8. Dendrochronology

"We can commence the serious business of studying ancient history and archaeology with a time-frame in place that is independent of ideologies and preconceptions, or so we like to think." Kuniholm (1993) 373

General

General introductions to dendrochronology

http://www.arts.cornell.edu/dendro (Aug. 2007, by Kuniholm and Manning).[599]

http://www.arts.cornell.edu/classics/Faculty/SManning_files/DendroInfo.pdf (Aug. 2007, Manning).

http://www.ltrr.arizona.edu/archive/biblio.html (Aug. 2007, by Grissino-Mayer).

http://www.ngdc.noaa.gov/paleo/treering.html (Aug. 2007, by the National Oceanic and Atmospheric Administration).

Baillie, *Tree Ring Dating and Archaeology, London* (1982/1990), id., *A Slice Through Time: Dendrochronology and Precision Dating, London* (1995); Ottaway (ed.), *Archaeology, Dendrochronology and the Radiocarbon Calibration Curve,* Dept. of Archaeology, Occasional Papers 9, University of Edinburgh (1983).

Few studies related to Ancient Near Eastern chronology are devoted to or include dendrochronological results, mainly because of the general lack of preserved wooden material from the Ancient Near East. As of today our main source of dendrochronological data which may be compared with historical texts comes from Anatolia, specifically Kārum Kaniš (Kültepe) and Acem-Höyük (Burušḫattum[600]). By 2003 the sequence of tree-rings covered the period from 2657 to 649 BC.[601] Scientists dated this chronology by obtaining high-precision ^{14}C determinations on a sequence of decadal samples (see Kuniholm *et al.* [1996] 780). These results were then matched with the results of precisely radiocarbon dated samples of European wood (for details see *ibid.* pp. 781–782).

Synchronisms and historical data may offer precise relative dates for 2nd millennium BC Mesopotamian chronology, but these cannot be turned in abslolute dates because of the lack of absolute astronomical or dendrochronological data.[602] Indeed, secure historical links are usually missing for potentially measurable wooden material. There is an increasing demand for natural science data – including dendrochronological information – to be used in chronological studies of Mesopotamia, despite serious uncertainties in this data (Reade [2001] 10–11).[603]

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599 http://www.arts.cornell.edu/dendro/pikbib.html#biblio for a useful selected bibliography. (Aug. 2007)

600 For this identification note Dercksen, in: *FS Veenhof* (2001) 61. Other places in the Ancient Near East have provided dendrochronological material as well. However, none of these can be linked with clear historical evidence.

601 For an anomaly correlating with the Greenland ice core anomaly (which shows signs of an volcanic eruption, most probably the eruption of Thera in 1645, 1628, or 1520 BC [i.e. HC or LC]) see Collon (2000) 7–8. Veenhof (2003) 58 also pointed out the problem of the identification of the cause of the "major growth anomaly" due to a "climatic event". Hammer *et al.*, CChEM 4 (2003) 87–94 favor the identification of this "climatic event" with the eruption of Thera. Before 2001 Kuniholm and his colleagues always dated the anomaly in the tree ring dates to 1628 BC, while later they preferred 1645 (which implies an Aegean high chronology which is hardly reconcilable with Egyptian chronology; see Manning [1999]). For the even higher eruption date of 1650/45 BC see Hammer, CChEM 1 (2000) 35–37 (→ also below). Friedrich *et al.*, *Science* 312 (2006) suggested a date for the eruption of Thera between 1627 and 1600. Note Bietak's replies of 2003, 2004 and Bietak – Höflmayer (2007) to the proposed high Aegean chronology and the difficulty in reconciling it with the low Egyptian chronology. Bietak prefers a lower eruption date of Thera (ca. 1550–1500 BC) due to archaeological observations (like the appearance of White Slip Ware I). According to him all the ^{14}C dates for this period are 50–100 years too high.

602 See Boese (1982) 16.

603 Some of the crucial questions concerning dendrochronological dates and dating methods are: Do the phases determined by exceptional growth really correlate with the eruption of Thera? Have the relevant years of deposition in the ice cores really been dated with such precision? Is the tree ring sequence incontrovertible and are the applied correlations correct? Is the timber really part of the structure in which the sealings were found? etc.

Value for Absolute Chronology[604]

The Malcolm and Carolyn Wiener Research Laboratory for Aegean and Near Eastern Dendrochronology at Cornell University, Ithaca (N.Y.), now under the direction of St. Manning (formerly P. Kuniholm), is the institution most actively involved with Eastern Mediterranean dendrochronological research. Kuniholm and his colleagues have already established numerous absolute and floating chronologies for juniper, pine and cedar from different sites in the Aegean and Turkey. A SCIEM 2000 project under the direction of O. Cichocki aims to "establish floating chronologies for the second millennium" and to "link the objects of the relevant time period to a relative chronology of certain historical events" (CICHOCKI *et al.* [2004] 96). Special emphasis is being given to *Cedrus libani*,[605] which from the Old Kingdom onwards was imported to Egypt and small groves and isolated individuals of which still survive in their natural habitat in Lebanon,[606] Turkey and Syria. This investigation is sampling as much material as possible starting from the present and going back to the 2nd millennium BC. So far 607 floating years of the 2nd millennium have been covered by the project (see CICHOCKI *et al.* [2004] 96–102 on problems in synchronizing measurement data).

The aim of the Aegean Dendrochronology Project is to construct tree-ring chronologies for the Eastern Mediterranean from the Neolithic to the present. Their data begins with tree-rings from living forests, extends back through the rings of timbers from medieval buildings and continues into the past as far as material evidence can be obtained. Since they do not follow any specific historically or archaeologically based chronology, the team considers itself in a "better" position than historians, archaeologists, etc. to shed some light on chronological issues. Presently, the continuous dendrochronological sequence goes back to the mid 3rd millennium BC; but these remote parts of the sequence still cannot be linked to the long absolute chronologies of the 2nd millennium AD. The sequence is given absolute dates by radiocarbon test on specifically selected rings.[607]

Discussed below is some of the dendrochronological evidence from Anatolia relevant for Mesopotamian chronology:[608]

8.1. Kārum Kaniš (Kültepe)

At Kültepe/Kārum Kaniš a number of palaces or palace-sized buildings were excavated in which resided the local rulers of Kaniš in business with the Assyrian traders.[609] The most important levels are Kārum Ib (ca. 18th cent. B.C. according to the MC) and Kārum II period (ca. one century earlier) because they (particularly Kārum II) produced an abundance of tablets. The time span between the periods has been frequently discussed (→ **Eponyms**). **KEL G** gives two to three years for the gap for the transitional period.

- **Waršama palace** (Kārum Ib): **1832 BC (+4/–7)***[610] is the construction date based on carbonized beams from the main building phase, all of which had attached bark were cut in the same year. Samples were also taken from repair pieces cut 17 and 61 years later. This indicates that the building stood at least 61 years, and that its destruction by fire occurred no earlier than **1771 BC (+4/–7)***. Also timber without attached bark used for repair of the structure was found.[611]

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[604] One aspect of the long-term scientific project "The Synchronization of Civilizations in the Eastern Mediterranean in the 2nd Millennium BC" is the dendrochronological investigation of wooden artifacts with special measuring-devices which do not destroy them.

[605] Note that different data would be obtained from other species of cedar, such as that from the Amānus.

[606] The numerous missing rings in samples from Lebanon indicate stress from solitary growth.

[607] Radiocarbon based "wiggle matching", which is applied by Kuniholm and his colleagues because of the lack of dendrochronological material bridging the past with the present, "involves matching specific irregularities on the master tree-ring calibration curve with irregularities in a series of known-interval radiocarbon dates from a given archaeological wood sample." (RENFREW, *Nature* 381 [1996] 733.) On improvements of this method see NEWTON – KUNIHOLM (2004) 165–176.

[608] Note the latest chart in NEWTON – KUNIHOLM (2004) 169 showing the changing tree-ring dates due to improvements in measurement during the past few years. According to them the present dates are "*accurate to within a very few years.*" (meaning that the intervals are constant, but the absolute dendrochronological sequence from the present to the 2nd millennium BC is still missing).

[609] T. ÖZGÜÇ, *The Palaces and Temples of Kültepe-Kaniš/Neša*, Türk Tarih Kurumu Basımevi, Ankara (1999).

[610] All dates marked in bold with an asterisk are based on the new dendrochronological results published by MANNING *et al.* (2001) 2532–2535, while the other numbers follow older results. See NEWTON – KUNIHOLM (2004) 169–172 for further comments and details on dates proposed in the past.

[611] COLLON (2000) 7 remarked that these dates fit well with the MC since at the end of Kārum Kaniš level II around 1850 BC (using KUNIHOLM *et al.*'s 1996 dates) the Waršama palace replaced an earlier structure (for the gap between Kārum Kaniš level Ib and II → **Eponyms** sub **10.5.**). Timbers of the entrance area of the older construction were dated post-2033 BC. Note also MICHEL (2002) 17–18.

- **Eski Sarayı** (Old Palace, Kārum II): In 1999 the team lead by Kuniholm took some samples from the Eski Saray, which is of the Kārum II period. These samples were from the door-sills and consisted of carbonized oak logs, which had been preserved for 30 years after the original excavation. Further samples came from the juniper floorboards of a room adjoining the entranceway: these have 520 preserved rings and match with a 395-year overlap the 503-year juniper sequence in the northwest trench at **Acem-Höyük** (wiggle-matched 627-year continuous chronology for the EBA/MBA extending from 2660 to 2033 BC [±4 years] for the outside ring on the floorboards at Kültepe). The life-span of this structure and date of its destruction remain unknown.

Phases of Kārum Kaniš/Kültepe according to NEWTON – KUNIHOLM (2004):

Eski Saray¦ (=K¤rum II)	Represented by a 521-year tree-ring chronology: 2544–2024 BC; buildings's lifespan unknown
Eski Saray¦ entranceway	Date not yet known
War¡ama Saray¦ (=K¤rum Ib)	Constructed in **1832 BC (+4/–7)***
	Early repair/ column installation in **1810 BC (+4/–7)***
	Structure stood until after **1771 BC (+4/–7)***

8.2. Acem-Höyük

- **Hatipler Tepesi**: This palatial building, from which samples of burnt juniper were taken, was constructed in **1774 BC (+4/–7)*** (= cutting date of the timbers).
- **Sarıkaya palace**: This palace was in use for at least 61 years. In its ruins were found bullae impressed with a seal of Šamšī-Adad I (10th year; see photo[612] Figure 5), whose timbers were felled in **1774 BC (+4/–7)*** (for the date → below). This is 58 years later than the timbers of the Waršama Palace. Since Šamšī-Adad I was a contemporary of Hammu-rāpi', the latter's reign could be placed in the first half of the 18th cent. BC, consistent with the MC/LC.[613] The seals of Šamšī-Adad I and his officials clearly postdate the palace's "construction" date of ca. 1774 BC. Some of the earliest documents from Kültepe-Kaniš Ib are associated with the later part of Šamšī-Adad's I reign, implying that the beginning of Kaniš level Ib is to be placed around or a little before the Assyrian king's accession. According to the latest evaluation of dendrochronological data, Šamšī-Adad's reign is between **1832 (+7/–1) BC*** and **1776 (+7/–1) BC*** (close to the MC).[614] The palace was repaired in **1766 (+4/–7) BC*** (NEWTON – KUNIHOLM [2004] 169).

MICHEL – ROCHER (1997–2000) 120–123 compared the dendrochronological data (older results; but see MANNING *et al.* [2001] 2535[26] for a revision using the most recent dendrochronological dates) with the eclipse data from the MEC, which reports that a solar eclipse occurred the year after Šamšī-Adad I was born. Though the data does not exactly match, the results tend towards the LC, with the best possible dates for the eclipse being 1744 and in 1795 BC (favouring the first [p. 123]). However, GASCHE *et al.*, *Dating* ... 10–11 and COLLON (2000) 7 refused to base results on the data from Acem-Höyük alone, since the relationship between the bullae found in the building and the timber remains are unclear (e.g. the timber may have been used for later rebuildings of the palace).[615] MICHEL (2002) 17–18 adapted her 1997–2000 results to Manning *et al.*'s new data, and opted for a slight lowering of the MC.

According to WARBURTON (2002) 112, the dendrochronological data fits the NC proposed by Gasche

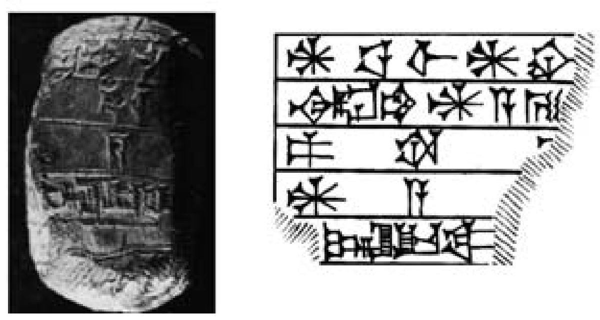

Figure 5 TUNCA (1989) pls. 1–2

[612] Ö. TUNCA (1989), pl. 137, 1–2 and (1993) 629–633. On a critical commentary concerning the seals' attribution to the 10th year of Šamšī-Adad I see GASCHE *et al.*, *Dating* ... 10[10].

[613] MANNING *et al.* (2001) 2534 and 2535[26] (on MC/LC). Kuniholm, using the older results, had formerly proposed a LC for Mesopotamia, dating Hammu-rāpi' to the second half of the 18th cent. BC.

[614] See MANNING *et al.* (2001) 2535[26]. These dates are comparable with those found for Šamšī-Adad I by MICHEL (2002) 17–18: 1792–1760 BC and, based on **Distanzangaben**, by PRUZSINSZKY (2006) 73–79.

[615] See also ZETTLER (2003) 19[7] (the stratigraphic context of the sealings remains unclear). One can observe that generally not too much confidence is put into this date by scholars of Ancient Near Eastern studies.

and his colleagues, which is based on a synthesis of astronomical, philological, and archaeological information (he also remarks on the methodology applied to chronological research). Warburton believed that Acem-Höyük provides an upper limit to the selection of eclipse dates (Michel calculated –1846, –1832, –1794 and –1763). However, problems arise as to the quality of the eclipse information (→ **Astronomical data**). GASCHE (2003) 207–208 (with reference to Michel's study) termed the dendrochronological dates as a "*chronologie pseudo-absolue*".

- **Building III in the northwest trench**: Longitudinal stretchers inside the walls near floor level provide a 503-year long chronology (report of 1999). The associated finds belong to the MBA and the construction is assumed to have been destroyed at the same time as the Hatipler Tepesi and Sarıkaya palace (situated approximately 400 meters to the southeast); → above and sub Eski Sarayı sub **8.1.**

8.3. Porsuk/Ulukışla

Timbers of the inner postern in the west city wall, which have attached bark, date to **1604 (+4/–7) BC***; and timbers from the outer postern in the west city wall (also with bark) to **1573 (+4/–7) BC***. MANNING *et al.* (2001) 2534–2535 connected the dendrochronological data of 61 trees found at Porsuk with the Thera (Santorini) eruption, since rings 854ff. show a growth anomaly. Ring 854 is currently dated to **1650 BC (+4/–7)***. This correlates with the large volcanic signal detected in the Greenland ice cores, which is dated to around **1645 BC (+4/–7)***, and supposed to represent

Comparison of dendrochronological results for construction- and repair-dates

War¡ama palace:

KUNIHOLM *et al.* (1996)	MANNING *et al.* (2001)	NEWTON - KUNIHOLM (2004)
1810	1832(+4/–7)	1832–1835
1749	1771(+4/–7)	1771–1774

Sar¦kaya palace:

1752	1774(+4/–7)	1774–1777
1744	1766(+4/–7)	1766–1769

Table 31 Comparison of Kārum Kaniš (Kültepe) and Acem-Höyük dates, see 8.1. and 8.2.

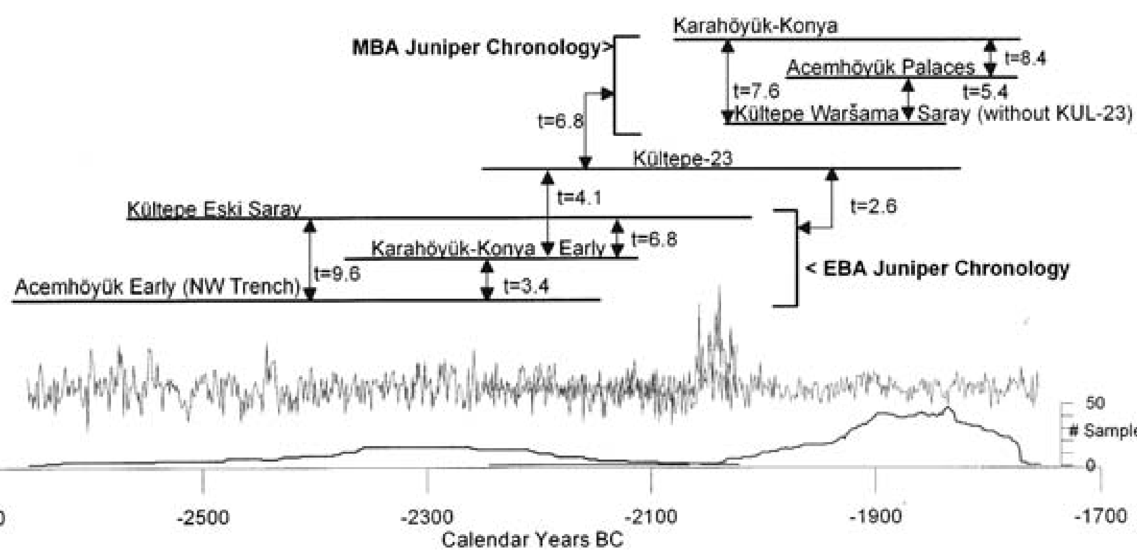

Figure 6 NEWTON – KUNIHOLM (2004) 176, fig. 7; here dendrochronological linkages with the associated t-scores as a measure of the quality of fit are shown

the Thera eruption. MANNING *et al.* point out that this implies a high Aegean chronology, since it is some 100–150 years earlier than the conventional 1520 BC date for the Thera eruption.[616]

8.4. Kara Höyük/Konya

One 198-year long sequence (the archaeological context remains unclear) which dates between 2359–2162 BC. The last preserved ring in wood from the site dates to **1768 (+4/–7) BC*.** (It has no bark, which means that the building may have been constructed after the wood was cut). For the dates see Figure 6.

Figure 6 is taken from NEWTON – KUNIHOLM (2004) 176, fig. 7. It shows the first half of a 2009-year tree-ring chronology for Anatolian juniper "pinned in place" by approximately 65 radiocarbon dates. It is the synthesis of the sampled and communicated dates throughout the past years. The links between the EBA and the MBA are three pieces of charcoal from Kültepe, one from the Waršama palace, and two from door-sills in the Eski Sarayı. The additional 1121 years of the Late Bronze Age and Iron Age tree-ring chronology are not shown: the full sequence thus runs from 2657 BC to 649 BC.[617]

8.5. Anatolian sites with wood samples dating to the 2nd half of the 2nd millennium BC

Kuşaklı-Höyük (Sarissa): The last preserved ring (no bark) of the wood sample found in the Hittite temple at Sarissa was dated to 1384 BC. However, a cuneiform tablet fragment found in the temple ruins used sign-forms characteristic of the 13th cent. BC, which would mean that the building was either rather long-lived or a number of rings had burned off the exterior of the wood (Kuniholm's suggestion in his 1996 report). In his online report of 2001 Kuniholm discussed new samples from Kuşaklı, as well as wood samples from **Ortaköy/Šapinuwa**[618] dating to the 14th and 16th cent. BC. More samples come from building C and the Southeast Gate. The material from building C shows a 144-year juniper chronology which cross dates with the established Bronze Age/Iron Age sequence. A crucial question for future research will be whether the temple of Sarissa of the Middle Kingdom, not built before Ḫattušili I, dates to the beginning or the end of the 16th cent. BC.[619]

From **Maşat-Höyük** come samples (without bark) collected from the upper Hittite level and dated to 1353 BC, where Late Helladic IIIB pottery was found (see Kuniholm's 1996 report). At **Tille Höyük** samples were taken from the gateway and the last preserved ring in them dated to 1140 BC ±37 years (Kuniholm's 1991 report).

Concluding Remarks

According to KUNIHOLM *et al.* (1996) 782, with their results, which combined high-precision radiocarbon wiggle-matching with dendro-marker events, the HC is unlikely. Today dendrochronological results seem to support either the LC or a lower MC. However, MANNING *et al.* [2001] 2532–2535 replaced the 1996 dating with dates 22 (+4/–7) years earlier using new radiocarbon wiggle-matched dates. According to Manning *et al.*, these offer a unique independent source for establishing the absolute chronology of the Ancient Near East and the Aegean and supersede the dates of 1996. The floating Anatolian Bronze Age-Iron Age tree ring chronology was linked to a continuous sequence running from living trees backward (Anatolian wood was compared with the sequence of German oak over a period of 250 years). This study rules out the UHC, HC and ULC, favoring MC – though the "low-Middle chronology" by MICHEL – ROCHER (1997–2000) is also considered plausible (p. 2534). Seal inscriptions found

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616 → above. The dates for Acem-Höyük will not be affected if the identification of the climatic anomaly or event with the eruption of Thera is incorrect: "... while having no effect on the date for Açemhüyük, because the date is dependent upon the 'climatic event' and not upon Thera. As the 'climatic event' itself has not – to my knowledge – been placed in doubt, that anchor is preserved. ..." (WARBURTON [2000] 62[13]) See BIETAK (2003) 23–33 for the difficulty of this high date.

617 They use the same radiocarbon curve as MANNING *et al.* (2001), but present an overall 3 sigma error range (99.7%) instead of 2 sigma (95.4%).

618 Large Hittite building with samples without bark dating to 1304 BC ±37 years and 1319 BC ±37: Kuniholm's report 1994. See also http://www.arts.cornell.edu/dendro/2001news/adp2001.html (Aug. 2007): "... Tentative dendro dates for the former in the 14th century BC and the latter in the 16th century BC are, in conjunction with radiocarbon work, contributing to a complete rethinking of Hittite chronology ..."

619 In case the results tend to the beginning of the 16th cent. BC, a lowered MC will be most likely for the Ancient Near East. According to MÜLLER-KARPE (2003) 387, the timbers used for the construction of the temple were cut in 1529 BC (Old Hittite Kingdom). But so far the construction of the temple cannot be assigned to a specific ruler. However, the tree-ring sequence is still floating and does not allow chronological conclusions. For further details on the dendrochronological results from Sarissa see KUNIHOLM – NEWTON, *MDOG* 134 (2002) 339–342. According to them, the buildings were quite old at the time of the major destructions at Kuşaklı/Sarissa.

in the Sarıkaya palace at Acem-Höyük date to the latter part of Šamšī-Adad's I reign (see esp. p. 2534) and indicate that the palace was in use during the Kārum Kaniš Ib period. So far, this is the only dendrochronological data that can contribute to the absolute chronology of Mesopotamia: the rest is less helpful due to the absence of inscriptions at the site which could provide another historical link.

Other than methodological difficulties (such as dating the eruption of Thera; or the accuracy of ^{14}C dating) the question is whether the timber was really part of the building in use during Šamšī-Adad's reign. It is also uncertain when the seals arrived at Acem-Höyük: After Šamšī-Adad's death or earlier?[620] At first glance there seems to exist a direct connection between the historical records and the dendrochronological data, which could presumably resolve the vexed chronological questions: but that is not really the case.[621] For the time being, one can not define the exact date of the beams' arrival in the palace in which they were found: one is therefore limited to hypothetical conclusions (VEENHOF [2000] 148–149). The dendrochronological data for Kārum levels at Kültepe, 1832 BC* and 1774 BC* for Kārum Ib, do not conflict with the MC/LC, but call into question either the archaeological associations between different areas of the Kültepe site or the assumed time length of the gap between Kārum Ib and II of the **Old Assyrian period**.[622] Within recent years Ancient Near Eastern chronological studies have focused on the Acem-Höyük dendrochronological date and the date Šamšī-Adad I solar eclipse. It is hoped that a firmly fixed dendrochronology will provide important evidence towards the resolution of a century of debate over Assyrian chronology. Key issues are the relationship between tree-growth-data, the consistency of radiocarbon determinations, volcanic eruptions (Thera[623]) and climatic changes. The exact archaeological contexts from which the wood-samples come need to be stated in the excavations reports in detail, or they are of little use for chronology. Dendrochronology will resolve chronological issues of the 2nd millennium BC only when direct links between timber and chronologically relevant texts are available.

8.6. Excursus: ^{14}C data

General

A general introduction to ^{14}C data and its use for chronology can be found on http://www.arts.cornell.edu/classics/Faculty/SManning_files/RadiocarbonIntro.pdf (Aug. 2007)

For further general studies see: BOWMAN, *Radiocarbon Dating, Interpreting the Past*, University of California (1990); CICHOCKI *et al.* (2004) 102–104; DAMON, *The History of the Calibration of Radiocarbon Dates by Dendrochronology*, BAR 379 (1987) 61–104; GOWLETT – HEDGES, *Radiocarbon Dating by Accelerator Mass Spectrometry Applications to Archaeology in the Near East*, BAR 379 (1987) 121–144; LEVY – HIGHAM (eds.), *The Bible and Radiocarbon Dating, Archaeology, Text and Science*, Oxford (2005); MANNING, *The Absolute Chronology of the Aegean Early Bronze Age: Archaeology, Radiocarbon and History*, Sheffield (1995); MOOK – WATERBOLK, *Radiocarbon Dating*, Handbooks for Archaeologists 3 (1985)

Selected further literature and comments on ^{14}C data

In the Ancient Near East: GUT (1999) 22–24; HASEL (2004) 6–11, HASSAN – ROBINSON (1987) 119–135; POTTS (1999a) 12–18; RÖLLIG (1965) 384–386; THOMAS (1992) 143–151

In Anatolia (combined with dendrochronology): AVILOVA, The Problems of Dating of the Anatolian Bronze Age: on the Radiocarbon Chronology of the Region, *Rossiyskaya arkheologiya* (1996) 5–10; KUNIHOLM – NEWTON (1989) 279–293; KUNIHOLM (1993) 371–173; MANNING *et al.* (2001) 2532–2535; REIMER (2001) 2494–2495; http://tayproject.org/veritabeng.html (Aug. 2007)

In connection with the eruption at Thera and the Aegean chronology: BALTER, New Carbon Dates Support Revised History of Ancient Mediterranean, *Science* 312 (28 April 2006) 508–509; BRONK RAMSEY *et al.*, Dating the Volcanic Eruption at Thera, *Radiocarbon* 46 (2004) 325–344; FRIEDRICH *et al.*, Santorini Eruption Radiocarbon Dated to 1627–1600 B.C., *Science* 312 (28 April 2006) 548; MANNING *et al.*, Chronology for the Aegean Late Bronze Age 1700–1400 B.C., *Science* 312 (28 April 2006) 565–569.

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620 See also READE (2001) 10 and VEENHOF (2003) 58, who still used Kuniholm's 1996 dates.

621 HUBER (2000) 173 stressed that the astronomical evidence cannot be discredited by dendrochronological evidence from a single site (he considers both as hard evidence).

622 See the new results based on the **KEL** and **MEC** by VEENHOF (2000), (2003), (2007) and (2008), MICHEL – ROCHER (1997–2000), MICHEL (2002) 17–18 and GÜNBATTI (2008).

623 A meeting "*Ashes and Ice. Workshop on Tephra Analysis and Ice Core Dating*", Vienna, 8.–10. July 2004, was organized by SCIEM 2000.

Value for Absolute Chronology

Among other methods, dendrochronology and ^{14}C-dating can lead to an absolute chronology.[624] As THOMAS (1992) 143 pointed out, radiocarbon dating had little influence upon the historical chronologies of Egypt and Mesopotamia (beginning with the first dynasty of Ur in the middle of the 3rd millennium BC) until the late 1960s, when it became possible to calibrate radiocarbon dates.[625] Before that, one had to rely on information only from archaeologists and historians, who correlated archaeological strata and pottery sequences with the historical documents and calendars of ancient times. For various reasons, we still do not have sufficient (published) ^{14}C data for the Ancient Near East.[626] THOMAS (1992) 148 urged that radiocarbon dates be used aware of their limits for absolute dating – specifically, for choosing among the high, middle and low chronologies of the 2nd millennium BC.[627] On the other hand POTTS (1999a) criticized the lack of ^{14}C data for Ancient Near Eastern chronology:[628] his chart of published ^{14}C measurement from Egypt to India clearly shows how little radiocarbon data exists for Mesopotamia.[629]

In the same volume GUT (1999) 22–25 pointed out how natural science data has been neglected in the study of the chronology of the Uruk period in the late 4th millennium BC.[630] However, she also cautioned about the proper gathering and processing of ^{14}C data from Near Eastern sites, listing the correct procedures: data-series from one find-complex of the site; conventional versus calibrated dates plus wiggle matching; and using data from short-lived, uncontaminated, organic material. In respect to Near Eastern archaeology Gut concluded that one should stick to relative chronology as the main dating-method as long as there are no major improvements in ^{14}C data gathering and analysis from Near Eastern sites.

A similar view was put forward by ZEEB (2001) 88–89 in his short report on chronological studies and advances during the recent past. He pointed out that in the case of older samples the length of the probability-values (+y/–y years) are sometimes even longer than the relevant Venus cycles and thus useless for Mesopotamian absolute chronology. Within the field of Ancient Near Eastern chronology of the 2nd millennium BC with its pre-existing historically based chronologies, ^{14}C data are believed to be less accurate and superfluous. Other sources such as the ELs or the AKL which are tied to at least one reliable astronomical date (in the 1st millennium) are, for the time being, considered more precise and accurate than ^{14}C-dating.

There is an increasing demand for radiocarbon dating because supra-regional comparisons of cultures are usually done via ^{14}C data. (But, as has been said, data for Mesopotamia is missing.[631]) And within the past few years there have been major improve-

[624] GASCHE (2003) 206–208 calls it a "pseudo-absolute" dating.

[625] LANDSBERGER (1954) used Libby's radiocarbon dates in his chronological study. But even today ^{14}C dates for the MBA are considered to be 50–100 years too high: see BIETAK (2003) 23–33, id. (2004) 215–222. → **Dendrochronology.**

[626] THOMAS (1992) 143–151 presented the most important ^{14}C-data for Mesopotamia, Syria and Anatolia concerning the 3rd millennium BC. He concluded: "Today, much greater emphasis must be placed upon historical chronologies rather than calibrated radiocarbon dating in the construction of archaeological chronologies of southwestern Asia, the Aegean and Greece. It has become increasingly clear that radiocarbon dating must be regarded as a 'fairly blunt tool', when it involves older radiocarbon dates." (p. 149; see p. 148 for radiocarbon dates from Mesopotamia for the Akkad and Post-Akkad periods, which cannot be used for chronological purposes).

[627] See also the abstract in *High* ... 3 (1989) stressing that many radiocarbon dates do not attain the required accuracy; note the discussion on pp. 24–30. In general radiocarbon dates are too high: e.g. Alalaḫ and the Levant (GATES, *High* ... 2, 78).

[628] See his short 1999 comment regarding the dating of the end of the Sukkalmaḫ dynasty, which correlates with the Mesopotamian Dark Age.

[629] Potts criticized the classical ceramic synchronisms and periodizations and the over-reliance on ceramic parallels (considered as an old methodology) which does not take into acount growing data and information. He pleaded for more use of new scientific methods within Ancient Near Eastern archaeology.

[630] The data presented in RÖLLIG (1965) 385–386 is not sufficiently exact ("*nur von höchst bedingtem Wert*") for absolute chronology, since it shows an uncertainty of at least 140 years, which is too much to eliminate the HC, the MC, or the LC. The dates presented were taken from MÜNNICH, *Science* 126 (1957) no. 3266, 194–199.

[631] The SCIEM 2000 project lead by W. Kutschera deals with ^{14}C-dating (see e.g. in CICHOCKI *et al.* [2004]). ^{14}C-data for Mesopotamian chronology was not discussed in detail by GASCHE *et al.*, *Dating* ... 10–11: note SEAL (2001) 164 referring to Dinkha level IV (contemporary with the time of Šamšī-Adad I) indicating a HC. For an overview of ^{14}C data in Mesopotamia see HASEL (2004) 9. However, BIETAK ([2003] 23–33 and [2004] 215–222) warned that generally the ^{14}C-dates for this period are still too high.

ments in the precision of radiocarbon dating. Still, it is not sufficiently accurate, as some scholars suggest, and has its limitations (e.g. the wiggles in curves give ranges and no absolute dates). For a survey of radiocarbon dating within the past decades emphasizing the mid–2nd millennium BC Eastern Mediterranean, see MANNING – RAMSEY (2003) 111–114. The ^{14}C data suggests a "High Chronology" for Aegean whereas conventional archaeology hints at a lower chronology: the difference is as much as 100 years. In the 1970s and 1980s, the results diverged considerably from estimates due to the methods then used. Today, better and more reliable chronological results can be achieved in combination with stratigraphy. Dendrochronology,[632] pumice analysis and ice-core dating will help improve the precision of the dates. Though at present there is a serious gap between the ^{14}C and archaeological dates for the Aegean and Eastern Mediterranean chronology, for the Ancient Near East – Syria, Anatolia and Mesopotamia – the effort has been to reconcile the so-called "hard" scientific dendrochronology and astronomy with the "floating" historical/textual information. However, for Mesopotamia we still miss material which offers reliable ^{14}C data and is clearly linked to a historical context.[633]

Links

AKL, Astronomical Data, Eponyms, KEL, MEC, Old Assyrian Period, Solar Eclipse

[632] See MANNING *et al.* (2001) and the reply by REIMER (2001) 2494–2495 on regional radiocarbon offsets (e.g. Germany and the Eastern Mediterranean), which make a difference on the high-precision chronologies (note the combined northern hemisphere data). As she pointed out (p. 2494): "The authors attempted to match the radiocarbon ages of a 'floating' tree-ring sequence (with unknown calendar age) from archaeological monuments in Anatolia to the combined Northern Hemisphere data set." (= anchoring of the tree-ring chronology)

[633] For an interesting note on the adaptation of the NC for the Indus Civilization see PONS (2003) 121 (referring to the problematic use of ^{14}C-data). Note also GASCHE (2003) 214 citing a study by G. POSSEHL, *The Indus Civilization, A Contemporary Perspective*, Walnut Creek, CA (2002) 29, who applied the NC as well.