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Cover

Detail of the upper side of the hind-wing of Plain Tiger, *Danaus chrysippus* (photo: Oriol Massana)

Painted Lady, *Vanessa cardui*, nectaring on Golden crownbeard, *Verbesina encelioides* (photo: Oriol Massana)

Editorial

The CBMS and BMSAnd network reveal that our butterfly populations are declining alarmingly

A number of on-going studies and already published works clearly indicate that climate change is currently one of the main threats affecting butterflies in the Mediterranean region. Understanding how climate affects butterflies is no easy matter but has become one of the most important tasks of the CBMS project. Another fundamental objective is to determine with precision what trends are operating in Catalan butterfly populations. Thus, in the section on conservation we discuss a study based on a complex methodology developed to evaluate trends in butterfly populations. The results are similar to those that we normally calculate using the TRIM programme despite the obvious differences in the methodologies used. Thus, we can confirm that declining trends are really widespread and that the degree of habitat specialisation is the ecological characteristic that best predicts the trend in a butterfly's population. In particular, specialist species are undergoing more serious declines than generalist species, which is inevitably leading to a homogenisation of our butterfly fauna, with communities being increasingly dominated by the commonest species.

In this *Cynthia*, the article on 'The Butterfly' is devoted to the Long-tailed Blue (*Lampides boeticus*), one of the commonest butterflies found in Catalonia and the Balearic Islands. We provide interesting information on the ecological characteristics of this migrant species, which will help understand certain features of its appearances in our counts. As well, exceptionally, we provide a description of two itineraries in western Catalonia that are geographically relatively close to each other: Mont-rebei and Menàrguens.

Finally, the identification guide finishes its descriptions of the more complex fritillaries of the genus *Melitaea* and opens a new block devoted to the larger fritillaries of the genus *Argynnis*.

The CBMS and BMSAnd network

Situation of the Butterfly Monitoring Scheme in Catalonia, Andorra and the Balearic Islands in 2015 and 2016

During the twenty-second and twenty-third years, there were, respectively, 84 and 83 active stations in the CBMS-BMSAnd network, the highest number ever. During these two years 13 new stations were established, including two more on Menorca and one in Andorra, and in all 244,560 butterflies belonging to 172 species were counted.

In 2015, counts were made at 84 stations, whilst in 2016 there were 83 active itineraries (Fig. 1). The overall number of stations has increased substantially in past years (Fig. 2) and 10 new stations were added to the network in 2014–2015; numbers remained stable in 2015–2016. This increase represents the first time that over 80 stations have been active during any one season. In 2017 over 80 stations were active once again, which suggests that the network has reached a new threshold of active stations that will ensure that the data it generates is even more robust.

The available annual series are shown in Figure 3. Of the 141 stations that in one year or another have been active, there are 54 (38%) that have generated 10 or more years of data and 25 with 15 or more years. These series are indicative of the potential of the CBMS database for analysing mid- and long-term trends in biodiversity.

New stations

Puigventós (CBMS-134, Baix Llobregat/Vallès Occidental, 431 m). Short itinerary (726 m, 8 sections) near two other walks (Collbató and Els Quatre Vents) that together form part of a LIFE-Montserrat project for improving silvopastoral management. The main objective of this project is to restore pasture as a means of favouring biodiversity and minimising the threat of forest fires in the Montserrat protected area. These itineraries hope to document changes in butterfly communities as open areas are being restored. In the first phase, counts were carried out in 2015 and 2016 but halted in 2017 and then will return in 2018. Management tasks were planned for the second year of the project (2016) on the basis of the counts obtained in 2015. Currently, most of the Puigventós itinerary is covered by calcicole scrub composed of rosemary, blue aphyllanthes and grasses, along with a much smaller part covered by holm-oak woodland. The drought that accompanied the first two years of counts greatly affected the initial results: 39 species detected, of which the majority are typically thermophile Mediterranean species at home in grassland and/or in scrub. Some of the commonest species include False Ilex Hairstreak (*Satyrium esculi*), Dusky Heath (*Coenonympha dorus*), Provence Chalkhill Blue (*Lysandra hispana*), Wall Brown (*Lasiommata megera*), Spanish (*Pyronia bathseba*) and Southern (*P. cecilia*) Gatekeepers, and Striped Grayling (*Hipparchia fidia*). Rarer species include important populations of Black Satyr (*Satyrus actaea*), Dingy Skipper (*Erynnis tages*), Chapman's Green Hairstreak (*Callophrys avis*) and Chapman's Blue (*Polyommatus thersites*). The counts are carried out by C. Gutiérrez.

Collbató (CBMS-135, Baix Llobregat, 395 m). Short itinerary (722 m, 8 sections) that also forms part of the LIFE-Montserrat project. It is less species-rich than the neighbouring Puigventós itinerary and in two years only 35 species have been detected. Scrub dominated by Mediterranean coraria occupies much of the itinerary, but there are also grassland and blue aphyllanthes scrub, as well as Aleppo pine and holm-oak woodland. This ensures that the Speckled Wood (*Pararge aegeria*) is fairly abundant. Otherwise, the dominant species are thermophile and denizens of low garrigue and scrub: Spanish Gatekeeper (*Pyronia bathseba*), False Ilex Hairstreak (*Satyrium esculi*), Dusky Heath (*Coenonympha dorus*), Two-tailed Pasha (*Charaxes jasius*) and Cleopatra (*Gonepteryx cleopatra*). A number of grassland species also occur including Wall Brown (*Lasiommata megera*), Striped Grayling (*Hipparchia fidia*) and Provence Chalkhill Blue (*Lysandra hispana*). Of interest is a single observation of a Marbled Skipper (*Carcharodus lavatherae*). Counts are carried out by J. Muñoz.

Els Quatre Vents (CBMS-136, Anoia, 548 m). Itinerary (823 m, 9 sections) that also forms part of the LIFE-Montserrat project. Part of this itinerary was affected by the Òdena forest fire in July 2015. The vegetation is dominated by calcicole scrub with rosemary, and stands of Aleppo pine and grassland in a few sections. Due to being at a greater altitude, this itinerary is more species-rich than nearby Collbató and in two years 46 species have been detected, with an annual average of 37. The dominant species are Wood White (*Leptidea sinapis*), Wall Brown (*Lasiommata megera*) and Common (*Polyommatus icarus*) and Panoptes (*Pseudophilotes panoptes*) Blues. Unlike the other two LIFE-Montserrat itineraries, species

such as Southern White Admiral (*Limenitis reducta*), Marsh Fritillary (*Euphydryas aurinia*) and Black-veined White (*Aporia crataegi*) linked to tree or tall scrub cover also appear here. There is also a good population of Spotted Fritillary (*Melitaea didyma*), as well as of rarer species such as Escher's (*Polyommatus escheri*) and Chapman's (*Polyommatus thersites*) Blues, Berger's Clouded Yellow (*Colias alfacariensis*) and Dingy Skipper (*Erynnis tages*). The counts are carried out by J. Muñoz.

Casau (CBMS-137, Vall d'Aran, 1171 m). Short itinerary (611 m, 7 sections) characterised by its rich butterfly fauna and the presence of species of great interest in terms of the Catalan butterfly fauna and the CBMS counts. The walk circumnavigates the village of Casau, passing through chiefly humid upland hay meadows and briefly a stretch of riparian ash woodland in section 1. In total, 72 species have been counted in two years of counts, with an annual average of 59; nevertheless, it is very likely that more species will appear in coming years. The exceptionality of this itinerary is due to the presence of species that are rare or unheard of in other CBMS itineraries. For example, two new species for the CBMS have been detected at Casau: Chequered Skipper (*Carterocephalus palaemon*) and Yellow-spotted Ringlet (*Erebia manto*). Other remarkable species include Clouded Apollo (*Parnassius mnemosyne*), Apollo (*Parnassius apollo*), Bright-eyed Ringlet (*Erebia oeme*), Duke of Burgundy (*Hamearis lucina*), Sooty Copper (*Lycaena tityrus*), Lesser Marbled Fritillary (*Brenthis ino*), Baton Blue (*Pseudophilotes baton*) and Marbled White (*Melanargia galathea*), the latter one of the commonest species on the itinerary and a species that in Catalonia is only found in the Vall d'Aran and neighbouring areas of the counties of Alta Ribagorça and Pallars Sobirà. Casau is thus one of the key itineraries in the CBMS network. Counts are carried out voluntarily by C. Casasnovas.

Besalú (CBMS-138, Garrotxa, 137 m). Itinerary (2,059 m, 11 sections) that runs around the town of Besalú and alongside the river Fluvià. Ruderal plant communities dominate in the first part of the walk, which then give way to human-influenced poplar plantations and parks and gardens. The butterfly community is moderately diverse, 57 species having been recorded in two years, and is dominated by generalist species or those that fly in degraded habitats including Small Heath (*Coenonympha pamphilus*), Common Blue (*Polyommatus icarus*), Small White (*Pieris rapae*), Iberian Marbled White (*Melanargia lachesis*), Meadow Brown (*Maniola jurtina*), Speckled Wood (*Pararge aegeria*) and Clouded Yellow (*Colias crocea*). Due to the humidity of the site and the fact that it lies in the generally humid county of La Garrotxa, there are also good numbers of Map Butterfly (*Araschnia levana*) and other species such as Green-veined White (*Pieris napi*), Lesser Purple Emperor (*Apatura ilia*), and Provençal Short-tailed (*Cupido alcetas*) and Short-tailed (*Cupido argiades*) Blues that are typically associated with humid forest habitats in northern Catalonia. Counts are carried out voluntarily by M. Lockwood.

Menàrguens (CBMS-139, Noguera, 225 m). Itinerary (1140 m, 10 sections) situated in an agricultural area that is very representative of the Pla de Lleida. The walk passes through abandoned fields, ruderal habitats, orchards and more natural arid environments including scrub dominated by thyme and therophyte plant communities. The aridity and extreme summer heat have a severe impact on the butterfly community (only 30 species recorded in three years), which consists of a number of generalist species found commonly in areas of intensive agriculture, and others that adapt well to the severe drought that hits western Catalonia in summer. Of the first group of species, Small (*Pieris rapae*), Large (*Pieris brassicae*) and Green-veined (*Pieris napi*) White, the latter common in irrigated areas where there is often an abundance of hoary cress (*Lepidium draba*), one of its preferred food plants, Common Blue (*Polyommatus icarus*), Clouded Yellow (*Colias crocea*), Swallowtail (*Papilio machaon*) and Small Copper (*Lycaena phlaeas*) are all common. The second group includes Adonis (*Lysandra bellargus*) and Panoptes (*Pseudophilotes panoptes*) Blues, Southern Gatekeeper (*Pyronia cecilia*), Brown Argus (*Aricia cramera*), Sage Skipper (*Muschampia proto*) and Spanish Festoon (*Zerynthia rumina*), species that are also characteristic of nearby itineraries at Timoneda d'Alfés and Mas de Melons. As well, typical migrant species such as Bath White (*Pontia daplidice*), very abundant in semi-steppe areas in Lleida, also appear in the itinerary. Counts are carried out voluntarily by M. Lee.

Madriu (CBMS-140, Andorra, 1338 m). Short itinerary (817 m, 11 sections), highly diverse and with a good representation of upland butterfly communities. Although siliceous grassland dominates much of the itinerary, there are stands of hazel and Scots pine and occasional patches of scree. In two years, 79 species with an annual average of 65, have been detected. Nevertheless, it is likely that these numbers will increase in future years given that the itinerary lies at an altitude known to harbour the highest species richness of butterflies in both Catalonia and Andorra. Some of the most interesting species include those that are relatively infrequent in the CBMS network as a whole but which are abundant at Madriu — Mazarine Blue (*Cyaniris semiargus*), Scarce Copper (*Lycaena virgaurea*), Dingy (*Erynnis tages*) and Essex (*Thymelicus lineola*) Skippers, the latter a common species in Andorra, and Lesser Marbled Fritillary (*Brenthis ino*). Also present but less abundantly are interesting subalpine species such as Apollo (*Parnassius apollo*), Amanda (*Polyommatus amandus*) and Turquoise (*Polyommatus dorylas*) Blues, a variety of mid-altitude ringlets (*Erebia* sp.) and even Clouded Apollo (*Parnassius mnemosyne*). Furthermore, stands of hazels and other deciduous trees explains the presence of species such as Camberwell Beauty (*Nymphalis antiopa*) and White Admiral (*Limenitis camilla*). This itinerary is funded by the Vall del Madriu-Perafita-Claror protected area and the parish of Escaldes-Engordany. Counts are carried out by Eduard Boldú and Antoni Feliu, guides in the protected area, and Isabel Rogé, Head of the Department of the Environment of the Parish of Escaldes-Engordany, as part of their regular work schedule.

Cadira d'en Galzeran (CBMS-141, Berguedà/Osona, 756 m). Longish itinerary (2369 m, 10 sections) that covers a mosaic of agricultural and natural habitats in the area of El Lluçanès. Of note are the presence of large areas of bare rock that harbour specialised plant communities that are valuable for many species of butterfly. Open grassland is also present, mixed in with holm and deciduous oaks, non-irrigated agricultural fields and associated ruderal vegetation. In two years, 73 species of butterfly have been recorded (annual average 62 species) that include an interesting combination of species of highly diverse characteristics. Generalist species (at least in northern Catalonia) dominate due to the clear agricultural nature of the site and to the abundance of grassland, and include Wall Brown (*Lasiommata megera*), Iberian Marbled White (*Melanargia lachesis*), Gatekeeper (*Pyronia tithonus*), Meadow Brown (*Maniola jurtina*), Small Heath (*Coenonympha pamphilus*) and Great Banded Grayling (*Brintesia circe*), as well as Small (*Pieris rapae*) and Large (*Pieris brassicae*) Whites, and Clouded Yellow (*Colias crocea*). Yet, there are also a couple of species – Essex Skipper (*Thymelicus lineola*) and False Grayling (*Arethusana arethusa*) – that are much more continental in type and are rare in coastal areas. Given the calcareous substrata, species such as Berger's Clouded Yellow (*Colias alfacariensis*) and Provence Chalkhill (*Lysandra hispana*), Chapman's (*Polyommatus thersites*), Escher's (*Polyommatus escheri*), Adonis (*Lysandra bellargus*) and even Catalan Furry (*Polyommatus fulgens*) Blues are also present. Alongside these species fly others that are more Mediterranean in nature such as Two-tailed Pasha (*Charaxes jasius*), Southern Gatekeeper (*Pyronia cecilia*) and Provence Hairstreak (*Tomares ballus*), and more central-European-type species such as Map Butterfly (*Araschnia levana*) and Small Tortoiseshell (*Aglais io*). The counts are carried out voluntarily by J. Noguera with occasional help from other counters such as J. Planes, E. Escútia, R. Portell, R. Muñoz and M. Fuentes,

Montgrí (CBMS-142, Baix Empordà, 42 m). Itinerary (1417 m, 10 sections) that runs through the heart of El Montgrí, a protected area of limestone landscape with a marked summer drought. The walk embraces olive groves, grassland, thyme and other types of scrub. There are practically no wooded sections along the walk, although small patches of garrigue, otherwise common in the area, do appear. The butterfly community is not particularly diverse – 43 species detected in two years with an annual average of 37 species – and is dominated by typically Mediterranean species such as False Ilex hairstreak (*Satyrium esculi*), Southern (*Pyronia cecilia*) and Spanish (*Pyronia bathseba*) Gatekeepers, and Cleopatra (*Gonepteryx cleopatra*). Other species that appear that are tied to calcareous and/or arid landscapes include Provence Chalkhill (*Lysandra hispana*), Panoptes (*Pseudophilotes panoptes*) and Adonis (*Lysandra bellargus*) Blues, Striped Grayling (*Hipparchia fidia*) and Berger's Clouded Yellow (*Colias alfacariensis*). Two rare species occur: Western Marbled White (*Melanargia occitanica*), one of the most threatened species in Catalonia, and Provence Hairstreak (*Tomares ballus*). This itinerary is funded by the Montgrí, Les Illes Medes i El Baix Ter Natural Park and the counts are carried out by A. Serrat, with assistance from C. Tobella and S. Ramos.

Els Arcs (CBMS-143, Osona, 731 m). Itinerary (1680 m, 11 sections) located in the north of the Plana de Vic. Most of the walk runs through calcareous grassland but there are also large extensions of bare rock and stands of downy oak. The butterfly community is highly diverse and similar to that at Cadira d'en Galzeran. In two years, 77 species have been detected, with an annual average of 68 species. Generalist species that are abundant in northern Catalonia dominate: Gatekeeper (*Pyronia tithonus*), Iberian Marbled White (*Melanargia lachesis*), Meadow Brown (*Maniola jurtina*), Wood White (*Leptidea sinapis*), Small (*Coenonympha pamphilus*) and Pearly (*C. arcania*) Heaths, along with the ubiquitous Common Blue (*Polyommatus icarus*), Small White (*Pieris rapae*) and Clouded Yellow (*Colias crocea*). It is worth remarking on the variety of blues present in the area, a fact linked to the calcareous substrata: Adonis (*Lysandra bellargus*), Short-tailed (*Cupido argiades*), Provençal Short-tailed (*Cupido alcetas*), Chapman's (*Polyommatus thersites*), Escher's (*Polyommatus escheri*), Green-underside (*Glaucopsyche alexis*), Black-eyed (*G. melanops*) and Amanda (*Polyommatus amandus*) Blues, the latter a typical Pyrenean species. Indeed, the proximity of the mountains of the Serralada Transversal and Pyrenees guarantees the presence of species such as Map Butterfly (*Araschnia levana*), The Ringlet (*Aphantopus hyperantus*), Silver-spotted Skipper (*Hesperia comma*) and fritillaries such as High Brown (*Argynnis adippe*), Spotted (*Melitaea cinxia*) and Lesser Spotted (*Melitaea trivia*), all species that are rare or even absent from many itineraries in central and southern Catalonia. Counts are carried out voluntarily by J. Grajera.

Montjuïc (CBMS-144, Barcelonès, 131 m). Itinerary (2429 m, 9 sections) that passes through much of the park of Montjuïc in Barcelona. Most sections run through different types of parks and gardens, but there are also sections that coincide with semi-natural Aleppo pine woodland, open grassland and therophyte plant communities. It is a highly interesting itinerary since it provides information about the butterfly communities present in an urban setting, and the data it generates complement data from the Turó del Carmel walk, situated in a different part of the city of Barcelona. In two years, 26 species have been detected (annual average = 23 species), almost identical to the figure for Turó del Carmel (27 species in four years). Most of the species present on Montjuïc are opportunists and characterised by their mobility and dispersive capacity, and include species such as Speckled Wood (*Pararge aegeria*), Large (*Pieris brassicae*) and Small (*Pieris rapae*) Whites, Clouded Yellow (*Colias crocea*), Bath White (*Pontia daplidice*), Swallowtail (*Papilio machaon*), Scarce Swallowtail (*Iphiclides feisthamelii*), Painted Lady (*Vanessa cardui*), Red Admiral (*Vanessa atalanta*), Long-tailed (*Lampides boeticus*) and Lang's Short-tailed (*Leptotes pirithous*) Blues and Mallow Skipper (*Carcharodus alceae*). Also detected is the Geranium Bronze (*Cacyreus marshalli*), an introduced species totally linked to built-up areas that is possibly Barcelona's commonest butterfly. The existence of fragments of natural Mediterranean vegetation guarantees the presence of a few relict species, some more specialist and only poorly dispersive, such as Spanish (*Pyronia bathseba*) and Southern (*P. cecilia*) Gatekeepers, Dappled White (*Euchloe crameri*), False Ilex Hairstreak (*Satyrium esculi*) and Iberian Marbled White (*Melanargia lachesis*). This itinerary is funded by Barcelona City Council's Area of Urban Ecology. Counts are carried out by O. Borruel, J. Quesada, M. Almendro and M. Garcia.

La Vall (CBMS-145, Menorca, 0 m). Long itinerary (2980 m, 11 sections) located on the north-west coast of Menorca. It runs through an area of dry non-irrigated cropland, a large area of natural vegetation (stands of juniper and Aleppo pine, calcicole scrub and therophyte plant communities), and a stretch of beach, dunes and sea-cliffs. As to be expected on an island, the butterfly community is poor and clearly dominated by generalist dispersive species. Only 20 species have been detected in each year, of which the most abundant are the Southern Blue (*Polyommatus celina*), Small White (*Pieris rapae*), Holly Blue (*Celastrina argiolus*), a very common species on Menorca, and the Speckled Wood (*Pararge aegeria*). Also common are migrants such as Bath White (*Pontia daplidice*), Painted Lady (*Vanessa cardui*), Red Admiral (*Vanessa atalanta*) and Clouded Yellow (*Colias crocea*). Finally, it is worth mentioning the small populations of a number of sedentary species including Green Hairstreak (*Callophrys rubi*), Small Heath (*Coenonympha pamphilus*) and Southern Gatekeeper (*Pyronia cecilia*). This itinerary is funded by the Menorcan Socio-Environmental Observatory (OBSAM) and Menorca Biosphere Reserve. The counts are carried out by staff from the OBSAM.

Talis (CBMS-146, Menorca, 0 m). Very long itinerary (3072 m, 16 sections) that runs along the southern coast of Menorca. It is a highly fragmented itinerary that includes an important variety of habitats ranging from built-up areas, cliffs, garrigues, pine and juniper woodland, non-irrigated fields to grassland. The butterfly community is very poor, with only 17 species detected in two years of counts. Generalist species such as Southern Blue (*Polyommatus celina*), Small White (*Pieris rapae*), Clouded Yellow (*Colias crocea*) and Speckled Wood (*Pararge aegeria*) predominate. Aside from the common migrant species, there are also populations of Meadow Brown (*Maniola jurtina*), Holly Blue (*Celastrina argiolus*), Cleopatra (*Gonepteryx cleopatra*) and, much more rarely, Brown Argus (*Aricia cramera*) and Small Heath (*Coenonympha pamphilus*). This itinerary is funded by the Menorcan Socio-Environmental Observatory (OBSAM) and Menorca Biosphere Reserve. The counts are carried out by staff from the OBSAM.

Species present

In 2015, 124,503 butterflies belonging to 169 species were counted, while in the following year the respective figures were 120,057 and 165. The number of species recorded during these two years is thus clearly above the average of 162.5 for the period 2006–2014 when the Andorran stations were already operative and data was already being gathered for Pyrenean species. Indeed, the 169 species recorded in 2015 were the highest ever annual total for the CBMS (Fig. 4) and was undoubtedly a direct consequence of the incorporation of a number of new stations in 2015 and 2016, which provide more complete coverage of Catalonia.

The list of butterflies detected over the past 10 years is given in Table 1. Up to 2016, 186 species had been detected in the CBMS network (out of a total of 201 species present in Catalonia). This figure represents 93% of all Catalan species, an excellent achievement that reflects the exhaustive nature of the network. The very few species that have not yet appeared in the counts are essentially high-altitude species that fly in extreme environments where there are no itineraries, or species that have only ever been recorded occasionally in Catalonia and probably do not maintain stable populations there.

Two new species have appeared in recent years: Chequered Skipper (*Carterocephalus palaemon*) in 2015 and Yellow-spotted Ringlet (*Erebia manto*) in 2016, both only found in the Vall d'Aran in Catalonia.

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For references, see the original Catalan version.

Fig. 1. Geographical situation of all the stations that have ever participated in the CBMS network (1994-2016), with their official number and name. Also shown are the generally accepted boundaries of the biogeographical regions present in Catalonia.[1]

Fig. 2. Evolution in 1994–2016 of the number of active stations in the CBMS network.

Fig. 3. Distribution of the complete annual series available for all the stations that have ever participated in the project. Also included is data from the stations of La Rubina and Vilaüt, active in 1988 and 1989, respectively, before the official start of the CBMS network.

Fig. 4. Number of species of butterfly detected each year in the CBMS network.

Table 1. Butterfly species recorded in any of the CBMS stations in the 10-year period (2007–2016). Also indicated is the number of stations at which the species was recorded each year. Taxonomic order follows the criteria suggested by www.fauna-eu.org.

Drawing. The Catalan furry blue (*Polyommatus fulgens*) is one of the most interesting species appearing in the Cadira d'en Galzeran station. This blue has local populations in areas of the Pre-Pyrenees and central Catalonia, always on limestone substrate. At present, fifteen populations are monitored in the CBMS network (drawing: M. Franch).

Photo 1. Active grazing pastures are an important part of the new itinerary of Els Arcs. Situated in the pre-Pyrenees in county of Osona, this area is home for a diverse community of butterflies containing a number of remarkable species. Of especial interest are the number of blues and Nymphalinae associated with the pastures, as well as more woodland-loving species including Map Butterfly (*Araschnia levana*) and The Ringlet (*Aphantopus hyperantus*) (Photo: J. Grajera).

Photo 2. The Yellow-spotted Ringlet (*Erebia manto*) is a variable species in Catalonia, where it is only found in the Vall d'Aran. Its occasional appearance on the Casau itinerary suggests that there is a larger population nearby. Its characteristic dark appearance, with no bands or eyes, makes it reasonably easy to identify.

Photo 3. The Montjuïc transect runs through the gardens of this emblematic mountain of the city of Barcelona. Although the community of butterflies is poor and is dominated by highly generalist and mobile species, some relict populations of a few sedentary Mediterranean elements still remain, such as Spanish (*Pyronia bathseba*) and southern (*Pyronia cecilia*) gatekeepers, and False Ilex hairstreak (*Satyrium esculi*). In the photograph, the section that crosses the gardens of Joan Brossa (photo: O. Borruel).

Photo 4. The Talis itinerary is the fifth CBMS station which collects complete data on the island of Menorca. All the Minorcan stations are coordinated by OBSAM as part of the project of monitoring the biodiversity of this reserve of the biosphere (Photo: D. Carreras)

Twenty-second and twenty-third years of the CBMS

Balance of the 2015 and 2016 seasons

In 2015 and 2016, Catalan butterfly numbers were the lowest since the CBMS counts began. This confirms the fall in butterfly populations observed in recent years, very possibly related to climate change and an increase in the number of episodes of extreme temperatures and droughts. Furthermore, the progressive dominance of communities by highly generalist species such as Small White (*Pieris rapae*) and Speckled Wood (*Pararge aegeria*) could be linked to a homogenisation of Catalonia's butterfly fauna. During these two years, the only butterfly that attained its highest population indices was the Holly Blue (*Celastrina argiolus*).

Weather and counts

As has become the norm in recent years, 2015 was another warm year with temperature anomalies over 0.5ºC (in some places up to 2.0ºC) throughout Catalonia, but especially in the pre-Pyrenees, eastern Pyrenees and certain parts of central and southern coastal and pre-coastal sectors. Only in February and September were temperatures below the averages for the period 1961–1990; by contrast, March–July was characterised by extremely high temperatures (see www.meteocat.com). Historically, 2015 was the fourth warmest year since records began and in some places (including the city of Barcelona) it was even the hottest of the current century.

Winter 2014–2015 was mild and the only cold spell with harsh frosts occurred during the first 10 days of February. The most remarkable feature, however, were the heat waves that began at the beginning of May, when record temperatures were recorded in many parts of Catalonia. June was also very hot despite the lack of any true heat waves. The first three weeks of July, however, brought persistent high temperatures and temperatures over 40ºC were recorded in many parts of Catalonia.

The year 2015 was dry or even very dry. In roughly half of Catalonia the total rainfall was less than 70% of the annual average, while in counties such as Pla d'Urgell, Bages, Vallès Occidental, Baix Llobregat and Baix Empordà annual rainfall did not even reach 50% of the yearly average. The driest months throughout Catalonia were April, October and December, of special significance given that April and, above all, October, are typically two of the wettest months of the year.

The year 2016 was climatically very similar to the previous year: hot (the fifth hottest on record) and dry. Anomalies over 0.5ºC were recorded throughout almost all of Catalonia but – other than in counties such as Barcelonès, Berguedà, Baix Llobregat and Alt Empordà – were not quite as remarkable as in 2015.

Winter 2016 was again mild and cold spells were infrequent and unremarkable to the extent that some central and southern coastal areas were frost-free throughout. Summer was once again hot (clearly above historical averages) but without the heat waves of the previous year. The exception was an extremely hot spell during the first week of September when temperatures almost reached 40ºC in western Catalonia and broke records in many parts of the country.

The winter of 2016 saw three months of drought (November–January) and was followed by a dry or very dry spring, the exception being April, which was wet throughout Catalonia. Summer and autumn were generally dry until November, which was a rainy month in much of Catalonia.

In 2015 and 2016, 3.58 and 4.46 counts, respectively, were lost per station (Figs 1a and b). The 2015 figure matches exactly the average number of counts lost per station for the period 2000–2016. By contrast, the figure for 2016 was somewhat higher than this average, largely due to two periods of storms that hindered the counts (Fig. 2a): the first in mid-May (week 10) and the second in mid-September (week 29) (see www.meteocat.com). The greater number of weeks lost in much of March and at the beginning of April, which is typical of all CBMS seasons to date (Figs 2a and b), reflects the fact that in upland areas where the snow remains well into spring counts begin later.

Changes in abundances: overview

The years 2015 and 2016 were, unfortunately, the worst ever in terms of butterfly abundances since the CBMS project began (23 years of data; Fig. 3). These results are truly very worrying as they reveal that, of the 66 commonest butterflies recorded on the CBMS network, 17 (26%) reached their lowest ever levels during these two years (Table 2: 10 species with lowest-ever numbers in 2016, seven species in 2015). By contrast, only one species recorded an all-time high during these two years.

These declines obviously lead to lower counts in many stations and, at the 69 stations that provided data in 2014 and 2015, the number of butterflies counted per station fell from 1,763.3 ± 1,234.7 (average ± standard deviation) to 1,559.1 ± 1,168.5 (Student test for paired samples, $P = 0.002$). This reveals an across-the-board problem in Catalonia, Andorra and Menorca. Despite the fall in the numbers of the commonest species in 2015 and 2016, clearly shown in Figure 3, a comparative analysis performed using data from 80 stations for these two years does not show any significant difference ($P = 0.623$) between the total number of butterflies per station in 2015 (1,512.9 ± 1,127.8) and 2016 (1,492.7 ± 1,169.9).

The same comparisons made for the number of species detected per station show significant declines between 2014 and 2015 ($P = 0.024$) but also between 2015 and 2016 ($P = 0.011$). The number of species per station for each of these two comparisons were: 2014 (47.62 ± 17.04) *vs*. 2015 (46.39 ± 17.40); 2015 (45.85 ± 17.97) *vs*. 2016 (44.54 ± 17.28). The fall in the number of species detected in 2016 may be the product of poorer detectability due to the scarcity of butterflies and/or in some cases local extinctions.

Overall, there is no doubt that over the past 23 years Catalan butterfly populations have seriously declined, a process that is clearly reflected in Figure 3. Despite the fact that – as been commented on various occasions – multiple factors are contributing to this decline, it is becoming increasingly clear that climate change (and the extreme periods of heat and drought that characterise it) is key to understanding these changes.

Changes in abundance: fluctuations in populations

The 20 commonest species in the CBMS and BMSAnd network in 2015 and 2016 are shown in Table 1. It is worth noting that the Small White (*Pieris rapae*) and Speckled Wood (*Pararge aegeria*) have established themselves as the commonest and most widespread CBMS species in recent years. Albeit always common, in previous years they were not quite as prominent. Given that these two species are both generalists, these results reveal how the Catalan butterfly fauna is becoming more homogenous, a process that has occurred in other areas where butterfly populations are declining due, for example, to the effects of climate change.[2] This phenomenon means that, as well, more specialist species – some of which were once dominant in many parts of Catalonia – will become less relevant. More specialist species whose populations are gradually declining include many Satyrinae such as the Iberian Marbled White (*Melanargia lachesis*), the gatekeepers (*Pyronia* spp.) and the heaths (*Coenonympha* spp.) (Table 2).

By contrast, amongst the species that increased in number most clearly in the past year there are two Lycaenidae, the False Ilex Hairstreak (*Satyrium esculi*) and Holly Blue (*Celastrina argiolus*). The former is one of the most abundant species in Catalonia and in some years (e.g. 2003, 2004 and 2010) is even the dominant species throughout the whole country. It is possible that its increase in 2016 was to a large extent due to favourable weather during the crucial larval development phase (i.e. abundant widespread rainfall in April), as well as to the relaxing of a series of density-dependent mortality factors as a result of a series of seasons with low population numbers.

The Holly Blue is an especially interesting case. This species regularly undergoes marked interannual fluctuations that give a 'saw-tooth' dynamic (Fig. 4). This behaviour occurs in other regions and, tentatively, it has been suggested that it is due to population regulation provoked by a specialist Ichneumonidae par-

asitoid (*Listrodomus nycthemerus*, present in Catalonia), which synchronises its populations with those of its host but with a time lag.[3] This regular cycle lasts 3–4 years in the described case in Great Britain but in Catalonia alternates between two-year and three-year cycles (Fig. 4), a difference that could be due to the larger number of annual generations in the Holly Blue in Mediterranean areas. Indeed, the 2016 annual index of the Holly Blue was its highest since the CBMS project began, the only species for which this was the case in the last two CBMS seasons.

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For references, see the original Catalan version.

Fig. 1. Coverage of the counts at the different CBMS stations in (a) 2015 and (b) 2016.

Fig. 2. Distribution of the lost counts during the official 30 weeks (1 March–26 September) of the (a) 2015 and (b) 2016 recording seasons.

Fig. 3. Ranking of the CBMS seasons in terms of the general abundance of the 66 commonest butterflies in the CBMS network. The best year to date was 2002 (closely followed by 1995) and the worst (in descending order) 2016, 2015 and 2012. Calculations were carried out using the methodology described by Greatorex-Davies & Roy (2001); annual indices were calculated with the TRIM programme.

Fig. 4. Fluctuations in the populations of the Holly Blue (*Celastrina argiolus*) in the CBMS network over a period of 23 years (1994–2016). This species has a regular population dynamic that consists of cycles of abundance lasting 2–3 years. It is possible, as has been seen in other regions, that these cycles are determined by the impact of the specialist Ichneumonid parasitoid *Listrodomus nycthemerus* (which attacks the larvae but emerges from the butterfly's chrysalis), with which there is a synchronisation with a time lag of 1–2 years.

Table 1. Sum of the annual indices and ranking of the abundance of the 20 commonest species in the CBMS network in the 2015 and 2016 seasons.

Table 2. Evolution of the overall annual indices for 107 species found in the CBMS network based on an arbitrary value of 1 for 1994. These indices were calculated using the TRIM programme.[4] Also indicated are the number of stations that provide data for each species and the population trend detected by the programme.

Photo 1. The Black-veined White (*Aporia crataegi*) is one of the 10 species (of the 66 used for the calculations in Figure 3) that reached its lowest ever numbers in Catalonia and Andorra in 2016. In the past two decades this species' numbers have declined moderately and it is now increasingly rare to see large groups as in the photograph (photo: J.M. Sesma).

Drawing 1. The Gatekeeper (*Pyronia tithonus*) also reached a historical low in 2016. The clear decline in this species in Catalonia has affected above all its populations in coastal and pre-coastal sites; indeed, some of these populations have died out. The evidence suggests that this highly negative tendency is directly related to the episodes of extreme temperatures and drought that have been recorded in the past years (drawing: M. Franch).

Habitat management and conservation

Over the past two decades declines in the populations of Catalan, Andorran and Menorcan butterflies have become widespread

We analysed CBMS and BMSAnd data gathered in 1994–2014 using a new methodology that takes into account errors in species detection. This technique allowed us to identify trends in the populations of the commonest species and highlight some life-history traits that correlate with the trends. Of the 66 species included in the final analysis, we found that 71% are in decline and just 23% are on the increase. The most negative trends are found in habitat-specialist species and in polyvoltine species. Finally, we discuss these results and the possible causes of these declines in Catalan butterfly populations.

Introduction

In recent years many studies have illustrated the generalised declines that are occurring in populations of a wide range of organisms.[1] This phenomenon is giving rise to a genuine crisis in the world's biodiversity and is attributable principally to so-called 'global change', that is, a combination of climate change, landscape transformation (e.g. habitat loss and fragmentation) and the expansion of invasive species — and their interactions.[2-4]

The way in which species respond to this global change depends in part on their biological and ecological characteristics. For instance, the species that disperse most easily can, in theory, move latitudinally and altitudinally in an attempt to maintain their climate niches.[5] Nevertheless, in many cases changes in species distributions occur much more slowly than theory predicts; this promotes a climatic debt that will have presumably negative repercussions on affected species. An alternative is phenological advancement, which can be an equally efficient mechanism for conserving the climatic niche during, for example, the breeding season.[7] Regardless of the mechanism employed, the fact that generalist species are usually more flexible in their responses to environmental change ensures that such species will be the most successful under this new scenario of global change. This will mean that natural communities will become more dominated by generalist species, as has been observed in recent years in European bird communities and Nordic butterfly populations.[8-9]

An initial evaluation of the population trends in Catalan butterflies based on the CBMS data in 1994–2008 confirmed both the importance of across-the-board declines in populations and the fact that more specialised species are the hardest hit.[10] Recently, a more complete evaluation has been performed that updates this initial analysis using data from more stations, longer data series and a more complex analytic method that takes into account errors in species detection during counts.[11] Here, we present the results of this new analysis and discuss whether or not the following hypotheses can be applied to the Catalan butterfly fauna:

1. In the context of global change, populations of specialist species are the hardest hit. As well, they experience stronger population fluctuations (that is, changes in numbers over time), which increases their risk of extinction.[12]

2. Certain ecological characteristics affect the direction and magnitude of population trends. Specifically, greater dispersive capacity is beneficial in more fragmented landscapes as it contributes to the persistence of populations.[13] Thus, greater dispersive ability is associated with more positive population trends and less population variability.

3. Under a scenario of climate change, the most thermophile species are expected to show relatively more positive population trends and exhibit less population variability than species better adapted to colder climes.

4. Polyvoltine species could display more positive population trends than univoltine species given that the ability to produce more than one annual generation will theoretically lead to greater population growth. Additionally, in the event of warmer temperatures, they may increase the number of generations during their flight seasons,[14] which will also tend to contribute to population growth.

5. The life stage that coincides with winter diapause will also affect population trends; previous studies have shown that species whose eggs or young larva have to withstand the winter months are more sensitive to climate change and are those that are experiencing the most serious population declines.[15]

Material and methods

Stations, annual series and species selection
The analysis was carried out using data from 116 CBMS and BMSAnd walks (Fig. 1) that were active in 1994–2014. Of the 183 species that have been recorded on the walks, only the 82 commonest species were selected (present in at least 10 stations).

Modelling trends and population variability
Rather than use the TRIM software to calculate population trends, in this analysis we adapted a Bayesian model for open populations that takes into account the errors in species detection that are inherent to the monitoring system (see details in reference 11). Our model estimates the rate of population growth (r) of a species for all the populations analysed using data from fortnightly abundance counts in discrete sections. A fortnight is regarded as a period of 'closure' in which it is assumed that changes of abundance do not occur; within this period the weekly counts are used to calculate errors in species detection.

Aside from the rate of population growth, the variability over time in populations was modelled for each species. This variability was measured using the coefficient of variation (CV), which represents the dispersion around the mean and is independent of the population size. The variability was calculated at two different temporal scales: (1) seasonally (fluctuations in population levels within a particular season) and (2) inter-annually (fluctuations in population levels between years).

Ecological attributes of the species

The following seven ecological attributes were considered as possible explanatory variables for both population trends and seasonal variability:[16] (1) habitat specialisation; (2) larval trophic specialisation (separating monophagous, oligophagous and polyphagous species); (3) degree of preference for open or closed habitats; (4) wing length (given that larger species disperse better); (5) a measurement of each species' thermal niche; (6) voltinism (number of annual generations); and (7) life stage in which the species overwinters.

Results

Rates of population growth

The models for 16 out of the 82 species did not converge and so the results are based on the remaining 66 species.

The rates of population growth fluctuated between -0.11 and 0.04, with a mean of -0.02. Growth rates were significantly positive in 15 species (22.7%), stable in five species (7.6%) and significantly negative in 46 species (69.7%).

The best-fitting models for the rates of population growth retained as explanatory variables habitat specialisation, voltinism, degree of preference for open or closed habitats, and wing size; nevertheless, only the first two variables had a significant effect. Worthy of note is habitat specialisation (P = 0.021), which had a negative effect on population growth (Fig. 2). This implies that the more specialist a species is in terms of its habitat choice, the more negative is its population trend. Nevertheless, it is important to highlight the fact that numerous generalist species were also found to have negative growth rates and are likewise in decline.

On the other hand, the models also confirm the importance of voltinism (P = 0.031) but, contrary to our hypothesis, polyvoltine species exhibit the most negative growth rates (Fig. 2).

Our analysis did not identify any other ecological characteristics that are able to explain population growth rates and so hypotheses 2, 3 and 5 are not confirmed.

Variability in populations over time and the importance of ecological characteristics

Intra-seasonal variation in abundances is heavily influenced by voltinism and is larger in polyvoltine species than in either bivoltine or univoltine species (P < 0.0001). This variation is less marked in polyphagous species and in species that do not overwinter as adults.

More relevant to conservation is the fact that variability over time is influenced basically by voltinism and habitat specialisation, being greater in habitat specialists and polyvoltine species (Fig. 3).

Discussion and conclusions

The data gathered from 116 CBMS and BMSAnd stations over a period of two decades reveal the existence of negative population trends in 70% of the 66 studied species. These trends can be partially predicted using just a few of the ecological characteristics of these species.

As has previously been demonstrated[10] and foreseen by hypothesis 1, the most specialist butterflies showed lower population growth rates and greater population variability. Thus, these species are more likely to suffer the most serious declines. This result matches findings from other regions[17-18] and is predictable from a theoretical perspective. Habitat generalists are able to derive the resources they need in a broader range of situations, which is an advantage in environments subject to constant change (i.e. under a context of global change). An inevitable consequence of this relationship between trends and the degree of habitat specialisation is that specialist species are progressively replaced by generalist species. This leads to an impoverishment and simplification of faunal communities, as has occurred in other European countries.[8-9]

Nevertheless, one of the most important results of our analysis is the worrying finding that negative population trends are also occurring in generalist species. This is comparable to the situation in other regions where anthropic pressure is much greater (e.g. Great Britain and the Netherlands) and where common species are also in decline.[20-21] Thus, it would seem that the generalised decline in our butterfly fauna is of the same order as the regressions occurring in European countries in which this problem was hitherto regarded as much more serious.

Our analyses also threw up a number of unforeseeable results. For instance, we found that polyvoltine species (a characteristic that is often correlated with generalism[22]) are undergoing the most serious declines, which contradicts hypothesis 4. We believe that this could be related to a greater vulnerability in polyvoltine species to climate change. On the one hand, these species have generations that are on the wing at the end of the season when the effects of summer drought are most being felt; by contrast, most univoltine species fly at the beginning of the season and so are less exposed to the negative effects of the hostile summer climate. Furthermore, the species that fly in a series of annual generations are most exposed to the adverse climatic effects (mainly drought and high temperatures), and when these effects persist their consequences are felt over a number of consecutive generations.

Another little-expected result was that the degree of preference for open or closed habitats was not significant for explaining population trends. This contrasts with a recent study[23] that indicates that the species most closely associated with woodland habitats have relatively more positive population trends than those that prefer open habitats. This discrepancy can be explained in various ways. Firstly, the results of this previous study were based on data from itineraries completely dominated by semi-natural and natural habitats (results from itineraries in agricultural areas, for example, were excluded; secondly, only the species that had a significant association with either grassland or forests were considered since a broad range of species whose association with one of these two extreme environments was not significant were not taken into account. Thus, it should come as no surprise that the effect on butterfly communities of the increase in forested areas in Catalonia will be severely minimised when intermediate situations and species not closely associated with one or the other habitat type are included.

Two other characteristics that we hypothesised might have an influence on population trends but which turned out not to be relevant were wing size and the thermal niche (hypotheses 2 and 3). The dispersive capacity of species is very difficult to measure objectively and a number of authors have suggested other more quantifiable characteristics that could serve as proxies of dispersion. One of the most commonly used traits is wing size as it is thought that greater wing size will aid dispersion. Although a number of studies have shown that this is so,[24] these two variables are only moderately correlated and so the predictive power of the dispersive capacity using wing size is relatively low.[25] From this perspective, the null effect of this variable is not surprising.

Neither were we able to confirm that the most thermophile species have less negative tendencies under a scenario of global warming. In fact, our most recent analyses tend to indicate that population trends in Catalonia are more closely related to the hydric niche (that is, the level of rainfall throughout a species' range) than to the thermal niche. Nevertheless, these analyses are still counterintuitive because many of the species most linked to arid areas are those that are undergoing the most serious declines. We are currently investigating the causes of this peculiar pattern.

Regardless of whether or not ecological attributes can predict trends, the results of this study reveal a very generalised decline in butterfly populations in Catalonia. Our estimates suggest that this decline could be affecting around 70% of Catalan butterfly species. These results are clearly higher than those obtained using the TRIM software since with this latter method a much greater percentage of trends are classified as 'uncertain'. A direct comparison between these two methods is not possible, however, because the models that they build differ in structural aspects that give rise to different types of mathematical behaviour.

Nevertheless, figures aside, all the studies based on the CBMS data clearly indicate that Catalan butterflies are in serious decline. The negative effect of climate change seems to be increasingly evident and would seem to be the main factor explaining these trends. Even so, changes in land use also play an important part in many species' trends as has been shown by a number of more specific studies.

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For references, see the original Catalan version.

Fig. 1. CBMS stations used to evaluate population trends in the 66 commonest species in 1994–2014.

Fig. 2. Variation in the population growth rates (r) in terms of the two most important ecological characteristics: habitat specialisation (measured with the SSI index, with specialists awarded the highest scores) and voltinism (separating univoltine species with a single annual generation, bivoltine species with two annual generations, and polyvoltine species with more than two annual generations).

Fig. 3. Variation in the interannual population variance in terms of the two most important ecological

characteristics: habitat specialisation (measured with the SSI index, with specialists awarded the highest scores) and voltinism.

Photo 1. The Berger's clouded yellow (*Colias alfacariensis*) is one of the species that have undergone a strong decline in Catalonia in the last 20 years. This polyvoltine butterfly is a specialist of open dry areas on limestone substrate (photo: D. Vilasís).

Photo 2. Although the short-tailed blue (*Cupido argiadas*) has experienced a certain increase in Catalonia in recent years (for example in several places in La Garrotxa), its historical range of distribution has diminished with the disappearance of coastal and southern populations (photo: J. Jubany).

The station

Menàrguens, a key itinerary for understanding the problems facing butterfly populations in agricultural areas of the Ebro Depression

Located in the north of the Central Depression in the agricultural plains around Balaguer, the Menàrguens itinerary runs through an area dominated by intensive agriculture dotted with patches of natural steppe-like vegetation. Despite the relatively low number of butterflies and lack of diversity, this butterfly walk is of great interest given the extreme climatic conditions of this part of western Catalonia and the fact that this is the only active station in the whole of the Lleida Plain.

The transect

Station 139 of the CBMS network, active since 2015, is located in the municipality of Menàrguens, close by the Serra Llarga-Secans de la Noguera Area of Natural Interest. For the most part it follows the bed of the river Farfanya, excavated in Quaternary gravel and sand deposits. It runs through a diversity of vegetation types, from the edges of irrigated cropland to patches of the steppe-like vegetation that is characteristic of the Ebro Depression.

It is 1,140 m in length and is divided into 10 sections with an average length of 114 m. It begins alongside an old irrigation ditch that waters the market gardens around the village of Menàrguens and whose earthen walls still stand. Here fruit trees (peach, pear and apple) and crops such as maize, alfalfa, wheat, rape and sunflower are cultivated. After crossing the C-13 road, the walk climbs up a couple of low hills and enters some of the typical steppe-like environments found in the Ebro Depression. Here, for example the vegetation varies and there are sections covered in low thyme (*Thymus vulgaris*) scrub and *Lygeum spartum* grassland, as well as sections dominated by early-spring-flowering arable weeds such as white rocket (*Diplotaxis erucoides*) or by plants that were once common in fields including *Nigella gallica*, a love-in-the-mist, and pheasant's eyes (*Adonis* sp.), and even the occasional small stand of holm oaks. Of note is one particular valley known as the *finca de les floretes* ('field of flowers') due to the abundance of spring flowers that grow there. The final section of the walk follows the edge of an irrigated field (alfalfa, cereals) where taller plants such as wild fennel (*Foeniculum vulgare*), scabious (*Scabiosa* sp.) and woody fleabane (*Inula viscosa*) grow, all of which are important nectar sources in mid- to late summer.

The butterflies

During the three years of counts, 1,150 butterflies belonging to 30 species have been counted. The annual averages for 2015–2017 were 504 butterflies (44,01 ex/100 m) and 20.7 species. The greatest abundance of butterflies occurs in spring since as summer progresses the natural vegetation dries up and the amount of available natural resources drops dramatically.

Peak numbers are recorded in April and are due to the abundance of Pieridae and the appearance of spring univoltine species such as Panoptes Blue (*Pseudophilotes panoptes*) and Spanish Festoon (*Zerynthia rumina*). Also relatively common at this time of year are polyvoltine species including the Common Swallowtail (*Papilio machaon*), Speckled Wood (*Pararge aegeria*) and Mallow Skipper (*Carcharodus alceae*). A second peak occurs between the second half of May and the end of June when both Adonis (*Lysandra bellargus*) and Common (*Polyommatus icarus*) Blues are on the wing. The hot summer months of July and August are a period of little activity, although at the end of August and in September there is a third peak provoked by the appearance of late generations of polyvoltine species such as Small and Green-veined (*Pieris rapae* and *P. napi*) Whites, Mallow Skipper, Common and Adonis Blues, Bath White (*Pontia daplidice*) and Brown Argus (*Aricia cramera*), and the appearance of Tree Grayling (*Hipparchia statilinus*). A few migrant or vagrant species turn up including Peacock (*Aglais io*), Red Admiral (*Vanessa atalanta*), Queen of Spain Fritillary (*Issoria lathonia*) and Mediterranean Skipper (*Gegenes nostrodamus*).

By far the commonest butterfly on the walk is the Small White, which, thanks to its generalist character and ability to adapt to ruderal habitats, is able to survive the twin pressures of intensive agriculture and the natural aridity of the area. The second commonest species is the Adonis Blue, which only flies in areas of natural vegetation. The third commonest is the Bath White, a common xerophile species that is abundant in the Ebro Depression.

The CBMS in agricultural areas

Numerous CBMS walks take place in natural parks or in other well-preserved areas that are home to a great diversity of butterflies. By contrast, areas that are seen as degraded are much less visited by naturalists despite the fact that good knowledge of the local butterflies would allow us to manage such areas much more sustainably. The Menàrguens station is located in an area in which butterfly populations are under great pressure due to local agricultural activities and the harsh climate.

A good example are the orchards where the number of butterflies is extremely low despite the presence of plenty of trophic resources for both adults and larvae. The reason behind this lack of butterflies is the frequency with which insecticides are applied to these tree crops. Nevertheless, pest control is increasingly coming to depend on semi-chemical methods, that is, the use of the pheromones to provoke sexual confusion and capture huge numbers of pest insects without damaging populations of other species. In the future it will be interesting to see whether butterfly populations increase as more sustainable techniques are applied in agricultural areas; butterfly counts in and amongst the fruit trees are the only way of knowing whether or not such increases are occurring.

I hereby encourage you to set up stations in agricultural and degraded areas as it is precisely here that, if we are to act positively, we urgently need more information about the effects of human pressure on the environment. On a more personal level, discovering the beauty of the wildlife hidden away in some of the country's most unlikely sites generates a particularly special sense of satisfaction.

Marina Lee

Photo. During the spring, the hedges of cereal fields are plenty of weeds that attract a species poor but interesting butterfly community (photo: M. Lee).

Fig. 1. Average abundance (average of the annual indices during the period 2015-2017) of the 15 commonest butterflies at the Menàrguens station.

Aerial photo. The CBMS transect at Menàrguens (La Noguera county), in a typical agricultural environment of the Ebro depression.

The station

The Mont-rebei itinerary lies on the border with Aragon and harbours an exceptionally interesting and diverse butterfly community

With almost 90 species detected to date, including rarities such as Twin-spot Fritillary, this itinerary is one of the most interesting of all CBMS walks. Nevertheless, despite this diversity, the 14 years of counts have witnessed a progressive decline in the number of species and butterflies. Possible causes include a combination of factors such as climate change giving rise to successive drought years and overgrazing by donkeys in the vicinity of the walk.

The itinerary

The Mont-rebei itinerary (Station 66 in the CBMS network; municipality of Sant Esteve de la Sarga) is situated at the western end of the great mountain ridge of Montsec d'Ares. It forms part of the Mont-rebei estate owned by the Fundació Catalunya-La Pedrera in Serra del Montsec, and lies within the boundaries of a protected area of natural interest. This foundation runs a number of management and research programmes of conservation interest, including this CBMS walk, which has been providing information since 2003.

The itinerary (1,740 m in length) is divided into seven sections with an average length

of 249 m. It lies at 536 m a.s.l. and there is a height difference of approximately 100 m between its lowest and highest points. The climate is continental Mediterranean, with an average annual temperature of 12.3ºC, and an average maximum temperature in mid-summer of 30.7ºC. Average annual rainfall is 737.2 mm.

The walk runs largely through open areas with grassland plant communities. Blue aphyllanthes scrub formations cover 65% of the itinerary, while a further 20% of the walk is covered by thin vegetation struggling to get a foothold in the impoverished calcareous soils; the remaining parts of the itinerary are covered by taller scrub. In the immediate vicinity of the walk there are stands of deciduous and holm oaks. The vegetation of the itinerary has changed very little during the 14 years it has been operating, and no impact worthy of note has altered the initial environmental conditions. The only real changes in the intervening years have been the introduction of low-intensity grazing by a herd of donkeys in sections 1, 2 and 7, and the sharp increase in tourism in the past four years, above all in the first two sections of the itinerary. Nevertheless, neither of these two factors alone would seem to be sufficient to explain the changes in the walk's butterfly fauna that have occurred.

The butterflies

The butterflies of the Mont-rebei itinerary are diverse and of great interest. In all, 88 species have been detected in 14 years: Hesperiidae (8 species), Papilionidae (3), Pieridae (14), Lycenidae (26), Libytheinae (1), Nymphalinae (16) and Satyrinae (20). The average annual number of species detected is 55.2.

The greatest butterfly diversity is on the wing in June. The cold winters ensure that the season starts slowly and very few species or individuals fly during the first weeks of the counts. Things begin to pick up quickly from late April onwards and by mid-June numbers have reached a peak. However, the number of species quickly falls off in July and August due to the high temperatures until a slight upswing occurs in September. The first species to fly appear when it is still relatively cold and correspond to those that have overwintered as adults – Cleopatra (*Gonepteryx cleopatra*) and Brimstone (*G. rhamni*) and Large Tortoiseshell (*Nymphalis polychloros*) – or those that are genuinely polyvoltine (*Iphiclides feisthamelii, Erynnis tages* and *Leptidea sinapis*). As spring progresses the first Orange-tips (*Anthocharis* sp.), whites (*Pieris* sp.), Clouded Yellows (*Colias* sp.), Hairstreaks (*Satyrium* sp.) and blues (*Polyommatus* sp.) appear, followed in late spring by the Fritillaries (*Argynnis, Melitaea* sp. and *Brenthis* sp.) and Marbled Whites (*Melanargia* sp). From July onwards and then through August and September these species gradually fall in number and are replaced by the Browns (*Lasiommata* sp.), Heaths (*Coenonympha* sp.), Gatekeepers (*Pyronia* sp.) and Graylings (*Hipparchia* sp.).

Nevertheless, the itinerary's most iconic species is the Twin-spot Fritillary (*Brenthis hecate*), a specialist feeder on dropwort (*Filipendula vulgaris*), a flower that is very abundant in the pastured grassland. This fritillary is vulnerable in Catalonia and just a few populations exist in the pre-Pyrenees and certain counties in central Catalonia.

Management in the Mont-rebei estate

Despite the lack of obvious changes in this itinerary since 2003, the number of butterflies has progressively fallen and the negative tendencies are highly significant — indeed, this itinerary has one of the clearest negative trends in the whole of the CBMS network.

In an attempt to disentangle this situation, we studied the population trends of the 10 most abundant species: we found that four– Iberian Marbled White (*Melanargia lachesis*), Common Blue (*Polyommatus icarus*), Black-veined White (*Aporia crataegi*) and Spanish Fritillary (*Euphydryas desfontainii*) – had declined significantly, while five – Provence Chalkhill Blue (*Polyommatus hispana*), Silver-studded Blue (*Plebejus argus*), Berger's Clouded Yellow (*Colias alfacariensis*), Wood White (*Leptidea sinapis*) and Knapweed Fritillary (*Melitaea phoebe*) – had remained stable; only Meadow Brown (*Maniola jurtina*) increased in number during this period. As well, there was also an important fall in Twin-spot Fritillary numbers. The likely cause is the recurring episodes of intense drought in recent years that undoubtedly have a negative effect on this Mediterranean area. Nevertheless, we cannot rule out the possibility that the effects of the pasturing – i.e. when and how often – by the donkeys (which graze a series of closed plots under rotation for 3–4 months a year) may have a cumulative knock-on effect.

Botanical monitoring is carried out in plots in sections 1 and 2 of the itinerary, but not in the remaining five sections. Currently, the state of conservation of sections 1 and 2 (where the largest population of dropwort grows) is regarded to be 'good'. However, studies of dry pastures in the south of France suggest that pasturing could have a certain negative impact on some butterfly species depending on when it is practised. Certain studies even mention the Twin-spot Fritillary, which seems to prefer abandoned pastures or pastures that are not grazed in the spring. This implies that spring and summer pasturing could have a negative impact on butterflies, for instance by increasing mortality amongst caterpillars, and reducing the number of egg-laying sites and nectar sources for adults. The pastures in the Mont-rebei estate are of exceptional interest due to the butterfly communities they harbour and pasturing is essential if they are to be maintained. Nevertheless, it may be time to contemplate a degree of regulation of the grazing to prevent over-pasturing.

It is worth mentioning too the growing visitor pressure on the site that has occurred over the past four years since the new tourist route between Catalonia and Aragon over the so-called 'Mont-rebei bridge' was opened. It has been calculated that there was an increase in the number of visitors from 2016 to 2017 of 75,000–100,000 people, the majority in May–September. At first sight, this massification should not have any direct effect on butterfly communities since most visitors do not leave the marked trails or enter the closed-off pastures. Even so, the impact that this increase is having on Mont-rebei is worrying and the Fundació Catalunya-La Pedrera is monitoring the situation and adopting measures to manage this mass of visitors more adequately.

Despite this rather sombre outlook, Mont-rebei is still more than worth a visit — find a peaceful morning to visit the estate and discover this superb landscape where nature and culture go hand-in-hand. For this reason alone, it is essential to conserve Mont-rebei and all it contains.

Jordi Solà

Photo. Making the butterfly count in section 7 of the itinerary, near the beginning of the Mont-rebei gorge (photo: C. Stefanescu).

Fig. 1. Average abundance (average of the annual indices during the period 2003-2017) of the 15 commonest butterflies at the Mont-rebei station.

Aerial photo. The CBMS transect at Mont-rebei (Pallars Jussà county), around the estate of the same name that is managed by the Catalunya-La Pedrera Foundation

Article review

Hernández-Roldán, J.L., Vicente, J.C., Vila, R. & Munguira, M.L., 2018
Natural history and immature stage morphology of Spialia skippers in the Iberian Peninsula (Lepidoptera: Hesperiidae). ***Nota lepidopterologica*****, 41: 1-22.**

Information on the ecology and morphology of a new skipper species for the Iberian Peninsula, *Spialia rosae*

In this article in *Nota lepidopterologica* we provide an exhaustive description of the recently described *Spialia rosae*. In an earlier article,[1] Hernández-Roldán *et al.* presented a multidisciplinary study separating this species from the commoner Red-underwing Skipper *Spialia sertorius* based on genetic, chemical, phylogenetic, geographical, morphological and biological aspects of this genus of skippers. In this second article, we analyse the habitat, biology and immature stages of the two *Spialia* species present in the Iberian Peninsula, *S. sertorius* and *S. rosae*. We also provide a map of localities in which this new species has been recorded, which suggests that it is likely that it will be found in more upland areas in the Iberian Peninsula (Fig. 1).

To date, *S. rosae* has been found in 92 10x10 km squares in the Pyrenees, as well as in the mountains of the Sistema Cantábrico, Sistema Ibérico, Sistema Central, Meseta Norte and Sistema Bético. Despite exhaustive searching, this new species has not yet been found in Catalonia.

S. rosae flies at between 470 and 2640 m a.s.l., whilst *S. sertorius* is found almost exclusively in lowland and low mountain areas. *S. rosae* occupies habitats at much higher altitudes but there is an overlap in certain montane (Cantabrian beech forests) and supra-Mediterranean (oak forests) areas, and so

the two species may live in sympatry in numerous areas. They are both indifferent to the substrate but differ greatly in their use of food plants, which turns out to be the most characteristic difference between the two species. Whilst *S. sertorius* uses salad burnet (*Sanguisorba minor*), *S. rosae* is known to feed on a number of different species of rose (*Rosa agrestis, R. canina, R. corymbifera, R. elliptica, R. micrantha, R. pendulina, R. pouzinii, R. sicula, R. squarrosa* and *R. tomentosa*). Female *S. rosae* lay their eggs individually on rose leaves and the larvae hatch within 4–5 days. The caterpillars feed on the leaves and construct silken shelters in which they also pupate. Adults emerge around 20 days later, flying in a single summer generation in July–August at higher altitudes or two (May–June and July–August) at lower altitudes. Larvae are attacked by the parasitoid *Microgaster australis* (Hymenoptera, Braconidae), which also attacks other skippers and the Red Admiral *Vanessa atalanta*.

The immature stages were studied with a scanning electron microscope. No differences were found between the two Iberian species and so it is impossible to separate these two skippers purely on the basis of morphological features, either as imagoes or in pre-imago stages. The eggs of *S. rosae* (Photo 1) are spherical, with a flattened base and a depression in the annular area where the micropylar rosette and micropyle orifices are located (and through which the male's sperm penetrates when fertilising the egg). It has 19–20 radial ridges that are fairly prominent in both *S. rosae* and *S. sertorius*.

The final-instar larva of *S. rosae* is similar to that of *S. sertorius*. It has a cephalic capsule with a reticulated surface covered by two types of silken hairs, some long, smooth and ending in a point, and the others, typical of the genus *Spialia*, that are very branched (Fig. 2). The chrysalis is grey with a waxy covering, which gives it bluish tones (like the skin of a plum). The mesothoracic tubercles are quite distinctive in the skippers. They have an undulating base, while the rest of the tubercle is covered in silken hairs that resemble a tightly packed paintbrush. The hairs on the chrysalis vary in length and are flat. Of note in the chrysalis are the abdominal spiracles that have spiny papillae (Photo 3) and the cremaster, the hook with a helical end that the chrysalis uses to attach itself to the silken pad cemented to the substrata.

From a conservation point of view, this new species has been catalogued as of Least Concern (LC according to the categories of the IUCN). This is due to its distribution area that exceeds 2,000 km^2, the upper limit for a species to be classified as vulnerable. Nevertheless, as an endemic species living in upland areas we believe that it could be vulnerable to climate change, which will sooner or later affect many mountain species. For the time being, we lack demographic data on this new species and so in the future it will be vital to study its population trends. Monitoring programmes thus offer an excellent possibility for such a study, although it is essential first of all to identify which species of *Spialia* is present at each monitoring station.

For references, see the original Catalan version.

Fig. 1. Known geographical distribution of *Spialia rosae*. The greater densities occurring in the northern Sub-Meseta are due to the exhaustive fieldwork carried out in the region – largely in the province of Segovia – by Juan Carlos Vicente.

Photo 1. Photograph of an egg of *Spialia rosae* taken by a scanning electron microscope from the side showing the prominent radial ridges.

Photo 2. Front end of a final-instar *Spialia rosae* caterpillar. The photograph was taken with a scanning electronic microscope and shows the different types of silken hairs and the shape of the cephalic capsule.

Photo 3. Spiracle (respiratory orifice) of a chrysalis of *Spialia rosae* showing the characteristics spiny papillae inside this structure.

The butterfly

The Long-tailed Blue *Lampides boeticus*, a subtropical species dwelling in our alfalfa fields

The Long-tailed Blue is probably the most widespread of all Catalan 'blues' and is one of the few that can turn up almost anywhere, from coastal regions to mountain-tops. This is due to its migratory behaviour and great dispersive ability, as well as to its faculty for using a great variety of food plants to complete its life cycle. It is rarely seen at the beginning of the season but from May onwards it progressively becomes one of the commonest butterflies in Catalonia, and is exceptionally abundant in alfalfa fields at the end of summer.

Geographical distribution and situation in the CBMS

Worldwide, the Long-tailed Blue has a cosmopolitan distribution, being absent only from the Americas and Arctic regions. It is very common in subtropical and temperate regions, while in Europe it occurs throughout the Mediterranean region and occasionally also reaches much higher latitudes as a migrant. Despite a northern European limit to its range at around 55ºN,[1] climate change may cause its populations in northern regions to expand rapidly and increase in coming years.[2] In the Iberian Peninsula and Balearic Islands it is one of the commonest and most widespread of all butterflies,[3] and, like in Catalonia, it is ubiquitous throughout.[4] Nevertheless, its presence is seasonal for it is most abundant in summer and at the beginning of autumn, when it is easiest to find. It is a known migrant that carries out an annual northward migration, first from its winter quarters in North Africa and the south of the Iberian Peninsula into the Mediterranean and, subsequently, in summer on towards central Europe.[5] Although no southward return flights have been documented at the end of summer or in autumn,[5] a recent record in mid October in a Pyrenean glacier points to this possibility.[6]

The Long-tailed Blue has appeared in almost all the CBMS stations apart from a few where counts have only recently started — however, its presence in these stations in the mid- or long-term is practically guaranteed (Fig. 1). In the BMSAnd network it is rarer and has appeared in five out of the eight stations for which data are available; this is due to the fact that this blue clearly prefers lowland habitats and becomes scarcer with altitude. Nevertheless, its great dispersive capacity ensures that it turns up even at altitude[6] and it has been observed in the Pessons (Andorra) itinerary that at 2278 m a.s.l is the highest itinerary in the CBMS and BMSAnd network.

Habitats and food plants

The Long-tailed Blue is one of the most polyphagous of all Catalan butterflies as it is able to feed on a remarkable range of host plants. In all, in Catalonia 17 plants belonging to five different plant families have been confirmed as being used for egg-laying (with a further two species recorded with egg-laying behaviour)[7], although it is likely that it uses even more plant species (see other food plants recorded in the Iberian Peninsula in references 3, 8 and 9). It has a clear preference for legumes (family Leguminosae); alfalfa (*Medicago sativa*) is probably the most used host plant and supports the numerically most important populations in Catalonia. However, given that the larvae are anthofagous and carpophagous (i.e. they feed on flowers and fruits, respectively), egg-laying only occurs on plants in flower or about to flower, which means that egg-laying has to take place at very specific moments. For example, it uses alfalfa above all in summer, small-flowered gorse (*Ulex parviflorus*) in October and November, and peas (*Pisum sativa*) and bladder senna (*Colutea arborescens*) in April and May. However, it becomes even more polyphagous when no Leguminosae are in flower and females will occasionally lay on plants of other families including Compositae, Malvaceae, Plantaginaceae and Polygonaceae.[7] Nevertheless, the survival rate of the caterpillars that hatch on the plants of these other families is unknown.

This polyphagous behaviour, combined with its migratory and dispersive habits, ensures that the Long-tailed Blue is a habitat generalist.[10] Although found in many different environments, it is above all associated with open areas and avoids woodland. Its greatest densities always occur in irrigated farmland, above all in alfalfa fields when in flower, where thousands may fly alongside two other common blues, the Common Blue (*Polyommatus icarus*) and Lang's Short-tailed Blue (*Leptotes pirithous*). It is one of the few butterfly species that regularly colonise parks and gardens, even in city centres.[11]

Phenology and biological cycle

The Long-tailed Blue is a polyvoltine species that produces uninterrupted generations for as long as temperatures remain suitable. The full biological cycle, from egg to adult, is completed in about 3–5 weeks according to laboratory experiments performed at constant temperatures of 20–30ºC.[8] Most of the Catalan population is unable to survive the winter and so its presence largely depends on the annual arrival of migrants from North Africa and the south of the Iberian Peninsula. Nevertheless, despite not showing a true diapause, the chrysalis can survive periods of moderate cold[8] and so individuals are often seen at the end of winter or

beginning of spring in coastal areas with mild temperatures, particular if the winter has not been too cold (Fig. 2a). These butterflies, however, only represent a small part of the overall Catalan population and probably contribute very little to the species' annual population dynamics, which are determined above all by the numbers that arrive as migrants and colonise Catalonia in the second half of spring. From that moment onwards, the generations of Long-tailed Blue appear successively and the species becomes ever more abundant until the beginning of autumn (Fig. 2a). Generations overlap and it is almost impossible to calculate how many full generations fly every year; that said, given the length of its biological cycle, it is possible that in some areas as many as 4–5 generations may hatch annually.

The species' phenology may vary as environmental conditions change. For example, in colder regions (Eurosiberian, subalpine and alpine regions) there is no evidence that the species is able to survive the winter and the first few migrant butterflies of the year only begin to timidly appear once spring is well underway (Figs 2b and c). In the Eurosiberian region, these first migrants produce a first summer generation relatively quickly, but from August onwards numbers diminish very rapidly (Fig. 2b). This could be explained by migration to more low-lying areas designed to avoid the unfavourable climatic conditions that soon become apparent at the end of summer in upland areas. Its phenology at high altitude is less clear, partly because far fewer Long-tailed Blues are observed at altitude (Fig. 2c). However, there is a peak in numbers at the end of summer that could be explained by southward migration across the Pyrenees by butterflies that have hatched in central Europe.[6,12]

Its eggs are laid one-by-one on as-yet unopened flower buds (Photo e), on the calyx of the flower (e.g. in the case of bladder senna) or, more rarely, on leaves and stems.[8] Eggs are white, disc-shaped, and measure a little over 0.5 mm in diameter (Photo a). The caterpillar, which hatches within 3–5 days and then passes through four instars, has the typical onisciform shape (broad and flattened like a woodlouse) of other Lycaenidae. It can be greenish or pink (Photos b-c, f-h), and has tentacles and nectaring glands that are moderately attractive to ants (Photo h) such as *Plagiolepis pygmaea*, *Tapinoma nigerrimum*, *Crematogaster* sp., *Camponotus* sp., *Formica* sp. and *Lasius grandis*.[8,13] It lives endophytically in seed pods or in the inflorescence of the Leguminosae on which it feeds. Not uncommonly, its larvae become carnivorous as they compete with others on flowers, and they will feed both on conspecifics (cannibalism) or on the larvae of other Lycaenidae (e.g. the larvae of Lang's Short-tailed Blue or Provence Hairstreak (*Tomares ballus*) when feeding on *Erophaca baetica*) (photo g)[13]. Carnivorous larvae grow more quickly and are heavier when they pupate[13]. Under natural conditions, the larva abandons its food plant to pupate amongst the leaf litter or under a stone.[8] The chrysalis is attached by a silken thread, varies in colour (brown or green) depending on the colour of the substrate, and has dark spots and a black dorsal stripe (Photo d).

Natural enemies

The larvae of the Long-tailed Blue are regularly attacked by the parasitoids *Cotesia specularis* (Braconidae: Microgastrinae), *Neotypus intermedius* and *Anisobas seyrigi* (Ichneumonidae: Ichneumoninae), all of which have a very narrow range of host species.[13-14] The first of these three parasitoids is gregarious and kills its prey when the larvae is in its final instar; the other species are solitary and they emerge from – and kill – the chrysalis. When collecting material for this article, another gregarious parasitoid that attacks Long-tailed Blue eggs was detected; as yet unidentified, it possibly belongs to the genus *Trichogramma* (Chalcidoidea: Trichogrammatidae).

The impact of these larval parasitoids on Long-tailed Blue populations has been estimated in populations in the south of Spain at 10-40% of sampled individuals.[13,15] These studies have also detected remarkable behaviour by the butterfly's larva, designed to ward off attacks by *C. specularis,* that has never been previously described in any other species: when a Long-tailed Blue larva detects the cocoons of the parasitoids that have hatched from a parasitized butterfly caterpillar, it eats them (Photo f), thereby reducing the risk of being preyed upon.[15]

Adult behaviour

The Long-tailed Blue is a fast nervous flier that is little evident at the beginning of the season when it flies in low densities. By contrast, by the end of summer and at the beginning of autumn is one of the commonest butterflies in ruderal environments and, above all, alfalfa fields. It can be easily confused with Lang's Short-tailed Blue, with which it often shares habitat. However, the Long-tailed Blue has a broad white post-discal band that is most pronounced on the under forewing.

Adults visit a great diversity of flowers that may or may not include the flowers of its larval food plants. Some of the most used flowers include alfalfa, rosemary (*Rosmarinus officinalis*), *Inula viscosa*, brambles (*Rubus* sp.) and various Leguminosae including common bird's-foot trefoil (*Lotus corniculatus*) and clovers (*Trifolium* sp.). Males are also attracted to damp ground, for example in freshly watered vegetable plots, behaviour that always occurs in the morning and, according to our records, above all at the end of summer.

Males show hilltopping behaviour, i.e. they visit hill-tops and ridgetops where they engage in disputes consisting of vertical flights and speedy acrobatic flights.[16-17] Territorial flights also occur along sunny banks and hedgerows, for example in the vicinity of nectar sources. Mating is easy to observe, above all in alfalfa fields during the strong summer emergences that occur in these habitats.

Population trends

In 1994–2017, Long-tailed Blue populations remained stable in Catalonia and Andorra (Fig. 3). Numbers fluctuate moderately according to the year and its coefficient of variation is 0.49, close to the average of 0.55 for the 107 species analysed.

Despite the moderate fluctuations compared to other species, it is worth highlighting the fact that in 2003 and 2009 Long-tailed Blues in Catalonia were clearly much more abundant. Secondary peaks were recorded in 1997, 2006 and 2012. There is a significant positive correlation ($r_p = 0.507$, $P = 0.013$) between the annual indices of this blue and those of the Painted Lady (*Vanessa cardui*), which was also very abundant in 2003, 2006 and, above all, in 2009. However, we have been unable to find similar correlations between the Long-tailed Blue and other migratory butterflies such as Lang's Short-tailed Blue, Clouded Yellow (*Colias crocea*), Bath White (*Pontia daplidice*) and Small White (*Pieris rapae*). The significant correlation with peaks in Painted Lady populations suggest that the population dynamics of this blue in Catalonia depends on the arrival of butterflies from North Africa in the second half of spring, as this is the key factor in explaining annual Painted Lady abundance in Catalonia.[18] The Long-tailed Blue is one of the commonest spring butterflies in the Maghreb (e.g. in the alfalfa fields in the north of Morocco and in the oases in the south), and also in the south of the Iberian Peninsula. Given this butterfly's known migratory behaviour,[19] combined with the difficulties it has to survive the winter in Catalonia (Fig. 2), it is probable that its African and southern Iberian populations are key to this species' population dynamics in Catalonia

Constantí Stefanescu, Jordi Jubany and Rafa Obregón

For references, see the original Catalan version.

Fig. 1. Relative abundance (expressed as the values of the annual index /100 m) of the Long-tailed Blue (*Lampides boeticus*) at CBMS and BMSAnd stations (1994–2017).

Fig. 2. Phenology of the Long-tailed Blue (a) at 111 lowland CBMS stations (Mediterranean environment, n = 14 130 individuals); (b) at 20 montane stations (central-European environment, n = 1694 individuals); i (c) at 11 high-mountain stations (alpine and subalpine environments, n = 301 individuals). Data gathered in 1994–2017 in Catalonia, Andorra and Menorca.

Fig. 3. Population fluctuations in the Long-tailed Blue in the CBMS and BMSAnd network in 1994–2016 calculated with the programme TRIM. Its trend is stable.

Photos. (a) Typical position of an egg at the base of an alfalfa bud; (b) and (c) caterpillars in the final instar, the latter with pink colouration; (d) chrysalis with typical brown colouration; (e) female egg-laying amongst alfalfa buds; (f) caterpillar preying on cocoons of *Cotesia specularis* from another parasitized larva; (g) caterpillar preying on a larva of *Leptotes pirithous*; (h) caterpillar attended by *Aphaenogaster gibbosa* (Photos: a–e, J. Jubany; f-h, R. Obregón).

Identification

How to separate the species of the genus *Melitaea* (3)

The three fritillaries of the genus *Melitaea* that cause most problems in the CBMS are the Provençal (*M. deione*), Heath (*M. nevadensis*) and Meadow (*M. parthenoides*) Fritillaries. Aside from all being very similar, they are all highly variable and so correct identification is fraught with difficulties. Of the three, the commonest in Catalonia is the Provençal Fritillary, which is also the only one that is polyvoltine, with two and even sometimes three generations from spring to autumn. The other two fly in early summer and are only found in upland areas: the Heath is a typical species of humid clearings in montane and subalpine woodland, whilst the Meadow is much more commonly found in pastures and other types of grassland in montane to alpine habitats.

The Provençal Fritillary occupies a broad altitudinal range, from sea level to 2,000 m a.s.l., and in Catalonia is only absent from the large littoral plains and the Central Depression.[1] It is common in Mediterranean habitats, in grassland and clearings, and along edges of holm oak woodland. It has been recorded at almost half of the CBMS and BMSAnd stations. Its preferred food plant is common snapdragon *Antirrhinum majus* but it will also use other members of this genus and, in the Montseny at least, ribwort plantain *Plantago lanceolata*.[2] Given the great difficulty in separating Provençal from Heath Fritillary, in many CBMS stations these two species are only separated to generic level. The Heath Fritillary (until recently known as *M. athalia celadussa*) is only found in the northern third of Catalonia where it flies locally but occasionally abundantly in the Pyrenees, pre-Pyrenees, mountains of the Serralada Transversal and El Montseny,[1] always in humid areas. In Catalonia it is documented as feeding on plantain and germander speedwell (*Veronica chamaedrys*).[2] The Meadow Fritillary is reasonably widespread in upland areas in the northern third of Catalonia but also has a few highly isolated and threatened population pockets in the province of Tarragona (mainly in the mountains of Prades, Montsant and Ports de Tortosa-Beseit).[1] It is a specialist feeder on plantains and is the most characteristic fritillary of open grassland in the Pyrenees. In all three species, females lay groups of 100+ eggs. Other than the Heath Fritillary, which soon adopts a solitary life, when they hatch, caterpillars live gregariously in silken webs on their food plants. Caterpillars overwinter when half-grown.

Constantí Stefanescu

For references, see the original Catalan version.

Drawings

PROVENÇAL FRITILLARY
Upperside: brown-orange; females larger and more contrastingly coloured; obvious black marking giving chequer-board appearance.
Underside: fore-wing orange except apex; hind-wing whitish with a yellow submarginal band with an obvious orange mark in each space.
Marked with line
discal spot with orange interior; postdiscal marking in space E1b not oblique; inner margin orange; marginal line unclear and usually discontinuous

HEATH FRITILLARY
Upperside: brown-orange with clear black markings that give it a generally darker appearance than the other *Melitaea* species discussed here; female with more contrasting colours and often darker.
Underside: fore-wing with relatively small black markings other than at apex; hind-wing with yellowish tones and a yellow submarginal band with an orange spot in every space; spots paler towards costa.
Marked with line
discal spot with dark shading inside; postdiscal marking in space E1b not oblique; inner margin generally black; black submarginal band typically thick; marginal and submarginal lines continuous and all equally thick

MEADOW FRITILLARY
Upperside: brown-orange, with smallish and often thinner (than the other two species) evident black markings; black margin well-marked; female more brightly coloured and often darker.
Underside: fore-wing with small black markings; hind-wing whitish or sometimes yellowish tones; dirty yellow submarginal band, with pale orange spots, often all but absent in the spaces nearest the costa.
Marked with line
discal spot narrower with dark shading inside; postdiscal marking in space E1b oblique; contrasting marginal black band; black inner margin; no black discal markings in E4 and E5; black submarginal band typically thick; marginal and submarginal lines continuous and all equally thick

It is easy to confuse these three fritillaries. Due to their intraspecific variability the diagnostic features mentioned here should only be regarded as a guide and are never definitive. A fourth species, the False Heath Fritillary (*Melitaea diamina*), can also be confused with these three species but is often much darker. In the case of the males, inspection of the genitalia is possible (it can be performed with a hand-lens with no need to sacrifice the butterfly) and can be used to separate with confidence False Heath and Meadow from each other and from Provençal-Heath; however, the genitalia of this latter pair are fairly similar and care must be taken (see drawings in ref. 3). Ecology and habitat preferences are also useful features that can be used. For example, phenology and geographical distribution alone can separate Provençal Fritillary from the others as it is the only one that flies in spring (in April in many areas) and at the end of summer (in September and even at the beginning of October). Likewise, Provençal is the only one of the three to be present in Mediterranean lowland environments. The Heath Fritillary has never been confirmed to fly in Tarragona and so the separation of this trio of species in the southern third of Catalonia is much easier.

Identification

How to separate the species of the genus *Argynnis* (1)

Five large spectacular fritillaries belonging to the genus *Argynnis* fly in Catalonia. All are powerful fliers and often visit flowers to nectar. They can be separated into two groups to aid identification, the first of which includes the two largest species, Silver-washed Fritillary (*A. paphia*) and the Cardinal (*A. pandora*). The former is abundant and easy to find in many sites, while the latter is seen much more irregularly and is harder to find. For this reason, when identifying the Cardinal in the field doubts may appear.

Although they can on occasions be observed together, these two fritillaries have different ecological requirements.[1] The Silver-washed Fritillary is common along rivers and in damp areas, often in deciduous stands, but also in holm-oak, pine and riparian woodland. It will also fly in open, even agricultural areas where it searches out nectar sources such as brambles, scabious and thistles. It is frequent in the northern half of Catalonia, but limited to mountain ranges in the southern half of the country and absent from much of the Central Depression and coastal agricultural areas. It is commonest at altitudes of 400–1,600 m a.s.l. and has been recorded in 61% of all CBMS itineraries. The Cardinal, on the other hand, prefers open and more arid environments, from grassland to ruderal vegetation, and also actively searches for nectar sources, above all thistles. In Catalonia it appears most regularly in pre-coastal parts of Tarragona and the mountains of L'Albera. However, it appears occasionally in many other areas due to its great dispersive capacity.[2] Most observations are in montane areas between 400–800 m a.s.l. and it has been detected in 22% of CBMS stations. Adults of both species are relatively long-living, which helps explain their protracted flight periods lasting from between May (the Cardinal flies first) to the end of September and even October, despite both being univoltine species. The bimodal flight curve of the Cardinal could be due to the fact that some adults aestivate. Males of both species patrol in search of females, and courtship is complex and attractive to watch.[3] The caterpillars of both species feed on violets.[1] In the Silver-washed Fritillary egg-laying is unusual since females lay their eggs in crevices in tree-bark, or sometimes directly on the ground or on the leaf litter near the violets that the caterpillars will feed on.[4] Overwintering takes places when the caterpillar is in its first instar.

Jordi Dantart

For references, see the original Catalan version.

Drawings

SILVER-WASHED FRITILLARY
Upperside: male bright orange, female duller or dark grey-green (f. *valesina*); lineal series of black markings.

Underside: fore-wing with smudged black marks; apex yellow-green, with orange lower half; hind-wing grey-green with three silvery vertical streaks; pink post-discal shading.
Marked with line
four lines of scent scales on M3, Cu1, Cu2 and A; discontinuous black discal markings between A and Cu2, and between Cu2 and Cu1; series of relatively large black postdiscal spots; lower half of wing orange

CARDINAL
Upperside: orange with greenish tones, more pronounced in female; black markings in vertical series.
Underside: fore-wing with black markings, apex yellow-green but lower half red; hind-wing grey-green with three vertical silvery streaks.
Marked with line:
two lines of scent scales on Cu1 and Cu2; continuous black discal markings between A and Cu2 and between Cu2 and Cu1; series of relatively small black postdiscal spots; lower half of wing red

These two species can be readily separated in the field. The Cardinal is more robust and generally larger than the Silver-washed Fritillary. The base of the fore-wing – red in the Cardinal and orange in the Silver-washed – is easy to observe when they are nectaring. Although the underside of the hind-wing is more variable, the green tones are more uniform and the vertical silvery streaks clearer in the Cardinal. In the Silver-washed, the green colouring is tinged with pink in the post-discal area and the vertical streaks are less clear-cut. The lines of scent scales on the upper fore-wing are distinct: two in the Cardinal and four in the Silver-washed; the series of black postdiscal spots are proportionally smaller in the Cardinal than in the Silver-washed.

Ajuntament Granollers
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