti, Ceramica di importazione egea e ceramica dipinta dell'età del bronzo, in: R. Peroni (ed.), Nuove ricerche sulla protostoria della Sibaritide (Roma 1984) 169–196.

Vagnetti 1999
L. Vagnetti, Mycenaean pottery in the central Mediterranean. Imports and local production in their context, in: J. P. Crielaard – V. Stissi – G. J. van Wijngaarden (eds.), The Complex Past of Pottery. Production, Circulation and Consumption of Mycenaean and Greek Pottery (Sixteenth to Early Fifth Centuries BC). Proceedings of the ARCHON International Conference, held in Amsterdam, 8–9 November 1996 (Amsterdam 1999) 137–161.

Vagnetti 2001a
L. Vagnetti, Preliminary remarks on Mycenaean pictorial pottery from the Central Mediterranean, Opuscula Atheniensia 25–26/2000–2001, 2001, 107–115.

Vagnetti 2001b
L. Vagnetti, Le ceramiche egeo-micenee, in: Trucco – Vagnetti 2001, 299–327.

Vagnetti 2006
L. Vagnetti, Tartarughe nella Sibaritide, in: E. Herring – I. Lemos – F. Lo Schiavo – L. Vagnetti – R. Whitehouse – J. Wilkins (eds.), Across Frontiers. Etruscans, Greeks, Phoenicians and Cypriots. Studies in Honour of David Ridgway and Francesca Romana Serra (London 2006) 339–348.

Vagnetti – Panichelli 1994
L. Vagnetti – S. Panichelli, Ceramica egea importata e di produzione locale, in: Peroni – Trucco 1994, 373–413.

Vagnetti et al. 2009
L. Vagnetti – R. E. Jones – S. T. Levi –M. Bettelli – L. Alberti, Ceramiche egee e di tipo egeo lungo i versanti adriatico e ionico della Peninsola italiana. Situazioni a confronto, in: E. Borgna – P. Cassola Guida (eds.), Dall'Egeo all'Adriatico. Organizzazioni sociali, modi di scambio e interazione in età postpalaziale (XII–XI sec. a. C.) / From the Aegean to the Adriatic. Social Organisations, Modes of Exchange and Interaction in Postpalatial Times (12th–11th c. BC). Atti del Seminario internazionale (Udine, 1–2 dicembre 2006), Studi e ricerche di protostoria mediterranea 8 (Rome 2009) 171–184.

Vanzetti 2000
A. Vanzetti, Broglio di Trebisacce nel quadro dell'Italia meridionale, in: M. Harari – M. Pearce (eds.), Il Protovillanoviano al di qua e al di là dell'Appennino. Atti della giornata di studio. Pavia, Collegio Ghisleri, 17 giugno 1995, Biblioteca di Athenaeum 38 (Como 2000) 133–171.

Vanzetti 2014
A. Vanzetti, Dall'Età del Bronzo all'Età del Ferro. Il contesto archeologico della più antica *Italìa* (I), in: Istituto per la Storia e l'Archeologia della Magna Grecia (ed.), Da *Italìa* a Italia. Le radici di un'identità, Atti del Cinquantunesimo Convegno di Studi sulla Magna Grecia, Taranto 29 settembre – 2 ottobre 2011 (Taranto 2014) 79–106.

Wright 2004a
J. C. Wright (ed.), The Mycenaean Feast [Special Issue, Hesperia 73, 2, 2004] (Princeton 2004).

Wright 2004b
J. C. Wright, A survey of evidence for feasting in Mycenaean society, in: Wright 2004a, 13–58.

Handmade Burnished Pottery in the Palace of Ayios Vasileios, Laconia (Southern Greece)

Eleftheria Kardamaki[1] – *Adamantia Vasilogamvrou*[2]

Abstract: The handmade burnished pottery appears in the late 13th and early 12th centuries BCE at many palatial centres of the Greek mainland and is particularly frequent in the Argolid. In the southeastern Peloponnese, Ayios Vasileios is, next to the Menelaion, the second site where this peculiar pottery class was found. The ongoing excavation in the newly found palatial centre may add valuable information for the interpretation of handmade pottery of the early 12th century BCE. The handmade pottery from Ayios Vasileios reflects shapes and decoration of Italian *impasto* pottery traditions that were common in many other sites of the Greek mainland and on Crete. The new finds seem to support the hypothesis of a foreign – in this case most probably Italian – population segment present in major centres, especially during the period that followed the severe destruction of the palaces in the Argolid. In the light of the typological connections between the Laconian and the Argolidan handmade burnished ware, especially from Tiryns, we suggest a movement of small groups of people from the Argolid to the south.

Keywords: Ayios Vasileios, Mycenaean palaces, LH III C Early, handmade burnished pottery, migrations

Introduction

Among the objects considered to mark the deep changes taking place after the destruction of the palaces on the Greek mainland around 1200 BCE belongs the pottery class of handmade burnished ware, previously known as 'barbarian' or Dorian pottery.[3] Although limited in numbers, its 'archaic' appearance and manufacture technique contrasted in such a way with the contemporary local pottery that it was immediately connected with the arrival of new populations on the Greek mainland and beyond.[4] The carriers of the handmade burnished ware (hereafter HBW) were consequently also related to the destructive events that led to the collapse of the Mycenaean palaces.[5] Almost 50 years after its first identification, HBW, its roots, inspiration and interpretation still represents a highly debated topic, whereby a clear answer concerning its sudden appearance has not yet been given. The excavation of more material on the Greek mainland and in the Levant during recent years has added new important data[6] and, at the same time, new aspects have been considered in an attempt to understand the conditions that led to the appearance of this pottery

1 Austrian Archaeological Institute, Austrian Academy of Sciences, Hollandstraße 11–13, 1020 Vienna, Austria; Eleftheria.Kardamaki@oeaw.ac.at.

2 Karpasias 4, 26441 Patras, Greece; adapanvas@gmail.com.

3 Schachermeyr 1980, 48, 60–61; Catling – Catling 1981, 76–82; Bouzek 1985, 182, fig. 91; 183–187, 242. See Jung 2006, 21–22, for discussion.

4 Rutter 1975, 17–32; Deger-Jalkotzy 1977, 78–89; Schachermeyr 1980, 56, 57, 61; Catling – Catling 1981, 71–82. For a summary of all theories related to the appearance of HBW see Kilian 2007, 73–74; Pilides 1994, 1–9. Possible regions of origin were sought at Troy, on the central Balkans, in the area of Coslogeni culture in southeastern Romania, or in Italy (Wace French 1969, 136; Milburn 1971, 338; Rutter 1975, 30–32; Rutter 1976, 187; Popham–Bankoff et. al. 1996).

5 Rutter 1975, 30–32; Deger-Jalkotzy 1977, 78–79; Schachermeyr 1980, 48.

6 The sites that offered new and valuable data for the study and interpretation of the HBW in the recent years are Dimini in Thessaly, Chania on Crete, Tell Kazel in Syria and Tell 'Arqa in Lebanon. See: Pålsson Hallager 2003, 253–254; pls. 84–85; Adrimi-Sismani 2003, 91–93, figs. 10–13; Jung 2008, 209–210; Badre et al. 2005, 34, fig. 9; Jung 2006, 209–210; Boileau et. al 2010, 1678–1679, 1686–1688; Adrimi-Sismani 2014, 562–570.

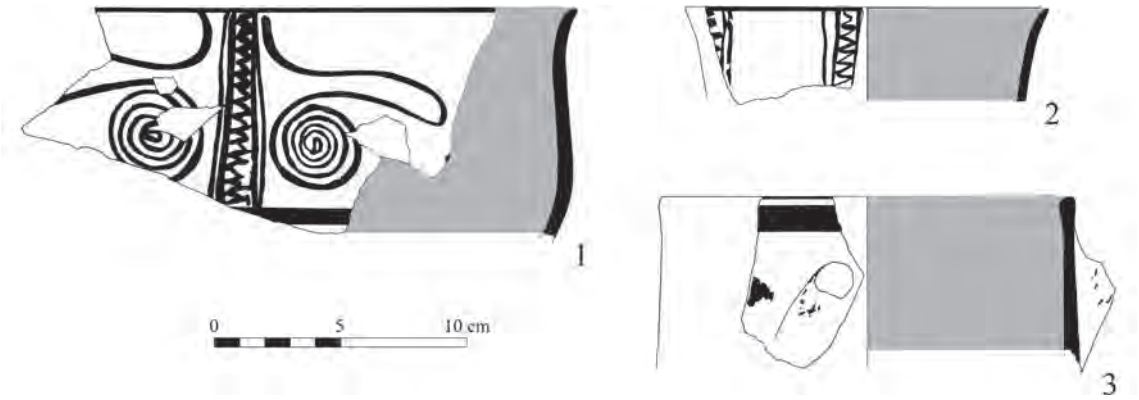


Fig. 1 LH IIIC Early pottery from the area of the court. Scale 1:3 (drawings: A. Poelstra Traga)

class.[7] The topic of this paper is to present the HBW from the newly identified palace of Ayios Vasileios in central Laconia.[8] Although still limited in number, the new material does offer valuable data that will allow us to get a more detailed picture for the chronological and geographical distribution of this 'alien' pottery class within LH IIIB2 and LH IIIC Early Mycenaean contexts.[9]

The Contexts of the HBW

The material presented here derives from deposits dating to the early 12th century BCE, a pottery phase termed as Transitional LH IIIB2 – LH IIIC Early,[10] LH IIIC Phase 1 or LH IIIC Early 1 in the Argolid (Fig. 1).[11] However, the exact appearance and character of the site during the final part of the 13th and the beginning of the 12th century BCE cannot be fully understood at the moment. This is mainly due to the fact that primary contexts dating to the latter period are rarely attested among the areas excavated so far, whereas the latest in situ deposits come from an extensive destruction horizon caused by fire dating to the end of LH IIIB1.[12] According to the first evidence from the ongoing study of the material, the earliest building remains can be dated to LH I/IIA. Pottery dating to MH III/LH I is mainly known from the area of the cemetery and the grave goods of the cist tombs.[13] The succeeding phases (LH II – LH IIIB1) seem to represent the major and most flourishing periods of the palace according to the material available so far. The building remains of the latter periods suggest the existence of very large and imposing structures like the large court and the stoas with the alternating columns and pillars.[14] As is the case with other major Laconian sites like the Menelaion, the characteristic pattern painted pottery types of the mature LH IIIA2, and LH IIIB phases are rare, whereas pottery dating to LH IIIC Early is well

7 Kilian 2007, 74–75, in his post mortem study discusses economic and social aspects of the phenomenon. The existence of lower status individuals is followed by Stockhammer 2008, 290–293 who observes the presence of HBW according to the model of Bankoff et al. 1996 for the so called 'Colona ware' in Virginia and South Carolina. See Jung 2006, 23–24, for a critical assessment of this theory. Small 1990, 3–25, like Walberg 1976, 186–187, previously, discusses the indigenous appearance of the HBW.

8 Aravantinos – Vasilogamvrou 2012, 41–54; Vasilogamvrou 2013; Vasilogamvrou 2014; Vasilogamvrou 2015; Vasilogamvrou 2018.

9 The term 'alien' has frequently been applied to HBW. See Popham et al. 2006.

10 Mountjoy 1997, 109–135; Mountjoy 2008, 377–384.

11 French 2011, 2, tab. 1; 35–49, 67; Podzuweit 2007, suppl. 84. See also Rutter 2003, 193–216; Vitale 2006, 177–204; Kardamaki 2013, 392–416, for the discussion of the pottery typology during the late Palatial and early Post-palatial periods (LH IIIB2 Late, LH IIIC Phase 1 or LH IIIC Early 1).

12 See Kardamaki 2017, 110–111 for a preliminary discussion of the destruction date of the palace.

13 Vasilogamvrou 2013, 72.

14 Vasilogamvrou 2015.

represented.[15] The latter material, as already mentioned above, comes from secondary layers and fills. Such deposits have been found around the early Mycenaean cemetery, in Building A and in the large court.[16] The layer excavated in the latter case consists of loose brown soil with stones and mostly fragmented sherds and it cuts the debris of the LH III B1 destruction.

HBW in Ayios Vasileios

According to the material excavated so far, HBW seems to represent a very rare pottery class at Ayios Vasileios. In the layers containing LH IIIC Early pottery described above, only six fragments have been identified (Figs. 1–2). The rarity of the HBW at Ayios Vasileios, however, does not significantly contradict the pattern of its distribution identified so far elsewhere. In Laconia, prior to the discovery of Ayios Vasileios, only the Menelaion had yielded evidence of that ware.[17] From the latter site, 52 vessel fragments have been published, but the material is neither statistically quantified nor does it originate from floor deposits.[18] That the HBW represented a rare group is also seen at the Citadel of Tiryns, the most prominent site for the study of this pottery class. The statistical analysis of the material there shows that the percentage of HBW during the period of its peak, namely in LH IIIC Early, is less than 1% of the total.[19] In some regions, like in Messenia and Attica HBW is almost totally absent[20] and in others like Achaea it is rare. Regarding Achaea, however, the rarity of HBW may lie in the fact that published settlement material from this region is lacking.[21] At Mycenae, Midea, Thebes and Dimini vessels of HBW have been published, but statistical studies that would show the frequency of the pottery class and its relation to the local pottery are rare.[22] Besides, HBW does not occur evenly even inside the same settlement. At Tiryns

---

15 In the Menelaion the LH IIIA2 phase is not well represented in general (Catling 2009, 359–399, 460–461). See Mountjoy 2008, 377, for LH IIIB at Ayios Stephanos.

16 See Vasilogamvrou 2018, 138–141, 142–147 for the LH IIIB2 – LH IIIC Early activities and remains in Building A.

17 HBW was recovered at Aetos South Slope, Aetos Stone Mound and Prophitis Elias Erosion Gully. Catling – Catling 1981, 76–77, figs. 2–3; 79, fig. 4; Catling 2009, 380–383, figs. 239–240, 301. According to Catling more pieces must have existed – especially in the Aetos South Slope material – that have been overlooked. See Demakopoulou 1982, 116–117, 123, pl. 59.135, for a HBW jug with incised decoration from the cemetery at Pellana. The vessel from Pellana is rather Submycenaean.

18 Only in one case can HBW be assigned to built structures, namely in the reoccupation level in the area of Building A in Aetos, South Slope (Catling 2009, 240). HBW was also found among the stones of the Aetos Stone Mound (Catling 2009, 247). Catling 2009, 170, notes the higher number of HBW fragments in the Prophitis Elias Erosion Gully than in the Aetos Stone Mound, but there is no account of sherds from various fabrics discovered in the deposit. HBW pieces represent 5% of the catalogued pieces from Prohitis Elias Erosion Gully. At Aetos Stone Mound HBW is probably less than 2.5% in a weight-based account of the fabrics. 2.5% is the percentage of the pottery belonging to categories other than cooking, painted, plain wares (Catling 2009, 249).

19 Kilian 2007, 46; Rahmstorf 2011, 315–318, 328–329, figs. 2–5. In the NE Lower Town HBW is more frequent than in the Lower Citadel. In the first building phase it represents 2.05% of the total and in the third phase (LH IIIC Developed) 9.85% (Stockhammer 2008, 286–287, fig. 71).

20 Rutter 1975, 29 ill. 16 (Athens, Agora). One jug is also known from tomb 4 in the cemetery of Perati (Iakovides 1969, pl. 45c.35). According to Jung 2006, 42 handmade vessels with round bases like the one from the Agora could have imitated the local cooking pots. From Messenia one carinated cup is reported from a possible LH IIIB2 context at Nichoria (Shelmerdine 1992, 512, 516; Pilides 1994, 23; Jung 2006, 34 n. 191).

21 At Teichos Dymaion there are some rim fragments with plain ribs. Although their stratigraphical position is not clear they very probably date to LH IIIC Early. In Teichos Dymaion two destruction horizons are assigned to LH IIIC Early and LH IIIC Middle to Late (Jung 2006, 29–30, 204, pl. 25–26).

22 In LH IIIC Early and Middle deposits 1a–c from Thebes, Pelopidou str. excavation, HBW amounts to less than 1% of the total diagnostic features (Andrikou 2006, 12 tab. 2). For Dimini, Midea and Mycenae see: Adrimi-Sismani 2003, 91–93, figs. 10–13; Adrimi-Sismani 2014, 562–570 (Dimini). Demakopoulou – Divari-Valakou 2009, 19, fig. 26; 20 fig. 31 (Midea). French 2011, 379 (no. 66-480, LH IIIC Early 1, Mycenae), 588 (no. 64-455), 590 (no. 64-456), 671 (no. 68-423). In the LH IIIC levels of the Citadel House Area at Mycenae (wash deposits) the coarse handmade pottery does not exceed 1% of the total (French 2011, 827, graph 6). See Romanos 2011, 193–194, for discussion on the frequency of HMBW at Mycenae.

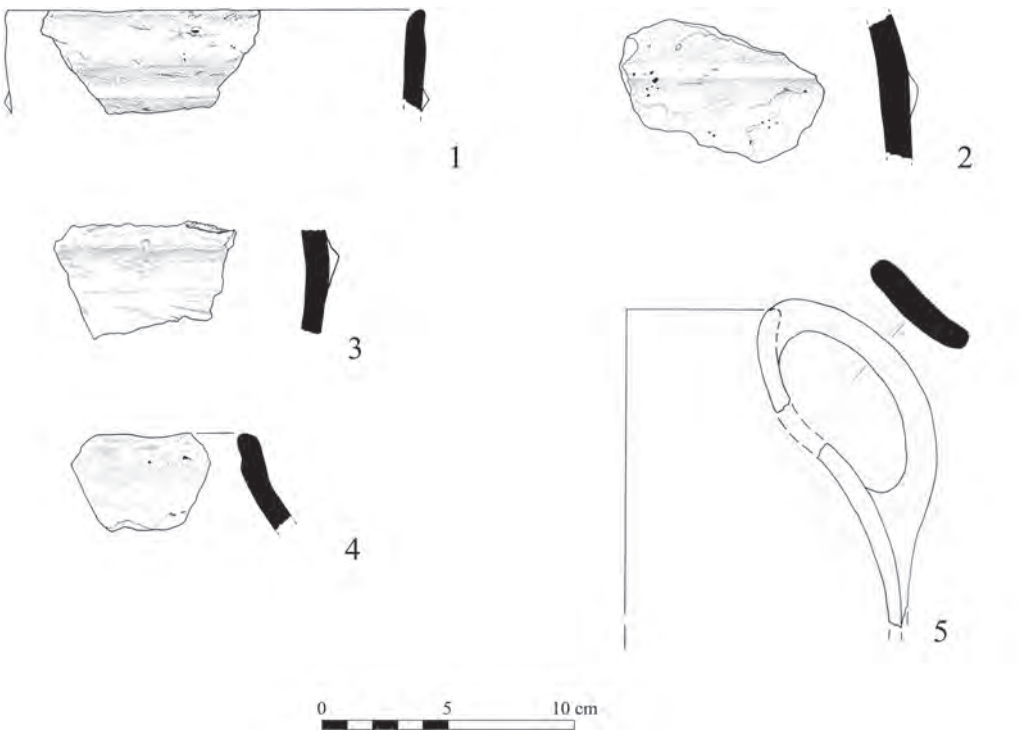


Fig. 2 Handmade burnished ware from Ayios Vasileios. Scale 1:3 (drawings: 1–4 A. Poelstra Traga; 5 V. Hachtmann)

many rooms and areas remained free from this pottery class[23] and in other cases there have been concentrations of HBW.[24] At the Menelaion no HBW was ever found close to the area of the Mansions. This fact is sometimes interpreted as a sign of the lower social status that this pottery class is believed to represent.[25] Another factor that could relate to the rarity of HBW at Ayios Vasileios could be a chronological one. It is very possible that HBW became more frequent during the later stages of LH IIIC Early and not directly after the destruction in the Argolid during the 'Transitional LH IIIB2–LH IIIC Early' or LH IIIC Early 1 phase.[26] It is thus more likely to have higher amounts of HBW at those sites that have a longer LH IIIC stratigraphy, although this is also not always the case.[27] Unfortunately, in most settlements characterised by a long stratigraphy the remains of the short-lived LH IIIC Early 1 phase are very scant for providing good and safe data for the exact distribution and the percentages of the HBW during the earliest Post-palatial period.[28]

[23] Kilian 2007, 50–51, 80. Very few pieces of HBW have been found in contexts that seem to have a more elite character during LH IIIB2 and LH IIIC Early (Rahmstorf 2011, 316–318).

[24] Belardelli – Bettelli 1999; Stockhammer 2008, 287–288.

[25] Catling 2009, 382. No piece of HBW is recorded from the slopes of the Mansion hills and the North Hill. The pottery from these contexts may be slightly earlier than the material from the Prophitis Elias Erosion Gully and the Aetos Stone Mound (Catling 2009, figs. 186, 215).

[26] Kilian 2007, 46, fig. 1. The peak of the HBW is during Building Horizon 19, in which pottery of the mature LH IIIC Early phase is present, like the monochrome carinated cups FS 240.

[27] At Lefkandi the very few handmade burnished vessels that are categorised as 'alien' are mainly restricted to Phase 1 (Popham et al. 2006, 215, 218, 217, fig. 2.42; pl. 49). The Lefkandi phase 1 postdates LH IIIC Early 1 and equals Rutter's Phases 2 and 3, possibly also Phase 4 early (see Mountjoy 1999, 39, tab. II; Stockhammer 2008, figs. 3–4).

[28] At Tiryns the stratigraphical division of LH IIIC Early 1 and 2 is not well presented. The levelling on top of the fresco dump in the western staircase of the palace took place in LH IIIC Early 1 (Kardamaki 2013, 413, 416). The layer underneath the floor of room 8/00 in the NE Lower Town is possibly of LH IIIC Early 1 date. However, this material has not been evaluated separately from that of the following phase (LH IIIC Early 2) (Stockhammer 2008, 157–158). In the Citadel House Area at Mycenae one cooking pot of handmade burnished ware was detected among other vessels of LH IIIC Early 1 date (French 2011, 379 [no. 66-480]).

The pieces from Ayios Vasileios are all very fragmented (Fig. 2.1–4). Due to their diameter and decoration, consisting of plain ribs or ribs with diagonal impressions, three pieces most probably come from barrel-shaped jars or wide-mouthed jars, a form that is very well known from other sites.[29] One sherd has a vertical profile (Fig. 2.1)[30] but the other two fragments could belong to wide-mouthed jars with an incurving upper body (Fig. 2.2–3).[31] Very interesting is another fragment from the neck and shoulder of a jug that was found in the upper fill of room 10 in Building A (Fig. 2.5).[32] This represents a relatively rare form and it is mainly known from later contexts.[33]

Most fragments have horizontal burnishing marks, but diagonal or vertical ones also appear.[34] The interior surface of the sherds is well burnished but in some pieces the burnishing is not preserved. The surface is more frequently red, rarely brown or black and the clay is gritty grey or red. The first evidence from the macroscopic examination of the material seems to confirm the results from the petrographic and chemical analyses at the nearby Menelaion but also other sites according to which, in most sites where it appears, the HBW is locally produced[35] and is characterised by a lack of standardisation concerning its manufacture and clay structure.[36] Among five probably contemporary sherds, there are two different fabrics of the HBW distinguished at Ayios Vasileios.

One fabric is represented by the jug (Fig. 2.5). It is hard fired and its clay is fine with few inclusions, while the dark surface of the fragment is very well burnished. The clay is micaceous and the few non-plastic angular inclusions are of light and dark colour.[37] Some of the inclusions may be grog. The other fabric is similar, but the inclusions that probably belong to grog are not visible.[38] In none of the identified HBW pieces are shiny platy inclusions, probably schist, macroscopically visible on the surface and clay, as is the case with the local coarse pottery.[39]

According to this, and especially due to the fact that the clay of HBW is micaceous like that from the local pottery, it cannot be excluded that it was produced at or close to Ayios Vasileios. As at Ayios Vasileios, the clay of the HBW from the Menelaion is also described as micaceous, but it also includes grog and schist.[40] However, the latter is at least macroscopically not recognisable in the HBW pottery from Ayios Vasileios. Thus, it will be interesting to confirm via analytical work whether the HBW from two sites lying so close as do Ayios Vasileios and the Menelaion, could be assigned to the same manufacturing place.[41]

---

29 Kilian 2007, pls. 2–10 (Tiryns).

30 Cf. Kilian 2007, pl. 10.126.

31 Cf. Kilian 2007, pl. 6.64–65. Catling 2009, 297, fig. 301.A266. Diagonal nail impressions on plastic zones occur but are not so broadly applied as is the case with the piece from Ayios Vasileios (cf. Catling 2009, fig. 239.PE 254, PE 257, with the nail impressions on the rim). The rim fragment in Fig. 2,4 reminds one of the 'olle with short neck' identified in LM IIIB2 layers at Chania (Pålsson Hallager 2003, 253–254, pl. 85.80-P0811). For the piece cf. also Kilian 2007, pl. 13.166.

32 Room 10 was reused in LH IIIB2 after a LH IIIA2 destruction (Vasilogamvrou 2018, 145).

33 Kilian 2007, pl. 18.209–211.

34 It has been observed that small shapes are better burnished or that the quality of the burnishing varies according to the fabric (Pilides 1994, 71)

35 Jones 1986, 261; Mommsen et al. 2002; Pålsson Hallager 2003, 253; Deger-Jalkotzy 2003, 466–467.

36 Jones 1986; Whitbread 1992, 304–306; Jones – Tomlinson 2009, 159–160; Badre et al. 2005, 23, 33–36; Boileau et al. 2010, 1682–1684, 1686–1688; Pilides – Boileau 2011, 116–120, note on the material from Cyprus that there are many singles. The jar from Maa-Palaeokastro is probably an import from the western Mediterranean or the Aegean.

37 Fig. 2.5: 10YR 5/3 and 5YR 5/4 and 10YR 4/1, clay: 10YR 3/2.

38 Fig. 2.1: surface: 2.5YR 6/8, clay: 2.5YR 5/8–10YR 4/1–2.5YR 5/8; Fig. 2.2: surface: 2.5YR 6/8, matrix: 2.5YR 5/8–10YR 4/1–2.5YR 5/8; Fig. 2.3: 2.5YR 5/6, matrix: 2.5YR 4/4–10YR 4/1–2.5YR 4/4; Fig. 2.4: 10YR 5/3 and 2.5YR 5/3, matrix: 2.5YR 4/8.

39 Also the local coarse pottery at Ayios Stephanos has inclusions characterised as weathered igneous rocks but the samples are earlier (MH III–LH I and LH IIA) (Whitbread – Jones 2008, 110–111). Also the HBW from the Menelaion is reported to include schist (Whitbread 1992, 300, fig. 82; 304)

40 Whitbread 1992, 306. Grog seems to be a common feature in the clay of HBW vessels, as it appears in the pottery from Cyprus and Tell Kazel. Badre et al. 2005, 35–36; Boileau et al. 2010, 1686; Pilides – Boileau 2011, 118.

41 The same needs to be confirmed for the HBW of LH IIIC Early from Mycenae, Tiryns and Midea in the Argolid.

The Origins of HBW Pottery in Laconia

By comparing the typology of the HBW vessels from Ayios Vasileios and the Menelaion, one has to reach the conclusion that there are quite a few differences between the two sites.[42] At the Menelaion many vessels have tall everted rims[43] whereas Ayios Vasileios seems to follow or reflect the pottery traditions of sites like Tiryns with a preference for barrel-shaped shapes with straight or incurving bodies and lipless rims (Fig. 2.1–3).[44] At Tiryns everted rims are rarer and when they occur they are more edged and not as tall as is the case at the Menelaion.[45] In the latter site the most favoured decoration consists of plastic cordons with finger impressions and the plain ribs are very rare.[46] Again, Ayios Vasileios seems to follow sites of the NE Peloponnese where plain ribs are equally frequent or even more frequent than plastic cordons with finger impression.[47] At Ayios Vasileios no piece with finger-impressed decoration has been identified so far, but this may be due to the small number of specimens known from the site. Three pieces carry plain horizontal ribs, and one is interrupted by a fingernail impression (Fig. 2.3).

Although it can be argued that most pieces from both Laconian sites are inspired by central and southern Italian pottery traditions of Recent Bronze Age 1 and 2,[48] the most characteristic Italian shape, the carinated cup, is missing here.[49] Very typical for the pottery of southern Italy are barrel-shaped jars, the so called *olle* with decoration consisting of cordons with finger impressions or plain horizontal ribs.[50] Especially the latter decoration on wide-mouthed jars of various types is now considered to be a very distinctive Italian pattern[51] since similar decoration appears otherwise in regions that seem to have virtually no contact to the Aegean.[52] Such vessel types seem to have a restricted distribution on the Greek mainland and show a concentration area in the Argolid.[53] Finger-impressed ribs, such as the ones carried by the vessels in the Menelaion, are also very well represented in southern Italy, but this kind of decoration has a wider distribution and is considered to be 'universal'.[54] Close parallels to Subapennine Italian types are also found for the pot with the handle attached to the rim from the Menelaion.[55] Concerning other areas of inspiration, there are

---

42 Another Laconian site where HBW has been found is Pellana. There one closed vessel with incisions on the body was excavated in a tomb (Demakopoulou 1982, pl. 59.135; Pilides 1994, fig. 13.6).

43 Catling 2009, figs. 239.PE254-260, 240.PE274, 278.AO49. At Aetos Stone Mound, however, most rims are cut and lipless (Catling 2009, fig. 301.A265, A266, A273).

44 Kilian 2007, pls. 2, 3.21–24; 5–6; 7.69–81.

45 Compare Catling 2009, 235 fig. 239.PE254-260 with Kilian 2007, pl. 7.82; 8.

46 Among the material catalogued, 25 pieces have finger-impressed ribs (Catling 2009, figs. 239.PE254–PE257, PE259–PE260, PE262–PE267; 240.PE274–PE277, PE279, PE284; 278.AO49, AO51; 301.A265, A269–A274) and only three have plain ribs (Catling 2009, figs. 240.PE276, 301.A266, A273).

47 At Tiryns, among a total of 179 catalogued pottery individuals (Kilian 2007, pls. 1–14, 15.179) 49 pieces have finger-impressed ribs and 72 have plain ribs.

48 See Jung 2006, 211–216, fig. 24, for the synchronisation of the Italian and Mycenaean/Minoan chronology.

49 HBW carinated cups occur at Dimini (Adrimi-Sismani 2003, fig. 13.BE36013, BE35986; Adrimi-Sismani 2014, 563), Tiryns (Kilian 2007, pl. 24.302–311), Korakou (Rutter 1975), Chania (Pålsson Hallager 2003, 253–254, pl. 85.70-P0352/0802/0956, 71-P0182, 84-P1345), Nichoria (Pilides 1994, 23), Lefkandi (Popham et al. 2006, 215, pl. 49.3) and possibly at Teichos Dymaion (Jung 2006, 36 with further references). This form that sometimes has horned handles has excellent parallels in Adriatic and Ionian sites of central-southern Italian pottery traditions (Damiani 2001, 240, fig. 86A; 245, fig. 87B; 248, fig. 88A (Torre Mordillo); Bettelli 2002, 123, fig. 54; 125, fig. 55; Belardelli – Bettelli 2007, 482–483, pl. 115.

50 Buffa 1994, 518, fig. 151 *(dolii* and *olle* of the FBA and the Early Iron Age, Broglio di Trebisacce); Buffa 2001, 262, fig. 89C.275 (Torre Mordillo).

51 Giardino 1994, 188, pl. 29.6, 8, 18; 191, pl. 31.27; 208, pl. 45.1 (Broglio di Trebisacce, Recent Bronze Age): Jung 2006.

52 A decoration consisting of plain ribs also appears in southeastern Romania, in the Coslogeni group. For a discussion see Jung 2006, 26–28.

53 Jung 2006, pl. 25.

54 Blegen et al. 1958 (Troy); Hochstetter 1984 (Kastanas). See Pilides 1994, fig. 37–38, for vessels with finger-impressed decoration from Cyprus, Troy, the Balkan region, Italy.

55 Kilian 2007, 59–60; Catling 2009, pl. 105.A268; see Jung et al. 2015, 460. See also Chania (Pålsson Hallager 2003).

pieces like the pot stand from the Menelaion, for which the attempt has been made to connect it with northern regions but an Italian inspiration is very possible.[56] Finally, the jug from Ayios Vasileios has no parallels in the Menelaion and it is possible that with this piece we have, for the first time in Laconia, the imitation of a Mycenaean shape in the HBW ware, a phenomenon observed in some other sites.[57] Although more material is required in order to arrive at safe conclusions, one could argue that in Laconia even very close sites like Ayios Vasileios and the Menelaion seem to have used and produced different types of HBW vessels and this conclusion once again demonstrates the complex nature of the HBW phenomenon. The only HBW vessel known from Pellana in the northern parts of Laconia, for which an Anatolian origin or influence is likely, also points in this direction. The small jug with incised zig-zag lines is reminiscent of vases of the so called "Knobbed" ware, a pottery class that appears in Troy during VIIb2.[58] Jugs with similar decoration appear occasionally at Tiryns[59] and on Cyprus.[60]

The Handmade Cooking Pottery

In recent years the need for a more detailed classification of the HBW pottery has been stressed.[61] Various LH IIIC sites have yielded evidence of closed handmade burnished vessels that have been used for cooking and are not readily connected with the group of HBW vessels of rather Italian inspiration discussed above.[62] This kind of vessel appears at sites that produced both HBW of Italian or not closely identifiable inspiration.[63] The category of these jars, recently termed handmade domestic pottery, is a pottery class with a limited shape repertoire.[64] It consists of closed vessels with a relatively high neck and flaring rim.[65] All known examples date in LH IIIC to the Early Iron Age and the region of their distribution during the early stages of the 12th century BCE is mainly central Greece.[66] As there is no clear indication concerning their origin and inspiration, it has been postulated that they represent the result of an indigenous reaction observed at sites that could not produce or possess high quality cooking pots after the destruction of the palaces.[67]

---

56 Hochstetter 1984, 157; Horejs 2005; Rahmstorf 2011, 318. For a different interpretation as a pot stand rather than a pyraunos see Jung 2006, 30–31. According to Jung, the piece from the Menelaion probably belongs to the group of pot stands identified at Dimini and Tiryns and is not related to the pyraunoi of Balkan type (see Horejs 2005, 79–81, 83 and 82, fig. 7, for the discussion and distribution of the pyraunoi in the southern Balkans). Kilian 2007, 27–28, suggests an influence from similar local forms for the HBW pot stands.

57 Deger-Jalkotzy 2003, 460–461, figs. 3–4; 466; Jung 2006, 39–40; Kilian 2007, 24, 52, 75–77.

58 Blegen et al. 1958. The exact dating of the vase within the LH IIIC period is not possible. The tomb contained pottery dating mainly from the LH IIIA2 to LH IIIC Advanced and one vessel may be Submycenaean. Demakopoulou 1982, 116–117.

59 Avila 1980, pl. 25.385. Already suggested by Demakopoulou 1982, 116–117, pl. 59.135.

60 Pilides 1994, 37–40, figs. 35, 40. Other HBW vessels with incised decoration are also known from Dimini and Volos (bowls), Tell Qasile and Beirut in the Levant and at Kition on Cyprus. See Pilides 1994, fig. 35.7; Jung 2006, 36–37, pl. 17.7; Guzovska – Yasur-Landau 2007, pl. 114. An Italian inspiration is possible for these vessels. See Jung 2006, 36–37, for the discussion of the pieces from Dimini and Volos, for which, however, the closest parallels are later (Final Bronze Age).

61 Pilides 1994, 77; Jung 2006; Lis 2009, 153–159, differentiates between three groups, namely handmade burnished pottery, Anatolian handmade and domestic handmade pottery. The third type consists mainly of cooking jugs, and the second is the handmade pottery confined to Troy.

62 The so-called 'Küchengeschrirr' at Kalapodi belongs to this group. See also the group of handmade domestic pottery as defined by Lis 2009; Jacob-Felsch 1996, 75–80, differentiated between the 'handgemachte polierte Ware' and the 'Küchengeschirr'. According to this, the second should be a different fabric that is lighter in colour and has a rougher surface. The repertoire includes both Mycenaean and non-Mycenaean shapes (Jung 2006, 41).

63 Jung 2006, 223.

64 See n. 59.

65 Jacob-Felsch 1996 (Kalapodi); Lis 2009, 157, fig. 18.3.1–8 (Kalapodi and Mitrou).

66 Lis 2009, 154, fig. 18.2.

67 Lis 2009, 159.

At Ayios Vasileios two categories of handmade cooking vessels have been identified that do not seem to fall into the category of the Italian-inspired HBW discussed above. The first contains jars with short necks and flaring rims (Fig. 3.1). These vessels occasionally have cut lips. Their surface is smoothed but not well burnished like the HBW vessels or even not at all burnished. Their use in the preparation of food is evident from traces of fire visible on the exterior surface of the fragments. According to the macroscopic examination of the material, all of the identified pieces could have been locally made. The clay of the fragments is gritty and contains a small quantity of mica, schist and small dark or light-coloured angular stones. Such cooking pots have so far been identified in secondary layers containing pottery of the LH IIIA1/A2 Early period and it is possible that they present evidence for an uninterrupted tradition of handmade cooking vessels from MH III/LH I onwards. In various LH IIB contexts of the site, handmade cooking pots dominate but during this period the presence of wheelmade tripods is attested.[68] The shape of the LH IIIA handmade cooking jars resemble in an astonishing way pots belonging to the handmade domestic pottery mentioned above that occur during LH IIIC at Aigeira, Kalapodi[69] and Athens.[70] Moreover, the edged rim is reminiscent of MH III/LH I cooking pots.[71] However, at the current stage of research and with the available material, it is not possible to say whether such vessels were in use until the beginning of the 12th century BCE at Ayios Vasileios.[72] Therefore, it is not possible to connect the handmade cooking pots of Ayios Vasileios with a pottery tradition that antedates the handmade domestic pottery of the 12th century BCE[73]

The second group of handmade cooking pottery is so far represented by a single piece (Fig. 3.2). It was found in a LH IIIC Early context in Building A. The cooking pot has a short everted rim and its surface is well smoothed but not burnished. It represents a relatively large cooking jar with a strap handle that is highly unusual for the cooking jars of that period. Its fabric is very different from that of the LH IIIA handmade cooking pots as it is very well fired and does not contain any macroscopically visible schist. As there are no predecessors for this form in the repertoire of the handmade cooking pottery at Ayios Vasileios and in Laconia in general, this pot may represent a foreign form. A striking resemblance with Cypriot handmade cooking pots exists for the rim and handle[74] but as the base of the vessel is not preserved the comparison to Cypriot cooking pots that have a rounded base should be left open. On the other hand, it is equally possible that this vessel was manufactured under a combined influence from both Mycenaean and HBW or handmade cooking pottery traditions, since such vertical strap handles appear in some closed HBW vessels that imitate local cooking pots.[75] A more remote parallel for the rim of the pot from Ayios Vasile-

---

68 Kardamaki 2017, 103–104. Evidence for flat-based wheelmade jars also appears sporadically during LH IIIA1/A2. See Horejs 2005, 84, fig. 9, for the distribution of MH/MM and early Mycenaean tripods in the Aegean.

69 One wheelmade pot from Kalapodi has the same thickened zone on the shoulder from the joining of the neck to the upper part of the vessel (Jacob-Felsch 1996, pl. 32,174). The cooking pots of Aigeira also imitate the local pots (Deger Jalkotzy 2003, 466; see Deger Jalkotzy 2003, 460, fig. 3, left for a jug that could have imitated local cooking jugs).

70 Rutter 1975, 29, ill. 16. It has been dated to LH IIIB2 – LH IIIC Early. This vase also has an edged rim, however its fabric is described as relatively fine and sandy. The ring from the joining of the neck to the shoulder, observed on the piece from Ayios Vasileios, is missing on that amphora.

71 Catling 2009; Zerner 2008.

72 According to Jung 2006, 46–47, the handmade cooking pots and the handmade cooking pots with round base could have been produced by nomadic shepherds that were in close cultural and economic interaction with the Mycenaean areas. We thank Reinhard Jung for discussing with us this issue and Jeremy Rutter and Walter Gauß for the discussion on the pieces.

73 At Kalapodi there is no good evidence of LH IIIB contexts in order to understand the chronological distribution of handmade cooking vessels (Jacob-Felsch 1996, 92). Walberg 1976, 186–187, notes the production of burnished pots in earlier periods and suggests that it was due to difficult conditions that this pottery was produced. Walberg stresses the fact that one of the main features of this pottery, which is the burnishing, is mainly to make the vessel water tight. Rutter 1976, replies that the predecessors are too few to establish continuity from earlier period.

74 Jung 2011, fig. 1.1. We thank R. Jung for pointing out to us the Cypriot cooking pots as parallels.

75 Mycenaean cooking pots produced in HBW are known from Mycenae and Tiryns, Thebes, Dimini and Kastro/Palia in Volos (Jung 2006, 39–40). Some examples seem to deviate from the main type, like the vessel from Mycenae that has a rounded base.

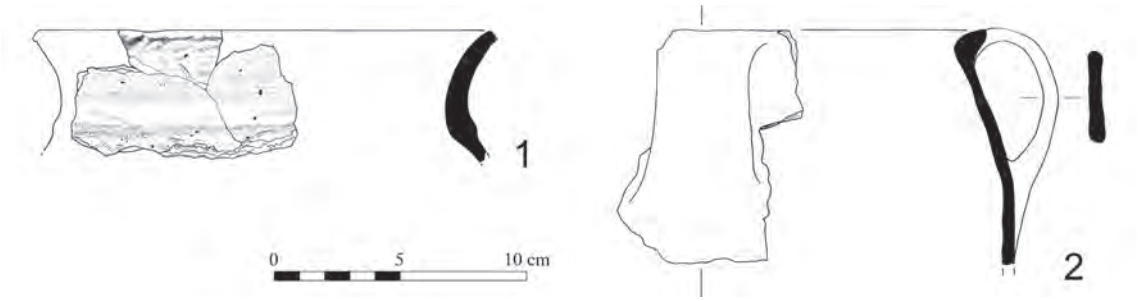


Fig. 3 1. Handmade cooking pot, LH IIIA1/LH IIIA2 Early; 2. Handmade cooking pot, LH IIIC Early. Scale 1:3 (drawings: 1 A. Poelstra Traga; 2 R. Jung)

ios can be found in handmade Aeginetan cooking jars.[76] The latter is particularly interesting as in Laconia the Aeginetan cooking pottery of the LH IIIC Early period is very rare.[77] On the other hand, the handles of the Aeginetan pots always have a round section and are not strap as is the case with the vessel from Ayios Vasileios.

Discussion

Although the small quantity of the new material and its recovery within secondary layers do not allow much interpretation regarding the function of the HBW at Ayios Vasileios, some first conclusions can be made. In general, its typological analysis suggests connections with southern Italian pottery traditions and, at the same time, it confirms the lack of standardisation observed among the HBW used at various sites.[78] The latter possibly indicates a small-scale production that could have been conducted even within small entities.[79] It is noteworthy that HBW in the Menelaion was probably produced by using locally available sources but in a distinct technological way that sets it apart from the local wares.[80]

From all the theories presented regarding the appearance of the HBW on the Greek mainland and in the Levant, the one that includes the physical presence of foreign groups from Italy is now most broadly accepted.[81] The interpretation of these movements towards the east is, however, still not fully understood. On the one hand, contacts between the Aegean and Italy started much earlier. From LH IIIA onwards Mycenaean pottery was regularly imported into Italy, whereas the production of Mycenaean shapes became more frequent in many Italian sites during LH IIIC.[82] The introduction of new European-type bronze weapons, ornaments and other objects, mainly during the Post-palatial period, is believed to come from Italy.[83] The so-called clay spools, swords of Naue II type, flange-hilted daggers of Pertosa type and bronze fibulae all appear for the first time during the final Palatial and the early Post-palatial period in Greece and seem to have constituted

76 Rutter 2003, 207, fig. 7.4.

77 Lindblom 2001. Two cooking jars from Aetos Stone Mound have the profile of Aeginetan cooking pots (Catling 2009, 427, fig. 309.A413, A416).

78 Kilian 2007, 56–66.

79 Catling 2009, 381.

80 Jones – Tomlinson 2009, 160.

81 Pålsson Hallager 2003; Kilian 2007, 77–80; Jung 2009, 78–80.

82 Jones 1986, 207–209. But there are also imports during LH IIIC (Vagnetti 1993, 151; Jones et al. 2005, 541, pl. 120, and recently Jung et al. 2015).

83 See Bouzek 1985, 121, fig. 57; 122, 152–159, for the distribution of the Naue II swords and bow fibulae and for early (LH IIIB) examples from the Aegean. Belardelli – Bettelli 2007, 483–484; Jung 2009, 72–77.

a 'package'.[84] The distribution of many of these objects, and especially the weapons, is wide and very quickly reaches Cyprus and the eastern Mediterranean.[85] In this regard the connection of metal workers or foreign warriors, even mercenaries in the service of the palaces who brought new technologies to Greece and Cyprus with migration movements that followed the destruction of the palaces has also been suggested.[86] On the other hand, one could argue that the presence of all these new objects does not necessarily presuppose the physical presence of Italian groups. They could have represented the result of contacts, exchange and trade and reflect the transfer of new ideas in both directions.[87] This would explain why in various sites of the Aegean only some components of the Italian package appear and not all. In Achaea, where the largest number of Naue II swords has been observed, HBW pottery is rather rare. In the Menelaion no clay spools have ever been identified. At Kontopigado, the LH IIIC Early 1 settlement and workshop located 5km south of the Acropolis, clay spools are found but there is no evidence for the use of HBW.[88] On Cyprus much of the HBW cannot be readily related to Italy but the new types of bronze weapons are well represented.[89]

However, the study of the Italian-type pottery such as HBW and the so-called pseudominyan wares seems to suggest the physical presence of foreign groups.[90] The percentage of the HBW is very low within the Mycenaean settlements and there is nothing to suggest that this pottery class and its content was ever really traded. That Ayios Vasileios and the Menelaion also belonged to the sites that may have had direct or indirect contacts with Italy is not only suggested by the HBW found there but is also supported by new chemical analyses conducted on the material from Punta di Zambrone. In the course of the latter analysis, one deep bowl has been isolated as deriving from Laconia.[91] Although swords of Naue type II have not been reported from Laconia, other bronze implements such as fibulae are identified both at Ayios Vasileios and Ayios Stephanos.[92]

If, then, the HBW can be connected with the real presence of newcomers from Italy, the new evidence strengthens the hypothesis of a rather substantial group of foreigners living in Laconia in close proximity to each other. More material is required in order to confirm the hypothesis that these groups living at or close to Ayios Vasileios and the Menelaion respectively produced different shapes since the process of imitating local closed vessels in handmade ware is observed only at the former site (Fig. 2.5).

The starting point of the Italian groups is also not easy to define. According to the data available so far, there are two regions providing good evidence for the presence of Italian people during the Palatial period. These are Chania on Crete[93] and Tiryns and Mycenae in the Argolid. Tiryns is not only the site that delivered the largest numbers of HBW but it is also the site where

---

84 Bouzek 1985, 241–242. The first real presence of clay spools at Tiryns takes place in LH IIIC Middle (Rahmstorf 2011, 321–322, 329, fig. 5). The earliest secure evidence of clay spools in the Aegean and Cyprus are recorded in an advanced stage of LH IIIC Early–LH IIIC Developed (Lefkandi Phase 1b). However, the geographical and chronological distribution of the clay spools is not in agreement with their movement east from Italy as the clay spools in the Aegean do not really antedate the spools from Cyprus and the Levant (Rahmstorf 2011, 320–323).

85 Bouzek 1985, 241; Bettelli 2002, 135, fig. 58; Jung 2006; Jung 2009.

86 Kilian 2007; Jung 2009; Pilides – Boileau 2011, 119–120, see a possible connection between the provenance of HBW in Cyprus in the Troodos region and the introduction of new bronze types by the makers of HBW.

87 Iacono 2015, 272–275.

88 The clay spool from Kontopigado probably belongs to a very early type and is also the earliest artefact of such kind in the Greek mainland (Kaza-Papageorgiou et al. 2011, 206, fig. 4.2).

89 Pilides 1994; Jung 2006, pl. 25; Jung 2009, 78.

90 The so-called pseudominyan pottery has been found at Tiryns, at Chania and at Dimini (Kilian 1980; Pålsson Hallager 2003; Adrimi-Sismani 2014, 599–561).

91 Jung et al. 2015.

92 Kilian 1985, 149, fig. 2.IIIB1; 152, 162. The study of the small finds from Building A is in progress.

93 According to Pålsson Hallager 2011, 371–372, the presence of immigrants from Italy living in the houses of locals at Chania during LM IIIB1 is possible. The number or the HBW vessels increased during LM IIIB2 at Chania.

the production of Mycenaean forms in HBW starts very early.[94] This is also the site where what Klaus Kilian called a high stage of assimilation of the Italian groups took place. Thus, it is possible that the events that occurred in the Argolid after the destruction of the palaces triggered the movement of a population previously situated in the palaces. The major destructions at Tiryns, Mycenae and Midea in LH IIIB2 that were followed by at least two more destruction events during LH IIIC Early[95] must have created a very unstable environment for the local population. Following Kilian, these events led to the arrival of refugees at the site of Tiryns at the end of that period.[96]

One explanation for the distribution of HBW would be that the Italian population previously living in the Argolid or Chania moved to various areas and settled down in major centres like Tiryns during the mature stages of LH IIIC Early. A migration of groups familiar with the production of HBW pottery from the Argolid to Laconia could have taken place by sea, but as the Menelaion and Ayios Vasileios are located at a considerable distance from the coast and as there is no evidence of HBW at coastal sites of that period like Ayios Stephanos, movement through the mountainous area of northern Laconia is also possible. This, rather than a movement directly on a sea route and from Italy, would explain the rarity of the HBW in Achaea.[97] However, since the amount of HBW constantly increases during LH IIIC Early, it cannot be excluded that the older population was accompanied by new groups of people that travelled by sea from Italy. Evidence from Laconia is scarce in this latter aspect as both Ayios Vasileios and the Menelaion show no real evidence for occupation after the earliest stage of LH IIIC Early (LH IIIC Early 1).[98] The large concentration of Italian-type HBW in the Argolid could even indicate that the movements of these groups targeted large centres, with which they were already familiar during the Palatial period.[99] In this respect, the increase in HBW during LH IIIC Early could also reflect the existence of a friendlier environment for the production of this pottery class after the collapse of the palaces. In the general picture also including the eastern Mediterranean, these movements, either from Italy or departing from the Aegean, are part of the so-called sea peoples waves depicted in the mortuary temple of Ramesses III at Medinet Habu. These probably involved real migrations as well as piracy, all kinds of processes to be expected after the collapse of the palatial state in Greece.

The ongoing excavation at Ayios Vasileios will possibly yield more new data in the future and will help us to understand better the long debated phenomenon of the HBW in the Mycenaean territories during the period of major political and economic changes that followed the destruction of the palaces.

Acknowledgments: The present study was conducted in the framework of an INSTAP-Post Doctoral Fellowship (2015) and of a FWF research project (P28023-G25). The authors are grateful to N. Karadimas, D. Kondyli and S. Voutsaki for their help during the study of the material.

94 Recent analyses by Rahmstorf 2011 suggest a smaller proportion of HBW than previously thought during the Palatial period.

95 See French 2011 for the stratigraphy during LH IIIC in the Citadel House Area of Mycenae. And also Stockhammer 2008 for the NE Lower Town in Tiryns.

96 Kilian 1980, 173.

97 The HBW of the Ionian Islands and northwestern Greece does not belong to the HBW vessels of Italian type (Jung 2006).

98 Catling 2009, 374, 378, 453 dates very few pieces in LH IIIC Middle. For discussion on the Menelaion see Vitale 2006, 200.

99 Eder – Jung 2005.

Bibliography

Adrimi-Sismani 2003
Β. Αδρύμη-Σισμάνη, Η γκρίζα ψευδομινύεια κεραμική και η στιλβωμένη χειροποίητη κεραμική από το μυκηναικό οικισμό Διμηνίου, in: Α. Μαζαράκης Αινιάν (ed.), Αρχαιολογικό Έργο Θεσσαλίας και Στερεάς Ελλάδας 1. Πρακτικά επιστημονικής συνάντησης, Βόλος 27.2–2.3.2003 (Volos 2006) 85–110.

Adrimi-Sismani 2014
Β. Αδρύμη-Σισμάνη, Ιωλκός – η εϋκτιμενη πόλη του Ομήρου: ένα αστικό κέντρο στον μύχο του Παγασητικού Κόλπου. Το διοικητικό κέντρο, οι οικίες και το νεκροταφείο (Volos 2014).

Andrikou 2006
E. Andrikou, The Late Helladic III pottery, in: E. Andrikou – V. L. Aravantinos – L. Godart – A. Sacconi – J. Vroom, Thèbes: fouilles de la Cadmèe II, 2. Les tablettes en linéaire B de la Odos Pelopidou, le contexte archéologique: la céramique de la Odos Pelopidou et la chronologie du linéaire B (Pisa, Rome 2006) 11–179.

Aravantinos – Vasilogamvrou 2012
V. Aravantinos – A. Vasilogamvrou, The first Linear B documents from Ayios Vasileios (Laconia), in: P. Carlier – Ch. de Lamberterie – M. Egetmeyer – N. Guilleux – F. Rougement – J. Zurbach (eds.), Études Mycéniennes 2010. Actes du XIII[e] Colloque International sur les Textes Égéens, Sèvres, Paris, Nanterre, 20–23 septembre 2010 (Pisa 2012) 41–54.

Avila 1980
R. Avila, Grabungen im Bereich des Baues 2, in: U. Jantzen (ed.), Grabungen in der Unterburg 1971, Tiryns IX (Mainz 1980) 1–87.

Badre et al. 2005
L. Badre – M.-C. Boileau – R. Jung – H. Mommsen, The provenance of Aegean and Syrian-type pottery found at Tell Kazel (Syria), *Ägypten und Levante* 15, 2005, 15–47.

Bankoff et al. 1996
H. A. Bankoff – N. Meyer – M. Stefanovich, Handmade burnished ware and the Late Bronze Age of the Balkans, Journal of Mediterranean Archaeology 9, 1996, 193–209.

Belardelli – Bettelli 1999
C. Belardelli – M. Bettelli, La Raum 127 dell'Unterburg di Tirinto. Distribuzione della ceramica pseudominia e HMB, in: V. La Rosa – D. Palermo – L. Vagnetti (eds.), επί πόντον πλαζόμενοι. Simposio italiano di studi Egei dedicato a Luigi Bernabò Brea e Giovanni Pugliese Carratelli, Roma, 18–20 febbraio 1998 (Rome 1999) 473–474.

Belardelli – Bettelli 2007
C. Belardelli – M. Bettelli, Different technological levels of pottery production. Barbarian and Grey Ware between the Aegean and Europe in the Late Bronze Age, in: I. Galanaki – H. Tomas – Y. Galanakis – R. Laffineur (eds.), Between the Aegean and Baltic Seas. Prehistory Across Borders. Proceedings of the International Conference Bronze and Early Iron Age Interconnections and Contemporary Developments between the Aegean and the Regions of the Balkan Peninsula, Central and Northern Europe, University of Zagreb, 11–14 April 2005, Aegaeum 27 (Liège, Austin 2007) 481–485.

Bettelli 2002
M. Bettelli, Italia meridionale e mondo miceneo. Ricerche su dinamiche di acculturazione e aspetti archeologici, con particolare riferimento ai versanti adriatico e ionico della penisola italiana, Grandi contesti e problemi della Protostoria italiana 5 (Florence 2002).

Blegen et al. 1958
C. W. Blegen – C. G. Boulter – J. L. Caskey – M. Rawson, Troy IV. Excavations Conducted by the University of Cincinnati 1932–1938, Settlements VIIa, VIIb, VIII (Princeton 1958).

Boileau et al. 2010
M.-C. Boileau – L. Badre – E. Capet – R. Jung – H. Mommsen, Foreign ceramic tradition, local clays. The Handmade Burnished Ware of Tell Kazel (Syria), Journal of Archaeological Science 37, 2010, 1678–1689.

Bouzek 1985
J. Bouzek, The Aegean, Anatolia and Europe. Cultural Interrelations in the Second Millennium B.C., Studies in Mediterranean Archaeology 29 (Prague, Gothenburg 1985).

Buffa 1994
V. Buffa, I materiali del Bronzo finale e della prima età del ferro, in: R. Peroni – F. Trucco (eds.), Enotri e Micenei nella Sibaritide I. Broglio di Trebisacce (Taranto 1994) 455–569.

Buffa 2001
V. Buffa, L'età del bronzo finale, in: F. Trucco – L. Vagnetti (eds.), Torre Mordillo 1987–1990. Le relazioni egee di una comunità protostorica della Sibaritide, Incunabula Graeca 101 (Rome 2001) 259–273.

Catling 2009
H. W. Catling, Sparta: Menelaion I. The Bronze Age, The British School at Athens Suppl. 45 (London 2009).

Catling – Catling 1981
H. W. Catling – E. A. Catling, Barbarian pottery from the Mycenaean settlement at the Menelaion, Sparta, The Annual of the British School at Athens 76, 1981, 71–82.

Damiani 2001
I. Damiani, L'età del bronzo recente, in: F. Trucco – L. Vagnetti (eds.), Torre Mordillo 1987–1990. Le relazioni egee di una comunità protostorica della Sibaritide, Incunabula Graeca 101 (Rome 2001) 235–257.

Deger-Jalkotzy 1977
S. Deger-Jalkotzy, Fremde Zuwanderer im spätmykenischen Griechenland. Zu einer Gruppe handgemachter Keramik aus den Myk. III C Siedlungsschichten von Aigeira, Österreichische Akademie der Wissenschaften, philosophisch-historische Klasse, Sitzungsberichte 326 (Vienna 1977).

Deger-Jalkotzy 2003
S. Deger-Jalkotzy, Work in progress. Report on the 'End of the Mycenaean Civilisation' project for the years of 1999–2001, in: M. Bietak (ed.), The Synchronisation of Civilisations in the Eastern Mediterranean in the Second Millennium B.C. II. Proceedings of the SCIEM 2000-EuroConference, Schloss Haindorf, 2.–7. May 2001, Contributions to the Chronology of the Eastern Mediterranean 4 (Vienna 2003) 455–470.

Demakopoulou 1982
Κ. Δημακοπούλου, Το μυκηναϊκό ιερό στο Αμυκλαίο και η ΥΕ ΙΙΙ Γ περίοδος στη Λακωνία (Athens 1982).

Demakopoulou – Divari-Valakou 2009
K. Demakopoulou – N. Divari-Valakou, Lower Acropolis. West Gate Area, Lower West Terrace, in: K. Demakopoulou – N. Divari-Valakou – M. Nilsson – A.-L. Schallin, Excavations in Midea 2007, Opuscula 2, 2009, 7–24.

Eder – Jung 2005
B. Eder – R, Jung, On the character of social relations between Greece and Italy in the 12th/11th cent. BC., in: R. Laffineur – E. Greco (eds.), Emporia II. Aegeans in the Central and Eastern Mediterranean. Proceedings of the 10th International Aegean Conference / 10e Recontre égéenne internationale, Italian School of Archaeology, Athens, 14.–18. April 2004, Aegaeum 25 (Liège, Austin 2005) 485–495.

French 2011
E. B. French, The Post-Palatial Levels, Well Built Mycenae 16/17 (Oxford 2011).

Giardino 1994
C. Giardino, I materiali dell'età del Bronzo recente, in: R. Peroni – F. Trucco (eds.), Enotri e Micenei nella Sibaritide I. Broglio di Trebisacce (Taranto 1994) 185–264.

Guzowska – Yasur-Landau 2007
M. Guzowska – A. Yasur-Landau, Handmade Burnished Ware in the Levant, in: I. Galanaki – H. Tomas – Y. Galanakis – R. Laffineur (eds.), I. Galanaki – H. Tomas – Y. Galanakis – R. Laffineur (eds.), Between the Aegean and Baltic Seas. Prehistory Across Borders. Proceedings of the International Conference Bronze and Early Iron Age Interconnections and Contemporary Developments between the Aegean and the Regions of the Balkan Peninsula, Central and Northern Europe, University of Zagreb, 11–14 April 2005, Aegaeum 27 (Liège, Austin 2007) 471–480.

Hochstetter 1984
A. Hochstetter, Kastanas. Ausgrabungen in einem Siedlungshügel der Bronze- und Eisenzeit Makedoniens 1975–1979. Die handgemachte Keramik. Schichten 19 bis 1, Prähistorische Archäologie in Südosteuropa 3 (Berlin 1984).

Horejs 2005
B. Horejs, Kochen am Schnittpunkt der Kulturen – zwischen Karpatenbecken und Ägäis, in: B. Horejs – R. Jung – E. Kaiser – B. Teržan (eds.), Interpretationsraum Bronzezeit. Bernhard Hansel von seinen Schülern gewidmet, Universitätsforschungen zur Prähistorischen Archäologie 121 (Berlin 2005) 71–94.

Iacono 2015
F. Iacono, Feasting at Roca. Cross-cultural encounters and society in the southern Adriatic during the Late Bronze Age, European Journal of Archaeology 18, 2, 2015, 259–281.

Iakovides 1969
Σ. Ιακωβίδης, Περατή. Το Νεκροταφείον, Βιβλιοθήκη της εν Αθήναις Αρχαιολογικής Εταιρείας 67 (Athens 1969).

Jacob-Felsch 1996
M. Jacob-Felsch, Die spätmykenische bis frühprotogeometrische Keramik, in: C. S. Rainer Felsch (ed.), Kalapodi. Die Ergebnisse der Ausgrabungen im Heiligtum der Artemis und des Apollon von Hyambolis in der antiken Phokis (Mainz 1996).

Jones 1986
R. E. Jones, Greek and Cypriot Pottery. A Review of Scientific Studies, BSA Fitch Laboratory Occasional Paper 1 (Athens 1986).

Jones – Tomlinson 2009
R. E. Jones – J. E. Tomlinson, Appendix G. Chemical analysis of Mycenaean pottery from Menelaion and its vicinity, in: Catling 2009, 147–169.

Jones et al. 2005
R. E. Jones – S. T. Levi – M. Bettelli, Mycenaean pottery in the central Mediterranean. Imports, imitations and derivatives, in: R. Laffineur – E. Greco (eds.) Emporia. Aegeans in the Central and Eastern Mediterranean. Proceedings of the 10th International Aegean Conference / 10e Rencontre égéenne internationale, Athens, Italian School of Archaeology, 14–18 April 2004, Université de Liège, Histoire de l'art et archéologie de la Grèce antique and University of Texas at Austin, Aegaeum 25 (Liège, Austin 2005) 539–545.

Jung 2006
R. Jung, Χρονολογια Comparata. Vergleichende Chronologie von Südgriechenland und Süditalien von ca. 1700/1600 bis 1000 v. u. Z., Veröffentlichungen der Mykenischen Kommission 26 (Vienna 2006).

Jung 2008
R. Jung, Die mykenische Keramik von Tell Kazel (Syrien), Damaszener Mitteilungen 15/2006, 2008, 147–218.

Jung 2009
R. Jung, Pirates of the Aegean. Italy – the East Aegean – Cyprus at the end of the second millennium BC, in: V. Karageorghis – O. Kouka (eds.), Cyprus and the East Aegean. Intercultural Contacts from 3000 to 500 BC. An International Symposium held at Pythagoreion, Samos, October 17th–18th 2008 (Nicosia 2009) 72–93.

Jung 2011
R. Jung, Innovative cooks and new dishes. Cypriot pottery in the 13th and 12th centuries BC and its historical interpretation, in: Karageorghis – Kouka 2011, 57–85.

Jung et al. 2015
R. Jung – H. Mommsen – M. Pacciarelli, From west to west. Determining production regions of Mycenaean pottery of Punta di Zambrone (Calabria, Italy), Journal of Archaeological Sciences: Reports 3, 2015, 455–463.

Karageorghis – Kouka 2011
V. Karageorghis – O. Kouka (eds.), On Cooking Pots, Drinking Cups, Loomweights and Ethnicity in Bronze Age Cyprus and Neighbouring Regions. An International Archaeological Symposium held in Nicosia, November 6th–7th 2010 (Nicosia 2011).

Kardamaki 2013
E. Kardamaki, Ein neuer Keramikfund aus dem Bereich der Westtreppe von Tiryns. Bemalte mykenische Keramik aus dem auf der Westtreppenanlage deponierten Palastschutt (PhD Diss,, University of Heidelberg 2013). doi: 10.11588/heidok.00014756

Kardamaki 2017
E. Kardamaki, The Late Helladic IIB to IIIA2 pottery sequence from the Mycenaean palace at Ayios Vasileios, Laconia, Archaeologia Austriaca 101, 2017, 73–142.

Kaza-Papageorgiou et al. 2011
Κ. Καζά-Παπαγεωργίου – Ε. Καρδαμάκη – Π. Κουτή – Ε. Μαρκοπούλου – Ν. Μούκα, Κοντοπήγαδο Αλίμου Αττικής. Οικισμός των ΠΕ και ΥΕ χρόνων και ΥΕ εργαστηριακή εγκατάσταση, Αρχαιολογική Εφημερίς 150, 2011, 197–274.

Kilian 1980
K. Kilian, Zum Ende der mykenischen Epoche in der Argolis, Jahrbuch des Römisch-Germanischen Zentralmuseums 27/1980, 1982, 166–195.

Kilian 1985
K. Kilian, Violinbogenfibeln und Blattbügelfibeln des griechischen Festlandes aus mykenischer Zeit, Prähistorische Zeitschrift 60, 1985, 145–203.

Kilian 2007
K. Kilian, Die handgemachte geglättete Keramik mykenischer Zeitstellung, Tiryns XV (Wiesbaden 2007).

Lindblom 2001
M. Lindblom, Marks and Makers. Appearance, Distribution and Function of Middle and Late Helladic Manufacturers' Marks on Aeginetan Pottery, Studies in Mediterranean Archaeology 128 (Jonsered 2001).

Lis 2009
B. Lis, Handmade and burnished pottery in the Eastern Mediterranean at the end of the Bronze Age. Towards an explanation for its diversity and geographical distribution, in: C. Bachhuber – R. G. Roberts (eds.), Forces of Transformation. The End of the Bronze Age in the Mediterranean. Proceedings of an International Symposium held at St. John's College, University of Oxford 25–26th March 2006 (Oxford 2009) 152–163.

Mommsen et al. 2002
H. Mommsen – E. Andrikou – V. Aravantinos – J. Maran, Neutron Activation Analysis results of Bronze Age pottery from Boeotia including ten Linear B inscribed stirrup jars of Thebes, in: E. Jerem – K. T. Biró (eds.), Proceedings of the 31st Symposium, Budapest, 26. April – 3. Mai 1998, Archaeometry 98, British Archaeological Reports. International Series 1043 (Oxford 2002) 607–612.

Mountjoy 1997
P. A. Mountjoy, The destruction of the Palace at Pylos reconsidered, The Annual of the British School at Athens 92, 1997, 109–137.

Mountjoy 1999
P. A. Mountjoy, Regional Mycenaean Decorated Pottery (Rahden/Westf. 1999).

Mountjoy 2008
P. A. Mountjoy, The Late Helladic pottery, in: Taylour – Janko 2008, 299–387.

Pålsson Hallager 2003
B. Pålsson Hallager, The Late Minoan III B:2 pottery, in: E. Hallager – B. Pålsson Hallager (eds.), The Greek-Swedish Excavations at the Agia Aikaterini Square, Kastelli, Khania 1970–1987 and 2001, vol. III. The Late Minoan IIIB2 Settlement (Stockholm 2003) 197–265.

Pålsson Hallager 2011
B. Pålsson Hallager, The Late Minoan III B:1 and III A2 pottery, in: E. Hallager – B. Pålsson Hallager (eds.), The Greek-Swedish Excavations at the Agia Aikaterini Square, Kastelli, Khania 1970–1987 and 2001, vol. IV. The Late Minoan IIIB1 and IIIA2 Settlement (Stockholm 2011) 273–280.

Pilides 1994
D. Pilides, Handmade Burnished Wares of the Late Bronze Age in Cyprus, Studies in Mediterranean Archaeology 105 (Jonsered 1994).

Pilides – Boileau 2011
D. Pilides – M.-C. Boileau, Revisiting the Handmade Burnished Ware of Cyprus. New analytical results, in: Karageorghis – Kouka 2011, 113–128.

Podzuweit 2007
C. Podzuweit, Studien zur spätmykenischen Keramik, Tiryns XIV (Wiesbaden 2007).

Popham – Milburn 1971
M. R. Popham – E. Milburn, The Late Helladic III C pottery of Xeropolis (Lefkandi). A summary, Annual of the British School at Athens 66, 1971, 333–352.

Popham et al. 2006
M. R. Popham – E. V. Schofield – E. S. Sherratt, The pottery, in: D. Evely (ed.), Lefkandi IV: The Bronze Age. The Late Helladic IIIC Settlement at Xeropolis, The British School at Athens Suppl. 39 (London 2006) 137–231.

Rahmstorf 2011
L. Rahmstorf, Handmade pots and crumbling loomweights, in: Karageorghis – Kouka 2011, 315–330.

Romanos 2011
C. L. Romanos, Handmade Burnished Ware in Late Bronze Age Greece and Its Makers (PhD Diss., University of Birmingham, Birmingham 2011) <https://etheses.bham.ac.uk/id/eprint/2963/> (last accessed 21 Jan. 2021).

Rutter 1975
J. B. Rutter, Ceramic evidence for northern intruders in southern Greece at the beginning of the Late Helladic III C Period, American Journal of Archaeology 79, 1975, 17–32.

Rutter 1976
J. B. Rutter, Non-Mycenaean' pottery. A reply to Gisela Walberg, American Journal of Archaeology 80, 1976, 187–188.

Rutter 2003
J. B. Rutter, The nature and potential significance of Minoan features in the earliest Late Helladic III C ceramic assemblages of the central and southern Greek mainland, in: S. Deger-Jalkotzy – M. Zavadil (eds.), LH III C Chronology and Synchronisms. Proceedings of the International Workshop Held at the Austrian Academy of Sciences at Vienna, May 7th and 8th, 2001, Veröffentlichungen der Mykenischen Kommission 20 (Vienna 2003) 193–216.

Schachermeyr 1980
F. Schachermeyr, Die ägäische Frühzeit IV. Griechenland im Zeitalter der Wanderungen vom Ende der mykenischen Ära bis auf die Dorier, Österreichischen Akademie der Wissenschaften, philosophisch-historische Klasse, Sitzungsbericht 372 (Vienna 1980).

Shelmerdine 1992
C. W. Shelmerdine, The LH IIIA2–IIIB pottery, in: W. A. McDonald – N. C. Wilkie (eds.), Excavations at Nichoria in Southwest Greece 2. The Bronze Age Occupation. (Minneapolis 1992) 495–521.

Small 1990
D. B. Small, Handmade Burnished Ware and prehistoric Aegean economics. An argument for indigenous appearance, Journal of Mediterranean Archaeology 3, 1, 1990, 3–25.

Stockhammer 2008
P. Stockhammer, Kontinuität und Wandel. Die Keramik der Nachpalastzeit aus der Unterstadt von Tiryns (PhD Diss., University of Heidelberg 2008). doi: 10.11588/heidok.00008612

Taylour – Janko 2008
W. D. Taylour – R. Janko, Ayios Stephanos. Excavations at a Bronze Age and Medieval Settlement in Southern Laconia, The British School at Athens Suppl. 44 (London 2008).

Vagnetti 1993
L. Vagnetti, Mycenaean pottery in Italy. Fifty years of study, in: C. Zerner – P. Zerner – J. Winder (eds.), Wace and Blegen. Pottery as Evidence for Trade in the Aegean Bronze Age 1939–1989. Proceedings of the International Conference held at the American School of Classical Studies, Athens, Decembre 2–3, 1989 (Amsterdam 1993) 143–154.

Vasilogamvrou 2013
Α. Βασιλογάμβρου, Ανασκαφή στον Άγιο Βασίλειο Λακωνίας, Πρακτικά της εν Αθήναις Αρχαιολογικής Εταιρείας 165/2010, 2013, 65–80.

Vasilogamvrou 2014
A. Βασιλογάμβρου, Ανασκαφή στον Άγιο Βασίλειο Λακωνίας, Πρακτικά της εν Αθήναις Αρχαιολογικής Εταιρείας 166/2011, 2014, 59–68.

Vasilogamvrou 2015
A. Βασιλογάμβρου, Ανασκαφή στον Άγιο Βασίλειο Λακωνίας, Πρακτικά της εν Αθήναις Αρχαιολογικής Εταιρείας 168/2013, 2015, 97–116.

Vasilogamvrou 2018
A. Βασιλογάμβρου, Ανασκαφή στον Άγιο Βασίλειο Λακωνίας, Πρακτικά της εν Αθήναις Αρχαιολογικής Εταιρείας 171/2016, 2018, 131–183.

Vitale 2006
S. Vitale, The LH III B–LH III C transition on the Mycenaean mainland. Ceramic phases and terminology, Hesperia 75, 2006, 177–204.

Wace French 1969
E. Wace French, The first phase of LH III C, Archäologischer Anzeiger 1969, 133–136.

Walberg 1976
G. Walberg, Northern intruders in Myc. III C?, American Journal of Archaeology 80, 1976, 186–187.

Whitbread 1992
I. K. Whitbread, Petrographic analysis of Barbarian Ware from the Menelaion, Sparta, in: J. M. Sanders (ed.), Φιλολάκων. Lakonian Studies in Honour of Hector Catling (London 1992) 297–306.

Whitbread – Jones 2008
I. K. Whitbread – R. E. Jones, Appendix 2: petrographic and chemical analysis of Middle and Late Helladic I–II pottery, in: Taylour – Janko 2008, CD-ROM 89–117.

Zerner 2008
C. Zerner, The Middle Helladic pottery, with the Middle Helladic wares from Late Helladic deposits and the potters' marks, in: Taylour – Janko 2008, 177–298.

‘Turn and Face the Strain’: Continuity and Change on Kos during the Mycenaean Late Palatial and Early Post-palatial Periods

Salvatore Vitale[1]

Abstract: This paper analyses the socio-political trajectories of Kos in the wider eastern Mediterranean context during the second part of the Palatial period and the early stages of the Post-palatial period of Mycenaean civilisation. To do so, elements of continuity and change from Late Helladic (LH) IIIB throughout LH IIIC Early are examined with reference to settlement distribution and architecture, burial landscape and tomb typology, and the quantity and quality of significant finds. The evidence indicates that LH IIIB was a phase of wealth and expansion on Kos, suggesting that during the 13th century BCE, the island may have played a prominent political role in the southeast Aegean. In addition, the analysis of the burial landscape implies a well-organised use of the space, possibly reflecting a solid and clearly defined social structure. The LH IIIB – LH IIIC Early transition on Kos was typified by signs of social uncertainty and upheaval, including an emphasis on the display of weapons at Langada and a fire destruction event at the settlement of the ‘Serraglio’. During LH IIIC Early, the number of sites attested on Kos decreased from LH IIIB, suggesting that the local population may have concentrated at the ‘Serraglio’. There is also evidence for a more fluid social structure, as suggested by the less organised spatial arrangement of the tombs at Langada. At least two elements, however, indicate the continuation of a certain degree of wealth and vivacity in the Koan community: an increase in the quantity and quality of the jewellery and an expansion in the diversity of imported ceramics, adornments, and bronze implements. Among these imports, a special case is represented by the concentration on Kos of Italian/European-type bronze objects, with a peak between late LH IIIB and LH IIIC Middle. The prompt reaction of the Koan community to the crisis following the collapse of Mycenaean Palatial society at the LH IIIB - LH IIIC Early transition may have been one of the key factors that led Kos to play a major role in the flourishing of the so-called East Aegean Koine during the successive LH IIIC Middle phase.

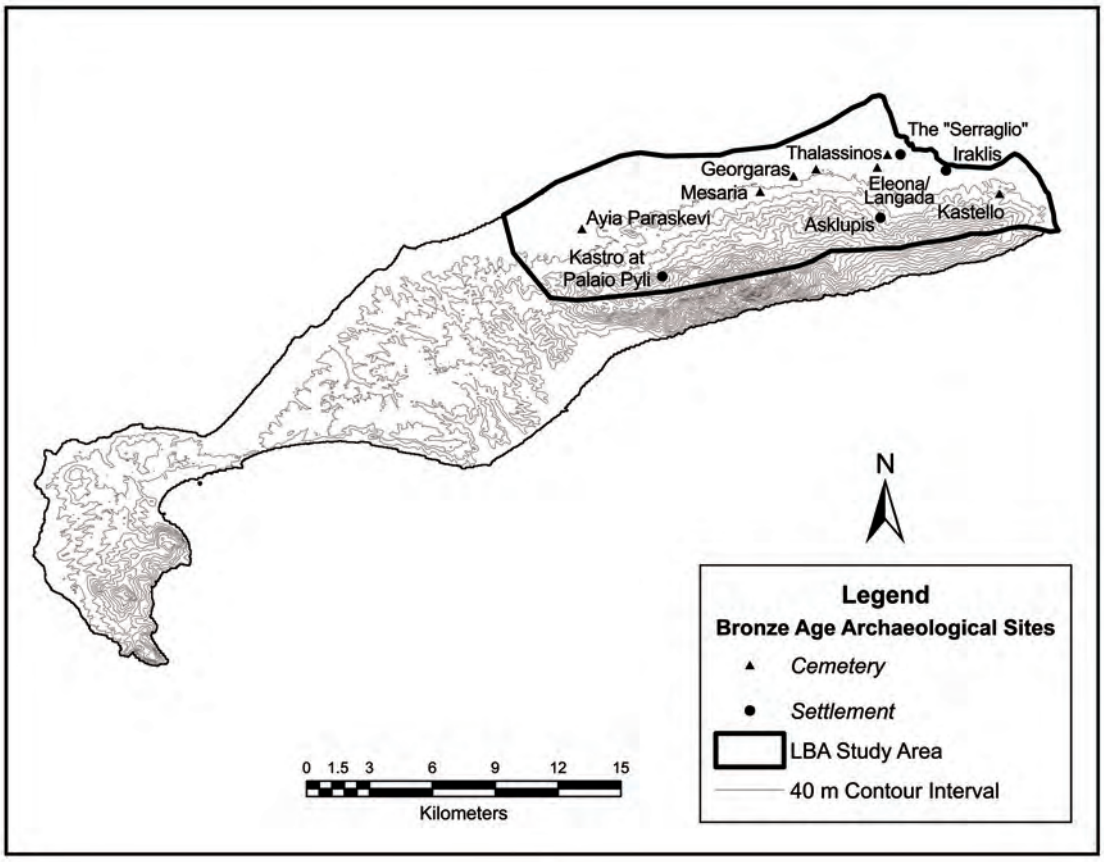
Keywords: Mycenaean Kos; Ahhiyawa; Sea Peoples; Mycenaean Palatial and Post-palatial society; Italo-Mycenaean relationships; funerary practices; burial landscape; spatial analysis

The aim of this paper is to investigate the socio-political history of the island of Kos (Fig. 1) during the second part of the Palatial period and the early stages of the Post-palatial period of Mycenaean civilisation, circa 1300 to 1150 BCE. This research is focused on the northeast part of the island, which provides the richest data set for this period. Attention is devoted to the analysis of three features that characterise Koan developments in material and cultural choices during Late Helladic (LH) IIIB and LH IIIC Early. These features include settlement distribution and architecture, burial landscape and tomb typology, as well as the quantity and quality of ceramics, jewellery, weapons, and miscellaneous tools made of bronze and stone. The presentation of the subject is divided into five sections. The first is an introduction on the character of the available data set. This part is followed by a phase-by-phase review of the evidence, an examination of the Italian/European-type bronze objects discovered on Kos, and a discussion of the socio-political meaning of elements of continuity and change during the periods of interest. The fifth and last section includes some final statements on the role of Kos in the wider eastern Mediterranean context from the beginning of the 13th to the middle of the 12th century BCE.

[1] Università degli Studi di Pisa, Dipartimento di Civiltà e Forme del Sapere, via dei Mille 19, stanza 3.05, 56126 Pisa, Italy; salvatore.vitale@for.unipi.it.



1



2

Fig. 1 Maps of northeast Kos including the main sites and areas under SEALP's study (1: base map from Google Earth adapted by C. McNamee, S. Vitale, T. Marketou; 2: C. McNamee, S. Vitale)

Data Set

The analysis proposed within this paper derives from the results of the 'Serraglio, Eleona, and Langada Archaeological Project' (SELAP), a research endeavour directed by the author and C. McNamee under the auspices of the Italian Archaeological School at Athens. SELAP is primarily based on the evidence recovered on Kos between 1935 and 1946 by L. Morricone.[2] Additional information on prehistoric northeast Kos is provided by the extensive survey carried out in the 1960s by R. Hope Simpson and J. F. Lazenby and the more recent rescue excavations by the Greek Archaeological service, especially T. Marketou, at the 'Serraglio' and at various sites in the vicinity of the modern town of Kos.[3]

While the investigations by the Greek Archaeological Service were carried out with up-to-date methodologies and provide us with exhaustive records, the resolution of the data from Morricone's excavations and Hope Simpson and Lazenby's survey is of uneven quality when compared to modern standards.[4] Morricone's materials constitute a large collection of finds, but the sample exhibits a significant bias due to the arbitrary discard strategies that were typical of Morricone's period. An additional problematic aspect is represented by the partial destruction of the original documentation, which occurred during World War II. Lost or missing data include most of the diaries from the excavations at the 'Serraglio', those from Eleona Tombs 1–20, as well as detailed drawings of plans, archaeological sections, and architectural features. Within the rather wide region explored by Hope Simpson and Lazenby, three aspects of the available evidence are particularly problematic: the non-systematic coverage of the area explored, the dearth of accurate information on the spatial distribution and the density of the archaeological artefacts, and the absence of refined geomorphological and environmental data.

Despite these limitations, during the last 11 years, SELAP's research has produced a significant amount of new information on Koan Bronze Age chronology, landscape, settlement patterns, architecture, burial practices, subsistence strategies, and technology.[5] SELAP's results show that substantial progress in our understanding of the past can be achieved by using a multidisciplinary and holistic analytical approach, even when the original data set mostly comes from old excavations.

Review of the Evidence

Kos during the Late Mycenaean Palatial Period: LH IIIB

Four settlements were occupied on northeast Kos during LH IIIB: the 'Serraglio', the Asklupis, Iraklis, and the Kastro at Palaio Pyli (Figs. 1–3).[6] In the 'Serraglio' sequence, LH IIIB encompasses the final part of Phase III:4a and all of Phase III:4b (Morricone's City III; Tab. 1;

---

2 Morricone 1950; Morricone 1967; Morricone 1975; Morricone 1978.

3 Hope Simpson – Lazenby 1970, 55–66, figs. 5–7, pls. 19–20; Papachristodoulou 1979; Papazoglou 1981; Marketou 1990a; Marketou 1990b; Marketou 2004; Marketou 2010, 762–763; Marketou in press (all with previous bibliography).

4 For specific observations on Morricone's excavation practices, see Vitale 2016a, 76.

5 Vitale 2012a; Vitale 2012b; Vitale 2013; Vitale 2016a; Vitale 2016b; Vitale 2017; Vitale 2018; Vitale 2019; Vitale – Hancock Vitale 2010; Vitale – Hancock Vitale 2013; Vitale – Trecarichi 2015; McNamee – Vitale 2016; McNamee – Vitale 2020; Vitale et al. 2017a; Vitale et al. 2017b; Vitale – Morrison 2017; Vitale – Morrison 2018; Vitale – McNamee 2019. See also Vitale 2006; Vitale 2007.

6 Hope Simpson – Lazenby 1970, 55–60, fig. 5; Morricone 1975, 392–393; Skerlou 1998, 553; Vitale 2006, 83–87; Marketou 2010, 763, 765; Vitale 2012a, 1238. Some of the sherds recovered at Misonisi, near Zia, are described as LBA in date and similar in fabric to those from the Asklupis and the Kastro at Palaio Pyli (Hope Simpson – Lazenby 1970, 58–59). However, it is impossible to establish exactly the chronological placement of these fragments based on Hope Simpson and Lazenby's original report.

Morricone's Excavations (Morricone 1975)		Marketou's Excavations (Marketou 1990a; Marketou 1990b; Marketou 2009; Marketou 2010)	Vitale (Vitale 2006; Vitale 2012a)	Vitale et al. 2017		Approximate Synchronisms	
Building Phases	**Suggested Chronology**	**Suggested Chronology**		**Building Phases**	**Suggested Chronology**	**Crete**	**Greek Mainland**
–	–	EBA 3 Early	–	I:1	EBA 3 Early	EM IIB–EM III	EH III
–	–	EBA 3 Late	–	1:2	EBA 3 Late		
–	–	MBA	–	II	MBA	MM IA–IIIA	MH I–III Early
Settlement Preceding City I, First Sub-Phase	MM III	LBA IA Early	LBA IA Early	III:1.a	LBA IA Early	MM IIIB or LM IA Early-Advanced**	MH III Late
Settlement Preceding City I, Second Sub-phase		LBA IA Mature	LBA IA Mature	III:1.b	LBA IA Mature	LM IA or LM IA Final**	LH I
City I	MBA III–LBA I or LBA I	LBA IB	LBA IB	III:2	LBA IB	LM IB	LH IIA
City II, First Sub-phase	LBA IIIA (= end of the period)	Disturbed LM II/LH IIB to LM/LH IIIC Late Sequence	LBA II–LBA IIIA1	III:3.a	LBA II–LBA IIIA1	LM II–LM IIIA1	LH IIB–LH IIIA1
City II, Second Sub-phase			LBA IIIA1	III:3.b	LBA IIIA1	LM IIIA1	LH IIIA1
City III, First Sub-phase	LBA IIIA–LBA IIIB		LH IIIA2–LH IIIB1	III:4.a	LH IIIA2–LH IIIB1	LM IIIA2-LM IIIB1	LH IIIA2–LH IIIB1
City III, Second Sub-phase	LBA IIIB Final (= end of the period)		LH IIIB1–LH IIIB2 Late	III:4.b	LH IIIB1–LH IIIB2 Late	LM IIIB1-LM IIIB2	LH IIIB1–LH IIB2 Late
City IV	LBA IIIC		LH IIIC Early–Middle	III:5	LH IIIC Early–Middle	LM IIIC Early–Subminoan	LH IIIC Early–Late ***

* The earliest phases of the LBA are termed LBA I, II, and IIIA1 because during these periods Koan material culture was still typified by a strong local character. From LH IIIA2 onward, the typical Mycenaean sequence and terminology can also be applied to Kos (see Vitale 2007, 44).
** See Van de Moortel 2001; Rutter – Van de Moortel 2006.
*** LH IIIC Phases 1–5, according to Rutter 1977; Rutter 1978.

Tab. 1 Occupational sequence at the settlement of the 'Serraglio' during the Bronze Age*

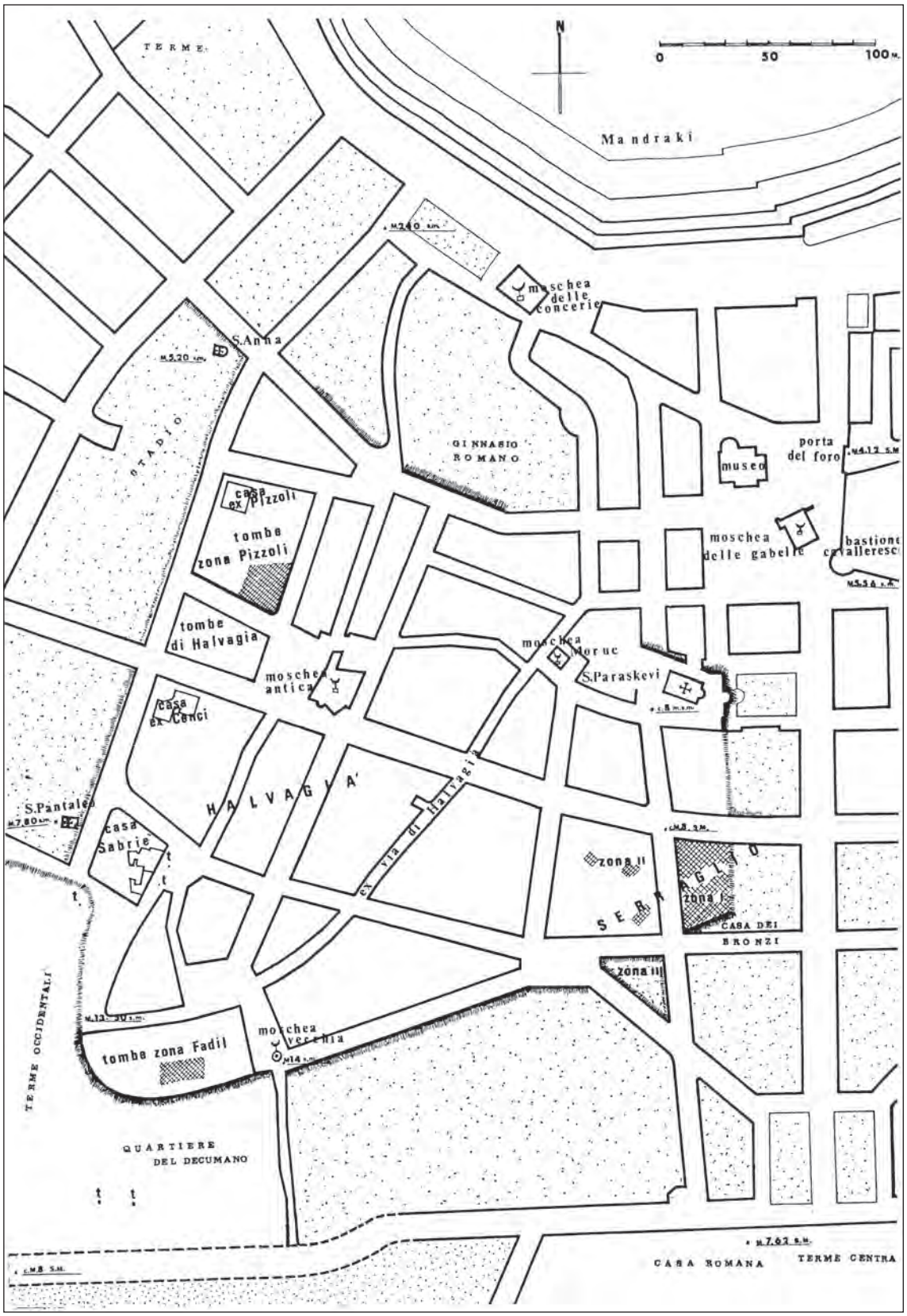


Fig. 2 The Bronze Age settlement of the 'Serraglio' with Morricone's main excavation sectors outlined in grey (after Morricone 1975, 152, fig. 7)

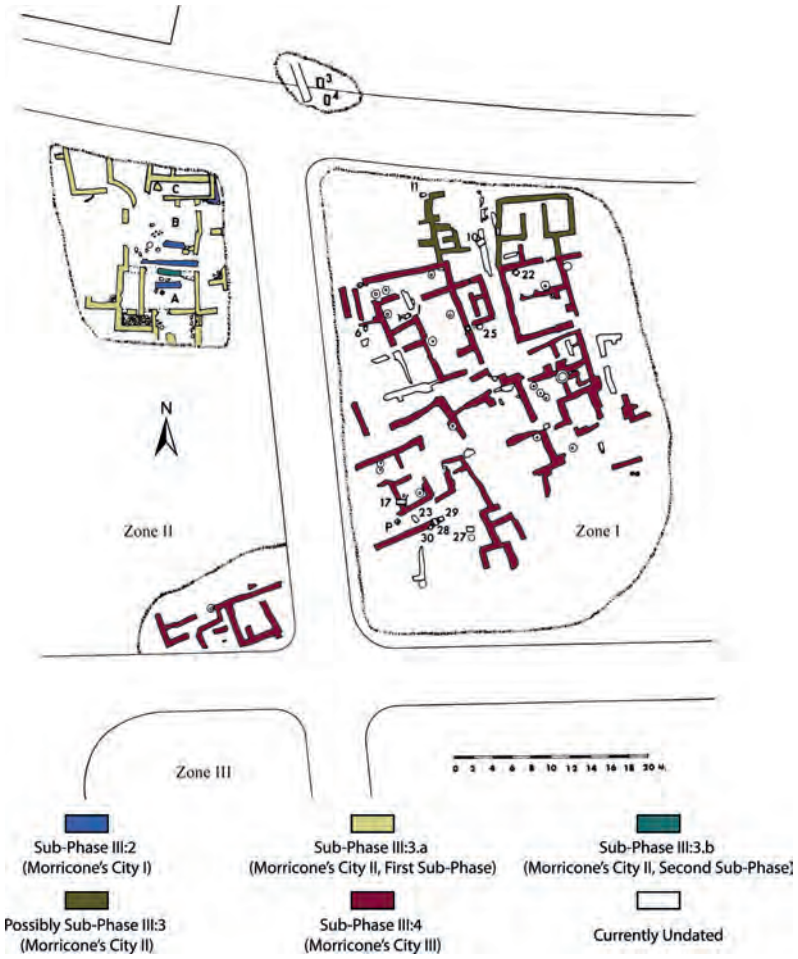


Fig. 3 The 'Serraglio', Zones I–II: Map showing the Early Iron Age tombs and the LBA vessels found in situ within the buildings of Sub-Phases III:2, 3, and 4. The locations of the Early Iron Age tombs are indicated by the occurrence of cardinal numbers (after Morricone 1975, 159, fig. 21, adapted by C. McNamee, S. Vitale).

Figs. 2–4).[7] The estimated size of the settlement during this period was large, measuring c. 6ha (Fig. 2). According to the excavator, Phase III:4 yielded the most impressive architectural remains within the Late Bronze Age (LBA) settlement. Structures were aligned in a north-northwest to south-southeast direction (Fig. 3). Walls were built carefully with regularly cut slabs and stones and were preserved up to a height of 0.90–1.00m (Fig. 4).[8]

The most informative deposit for Phase III:4a is the fill underneath the floor of the House of the Figs in Zone II of the 'Serraglio' (Fig. 4.3).[9] This assemblage contained circa 300 sherds, around 80.0% of which date to LH IIIA2 – LH IIIB1 (Fig. 5). Richer evidence is available for Phase III:4b, which included three types of contexts. The first type is represented by a series of rooms from Zone I of the 'Serraglio' with several in situ storage vases (Fig. 3). The second type is an occupation surface with a cleaver-like razor and a single flat axe brought to light in Zone I of the 'Serraglio' (Fig. 6). The third context is a destruction deposit found on the floor of the House of the Figs, which provides a firm LH IIIB2 Late date for the end of Phase III:4b (Fig. 7).[10]

7 Vitale 2006, 83–87, figs. 13–14; Vitale 2012a, 1238, tab. 1, fig. 7.

8 Morricone 1975, 178–179, 206, 227–231, 245, 392–393, figs. 21, 64–66, 111–113, 154, 158–159, 188, 190, plan B; Vitale – McNamee 2019.

9 For a preliminary report on these materials, see Vitale 2006, 83–85, fig. 13.

10 Morricone 1975, 155, 165, 169, 227–231, figs. 12, 36, 47, 154, 158–159; Vitale 2006, 85–87, fig. 14; Vitale 2012a, 1238, fig. 7.

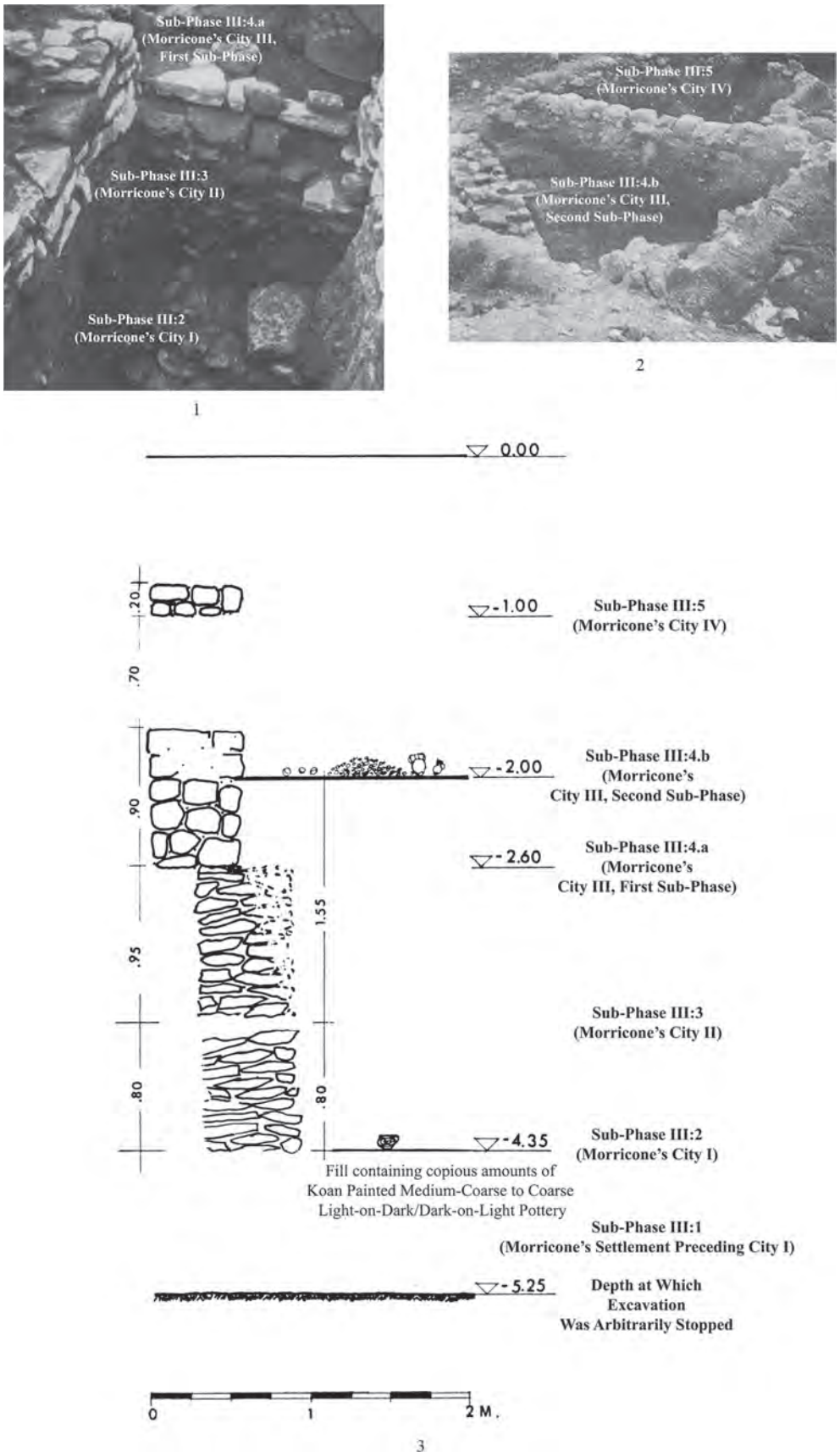


Fig. 4 The 'Serraglio', Zone II, northwest corner: 1. View of the walls of Sub-Phases III:2, III:3, and III:4a; 2. View of the walls of Sub-Phases III:4b and III:5; 3. Reconstructed stratigraphic section after the sounding of February and March 1946 (after Morricone 1975, 227, 230–231, figs. 154, 158–159, adapted by S. Vitale)

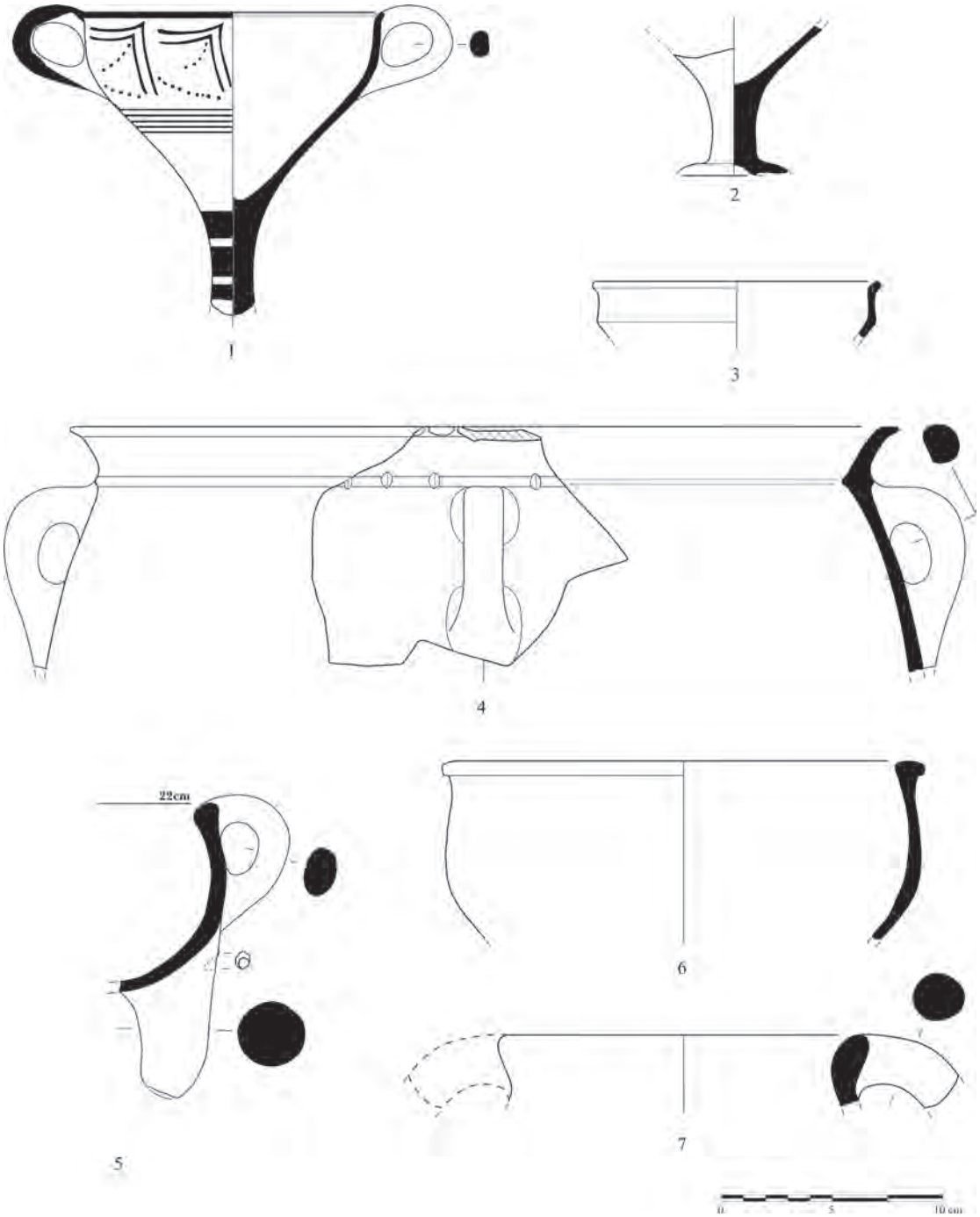


Fig. 5 The ‘Serraglio’, Zone II, northwest corner: LH IIIA2–LH IIIB1 fragments from the fill underneath the final floor of the House of the Figs. Scale 1:3 (1: S. Regio, M. Rossin, T. Ross; 2: S. Regio, T. Ross; 3: M. Rossin, T. Ross; 4, 6–7: S. Regio, T. Ross; 5: M. Rossin, T. Ross)

Circa three kilometres southwest of the ‘Serraglio’, LH IIIB human activity in the area of the Asklupis is suggested by a few bowl and kylix fragments recovered by Hope Simpson and Lazenby (Figs. 1, 8), but this evidence is not sufficient to clarify the character of the site during this phase.[11] The same consideration applies to the possible settlement remains recovered at Iraklis, located in the area of Psalidi, a couple of kilometres southeast of the ‘Serraglio’ (Fig. 1).

[11] Hope Simpson – Lazenby 1970, 57.

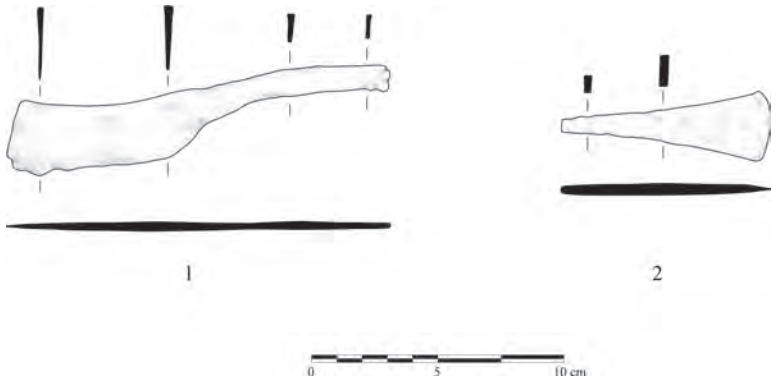


Fig. 6 The 'Serraglio', Zone I: A cleaver-like razor and a single flat axe from an occupation surface dating to Sub-Phase III:4. Scale 1:3 (1–2: S. Regio, T. Ross)



Fig. 7 The 'Serraglio', Zone II, northwest corner, destruction deposit: LH IIIB2 Late vessels found in situ on the final floor of the House of the Figs. Scale 1:3 (1, 3: S. Regio, A. Caputo, A. Trecarichi; 2, 4: M. Rossin, A. Caputo, A. Trecarichi)

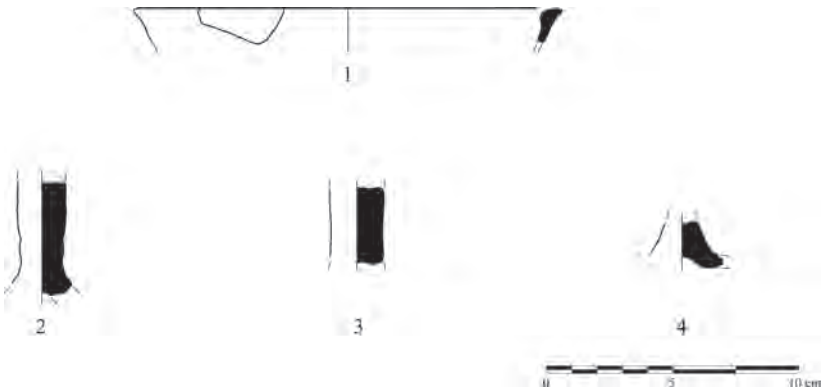


Fig. 8 The Asklupis: Unstratified unpainted LH IIIA2/LH IIIB bowl and kylix sherds. Scale 1:3 (M. Rossin, T. Ross)



Fig. 9 The Kastro at Palaio Pyli: LH IIIB fortification wall (S. Vitale)

Turning to the opposite side of the Mesaria Plain, an impressive fortification wall preserved up to seven courses was discovered along a scree slope at the Kastro at Palaio Pyli (Fig. 9).[12] This structure is the only secure example of a Mycenaean fortification wall in the Dodecanese.[13] The Palaio Pyli wall, dated to LH IIIB based on surface sherds,[14] implies a fortified stronghold on top of the Kastro hill, which has a commanding view over the fertile Mesaria Plain, the islands of Kalymnos and Pserimos, and the west coast of Anatolia (Fig. 10). The site may have overlooked the rich Mesaria agricultural supplies, as well as the important sea trade routes to the north.[15]

[12] Hope Simpson – Lazenby 1970, 59–60, pl. 21.

[13] The construction technique of the fortification wall at the Kastro at Palaio Pyli is considered cyclopean by R. Hope Simpson (Hope Simpson 1981, 201, pl. 30b). This attribution is rejected by D. Field (Field 1984, 201–202), but there is a consensus on the Mycenaean character of the structure.

[14] See Hope Simpson – Lazenby 1970, 60.

[15] See Vitale et al. 2017b, 246, pl. 75.



Fig. 10 The Kastro at Palaio Pyli: The Mesaria Plain, the islands of Kalymnos and Pserimos, and the Bodrum peninsula from the summit of the fortified LH IIIB site (S. Vitale)

Turning to the funerary sphere, a total of eight LH IIIB cemetery sites have been identified on northeast Kos. The largest evidence comes from Eleona and Langada. In addition, isolated chamber tombs were found at Kastello, Iraklis, Mesaria, and Ayia Paraskevi, while two tholos tombs were found in the Thalassinos and the Georgaras properties (Fig. 1).[16] It is important to stress that thus far Kos is the only island in the Dodecanese where tholos tombs are attested. The tholos found in the Thalassinos property was used only during LH IIIB and was located c. 250m west of the Fadil area, which was the western border of the settlement of the 'Serraglio' during the LBA. The tholos found in the Georgaras property, on the other hand, was located c. three kilometres to the southwest of the 'Serraglio' and was used from LH IIIA2 Early throughout LH IIIC Middle.[17]

Eleona and Langada were located on the opposite sides of an alluvial drainage, c. 750m southwest of the 'Serraglio' (Figs. 1, 11). They included a total of 83 tombs, dating from LBA II to LH IIIC Middle (Tabs. 2–3). The majority of the tombs were set into pozzolana layers. Others were built into both alluvium and pozzolana or, to a lesser extent, into a deeper and harder clay stratum.[18] Morricone classified all of the 83 graves as chamber tombs.[19] Recent studies on the Koan Mycenaean burial landscape conducted by the author and C. McNamee, however, have questioned Morricone's original attribution and suggested that 17 of the 61 graves from Langada may have been simple pits rather than chamber tombs.[20] This reconstruction is based on the fact that these 17 graves do not exhibit any of the diagnostic features that characterise Mycenaean chamber tombs, including the occurrence of multiple interments, *dromoi*, and built architectural

16 Morricone 1967; Hope Simpson – Lazenby 1970, 55, 60, fig. 5; Papazoglou 1981; Skerlou 2001; Skerlou 2003; Benzi 2005; Marketou 2010, 765; Vitale 2012a, 1237–1238, tab. 2; Vitale – Trecarichi 2015, 315–316, tab. 2; McNamee – Vitale 2016.

17 Gregoriadou 2001; Skerlou 2003; Marketou in press.

18 McNamee – Vitale 2016; McNamee – Vitale 2020.

19 Morricone 1967, 22.

20 McNamee – Vitale 2016; McNamee – Vitale 2020.

features, such as closure walls, benches, and platforms.[21] If the same criteria were applied to Eleona, the minimum number of chamber tombs from this site would be 14 out of a total of 22 graves. However, because of the lack of excavation diaries for Eleona Tombs 1–20,[22] no conclusive assessment on the type, shape, size, and spatial arrangement of the tombs from this cemetery can be conducted. While the discussion of these characteristics must be limited to Langada, other features, including the chronology of the burials and the quality and quantity of the finds can be discussed for both cemeteries.

	LBA II	**LBA IIIA1**	**LH IIIA2**	**LH IIIB**	**LH IIIC Early**	**LH IIIC Middle**	**Undatable**
Eleona	4	13	5	6	4	13	–
Langada	–	–	10	19	22	27	5
Total	**4**	**13**	**15**	**25**	**26**	**40**	**5**
LBA II: E. Ts. 2, 4, 8, 18. LBA IIIA1: E. Ts. 3, 4, 7, 8, 10, 11, 12, 14, 16, 17, 18, 21, 22. LH IIIA2: E. Ts. 2, 10, 15, 16, 18; L. Ts. 3, 16, 25, 29, 37, 38, 41, 51, 54, 56. LH IIIB: E. Ts. 4, 5, 6, 15, 19, 20; L. Ts. 10, 15, 19, 20, 21, 28, 30, 35, 36, 37, 40, 46, 48, 49, 52, 53, 57, 59, 60. LH IIIC Early: E. Ts. 4, 11, 13, 20; L. Ts. 4, 5, 6, 10, 11, 13, 17, 19, 22, 23, 24, 25, 26, 31, 35, 43, 44, 52, 53, 57, 59, 61. LH IIIC Middle: E. Ts. 1, 2, 4, 6, 7, 8, 11, 12, 13, 15, 20, 21, 23; L. Ts. 1, 2, 6, 8, 9, 10, 11, 14, 15, 17, 18, 19, 20, 32, 33, 34, 35, 39, 41, 44, 45, 47, 50, 52, 55, 57, 61. Undatable: L. Ts. 7, 12, 27, 42, 58.							
* The total exceeds 83, because many tombs were utilised during more than one phase.							

Tab. 2 Chronological distribution of the tombs in use at Eleona and Langada

	LBA II	**LBA IIIA1**	**LH IIIA2**	**LH IIIB**	**LH IIIC Early**	**LH IIIC Middle**	**Undatable**	**Total**
Eleona	4	10	1	4	1	2	–	**22**
Langada	–	–	10	18	14	14	5	**61**
Total	**4** (4.8%)	**10** (12.0%)	**11** (13.3%)	**22** (26.5%)	**15** (18.1%)	**16** (19.3%)	**5** (6.0%)	**83** (100.0%)
LBA II: E. Ts. 2, 4, 8, 18. LBA IIIA1: E. Ts. 3, 7, 10, 11, 12, 14, 16, 17, 21, 22. LH IIIA2: E. T. 15; L. Ts. 3, 16, 25, 29, 37, 38, 41, 51, 54, 56. LH IIIB: E. Ts. 5, 6, 19, 20; L. Ts. 10, 15, 19, 20, 21, 28, 30, 35, 36, 40, 46, 48, 49, 52, 53, 57, 59, 60. LH IIIC Early: E. T. 13; L. Ts. 4, 5, 6, 11, 13, 17, 22, 23, 24, 26, 31, 43, 44, 61. LH IIIC Middle: E. Ts. 1, 23; L. Ts. 1, 2, 8, 9, 14, 18, 32, 33, 34, 39, 45, 47, 50, 55. Undatable: L. Ts. 7, 12, 27, 42, 58.								

Tab. 3 Absolute number of tombs built at Eleona and Langada

[21] McNamee – Vitale 2016; McNamee – Vitale 2020. It is interesting to note how the understanding of the typology of the tombs at Eleona and Langada has changed over time. In 1936, L. Laurenzi reported for the first time on the discovery of the cemeteries and stated that the graves were Mycenaean simple pits (Laurenzi 1936, 141). By contrast, in his first discussion of his excavations at Eleona and Langada, Morricone claimed that the graves were all collapsed chamber tombs, each being provided with a *dromos* (Morricone 1950, 13–25). Finally, in 1967, Morricone confirmed that the graves were all collapsed chamber tombs, but stated that the original cuts for *dromoi* and chambers were very hard to recognise, because of the crumbly consistence of the alluvial and pozzolana sediments into which most of the tombs were dug (Morricone 1967, 13–25). More specifically, Morricone mentions only five instances where he could tentatively identify the traces of a *dromos*, including Tombs 35, 40, 48, 58, and 60 (Morricone 1967, 11, 22, 169, 195, 229, 253, 260).

[22] Morricone 1967, 9, n. 1.

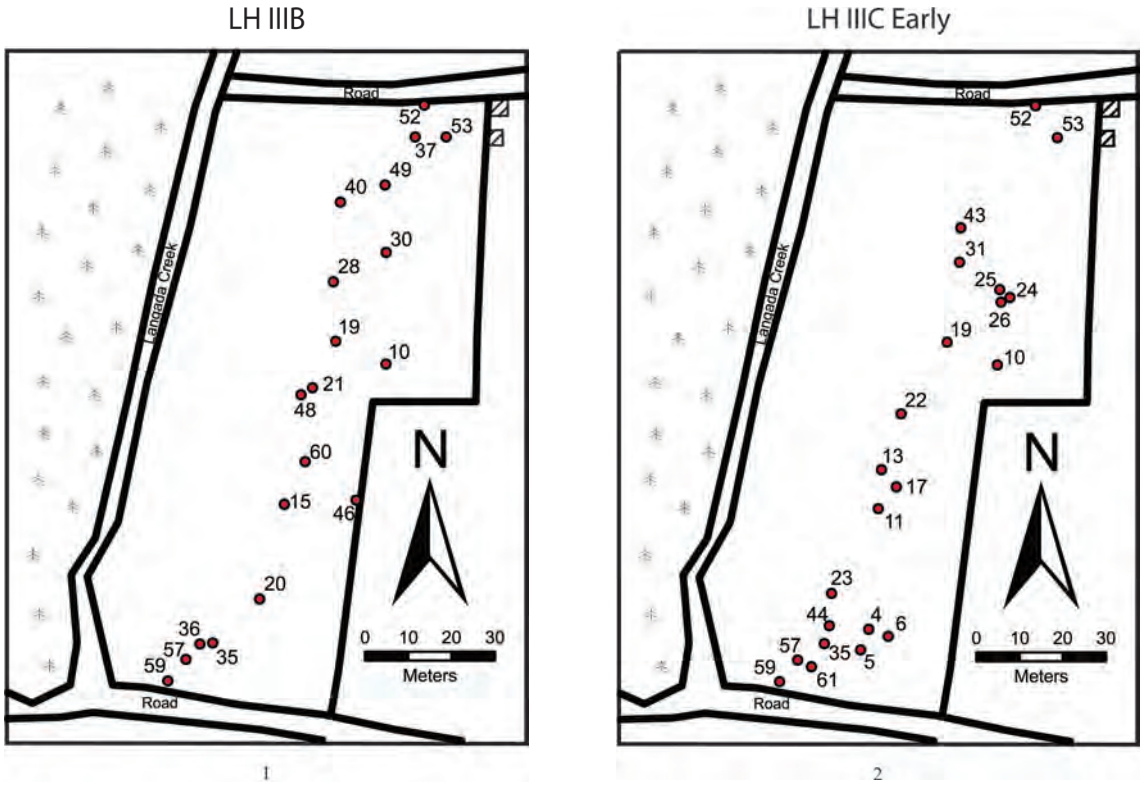


Fig. 11 Eleona and Langada: 1. Plan indicating the location of all of the Langada tombs used during LH IIIB; 2. Plan indicating the location of all of the Langada tombs used during LH IIIC Early (1–2: C. McNamee, S. Vitale)

LH IIIB was the most impressive building period at Eleona and Langada, with 22 newly constructed tombs, representing 26.5% of the total (Tab. 3; Fig. 11.1). When re-used tombs from previous phases are considered, the number of LH IIIB graves totals 25, making up 19.5% of the sample from the two cemeteries (Tab. 2). These figures are even more impressive if they are considered against the data from LH IIIA2. In this case, during LH IIIB there is a 13.2% increase in terms of newly built tombs and a 7.8% increase in terms of the total number of used tombs. These elements suggest demographic growth between LH IIIA2 and LH IIIB.

The exact location of the Eleona tombs is uncertain, due to the lack of the excavation diaries. However, Morricone states that they were all built in a single row on the slope of a low hill facing north.[23] More precise information is available for Langada, where 18 tombs were built during LH IIIB (Tab. 3; Fig. 11.1). According to SELAP's recent analysis, 16 of these graves can be safely attributed to the chamber tomb type.[24] The majority of these chamber tombs had a circular shape and faced west.[25] Approximate dimensions are provided for only nine of the 16 chamber tombs. Generally, the size was not particularly impressive, with an average of 4.89 square metres.[26] The distribution reflects an organised use of the area, with the tombs being widely spaced across the whole field (Fig. 11.1).

[23] Morricone 1967, 22–25.

[24] McNamee – Vitale 2016; McNamee – Vitale 2020. Securely identified chamber tombs built at Langada during LH IIIB include nos. 10, 15, 19, 20, 21, 28, 30, 35, 40, 48, 49, 52, 53, 57, 59, and 60. Possible pits include nos. 36 and 46.

[25] Morricone 1967; McNamee – Vitale 2016; McNamee – Vitale 2020. Of the sixteen securely identified chamber tombs built at Langada during LH IIIB, five (nos. 35, 40, 52, 53, and 57) had a rough circular shape, two had a roughly square shape (nos. 10 and 59), and two had a roughly rectangular shape (nos. 21 and 60), while the original shape could not be ascertained for seven tombs (nos. 15, 19, 20, 28, 30, 48, and 49). The shape of the two possible pits (nos. 36 and 46) was not recognised.

[26] Among securely identified chamber tombs, approximate dimensions are provided for Langada Tombs 10, 21, 35, 40, 52, 53, 57, 59, and 60 (Morricone 1967, 99–111, 136–142, 169–172, 195–196, 233–242, 247–253, 255–264).

Turning to the finds, it should be underlined that no thorough quantitative assessment of the ceramics from the 'Serraglio' can be accomplished. In fact, with the exception of the contexts mentioned previously, all of the materials stylistically attributable to Phase III:4 were unstratified and selected arbitrarily by Morricone. A more accurate evaluation is possible for the ceramics from Eleona and Langada, where LH IIIB pottery corresponds to 18.6% of the total assemblage and is 6.0% greater than the pottery dating to LH IIIA2 (Tab. 4).

Date	Eleona	Langada	Total
LBA II/LH IIB	8	–	**8** (1.7%)
LBA IIIA1/LH IIIA1	27	–	**27** (5.8%)
LH IIIA2	8	51	**59** (12.6%)
LH IIIB	17	70	**87** (18.6%)
LH IIIC Early	6	85	**91** (19.4%)
LH IIIC Middle	27	101	**128** (27.4%)
LBA II/LH IIB–LBA IIIA1/LH IIIA1	1	–	**1** (0.2%)
LBA II/LH IIB–LH IIIA2	2	–	**2** (0.4%)
LH IIIA2–LH IIIB	1	–	**1** (0.2%)
LH IIIA2–LH IIIC Early	–	1	**1** (0.2%)
LH IIIB–LH IIIC Early	2	3	**5** (1.1%)
LH IIIB–LH IIIC Middle	–	2	**2** (0.4%)
LH IIIC Early–LH IIIC Middle	3	24	**27** (5.8%)
Undatable	8	21	**29** (6.2%)
Total	**110** (23.5%)	**358** (76.5%)	**468** (100.0%)

Tab. 4 Chronological distribution of pottery vessels from Eleona and Langada

Overall, three broad observations can be made on the LH IIIB pottery from the 'Serraglio', Eleona, and Langada. First, LH IIIB materials are widely represented and all functional categories of Mycenaean pottery are attested.[27] Second, locally produced Mycenaean pottery is very widespread and roughly conforms stylistically and technologically to Greek mainland productions. Third, according to SELAP's macroscopic fabric analysis, most of the imports comes from the northeast Peloponnese.[28]

The non-ceramic evidence indicates that during LH IIIB precious and semiprecious small finds were spread evenly throughout the tombs (Figs. 12–13), suggesting that adornments were not exclu-

[27] Vitale 2016a, 84–86.

[28] Mountjoy 1999, 1092–1097, figs. 446–448; Vitale 2016a, 84–86.

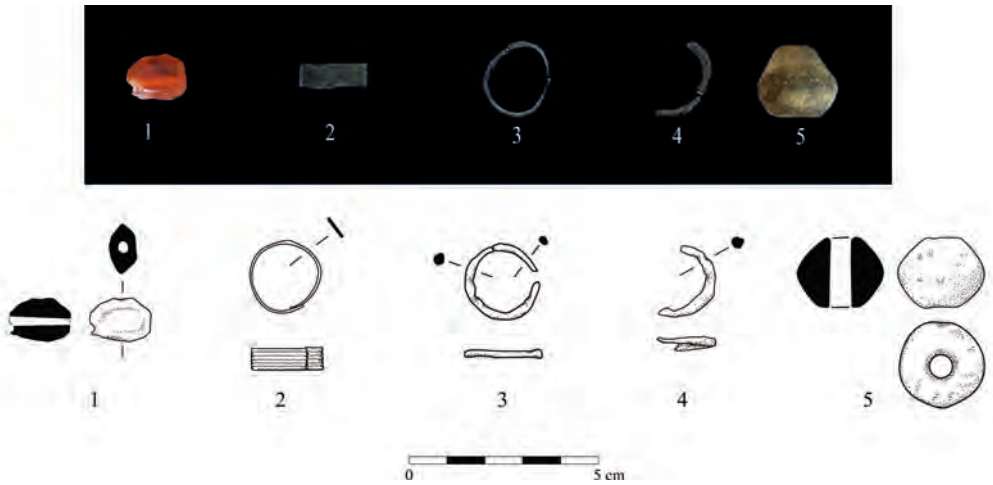


Fig. 12 Langada: LH IIIB2 Late adornments in carnelian (no. 1), bronze (nos. 2–4), and terracotta (no. 5) from Tomb 21. Scale 1:2 (1–5: photo S. Vitale; drawings M. Rossin, T. Ross)

sively reserved for the elite (Tab. 5).[29] In fact, during LH IIIB, especially late LH IIIB, social status was underlined by the display of weapons (Tab. 6).[30] This is shown particularly well by the finds from Langada Tombs 21 and 46. The former included a Naue II sword and a spearhead with a fully cast socket (Fig. 14), while the latter included a Type F-2 sword, another spearhead, two knives, and a cleaver (Fig. 15).[31] Langada Tombs 21 and 46 were single burials and both date to LH IIIB2 Late.[32]

	Head/Hair	Neck	Hand/Arm	Clothes	Total	Materials
Eleona, Tomb 19	–	–	–	**3** - 1 biconical button in terracotta - 2 conical buttons in steatite	**3**	Ivory (1) Bronze (5) Carnelian (1) Stone (1) Steatite (4) Terracotta (6)
Langada, Tomb 21	–	**1** - 1 amygdaloidal pendant in carnelian	**4** - 4 band rings in bronze (1 incised)	**1** - 1 biconical button in terracotta	**6**	
Langada, Tomb 30	–	**1** - 1 globular bead in stone	–	**1** - 1 biconical button in terracotta	**2**	
Langada, Tomb 36	–	–	**1** - 1 band ring in bronze	**1** - 1 biconical button in terracotta	**2**	
Langada, Tomb 48	–	–	–	**1** - 1 conical button in steatite	**1**	
Langada, Tomb 60	–	–	–	**4** - 2 biconical buttons in terracotta - 1 conical button in steatite - 1 flattened biconical button in ivory	**4**	
Total	–	**2**	**5**	**11**	**18**	

Tab. 5 Distribution of adornments from LH IIIB qualified groups at Eleona and Langada by type and material

29 Vitale 2016b, 260–261, figs. 4–5, tab. 3. The terminology used for adornments conforms to Konstantinidi 2001.
30 Vitale 2012b, 411–412; Vitale 2016b, 260–261, 263, pls. 2a–b, 3.
31 The terminology used for weapons conforms to Kilian-Dirlmeier 1993.
32 Morricone 1967, 136–142, figs. 121–128; Vitale 2012a, 1238, figs. 2, 5–6; Vitale 2012b, 410–411, pls. 94a, d–e; 95a–e.

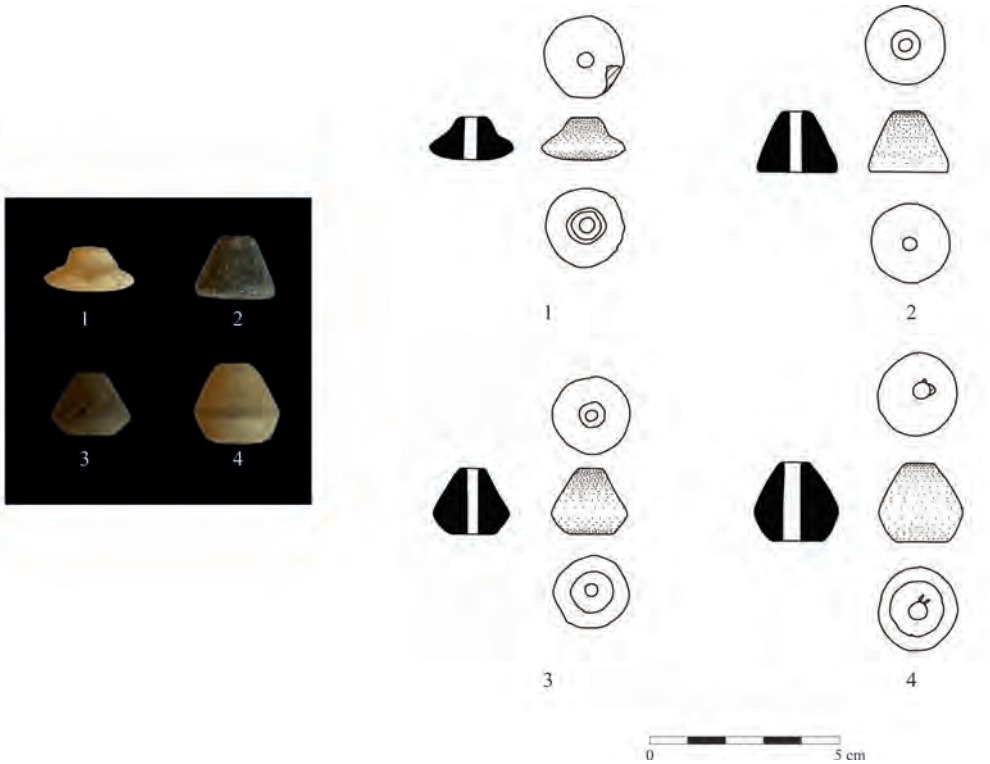


Fig. 13 Langada: LH IIIB buttons/spindle whorls in ivory (no. 1), steatite (no. 2), and terracotta (nos. 3–4) from Tomb 60. Scale 1:2 (1–4: photo S. Vitale; drawings M. Rossin, A. Trecarichi, T. Ross)

	Bronze			Other Materials			Total
	Weapons	**Weapons/Tools and Tools**	**Subtotal**	**Weapons**	**Weapons/Tools and Tools**	**Subtotal**	
Eleona	5 4 spearheads; 1 sword	5 1 casting waste; 1 blade fragment; 1 knife; 2 razors/ cleavers	10 (13.3%)	–	1 1 obsidian blade	1 (4.5%)	**11** (11.3%)
Langada	44 37 arrow-heads; 4 spearheads; 3 swords	21 4 awls; 2 chisels; 3 cleavers; 1 conical cap; 7 knives; 2 razors/cleavers; 1 set of tongs; 1 pair of tweezers	65 (86.7%)	–	21 3 whetstones; 18 lead fishing weights	21 (95.5%)	**86** (88.7%)
Total	**49**	**26**	**75** (100.0%; 95.1%)	**–**	**22**	**22** (100.0%; 4.9%)	**97**
Weapons: E. Ts. 4 or 5, 6 or 7; L. Ts. 15, 16, 21, 34, 37, 46, 53, stray finds. Weapons/Tools and Tools: E. Ts. 15, 17, 20, 21; L. Ts. 11, 15, 25, 34, 37, 38, 42, 43, 45, 46, 52, 58, stray finds (two of the three stray finds are currently unpublished).							

Tab. 6 Distribution of weapons and weapons/tools from Eleona and Langada by type and material

The overall character of the jewellery and weapons from Eleona and Langada roughly conforms to standard Mycenaean funerary assemblages. The occurrence of possible ‘exotics’ is worth noting. An ivory flattened biconical button from Langada Tomb 60 (Fig. 13.1) may have come from either the Near East or Egypt, where this material was common during the 2nd millennium

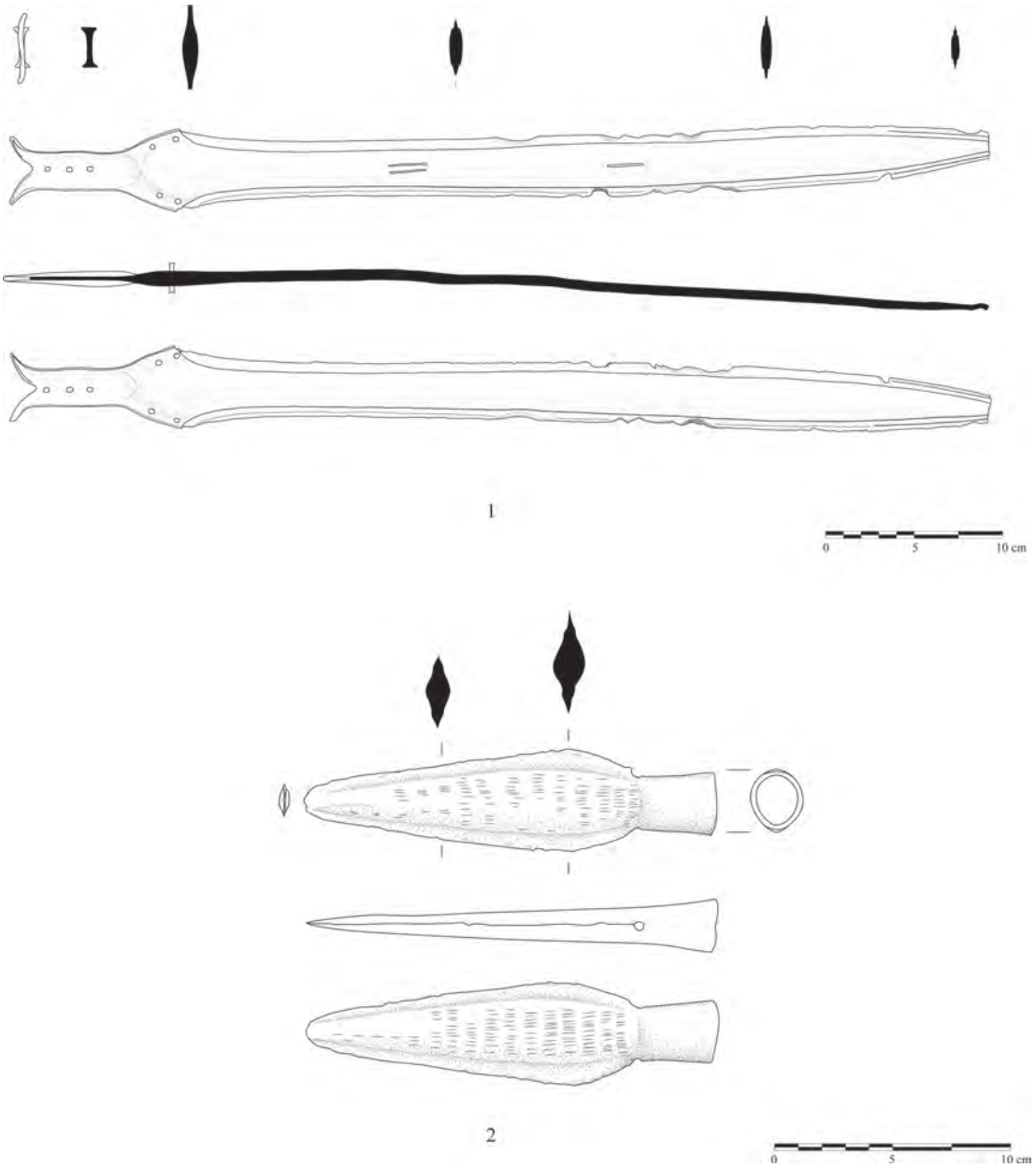


Fig. 14 Langada: LH IIIB2 Late weapons from Tomb 21. (1) scale 1:4, (2) scale 1:3 (1: S. Regio, A. Trecarichi; 2: S. Regio, M. Rossin, T. Ross)

BCE.[33] A Near Eastern origin is also possible for the amygdaloidal bead in carnelian from Langada Tomb 21 (Fig. 12.1).[34] At the same time, the sword and the spearhead from Langada Tomb 21 (Fig. 14) are related to Italian prototypes and their occurrence on Kos may indicate contacts with the central Mediterranean at the end of LH IIIB (see below).[35]

33 Vitale 2016b, 260–261, tab. 3, fig. 4, pl. 1d.

34 See Matarese et al. 2015, 140; Vitale 2016b, 260–261, tab. 3, fig. 5, pl. 1h. The attribution of the small finds recovered during the excavation of Langada Tomb 21 to the single deceased from this burial is possible but not altogether certain (Morricone 1967, 136).

35 Morricone 1967, 137 n. 1; 138 n. 1–2, 139; Vitale 2012b, 411, 413; Vitale 2016b, 261; Vitale et al. 2017b (all with previous bibliography).

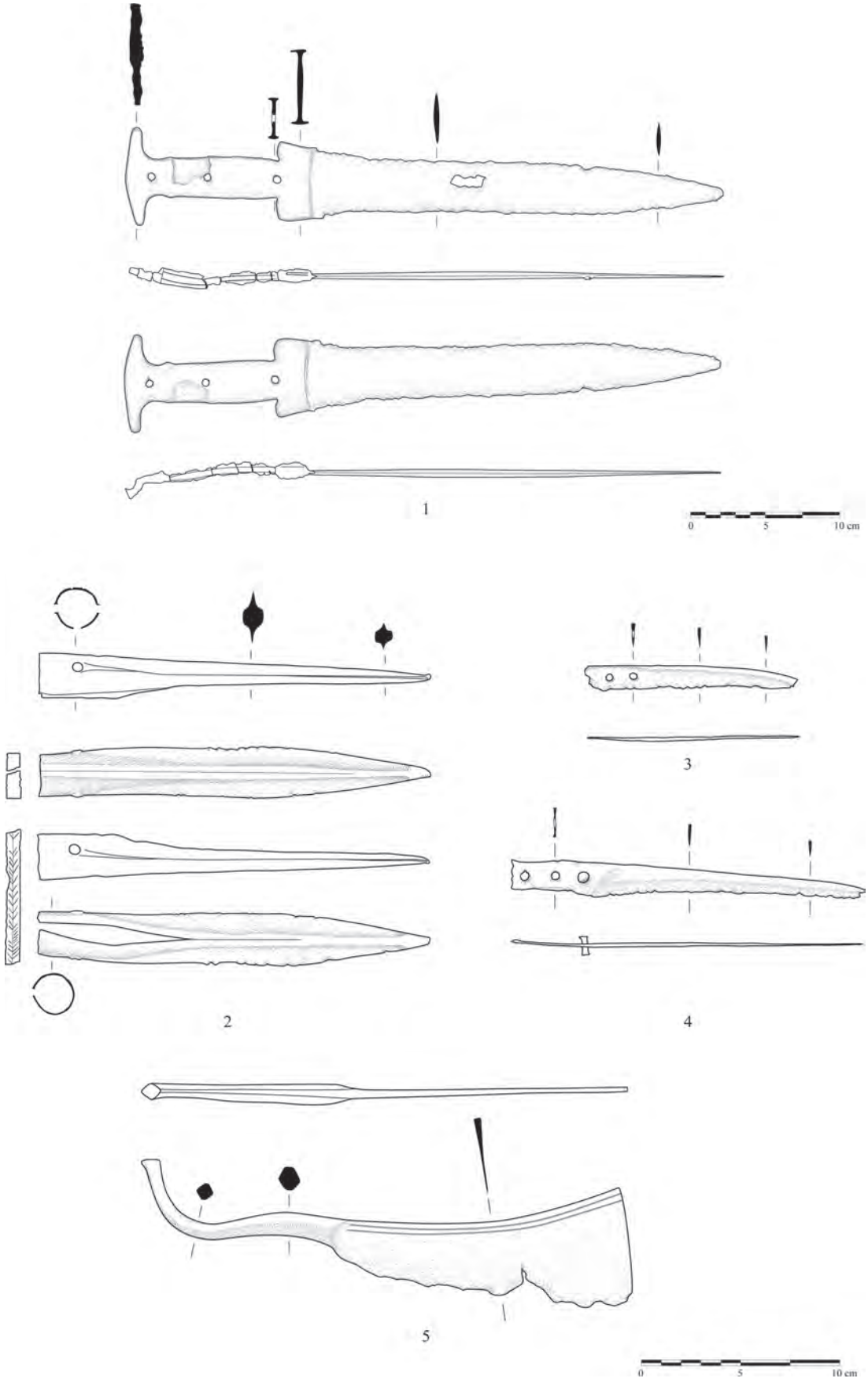


Fig. 15 Langada: LH IIIB2 Late weapons and weapons/tools from Tomb 46. (1) scale 1:4, (2–5) scale 1:3 (1–4: S. Regio, T. Ross; 5: M. Rossin, T. Ross)

A final important element to be mentioned in this review is the uneven distribution of jewellery, weapons, and tools between Eleona and Langada (Tabs. 5–6). In fact, all of the weapons from LH IIIB qualified contexts come from Langada.[36] Similarly, of the 18 adornments from qualified find groups, 15 come from Langada, while only three come from Eleona.

Kos during the Initial Mycenaean Post-palatial Period: LH IIIC Early

The only northeast Koan settlement with secure occupation during this phase was the 'Serraglio', where LH IIIC Early is included within Phase III:5 (Morricone's City IV; Tab. 1; Figs. 1–2, 4.2–3).[37] Unfortunately, the architectural remains were heavily disturbed by later building activities and, although unstratified LH IIIC Early ceramics are well represented, no closed contexts from this phase were recovered.[38]

The size of the settlement of Phase III:5 cannot be securely determined. However, based on the spread of LH IIIC Early stray finds, it seems that no significant change in dimensions occurred from LH IIIB (Fig. 2). The structures of Phase III:5 were aligned in a northwest to southeast direction with a slight change from Phase III:4. Walls were less carefully built than those of Phase III:4 with irregularly cut stones preserved for a single course only up to a height of 0.20–0.30m (Fig. 4.2–3).[39]

Although a few isolated finds from Iapili have been tentatively attributed to disturbed burials, the only certain evidence from LH IIIC Early funerary contexts on northeast Kos comes from Georgaras, Eleona, and Langada (Figs. 1, 11.2).[40] At Eleona and Langada, 15 tombs were constructed in this phase, representing 18.1% of the total, with an 8.4% decrease from LH IIIB (Tab. 3). However, when re-used tombs are considered, LH IIIC Early graves total 26, making up 20.3% of the sample, with a slight increase (0.8%) from LH IIIB (Tab. 2).

SELAP's analysis has established that only 9 out of the 14 graves built at Langada during LH IIIC Early can be attributed definitely to the chamber tomb type.[41] Within this sample, there is more variability in shape than in LH IIIB, with roughly rectangular and square chambers prevailing over circular specimens.[42] The majority of the tombs continued to face west. Chamber dimensions were smaller than in LH IIIB, with an average of 3.73 square metres.[43] In addition, the locations of the LH IIIC Early tombs suggest a less organised use of the space compared to the previous phase (Fig. 11.2).

Among unstratified LH IIIC Early ceramics from the 'Serraglio', an important novelty is the appearance of amphoroid and ring-based kraters FS 56 and 282. Four pictorial fragments with men bearing Sea Peoples-like feathered helmets may be dated stylistically either to this period or to the successive LH IIIC Middle (Fig. 16).[44] At Eleona and Langada, LH IIIC Early pottery

---

36 Following A. Furumark's terminology, qualified contexts include closed deposits and stylistically 'homogeneous find groups' (Furumark 1941, 32–33).

37 Morricone 1975, 227, 249–250, 393–394, figs. 154, 158–159, 190, plan B. The Kastro at Palaio Pyli may or may not have been in use during LH IIIC Early (see Hope Simpson – Lazenby 1970, 60).

38 Mountjoy 1999, 1097–1105, figs. 448–451; Vitale 2006, 87; Vitale 2012a, 1237, tab. 1.

39 Morricone 1975, 393–394, fig. 154; Vitale – McNamee 2019.

40 Hope Simpson 1965, 187; Morricone 1967; Morricone 1975, 271–272, fig. 226; Marketou in press.

41 McNamee – Vitale 2016; McNamee – Vitale 2020. Securely identified chamber tombs built at Langada during LH IIIC Early include nos. 4, 5, 6, 11, 13, 17, 31, 44, and 61. Possible pits include nos. 22, 23, 24, 26, and 43.

42 Morricone 1967; McNamee – Vitale 2016; McNamee – Vitale 2020. Of the nine securely identified chamber tombs built at Langada during LH IIIC Early, one (no. 61) had a roughly circular shape, one had a roughly square shape (no. 17), and three had a roughly rectangular shape (nos. 4, 6, and 13), while the original shape could not be ascertained for four tombs (nos. 5, 11, 31, and 44). The shape of the possible pits was approximately rectangular in the case of tomb no. 23, approximately circular in the case of tomb no. 22, and was not recognised in the cases of tombs nos. 24, 26, and 43.

43 Among securely identified chamber tombs, approximate dimensions are provided for Langada Tombs 4, 6, 13, 17, and 61 (Morricone 1967, 94–97, 116–117, 127–130, 264–268).

44 Vitale – McNamee 2019, 572–573, pl. 200e–h (with previous bibliography).

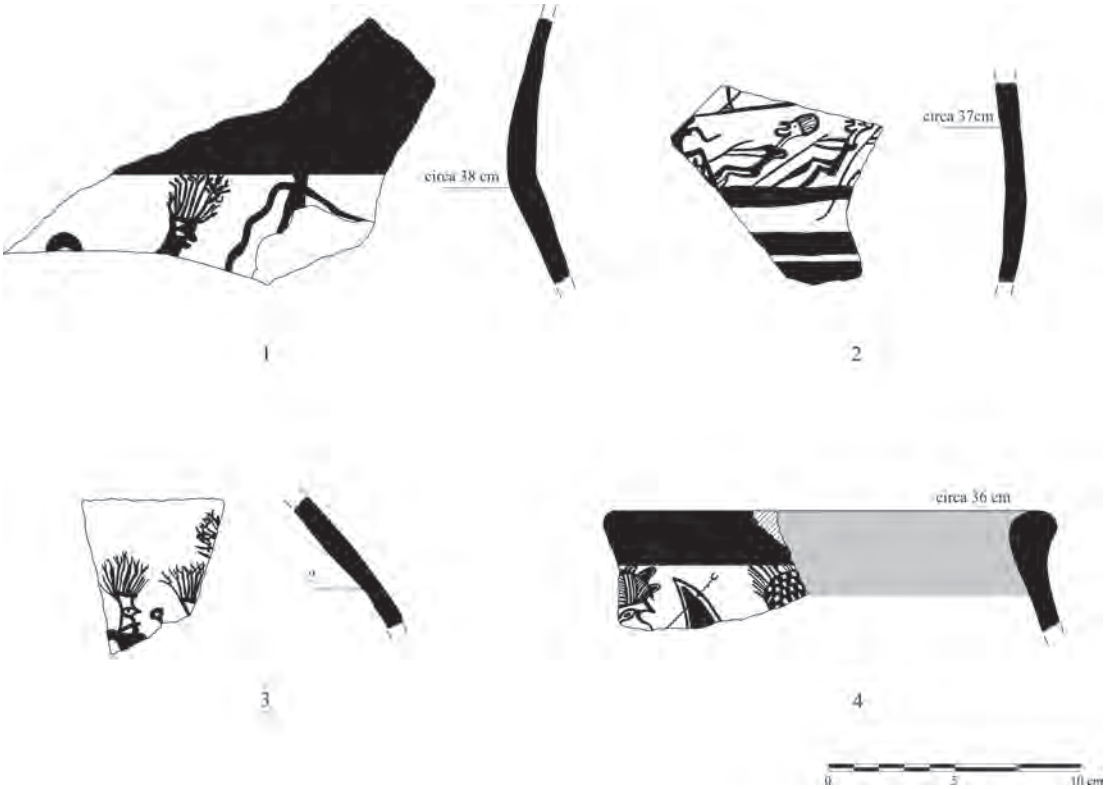


Fig. 16 The 'Serraglio': Unstratified LH IIIC Early/Middle amphoroid and ring-based kraters FS 56, 282 with Sea Peoples characters FM 1. Scale 1:3 (1–4: M. Rossin, A. Trecarichi)

corresponds to 19.4% of the total, with a 0.8% increase from LH IIIB (Tab. 4). The general characteristics of Koan LH IIIC Early ceramics also continue without dramatic changes from the previous phase. However, two shifts can be noticed. The first is an increase in the proportion of locally produced pottery. The second is the occurrence of a more varied pattern of imports that, in addition to the northeast Peloponnese, now also include Cretan (Fig. 17.1), Cypriot (Fig. 17.2–3), and possibly Trojan vessels (Fig. 17.4).[45] In terms of local ceramic manufacture habits, there is a clear continuity between LH IIIB and LH IIIC Early.[46]

While no weapons from Eleona and Langada can be securely dated to LH IIIC Early, this phase brought a rise in the quantity of precious and semiprecious adornments from qualified contexts at Eleona and Langada (Tabs. 5, 7; Figs. 18–19), as well as a change in the diversity of the offerings, with more exotic materials and shapes being seen. A peak in the concentration of the finds was discovered in Group 2 of Langada Tomb 57, providing an argument for the use of jewellery as a status symbol (Tab. 7; Fig. 19).[47] The assemblage from this tomb suggests direct or indirect contacts with the Baltic region or Italy, as well as with the Near East or Egypt. Contacts with the Baltic or Italy are shown by the occurrence of an amber bead (Fig. 19.4), while contacts with the Near East or Egypt are suggested by a discoid bead in carnelian (Fig. 19.2) and five pendants in the shape of lotus flower buds, two in coral and three in carnelian, which are now

[45] Mountjoy 1999, 1097–1105, figs. 448–451; Vitale 2016a, 84–86. Cypriot imports are represented by two simple style stirrup jars from Langada Tomb 53. These vases, which are dated here to LH IIIC Early, were previously assigned to LH IIIB by R. Jung (Jung 2008, 167 n. 80).

[46] For Koan LBA manufacturing practices, see Vitale 2017; Vitale – Morrison 2017.

[47] Morricone 1967, 247–253, figs. 273–277. The materials from Langada Tomb 57 have been subdivided into three groups based on stratigraphic and contextual evidence (Vitale 2016a, 77, tab. 5.2; Vitale 2016b, 262, tab. 4). Group 2 includes the finds associated with vases nos. 230, 233, and 235.

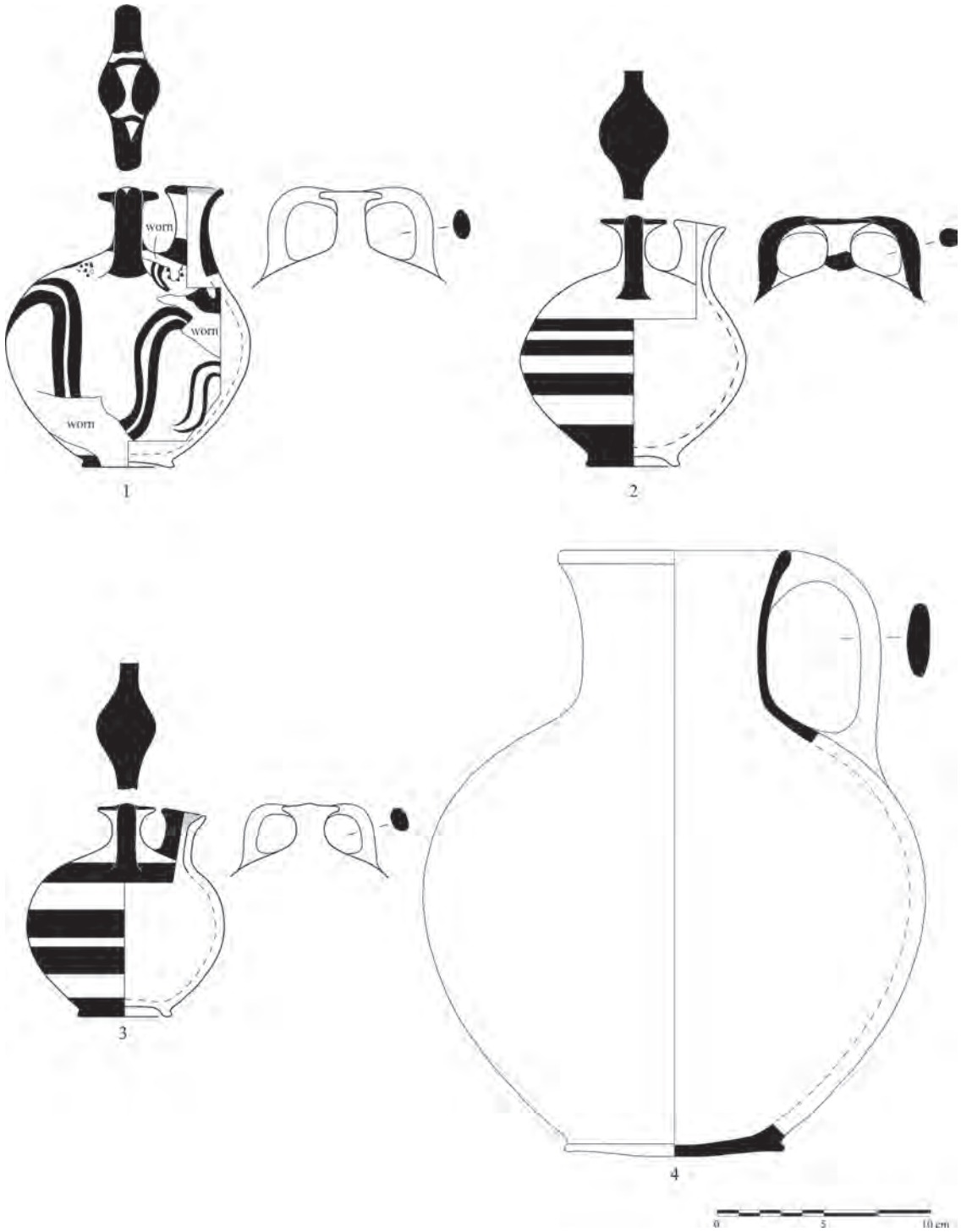


Fig. 17 Langada: LH IIIC Early (nos. 1–3) and LH IIIC Early/Middle (no. 4) ceramic imports from Crete, Cyprus, and Troy. Scale 1:3 (1: S. Regio, M. Rossin, A. Trecarichi; 2–3: S. Regio, T. Ross; 4: S. Regio, A. Trecarichi)

lost.[48] Additional evidence for possible contacts between Kos and the Near East is provided by another globular bead in carnelian from Langada Tomb 31.[49]

48 Vitale 2016b, 261–263, tab. 4, fig. 7b, pl. 2g.

49 Morricone 1967, 159–161, figs. 156, 159–161. Vitale 2016b, 261–262, tab. 4. For the possible Near Eastern provenance of adornments made in carnelian see Matarese et al. 2015, 140.

	Head/Hair	Neck	Hand/Arm	Clothes	Total	Materials
Langada, Tomb 23	**1** - 1 spiraliform hairclip in bronze	–	–	–	**1**	Amber (1) Bronze (5) Coral (2) Carnelian (5) Faience (1) Glass (6) Steatite (3)
Langada, Tomb 24	–	**1** - 1 amygdaloidal bead in faience	**1** - 1 bracelet in bronze	**1** - 1 conical button in steatite	**3**	
Langada, Tomb 26	–	–	**1** - 1 spiraliform ring in bronze	**1** - 1 conical button in steatite	**2**	
Langada, Tomb 31	–	**1** - 1 globular bead in carnelian	**2** - 2 bracelets in bronze	–	**3**	
Langada, Tomb 57 (Group 2)	–	**14** - 1 discoid bead in carnelian - 2 coral pendants in the shape of lotus flower buds - 6 glass beads (4 globular, 2 tapered) - 1 amygdaloidal bead in amber - 1 pendant in steatite - 3 carnelian pendants in the shape of lotus flower buds	–	–	**14**	
Total	**1**	**16**	**4**	**2**	**23**	

Tab. 7 Distribution of adornments from LH IIIC Early qualified groups at Eleona and Langada by type and material

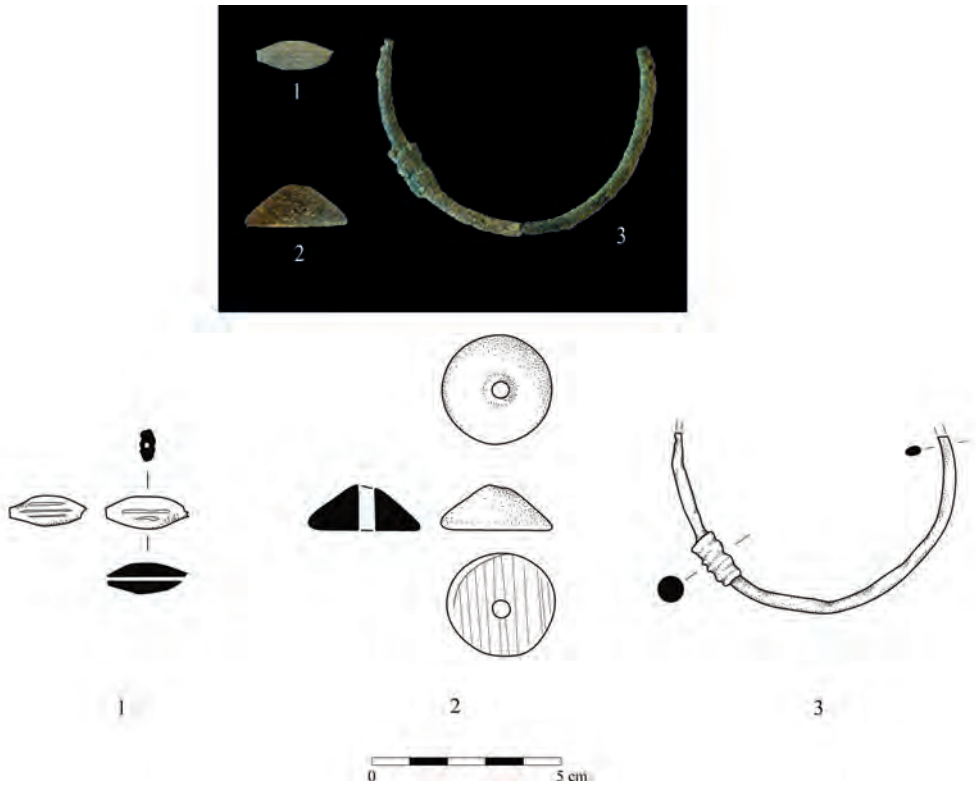


Fig. 18 Langada: LH IIIC Early adornments in faience (no. 1), steatite (no. 2), and bronze (no. 3) from Tomb 24. Scale 1:2 (1–3: photo S. Vitale; drawings S. Regio, T. Ross)



Fig. 19 Langada: LH IIIC Early adornments in steatite (no. 1), carnelian (no. 2), glass (no. 3), and amber (no. 4) from Tomb 57, Group 2. Scale 1:2 (1–4: photo S. Vitale; drawings M. Rossin, T. Ross)

Besides qualified contexts, an increase in the quantity and quality of the jewellery is also suggested by the evidence from Langada Tomb 10, the richest burial ever found at this site.[50] This grave contained six embossed golden sheets decorated with double Argonauts (Fig. 20.1–6); two golden rings (Fig. 20.7–8); a golden hair clip (Fig. 20.9); two necklaces, one in gold (Fig. 20.10) and one made of gold and precious stones (Fig. 20.11); a stone cylinder with golden coatings on both sides (Fig. 20.12); two silver or iron rings (Fig. 20.13–14); a bronze, finely incised violin-bow fibula (Fig. 20.15); two amber beads; a steatite button; a bronze hook, and a fragmentary bronze ring. Contacts with Italy/Europe are again suggested by the incised fibula and the amber beads. Of the 28 vessels found within Langada Tomb 10, eleven date to LH IIIC Early, seven date to LH IIIC Early/Middle, eight date to LH IIIC Middle, one dates to LH IIIB2 Late, and one cannot be assigned to a specific phase based on stylistic grounds.[51] The chronological distribution of these vessels implies that most, if not all of the jewellery from Tomb 10, was deposited during LH IIIC Early and LH IIIC Middle.

Despite the occurrence of exotica, Koan small finds do not deviate from the typical Mycenaean repertoire. All of the LH IIIC Early jewellery from Eleona and Langada comes from the latter cemetery, showing the same uneven distribution noticed for LH IIIB (Tabs. 5, 7). Such a tendency, implying a wealth distinction between Elena and Langada, is not limited to LH IIIB and LH IIIC Early. Around 90,0% of the jewellery from these two cemeteries comes from Langada[52] and a similar distributional pattern is implied by weapons and other miscellaneous tools in bronze and stone throughout the history of these cemeteries (Tab. 6).

Italian/European-Type Bronze Objects on Kos

The Naue II sword and the spearhead with a fully cast socket from Langada Tomb 21 (Fig. 14), as well as the fibula from Tomb 10 (Fig. 20.15) are part of a larger group of bronze objects of possible Italian and/or European origin discovered on Kos.[53] This assemblage includes another spearhead with a fully cast socket (Fig. 21.1) and a knife of the so-called Scoglio del Tonno type with incised decoration along its top (non-cutting) edge (Fig. 21.2), both from the ‘Serraglio’; one razor with incised handle decoration from Langada Tomb 34 (Fig. 21.3); and one violin-bow fibula with a leaf-shaped bow from Langada Tomb 20 (Fig. 21.4).[54]

50 Morricone 1967, 99–111, figs. 81–91, 315a.

51 See Morricone 1967, 103–11, figs. 85–91, 315a. The vessels attributable to LH IIIC Early are nos. 8, 10, 54, 105, 109, 111, 114, 279, 281, 282, and 284. The vessels attributable to LH IIIC Early/Middle are nos. 99, 101, 104, 106, 107, 108, and 113. The vessels attributable to LH IIIC Middle are nos. 100, 102, 103, 110, 112, 278, 280, and 285. Finally, vessel no. 1365 can be assigned to LH IIIB2 Late, while no. 291 cannot be dated closely.

52 Vitale et al. 2017a, 275–277, tab. 22.

53 For a more thorough discussion of the relationships between Italy/Europe, Kos, and the Dodecanese, including details on bronze and amber objects, see Vitale et al. 2017b, 248–251.

54 See Benzi 2009b (with previous bibliography); Jung 2009; Jung – Mehofer 2009.

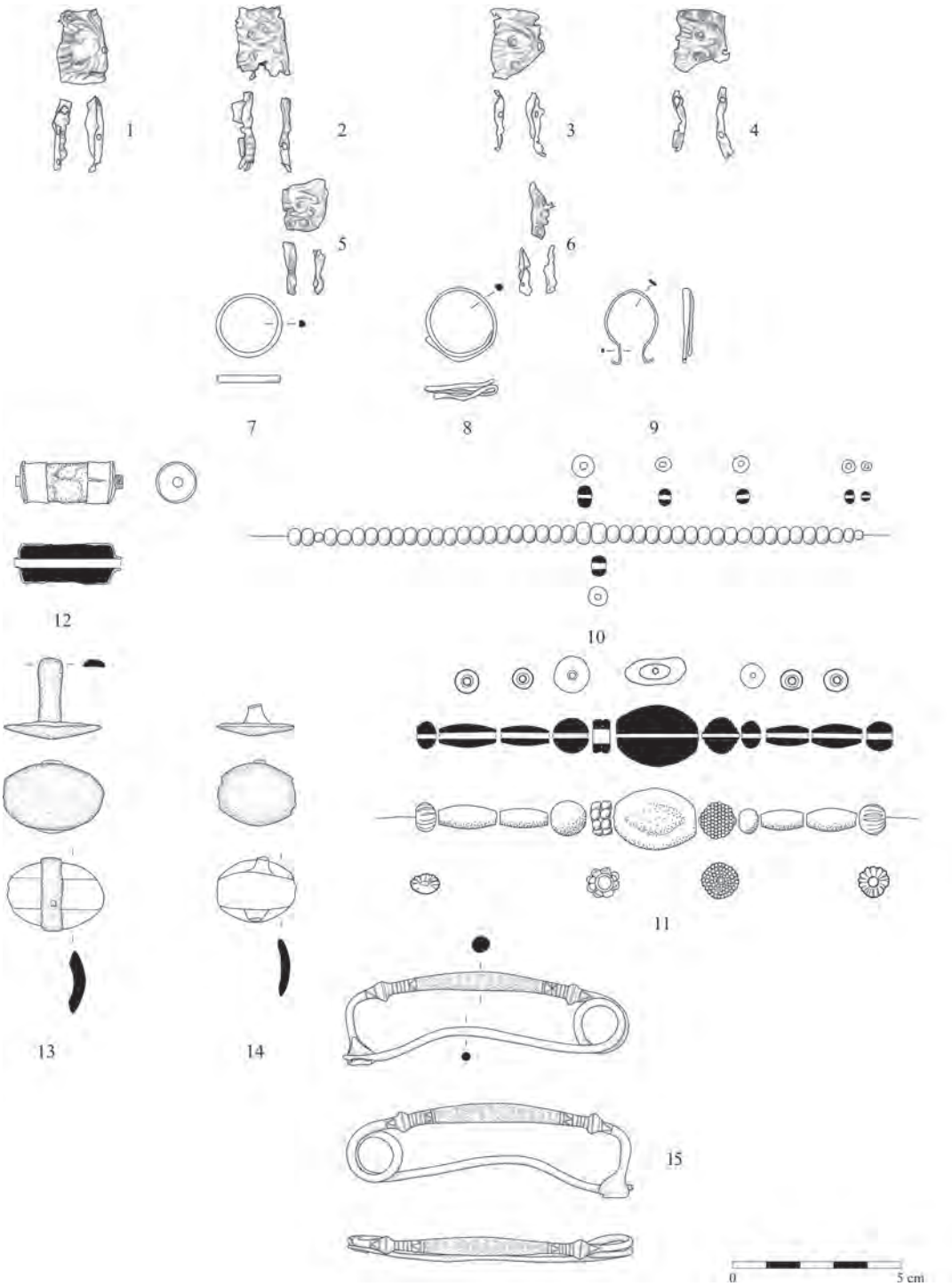


Fig. 20a Langada: LH IIIC Early/Middle (?) adornments in gold (nos. 1–10), gold, amethyst, carnelian, agate, and faience (no. 11), gold and blue stone (no. 12), silver or iron (nos. 13–14), and bronze (no. 15) from Tomb 10. Scale 1:2 (1–15: drawings M. Rossin, T. Ross)

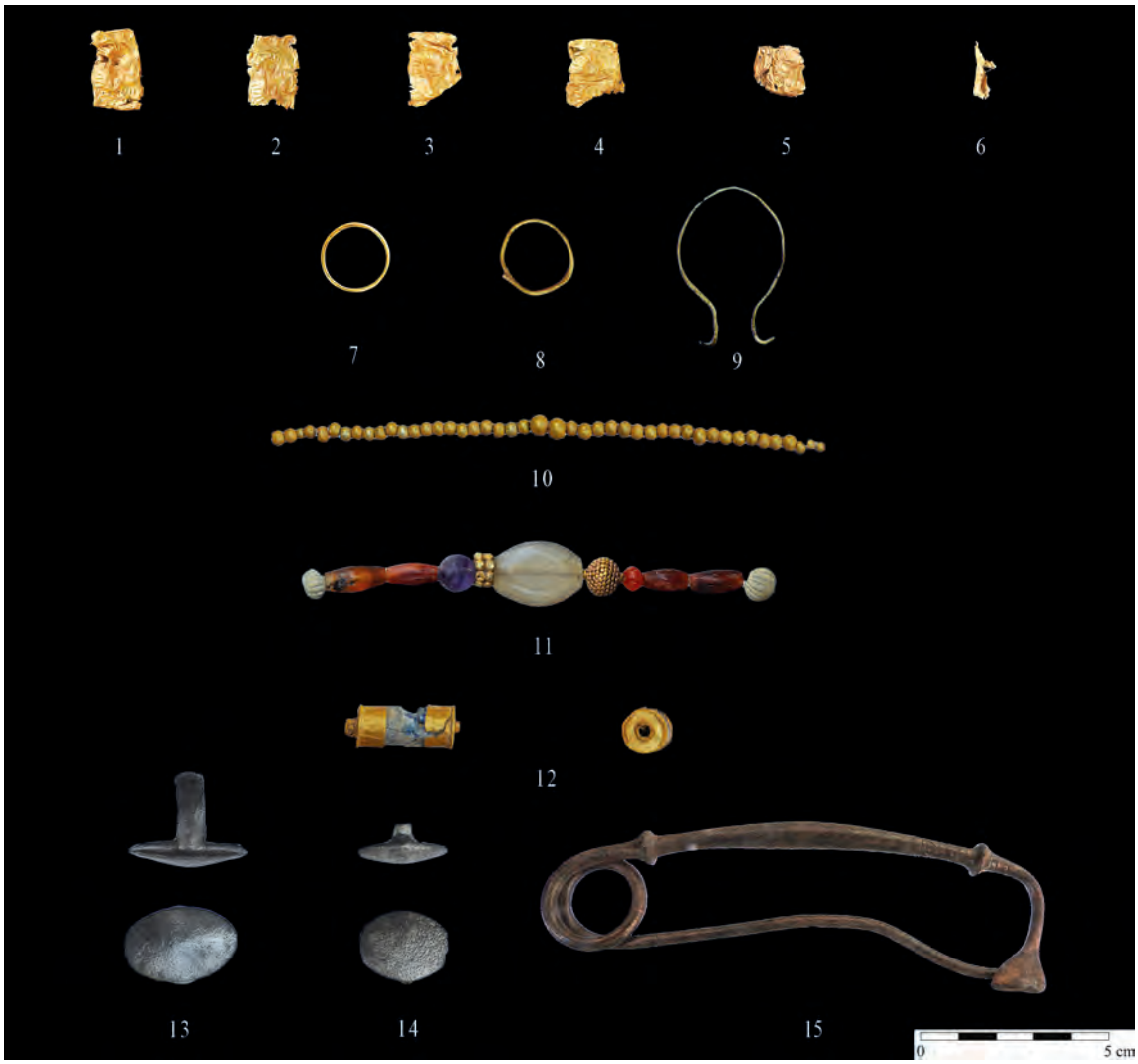


Fig. 20b See Fig. 20a (1–15: photo S. Vitale)

Due to SELAP's analysis of the stratigraphy and the complete or largely restorable vases from the 'Serraglio', Eleona, and Langada, the majority of these objects can now be dated with greater precision than they were in Morricone's publications (Tabs. 2–3, 8). As mentioned previously, the weapons from Langada Tomb 21 (Fig. 14) date to LH IIIB2 Late.[55] Langada Tomb 10 yielded pottery dating from LH IIIB2 Late to LH IIIC Middle, but the fibula from this tomb (Fig. 20.15) must be attributed typologically either to LH IIIC Early or LH IIIC Middle.[56] The vases from Langada Tomb 20 date to either LH IIIB1 or LH IIIC Middle, suggesting that the leaf-shaped fibula within this grave (Fig. 21.4) belongs to the later of these phases.[57] The razor from Langada Tomb 34 (Fig. 21.3) must belong to LH IIIC Middle, as do all the vases from this grave.[58] Finally, the Scoglio del Tonno knife and the undecorated spearhead with a fully cast socket recovered at the 'Serraglio' (Fig. 21.1–2) come from unstratified contexts. While the

55 Morricone 1967, 136–142, figs. 121–128.
56 Morricone 1967, 99–111, figs. 81–91.
57 Morricone 1967, 134–135, figs. 119–120. While LH IIIC Middle is the most accurate date based on contextual evidence, on stylistic grounds, a date within LH IIIC Early for the fibula from Langada Tomb 20 cannot be completely excluded (see Kilian 1985, 183, 194, fig. 8).
58 Morricone 1967, 163–168, figs. 166–171.

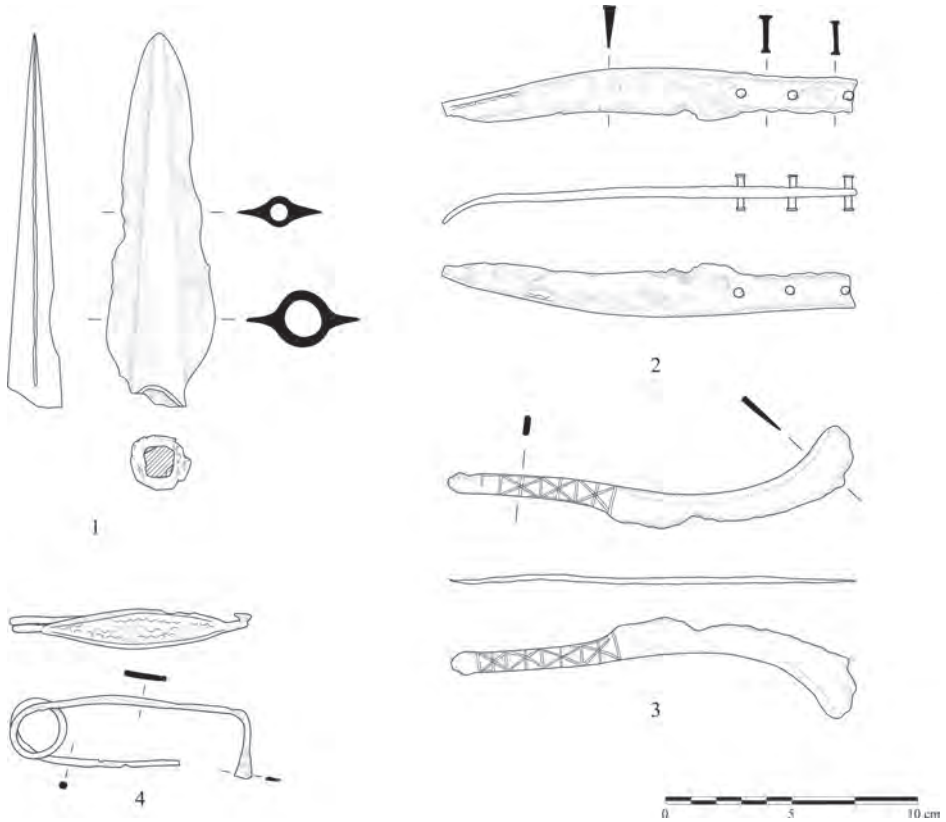


Fig. 21 The ‘Serraglio’ and Langada: Italian/European-type bronze objects. Scale 1:3
(1: S. Regio, R. Jung, T. Ross; 2–4: M. Rossin, T. Ross)

chronology of the former remains uncertain, the latter can be assigned typologically to the end of LH IIIB or to LH IIIC.

If the wider Dodecanesian area is considered, the spatial and chronological distribution of bronze objects of possible Italian/European origin shows interesting patterns. These finds were especially concentrated in funerary contexts. Kos seems to have had a prominent role in the region, as it includes 7 out of a total of 10 Italian/European-type bronzes from the Dodecanese. The remaining three bronzes[59] all come from Rhodes.

These data are particularly remarkable, if one considers the uneven number of excavated sites, especially cemeteries, on Kos compared to Rhodes and the disparate quantity of bronzes between the two islands. The total of known Mycenaean tombs on Kos (89 examples) is almost dwarfed by the Rhodian data set (166 examples).[60] Excluding adornments, LBA bronzes from Kos include 111 specimens (58 weapons and 53 weapons/tools or tools), while bronzes from Rhodes include 188 objects (80 weapons and 108 weapons/tools or tools).

The chronological distribution of the Italian/European-type objects from Rhodes has similarities and differences with the trends outlined previously for Kos. On Rhodes, two of the bronzes with Italian/European parallels date to LH IIIC, while one cannot be assigned to any specific

[59] The Italian/European-type bronzes from Rhodes consist of a ring-handled knife found in Tomb 15 from A. Maiuri’s excavations at Ialysos, an arched fibula with plastic knots from Tomb 4 at Aspropilia, and a knife with a slightly sinuous blade of uncertain provenance, currently stored in the Archaeological Museum of Florence (see Benzi 1992, 223; Benzi 2009b, 157–163, figs. 1–3; Karantzali 2001, 18–19, 21, 70–71, fig. 42, pl. 47a). The latter specimen closely resembles the Scoglio del Tonno knife from the ‘Serraglio’.

[60] The 89 Koan tombs include 83 graves from Eleona and Langada, the isolated chamber tombs from Ayia Paraskevi, Mesaria, Iraklis, and Kastello, as well as the Georgaras and Thalassinos tholoi. The 166 Rhodian tombs include 129 graves from Ialysos and 37 from other Mycenaean cemeteries on the island (see Vitale et al. 2017b, 249).

period, as it lacks contextual evidence.[61] This information implies that, within the Dodecanese, Italian/European-type bronze objects made their initial appearance on Kos during LH IIIB2 Late and that the uneven distribution of these imports on Kos and Rhodes increased during the phases between LH IIIB2 Late and LH IIIC Middle.

Discussion of the Data

The evidence presented above indicates that LH IIIB was a phase of expansion on Kos. The good quality of the structures of Phase III:4 implies the importance to the local community of a carefully built architectural environment. The distribution of the sites suggests that the north-eastern part of the island was densely occupied with two prominent sites, one at the 'Serraglio' and another at the Kastro at Palaio Pyli (Fig. 1). The 'Serraglio' and the associated cemeteries at Thalassinos, Eleona, and Langada show evidence for demographic growth and social stratification during LH IIIB. Demographic growth from LH IIIA2 is suggested by the increase in the number of the tombs and the vessels accompanying the deceased individuals at Eleona and Langada (Tabs. 2–4). Social stratification is implied by two elements. The first is the difference in tomb typology between the tholos at Thalassinos and the chamber tombs at Eleona and Langada, while the second is the status distinction between Eleona and Langada, with the latter including the wealthier burials in the community. At the same time, the spatial distribution of the graves at Langada (Fig. 11.1), as well as the existence of specific trends in tomb typology and shape, with a preference for chamber tombs with roughly circular plans, are indicative of a well defined social structure. On the opposite side of the Mesaria Plain, the importance of the Kastro at Palaio Pyli during LH IIIB is shown by the impressive defence wall, most likely implying the existence of a fortified stronghold (Figs. 9–10).

The LH IIIB to LH IIIC transition on northeast Kos was typified by potential signs of social uncertainty and upheaval. At Eleona and Langada, during LH IIIB2 Late, social distinction was expressed through the display of weapons (Fig. 14–15). At the end of the same phase, the 'Serraglio' was affected by a fire destruction event (Fig. 7). Slightly later, during LH IIIC Early and/or LH IIIC Middle, Sea Peoples-like characters were depicted on four local kraters (Fig. 16).

During LH IIIC Early, the number of sites attested on northeast Kos decreased from the previous phase. This fact suggests that the population may have abandoned smaller settlements and concentrated at the 'Serraglio' (Fig. 1), where the unimpressive quality of the structures of Phase III:5 indicates a decrease in the importance to the local community of a carefully built architectural environment. While status differentiation between Eleona and Langada continues, there is evidence for a more fluid social structure. This is shown by the less organised spatial arrangement of the tombs at Langada (Fig. 11.2), the increased variability in the shape of the chamber tombs, and the growth in the number of less formalised burial types, such as pit graves. In addition, the tholos tomb at Thalassinos was no longer used during LH IIIC Early.

These possible signs of social change by no means implied an impoverishment of northeast Kos. Two elements testify to the wealth and vivacity of the Koan community during LH IIIC Early. The first one is an increase in the quantity and quality of the jewellery (Tabs. 5, 7; Figs. 18–20). The second is the expansion in the diversity of ceramic and non-ceramic imports (Tabs. 4–5, 7; Fig. 17–20), which may have included the northeast Peloponnese, the Baltic region, Italy/Europe, the Near East, Cyprus, and Egypt, thus suggesting a more varied pattern of contacts as compared to LH IIIB.

Besides elements of change, there is also evidence for continuity in the material culture. The LH IIIB to LH IIIC transition on Kos was smooth in terms of local ceramic manufacturing hab-

[61] The ring-handled knife found in Tomb 15 from Ialysos and the arched fibula from Tomb 4 at Aspropilia date to LH IIIC Early-Middle and LH IIIC Middle-Late respectively. The knife stored in the Archaeological Museum of Florence cannot be dated precisely (Benzi 2009b, 157–163).

its.[62] Similarly, despite the acquisition of a more diverse array of imported jewellery during LH IIIC Early, the repertoire of the adornments from Eleona and Langada preserved an overall Mycenaean character.

The Italian/European-type bronze objects discovered on Kos (Figs. 14, 20.15, 21) and in the wider Dodecanesian area raise two significant questions. The first one concerns the reason why these items appeared during the phases from LH IIIB2 Late to LH IIIC Middle (Tab. 8). A possible answer is that the peak in the circulation of Italian/European-type objects in the southeast Aegean may relate to piracy, a phenomenon that likely grew during the troubled last decades of the 13th century BCE with the collapse of the Mycenaean palaces.[63] In addition to the previously mentioned signs of social upheaval on Kos at the LH IIIB to LH IIIC Early transition, other data indicate political tension in the southeast Aegean waters during LH IIIB. In the mid-13th-century Tawagalawa letter, a Hittite king, presumably Hattusili III, addressed the king of Ahhiyawa complaining about the Hittite renegade Piyamaradu, who repeatedly raided the western frontier of the Hittite empire before fleeing back to safety in the Ahhiyawan territory.[64] Eventually, tension along the western Anatolian coast may have culminated in the destruction of Miletus at the LH IIIB to LH IIIC Early transition.[65]

	LH IIIB2 Late	LH IIIB2 Late – LH IIIC Middle	LH IIIC Early–Middle	LH IIIC Middle	Undatable	Total
Scoglio del Tonno type knife (the 'Serraglio', stray find)	–	–	–	–	1	**1**
Spearhead with a fully cast socket (the 'Serraglio', stray find)	–	1	–	–	–	**1**
Violin bow fibula (Langada, Tomb 10)	–	–	1	–	–	**1**
Naue II sword (Langada, Tomb 21)	1	–	–	–	–	**1**
Spearhead with a fully cast socket (Langada, Tomb 21)	1	–	–	–	–	**1**
Violin bow fibula, leaf-shaped bow (Langada, Tomb 20)	–	–	–	1	–	**1**
Razor with incised handle decoration (Langada, Tomb 34)	–	–	–	1	–	**1**
Total	**2**	**1**	**1**	**2**	**1**	**7**

Tab. 8 Chronological distribution of Italian/European-type bronzes from the 'Serraglio', Eleona, and Langada

Based on these data, piracy may provide a good explanation to address the increased presence of Italian/European-type objects on Kos from LH IIIB2 Late to LH IIIC Middle. Considering the iconography of the characters depicted on locally produced LH IIIC Early and/or Middle kraters from the 'Serraglio' (Fig. 16), it seems probable for pirates in the southeast Aegean to have been connected to the raids in the region by the so-called Sea Peoples.[66]

The second question raised by the Italian/European-type bronze objects found in the Dodecanese concerns the prominent role of Kos, which is demonstrated by the quantitative distribution of these items. Considering the chronological placement of the finds, with a significant peak

62 For Koan LBA manufacturing practices, see Vitale 2017; Vitale – Morrison 2017.
63 Jung 2009.
64 Beckman et al. 2011, 101–122.
65 Mountjoy 2004.
66 Mountjoy 2005; Jung 2009; Vitale 2012a, 1236; Vitale 2012b, 413–414, pl. 95f–i.

between the end of LH IIIB and LH IIIC Middle, the answer to this question may lay in the different trajectories followed by Kos and Rhodes in the 13th century BCE. In contrast to Koan wealth and expansion, the major settlements and trading outposts in northwestern Rhodes, as well as the nearby cemeteries, appear either to have been abandoned or in substantial decline during LH IIIB.[67] Rhodes witnessed a revival in the Post-palatial period, especially at Ialysos, as indicated by the rich finds from Tombs 20 and 61.[68] However, it is likely that once the Italian/European contacts with Kos increased at the end of the 13th century BCE, the pattern continued naturally into the 12th century. As a result, Rhodes may have been more marginally involved in Dodecanesian connections with Italy/Europe during LH IIIC, despite its rich revival at that time.

Final Statements

Following the brief discussion of the data provided above, three final statements can be made concerning Koan socio-political trajectories in the wider context of the eastern Mediterranean from the beginning of the 13th to the middle of the 12th century BCE. First, considering the wealth of the island during LH IIIB, it is likely that the importance of Kos within this phase may have grown at the expense of Rhodes. This fact suggests that, during LH IIIB, Kos may have had a prominent political role in the southeast Aegean, an area which was most likely Ahhiyawan territory at that time.[69]

Second, Kos was affected by the crisis that marked the transition between the 13th and the 12th century BCE not only within the Aegean area, but, more generally, all over the eastern Mediterranean. This fact is demonstrated by the final destruction of the settlement of Phase III:4b at the 'Serraglio' during LH IIIB2 Late and by the emphasis placed on weapons in the offerings accompanying the deceased individuals buried in Tombs 21 and 46 at Langada, which also date to LH IIIB2 Late.[70]

Third, despite the upheavals that occurred at the end of LH IIIB, the Koan inhabitants were able to face the crisis and profit from the opportunities created by the more fluid 'international' socio-political scenario after the fall of the Mycenaean palaces. This fact is demonstrated by the degree of wealth of LH IIIC Early burials at Eleona and Langada (Tabs. 6–8). Such a prompt reaction may have been one of the key factors that led Kos to play a major role in the flourishing of the so-called East Aegean Koine during LH IIIC Middle.[71]

Acknowledgements: This paper summarises some of the most important results of SELAP's 2009 to 2019 study seasons and could not have been written without the insights and suggestions provided by the colleagues that have worked on Kos along with the writer during the last 11 years. The writer is particularly indebted to Nicholas G. Blackwell (study of bronze tools), Calla McNamee (landscape and spatial analysis), Jerolyn E. Morrison (macroscopic fabric analysis), Ioannis Iliopoulos (petrographer), and Kalliopi-Sofia Passa (petrographer). He is also very grateful to Mario Benzi, Elisabetta Borgna, Maria Chalkiti, Giampaolo Graziadio, Reinhard Jung, Toula Marketou, Jeremy B. Rutter, and Elpida Skerlou for their support during the Koan study seasons and/or their constructive comments on earlier versions of this manuscript. A final thanks goes to Teresa Hancock Vitale for improving the English text. SELAP's 2009 to 2019 seasons were made possible through generous grants from the Ministry of Education, Lifelong Learning and Religious Affairs of the Hellenic Republic, the Institute for Aegean Prehistory (INSTAP), The Shelby White – Leon Levy Program for Archaeological Publications, the University of Calabria, The Mediterranean Archaeological Trust, and the Rust Family Foundation. The writer is also very grateful to the former and current directors of the Italian Archaeological School at Athens, E. Greco and E. Papi, for their unfailing logistical and scientific support throughout these years.

67 Mee 1982, 87; Benzi 1992, 214–216; Vitale 2012a, 1246; Vitale 2012b, 413.

68 Benzi 1992, 222, 271–275, 361–365.

69 See Vitale 2012a, 1246; Vitale 2012b, 413; Vitale 2016a, 87. On the Ahhiyawa question, see Re 1986; Re 1994; Mountjoy 1998; Niemeier 1999; Benzi 2002; Hope Simpson 2003; Benzi 2009a; Fischer 2010; Hawkins 2015 (all with previous bibliography).

70 Vitale 2012a, 1238, figs. 2, 5–6; Vitale 2012b, 410–412, pls. 94a, d–e; 95a–e; Vitale 2016b, 260–261, 263, pls. 2a–b, 3; Vitale et al. 2017b.

71 Mountjoy 1999, 45, 50, 1106–1125, figs. 452–461.

Bibliography

Beckman et al. 2011
G. Beckman – T. Bryce – E. Cline, The Ahhiyawa Texts, Writings from the Ancient World 28 (Atlanta 2011).

Benzi 1992
M. Benzi, Rodi e la civiltà micenea, Incunabula Graeca 94 (Rome 1992).

Benzi 2002
M. Benzi, Anatolia and the eastern Aegean at the time of the Trojan war, in: F. Montanari (ed.), Omero tremila anni dopo. Atti del congresso di Genova 6–8 luglio 2000, Storia e Letteratura Raccolta di Studi e Testi 210 (Rome 2002) 343–405.

Benzi 2005
M. Benzi, A group of Mycenaean vases and bronzes from Pyli, Kos, in: B. Adembri (ed), Αείμνηστος. Miscellanea di studi per Mauro Cristofani (Florence 2005) 15–24.

Benzi 2009a
M. Benzi, La guerre fantôme. La guerre de Troie dans une perspective archéologique, in: M. Fartzoff – M. Faudot – E. Geny – M.-R. Guelfucci (eds.), Reconstruire Troie. Permanence et renaissances d'une cité emblématique (Ville de Besançon 2009) 445–468.

Benzi 2009b
M. Benzi, Dodecanese – Italy – Europe. Rediscovering some long known objects, Annuario della Scuola archeologica di Atene e delle missioni italiane in Oriente 87, 2009, 157–168.

Field 1984
D. Field, Mycenaean Fortifications on the Mainland of Greece (PhD Diss., University of Cambridge, Cambridge 1984).

Fischer 2010
R. Fischer, Die Ahhijawa-Frage. Mit einer kommentierten Bibliographie, Dresdner Beiträge zur Hethitologie 26 (Wiesbaden 2010).

Furumark 1941
A. Furumark, Mycenaean Pottery. Vol. 2, Chronology, Skrifter utgivna av Svenska Institutet i Athen 21 (Stockholm 1941).

Gregoriadou 2001
D. Γρηγοριάδου, 3ο χλμ. Επαρχιακής οδού Κω-υπαίθρου, ΚΜ 49 γαιών Κω-εξοχής (οικόπεδο Δ. Γεωργαρά), Αρχαιολογικόν Δελτίον 51Β′2/1996, 2001, 690–692.

Hawkins 2015
J. D. Hawkins, The political geography of Arzawa (western Anatolia), in: Stampolidis et al. 2015, 15–31.

Hope Simpson 1965
R. Hope Simpson, A Gazetteer and Atlas of Mycenaean Sites, Bulletin of the Institute of Classical Studies of the University of London, Suppl. 16 (London 1981).

Hope Simpson 1981
R. Hope Simpson, Mycenaean Greece (Park Ridge 1981).

Hope Simpson 2003
R. Hope Simpson, The Dodecanese and the Ahhiyawa question, The Annual of the British School at Athens 98, 2003, 203–237.

Hope Simpson – Lazenby 1970
R. Hope Simpson – J. F. Lazenby, Notes from the Dodecanese II, The Annual of the British School at Athens 65, 1970, 47–76.

Jung 2008
R. Jung, Die mykenische Keramik von Tell Kazel (Syrien), Damaszener Mitteilungen 15/2006, 2008, 147–218.

Jung 2009
R. Jung, Pirates of the Aegean. Italy – the East Aegean – Cyprus at the end of the second millennium BC., in: V. Karageorghis – O. Kouka (eds.), Cyprus and the East Aegean. Intercultural Contacts from 3000 to 500 BC. An International Symposium Held at Pythagoreion, Samos, October 17th–18th 2008 (Nicosia 2009) 72–93.

Jung – Mehofer 2009
R. Jung – M. Mehofer, A sword of Naue II type from Ugarit and the historical significance of Italian-type weaponry in the Eastern Mediterranean, Aegean Archaeology 8/2005–2006, 2009, 111–135.

Karantzali 2001
E. Karantzali, The Mycenaean Cemetery at Pylona on Rhodes, British Archaeological Reports International Series 988 (Oxford 2001).

Kilian 1985
K. Kilian, Violinbogenfibeln und Blattbügelfibeln des griechischen Festlandes aus mykenischer Zeit, Prähistorische Zeitschrift 60, 1985, 145–203.

Kilian-Dirlmeier 1993
I. Kilian-Dirlmeier, Die Schwerter in Griechenland (außerhalb der Peloponnes), Bulgarien und Albanien, Prähistorische Bronzefunde IV, 12(Stuttgart 1993).

Konstantinidi 2001
E. M. Konstantinidi, Jewellery Revealed in the Burial Contexts of the Greek Bronze Age, British Archaeological Reports International Series 912 (Oxford 2001).

Laurenzi 1936
L. Laurenzi, Attività del servizio archeologico nelle isole italiane dell'Egeo nel biennio 1934–1935, Bollettino d'arte 30, 1936, 129–148.

Marketou 1990a
T. Marketou, Santorini Tephra from Rhodes and Kos. Some chronological remarks based on the stratigraphy, in: D. A. Hardy – A. C. Renfrew – J. A. Sakellarakis – P. M. Warren (eds.), Thera and the Aegean World III. Proceedings of the 3rd International Scientific Congress, Santorini, Greece, 3–9 September 1989 (London 1990) 100–113.

Marketou 1990b
T. Marketou, Asomatos and Serraglio. Early Bronze Age production and interconnections, Hydra 7, 1990, 40–49.

Marketou 2004
Τ. Μαρκέτου, Η Πρώιμη Εποχή του Χαλκού στην Κω, in: Α. Γιαννικουρή – Η. Ζερβουδάκη – Η. Κόλλιας, – Ι. Παπαχριστοδούλου (eds.), Χάρις Χαίρε. Μελέτες στη μνήμη της Χάρης Κάντζια (Athens 2004) 17–37.

Marketou 2010
T. Marketou, Dodecanese, in: E. H. Cline (ed.), The Oxford Handbook of the Bronze Age Aegean (ca. 3000–1000 BC) (Oxford 2010) 762–774.

Marketou in press
Τ. Μαρκέτου, Θολωτοί τάφοι στην περιφέρεια του μυκηναϊκού κόσμου. Η περίπτωση του τάφου της Μεσαριάς στο νησί της Κω, in: E. Karantzali – P. Kounouklas (eds.), Proceedings of the 3rd International Colloquium 'The Periphery of the Mycenaean World. Recent discoveries and research results', Lamia (Lamia, in press).

Matarese et al. 2015
I. Matarese – A. Crispino – R. Jung – M. C. Martinelli – P. Pallante – M. Pacciarelli, Vaghi e pendenti litici dell'età del bronzo dalla Sicilia e dalle Eolie, Archaeologia Austriaca 99, 2015, 111–153.

Mee 1982
C. B. Mee, Rhodes in the Bronze Age (Warminster 1982).

McNamee – Vitale 2016
C. McNamee – S. Vitale, Burial landscape, spatial organization, and societal changes at the Mycenaean cemeteries of Eleona and Langada on Kos, in: Archaeological Institute of America. 117th Annual Meeting. Abstracts, January 7–10, 2016, San Francisco, California (Boston 2016) 196.

McNamee – Vitale 2020
C. McNamee – S. Vitale, Langada revisited. Construction practices, space, and sociocultural identity in the Koan burial arena during the Mycenaean Palatial and Post-palatial periods, in: J. Murphy (ed.), Death in Late Bronze Age Greece. Variations on a Theme (New York 2020) 241–247.

Morricone 1950
L. Morricone, Scavi e ricerche a Coo (1935–1943). Relazione preliminare, Bollettino d'arte 35, 1950, 316–331.

Morricone 1967
L. Morricone, Eleona e Langada. Sepolcreti della tarda Età del Bronzo a Coo, Annuario della Scuola archeologica di Atene e delle Missioni italiane in Oriente 43–44/1965–1966, 1967, 5–311.

Morricone 1975
L. Morricone, Coo. Scavi e scoperte nel 'Serraglio' e in località minori (1935–1943), Annuario della Scuola archeologica di Atene e delle Missioni italiane in Oriente 50–51/1972–1973, 1975, 139–396.

Morricone 1978
L. Morricone, Sepolture della prima Età del Ferro a Coo, Annuario della Scuola archeologica di Atene e delle Missioni italiane in Oriente 56, 1978, 9–427.

Mountjoy 1998
P. A. Mountjoy, The east Aegean – west Anatolian interface in the Late Bronze Age. Mycenaeans and the kingdom of Ahhiyawa, Anatolian Studies 48, 1998, 33–67.

Mountjoy 1999
P. A. Mountjoy, Regional Mycenaean Decorated Pottery (Rahden/Westf. 1999).

Mountjoy 2004
P. A. Mountjoy, Miletos. A note, The Annual of the British School at Athens 99, 2004, 189–200.

Mountjoy 2005
P. A. Mountjoy, Mycenaean connections with the Near East in LH IIIC. Ships and Sea People, in: R. Laffineur – E. Greco (eds.), Emporia. Aegeans in the Central and Eastern Mediterranean. Proceedings of the 10th International Aegean Conference / 10e Rencontre Égéenne Internationale. Athens, Italian School of Archaeology, 14–18 April 2004, Aegaeum 25 (Liège, Austin 2005) 423–427.

Niemeier 1999
W.-D. Niemeier, Mycenaeans and Hittites in war in western Asia Minor, in: R. Laffineur (ed.), Polemos. Le contexte guerrier en Égée à l'Âge du Bronze, Aegaeum 19 (Liège, Austin 1999) 141–155.

Papachristodoulou 1979
Ι. Παπαχριστοδούλου, Κως (Ύπαιθρος) Μεσαριά – Καστέλλες, Αρχαιολογικόν Δελτίον 34, 1979, 457–459.

Papazoglou 1981
Λ. Παπάζογλου, Μυκηναϊκός θαλαμωτός τάφος στο Κάστελλο Κω, Athens Annals of Archaeology 14, 1981, 62–75.

Re 1986
L. Re, Testimonianze micenee in Anatolia, in: M. Marazzi (ed.), L'Anatolia ittita. Repertori archeologici ed epigrafici (Roma 1986) 142–194.

Re 1994
L. Re, Le importazioni micenee in Anatolia, in: M. Marazzi (ed.), La Società Micenea (Roma 1994) 444–457.

Rutter 1977
J. B. Rutter, Late Helladic IIIC pottery and some historical implications, in: E. N. Davis (ed.), Symposium on the Dark Ages in Greece. The Archaeological Institute of America, New York Society and Hunter College, City University of New York, April 30, 1977 (New York 1977) 1–20.

Rutter 1978
J. B. Rutter, A plea for the abandonment of the term 'Submycenaean', Temple University Aegean Symposium 3, 1978, 58–65.

Rutter – Van de Moortel 2006
J. B. Rutter – A. Van de Moortel, Minoan pottery from the southern Area, in: J. W. Shaw – M. C. Shaw (eds.), Kommos V. The Monumental Buildings at Kommos (Princeton and Oxford 2006) 261–715.

Skerlou 1998
Ε. Σκέρλου, Ηρακλής. Αγροτικός δρόμος (σε επαφή με τη δυτική πλευρά του οικοπέδου Γ. Ζορντού, ΚΜ 836), Αρχαιολογικόν Δελτίον 48Β′2/1993, 1998, 553.

Skerlou 2001
Ε. Σκέρλου, Περίχωρα της πόλης Κω, Αρχαιολογικόν Δελτίον 51 Β′2/1996, 2001, 689–692.

Skerlou 2003
Ε. Σκέρλου, Κως. Δυτικός τομέας της πόλης, Αρχαιολογικόν Δελτίον 52 Β′3/1997, 2003, 1110–1111.

Stampolidis et al. 2015
N. Stampolidis – M. Çiğdem – K. Kopanias (eds.), Nostoi. Indigenous Culture, Migration and Integration in the Aegean Islands and Western Anatolia During the Late Bronze and Early Iron Age (Istanbul 2015).

Van de Moortel 2001
A. Van de Moortel, The area around the kiln and the pottery from the kiln and the kiln dump, in: J. W. Shaw – A. Van de Moortel – P. M. Day – V. Kilikoglou (eds.), A LM IA Ceramic Kiln in South-Central Crete. Function and Pottery Production, Hesperia Supplement 30 (Princeton 2001) 25–110.

Vitale 2006
S. Vitale, L'insediamento di 'Serraglio' durante il Tardo Bronzo. Riesame dei principali contesti portati alla luce da Luigi Morricone tra il 1935 ed il 1946, Annuario della Scuola archeologica di Atene e delle Missioni italiane in Oriente 83, 2006, 71–94.

Vitale 2007
S. Vitale, The Early Late Bronze Age pottery from Italian excavations at 'Serraglio' on Kos. A reassessment of the complete or almost complete local vases with no preserved context, Αγωγη. Atti della Scuola di Specializzazione in Archeologia 3, 2007, 43–63.

Vitale 2012a
S. Vitale, The Serraglio, Eleona, and Langada Archaeological Project (SELAP). Report on the results of the 2009 and 2010 study seasons, Annuario della Scuola archeologica di Atene e delle Missioni italiane in Oriente 87, 2012, 1233–1252.

Vitale 2012b
S. Vitale, Dressing up the dead. The significance of Late Helladic IIIB adornments from Eleona and Langada at Kos, in: M.-L. Nosch – R. Laffineur (eds.), Kosmos. Jewellery, Adornment and Textiles in the Aegean Bronze Age. Proceedings of the 13th International Aegean Conference / 13e Rencontre égéenne internationale, University of Copenhagen, Danish National Research Foundation's Centre for Textile Research, 21–26 April 2010, Aegaeum 33 (Liège, Austin 2012) 407–415.

Vitale 2013
S. Vitale, The Asklupis reconsidered. A preliminary report on the chronology and burial practices of an Early Bronze Age 2 cemetery on Kos, Aegean Archaeology 10, 2013, 47–63.

Vitale 2016a
S. Vitale, Cultural entanglements on Kos during the Late Bronze Age. A comparative analysis of 'Minoanisation' and 'Mycenaeanisation' at the 'Serraglio', Eleona, and Langada, in: E. Gorogianni – P. Pavúk – L. Girella (eds.), Beyond Thalassocracies. Understanding Processes of Minoanisation and Mycenaeanisation in the Aegean (Oxford, Philadelphia 2016) 75–93.

Vitale 2016b
S. Vitale, Oggetti d'ornamento, gioielli ed altri reperti mobili dalle necropoli micenee di Eleona e Langada a Kos, in: F. Longo – R. Di Cesare – S. Privitera (eds.), Dromoi. Studi sul mondo antico offerti ad Emanule Greco dagli allievi della Scuola Archeologica Italiana di Atene (Salerno 2016) 257–275.

Vitale 2017
S. Vitale, The Koan ceramic assemblage during the Late Bronze Age. Classification, chronology, typology, and significance, in: Π. Τριανταφυλλίδης (ed.), Το Αρχαιολογικό Έργο στα Νησιά του Αιγαίου. Διεθνές Επιστημονικό Συνέδριο, Ρόδος, 27 Νοεμβρίου – 1 Δεκεμβρίου 2013 (Mytilene 2017) 151–174.

Vitale 2018
S. Vitale, Le ceramiche della 'tradizione mista' a Kos durante il Tardo Bronzo IA (Oxford 2018).

Vitale 2019
S. Vitale, Some unpublished small finds from the Asklupis on Kos, Αγωγη. Atti della Scuola di Specializzazione in Beni Archeologici 10–11, 2019, 7–23.

Vitale – Hancock Vitale 2010
S. Vitale – T. Hancock Vitale, The Minoan and Mycenaean expansion in the Dodecanese. The evidence from the 'Serraglio' on Kos and its theoretical implications, in: K. Dziegielewski – M. S. Przybyła – A. Gawlik (eds.), Migration in Bronze and Early Iron Age Europe, Prace Archeologiczne Studies 63 (Krakow 2010) 63–85.

Vitale – Hancock Vitale 2013
S. Vitale – T. Hancock Vitale, The Minoans in the southeastern Aegean? The evidence from the 'Serraglio' on Kos and its significance, in: M. E. Alberti – S. Sabatini (eds.), Exchange Networks and Local Transformations. Interactions and Local Changes in Europe and the Mediterranean between Bronze and Iron Age (Oxford 2013) 44–59.

Vitale – Trecarichi 2015
S. Vitale – A. Trecarichi, The Koan tradition during the Mycenaean age. A contextual and functional analysis of local ceramics from the "Serraglio", Eleona, and Langada, in: Stampolidis et al. 2015, 311–335.

Vitale – Morrison 2017
S. Vitale – J. E. Morrison, Food and cultural identity on Kos during the Bronze Age. A typological, technological, and macroscopic fabric analysis of the storage and cooking pottery assemblage, in: J. A. Hruby – D. A. Trusty (eds.), From Cooking Vessels to Cultural Practices in the Late Bronze Age Aegean (Oxford, Philadelphia 2017) 72–97.

Vitale – Morrison 2018
S. Vitale – J. E. Morrison, The Final Neolithic and Early Bronze Age pottery from the site of the Asklupis in the northeast Koan region, Annuario della Scuola archeologica di Atene e delle Missioni italiane in Oriente 95, 2018, 39–64.

Vitale – McNamee 2019
S. Vitale – C. McNamee, Ideological and narrative memory on Late Bronze Age Kos. From theory to case study, in: E. Borgna – I. Caloi – F. Carinci – R. Laffineur (eds.), Μνημη/Mneme. Past and Memory in the Aegean Bronze Age. Proceedings of the 17th International Aegean Conference, University of Udine, Department of Humanities and Cultural Heritage, Ca' Foscari University of Venice, Department of Humanities, 17–21 April 2018, Aegaeum 43 (Leuven, Liège 2019) 569–575.

Vitale et al. 2017a
S. Vitale – T. Marketou – C. McNamee – E. Ballan – N. G. Blackwell – I. Iliopoulos – C. Mantello – J. E. Morrison – K. Moulo – I. Moutafi – K.-S. Passa – E. Vika, Serraglio, Eleona, and Langada Archaeological Project (SELAP). Report on the results of the 2011 to 2015 study seasons, Annuario della Scuola archeologica di Atene e delle Missioni italiane in Oriente 94/2016, 2017, 225–285.

Vitale et al. 2017b
S. Vitale – N. Blackwell – C. McNamee, Kos, Italy, and Europe during the Mycenaean period. Evidence for a special connection, in: M. Fotiadis – R. Laffineur – Y. Lolos – A. Vlachopoulos (eds.), Έσπερος/Hesperos. The Aegean Seen from the West. Proceedings of the 16th International Aegaean Conference, University of Ioannina, Department of History and Archaeology, Unit of Archaeology and Art History, 18–21 May 2016, Aegaeum 41 (Leuven, Liège 2017) 243–252.

The Trapeza Cemetery near Aigion: its Western Connection in a Diachronic Perspective

Elisabetta Borgna[1]

Abstract: In this contribution some results from the recent fieldwork at the Mycenaean chamber tombs cemetery of the Trapeza of Aigion are presented; in particular the occupation of Tomb 1 is contextualised within a period ranging from the 15th to the 11th century BC. The re-use of the tomb in the Post-palatial period, after the critical date of 1200 BC, seems to have coincided with a time of expansion and cultural vitality of the small community of the Trapeza, most probably as a consequence of the increasing importance of the Corinthian Sea in the east–west-oriented relationships on a Mediterranean scale. The diachronic perspective adopted in this study permits us to focus on an intense Aegean–Adriatic interaction during the last phase of burial occupation in LH IIIC Late/SM or advanced Italian Final Bronze Age. The study of the pottery in its context reveals a phenomenon of convergence in the field of ritual practices and symbolic behaviours, implying social exchange and mobility of both ideas and people along the Adriatic and Ionian seas.

Keywords: Achaea, Mycenaean Post-palatial period, Final Bronze Age, chamber tombs, LH IIIC pottery, ritual practices, Adriatic connection, symbolic exchange

The Mycenaean Cemetery of Chadzi/Trapeza: Past and Present Research

Past Research

The funerary site of Chadzi/Trapeza has been a dot on the map of the sparse Mycenaean occupation of Eastern Achaea for a very long time (Fig. 1). The origin of the collection of archaeological materials coming from a few disturbed chamber tombs dates back to the early 20th century; at that time unsystematic investigations on the southwestern slope of the Trapeza hill, 7km inland from Aigion, provided the local museum with a substantial group of vessels and several small finds.[2] The pottery was later only partially published by P. Åström, A. Papadopoulos and P.A. Mountjoy,[3] and has recently been reconsidered in the framework of the new on-going research.[4] The surviving vessels date mainly to LH IIIA2; they are, however, well suited for representing a wider span of time, ranging from LH IIIA1 well into the Post-palatial period, though IIIC is curiously not well represented.

Unfortunately, the connection of the vessels to the Trapeza is rather elusive, as the artefacts discovered at this site were soon mixed with others from a nearby valley – specifically the site of Achouria/Achladies, some 5km to the east of the Trapeza – and no indication of provenance was recorded for any single object.[5] Though the evidence is therefore not completely reliable for testing the chronological and cultural dynamics of use of the Trapeza cemetery, on the basis of various criteria it nonetheless seems reasonable to state that most materials indeed come from

[1] Department of Humanities and Cultural Heritage, University of Udine, Palazzo Caiselli, Vicolo Florio 2, 33100 Udine, Italy; elisabetta.borgna@uniud.it.

[2] Kyparisses 1939; for the history of research see Papadopoulos 1979, 35; Giannopoulos 2008, 74–75; Licciardello 2012/2013; Borgna – Vordos 2016, 448 n. 6; Borgna – De Angeli 2020.

[3] Åström 1964, 89–110; Papadopoulos 1979, 218–219 nos. 831–864; Mountjoy 1999, 400.

[4] Licciardello 2012/2013.

[5] Papadopoulos 1979, 35–36; Mountjoy 1999, 400; Giannopoulos 2008, 74–75.

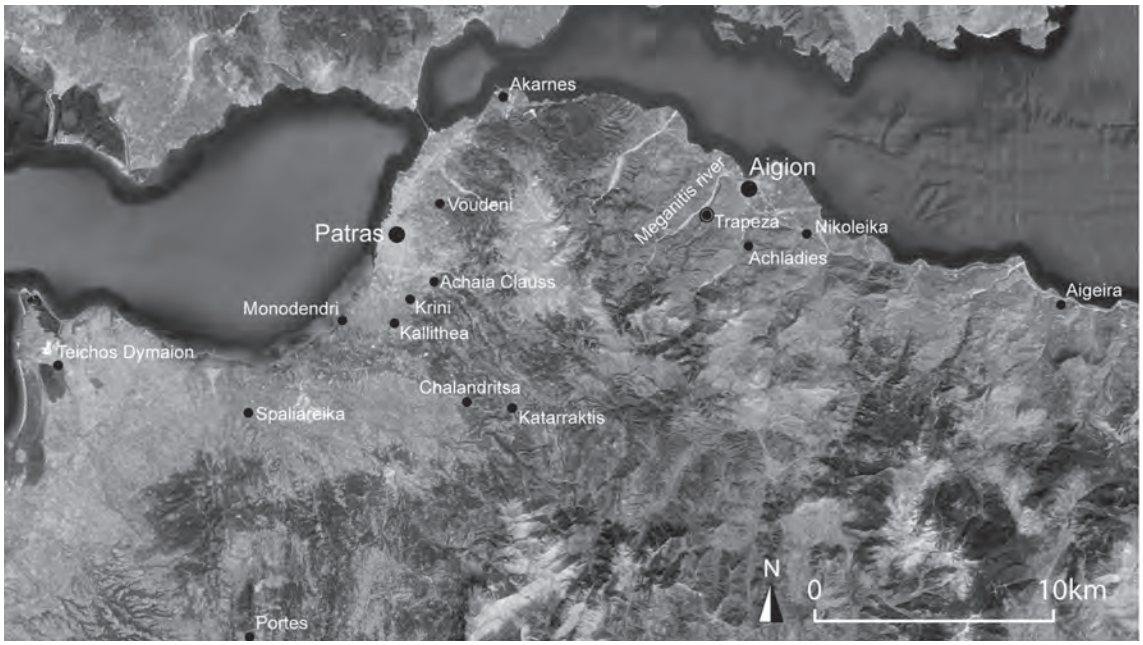


Fig. 1 Map of LH IIIC Achaea with main sites (elaborated from Google Earth)

this site, which, according to the results of the present research, was a seemingly wide cemetery serving a long-lasting community.[6]

Further clues that the hill was occupied for funerary purposes consisted in a few stray finds which, in the course of time, have been brought to the museum: a conical stirrup jar decorated with simple multiple stems (Fig. 2) – most probably dating early in LH IIIB based on the standards of the pottery workshops in the Argolid and with good parallels even in the Western Peloponnese, both in Achaea and in Elis[7] – seems to have been found in the very same area where the tombs were supposed to be located, though their position had been never recorded on a map. This evidence is all the more interesting as LH IIIB vessels are not abundant in the museum group and even less in the ceramic repertoire from current excavations (see below), which suggests a substantial increase in the circulation and deposition of pottery in the Post-palatial period. While pointing to a kind of gap in the occupation during LH IIIB, the evidence might therefore suggest that the size of the community living at the Trapeza site was possibly not uniform and constant, but might have fluctuated over time and certainly experienced some major discontinuities, probably consistent with a demographic shrinkage and even a possible temporary abandonment in the late Palatial period preceding a substantial Post-palatial reoccupation of the area.[8] We cannot exclude the possibility that a decrease in the late Palatial or IIIB occupation might have been connected to a process of centralisation and hierarchisation of the Achaean settlement pattern – a process attested in Western Achaea by the building of the Cyclopean walls around Teichos Dymaion sometime in the 13th century.[9]

Life at the Trapeza, however, went on without definitive gaps throughout the Late Bronze Age, starting at least LH IIIA1, possibly late in the 15th century BC.

6 Borgna – De Angeli 2019; Borgna – De Angeli 2020; Borgna – Vordos 2019.

7 See e.g. at Aigeira: Mountjoy 1999, 414–415, fig. 145.48; in Elis at Strephi: Mountjoy 1999, 386–387, fig. 134.60; cf. Nikolentzos 2011.

8 For comparable diachronic dynamics see, in the neighbouring regions, Nikolentzos 2011 (Elis); cf. Deger-Jalkotzy 2007, 129 for the cemetery of Elateia in Phocis (LH IIIB late–IIIC early); for alternative explanations see Moschos 2009a, 348, for Achaea; Murphy 2014, 215, for Messenia.

9 For Teichos Dymaion see: Giannopoulos 2008, 23–28; Moschos 2009a, 346; Kolonas 2009 with references to previous literature; Kolonas 2012.



Fig. 2 Conical stirrup jar, stray find from the area of the cemetery, in the Aigion Museum. Scale 1:3 (AM 885) (drawing: N. Papadopoulos)

In the main we consider it quite reasonable to infer that the dynamics of occupation of the Trapeza were strictly dependent on those recorded at Aigion: the main Mycenaean regional settlement during the Palatial period was located on the sea and possibly aimed at both control of the major routes connecting the coastal area with the inner Peloponnese and exploitation of the hinterland.[10] The Trapeza is located at the crossroads of strategic communication routes and is well provided with land and rural resources. As we shall see, even the increasing importance of the site during the Post-palatial period might somehow be connected – this time by contrast – with the Aigion population dynamics. This is particularly true if we accept that the more dense human occupation of Eastern Achaea in LH IIIC – including for instance the evidence of Nikoleika with its large cemetery –[11] as well as the shift towards life in the highlands – as attested at Aigeira –[12] may be a consequence of either a phenomenon of political decentralisation or decline and deterioration of living conditions on the coastal plain, without ruling out the arrival of new groups.

On-going Research

These general considerations are strongly supported by the results of the on-going field project at the Trapeza, where Greek excavations have been exploring the rich archaeological landscape centred on a monumental Greek town, possibly the ancient Rhypes, since 2007.[13] Since 2010, within the framework of a project aiming at the investigation of the prehistoric landscape, I have had the opportunity to look for the lost Mycenaean funerary site, which has finally been identified on a knoll at the foot of the Trapeza, on its southwestern slope (Fig. 3). Standard chamber tombs excavated into the slope of the hill – and now mostly filled by the sandy deposits originating from their collapsed vaults – were arranged possibly according to a radial layout around the top of the small hill.[14] They were ordered at different levels, certainly implying several rows and possibly discrete clusters (Fig. 4).[15] We may imagine a terraced slope with each terrace giving access to a number of tombs, facing both the small valley overlooked by the settlement discovered during

10 Papadopoulos 1976; Papadopoulos 1979, 34–35; Mountjoy 1999, 399–400; Giannopoulos 2008, 75–81; Papazoglou-Maniouodaki 2010; Papazoglou-Maniouodaki 2015; but see also Arena 2015; Borgna – De Angeli 2020.

11 Petropoulos 2007; Giannopoulos 2008, 81–83.

12 Deger-Jalkotzy 2003; Alram Stern – Deger-Jalkotzy 2006; Gauß et al. 2013.

13 Excavations are directed by Andreas Vordos and focus on the Greek temple as well as on the remains of the archaic town; see Vordos 2002; Vordos 2006; Borgna – Vordos 2016; Borgna et al. 2019; Borgna – Vordos 2019; Vordos 2019.

14 For a preliminary analysis of the tombs see in particular Borgna – De Angeli 2019; Borgna – De Angeli 2020; Borgna – Vordos 2019; cf. De Angeli 2015.

15 See the irregular layout of several Achaean cemeteries implying grouping of few tombs: Papadopoulos 1979; Giannopoulos 2008; cf. Cavanagh – Mee 1998, 61–62.



Fig. 3 View of the Trapeza with the site of the cemetery from south-west (photo: E. Borgna)

fieldwork on the opposite side of the Trapeza to the south[16] and, westwards, to the large valley of the River Meganitis.

The identification of six chamber tombs[17] and the complete excavation of two of them account for our work in the 2014 annual campaign, which was carried out by systematically following principles of stratigraphic excavation. The aim of reconstructing the life-cycle of each funerary structure has been pursued by both recognising the detailed sequence of past actions traceable in the stratigraphic record and exploring the patterns of use and re-use of material culture in the funerary contexts: the location, mode of disposal and traces of use of the objects have been considered in order to read the palimpsest of the social and cult practices performed in, at and near the tombs, including events other than single burials.[18]

The Trapeza Site in the Framework of the East–West-oriented Long-distance Mediterranean Relationships

The Complex Life of a Mycenaean Tomb

Among the many possible directions of research, the data of the Trapeza offer a very useful dynamic perspective on the role of Eastern Achaea in the network of the east–west-oriented relation-

16 Borgna – Vordos 2016; it is fair to say, however, that the preliminary results of the first campaign of fieldwork in 2015, while confirming the existence of a large MH settlement, so far offer only scanty hints of Mycenaean occupation: Borgna et al. 2019.

17 To the five tombs identified in the 2012–14 campaigns (Borgna – De Angeli 2020) it is now possible to add further structures which have been localised and partially excavated in the campaigns 2015–2019 and raise the whole number of tombs up to 11.

18 Borgna – De Angeli 2019.

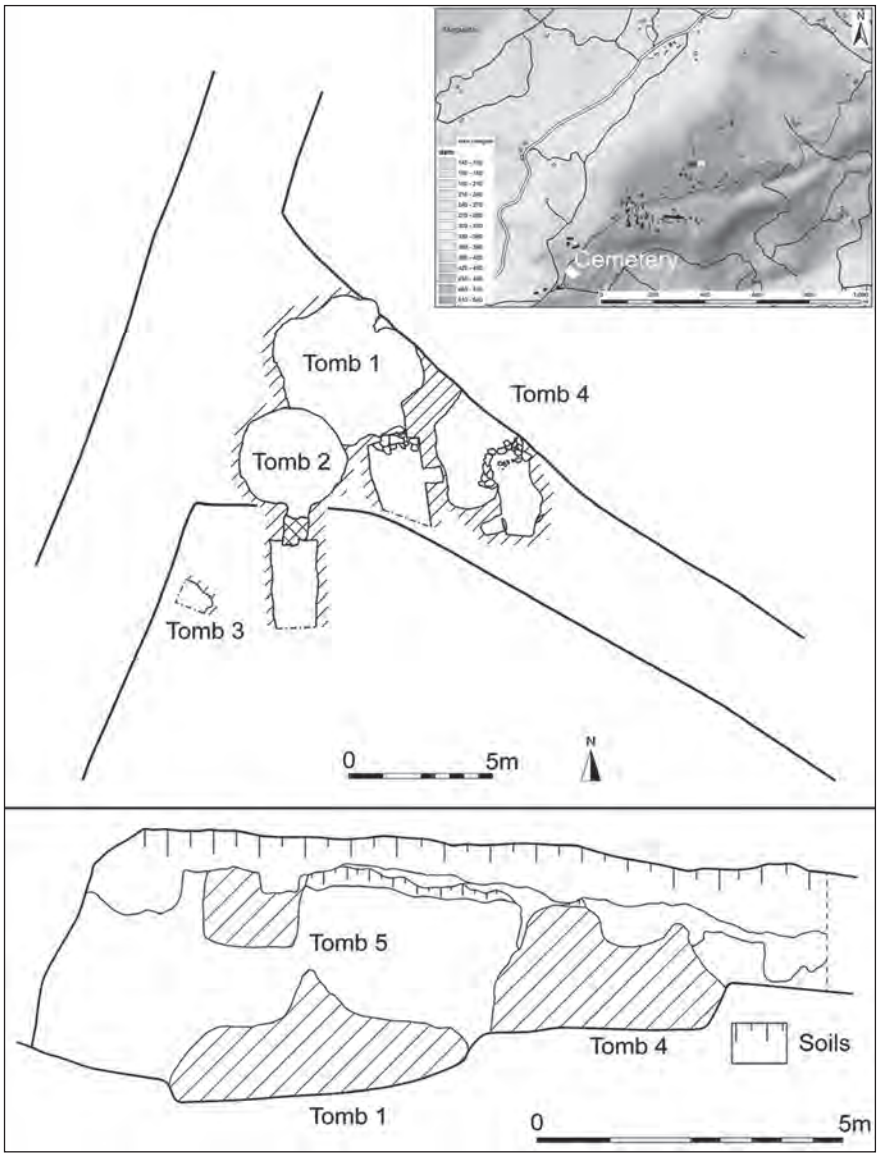


Fig. 4 Plan of the tombs 1–4 (updated 2015) with sketch of the north section; drawing showing the footprint area of the structures identified (G. De Angeli)

ships via the Corinthian Sea towards the end of the Late Bronze Age, with special reference to the Ionian–Adriatic and Italian regions.[19]

In the attempt to make a contribution to this topic, I would like to introduce some data obtained from the exploration of Tomb 1 (Fig. 4), founded in LH IIIA1 and used till the very end of the Bronze Age.[20] Though it had been disturbed in modern times by the construction of a rural track, so that the upper part of the stratigraphic sequence was partially missing, the stratigraphy in both the chamber and the dromos was sufficiently well preserved for attesting a complex pattern of use, in particular concerning the Post-palatial occupation (12th–11th centuries).

The structure – cut in the sandy bedrock and provided with a large subquadrangular chamber, a dromos and a dog-leg passageway or stomion, blocked with huge irregular stones – presented

19 Borgna 2013, in part. 136–138; Borgna – Vordos 2016; Borgna 2017a; Borgna 2019.

20 On the diachronic pattern of use of chamber tombs in part. in Achaea see Cavanagh – Mee 1998, 66; Wright 2008, 147.



Fig. 5 Fragment of krater from the dromos of Tomb 1 (SU 223/227), in the Aigion Museum. Scale 1:3 (photo: E. Borgna)

a niche in the right wall of the dromos and an oblong pit cut into the ground of the chamber.[21] Both the niche and the pit housed the remains of earlier burials, disarticulated but respectfully deposited, most likely as the outcome of an overall clearance of the tomb on the occasion of its reopening.

The stratigraphy of the fill deposits in the dromos presented two major discontinuities, which may be interpreted as two episodes of re-use after the primary occupation. Only the most recent reopening could be associated with a few pieces of material culture, useful for obtaining both an indication of chronology and an insight into meaningful ritual actions: close to the blocking wall – at the base of the uppermost filling layer – some sherds belonging to drinking vessels came to light; in particular the fragment of a huge IIIC krater (Fig. 5), possibly dating late in the period, points to a social practice well attested in some other cemeteries, for example at Ayia Triada in Elis and Elateia in Phocis, on the other side of the Corinthian Sea.[22]

Though not precisely and definitely datable, the discontinuities recorded in the dromos may be related to the stratigraphic sequence in the chamber, where evidence of the primary use of the tomb in LH IIIA consisted exclusively in secondary depositions of vessels and human remains, which had been moved and manipulated when the structure, on the occasion of the Post-palatial re-use, experienced a major re-styling implying an overall clearance. The stratigraphy illuminates three main depositional phases in LH IIIC.

LH IIIC Phase 1

The first phase matches the earlier discontinuity in the dromos. A badly preserved primary burial located toward the centre of the chamber belongs to this phase; to its burial activity we may stratigraphically relate a small group of vessels found quasi in situ along the southeastern edge of the chamber together with a cluster of scattered small finds, intentionally destroyed, including steatite buttons, gold pendants and gold beads, a seal, many simple globular and ring-shaped faience beads, several stone buttons and an iron ring bezel.[23]

[21] For the stratigraphic explanation and discussion on the depositional dynamics see Borgna – De Angeli 2020.

[22] Elis: Vikatou 1999, 251; Schoinas 1999; Vikatou 2001; Nikolentzos 2011, 123; Phocis: Deger-Jalkotzy 2007, 129; in general see: Cavanagh – Mee 1998, 114–115; Cavanagh – Mee 2014, 52–53; in Achaea see the comparable krater from the blocking wall of Tomb 2 at Mitopolis: Christakopoulou-Somakou 2010, 52, 55, pl. 6 (I am grateful to Reinhard Jung for drawing my attention to this context); see now with references Borgna et al. 2019; for parallels for shape and decoration see e.g. Evely 2006, 192–193, fig. 2.23, 2 (Lefkandi); Mountjoy 2009, 305, fig. 9 (FS 282 for IIIC Late); see also Mountjoy 2009, 233 no. 191 (Corinthia, IIIC Early).

[23] On ritual destruction see Cavanagh – Mee 1998, 112–113; Gallou 2005.



Fig. 6 Stirrup jar from Tomb 1 (SU 261), in the Aigion Museum. Scale 1:3 (photo: E. Borgna)



Fig. 7 Tripod stirrup jar from Tomb 1 (SU 261), in the Aigion Museum. Scale 1:3 (photo: E. Borgna)



Fig. 8 Globular stirrup jar from Tomb 1 (SU 261), in the Aigion Museum. Scale 1:3 (photo: E. Borgna)

Besides a red monochrome juglet, we can mention a fine globular stirrup jar, decorated with chevron and hatched triangles on the shoulder, a framed zig-zag immediately below and a system of linear decoration consisting of a few well-spaced groups of bands without fine line groups (Fig. 6). The vessel should not be dated before LH IIIC Middle, according to some good parallels, both in Achaea – for instance at Krini and Aigeira – and elsewhere.[24] A tripod stirrup jar with elaborate decoration of net and solid triangles (Fig. 7) – by finding parallels in nearby contexts as well as more distant regions, such as Elis, and even the Eastern Aegean – might also be attributed to mid-IIIC.[25] A nearby globular stirrup jar with pictorial decoration (Fig. 8) seems to belong to the same phase: both the isolated fish on the belly and the stemmed spirals on the shoulder may be related to the pottery production of several Aegean maritime sites, including the islands and the Dodecanese, as various pieces of evidence from Rhodes, Kos, and also Naxos, Perati and Asine may testify.[26] Spiral patterns appear at nearby Nikoleika on the shoulder of a similarly-shaped stirrup jar, dated to IIIC Middle.[27]

Moreover, a clear-cut indication of contacts with the Eastern Aegean is given by the bucranium-shaped gold pendants which, by finding parallels at Tiryns, Perati, Naxos, as well as in Crete and Cyprus, help us to outline a network of relationships similar to that suggested through the comparative analysis of the vessels.[28]

Although we cannot rely on clear stratigraphic relationships, we would associate with the same phase a couple of monochrome vessels, such as a belly-handled amphora and an alabastron, which had fallen down into the chamber of Tomb 2, located a little downwards along the slope (Fig. 4).[29]

LH IIIC Phase 2

It is fair to say that we do not have at our disposal reliable stratigraphic grounds useful for distinguishing the material culture related to Phase 1 – marking the Post-palatial reopening of the tomb (and possibly corresponding to phase 3 in Western Achaea according to I. Moschos) – [30] from that belonging to a further – or middle – depositional phase, which is clearly attested by a burial directly

[24] See, at Krini, a couple of stirrup jars where groups of parallel bands replace the common IIIC Early banding system including fine lines: Papazoglou-Manioudaki 1994, 193, pl. 29b; at Aigeira: Papadopoulos 1979, 74, figs. 98c, d; Clauss: Papadopoulos 1979, figs. 66e, f; 206c; Petropoulos 2007, 279, figs. 27, 29 (IIIC Middle); Giannopoulos 2008, pls. 22; 38.13 (Spaliareika, Grab 2, Befund 2). The adoption of three groups of loosely spaced bands or a group of bands on the shoulder + one band near the base for FS 175 (often including a framed zig-zag line under the shoulder) seems to be common in IIIC Middle, see e.g. in the Argolid and Attica: Mountjoy 1999, 595, fig. 221.450; cf. at Kos: Mountjoy 1999, 168, fig. 47.356–357; see also Mountjoy 1999, 428–429, figs. 150–151.

[25] Papadopoulos 1979, 95, fig. 119 (Clauss); O. Vikatou in Heilmeyer et al. 2012, 312 cat. no. 1/65 (Elis): for the decorative pattern of solid painted triangles, several parallels seem to point to Eastern Aegean: Paschalidis – McGeorge 2009, 97, fig. 12 (import from Naxos?); Kos, Langada: Morricone 1967, 230, fig. 248; see also at Rhodes and Naxos: Mountjoy 1999, 986, fig. 400f (outlined solid triangle); 952, fig. 388.43; in Phocis: Mountjoy 1999, 788, fig. 311.285.

[26] See e.g. Vlachopoulos 2003, 512, fig. 22 (Grotta); Vlachopoulos 2006, pl. 90, no. 1728 (Naxos, Kamini, hydria); at Kos, Langada: Morricone 1967, 205–206, no. 7, fig. 217; 289–290, no. 269, fig. 355; at Perati: Iakovidis 1969/1970, 175, fig. 62, no. 909; cf. at Spata, already in LH IIIB 1 on a conical stirrup jar: Mountjoy 1999, 549, fig. 199.229; at Olympia (Mageiras, tomb 7, IIIC Middle/Late): Heilmeyer et al. 2012, 308, cat. 1/53; for stemmed spirals see Benzi 1992, 93 (FM 51) with references.

[27] Petropoulos 2007, 284, fig. 73a, b (IIIC Middle).

[28] Tiryns: Maran 2006, 137–138, fig. 8.4, with references; Perati: Iakovidis 1969/1970, 297–298, pls. 15a; 54c; Naxos: Vlachopoulos 2006, 275, pl. 12; Rhodes: Benzi 1992, 187; 328, no. 7; pl. 186e; for Crete and the relationships with Cyprus: Kanta 2005; Karageorghis et al. 2014, 244 with references, 300, no. 5; see now Borgna 2018 with references; cf. Konstantinidi-Syvridi 2016.

[29] For monochrome vessels in IIIC Achaea, even early in the period, cf. Deger-Jalkotzy 2003, 61; for the belly-handled amphora see Papadopoulos 1979, fig. 199a (Chalandritsa); cf. in Elis Mountjoy 1999, 389, fig. 135.64 (IIIC Early); 392, fig. 137.77 (IIIC Late); for the monochrome alabastron see also in Eastern Aegean, e.g. Morricone 1967, 89, no. 5, fig. 67 (Kos); Mountjoy 1999, 731, fig. 282 (in part. no. 21, also for the long flaring rim [from Skyros]).

[30] Moschos 2009a, 356; Moschos 2009b, 238, tab. 1; Paschalidis – McGeorge 2009, 89–95; see now Paschalidis 2018.



Fig. 9 Stirrup jar from Tomb 1 (SU 320), in the Aigion Museum. Scale 1:3 (PT 587) (photo: E. Borgna)



Fig. 10 Small stirrup jar from Tomb 1 (SU 320/321), in the Aigion Museum. Scale 1:3 (PT 605) (photo: E. Borgna)

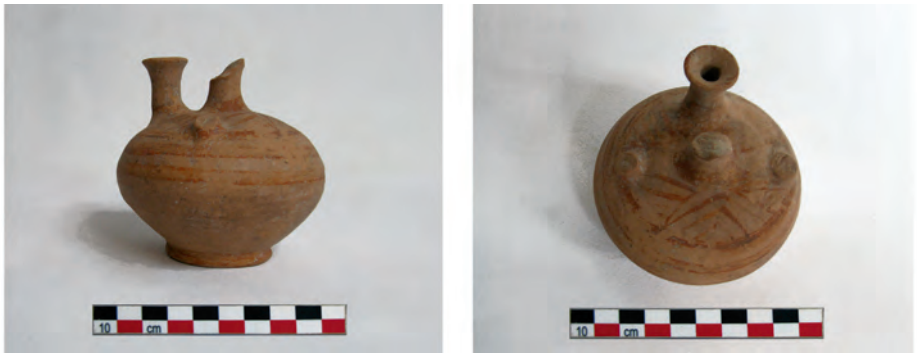


Fig. 11 Small stirrup jar from Tomb 1 (SU 239), in the Aigion Museum. Scale 1:3 (photo: E. Borgna)

superimposing the previous one. Several hints, further strengthened by the lack of any clear discontinuity in the dromos fill, prompt us to suggest that the tomb remained open for a span of time corresponding to a continuous occupation, possibly related to the celebration of cults in the chamber and not exclusively to single burial depositions. The exciting discovery of a platform, bench or bed, made with older bones and associated with upside-down vessels used for ritual offering and libation might justify the reconstruction of a performative scenario, the outcome of which may well have been the discarding of broken vessels, some deriving from earlier funerary sets, many constituting – in their secondary deposition – a well-structured heap or pile mixed with ancestors' bones (see below). On the other hand, we have to admit that even vessels discovered in situ in apparently primary contexts may be misleading for the definition of a chronological sequence, as it is now quite clear that even though people entered the tombs with their own package of material culture, they moved, mixed and re-used earlier objects, creating new associations and groups.[31]

A preliminary comparative analysis of some vessels has lead us to cautiously propose a pattern of chronological evolution according to which this middle phase, involving cult activities and ending with a burial deposition over the bone platform, may have spanned a period including the whole of IIIC Middle and possibly lasting well into IIIC Late (possibly phase 4 in Western Achaea?).[32] Indeed, we might attribute several small vessels such as juglets, lekythoi and stirrup jars to a date possibly ranging from IIIC Advanced to IIIC Late; this is the case with a few stirrup jars decorated with composite decorative patterns, such as hatched triangles associated with segmented zig-zag lines (Fig. 9),[33] or concentric semicircles with vertical wavy lines,[34] or varied patterns of elaborate triangles (Fig. 10).[35] Several parallels are available in the same contexts that have been previously mentioned, in particular in the Aegean islands. Some elements which seem well-rooted in the Achaean contexts on the basis of possible comparisons at Krini, Spaliareika, Clauss, may also be related to sites located on the opposite side of the Corinthian Sea, such as Elateia in Phocis: in these contexts several vessels, dated either to IIIC Advanced or an early part of IIIC Late, offer good comparisons, in particular for the small stirrup jars, such as the slightly biconical exemplar characterised by a banding system including a few irregularly spaced bands and a plain lower body, and decorated with hastily drawn patterns such as multiple triangles (Fig. 11).[36]

LH IIIC Phase 3

The end of this long occupation – possibly to be framed late in the 12th century BC – might have been followed by a short abandonment or gap, stratigraphically emphasised by a thick and homogeneous sandy sediment fill covering the previous remains and possibly deriving from a slow process of decay of the chamber's ceiling and walls.[37]

---

31 On the ambiguity of tombs as closed deposits cf. Chapman 2013; for the Achaean contexts cf. Giannopoulos 2008, 101, 121.

32 Moschos 2009a, 360–362; Moschos 2009b, 238, tab. 1; Paschalidis – McGeorge 2009, 95.

33 Benzi 1992, 283, no. 7, pl. 173 (oinochoe).

34 Cf. e.g. on Kos: Mountjoy 1999, 1120, fig. 459.156 (IIIC Middle).

35 Cf., with dense banding system, in IIIC Middle Phocis according to Mountjoy 1999, 782, fig. 308.252, 253; cf. Papadopoulos 1979, figs. 210a, b; 212e, f; 223g, f; Giannopoulos 2008, pls. 33; 45.44 (Befund 6); 49.53 (Spaliareika, Grab 2, Befund 7).

36 Deger-Jalkotzy 2007, 152, fig. 4, in part nos. 3–6 (IIIC Advanced–Late?); Deger-Jalkotzy 2009, 81–82 (small specimens widespread since IIIC Late – cf. 104, fig. 3, 5); Giannopoulos 2008, 233–237, pl. 26.39–41 (Spaliareika, Grab 2, Befund 6: IIIC Advanced–Late); for the squat or slightly biconical-shaped small FS 175 stirrup jar with open banding and unpainted lower body see e.g. in Phocis, IIIC Late: Mountjoy 1999, 789, fig. 312.288; 788 fig. 311.284; cf. also Paschalidis – McGeorge 2009, 93–94, fig. 10a, 3 (phase 3, Developed–Advanced); cf. also Papadopoulos 1979, fig. 91f; for banding system 91h (Chalandritsa); for the open banding see also in IIIC Late Elis: Heilmeyer et al. 2012, e.g. 312, cat. no. I.66.

37 The interpretation of this deposit is still under scrutiny; in some circumstances scholars prefer to interpret the presence of sandy layers dividing burial depositions as deliberate deposits: Cavanagh – Mee 1998; see for example at Perati: Iakovidis 1969/1970, 76; Papazoglou-Manioudaki 1994, 176; cf. Borgna – De Angeli 2020.



Fig. 12 Stirrup jar from Tomb 1, Burial 1 (SU 319), in the Aigion Museum. Scale 1:3 (PT 594) (photo: E. Borgna)



Fig. 13 Small amphora from Tomb 1, Burial 1 (SU 319), in the Aigion Museum. Scale 1:3 (PT 606) (photo: E. Borgna)

The latest use of the chamber may be related to the second or most recent reopening attested in the dromos. Funerary activity is then represented by a single primary burial consisting of an adult woman provided with two vessels – a biconical banded stirrup jar decorated with fringed concentric semicircles on the shoulder and a small amphora (Figs. 12–13) – both entirely suitable for dating the context to the very end of LH IIIC Late, possibly corresponding to the IIIC Late/SM transition at Elateia and Western Achaea.[38] All along the western edge of the chamber a row of impressive vessels, in places grouped in closer clusters, seems to have served special cult functions, such as possibly washing and anointing and even offering and libation.[39] Stratigraphy

[38] For the stirrup jars see in part. in Phocis: Mountjoy 1999, 789, fig. 312.291 (IIIC Late); at Voudeni, phase 6a: Moschos 2009b, 281, fig. 19; from Clauss: Papadopoulos 1979, fig. 74; for the small amphora see possible parallels at Elateia (Deger-Jalkotzy 2009, 89, fig. 6, but narrow-necked); cf. at Crete: D'Agata 2007, 106, fig. 3; 117, fig. 19.1, 5, Thronos and Knossos, Kephala, IIIC Late–SM); better parallel at Perati: Mountjoy 1999, 606, fig. 226.524 (IIIC Late); at Lefkandì (also for the surface treatment): Evely 2006, 204, fig. 2.31.7 (phase 2a); for SM amphoriskoi with handles from shoulder to lip see Ruppenstein 2007, 146–151; Ruppenstein 2009, 330; cf. also Borgna 2017a; for the burial, Borgna 2019.

[39] Cf. Cavanagh – Mee 1998, 114; Gallou 2005.

apparently confirmed the substantially synchronous relationships which linked the burial and the various acts of deposition of these vessels, which a pure stylistic analysis would possibly assign to slightly different and successive phases.



Fig. 14 Elaborate stirrup jar from Tomb 1 (SU 340), in the Aigion Museum. Scale 1:4 (photo: E. Borgna)



Fig. 15 Group formed by a belly-handled amphora and a small stirrup jar on top from Tomb 1. Scale 1:4 (SU 316), in the Aigion Museum (PT 721, 722) (photo: Aigion Museum)

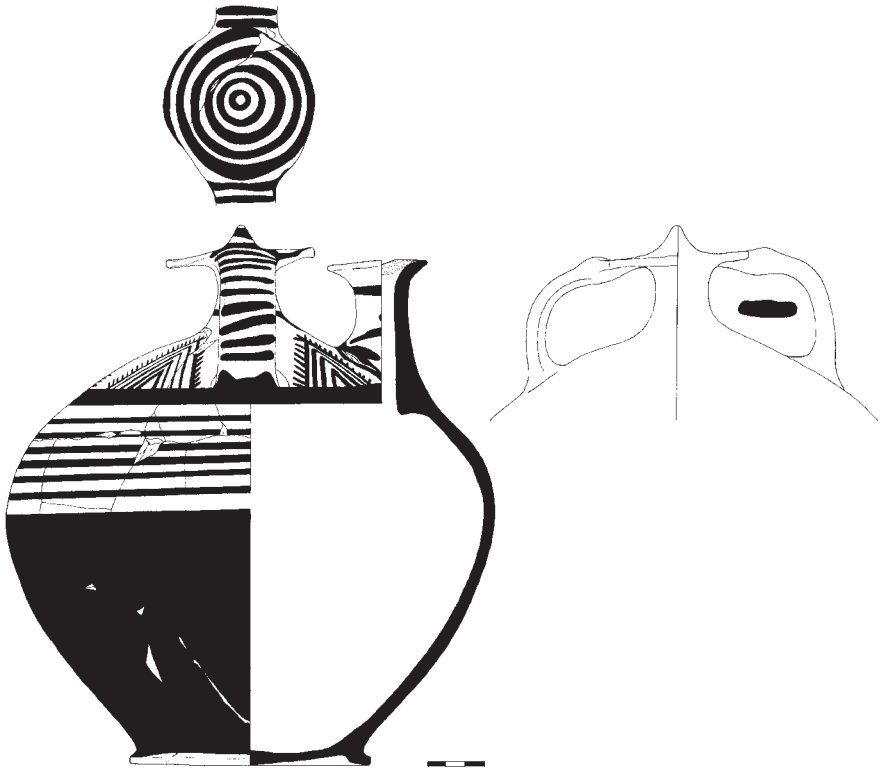


Fig. 16 Stirrup jar from Tomb 1 (SU 340), in the Aigion Museum. Scale 1:4 (PT 742) (drawing: N. Petropoulos)

With the exception of a high-quality elaborate imported stirrup jar, which I am inclined to date to IIIC Late (Fig. 14),[40] and possibly a monochrome collar-necked amphoriskos with a reserved zone for the wavy band pattern,[41] most vessels stand out for their homogeneous decorative style which, by clearly departing from the previous repertoire, points to Western Achaea and, in general, the regions included in the West Mainland koiné.[42] The most elaborate products, consisting of belly-handled amphoras (Fig. 15) and four-handled amphoras, may be compared with vessels attributed by I. Moschos to his phase 6 (possibly 6a or even 6b) at Voudeni and to Submycenaean in other areas, such as in Phocis, where an exclusive connection with Achaea seems to be displayed by the local pottery precisely in this late period.[43] I would be inclined to attribute to a Submycenaean phase also the large stirrup jar – belonging to FS 177 (Fig. 16) – which stood together with the above-mentioned amphoriskos, two belly-handled amphoras and

[40] See in general for Achaea: Papadopoulos 1979; an attempt at chronological attribution for Achaean elaborate stirrup jars with solid lower body in Giannopoulos 2008, 234, in part. pls. 28 and 29.44: IIIC Late; elaborate comparable stirrup jars, with solid lower walls, are mainly attributed to IIIC Advanced at Elateia: Deger-Jalkotzy 2007, 151, fig. 3.3–4; parallels may be found in IIIC Late Athens (Mountjoy 1999, 618, fig. 234.566) and in the IIIC Late repertoire of close style vessels, even out of the Argolid: see in particular in Eastern Aegean at Rhodes e.g. Mountjoy 1999, 1070, fig. 439.269 (from the Argolid) and 271 in orange clay (like the exemplar of the Trapeza, which might be an import).

[41] See Borgna – Vordos 2016; cf. in IIIC Late Argolid: Mountjoy 1999, 176, fig. 50.375; in the funerary burial tumulus at Argos, IIIC Late: Piteros 2001, 109, fig. 21.

[42] Mountjoy 1999, 365; Moschos 2002; Moschos 2009a, 364 for phase 6a; from the perspective of the Trapeza cemetery see now also Borgna – Licciardello in press.

[43] Moschos 2009b, in part. 286, figs. 35, 36; Mountjoy 1999, 746–747; 794, fig. 315.300; for strong stylistic continuity in the LBA–EIA transition see also Kouvaras in Aetolo-Akarnania: Stavropoulou-Gatsi et al. 2012; for connection with Phocis see also Deger-Jalkotzy 2014 with references.

a small stirrup jar with multiple fringed triangles on the shoulder, as well as the small stirrup jar with multiple triangles serving as a lid to a huge belly-handled amphora (Fig. 15).[44]

Are these elaborate vessels contemporary to the burial? Or do they belong to different and succeeding phases of production and circulation, covering a period throughout LH IIIC Late and Submycenaean, a period during which cult activities might have continued to be performed in the tomb even after the last burial? The hypothesis that the upper floor of the chamber was cut during levelling activities and the removal of earlier burials – as scattered human remains and some stratigraphic evidence might indicate – would imply sequencing the pottery repertoire. Clearance and removal of previous remains preceding the last funeral may account for the absence of a whole ceramic phase (possibly phase 5 in Western Achaea?): pure IIIC Late burials might have been primarily associated with a couple of vessels lately redeposited at the edge of the tomb, such as the above-mentioned high-quality elaborate stirrup jar. By contrast, the remaining pottery seems to match products attributed to slightly later phases, such as phases 6a and 6b in Western Achaea. Then the community settled at the Trapeza seems to have been well connected to Western Achaea and probably participated in the west-oriented relationships reaching the Ionian and Adriatic regions, as may be suggested by the well-known evidence of the last Mycenaeans in Apulia.[45]

Changing Patterns of Funerary Customs as Evidence of Social Interaction

It is worth noticing that these new clues in favour of west-oriented long-distance relationships fit well with the contemporary sudden appearance of new features in the realm of ritual and symbolic communication, as the meaningful symbolic discourse performed by some vessels found in situ at the edge of the chamber clearly demonstrates.[46]

Change and transformation in the dynamics of the intra- and interregional social relationships maintained by the community which buried its dead at the Trapeza site in the Post-palatial period may indeed be better understood through the diachronic evaluation of ritual customs including the ideological approach toward death and funerals.

LH IIIC Phases 1–2

The early re-use of the tomb in LH IIIC was surely perceived and performed as a new beginning: marked by an overall clearance, it implied a substantial re-styling including the monumentalisation of the entrance by laying a large monolithic threshold, which seems to have adapted to well-known ritual requirements in the Mycenaean tradition, usually fulfilled with a few ritual acts included in the so-called liminal or 'thresholds rites'.[47] Furthermore, in the new layout much emphasis seems to have been given to a core of ritual practices underlining a respectful approach toward the previous users of the tomb, who represented a legitimising past. The new occupants, who certainly – to judge from the valuable objects they brought into the tomb – belonged to an emergent social group, devoted special care to their ancestors, who became the object of special cult acts: the ordered disposal of human remains in the pit was followed by a libation ritual, as demonstrated by the neck of a juglet inserted in and projecting from the very same pit. Moreover,

[44] In particular for the stirrup jar see an exemplar dated to SM at Tiryns: Mountjoy 1999, 193, fig. 60.460, considered an Achaean import; cf. Eder 2009, 147, fig. 4.6–7 (Kephallenia and Tiryns); for the banding system cf. also Papadopoulos 1979, figs. 97a, b (Clauss, Chalandritsa); for the small stirrup jar see, for shape and decorative pattern, at Delphi: Mountjoy 1999, 794, fig. 315.309; for banding system Eder 2009, 144, fig. 1.4 (Elis).

[45] Benzi – Graziadio 1996; Eder 2003; Eder – Jung 2005; Jung 2006; Borgna 2013, 138–141 with references; ultimately for Italo-Aegean pottery including both Roca Vecchia and S. Maria di Leuca: Jones et al. 2014.

[46] See Borgna – Vordos 2016; Borgna 2019.

[47] Cavanagh – Mee 1998, 115, 120; for a threshold in a chamber tomb at Perati see Iakovidis 1969/1970, pl. 146a.



Fig. 17 a–b. Four-handled amphora from Tomb 1 (SU 340); c. Wall fragment including the handle of the four-handled amphora (SU 242), in the Aigion Museum. Scale 1:6 (PT 740) (photos: E. Borgna; drawing: N. Petropoulos)

the bones of their ancestors were manipulated for the construction of cult structures such as the bone platform or altar (see above), where offerings and libations were deposited.[48]

In the main, a clear perception of cultural continuity can be obtained from the evaluation of the behaviours that left traces in the archaeological record throughout the two earlier IIIC depositional phases.

LH IIIC Phase 3

Only in the last, or third, phase of use of the tomb – IIIC Late/SM, well into the 11th century – do the discontinuities perceivable from the analysis of both stratigraphy and pottery style seem to find correspondence in a changed approach towards death as well as in the acceptance of new ritual acts.

A few pits or holes were then excavated in the ground, most probably with the purpose of spoiling and robbing, while scattered human remains seem to point to a changed approach to the treatment of previous burials. In the meantime, new ideological concepts seem to have affected the domain of ritual practices, possibly under the influence of foreign inputs coming from the West. The ritual breakage of the handle now emerges as a substantial step in a dramatic performance involving vessels, in particular in the case of a high-value elaborately decorated four-

[48] See in particular Borgna – De Angeli, 2020. On the practice of manipulation as a part of a cult of the dead and ancestors in the Mycenaean world see: Cavanagh 1978; Cavanagh – Mee 1998, 76; recently Gallou 2005; Gallou – Georgiadis 2006; Cavanagh 2008, 339–340; Boyd 2002, 84–87, 94–95; Boyd 2014a; Boyd 2014b; Murphy 2014; for pits as contexts of secondary burials e.g. Wells 1990, 135–136.



Fig. 18 Lekythos from on top of the four-handled amphora (Tomb 1, SU 340), in the Aigion Museum. Scale 1:3 (photo: E. Borgna)

handled jar (Fig. 17a–b): a large fragment cut from its wall (Fig. 17c), including the handle, was ritually deposited in a very small pit/hole in the middle of the tomb.[49] We are prompted to relate this evidence to the practice of mutilation of the vessels' handle in many funerary contexts where cremation is attested in Bronze Age Italy, beginning with some *terramare* cemeteries and with particular evidence in various Protovillanovan Final Bronze Age sites, such as Pianello di Genga and Frattesina le Narde for the Adriatic area.[50]

In these contexts based on cremation, the dematerialisation of objects through fragmentation might be symbolically related to the disembodiment of the corpse through fire. To the very same sphere of cosmological meanings related to rebirth and renewal of life it would be possible to associate some special imagery and symbols, such as the sun imagery including the chariot of the sun and the sun boat, which we find adopted in the funerary domain of LBA Europe and Italy: [51] As for the Adriatic area, it is worth mentioning in particular the Final Bronze Age cemetery of Pianello di Genga, where the stylised sun-boat composition is represented on a few funerary urns.[52]

The evidence therefore appears all the more compelling when such stylised imagery makes its appearance in our context: the above-mentioned four-handled jar represents a decorative composition focusing on symbolic motifs such as the wheel/sun, hinting at both a wheeled vehicle and the travel of the sun (Fig. 17a). The elaborate spiraliform pattern on the small lekythos serving as a lid for this vessel (Fig. 18) is moreover readily comparable to several well-known stylised representations of the sun-boat, in particular those on the preciously decorated golden discs from both Italy and the Aegean, a class of objects overtly involved in the Aegean–Italian interaction of the Late Bronze Age.[53]

---

49 For a more detailed report see Borgna – Vordos 2016; Borgna – De Angeli 2020.

50 For *terramare* see Cardarelli – Tirabassi 1997, 681; e.g. at Bovolone (Salzani, 2010, 122) and Casinalbo (Cardarelli 2014, 741–742); for Pianello: Bianco Peroni et al. 2010; for Frattesina: Salzani – Colonna 2010, 298.

51 For full references and discussion of this topic see Borgna – Vordos 2106.

52 Bianco Peroni et al. 2010, in part. 110, pl. 66B1 (Tomb 83); 90, pl. 51B1 (Tomb 56).

53 For the golden disc see: Jung 2007 with references; Cassola Guida 2011; Bettelli 2012; Borgna – Vordos 2016 with further references. As far as I know, in the Aegean pottery no strict parallel exists for this stylised figurative composition; for comparable fringed patterns cf. at Voudeni, phase 6a: Moschos 2009b, 279, fig. 11. As for the pattern on a well-known fragment of a krater from Tiryns (Slenczka 1974, 29–30, no. 45, pl. 39.1e), R. Jung casts doubt on the interpretation as a sunboat with bird protome (Jung 2007, 222, n. 20); for the bird protome as a decorative motif on pottery see e.g. Borgna 2003, 277, n. 647; Borgna 2013, 132, fig. 6; for comparison of the pattern from the Trapeza with similar highly standardised compositions in the Adriatic contexts see also Borgna 2017a.

As is well known, the mid-Adriatic regions are supposed to have had a special role in the relationships between Italy and the Aegean since an early phase of Late Bronze Age;[54] we may suppose that their role became all the more important at the end of the period; as far as the funerary contexts are concerned, some similarities between the material culture of the LH IIIC Middle/Late tumulus of Chania near Mycenae on the one hand, and on the other that of the Final Bronze Age cemetery of Pianello di Genga – with particular reference to its mid-phase – are worth observing.[55]

Conclusions

Precisely in the very last period of the Late Bronze Age, namely a mid or advanced phase of the Italian Final Bronze Age, notwithstanding the fading importance of Aegean pottery in Italy, the relationships between Italy and the Aegean therefore seem to have strengthened, including social behaviour and ideological patterns, and directly involving the mid- and even north Adriatic regions on the one hand and the communities facing the corridor route of the Corinthian Sea on the other hand.[56]

I would like to conclude by underlining some points emerging from the preliminary study of some funerary contexts of the Trapeza, where the reopening of the tombs during LH IIIC, somewhere toward the mid-12th century, marked a kind of new foundation, due to either a new arrival of people or a substantial growth and flourishing of an existing rural community. Wealth and elaborate patterns of material culture seem then to have been founded on the involvement of the community – or its emerging elite – in a new network of long-distance east–west-oriented relationships. Some evidence, such as the golden bucranium-shaped earrings, points strongly to contacts with the Aegean Islands and the eastern Mediterranean, possibly mediated by some major centres such as Tiryns or as the community burying its dead at Perati, in Attica. I dare to suggest that this phenomenon might have been related to relevant transformative dynamics in the network of international relationships after an early phase of the Post-palatial period: the increasing importance of the corridor route might have had to do with a decline of the western route connecting Crete with the Italian Ionian sites via the western Peloponnese, a decline possibly dependent on the fading role of Chania in the maritime activities just after LM IIIC Early.[57] However, the western connection seems clearly appreciable in Eastern Achaea only in a later phase, namely LH IIIC Late/SM – advanced Final Bronze Age in Italy (Bronzo Finale 2) or the 11th century BC – a phase marked at the Trapeza by a kind of discontinuity in the material culture as well as in ritual and ideological activities including the approach to the past. At that time the Trapeza community seems to have been in close contact with people and communities living in western Greece – in both central Greece and the Peloponnese – and looking westwards, namely towards the Ionian–Adriatic regions and even the northern Adriatic; in this chronological and cultural framework, we may claim for the Trapeza an important role in the transmission of innovative ideas, social and ideological patterns and ritual practices from west to east.

Acknowledgements: I am very grateful to Andreas Vordos, director of the Greek excavation at the Trapeza of Aigion, for inviting me to participate in the project and permitting study and publication of the prehistoric contexts. Since 2010 a group of Italian archaeologists has been working at the Trapeza under my supervision and thanks to support from the Institute of Aegean Prehistory, the University of Udine, the Ministero degli Affari Esteri, the Istituto Italiano di Preistoria e Protostoria, the Scuola di Specializzazione in Beni Archeologici of the Universities of Trieste, Udine, Venezia and

54 Sabbatini et al. 2009; Radina – Recchia 2010, in part. 165 with references.

55 See, for similar urn shapes, at Chania: Palaiologou 2013, 257, fig. 6a,b; at Pianello: Bianco Peroni et al. 2010, 158–159, fig. 13.64e.

56 For special involvement of the northern Adriatic region in the relationships with the Aegean see: Borgna – Cassola Guida 2009; Radina – Recchia 2010, in part. 153–163; Borgna 2013, with references; Borgna 2017b.

57 Hallager – Hallager 2000; Borgna 2012; Borgna 2013, 129–133 with references.

private donors. I would like to thank Reinhard Jung for inviting me to participate in the conference in Rome, where I had the opportunity to learn a lot. For useful suggestions and comments during their visits at the Trapeza, I am indebted to Sigrid Deger-Jalkotzy, Lena Papazoglou-Manioudaki, Walter Gauß, Reinhard Jung, Ioannis Moschos, Costas Paschalidis; however, I bear sole responsibility for the content of this article, including possible mistakes.

Bibliography

Alram-Stern – Deger-Jalkotzy 2006
E. Alram-Stern – S. Deger-Jalkotzy, Aigeira I.3. Die mykenische Akropolis. Vormykenische Keramik, Kleinfunde, archäozoologische und archäobotanische Hinterlassenschaften, naturwissenschaftliche Datierung, Veröffentlichungen der Mykenischen Kommission 24 (Vienna 2006).

Arena 2015
E. Arena, Mycenaean peripheries during the Palatial Age. The case of Achaia, Hesperia 84, 1–46.

Åström 1964
P. Åström, Mycenaean pottery from the region of Aigion, with a list of prehistoric sites in Achaia, Opuscula Atheniensia 5, 1964, 89–110.

Benzi 1992
M. Benzi, Rodi e la Civiltà Micenea, Incunabula Graeca 94 (Rome 1992).

Benzi – Graziadio 1996
M. Benzi – G. Graziadio, The last Mycenaeans in Italy? Late LH IIIC pottery from Punta Meliso, Leuca, Studi Micenei ed Egeo-Anatolici 38, 1996, 95–138.

Bettelli 2012
M. Bettelli, Variazioni sul sole. Immagini e immaginari nell'Europa protostorica, Studi Micenei ed Egeo-Anatolici 54, 2012, 185–205.

Bianco Peroni et al. 2010
V. Bianco Peroni – R. Peroni – A. Vanzetti, La necropoli del Bronzo Finale di Pianello di Genga, Grandi contesti e problemi della Protostoria italiana 13 (Florence 2010).

Borgna 2003
E. Borgna, Il Complesso di Ceramica Tardominoico III dell'Acropoli Mediana di Festòs. Scavi 1955–56 (Padua 2003).

Borgna 2012
E. Borgna, Metallurgical production and long-distance interaction. New evidence from LM III Phaistos, Creta Antica 12/2011, 2012, 289–306.

Borgna 2013
E. Borgna, Di periferia in periferia. Italia, Egeo e Mediterraneo orientale ai tempi della koinè metallurgica, Rivista di Scienze Preistoriche 63, 2013, 125–153.

Borgna 2017a
E. Borgna, The Last Mycenaeans and the Adriatic connection. A view from the Trapeza cemetery, eastern Achaea, in: M. Fotiadis – R. Laffineur – Y. Lolos – A. Vlachopoulos (eds.), Έσπερος/Hesperos. The Aegean Seen from the West. Proceedings of the 16th International Aegaean Conference, University of Ioannina, Department of History and Archaeology, Unit of Archaeology and Art History, 18–21 May 2016, Aegaeum 41 (Leuven, Liège 2017) 473–482.

Borgna 2017b
E. Borgna, Spunti per un allargamento dei confini dell'analisi comparativa. Relazioni tra Egeo e Alto Adriatico nelle produzioni ceramiche del tardo Bronzo, in: A. Angelini – M. Cupitò – M. Vidale – V. Donadel (eds.), Beyond Limits. Studi in Onore di Giovanni Leonardi, Antenor Quaderni 39 (Padua 2017) 389–400.

Borgna 2018
E. Borgna, Sui pendenti aurei a protome bovina e sul ruolo di Creta nelle relazioni mediterranee della fine dell'età del bronzo, in: G. Baldacci – I. Caloi (eds.), Rhadamanthys. Studi di archeologia minoica in onore di Filippo Carinci per il suo 70° compleanno, British Archaeological Reports International Series 2884 (Oxford 2018) 269–279.

Borgna 2019
E. Borgna, Oggetti e individui sulle rotte della mobilità mediterranea della fine dell'età del bronzo. Dati recenti e recentissimi dalla necropoli della Trapezà di Eghion, Rivista di Scienze Preistoriche 69, 2019, 1–28.

Borgna – Cassola Guida 2009
E. Borgna – P. Cassola Guida (eds.), Dall'Egeo all'Adriatico. Organizzazioni sociali, modi di scambio e interazione in età postpalaziale (XII–XI sec. a. C.) / From the Aegean to the Adriatic. Social Organisations, Modes of Exchange and Interaction in Postpalatial Times (12th–11th c. BC). Atti del Seminario internazionale (Udine, 1–2 dicembre 2006), Studi e ricerche di protostoria mediterranea 8 (Rome 2009).

Borgna – De Angeli 2019
E. Borgna – G. De Angeli, Ordinary people in the flow of history. Tomb 6 at the Trapeza and the Mycenaeans in Eastern Achaea, Annuario della Scuola Archeologica Italiana di Atene 97, 2019, 26–57.

Borgna – De Angeli 2020
E. Borgna – G. De Angeli, The chamber tombs of the Trapeza, Aigion. Preliminary observations on the complex funerary rituals of a small Mycenaean community, in: J. M. A. Murphy (ed.), Death in Late Bronze Age Greece. Variations on a Theme (Oxford 2020) 145–170.

Borgna – Licciardello in press
E. Borgna – A. Licciardello, Eastern Achaea between the Mycenaean palaces and western Greece. Some observations from the Trapeza cemetery near Aigion, in: The Periphery of the Mycenaean World, 3rd International Conference, Lamia May 2018 (in press).

Borgna – Vordos 2016
E. Borgna – A. G. Vordos, Construction of memory and the making of a ritual landscape. The role of gods and ancestors at the Trapeza of Aigion, Achaea, at the LBA–EIA transition, in: E. Alram-Stern – F. Blakolmer – S. Deger-Jalkotzy – R. Laffineur – J. Weilhartner (eds.), Metaphysis. Ritual, Myth and Symbolism in the Aegean Bronze Age. Proceedings of the 15th International Aegean Conference, Vienna, Institute for Oriental and European Archaeology, Aegean and Anatolia Department, Austrian Academy of Sciences, and Institute of Classical Archaeology, University of Vienna, 22–25 April 2014, Aegaeum 39 (Leuven, Liège 2016) 447–457.

Borgna – Vordos 2019
E. Borgna – A. G. Vordos, Mycenaeans and Achaeans. Preliminary notes on the occupation of the Trapeza of Aigion during the Late Bronze Age and in early historical times, in: E. Greco – A. D. Rizakis (eds.), Gli Achei in Grecia e Magna Grecia. Nuove scoperte e nuove prospettive. Atti del Convegno di Aighion (12–13/12/2016), Annuario della Scuola Archeologica di Atene e delle Missioni Italiani in Oriente Suppl. 3 (Rome 2019) 13–32.

Borgna et al. 2019
E. Borgna – G. De Angeli – A. Licciardello – A. Mercogliano – A. G. Vordos, Natural and human components shaping a landscape of memory during the long-term occupation of the Trapezà, Aigion, Achaea, in: E. Borgna – I. Caloi – F. Carinci – R. Laffineur (eds.), Μνημη/Mneme. Past and Memory in the Aegean Bronze Age. Proceedings of the 17th International Aegean Conference, University of Udine, Department of Humanities and Cultural Heritage, Ca' Foscari University of Venice, Department of Humanities, 17–21 April 2018, Aegaeum 43 (Leuven, Liège 2019) 329–338.

Boyd 2002
M. J. Boyd, Middle Helladic and Early Mycenaean Mortuary Practices in the Southern and Western Peloponnese, British Archaeological Reports International Series 1009 (Oxford 2002).

Boyd 2014a
M.J. Boyd, The development of the Bronze Age funerary landscape of Nichoria, in: Nakassis et al. 2014, 191–208.

Boyd 2014b
M. J. Boyd, The materiality of performance in Mycenaean funerary practices, World Archaeology 46, 2, 2014, 192–205.

Cardarelli 2014
A. Cardarelli, La Necropoli della Terramara di Casinalbo, Grandi contesti e problemi della Protostoria italiana 15 (Florence 2014).

Cardarelli – Tirabassi 1997
A. Cardarelli – J. Tirabassi, Le necropoli delle Terramare emiliane, in: M. Bernabò Brea – A. Cardarelli – M. Cremaschi (eds.), Le Terramare. La più Antica Civiltà Padana, Catalogo della Mostra (Modena 1997) 677–697.

Cassola Guida 2011
P. Cassola Guida, Dall'alto Adriatico all'Egeo. Qualche osservazione sui "dischi solari" della tarda età del bronzo, in: F. Carinci – N. Cucuzza – P. Militello – O. Palio (eds.), Κρήτης Μινωίδος. Tradizione e Identità Minoica tra Produzione Artigianale, Pratiche Cerimoniali e Memoria del Passato. Studi offerti a Vincenzo La Rosa per il suo 70° compleanno (Padua 2011) 439–454.

Cavanagh 1978
W. G. Cavanagh, A Mycenaean second burial custom?, Bulletin of the Institute of Classical Studies London 25, 1978, 171–172.

Cavanagh 2008
W. G. Cavanagh, Death and the Mycenaeans, in: C. W. Shelmerdine (ed.), The Cambridge Companion to the Aegean Bronze Age (Cambridge 2008) 327–341.

Cavanagh – Mee 1998
W. G. Cavanagh – Ch. Mee, A Private Place. Death in Prehistoric Greece, Studies in Mediterranean Archaeology 125 (Jonsered 1998).

Cavanagh – Mee 2014
W. G. Cavanagh – Ch. Mee, 'In vino veritas'. Raising a toast at Mycenaean funerals, in: Y. Galanakis – T. Wilkinson – J. Bennet (eds.), Αθύρματα. Critical Essays on the Archaeology of the Eastern Mediterranean in Honour of E. Susan Sherratt (Oxford 2014) 51–56.

Chapman 2013
R. Chapman, Death, burial and social representation, in: S. Tarlow – N. Stutz (eds.), The Oxford Handbook of the Archaeology of Death and Burial (Oxford 2013) 47–57.

Christakopoulou-Somakou 2010
Γ. Χριστακοπούλου- Σωμάκου, Μυκηναϊκό νεκροταφείο Μιτόπολης Αχαΐας, Φαίδιμος 2 (Patras 2010).

D'Agata 2007
A. L. D'Agata, Evolutionary paradigms and Late Minoan III. On a definition of LM IIIC Middle, in: Deger-Jalkotzy – Zavadil 2007, 89–118.

De Angeli 2015
G. De Angeli, La necropoli micenea della Trapezà di Eghion (Acaia-Grecia). Alcune considerazioni sullo scavo stratigrafico di tombe a camera realizzate in sabbia, in: A. M. Jasink – L. Bombardieri (eds.), Akrothinia. Contributi di giovani ricercatori italiani agli studi egei e ciprioti (Florence 2015) 59–77. Online <http://www.fupress.com/archivio/pdf/2952_7251.pdf> (last accessed 14 Feb. 2019).

Deger-Jalkotzy 2003
S. Deger-Jalkotzy, Stratified pottery deposits from the Late Helladic IIIC settlement at Aigeira/Achaia, in: Deger-Jalkotzy – Zavadil 2003, 53–75.

Deger-Jalkotzy 2007
S. Deger-Jalkotzy, Defining LH III C Middle at the cemetery of Elateia-Alonaki in central Greece, in: Deger-Jalkotzy – Zavadil 2007, 129–159.

Deger-Jalkotzy 2009
S. Deger-Jalkotzy, From LH IIIC Late to the Early Iron Age: the Submycenaean period at Elateia, in: Deger-Jalkotzy – Bächle 2009, 77–116.

Deger-Jalkotzy 2014
S. Deger-Jalkotzy, A very underestimated period. The Submycenaean phase of Early Greek Culture, in: Nakassis et al. 2014, 41–52.

Deger-Jalkozty – Bächle 2009
S. Deger-Jalkotzy – A. E. Bächle (eds.), LH III C Chronology and Synchronisms III. LH III C Late and the Transition to the Early Iron Age. Proceedings of the International Workshop held at the Austrian Academy of Sciences at Vienna, February 23rd and 24th, 2007, Veröffentlichungen der Mykenischen Kommission 30 (Vienna 2009).

Deger-Jalkotzy – Zavadil 2003
S. Deger-Jalkotzy – M. Zavadil (eds.), LH III C Chronology and Synchronisms. Proceedings of the International Workshop Held at the Austrian Academy of Sciences at Vienna, May 7th and 8th, 2001, Veröffentlichungen der Mykenischen Kommission 20 (Vienna 2003).

Deger-Jalkotzy – Zavadil 2007
S. Deger-Jalkotzy – M. Zavadil (eds.), LH IIIC Chronology and Synchronisms II. LH IIIC Middle, Proceedings of an International Workshop held at the Austrian Academy of Sciences at Vienna, October 29th and 30th, 2004, Veröffentlichungen der Mykenischen Kommission 28 (Vienna 2007).

Eder 2003
B. Eder, Patterns of contact and communication between the regions south and north of the Corinthian Gulf in LH IIIC, in: N. Kyparissi-Apostolika – M. Papakonstantinou (eds.), Β' Διεθνές Διεπιστημονικό Συμπόσιο «Η Περιφέρεια του Μυκηναϊκού Κόσμου», Λαμία 1999 / 2nd International Interdisciplinary Colloquium "The Periphery of the Mycenaean World", Lamia 1999. Πρακτικά / Proceedings (Athens 2003) 37–54.

Eder 2009
B. Eder, The Late Bronze Age/Early Iron Age transition in western Greece. Submycenaean studies, in: Deger-Jalkotzy – Bächle 2009, 133–149.

Eder – Jung 2005
B. Eder – R. Jung, On the character of social relations between Greece and Italy in the 12th/11th c. BC, in: Laffineur – Greco 2005, 485–495.

Evely 2006
D. Evely (ed.) Lefkandi IV. The Bronze Age, The British School at Athens, Suppl. 39 (London 2006).

Froussou 1999
Ε. Φρούσσου (ed.), Α΄ Διεθνές Διεπιστημονικό Συμπόσιο «Η Περιφέρεια του Μυκηναϊκού Κόσμου», Λαμία, 25–29 Σεπτεμβρίου 1994. Πρακτικά (Lamia 1999).

Gallou 2005
Ch. Gallou, The Mycenaean Cult of the Dead, British Archaeological Reports International Series 1372 (Oxford 2005).

Gallou – Georgiadis 2006
Ch. Gallou – M. Georgiadis, Ancestor cult, tradition and regional variation in Mycenaean culture, in: M. Georgiadis – Ch. Gallou (eds.), The Archaeology of Cult and Death. Proceedings of the Session organized for the 9th Annual Meeting of the European Association of Archaeologists, 11th September 2003, St. Petersburg, Russia (Budapest 2006) 125–149.

Gauß et al. 2013
W. Gauß – R. Smetana – J. B. Rutter – J. Dorner – P. Eitzinger – Ch. Klein – A. Kurz – A. Lätzer-Lasar – M. Leibetseder – Ch. Regner – H. Stümpel – A. Tanner – C. Trainor – M. Trapichler, Aigeira 2012. Bericht zu Aufarbeitung und Grabung, Jahreshefte des Österreichischen Archäologischen Instituts in Wien 82, 2013, 69–91.

Giannopoulos 2008
Th. G. Giannopoulos, Die letzte Elite der mykenischen Welt. Achaia in mykenischer Zeit und das Phänomenon der Kriegerbestattungen im 12.–11. Jahrhundert v. Chr., Universitätsforschungen zur prähistorischen Archäologie 152 (Bonn 2008).

Greco 2002
E. Greco (ed.), Gli Achei e l'Identità Etnica degli Achei d'Occidente, Atti del Convegno Internazionale di Studi, Paestum, 23–25 febbraio 2001 (Paestum 2002).

Hallager – Hallager 2000
E. Hallager – B. P. Hallager, The Greek-Swedish Excavations at the Agia Aikaterini Square, Kastelli, Khania 1970–1987, vol. II. The Late Minoan IIIC Settlement (Stockholm 2000).

Heilmeyer et al. 2012
W. D. Heilmeyer – N. Kaltsas – H.-J. Gehrke – G. E. Hatzi – S. Bocher (eds.), Mythos Olympia. Kult und Spiele, Martin-Gropius-Bau, Berlin, 31. August 2012 – 7. Januar 2013 (Munich 2012).

Iakovidis 1969/1970
Σ. Ιακωβίδης, Περατή. Το Νεκροταφείον, Βιβλιοθήκη της εν Αθήναις Αρχαιολογικής Εταιρείας 67 (Athens 1969/1970).

Jones et al. 2014
R. Jones – S. T. Levi – M. Bettelli – L. Vagnetti, Italo-Mycenaean Pottery. The Archaeological and Archaeometric Dimensions, Incunabula Graeca 103 (Rome 2014).

Jung 2006
R. Jung, Χρονολογία Comparata: Vergleichende Chronologie von Südgriechenland und Süditalien von ca. 1700/1600 bis 1000 v. u. Z., Veröffentlichungen der Mykenischen Kommission 26 (Vienna 2006).

Jung 2007
R. Jung, Goldene Vögel und Sonnen. Ideologische Kontakte zwischen Italien und der postpalatialen Ägäis, in: E. Alram-Stern – G. Nightingale (eds.), Keimelion. Elitenbildung und elitärer Konsum von der mykenischen Palastzeit bis zur homerischen Epoche. Akten des internationalen Kongresses vom 3. bis 5. Februar 2005 in Salzburg, Veröffentlichungen der Mykenischen Kommission 27 (Vienna 2007) 219–255.

Kanta 2005
A. Kanta, The gold earring from the cemetery of Krya and Mediterranean trade towards the end of the Bronze Age, in: Laffineur – Greco 2005, 701–706.

Karageorghis et al. 2014
V. Karageorghis – A. Kanta – N. Ch. Stampolidis – Y. Sakellarakis (eds.), Kypriakà in Crete. From the Bronze Age to the End of the Archaic Period (Nicosia 2014).

Kolonas 2009
L. Kolonas, Network of Visitable Mycenaean Settlements and Cemeteries in the Prefecture of Patras (Athens 2009).

Kolonas 2012
L. Kolonas, Τείχος Δυμαίων, in: Α. Γ. Βλαχόπουλος (ed.), Αρχαιολογία. Πελοπόννησος (Athens 2012) 356–359.

Konstantinidi-Syvridi 2016
E. Konstantinidi-Syvridi, Gold bull's head ornaments from the Tiryns hoard and the distribution of the type in the LH IIIC periphery of the Mycenaean world, in: E. Papadopoulou-Chrysikopoulou – V. Chrysikopoulou – G. Christakopoulou (eds.), Achaios. Studies Presented to Professor Thanasis I. Papadopoulos (Oxford 2016) 127–135.

Kyparisses 1939
Ν. Κυπαρισσης, Μυκηναϊκά νεκροταφεία αρχαίας Αχαίας, Πρακτικά της εν Αθήναις Αρχαιολογικής Εταιρείας 1939, 17–103.

Laffineur – Greco 2005
R. Laffineur – E. Greco (eds.), Emporia. Aegeans in Central and Eastern Mediterranean. Proceedings of the 10th International Aegean Conference / 10e Rencontre égéenne internationale, Athens, Italian School of Archaeology, 14–18 April 2004, Aegaeum 25 (Liège, Austin 2005).

Licciardello 2012/2013
A. Licciardello, La necropoli micenea della Trapeza. I materiali nelle collezioni del museo di Eghion (Scuola Interateneo di Specializzazione in Beni Archeologici, Università di Trieste, Udine e Venezia, a.a. 2012/2013).

Maran 2006
J. Maran, Coming to term with the past. Ideology and power in Late Helladic IIIC, in: S. Deger-Jalkotzy – I. Lemos (eds.), Ancient Greece. From the Mycenaean Palaces to the Age of Homer (Edinburgh 2006) 123–150.

Morricone 1967
L. Morricone, Eleona e Langada. Sepolcreti della tarda età del bronzo a Coo, Annuario della Scuola Archeologica di Atene e delle Missioni Italiane in Oriente 43–44/1965–1966, 1967, 5–311.

Moschos 2002
I. Moschos, Western Achaea during the LH IIIC period. Approaching the latest excavation evidence, in: Greco 2002, 15–41.

Moschos 2009a
I. Moschos, Evidence of social re-organization and reconstruction in Late Helladic IIIC Achaea and modes of contacts and exchange via the Ionian and Adriatic Sea, in: Borgna – Cassola Guida 2009, 345–414.

Moschos 2009b
I. Moschos, Western Achaea during the succeeding LH III C Late period. The Final Mycenaean phase and the Submycenaean period, in: Deger-Jalkotzy – Bächle 2009, 235–288.

Mountjoy 1999
P. A. Mountjoy, Regional Mycenaean Decorated Pottery (Rahden/Westf. 1999).

Mountjoy 2009
P. A. Mountjoy, LH IIIC Late. An East Mainland – Aegean koine, in: Deger-Jalkozty – Bächle 2009, 289–312.

Murphy 2014
J. Murphy, The varying place of the dead in Pylos, in: Nakassis et al. 2014, 209–221.

Nakassis et al. 2014
D. Nakassis – J. Gulizio – S. A. James (eds.), Ke-ra-me-ja. Studies Presented to Cynthia W. Shelmerdine (Philadelphia 2014).

Nikolentzos 2011
Κ. Χ. Νικολέντζος, Μυκηναϊκή Ηλεία. Πολιτιστική και πολιτική εξέλιξη, εθνολογία, δεδομένα και προβλήματα (Athens 2011).

Palaiologou 2013
H. Palaiologou, Late Helladic IIIC cremation burials at Chania of Mycenae, in: M. Lochner – F. Ruppenstein (eds.), Brandbestattungen von der mittleren Donau bis Ägäis zwischen 1300 und 750 v. Chr. Akten des internationalen Symposiums an der Österreichischen Akademie der Wissenschaften in Wien, 11.–12. Februar 2010, Mitteilungen der Prähistorischen Kommission 77 (Vienna 2013) 185–196.

Papadopoulos 1976
A. J. Papadopoulos, Excavations at Aigion – 1970, Studies in Mediterranean Archaeology 46 (Gothenburg1976).

Papadopoulos 1979
Th. J. Papadopoulos, Mycenaean Achaea (Gothenburg 1979).

Papazoglou-Manioudaki 1994
L. Papazoglou-Manioudaki, A Mycenaean warrior's tomb at Krini near Patras, The Annual of the British School at Athens 89, 1994, 171–200.

Papazoglou-Manioudaki 2010
L. Papazoglou-Manioudaki, The Middle Helladic and Late Helladic I periods at Aigion in Achaia, in: A. Philippa-Touchais – G. Touchais – S. Voutsaki – J. Wright (eds.), Mesohelladika. La Grèce continentale au Bronze Moyen. Actes du Colloque International Organisé par l'École Française d'Athènes, en coll. avec l'ASCSA et le Netherlands Institute in Athens, Athènes, 8–12 Mars 2006, Bulletin de Correspondance Hellénique, Suppl. 52 (Athens, Paris 2010) 132–134.

Papazoglou-Manioudaki 2015
L. Papazoglou-Manioudaki, The Early Mycenaean settlement at Aigion in Achaea and the western frontier of the north-east Peloponnese, in: A. L. Schallin – I. Tournavitou (eds.), Mycenaeans Up To Date. The Archaeology of the North-Eastern Peloponnese. Current Concepts and New Directions (Stockholm 2015) 313–324.

Paschalidis 2018
C. Paschalidis, The Mycenaean Cemetery of Achaia Clauss near Patras. People, Material Remains and Culture in Context (Oxford 2018).

Paschalidis – McGeorge 2009
C. Paschalidis – Ph. J. P. McGeorge, Life and death in the periphery of the Mycenaean world at the end of the Late Bronze Age. The case of the Achaea Klauss cemetery, in: Borgna – Cassola Guida 2009, 79–113.

Petropoulos 2007
M. Petropoulos, A Mycenaean cemetery at Nikoleika near Aigion of Achaia, in: Deger-Jalkotzy – Zavadil 2007, 253–285.

Piteros 2001
Χ. Πιτερός, Ταφές και τεφροδόχα αγγεία τύμβου της ΥΕ ΙΙΙΓστο Αργος, in: Ν. Χ. Σταμπολίδης (ed.), Καύσεις στην εποχή του Χαλκού και την Πρώιμη Εποχή του Σιδήρου, Ρόδος, 29 Απριλίου – 2 Μάιου 1999 (Athens 2001) 99–120.

Radina – Recchia 2010
F. Radina – G. Recchia (eds.), Ambra per Agamennone. Indigeni e Micenei tra Adriatico, Ionio ed Egeo (Bari 2010).

Ruppenstein 2007
F. Ruppenstein, Die submykenische Nekropole. Neufunde und Neubewerbung, Kerameikos. Ergebnisse und Ausgrabungen XVIII (Munich 2007).

Ruppenstein 2009
F. Ruppenstein, The transitional phase from Submycenaean to Protogeometric. Definition and comparative chronology, in: Deger-Jalkotzy – Bächle 2009, 327–243.

Sabbatini et al. 2009
T. Sabbatini – M. Silvestrini – F. Milazzo, Moscosi di Cingoli (Macerata) e l'area centroadriatica nella tarda età del bronzo. Aspetti di carattere internazionale e di koinè metallurgica fra Egeo e area alpina, in: Borgna – Cassola Guida 2009, 235–256.

Salzani 2010
L. Salzani, La necropoli dell'età del bronzo di Bovolone, Memorie del Museo Civico di Storia Naturale di Verona, 2. serie, Sezione Scienze Dell'Uomo 10 (Verona 2010).

Salzani – Colonna 2010
L. Salzani – C. Colonna (eds.), La Fragilità dell'Urna. I Recenti Scavi a Narde, Necropoli di Frattesina (XII–IX sec. a. C.), Catalogo della Mostra (Rovigo 2010).

Schoinas 1999
Χ. Σχοινάς, Εικωνιστική παράσταση σε όστρακα κρατήρα από την Αγία Τριάδα Ηλίας, in: Froussou 1999, 257–262.

Slenczka 1974
E. Slenczka, Figürlich bemalte mykenische Keramik aus Tiryns, Tiryns VII (Mainz 1974).

Stavropoulou-Gatsi – Jung – Mehofer 2012
Μ. Σταυροπούλου Γάτση – R. Jung – M. Mehofer, Τάφος «Μυκηναίου» Πολεμιστής στον Κουβαρά Αιτωλοακαρνανίας. Πρώτη Παρουσίαση, in: N. Ch. Stampolidis – A. Kanta – A. Giannikouri (eds.), Athanasia. The Earthly, the Celestial and the Underworld in the Mediterranean from the Late Bronze and the Early Iron Age, International Archaeological Conference, Rhodes, 28–31 May, 2009 (Iraklio 2012) 247–264.

Vikatou 1999
Ο. Βικάτου, Το μυκηναϊκό νεκροταφείοτης Αγίας Τρίαδας Ηλίας, in: Froussou 1999, 237–256.

Vikatou 2001
Ο. Βικάτου, Σκήνη πρόθεσης από το μυκηναικό νεκροταφείο της Αγίας Τριάδας, in: V. Mitsopoulos-Leon (ed.) Forschungen in der Peloponnes, Akten des Symposions anläßlich der Feier '100 Jahre Österreichisches Archäologisches Institut Athen,' Athen 5.3.–7.3.1998 (Athens 2001) 273–284.

Vlachopoulos 2003
A. G. Vlachopoulos, The Late Helladic IIIC 'Grotta Phase' of Naxos. Its synchronisms in the Aegean and its non-synchronisms in the Cyclades, in: Deger-Jalkotzy – Zavadil 2003, 217–234.

Vlachopoulos 2006
Α. Γ. Βλαχόπουλος, Η Υστεροελλαδική ΙΙΙΓ περίοδος στή Νάξο. Τα ταφικά σύνωλα και οι συσχετισμοί τους με το Αιγαίο, Πανεπιστήμιο Αθηνών, Φιλοσοφική Σχολή, Δημοσιεύματα Περιοδικού «Αρχαιογνωσία» 4 (Athens 2006).

Vordos 2002
A. G. Vordos, Rhypes. A la recherche de la métropole achéenne, in: Greco 2002, 217–234.

Vordos 2006
Α. Γ. Βορδος, Τοπογραφικά δεδωμένα μετά από επιφανειακή έρευνα στον αρχαιλογικό χώρο Τραπεζάς Αιγίου, in: Ντ. Ζαφειροπούλου (ed.), Α′ Αρχαιολογική Σύνοδος Νότιας και Δυτικής Ελλάδας, Πάτρα 9–12 Ιουνίου 1996 (Athens 2006) 61–70.

Vordos 2019
A. G. Vordos, Monuments and cult at the sanctuary of Trapeza at Aigion from the 8th century B.C., in: E. Greco – A. D. Rizakis (eds.), Gli Achei in Grecia e Magna Grecia. Nuove scoperte e nuove prospettive. Atti del Convegno di Aighion (12–13/12/2016), Annuario della Scuola Archeologica di Atene e delle Missioni Italiani in Oriente Suppl. 3 (Rome 2019) 143–164.

Wells 1990
B. Wells, Death at Dendra. On mortuary practices in a Mycenaean community, in: R. Hägg – G. C. Nordquist (eds.), Celebrations of Death and Divinity in the Bronze Age Argolid. Proceedings of the Sixth International Symposium at the Swedish Institute at Athens, 11–13 June, 1988 (Stockholm 1990) 135–136.

Wright 2008
J. Wright, Chamber tombs, family and state in Mycenaean Greece, in: C. Gallou – M. Georgiadis – G. M. Muskett (eds.), Dioskouroi. Studies presented to W. G. Cavanagh and C. B. Mee on the anniversary of their 30-year joint contribution to Aegean Archaeology, British Archaeological Reports International Series 1889 (Oxford 2008) 144–153.

Index

Acarnania 483
Achaea 26, 28, 93, 96, 279, **280**, **282–283**, 357 n. 62, 373 n. 142, 459, 463–464, 468–471, 483, 492, 495 n. 30, **561–585**
Achaia Clauss **14**, 355, **562**, 568 n. 25, 570, 571 n. 38, 574 n. 44
aDNA 18, **267–276**
Adriatic (Sea) 13, 17, 21, 24–26, 28, 90, 97, 118, 120, 122–123, 131, 147, 226, 230, 298, 373, 375, 408, 425, 438–439, 482–483, 514 n. 49, 561, 565, 574, 576–577
Aeolian Islands 15, 20–21, 25, **41**, **68**, 69–70, 98, 113–115, 128, 157–158, 185, 186, 289, **294–299**, **346**, 358
Aetolia-Acarnania 93, 361 n. 102
Ahhiyawa 27, 527, 554–555
Aigeira 516, **562**, 563, 568
alabastron 93, 366, 495, 568
amber 11, 87 n. 53, **95–96**, 161, 352, **401–404**, 438, **453**, 546, 548, **549**
amphora 93, 113, 119, **126–127**, 131, 148 n. 45, 150, 366, **427–428**, **449–450**, 474, 516 n. 70
– belly-handled amphora 470, 568, **572–574**
– neck-handled amphora 463, 470, 472–473, **476**, 477, 480, **571**
– four-handled amphora 573, **575–576**
amphoroid krater (Italo-Mycenaean, belly-handled) **26**, **478**, **493**, **496**
Apennine *facies* **15**, 21, 69, 90, 93, 101 n. 131, 102, 113, **115–119**, 131–132, 147, 150 n. 69, 151 n. 71, 316, 409–410, 414, 426, 430, 435
Apulia 17, 21, 24–26, 30, 31, 56, 78, 80 n. 21, **85–87**, 126 n. 31, 128 n. 36, 135, 139, 148, 183–187, 231, 237–238, **250–253**, 298, 316, 349, 355, **364**, **370–371**, 375 n. 147, **408–412**, **425–443**, **445–457**, **459–490**, 494–495, 501, 574
Argolid 26, 94, 353–354, 472–473, 481 n. 122, 483, 509, 510, 511–514, 518–519, 562, 568 n. 24, 573 n. 40
Ariano Irpino *see* La Starza
Asklupis *see* Kos
Ássiros 136, 141 n. 27, 443
Ayía Triádha (Ayia Triada), Crete 98 n. 121
Ayía Triádha (Ayia Triada), Elis 566
Áyios Stéphanos (Ayios Stephanos) **14**, 471, 511 n. 15, 513 n. 39, 519
Áyios Vasílios (Ayios Vasileios) 9, **14**, 327, 334, 342, **509–525**
Ausonian I *facies* 23 n. 54, 80, 84, 87, 90–92, **113–134**, 298 n. 18, 303, 316, 349, 353, 366, 368
awl 20, 97, **347**, **353**, 354, **368**, **382**, 542
axe
– bronze axe **356–358**, 366 n. 127, **372–373**, **375–376**, **384**, **532**, **535**
– stone axe 70, 96
axe-shaped handle projection **117–118**, 125, 147, 150

Badia Malvagna *see* hoard
barley 20, 88, **162**, **167–170**, **176–178**, **180–184**, 188, 190, 193–209
Basilicata 21, 87, 128 n. 36, 298, 316 n. 37, 460, 477, 491, 495
bead
– amber bead 87 n. 53, **95–96**, 352, **401–404**, 438, **453**, **546**, **548–549**
– bronze bead **347**, **351–352**, 357, **376**, **381**
– carnelian bead **540–541**, **543**, **546–550**
– faience bead 80, 87 n. 53, 102, 161, 179, 181, 188, **548**, **550**, 566
– glassy faience bead 95
– rock crystal bead 100, **436–437**
– stone bead 352
Boeotia 93, 98, 463, 467, 468, 470 n. 50
Broglio di Trebisacce **14**, 21, 23, 25–26, 87, 90, 94–95, 96 n. 106, 122, 128 n. 36, 147–149, **186**, **227**, 229, 230, 237, 238, **252–253**, 315–316, 333, 353 n. 41, 409, **412–414**, 418–419, 460–461, 476, **477–480**, **491–508**, 514
bucranium **248–249**, 568, 577

^{14}C-dates *see* radiocarbon dates
Calabria **13–404**, 409, **412–414**, 419, 460–462, 482–483, 491, 502 n. 65, 555
Campania 25 n. 73, 113 n. 1, 135 n. 2, **184–186**, 237, 250, **314–315**, 366
Canosa (Contrada Pozzillo) **14**, 86, 349, 438
Capo D'Orlando **14**, 123, 126
Capo Graziano *facies* 25, 298, 315, 322
carinated bowl
– carinated bowl of handmade *impasto* pottery 315, 479
– Mycenaean carinated bowl 449, 474
– Italo-Mycenaean carinated bowl **464**, **469**, **474**, **496**, 500
carinated cup
– carinated cup of handmade *impasto* pottery **80–82**, **122–126**, 150, 303, **309–312**, 314, **322**, 511, 514
– Mycenaean carinated cup FT 240 512
– Italo-Mycenaean carinated cup 500–501
Carpathian Basin 24 n. 66, 357, 359 n. 88, 361
Casinalbo 148, 349, 576 n. 50

Castellace **14**, 87, **346**, **356**, **361**, **364–365**, **368–370**, 372, 376, **384–385**
Castelluccio 21
cattle 19–20, 89, 182, **237–256**, 277, 279, **280**, **284–286**, 407, 408, **410–415**, 419–420
Cavallino **14**, 237, **250–252**, **411**
Cessaniti *facies* 19, 299 n. 32, 322
chaîne opératoire 303, 314, 315, 334, 451
Chalandrítsa 96 n. 107, **280**, **282**, **562**, 568 n. 29, 570 n. 36, 574 n. 44
chamber tomb
– Cypriot chamber tomb 360 n. 93
– Italian MBA chamber tomb **85–87**
– Mycenaean chamber tomb 27, 96 n. 107, 351, 353–355, 357 n. 62, 470, 473, 475 n. 103, 537–539, 545, 552, 553, **561–585**
Chaniá (Chania on Crete) **14**, 26, 93, 98 n. 121, 334, 483 n. 142, 509 n. 6, 513 n. 31, 514, 518–519, 577
Chánia (Chania in the Arglid) 577
chisel 354, 542
Clauss *see* Achaia Clauss
conulus **96**, 102
Coppa Nevigata **14**, 21 n. 41, 23–25, 27, 85, 87, 88 n. 54, 97 n. 111, 126 n. 31, **135 n. 5**, 139, 148, 183, **186**, 226, **229–230**, 237, **250–253**, 316, **409–412**, 418–419, **425–443**, 460
copper 22–24, 27, 98, 102, **345–395**, **436**, 438–439
– copper ore 24, **345–400**
– copper slag **346–347**, **363–365**, **367**, 368
Crete 25, 26 n. 82, 27, 93–94, 98, 226, **333–334**, 353–354, 449, 459–460, 462 n. 24, 474, 483, 509 n. 6, 518, 530, 547, 568, 571 n. 38, 577
Custoza 360 n. 95
cutting tool 20, 97, **347**, **353–355**, 368, **377**
Cyprus 25 n. 76, 94, 349–351, 361, **364**, **367–368**, 372–372, 375–376, 397, 482, 497, 513 n. 40, 514 n. 54, 515, **516–517**, 518, **547**, 553, 568

dagger 97, **354**, 359, 382, 500
– grip-tongue dagger of type Bertarina **356**, **359–360**, 366, **371–373**, **383–384**
– grip-tongue dagger of type Merlara 359
– grip-tongue dagger of type Pertosa **355**, 368, 517
– grip-tongue dagger of type Tenno **356**, **359–360**
– grip-tongue dagger of type Torre Castelluccia **434**, **438**
deep bowl
– deep bowl of handmade *impasto* pottery **120–121**, 150, 310
– Minoan deep bowl **91**, **93**
– Mycenaean deep bowl FT 284/285 **91**, 98 n. 121, 148–149, 327, **446–447**, **463–464**, **468–471**, 475, 481, 500, 518
Dhimíni (Dimini) 26, 373, 509 n. 6, 511, 514 n. 49, 515, 516 n. 75, 518 n. 90
dipper
– Mycenaean dipper FT 236 **91**, **93**, 446, **448–449**, 500
– dipper of handmade *impasto* pottery **121–122**, 125–126, 147
Dodecanese 26–27, **527–560**, 568
dog 89, 239, **240**, **242–245**, **248**, 250–253, **279–281**, **283**, 286

eagle 237, **246**, 249
Egnazia **14**, **411**
Egypt 27, 84 n. 30, 94, 150, 185, 542, 546, 553
Elátia (Elateia) 100, 562 n. 8, 566, 570–571, 573 n. 40
electrical resistivity 45, 47–49, **50–51**
Eleona *see* Kos
emmer 20, 88, 157, **162**, **167–170**, **176–178**, **180–182**, 183, 188, **189–209**
Enkomi 360 n. 93, 361, 368

fibula 346, 517, 518
– bow fibula **352–353**, **366**, 368, **373**, 376, **385**, 517 n. 83, 552 n. 59, 553 n. 61
– fibula with leaf-shaped bow 549, **551–552**, 554
– violin-bow fibula 87 n. 47, **549–551**, 554
fish 84, 89, 161, **246**, **357**, 568
fishhook **82**, 346 n. 6, **357**, **380**
fortification 18–20, 23 n. 53, 26, 27 n. 88, **48–50**, **52**, 54, 67, **69–80**, **83–85**, 92, 94, 97, 99, 101, 114 n. 8, 115, 117 n. 17, 135, **137–140**, **147–152**, 158, 165, 174, 217, 223, 231, 238, 241–242, 257–260, **263**, **265**, 278, **283**, 291, 299–300, 345–346, 372, 376–383, **445–446**, 461, 468, 470, **536–537**
Foúresi 357 n. 62
Frattesina (*see* also hoard) **14**, 81 n. 26, 346, 356, 362–363, 373, 385, 438, 576

Gallo di Briatico **14**, 87 n. 48, **100**, 345, **346**, **352–353**, **365**, **374–375**, **383**
goat 19–20, 89, 182, **239–243**, **247–248**, **251–253**, 280, 407, 408, 410, **412–415**, 419, 448
gold 360 n. 91, 375, 500, **549–551**, 566, 568, 576–577
– golden ring 100, **549–551**
greave 354, **356**, **360–361**, **368–372**, **384–385**
grinding stone 8, 20, 98, **289–301**
Grotta Manaccora 14, **86–87**
Grotta Misa 184
Grotta della Monaca **14**, **363**, **365**
ground penetrating radar (GPR) 45, 47–49
Gualdo Tadino *see* hoard

Hala Sultan Tekke **14**, 18
hammer-axe (stone) 363
harbour bay 17–18, 24, **55–66**, 102, 114, 158, 277, 279, 303–304
Hattusili III (Hittite Great King) 554
hearth 48, 51, 53, 85, 139, 430–432
Hellanicus 114
hoard find 22 n. 51, 355
– Badia Malvagna 357
– Crotone **373**
– Frattesina, hoard no. 4 **356**, 362, 373, **385**
– Gerocarne 357 n. 66
– Gualdo Tadino 355
– Lipari, acropolis 22 n. 51, 23–24, 357, 359
– Mesić-Špaja 359 n. 89
– Mycenae, Mylonas hoard 353 n. 42
– Mycenae, Poros Wall hoard **367**
– Mycenae, Tsountas hoard I 353 n. 42

– Pila del Brancón 360 n. 93
– Surbo 23
– Tiryns 361, 568, 577
horned handle **123–124**, 514 n. 49
horse 89–90, 173, **243–245**, **248**, 252, **279–280**, **284–286**, **418–419**
horse-head handle **123**, **125**, 147 n. 38
Hyblean Mountains 294, 298–299 n. 31, 313
hydria **449–450**, **464**, **470**, **473–474**, **476**, 568 n. 26
hypogaeum **86–87**, 355

Ionian Islands 483, 519 n. 97
Ionian Sea 24, 28, 135, 491, 561
ingot 361–362
– bronze ingot 97, **354**, **361–362**, **368**, **376**
– copper ingot 23–25, **366–370**, 375, **436**, 438
– lead ingot 346, **356**, **362**, 363, **373–374**, **385**
Iraklis *see* Kos
ivory 67, 80, 84, **99–103**, 407, 419–420, **436–438**, **451–452**, **541–542**

jar 576
– jar of handmade *impasto* pottery 87, **119**, **126–128**, 150 n. 66, **307–311**, **313–314**, **322–323**, 352–353, 383, **479**, **512–513**, **516–517**
– Italo-Mycenaean jar (*see* also amphoroid krater) 26 n. 77, **493–496**
– Mycenaean four-handled jar *see* amphora (four-handled)
jug
– jug of handmade *impasto* pottery **311**, 511 n. 17, 512–513, 515, 516 n. 69
– Mycenaean jug 330 n. 17, **449–450**, **464**, **469–470**, **472**, 474, 476, 568, 570, 574

Kastanás 136, 150 n. 65, 514 n. 54
Kastro (at Palaio Pyli) *see* Kos
Kephallenia 93, 574 n. 44
knife **347**, 354, **357**, 359–360, **366**, **382–383**, **541–542**, **544**, 552–553
– type Baierdorf 453
– type Scoglio del Tonno **434**, **438**, **549**, 551, **552**, 554
– variety Matrei 23 n. 52
Knossos 452, 571 n. 38
Kos **14**, **527–560**, 570 n. 34
– Asklupis settlement **528**, 529, 534, **536**
– Eleona cemetery **528**, **537–555**
– Iraklis settlement **528**, 529, 534, 537, 552 n. 60 (tomb)
– Kastro settlement (at Palaio Pyli) **528–529**, **536–537**, 545 n. 37, 553
– Langada cemetery 26, 527, **528**, 529, **537–555**, 568
– Serraglio settlement 27, 527, **528**, **529–535**, 537, 540, **545–546**, **549**, **551–555**
krater FT 281/282 **446**, **448**, **463–464**, 469–470, **471–472**, **475–476**, 480 n. 117, 481, 494 n. 18, **496**, 500, **545–546**, 553–554, **566**, 576 n. 53

La Starza (Ariano Irpino) **14**, 87, 237, **250–251**, 258, 409, 414
Laconia 26, **93–94**, **327**, **340–343**, 449, 471, **509–519**
Langada *see* Kos
Lavrio (Laurion, Lauriōtikē) **364**, **367**, **373–375**
lead isotopes 23–24, 98, 100 n. 129, 349, **362–368**, **371–376**, 439
lead wheel 376, 377
– type Narce 358
– type Redù 358
– Aegean type **347**, **358**, **373–377**
Lefkandí **14**, 24, 95 n. 94, **136 n. 10**, 477 n. 111, 512 n. 27, 514 n. 49, 518 n. 84, 566 n. 22, 571 n. 38
Levant 497, 509, 515 n. 60, 517, 518 n. 84
Lipari (island) **14**, 21, 24, 25 n. 72, **68**, 87, 98 n. 115, 147 n. 31, 303, **313**, 316, **346**, 375
– Lipari acropolis (settlement, *see* also hoard) 21, 22 n. 51, **135 n. 5**, 78, 80, 84, **86–87**, **90–92**, **113–132**, **135**, 151 n. 72, **298**, **316**, 349, 353, 357, 366, 494 n. 18
loom weight 20, **97–98**, 113, **119**, 128, **130–131**

magnetometry **45–46**, **48–54**, **70–71**, **83**
Mália 334, 353
Máyiras (Mageiras) 361 n. 102, 568 n. 26
Merneptah (pharaoh, 1224–1214 BCE) 100
Messenia 18, 94, 511, 562 n. 8
metallurgical koiné **24**, 69, **97–98**, 360–361, **437**
Midea 94, 351 n. 31, 395, 472 n. 63, 511 n. 22, 513 n. 41, 519
Milazzese *facies* 21, 80, 90, 92, 113, 114, **116–117**, **119**, 131, **147**, **151**, **298**, 316 n. 42, **322**, 494 n. 18
Miletus 27, 450, 554
millet 20, 88, 157, **162–164**, **167–170**, **176–182**, 184, 188, **189**, **191–209**
Minoan pottery 15, 25–26, **91–94**, 100, 136, 158, 303, 321, **323–324**, **330–331**, **333–334**, 453, 459–460, 473–474, 480, 483, 495, 497
Mitópoli 96 n. 107, 566 n. 22
mould (casting mould) 23, 84, 357–358, 362 n. 112, 373, 377, 384, **435–436**
molluscs 90, 418, 432–433
Monopoli **14**, 20, 186, 187, 317, **411**
Mycenae (*see* also hoard) **14**, 26 n. 86, 94, 136, 334, 352 n. 37, 355, 373, 375, **452**, 470, 472 n. 69, 475, 511, 512 n. 28, 513 n. 41, 516 n. 75, 518–519, 577
Mycenaean pottery 21, 25, **81**, 88, **91–94**, 102, 115, 135, **148–151**, 279, 316, **340–343**, 362, 418, **427–428**, 431, 433–435, **445–453**, **459–483**, **491–502**, 517, **532–536**, 540, **545–547**, 553, **562–563**, **566–577**

Neopalatial period (Minoan) **99–101**, 352–353
Neutron Activation Analysis (NAA) 21, 25–26, **93–94**, 148, 304, **321–334**, **337–343**, **459–483**
Nola **14**, 184, **186–187**
nuraghe **186**, **366–368**

Oliva Torricella **14**, 184
Olmo di Nogara 348, 360 n. 95
olive
– olives (fruit) 20, 89, **163**, **169**, **172**, **174–177**, **180**, **184–187**, **190–191**, **196**, **207–208**, **210**, 225–226, 230

– olive tree/wood 175, 180, 183, 187, 188, **215–232**
Oratino-La Rocca 122, 147 n. 34, 148, 414, 438
oven 323, **428**, **430–432**

Palatial period (Mycenaean) 92, 96, 135–136, 148–150, 351, 355, 462, 471, 476–477, 481, 510 n. 11, 517–519, 527, **529–545**, 562–563
Passo Murato **346**, **356–358**, **365**, **369**, **373**, 375–376, **384**
Peloponnese 25, 93–94, 148, **280**, 355, 361 n. 102, 428, 462 n. 24, 463, 468, 470, 483, 492, 509, 514, 540, 546, 553, **561–577**
Peratí (Perati) 351, 475 n. 103, 511 n. 20, 568, 570 n. 37, 571 n. 38, 574 n. 47, 577
petrographic analyses **303–316**, **321–334**, 460, **477–480**
pig 19–20, 89, 137, 138 n. 12, 173, 182, 237, **239–245**, **247–248**, **251–252**, 269, 272, 277, **279–281**, **284**, **286**, 408, **410–417**, 448
pin **346–351**, **352**, **358**, **375**
– double spiral-headed pin 86, **346–348**, **366**, **379**, **383**
– pin with globular head **347**, **349**, **366**, **379–380**
– roll-headed pin **347–349**, **381**
– type Biandronno **434**, **438**
pithos **21**, 25–27, 87, 94, **119**, **128–129**, 131, **150–151**, 230, 307, **311**, 316, **323**, 333, 375, 459, **464**, **469**, **477–480**, **483**
Piyamaradu 554
Po plain 24, 90, 303, 361–363, 366
Poro promontory 16, 18–20, 37, **41**, **67–70**, 90, 95 n. 101, 114, 182 n. 61, 217, 224–227, 230, **250**, 277, **279**, **284–286**, 290, 292, 298–299, 327, 346, 352, 357
Portella **14**, 21, 135 n. 6, **151 n. 72**, 154, **185–186**, **231**, 298
Pórtes 360 n. 93, 361 n. 102
Post-palatial period (Mycenaean) 92, 94, 100, 135, 351, 360, 462, 469, 471, 472, 474, 476 n. 105, 477, 481, 510 n. 11, 512, 517, 527, **545–555**, 561–563, **566–577**
Prehistoric Olynthus/Áyios Mámas 136
Protoapennine *facies* 237, **409–411**
Protovillanovan *facies* **15**, 24, 84, 120, 576
Punta di Zambrone **13–404**, 409, 419, 459–462, 467–468, 470, 480–483, 502 n. 65, 518
Pylos 18, **94**, 136, 148, 452, 468, 471

radiocarbon dates 15, 17, 58, 70 n. 14, 84, 86, 90, 102, 117 n. 17, **135–152**, 157 n. 4, 158 n. 11, 160, 165–166, **176 n. 48**, 265 n. 22
Ramesses III (paraoh, 1195–1164 BCE) 100, 150 n. 65, 519
red deer 89–90, **239–245**, 250, 252–253, **280**, **285–286**, **410–417**, 420
Rhodes 552–553, 555, 568, 573 n. 40
Roca *see* Roca Vecchia
Roca Vecchia **14**, 17, 21 n. 41, 23, 25–27, 56, 80, 84, 85 n. 37, 91, 94–95 n. 94, 97 n. 111, 99, 126 n. 31, 128 n. 36, **135 n. 5**, 148–149, 153, **185–186**, **231**, 238, **252**, 348–349, 353, 409, **411**, 419, 435 n. 28, 436, 438, **445–453**, **459–483**, **493–497**, 500–501, 574 n. 45
rock crystal 100, 352, **436–438**

Sa Osa **185–187**
Salina (island) 21, **68**, 135 n. 6, 185, 186, 231, 298, **346**
Santa Rosa di Poviglio 129, 131
Sant'Angelo Muxaro 359 n. 82
Sardinia 24, 89 n. 61, **183–188**, **294–297**, 314 n. 20, 362, **366–368**, 373, **375–376**, 397
seal 100, 352, 375, **450–451**, 566
sealing 22
Serraglio *see* Kos
sheep 19–20, 89, 182, **239–245**, **247–248**, **251–253**, **279–280**, **284–286**, 407–408, **410–415**, 419
sickle 182, **434**, 438 n. 45
silver 362, **549–550**
– silver bracelet **100**, 345, **352–353**, **373–375**, **383**
simetite 403
Síssi 98–99
Spaliareika 568 n. 24, 570
spearhead 26, 541, **543**, **549**, **551–552**, **554**
– type Pazhok 368
– type Pila del Brancòn **434**, 438–439
spindle whorl 20, 96 n. 108, 98, 113, **119**, **128–131**, **358**, 542
spool **97–99**, 517–518
stirrup jar 93, 102, **323**, 330, **333–334**, 449, **464**, 473, 481, 483, 495, **535**, 546 n. 45, **547**, **562–563**, **567–574**
strontium isotopes 18, 89–90, **277–286**
Subapennine *facies* **15**, 21, 24, 26, 69, 85 n. 33, 90–91, 98, 102, **113–132**, **147–151**, 157, 215, 230, 258, 303, 317, 334, 373, 409–410, 414, **425–439**, 481–482, 514
subaqueous survey 55, 57, 58, 61, **64**
succinite **402–403**
Surbo 23
sword 86, 97, 345, **359–360**, 500, 542
– type Cetona (Naue II, type A) 26, 86, **356**, **359–361**, **366**, **373**, **375**, **383–384**, 517–518, 541, **543**, **549**, **554**
– type F-2 **541**, **544**
– type Pertosa 358
– type Frassineto 359
– type Thapsos 358
Sybaris (plain of) 21, 25, 26 n. 77, 91, 94, 122, 128, 147–149, 230, 238, 304, 315, 333, 396, 409, 412, 459–461, 463, 467, **477–480**, **482–483**, **491–502**
Sybaritis *see* plain of Sybaris

Teichos Dymaion 94 n. 94, **280**, **282**, 373 n. 142, 469, 471, 511 n. 21, 514 n. 49, 562
Tell el-Dabᶜā 18
Tell Kazel 450, 509 n. 6, 513 n. 40
Termitito 128 n. 36, 316 n. 37, 438, 460, 476, 477 n. 107, 482–483, 494 n. 18
terramare 24, 122, 147, 185, 359 n. 84, 438, 453, 576
Thapsos-Milazzese *facies* 69, 90, 113–114, **116–117**, **119**, 131, 147, **151**, **322**

Thebes 98, 450 n. 25, 470–471, 511, 516 n. 75
Thessaloníki Toúmba 136, 150 n. 65
Thucydides 114
Tiryns (*see* also hoard) **14**, 26, 94, **136 n. 8**, 351 n. 31, 358, 361–362, 373, 471–473, 475, 477 n. 111, 481 n. 123, 509, **511–516**, **518–519**, 574 n. 44, 576 n. 53
Torre Castelluccia **85–86**, 128 n. 36, 238, 250
Torre Mordillo **14**, 21 n. 41, 23, 26, 90, 120, 122, 128 n. 36, 147–149, **186**, 230, 238, 250, **252–253**, 333 n. 25, 409, **412–414**, 419, 461, 477, 480, **491–495**, 497, 514
transhumance 19, 237, 250, 278, **285–286**, **419–420**
Trentino 27, 345, 359 n. 83, 362, **364–367**, **373**, 375–376, 439
Trinitapoli **14**, 23, **86–87**, 355
Tropea 19, 21 n. 43, **56**, 62, 67, 87, 114, **159**, 225, **279**, 289 n. 7, **346**, **356**, **360**, **365–336**, **369**, **372–373**, **383**
Tropea peninsula **14**, 21, **42–43**, 67, 69, 85, 88, 90, 93–94, **100–102**, 114–115, 117–119, 123, 157–158, 217, 303, 315, 345, 352, 360, 366, **373**, 375
Tufariello **186**, 225, **229**, 237, **250–251**, 409, 414
turtle **451–452**
tweezers 97, **347**, **355**, 357, 366, 371, **381**, 542
Tyrrhenian Sea 13, 17, 21, 23–25, 28, 37, **39–41**, **55–56**, 62, **67–68**, 70, 78, 87, 89–92, 94, 98, 102, 117, 120, 122, 128, 131, 147, 149, 151 n. 71, **157–158**, 183, 215, 216, 224–225, 292, 299, 303, 314–315, 375, **396–397**, 409, 460–461, 482–483

Uluburun 362, 368 n. 137, 450
underwater survey (*see* also subaqueous survey) 17, 103

Vibo Valentia **14**, 67, **85–86**, **279**, 303, 321, **346**, **356**, **360–361**, 363, **365–366**, **368–369**, **371–373**, 375–382, **383–384**, 502 n. 65
Volos 515 n. 60, 516 n. 75
Voúdeni **14**, **280**, **282**, 357 n. 62, 469, 571 n. 38, 573, 576 n. 53

weeds 20, **175–182**, 188
weight (*see* also loom weight) **24–25**, 97, 131, **354**, **361–362**, **376**, **435–436**, **438**, 542
wheat **136 n. 10**, **162**, **167–170**, **176–178**, **180–184**, **188–209**, 448

This monograph presents a significant portion of the scientific results of the archaeological excavations at the Bronze Age settlement site of Punta di Zambrone on the Tyrrhenian coast of Calabria (southern Italy). These excavations were conducted from 2011 to 2013 in an Italian-Austrian cooperation. The book is the first in a series dedicated to the final publication of those excavations and focuses on the later part of the settlement history (13th–12th centuries BCE). Major topics include the topography of the site (including a harbour bay), its chronology, investigations into the economic basis of the Bronze Age society and its local, regional and interregional interactions. The new data from Punta di Zambrone are evaluated in comparison with new research results from coeval sites in Italy and Greece, which forms the basis for a historical contextualisation of the settlement and thus contributes to the broader reconstruction of Mediterranean history at the end of the 2nd millennium BCE. These coeval sites are presented by their excavators or investigators.

The authors conducted geophysical and bathymetric surveys as well as underwater archaeological investigations, typological analyses of artefacts, a definition of the relative and absolute chronology, archaeobotanic and archaeozoological studies, aDNA analysis, Sr isotope analyses on human and animal teeth, chemical and Pb isotope analyses on metal artefacts, provenance analyses of pottery vessels, amber and stone artefacts (from Zambrone and other sites).

Made in Europe

ISBN 978-3-7001-8615-1

9 783700 186151