

# The Mont Avic – Mont Emilius Massif (NW Italy): a confirmed butterfly hotspot (Lepidoptera, Papilionoidea)

Andrea Battisti, Daniele Stellin & Massimo Bocca

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## Abstract

Species inventories are fundamental to understanding biodiversity and guiding conservation efforts. This study presents the first comprehensive butterfly (Papilionoidea) checklist for the Mont Avic – Mont Emilius Massif (Northwest Italy), a Special Protected Area within the Natura 2000 network. The area includes four additional Special Areas of Conservation and the Mont Avic Natural Park. Data collected between 2019 and 2024 confirmed 140 taxa of butterflies out of 146 total for the area, these last representing 50.3% of the Italian fauna. The butterfly community includes: i) two new species for the Aosta Valley region (*Apatura ilia* and *Neptis rivularis*); ii) 17 newly recorded taxa for the study area; iii) four species of conservation concern listed in the European Habitats Directive 92/43/EEC (*Phengaris arion*, *Parnassius apollo*, *Euphydryas aurinia*, *Zerynthia polyxena*); iv) a significant proportion of species endemic to the mountains of Southern Europe (11.6%), particularly within the genus *Erebia* (15 species). Additionally, we provide distributional, ecological or conservation insights for 28 taxa of particular interest.

## Profile

Protected area

Special Protected Area

Mont Avic and Mont

Emilius

Mountain range

Alps, Italy

## Introduction

Mountain regions host a remarkable biodiversity driven by diverse climatic conditions, steep environmental gradients and complex topography, which together create a wide variety of habitats and ecological niches. In recent decades, rapid environmental changes have driven a global decline in species (Ceballos et al. 2015), particularly among habitat-specialist taxa in mountain and alpine biomes (Beniston 2003; Rödder et al. 2021). Understanding species assemblages within these biomes is therefore crucial to addressing these challenges and developing effective conservation strategies.

Pollinating arthropods are fundamental to ecosystem functioning (Ghazanfar et al. 2016; Muinde & Katumo 2024) and serve as effective bioindicators due to their rapid response to environmental disturbances and some groups being easy to identify at lower taxonomic levels (Gerlach et al. 2013). These traits make them ideal models for studying the impacts of habitat loss, fragmentation and climate change, key drivers of biodiversity loss, particularly in the Alps and in the alpine environment (Inouye 2020). Despite their ecological role, knowledge gaps with regard to distribution remain across the Alps, especially in remote or little-known areas.

Butterflies, a key insect group, play an important role in national monitoring schemes (Sevilleja et al. 2020) and multi-taxa approaches (Viterbi et al. 2013). The Northwestern Alps host some of Europe's most important areas for species diversity and endemism, which are considered Prime Butterfly Areas by Van Swaay et al. (2006) and Balletto et al. (2010). The Mont

Avic Natural Park (hereinafter MANP) in the Western Alps is already recognized for its butterfly diversity (Brockmann et al. 1993; Pensati 2007–2008). However, little information is available on the enlarged sector of the Mont Avic – Mont Emilius massif, a European bird protection site (Directive 2009/147/EC). This area also includes four Special Areas of Conservation for habitats and species of conservation concern, and it remains understudied for its arthropod diversity, especially at higher altitudes.

As part of the Italy-France cross-border cooperation project *Alcotra* (2014–2020), the specific initiative no. 3896 *COBIODIV* (more info at: <https://www.interreg-alcotra.eu/it/cobiodiv-conoscere-la-biodiversita-e-gli-ecosistemi-proteggerli-meglio-insieme>) aimed to promote *hidden biodiversity data acquisition activities*, addressed to specific target species in the surroundings of the Mont Avic – Mont Emilius massif. The project focuses on species listed in the European Habitat Directive 92/43/EEC and on rare or endemic species.

Monitoring biodiversity in protected areas is crucial for assessing their effectiveness and providing data for proper management (Le Saout et al. 2013; Thomas & Gillingham 2015; Gray et al. 2016). Since its establishment, the MANP has prioritized scientific research to support evidence-based management and effective conservation strategies (Bocca et al. 2009).

We believe it is crucial to share our findings on the butterflies of the Mont Avic – Mont Emilius massif to expand knowledge of local butterfly diversity and provide a resource for managing and conserving Alpine species and habitats. Our work also establishes a baseline for future research at the local level, especially regarding climate change and altitudinal shift.

## Materials and methods

The study area corresponds to the Special Protection Area (SPA) IT1202020 *Mont Avic and Mont Emilius*, part of the European Natura 2000 Network (Trochet & Schmeller 2013), which is entirely located in the Aosta Valley, in the Northwestern Alps. This SPA includes four additional Special Areas of Conservation (SACs): 1) IT1206054 *Vallone del Grauson*; 2) IT1205065 *Vallone dell'Urtier*; 3) IT1205100 *Ambienti d'alta quota della Vallée de l'Allegne*; and 4) IT1202000 *Mont Avic Natural Park*, a locally protected area that has undergone two recent boundary revisions: on 31 May 2003, with an expansion towards the Champorcher Valley (Regional President's Decree No. 298), and more recently, on 16 May 2023 (RPD No. 390), further extending towards the Clavalité Valley.

This area encompasses a vast territory of the Northwestern Alps, extending from the Cogne Valley in the west along the entire orographic right side of the Dora Baltea River and reaching the border with the Piedmont region in the southeast. The SPA covers an area of 31,544 hectares, with an altitude range spanning 900 to 3,559 meters (Mont Emilius), and features over 20 peaks rising above 3,000 meters (Mont Avic at 3,006 meters).

Five sectors were identified to map the species distribution: i) W sector – Grauson and Urtier valleys; ii) NW sector – Mont Emilius area; iii) N sector – Clavalité and Saint-Marcel valleys; iv) NE sector – Mont Avic area; and v) SE sector – Champorcher valley. Data collection at lower altitudes (from 450 m) was limited to the NE and SE sectors, whereas all other data points are located at higher elevations (from 1,000 m). Data collection extending beyond the formal administrative boundaries of the former SPA, resulting in a study area of at least 41,000 ha (Figure 1). The expanded areas are evident from the data distribution shown in Figure 1. This mountain area hosts a remarkable diversity of habitats (Figure 2), including 28 types listed in Annex I of the *Habitat Directive* 92/43/EEC, six of which are of priority concern (\*). Among these, habitats of particular interest for butterflies include calcareous and siliceous grasslands, which are often rich in herbaceous species (codes 6110, 6150, 6170, 6210, 6230\*, 6240), peat bogs (7110\*, 7140), alpine pioneer formations of the *Caricion bicoloris-atrofuscae* (7240\*), scree and rock faces (8110, 8120, 8130, 8210, 8220, 8230), and limestone pavements (8240\*) (Bocca et al. 2016).

Original data were collected in the whole study area and from 2019 to 2024 by active sampling from March to September, from 500 to 3,559 meters of altitude, as part of three different initiatives: (1) the *COBIO-DIV* project, which focused across the entire study area on eight taxa of interest (*Parnassius apollo*, *P. phoebus*, *Phengaris arion*, *P. alcon ssp. rebeli*, *Euphydryas aurinia*, *Colias palaeno*, *Apatura iris* and *Zerynthia polyxena*). For these target species the COBIODIV project required

the identification of suitable sites where standardized and repeatable long-term sampling could be carried out, following the guidelines established in Italy by ISPRA (Institute for Environmental Protection and Research in Italy) for the monitoring of the species listed in the annexes II and IV of the *Habitat Directive* 92/43/EEC (Stoch & Genovesi 2016). Given the limited knowledge about butterflies in the study area, achieving this goal required extensive field exploration within each valley to locate suitable habitats for the target species and to confirm their presence. Numerous surveys were therefore conducted in many sites, each time investigating the entire butterfly community present, often by explorative linear transects carried out as described in Van Swaay et al. (2012). All collected data, whether from standard sites later selected or from less suitable sites for the target species (including occasional records or non-standardized observations), were georeferenced and archived. These data significantly contributed to improving faunistic and distributional knowledge of butterflies in the study area, together with data collected through the following two initiatives; (2) a standardized monitoring by linear transects as part of the European Butterfly Monitoring Scheme (eBMS; Sevilleja et al. 2020) at three localities, Veulla (1,290 m), Costaz (1,550 m) and Pian Inseta (2,350 m) (see Figure 1), partially supported by the MANP with the valuable support of the park rangers, coordinated by the park ranger Gianna Bosio thanks to her expertise in the field; and (3) additional original data from personal observations (free net sampling and occasional records) by one of the authors (AB) and by Gianna Bosio, with a particular focus on butterfly communities in remote or little-known localities. In addition, previous lists come from the first two inventories promoted by the MANP, which covered the Chalamy Valley (NE sector) from 450 to 2,350 meters, both within and outside the Natural Park (Brockmann et al. 1993); and the Champorcher Valley (SE sector) within the park boundaries from 1,850 to 2,910 meters (Pensati 2007–2008).

Species identification was primarily done in the field, with challenging taxa identified later through photographs or genitalia examination for the genera *Pyrargus*, *Melitaea*, and *Hipparchia*. Taxonomy follows the most recent nomenclature by Wiemers et al. (2018), considering some taxa classified as true species in Italy by Balletto et al. (2014) as subspecies. The ecological preferences (humidity and temperature) presented for each species follow those of Balletto and Kudrna (1985).

## Results

We collected 4,885 recent original data, observing 140 taxa (Table 1), with mesophilous species predominating, followed by thermophilous / xerophilous species (23.97%) and microthermal / hygrophilous species (4.11%).

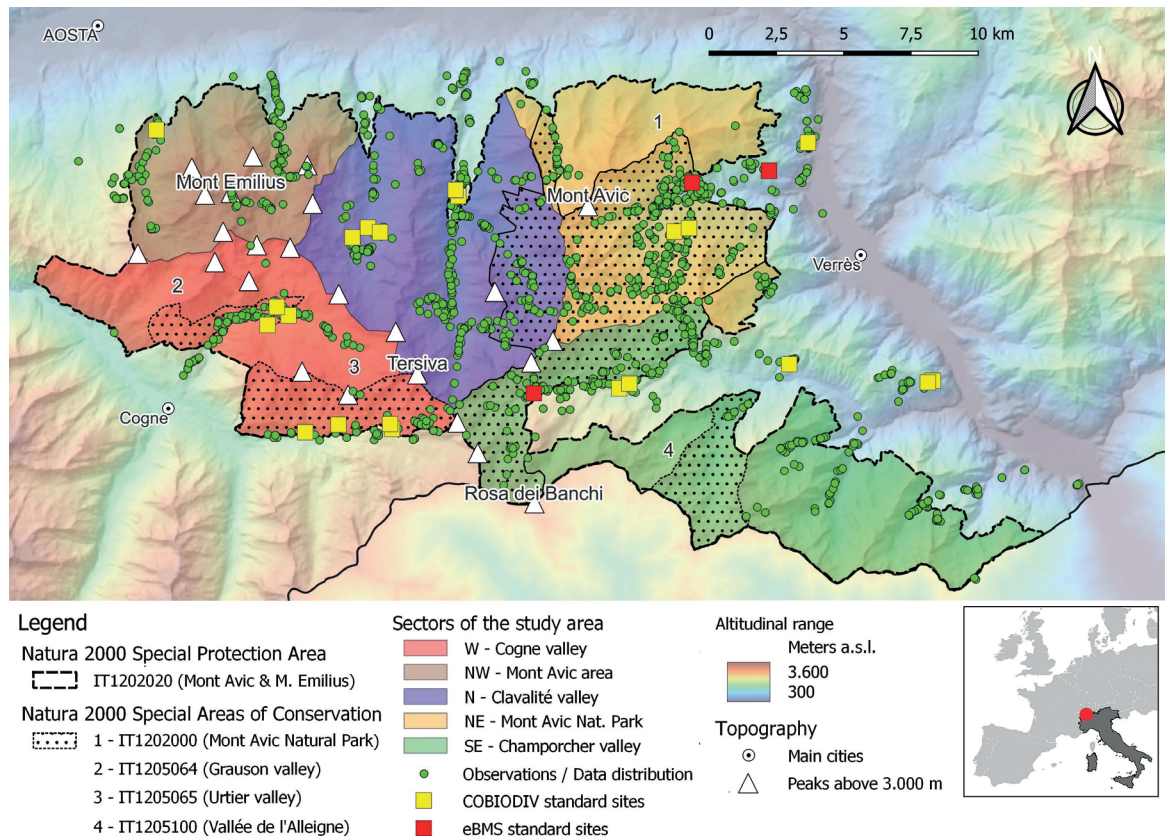


Figure 1 – The study area of the Mont Avic and Mont Emilius massif at the southern border of the Aosta Valley region, North-west Italy. Red dots represent original data from the last five years, with each dot corresponding to one or more observations within an area of approximately 100 m radius. The figure was produced using QGIS (version 3.22; QGIS Development Team); DTM data source: <https://mappe.regione.vda.it/pub/geonavig/geodownload.asp?carta=DTM0508>; Natura2000 spatial data source: <https://www.eea.europa.eu/data-and-maps/data/natura-14/natura-2000-spatial-data>; Map Design: Andrea Battisti 2025.

Two taxa are reported for the first time for the Aosta valley region: *Apatura ilia* and *Neptis rivularis*; and 15 more taxa are reported for the first time for the study area: *Brenthis hecate*, *Coenonympha gardetta* ssp. *darwiniana*, *Colias crocea*, *C. palaeno*, *Erebia medusa*, *E. meolans*, *E. pluto*, *E. triarius*, *Kretania trappi*, *Lybithea celis*, *Polyommatus daphnis*, *Pyrgus cacaliae*, *P. armoricanus*, *Satyrrium spini* and *Thecla betulae*. The total proportion of restricted endemics from the mountains of Southern Europe reaches 11.6% (17 species), including nine taxa exclusive to the Alps (*Pyrgus cacaliae*, *P. carlinae*, *Lycaena hippothoe* ssp. *eurydame*, *L. tityrus* ssp. *subalpina*, *Kretania trappi*, *C. gardetta* ssp. *darwiniana* (without ruling out the ssp. *macrogamma*), *Oeneis glacialis*, *Erebia mnestra*, *E. melampus*). Additionally, eight more taxa are distributed in the Alps and one more mountain range among the Apennines, Pyrenees or Dinaric Alps (*Euchloe simplonia*, *Euphydryas aurinia* ssp. *debilis*, *E. cynthia*, *Melitaea varia*, *Coenonympha gardetta*, *Erebia arvernensis*, *E. pluto*, *E. montana*). The genus *Erebia* is the most represented, with 15 species (10.3%).

Four species of conservation concern at the European level, as listed in Annex II and/or IV of the Habitat Directive 92/43/EEC, are present: *Phengaris arion*, *Parnassius apollo*, *Euphydryas aurinia* and *Zerynthia polyxena*.

## Discussion

The study area hosts a total of 146 taxa, of which 140 were confirmed by the original data of the present study and six were only reported in Brockmann et al. (1993), representing 50.3% of the entire Italian diurnal butterfly fauna (Balletto et al. 2014). Among these, two taxa are not considered valid species by Wiemers et al. (2018): *Coenonympha gardetta* ssp. *darwiniana* and *Lycaena tityrus* ssp. *subalpina*. Two decades ago, Brockmann et al. (1993) only reported *L. tityrus* in the Chalamy Valley, with observations at two different altitudes: at 500 and 2,200 m. Thanks to our recent records, which only refer to *L. t. subalpina*, exclusively observed above 1,290 m, we can deduce that the observations above 2,000 m by Brockmann et al. were probably referred to the latter, leaving us to consider that both ssp. *subalpina* and ssp. *tityrus* are present in the study area, each occupying different elevational ranges.

Within the formal boundaries of the MANP, we can confirm the presence of 113 species. Three of the newly recorded species had already been mentioned by Brockmann et al. (1993) as likely present and have now been confirmed: *C. gardetta* ssp. *darwiniana*, *C. palaeno* and *E. pluto*. Similarly, 15 years ago, Pensati (2007–

2008) recorded *E. aethiops*, *E. gorge* and *P. phoebus* for the first time within the Park's SE sector. We believe that nearly all newly observed species have likely been historically present but remained unrecorded due to sampling deficiencies.

Even in protected and well-managed areas, conservation efforts may be limited by ongoing long-term trends linked to recent climate changes, as observed on larger scales (Holsinger et al. 2019). Although four species are listed in Annex II and/or IV of the Habitats Directive 92/43/EEC, the IUCN Red List classifies them as Near Threatened or Least Concern in Italy (Balletto et al. 2015). The only exception is a fifth species, *Kretania trappi*, which is not included in the annexes of the Habitats Directive but is classified as Vulnerable in Italy. At the European level (Van Swaay et al. 2010), only *Phengaris arion* is Endangered, while 14 species are Near Threatened (see Table 1).

By comparing species diversity across four protected areas in the Alps, each representative of butterfly hotspots: i) the Maritime Alps (Bonelli et al. 2015) – referring to about 28,000 ha; ii) the Mont Avic – Mont Emilius Massif (present study) – 41,000 ha; iii) the Veglia Devero Natural Park (Battisti et al. 2019) – 15,000 ha; and iv) the Stelvio National Park (Bonifacino et al. 2017) – 130,000 ha, we can assess their total species richness, which amounts to 150, 146, 107 and 144 species respectively. The proportion of southern European mountain endemic species of these areas is: 9%, 12%, 12% and 8% respectively. These numbers highlight the remarkable diversity of species across the Alps, including the Mont Avic – Mont Emilius Massif. Nonetheless, species distribution has been shaped by geography and Quaternary glaciations, with glacial refugia and recolonization from surrounding areas contributing to the high biodiversity and presence of unique local endemics in these sectors of the Alps.

Amid the ongoing sixth mass extinction (Ceballos et al. 2015), this study underscores the need to preserve habitats and species in the study area for future generations. Locally, this requires preventing new infrastructure and mitigating overgrazing and over-tourism in both managed and wild areas. Particular attention should be given to ecotones, such as grassy lake, pond banks, forest-grassland and rock-grassland ecotones, but especially to arid medium-altitude slopes, which host the highest diversity within the 1,000–2,500 m belt, consistent with biodiversity patterns observed in the Western Alps by Viterbi et al. (2013).

A discussion of 28 species of interest follows, grouped by topic and alphabetically:

#### Topic 1 - New taxa for the study area

*Apatura ilia* – New species for the Aosta Valley region. A single observation was recorded on 4 August 2022 at 400 m in the NE sector, along the lower Chalamy stream; *Brenthis hecate* – A single observation was recorded on 21 June 2023 at 730 m in the NE sector (the specimen at: <https://www.inaturalist.org/>

observations/168622141). This species appears very rare in the Aosta Valley, with only one other record by Hellmann et al. (1999); *Coenonympha gardetta* ssp. *darwiniana* – This taxon is well represented in the Ossola Valley (Piedmont), while *C. macromma* has recently been confirmed in the Western Alps (Capblancq et al. 2019). In this study, five records likely refer to *C. darwiniana* (three specimens at: <https://www.inaturalist.org/observations/51001628>; .../51001855; .../55679942). Previously, it was recorded in the region only above 2,000 m at Gressoney-La-Trinité (Hellmann et al. 1999), suggesting the left side of the Dora Baltea River as its eastern distribution limit. Schmitt and Besold (2010), who supported species status for all four taxa in this group, proposed *C. darwiniana* as a possible hybrid between *C. arcania* and *C. gardetta*, originating from a Würm glacial refuge and later expanding. Almost all observations above 1,700 m in the study area refer to *C. gardetta* (73 recent observations), while *C. arcania* is well represented from the valley floor up to 1,800 m (94 rec. obs.). In our study area, the closest observations of these two taxa occur on the right side of the Chalamy valley, within the MANP. Here, *C. arcania* is common up to 1,600 m around *La Veuilla*, with a single specimen recorded at 1,700 m in the forest; just 200 m away, *C. gardetta* is common at *Leser Desot* (1,785 m). In five other instances, we observed a short gap (0.7–1.2 km) between the highest *C. arcania* and the lowest *C. gardetta* along the altitudinal gradient in the N, NE and SE sectors. The five records of *C. gardetta* ssp. *darwiniana* were all above 1,800 m, specifically near *Leser Damon*, *Vallette Lake* and *Muffé Lake*, where the two main taxa were observed at their shortest distances. We do not rule out the presence of a *C. darwiniana* population, but we consider it a rare taxon in our study area. However, given its low occurrence density, the possibility of true hybrids cannot be excluded, and it could also be *C. macromma*. This should be supported by the fact that in northern Piedmont *C. darwiniana* is generally common and widespread, but sympatry with *C. gardetta* is not reported (Battisti et al. 2019); *Colias crocea* – This species has been quite common in recent years, with records from 15 localities, including at 2,800 m. Surprisingly, despite being an easily identifiable common species, it was not recorded in the past in the area, and is the only species showing a clear increase in the last decade. This could suggest a recent colonization, or dispersal, to higher altitudes, possibly driven by rising temperatures and decreasing precipitation in northern Italy (Kotlarski et al. 2023; Mombrini et al. 2023); *Colias palaeno* – Already cited as a probable presence by Brockmann et al. (1993), due to the presence in the MANP of *Vaccinium uliginosum* ssp. *microphyllum* (Lange) Tolm. (= *Vaccinium gaultherioides* Bigelow) (Bovio 2014; FLORAVIDA 2025). Recently, *C. palaeno* was confirmed with 12 observations from six localities, in both wet and dry (Figure 2e) open shrublands with both *V. uliginosum* L.



Figure 2 – Habitat examples from the sectors of the study area: a) Mont Emilius with high altitude slopes, NW sector; b) High Urtier valley, W sector; c) Mont Avic Natural Park, NE sector; d) habitat diversity within the small valleys in the N sector; e) alpine dry shrublands, W sector; f) deciduous forests with clearings above 1,000 m, SE sector. © Andrea Battisti (all pictures)

and *V. myrtilus* L.; *Erebia pluto* – Confirmed above 2,600 m throughout its habitat (Figure 2a), with observations from eight localities; *Kretania trappi* – The

rarest European species observed in our study. The first confirmed record originates from the W sector thanks to the fieldwork of Panarietti's master's thesis

(2023). In 2024, a few additional observations were confirmed in the N sector; *Lybithea celtis* – Confirmed by a few observations from a single location at 500 m. It is likely more widespread at lower altitudes in the NE and SE sectors, where the host plant *Celtis australis* L. is known up to 500 m (Bovio 2014; FLORAVDA 2025); *Neptis rivularis* – New species for the Aosta Valley region. A single observation was recorded on 4 August 2022 at 400 m in the NE sector, along the lower Chalamy stream. *Polyommatus daphnis* – This species is known from a few thermophilic locations across the Aosta Valley (Hellmann et al. 1999). In the study area, it is confirmed from a new site: a thermophilic slope in the N sector, featuring rocky outcrops, Scots pine, and herbaceous vegetation. The species was observed there on 19 July 2024, at 1,130 m, close to its known altitudinal limit in Northwest Italy; *Pyrgus cacaliae* – A single specimen was collected on 20 July 2024 at 2,490 m in the N sector, with identification confirmed by genitalia examination. As noted by Hellmann et al. (1999), this species is widespread in the region and was likely just underestimated in the study area; *Pyrgus armoricanus* – A common and widespread species in lowlands, but rare in the Aosta Valley (Hellmann et al. 1999). A single specimen was collected at the southernmost edge of the study area on 14 August 2023, with identification confirmed by genitalia examination (at: <https://www.inaturalist.org/observations/178351010>); *Thecla betulae* – A rare species in the whole region, with no data from the past 20 years based on the results of Alberti et al. (2025). We observed it twice within the MANP, on 21 June 2022 and 3 September 2024 (at: <https://www.inaturalist.org/observations/239592077>). In the recent past, one of the authors (MB) recorded it in the MANP on 22 September 2010, and elsewhere in the region on 19 August 2006 and 10 September 2007, confirming its more regular presence in this Alpine area, leading to think that the species is probably underestimated due to its low detectability.

## Topic 2 – Target species from the project COBIODIV and species of conservation concern

The COBIODIV project focused on eight diurnal butterfly species, selected for their conservation importance or because they are rare or poorly known in the Aosta Valley region:

*Apatura iris* – Previously known in the area from a single observation (Brockmann et al. 1993), this study reports 13 observations from seven localities, all but one outside the Natura 2000 boundaries. The species is well represented at the only site within these boundaries, at 1,630 m in the NW sector, where nectar flowers (*Cardus* sp.) are abundant in the ecotone with the priority habitat 9180\* - Tilio-Acerion forests of slopes, where a maximum of eight individuals were observed feeding together on 10 August 2020; *Colias palaeno* – See Topic 1; *Euphydryas aurinia* ssp. *debilis* – The nominal form is a protected species listed in Annex II of

the Habitats Directive. In the study area *E. aurinia* ssp. *debilis* occurs in the following habitats: 4,060 – alpine heath, 7,110 – raised bogs and 7,140 – transition mires. This taxon (also known as *E. glaciegenita*, Balletto et al. 2014) was previously recorded for two localities in the upper Chalamy and Champorcher valleys, and thanks to this study, its known range expanded to six additional localities. The species appears widespread in the study area and the Alps but remains localized and difficult to observe because its phenology varies across valleys. Adults seem to be active only a few days at each site, flying between late June and mid-August (at higher altitudes or north-facing slopes), showing an earlier flight period than reported in the Gran Paradiso National Park by Casacci et al. (2015). Despite this, *E. a. debilis* is classified as of Least Concern due to its wide distribution and absence of direct threats; *Parnassius apollo* – This protected species is listed in Annex IV of the Habitats Directive. It can reach high local densities, as observed in the W sector, with 41 individuals recorded along a one km transect at 2,200 m on 6 August 2021. The species is widespread between 1,055 and 2,528 m and does not face direct threats. However, CITES Appendix II (CITES 2025) states: *Although not currently at risk of extinction, the species may become so without trade controls*; *Parnassius phoebus* – Confirmed in the MANP only after Pensati (2007–2008), this species is now known abundant and widespread within its habitat, with 73 observations from 29 localities between 1,500 and 3,000 m. Notably, a small stream plain with a north exposure at the lowest altitude (outside Natura 2000) is home to the species, which is active from mid-June but not in July, unlike other sites where it persists until the end of August; *Phengaris arion* – A protected species (Habitats Directive, Annex IV), widespread across the Alps and not facing direct threats in this biogeographic region. In our study area, we recorded 53 observations from 21 localities, ranging from 1,100 to 2,419 m. However, significant densities were never observed, with a maximum of four individuals at any site; *Phengaris alcon* ssp. *rebeli* – This species, referred to as *P. alcon*, had not been observed since 1992 (Brockmann et al. 1993), and was listed as of interest for more recent confirmation and because it is threatened similarly to other European species of *Phengaris* in Europe (Maes et al. 2019; Kajzer-Bonk & Nowicki 2022). Although not protected, it is rarer than *P. arion*, with only 15 records from nine localities, typically with one or two individuals per site. Notably, it was not found every year at known sites. The *P. alcon* complex, which includes various ecotypes across Europe, is debated, with the *rebeli* ecotype being the only taxon reported here. While not considered a valid species by some authors (Wiemers et al. 2018), recent genomic studies (Lucek et al. 2024) recommend recognizing it as a distinct species. In the study area, *P. alcon* ssp. *rebeli* co-occurs with *P. arion* at least at five sites, suggesting that management actions for *P. arion* should also benefit it; *Zerynthia polyxena* – A protected species (Habitats

Directive, Annex IV), previously considered very rare in the region (Hellmann et al. 1999), and therefore targeted for standardized data collection. The COBIO-DIV project helped to confirm a broader distribution than expected, with high local densities in some areas. Notably, 24 adults were observed along a 400 m transect on 16 April 2022. However, all known sites are outside protected areas or the Natura 2000 network, highlighting the need to establish or expand protected sites to include populations of this rare and protected species (Battisti et al. 2023).

### Topic 3 – Species not confirmed in recent years and other species of interest

Four species previously reported by Brockmann et al. (1993) were unconfirmed: *Carcharodus alceae* and *Iolana iolas* – These two species were previously recorded in the study area with only one and two observations, respectively, in the lower Chalamy valley (NE sector). Their occurrence at lower altitudes, combined with their *uncommon presence* as reported by Hellmann et al. (1999), likely contributed to the lack of recent confirmations; *Thymelicus acteon* – The absence of recent observations for this taxon may be linked to its occurrence at lower altitudes and, to a lesser extent, to the limited genitalia examinations of specimens identified as *T. sylvestris*. We only recorded 17 observations from 10 localities of *T. sylvestris*, with just two records from the NE sector below 1,300 m, where Brockmann et al. (1993) reported *T. acteon*. Nevertheless, targeted sampling could confirm the species in the SE and NE sectors, where it is likely present as *common and widespread at lower altitudes in the region* as described by Hellmann et al. (1999); *Melitaea aurelia* – Only one recent observation is available, but it remains doubtful, as the single specimen, recorded in early summer at a relatively low elevation (1,300 m), was not examined for genital structures. Moreover, no other individuals have raised sufficient taxonomic uncertainty to warrant genitalia examination. As with the previously discussed species, it is possible that the limited sampling effort early in the season, at relatively low elevations, was insufficient to confirm the species reported by Brockmann et al. (1993).

We also highlight *Oeneis glacialis*, a species generally considered uncommon, possibly due to its preference for rocky habitats and cliffs, or its biennial life cycle, which may cause it to be absent in alternate years. Notably, all our observations with 16 records from 11 localities were in even years (2020 and 2024).

*Erebia medusa* and *E. meolans* are recorded only in the SE sector and represent a small fraction of the total data. *E. medusa* is restricted to the Fer Creek, with no more than 10 individuals observed at the same localities on 29 June and 14 July 2021, making this the only confirmed site for the species in the region over the past 50 years (Hellmann et al. 1999). *E. meolans*, instead, is known from a single observation at Brenve Creek (at: <https://www.inaturalist.org/observations/123229856>), and is generally rare in the region,

with just one historical record for the SE sector in the study area and only one recent observation elsewhere by one author (AB) (at: <https://www.inaturalist.org/observations/124587186>).

In conclusion, we address the complex *Leptidea sinapis*, where the presence of *L. juvernica* cannot be ruled out, given that identification requires genetic analysis (Dincă et al. 2013), despite suggested differences in trophic niches (Gallo et al. 2015). Ongoing research continues to uncover new taxonomic distinctions across southern Europe (Nazari et al. 2023), including cases of sympatry in mountain regions (Solovyev et al. 2015). For now, we can only confirm the presence of this species complex in the area.

### Conclusions / Highlights

We updated the list of diurnal butterflies (Papilionoidea) occurring in the enlarged Special Protected Area *Mont Avic* and *Mont Emilius* to 146 taxa (50% of the Italian butterfly fauna);

We highlight the notable percentage of endemic or ecologically significant mountain species, emphasizing how this area could be considered a hotspot for butterflies in Europe;

We provide a detailed discussion on 28 taxa of particular interest, along with distribution, abundance and ecology for all taxa.

### Data availability

All data are archived at the offices of the Mont Avic Natural Park Management Authority and may be consulted or used upon request, provided that such use aligns with the Authority's ethical guidelines and receives prior authorization (for further details: <https://montavic.it/#contatti>).

### Acknowledgments

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## Authors

### Andrea Battisti

is a field biologist and naturalist who specialises in birds and diurnal butterflies, with a particular focus on Italian species of conservation concern. His work covers the broader biodiversity of north-western Italy and its associated habitats, including studies on Odonata and Orthoptera.

### Daniele Stellan

has a degree in Natural Sciences and specialises in Freshwater Ecology. He is the author and co-author of numerous scientific and technical articles on the protection and management of Alpine freshwater ecosystems. He is currently the director of the Mont Avic Natural Park in the Aosta Valley.

### Massimo Bocca

has a degree in agronomic sciences and wrote his thesis on entomology. Former Director of the Mont Avic Natural Park and the Natural History Museum of the Aosta Valley. He is the author of over 50 scientific papers on zoology, particularly ornithology.

Table 1 – Checklist of species and their associated information within the study area. Nomenclature follows Wiemers et al. (2018), with subspecies nomenclature as taxa by Balletto et al. (2014) if deemed appropriate. Table details:

- i) Sector codes correspond to cardinal directions (W = West, NW = North-West, N = North, NE = North-East, SE = South-East), as shown in Figure 1;
- ii) Altitudinal range is rounded to the nearest 10 meters. Maximum altitude is highlighted in bold if above 3,000 m and the lowest or highest altitude from a single observation is given in brackets. When the altitudinal limit was not confirmed by the original data of the present work, the reference literature is cited in lowercase brackets as (A) = Brockmann et al. (1993), or (B) = Pensati (2007–2008);
- iii) Abundance estimation based on recent years: ‘Abundant’=more than 100 individuals/year, occurring in more than 20 localities; ‘Common’=more than 10 individuals/year in over 10 localities; ‘Rare’=less than five individuals/year, observed in less than 10 localities at all; ‘Very Rare’=less than three individuals ever recorded; ‘Biblio’=literature data only;
- iv) Occurrence in Natura 2000 sites is marked as ‘x’ if the species has been recorded within the boundaries, or as ‘Pr’ if highly probable due to habitat availability and nearby occurrences;
- v) Ecological preferences categorized by temperature (eurythermal, microthermal, mesothermal, thermophilous) and ground humidity (eurychorous, hygrophilous, mesophilous, xerophilous) following Balletto & Kudrna (1985);
- vi) Species endemic to the mountains of Southern Europe are marked as ‘A’=Alpine, or ‘A+’=if their distribution includes the Alps and one other mountain range among the Apennines, Pyrenees or Dinaric Alps;
- vii) IUCN Red List categories are reported for Italy and Europe as Endangered (EN), Vulnerable (VU), Near Threatened (NT), or Not Evaluated (NE).

For completeness, previously reported nomenclature (Brockmann et al. 1993; Pensati 2007–2008) follows: *Aglaia io* (previously treated as *Inachis io*), *Agriades* sp. (formerly *Vaccinia* sp. or *Albulina* sp.), *Boloria* sp. (prev. *Clossiana* sp.), *Erebria arvernensis* (prev. *E. carmentis*), *Euphydryas cynthia* (prev. *Hypodryas cynthia*), *Euphydryas aurinia* ssp. *debilis* (listed as *Eurodryas* a. or *E. glaciogenita*), *Phengaris* sp. (prev. *Maculinea* sp.), *Plebejus* sp. (prev. as *Lycaeides* sp.), *Melitaea* sp. (prev. *Melicta* sp.), *M. celadussa* (mistaken for *M. athalia* or *M. nevadensis*), *Ochlodes sylvanus* (prev. as *O. venatus*), *Polyommatus* sp. (listed as *Agrodiaetus* sp. or *Plebicula* sp.), *Pontia edusa* (mistaken for *P. daplidice*), *Speyeria aglaja* (listed as *Argynnis* a. or *Mesoacidalia* a.) and *Vanessa cardui* (prev. as *Cynthia* c.).

| Taxon                                                      | Distribution                         | Altitudinal Range [m]                      | Abundance estimation | IT1202000 - Mont Avic & Mont Emilius | IT1202020 - Mont Avic Natural Park (boundaries 2023) | IT1206054 - Vallone del Grauson | IT1205065 - Vallone dell'Urlier | IT1205100 - Vallée de l'Allegne | Ecology (thermal & humidity preferences) | Endemism | Italian Red List | IUCN Red List |
|------------------------------------------------------------|--------------------------------------|--------------------------------------------|----------------------|--------------------------------------|------------------------------------------------------|---------------------------------|---------------------------------|---------------------------------|------------------------------------------|----------|------------------|---------------|
| <b>PAPILIONIDAE</b>                                        |                                      |                                            |                      |                                      |                                                      |                                 |                                 |                                 |                                          |          |                  |               |
| <b>Papilioninae</b>                                        |                                      |                                            |                      |                                      |                                                      |                                 |                                 |                                 |                                          |          |                  |               |
| <i>Iphiclide podalirius</i> (Linnaeus, 1758)               | NW–NE–SE                             | 500–2,550                                  | Rare                 | x                                    | x                                                    | -                               | -                               | -                               | Thermophilous; Mesophilous               |          |                  |               |
| <i>Papilio machaon</i> Linnaeus, 1758                      | whole area                           | 500–2,225                                  | Common               | x                                    | x                                                    | x                               | x                               | -                               | Thermophilous; Mesophilous               |          |                  |               |
| <b>Parnassiinae</b>                                        |                                      |                                            |                      |                                      |                                                      |                                 |                                 |                                 |                                          |          |                  |               |
| <i>Parnassius phebue</i> (Fabricius, 1793)                 | W–NW–N–SE                            | 1,510–3,010                                | Common               | x                                    | x                                                    | x                               | x                               | x                               | Thermophilous; Hygrophilous              |          |                  | NT            |
| <i>Parnassius apollo</i> (Linnaeus, 1758)                  | whole area                           | 1,050–2,530                                | Abundant             | x                                    | x                                                    | x                               | x                               | x                               | Mesotherma; Xerophilous                  |          |                  | NT            |
| <i>Zerynthia polyxena</i> ([Denis & Schiffermüller], 1775) | NE–SE                                | 640–1,460                                  | Common               | -                                    | -                                                    | -                               | -                               | -                               | Mesothermal; Mesophilous                 |          |                  |               |
| <b>HESPERIIDAE</b>                                         |                                      |                                            |                      |                                      |                                                      |                                 |                                 |                                 |                                          |          |                  |               |
| <b>Heteropterinae</b>                                      |                                      |                                            |                      |                                      |                                                      |                                 |                                 |                                 |                                          |          |                  |               |
| <i>Carterocephalus palaemon</i> (Pallas, 1771)             | N–NE–SE                              | 1,280–1,970                                | Rare                 | x                                    | x                                                    | -                               | -                               | -                               | Mesothermal; Mesophilous                 |          |                  |               |
| <b>Hesperiinae</b>                                         |                                      |                                            |                      |                                      |                                                      |                                 |                                 |                                 |                                          |          |                  |               |
| <i>Ochlodes sylvanus</i> (Esper, 1777)                     | NW–N–NE–SE                           | 700–1,890                                  | Common               | x                                    | x                                                    | -                               | -                               | -                               | Mesothermal; Mesophilous                 |          |                  |               |
| <i>Hesperia comma</i> (Linnaeus, 1758)                     | whole area                           | 1,290–2,590                                | Abundant             | x                                    | x                                                    | x                               | x                               | x                               | Thermophilous; Mesophilous               |          |                  |               |
| <i>Thymelicus acteon</i> (Rottemburg, 1775)                | NE <sub>(A)</sub>                    | 520–1,310                                  | (Biblio)             | -                                    | -                                                    | -                               | -                               | -                               | Thermophilous; Mesophilous               |          |                  | NT            |
| <i>Thymelicus sylvestris</i> (Poda, 1761)                  | whole area                           | 720–2,130                                  | Common               | x                                    | x                                                    | -                               | x                               | -                               | Thermophilous; Mesophilous               |          |                  |               |
| <i>Thymelicus lineola</i> (Ochsenheimer, 1808)             | whole area                           | 1,260–2,380                                | Common               | x                                    | x                                                    | Pr                              | x                               | Pr                              | Mesothermal; Mesophilous                 |          |                  |               |
| <b>Pyrginae</b>                                            |                                      |                                            |                      |                                      |                                                      |                                 |                                 |                                 |                                          |          |                  |               |
| <i>Spialia sertorius</i> (Hoffmansegg, 1804)               | whole area                           | 1,290–2,320                                | Rare                 | x                                    | x                                                    | x                               | -                               | -                               | Mesothermal; Mesophilous                 |          |                  |               |
| <i>Carcharodus alceae</i> (Esper, 1780)                    | NE <sub>(A)</sub>                    | 500                                        | (Biblio)             | -                                    | -                                                    | -                               | -                               | -                               | Mesothermal; Mesophilous                 |          |                  |               |
| <i>Carcharodus lavatherae</i> (Esper, 1783)                | N–NE <sub>(A)</sub>                  | 450 <sub>(A)</sub> –1,530                  | Rare                 | -                                    | -                                                    | -                               | -                               | -                               | Thermophilous; Xerophilous               |          |                  | NT            |
| <i>Carcharodus floccifera</i> (Zeller, 1847)               | W–N–NE <sub>(A)</sub>                | 1,250 <sub>(A)</sub> –2,340                | Rare                 | x                                    | Pr                                                   | Pr                              | x                               | -                               | Eurythermal; Eurychorous                 |          |                  | NT            |
| <i>Erynnis tages</i> (Linnaeus, 1758)                      | W–N–NE–SE                            | 730–2,310                                  | Common               | x                                    | x                                                    | Pr                              | Pr                              | Pr                              | Eurythermal; Mesophilous                 |          |                  |               |
| <i>Pyrgus malvoides</i> (Elwes & Edwards, 1897)            | whole area                           | 500 <sub>(A)</sub> –2,640 <sub>(B)</sub>   | Common               | x                                    | x                                                    | Pr                              | x                               | Pr                              | Mesothermal; Mesophilous                 |          |                  |               |
| <i>Pyrgus carthami</i> (Hübner, [1813])                    | W–N–NE–SE                            | 450 <sub>(A)</sub> –2,280                  | Common               | x                                    | x                                                    | x                               | Pr                              | -                               | Thermophilous; Mesophilous               |          |                  |               |
| <i>Pyrgus cacaliae</i> (Rambur, 1839)                      | N                                    | 2,490                                      | Very Rare            | x                                    | -                                                    | -                               | -                               | -                               | Mesothermal; Mesophilous                 | A        |                  |               |
| <i>Pyrgus alveus</i> (Hübner, [1803])                      | NE <sub>(A)</sub> –SE <sub>(B)</sub> | 1,550 <sub>(A)</sub> –2,690 <sub>(B)</sub> | Rare                 | x                                    | x                                                    | -                               | -                               | -                               | Mesothermal; Xerophilous                 |          |                  |               |
| <i>Pyrgus andromedae</i> (Wallangren, 1853)                | N–NE <sub>(A)</sub> –SE              | 1,490–2,310                                | Rare                 | x                                    | x                                                    | -                               | -                               | x                               | Eurythermal; Mesophilous                 |          |                  |               |

|                                                                    |                            |                                           |           |   |   |    |    |    |                             |    |    |    |
|--------------------------------------------------------------------|----------------------------|-------------------------------------------|-----------|---|---|----|----|----|-----------------------------|----|----|----|
| <i>Pyrgus armoricanus</i> (Oberthür, 1910)                         | SE                         | 540                                       | Very Rare | - | - | -  | -  | -  | Thermophilous; Mesophilous  |    |    |    |
| <i>Pyrgus carlinae</i> (Rambur, [1839])                            | whole area                 | 1,520–2,620                               | Common    | x | x | x  | x  | Pr | Mesothermal; Xerophilous    | A  |    |    |
| <b>PIERIDAE</b>                                                    |                            |                                           |           |   |   |    |    |    |                             |    |    |    |
| <b>Dismorphiinae</b>                                               |                            |                                           |           |   |   |    |    |    |                             |    |    |    |
| <i>Complex Leptidea sinapis</i> (Linnaeus, 1758)                   | whole area                 | 520–1,880                                 | Common    | x | x | -  | -  | x  | Mesothermal; Mesophilous    |    |    |    |
| <b>Coliadinae</b>                                                  |                            |                                           |           |   |   |    |    |    |                             |    |    |    |
| <i>Gonepteryx rhamni</i> (Linnaeus, 1758)                          | whole area                 | 500 <sub>(A)</sub> –2,330 <sub>(B)</sub>  | Common    | x | x | -  | -  | Pr | Mesothermal; Mesophilous    |    |    |    |
| <i>Colias alfacariensis</i> Ribbe, 1905                            | W–NW–NE <sub>(A)</sub> –SE | 1,300 <sub>(A)</sub> –2,500               | Common    | x | x | x  | x  | -  | Thermophilous; Mesophilous  |    |    |    |
| <i>Colias phicomone</i> (Esper, [1780])                            | whole area                 | 1,720–2,850 <sub>(B)</sub>                | Abundant  | x | x | x  | x  | Pr | Mesothermal; Xerophilous    |    |    | NT |
| <i>Colias crocea</i> (Geoffroy, 1785)                              | W–N–NE–SE                  | 730–2,800                                 | Common    | x | x | x  | Pr | Pr | Thermophilous; Mesophilous  |    |    |    |
| <i>Colias palaeno</i> (Linnaeus, [1760])                           | NW–N–NE–SE                 | (1,620)<br>2,050–2,470                    | Rare      | x | x | -  | -  | Pr | Mesothermal; Hygrophilous   |    |    |    |
| <b>Pierinae</b>                                                    |                            |                                           |           |   |   |    |    |    |                             |    |    |    |
| <i>Aporia crataegi</i> (Linnaeus, 1758)                            | whole area                 | 500 <sub>(A)</sub> –2,520                 | Abundant  | x | x | x  | x  | Pr | Mesothermal; Mesophilous    |    |    |    |
| <i>Pontia callidice</i> (Hübner, [1800])                           | whole area                 | 2,000–3,559                               | Common    | x | x | Pr | Pr | Pr | Microthermal; Xerophilous   |    |    |    |
| <i>Pontia edusa</i> (Fabricius, 1777)                              | NE                         | 500–1,530                                 | Rare      | x | x | -  | -  | -  | Thermophilous; Xerophilous  |    |    |    |
| <i>Pieris brassicae</i> (Linnaeus, 1758)                           | N–NE–SE                    | 500–2,330 <sub>(B)</sub>                  | Rare      | x | x | -  | -  | -  | Mesophilous                 |    |    |    |
| <i>Pieris rapae</i> (Linnaeus, 1758)                               | SE                         | 500–2,820                                 | Common    | x | x | Pr | x  | Pr | Eurythermal; Mesophilous    |    |    |    |
| <i>Pieris mannii</i> (Mayer, 1851)                                 | NE                         | 500 <sub>(A)</sub> –730<br>(1,300)        | Rare      | - | - | -  | -  | -  | Thermophilous; Xerophilous  |    |    |    |
| <i>Pieris bryoniae</i> (Hübner, [1806])                            | whole area                 | (500 <sub>(A)</sub> )<br>1,430–2,350      | Abundant  | x | x | Pr | Pr | Pr | Microthermal; Mesophilous   |    |    |    |
| <i>Pieris napi</i> (Linnaeus, 1758)                                | whole area                 | 500–1,940<br>(2,160)                      | Common    | x | x | Pr | Pr | x  | Mesothermal; Mesophilous    |    |    |    |
| <i>Euchloe simplonia</i> (Freyer, 1829)                            | NW–N–NE–SE <sub>(B)</sub>  | (1,400)<br>1,900–2,300                    | Rare      | x | x | -  | -  | -  | Mesothermal; Xerophilous    | A+ |    |    |
| <i>Anthocharis cardamines</i> (Linnaeus, 1758)                     | N–NE–SE                    | 500–2,230 <sub>(B)</sub>                  | Common    | x | x | -  | -  | Pr | Mesothermal; Mesophilous    |    |    |    |
| <b>RIODINIDAE</b>                                                  |                            |                                           |           |   |   |    |    |    |                             |    |    |    |
| <b>Nemeobiinae</b>                                                 |                            |                                           |           |   |   |    |    |    |                             |    |    |    |
| <i>Hamearis lucina</i> (Linnaeus, 1758)                            | W–N–NE–SE                  | 500–1,510                                 | Rare      | x | x | -  | -  | -  | Mesothermal; Mesophilous    |    |    |    |
| <b>LYCAENIDAE</b>                                                  |                            |                                           |           |   |   |    |    |    |                             |    |    |    |
| <b>Lycaeninae</b>                                                  |                            |                                           |           |   |   |    |    |    |                             |    |    |    |
| <i>Lycaena alciphron</i> (Rottemburg, 1775)                        | W–NW–N–NE                  | 500–1,870                                 | Common    | x | x | Pr | Pr | -  | Mesothermal; Xerophilous    |    |    |    |
| <i>Lycaena hippothoe</i> ssp. <i>eurydame</i> (Hoffmannsegg, 1806) | whole area                 | 1,100 <sub>(A)</sub> –2,640               | Common    | x | x | x  | x  | Pr | Mesothermal; Mesophilous    | A  |    |    |
| <i>Lycaena phlaeas</i> (Linnaeus, [1760])                          | NE–SE                      | 500–1,560                                 | Common    | x | x | -  | -  | -  | Thermophilous; Eurychorous  |    |    |    |
| <i>Lycaena virgaurea</i> (Linnaeus, 1758)                          | whole area                 | 1,000–2,300                               | Common    | x | x | x  | Pr | x  | Mesothermal; Mesophilous    |    |    |    |
| <i>Lycaena tityrus</i> (Poda, 1761)                                | NE                         | 500 <sub>(A)</sub>                        | (Biblio)  | - | - | -  | -  | -  | Mesothermal; Mesophilous    |    |    |    |
| <i>Lycaena tityrus</i> ssp. <i>subalpina</i> (Speyer, 1851)        | W–N–NE–SE                  | 1,290–2,310                               | Common    | x | x | x  | Pr | Pr | Mesothermal; Mesophilous    | A  |    |    |
| <b>Theclinae</b>                                                   |                            |                                           |           |   |   |    |    |    |                             |    |    |    |
| <i>Thecla betulae</i> (Linnaeus, 1758)                             | NE                         | 1,550                                     | Very Rare | x | x | -  | -  | -  | Mesothermal; Mesophilous    |    |    |    |
| <i>Favonius quercus</i> (Linnaeus, 1758)                           | NE <sub>(A)</sub>          | 500 <sub>(A)</sub>                        | (Biblio)  | - | - | -  | -  | -  | Thermophilous; Mesophilous  |    |    |    |
| <i>Callophrys rubi</i> (Linnaeus, 1758)                            | N–NE–SE                    | 610–2,230                                 | Common    | x | x | -  | -  | Pr | Eurythermal; Mesophilous    |    |    |    |
| <i>Satyrus ilicis</i> (Esper, 1779)                                | NE                         | 500–1,350                                 | Very Rare | - | - | -  | -  | -  | Thermophilous; Mesophilous  |    |    |    |
| <i>Satyrus spini</i> ([Denis & Schiffermüller], 1775)              | NW–N                       | 1,280–2,350                               | Rare      | x | - | -  | -  | -  | Mesothermal; Mesophilous    |    |    |    |
| <b>Polyommatainae</b>                                              |                            |                                           |           |   |   |    |    |    |                             |    |    |    |
| <i>Celastrina argiolus</i> (Linnaeus, 1758)                        | NE–SE                      | 725–1,300                                 | Rare      | - | - | -  | -  | -  | Mesothermal; Mesophilous    |    |    |    |
| <i>Phengaris alcon</i> ssp. <i>rebeli</i> (Hirschke, 1905)         | NW–N–NE–SE                 | 1,100 <sub>(A)</sub> –2,350               | Rare      | x | x | -  | -  | -  | Thermophilous; Hygrophilous |    |    |    |
| <i>Phengaris arion</i> (Linnaeus, 1758)                            | W–N–NE–SE                  | 1,100–2,420                               | Common    | x | x | x  | x  | Pr | Thermophilous; Xerophilous  |    |    | EN |
| <i>Scolitantides orion</i> (Pallas, 1771)                          | NE–SE                      | 500–1,310                                 | Rare      | x | - | -  | -  | -  | Thermophilous; Xerophilous  |    |    |    |
| <i>Iolana iolas</i> (Ochsenheimer, 1816)                           | NE <sub>(A)</sub>          | 500–1,250                                 | (Biblio)  | - | - | -  | -  | -  | Thermophilous; Xerophilous  |    | NT | NT |
| <i>Glaucopteryx alexis</i> (Poda, 1761)                            | N–NE–SE                    | 500–1,680                                 | Rare      | - | - | -  | -  | -  | Mesothermal; Mesophilous    |    |    |    |
| <i>Cupido osiris</i> (Meigen, 1829)                                | W–NE                       | 1,500–2,333                               | Rare      | x | - | -  | x  | -  | Mesothermal; Mesophilous    |    |    |    |
| <i>Cupido minimus</i> (Fuessly, 1775)                              | whole area                 | (500 <sub>(A)</sub> )<br>1,500–2,620      | Abundant  | x | x | x  | x  | Pr | Thermophilous; Xerophilous  |    |    |    |
| <i>Plebejus argus</i> (Linnaeus, 1758)                             | W–N–NE–SE                  | 1,250–2,360                               | Common    | x | x | -  | -  | Pr | Mesothermal; Mesophilous    |    |    |    |
| <i>Plebejus idas</i> (Linnaeus, [1760])                            | whole area                 | 1,500–2,530                               | Abundant  | x | x | x  | x  | Pr | Mesothermal; Mesophilous    |    |    |    |
| <i>Agriades orbitulus</i> (Prunner, 1798)                          | whole area                 | 1,800–2,810                               | Rare      | x | x | x  | x  | -  | Microthermal; Xerophilous   |    |    |    |
| <i>Agriades optilete</i> (Knoch, 1781)                             | NW–N–NE                    | 1,550–2,370                               | Rare      | x | x | -  | -  | -  | Microthermal; Hygrophilous  |    |    |    |
| <i>Agriades glandon</i> (Prunner, 1798)                            | whole area                 | 2,023–2,720                               | Common    | x | x | x  | x  | Pr | Microthermal; Hygrophilous  |    |    |    |
| <i>Eumedonia eumedon</i> (Esper, 1780)                             | NW–N–NE–SE                 | (1,100 <sub>(A)</sub> )<br>1,700–2,310    | Common    | x | x | -  | -  | Pr | Mesothermal; Mesophilous    |    |    |    |
| <i>Kretania trappi</i> (Verity, 1927)                              | W–N                        | 1,510–1,860                               | Rare      | x | - | Pr | Pr | -  | Thermophilous; Xerophilous  | A  | VU | NT |
| <i>Cyaniris semiargus</i> (Rottemburg, 1775)                       | whole area                 | (500 <sub>(A)</sub> ) 1,100–2,700 (3,010) | Abundant  | x | x | x  | x  | x  | Mesothermal; Mesophilous    |    |    |    |
| <i>Aricia nicias</i> (Meigen, 1829)                                | whole area                 | 1,550–2,400                               | Common    | x | x | x  | x  | -  | Microthermal; Mesophilous   |    |    |    |
| <i>Aricia artaxerses</i> ssp. <i>allous</i> (Geyer, [1837])        | whole area                 | 1,470–2,400                               | Common    | x | x | x  | x  | x  | Mesothermal; Mesophilous    |    |    |    |
| <i>Aricia agestis</i> ([Denis & Schiffermüller], 1775)             | NE–SE                      | 1,150–1,550                               | Rare      | x | x | -  | -  | -  | Mesothermal; Mesophilous    |    |    |    |

|                                                                     |                   |                                                       |           |   |    |    |    |    |                            |    |  |    |
|---------------------------------------------------------------------|-------------------|-------------------------------------------------------|-----------|---|----|----|----|----|----------------------------|----|--|----|
| <i>Lysandra bellargus</i> (Rottemburg, 1775)                        | W–N–NE–SE         | 450 <sub>(A)</sub> –2,190<br>(2,550 <sub>(B)</sub> )  | Common    | x | x  | Pr | Pr | -  | Thermophilous; Xerophilous |    |  |    |
| <i>Lysandra coridon</i> (Poda, 1761)                                | whole area        | 1,100–2,600                                           | Abundant  | x | x  | x  | x  | x  | Thermophilous; Xerophilous |    |  |    |
| <i>Polyommatus escheri</i> (Hübner, [1823])                         | W–N–NE            | 1,500–2,380                                           | Rare      | x | -  | Pr | Pr | -  | Thermophilous; Mesophilous |    |  |    |
| <i>Polyommatus thersites</i> (Cantener, 1835)                       | N–NE              | 1,060–1,500<br>(1,800 <sub>(A)</sub> )                | Rare      | - | -  | -  | -  | -  | Thermophilous; Xerophilous |    |  |    |
| <i>Polyommatus daphnis</i> ([Denis & Schiffermüller], 1775)         | NW                | 1,130                                                 | Very Rare | - | -  | -  | -  | -  | Thermophilous; Xerophilous |    |  |    |
| <i>Polyommatus dorylas</i> ([Denis & Schiffermüller], 1775)         | whole area        | 1,050–2,570                                           | Common    | x | x  | x  | x  | x  | Thermophilous; Xerophilous |    |  | NT |
| <i>Polyommatus icarus</i> (Rottemburg, 1775)                        | N–NE–SE           | 450–2,000                                             | Common    | x | x  | -  | -  | Pr | Eurythermal; Eurichorous   |    |  |    |
| <i>Polyommatus eros</i> (Ochsenheimer, 1808)                        | W–N–NE–SE         | 1,860–2,700                                           | Common    | x | x  | x  | x  | -  | Mesothermal; Mesophilous   |    |  | NT |
| <i>Polyommatus damon</i> ([Denis & Schiffermüller], 1775)           | whole area        | 1,510–2,400                                           | Abundant  | x | x  | x  | x  | Pr | Thermophilous; Xerophilous |    |  | NT |
| <b>NYMPHALIDAE</b>                                                  |                   |                                                       |           |   |    |    |    |    |                            |    |  |    |
| <b>Limnitiidae</b>                                                  |                   |                                                       |           |   |    |    |    |    |                            |    |  |    |
| <i>Neptis rivularis</i> (Scopoli, 1763)                             | NE                | < 500                                                 | Very Rare | - | -  | -  | -  | -  | Mesothermal; Mesophilous   |    |  |    |
| <i>Limnitis reducta</i> Staudinger, 1901                            | N–NE              | 510–1,350                                             | Rare      | - | -  | -  | -  | -  | Mesothermal; Mesophilous   |    |  |    |
| <i>Limnitis populi</i> (Linnaeus, 1758)                             | N–NE              | 1,060–1,170                                           | Rare      | - | -  | -  | -  | -  | Mesothermal; Mesophilous   |    |  |    |
| <b>Heliconiinae</b>                                                 |                   |                                                       |           |   |    |    |    |    |                            |    |  |    |
| <i>Issoria lathonia</i> (Linnaeus, 1758)                            | whole area        | 500–2,520                                             | Abundant  | x | x  | x  | x  | Pr | Thermophilous; Mesophilous |    |  |    |
| <i>Brenthis hecate</i> ([Denis & Schiffermüller], 1775)             | NE                | 730                                                   | Very Rare | - | -  | -  | -  | -  | Mesothermal; Mesophilous   |    |  |    |
| <i>Brenthis ino</i> (Rottemburg, 1775)                              | NW–N–NE           | 1,300–1,900                                           | Rare      | x | Pr | -  | -  | -  | Mesothermal; Hygrophilous  |    |  |    |
| <i>Brenthis daphne</i> ([Denis & Schiffermüller], 1775)             | NW–N–NE           | 500–1,650                                             | Rare      | x | Pr | -  | -  | -  | Mesothermal; Mesophilous   |    |  |    |
| <i>Argynnis paphia</i> (Linnaeus, 1758)                             | NW–N–NE           | 500–1,790                                             | Common    | x | x  | -  | -  | -  | Mesothermal; Mesophilous   |    |  |    |
| <i>Speyeria aglaja</i> (Linnaeus, 1758)                             | whole area        | 1,070–2,500                                           | Abundant  | x | x  | x  | x  | x  | Mesothermal; Mesophilous   |    |  |    |
| <i>Fabriciana niobe</i> (Linnaeus, 1758)                            | whole area        | (1,100 <sub>(A)</sub> )<br>1,300–2,730 <sub>(B)</sub> | Abundant  | x | x  | x  | x  | x  | Mesothermal; Mesophilous   |    |  |    |
| <i>Fabriciana adippe</i> ([Denis & Schiffermüller], 1775)           | NW–NE–SE          | 1,120–2,420                                           | Rare      | x | x  | -  | -  | Pr | Mesothermal; Mesophilous   |    |  |    |
| <i>Boloria pales</i> ([Denis & Schiffermüller], 1775)               | whole area        | (1,550 <sub>(A)</sub> )<br>2,130–3,010                | Rare      | x | x  | Pr | x  | Pr | Mesothermal; Xerophilous   |    |  |    |
| <i>Boloria napaea</i> (Hoffmansegg, 1804)                           | whole area        | 1,950–2,880                                           | Abundant  | x | x  | x  | x  | Pr | Mesothermal; Hygrophilous  |    |  |    |
| <i>Boloria euphrosyne</i> (Linnaeus, 1758)                          | whole area        | (1,100 <sub>(A)</sub> )<br>1,300–2,310                | Abundant  | x | x  | x  | Pr | Pr | Mesothermal; Mesophilous   |    |  |    |
| <i>Boloria titania</i> (Esper, [1793])                              | whole area        | 1,290–2,300                                           | Common    | x | x  | Pr | Pr | Pr | Mesothermal; Hygrophilous  |    |  | NT |
| <b>Apaturinae</b>                                                   |                   |                                                       |           |   |    |    |    |    |                            |    |  |    |
| <i>Apatura iris</i> (Linnaeus, 1758)                                | NW–N–NE–SE        | 820–1,680                                             | Common    | x | -  | -  | -  | Pr | Mesothermal; Mesophilous   |    |  |    |
| <i>Apatura ilia</i> ([Denis & Schiffermüller], 1775)                | NE                | < 500                                                 | Very Rare | - | -  | -  | -  | -  | Mesothermal; Mesophilous   |    |  |    |
| <b>Nymphalinae</b>                                                  |                   |                                                       |           |   |    |    |    |    |                            |    |  |    |
| <i>Vanessa cardui</i> (Linnaeus, 1758)                              | whole area        | 500–3,010                                             | Common    | x | x  | Pr | Pr | Pr | Mesothermal; Euricora      |    |  |    |
| <i>Vanessa atalanta</i> (Linnaeus, 1758)                            | whole area        | 500–2,590                                             | Common    | x | x  | x  | Pr | Pr | Mesothermal; Mesophilous   |    |  |    |
| <i>Aglais io</i> (Linnaeus, 1758)                                   | NE–SE             | 500 <sub>(A)</sub> –2,680                             | Rare      | x | x  | -  | -  | -  | Ubiquitous                 |    |  |    |
| <i>Aglais urticae</i> (Linnaeus, 1758)                              | whole area        | 500–3,180                                             | Abundant  | x | x  | x  | x  | x  | Ubiquitous                 |    |  |    |
| <i>Polygonia c-album</i> (Linnaeus, 1758)                           | NW–N–NE–SE        | 500–1,730<br>(2,030)                                  | Common    | x | x  | -  | -  | Pr | Mesothermal; Mesophilous   |    |  |    |
| <i>Nymphalis polychloros</i> (Linnaeus, 1758)                       | NE–SE             | 520–1,310                                             | Rare      | - | -  | -  | -  | -  | Mesothermal; Mesophilous   |    |  |    |
| <i>Nymphalis antiopa</i> (Linnaeus, 1758)                           | NW–N–NE–SE        | 500–2,290                                             | Rare      | x | x  | -  | -  | Pr | Mesothermal; Mesophilous   |    |  |    |
| <i>Euphydryas aurinia</i> (Rottemburg, 1775)                        | whole area        | 1,970–2,710                                           | Common    | x | x  | x  | x  | Pr | Mesothermal; Mesophilous   | A+ |  |    |
| <i>Euphydryas debilis</i> (Oberthür, 1909)                          | whole area        | (1,550)<br>2,260–2,710 <sub>(B)</sub>                 | Common    | x | x  | x  | Pr | Pr | Mesothermal; Xerophilous   | A+ |  |    |
| <i>Melitaea didyma</i> (Esper, 1778)                                | W–N–NE–SE         | 500–2,190                                             | Common    | x | x  | x  | x  | -  | Thermophilous; Mesophilous |    |  |    |
| <i>Melitaea phoebe</i> ([Denis & Schiffermüller], 1775)             | whole area        | 500–2,390                                             | Common    | x | x  | x  | x  | x  | Thermophilous; Mesophilous |    |  |    |
| <i>Melitaea cinxia</i> (Linnaeus, 1758)                             | W–N–NE–SE         | 500 <sub>(A)</sub> –2,350                             | Common    | x | x  | Pr | x  | Pr | Thermophilous; Mesophilous |    |  |    |
| <i>Melitaea diamina</i> (Lang, 1789)                                | NW–N–NE–SE        | (1,100 <sub>(A)</sub> )<br>1,520–2,280                | Rare      | x | x  | x  | x  | Pr | Mesothermal; Hygrophilous  |    |  |    |
| <i>Melitaea celadussa</i> Fruhstorfer, 1910                         | whole area        | 500–2,300                                             | Abundant  | x | x  | x  | x  | x  | Mesothermal; Mesophilous   |    |  |    |
| <i>Melitaea deione</i> (Geyer, [1832])                              | NE                | 1,000–1,550                                           | Rare      | x | x  | -  | -  | -  | Thermophilous; Mesophilous |    |  |    |
| <i>Melitaea varia</i> Herrich-Schäffer, 1851                        | whole area        | 1,500–2,510                                           | Common    | x | x  | x  | x  | Pr | Mesothermal; Mesophilous   | A+ |  |    |
| <i>Melitaea aurelia</i> Nickerl, 1850                               | NE <sub>(A)</sub> | 1,100–1,500                                           | (Biblio)  | - | -  | -  | -  | -  | Mesothermal; Mesophilous   |    |  | NT |
| <b>Libytheinae</b>                                                  |                   |                                                       |           |   |    |    |    |    |                            |    |  |    |
| <i>Libythea celtis</i> (Laicharting, 1782)                          | NE                | 510–530                                               | Very Rare | - | -  | -  | -  | -  | Mesothermal; Mesophilous   |    |  |    |
| <b>Satyrinae</b>                                                    |                   |                                                       |           |   |    |    |    |    |                            |    |  |    |
| <i>Coenonympha pamphilus</i> (Linnaeus, 1758)                       | whole area        | 500–1,930                                             | Common    | x | x  | -  | -  | Pr | Eurythermal; Euricora      |    |  |    |
| <i>Coenonympha gardetta</i> (Prunner, 1798)                         | whole area        | (1,420)<br>1,710–2,780                                | Abundant  | x | x  | x  | x  | x  | Mesothermal; Mesophilous   | A+ |  |    |
| <i>Coenonympha gardetta</i> ssp. <i>darwiniana</i> Staudinger, 1871 | NE–SE             | 1,890–2,180                                           | Rare      | x | x  | -  | -  | -  | Mesothermal; Mesophilous   | A  |  |    |
| <i>Coenonympha arcania</i> (Linnaeus, [1760])                       | NW–N–NE–SE        | 520–1,840<br>(2,060 <sub>(B)</sub> )                  | Abundant  | x | x  | -  | -  | Pr | Mesothermal; Mesophilous   |    |  |    |

|                                                       |            |                                        |            |   |   |    |    |    |                            |    |  |    |
|-------------------------------------------------------|------------|----------------------------------------|------------|---|---|----|----|----|----------------------------|----|--|----|
| <i>Pararge aegeria</i> (Linnaeus, 1758)               | N-NE-SE    | 520–1,750                              | Common     | x | x | -  | -  | Pr | Mesothermal; Mesophilous   |    |  |    |
| <i>Lasiommata maera</i> (Linnaeus, 1758)              | whole area | 500–2,130                              | Abundant   | x | x | x  | x  | x  | Mesothermal; Mesophilous   |    |  |    |
| <i>Lasiommata petropolitana</i> (Fabricius, 1787)     | whole area | (1,100 <sub>(A)</sub> )<br>1,350–2,010 | Common     | x | x | Pr | Pr | x  | Mesothermal; Mesophilous   |    |  |    |
| <i>Lasiommata megera</i> (Linnaeus, 1767)             | NE-SE      | 500–1,530                              | Common     | x | x | -  | -  | Pr | Eurythermal; Xerophilous   |    |  |    |
| <i>Melanargia galathea</i> (Linnaeus, 1758)           | whole area | 520–2,150                              | Abundant   | x | x | x  | x  | x  | Mesothermal; Mesophilous   |    |  |    |
| <i>Hipparchia fagi</i> (Scopoli, 1763)                | NW-N-NE-SE | (500 <sub>(A)</sub> )<br>1,070–1,520   | Common     | x | x | -  | -  | Pr | Mesothermal; Mesophilous   |    |  | NT |
| <i>Hipparchia semele</i> (Linnaeus, 1758)             | W-NW-N-NE  | 1,140–2,010                            | Rare       | x | x | Pr | Pr | -  | Thermophilous; Mesophilous |    |  |    |
| <i>Brintesia circe</i> (Fabricius, 1775)              | NE         | 500–1,780                              | Rare       | x | x | -  | -  | -  | Mesothermal; Xerophilous   |    |  |    |
| <i>Oeneis glacialis</i> (Moll, 1785)                  | NW-N-NE-SE | 1,500–2,650                            | Common[15] | x | x | -  | -  | Pr | Mesothermal; Xerophilous   | A  |  |    |
| <i>Satyrus ferula</i> (Fabricius, 1793)               | whole area | 1,070–1,740<br>(2,430)                 | Abundant   | x | x | x  | x  | x  | Thermophilous; Xerophilous |    |  |    |
| <i>Hyponephele lycaon</i> (Kühn, 1774)                | whole area | 1,070–2,190                            | Abundant   | x | x | x  | x  | Pr | Thermophilous; Xerophilous |    |  |    |
| <i>Aphantopus hyperantus</i> (Linnaeus, 1758)         | NW-N-NE-SE | 1,030–1,440                            | Rare       | - | - | -  | -  | -  | Mesothermal; Mesophilous   |    |  |    |
| <i>Maniola jurtina</i> (Linnaeus, 1758)               | NW-N-NE    | 500 <sub>(A)</sub> –1,550              | Common     | x | x | -  | -  | -  | Mesothermal; Mesophilous   |    |  |    |
| <i>Erebia meolans</i> (Prunner, 1798)                 | SE         | 1,570                                  | Very Rare  | x | - | -  | -  | Pr | Mesothermal; Xerophilous   |    |  |    |
| <i>Erebia arvernensis</i> Oberthür, 1908              | whole area | 1,550–3,010                            | Abundant   | x | x | x  | x  | x  | Mesothermal; Xerophilous   | A+ |  |    |
| <i>Erebia gorge</i> (Hübner, [1804])                  | whole area | 2,250–3,390                            | Rare       | x | x | Pr | Pr | Pr | Mesothermal; Xerophilous   |    |  |    |
| <i>Erebia pandrose</i> (Borkhausen, 1788)             | whole area | 2,170–2,690                            | Common     | x | x | Pr | x  | Pr | Microthermal; Xerophilous  |    |  |    |
| <i>Erebia euryale</i> (Esper, 1805)                   | whole area | 1,120–2,360                            | Abundant   | x | x | Pr | x  | x  | Mesothermal; Mesophilous   |    |  |    |
| <i>Erebia ligea</i> (Linnaeus, 1758)                  | NW-NE-SE   | 990–1,620<br>(2,140 <sub>(B)</sub> )   | Rare       | x | x | -  | -  | x  | Mesothermal; Mesophilous   |    |  |    |
| <i>Erebia pluto</i> (Prunner, 1798)                   | whole area | 2,680–3,180 m                          | Rare       | x | x | -  | x  | -  | Microthermal; Xerophilous  | A+ |  |    |
| <i>Erebia mnestra</i> (Hübner, [1804])                | whole area | (1,150 <sub>(A)</sub> )<br>2,090–3,000 | Common     | x | x | x  | x  | Pr | Mesothermal; Mesophilous   | A  |  |    |
| <i>Erebia albergana</i> (Prunner, 1798)               | whole area | (1,100 <sub>(A)</sub> )<br>1,300–2,380 | Abundant   | x | x | x  | x  | Pr | Mesothermal; Mesophilous   |    |  |    |
| <i>Erebia melampus</i> (Fuessly, 1775)                | NW-N-NE-SE | 1,540–2,420 <sub>(B)</sub>             | Abundant   | x | x | -  | -  | Pr | Mesothermal; Mesophilous   | A  |  |    |
| <i>Erebia triarius</i> (Prunner, 1798)                | N-NE-SE    | 730–2,340                              | Rare       | x | x | -  | -  | -  | Mesothermal; Mesophilous   |    |  |    |
| <i>Erebia medusa</i> ([Denis & Schiffermüller], 1775) | SE         | 1,560–1,700                            | Rare       | x | - | -  | -  | -  | Mesothermal; Mesophilous   |    |  |    |
| <i>Erebia aethiops</i> (Esper, 1777)                  | NE-SE      | 1,100–1,900<br>(2,250 <sub>(B)</sub> ) | Abundant   | x | x | -  | -  | x  | Mesothermal; Mesophilous   |    |  |    |
| <i>Erebia epiphron</i> (Knoch, 1783)                  | whole area | (1,550 <sub>(A)</sub> )<br>1,700–2,790 | Abundant   | x | x | x  | x  | x  | Mesothermal; Mesophilous   |    |  |    |
| <i>Erebia montana</i> (Prunner, 1798)                 | whole area | 1,380–2,630                            | Abundant   | x | x | x  | x  | x  | Mesothermal; Xerophilous   | A+ |  |    |

(A) Brockman et al., 1993

(B) Pensati, 2007–2009