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Cover

Detail of the underside of the lower wing of Striped Grayling, *Hipparchia fidia* (photo: Jordi Jubany)

A male of the chequered skipper, *Carterocephalus palaemon*, from the Vall d'Aran (photo: Jordi Jubany)

Editorial

It is time to act to save our threatened butterflies!

This new edition of *Cynthia* provides updated information on the CBMS and BMSAnd networks and casts its eye over data from two difficult years, 2019 and 2020. The former was dry and hot, exemplified by one of the most intense heatwaves ever experienced in Catalonia. These adverse weather conditions were largely responsible for a very poor butterfly season during which nine species registered historically low counts. Conversely, 2020 was wet and lacking in heatwaves, which enabled many species to recover. The great difficult in 2020, however, was not related to the weather: the lockdown during the Covid-19 pandemic restricted people's movements greatly at the beginning of spring and was a serious obstacle for most butterfly counts. Fortunately, the counting season was saved in around a third of all itineraries and, thanks to the new method of analysis that we have begun to use (which is explained in one of the articles in this edition of *Cynthia*), these counts enabled us to estimate annual abundancies for the majority of butterfly species.

One of the improvements enshrined in this new statistical method is the identification of trends in different climatic regions. Using thermal thresholds, we have established three climatic regions in Catalonia (humid Mediterranean, arid Mediterranean and alpine/subalpine) in which butterflies behave phenologically in different ways. The calculations of populational trends in these three regions throw up interesting but at times contradictory patterns that will become a key in understanding the effects of climate change on Catalan butterfly populations. Furthermore, the splendid increase in the number of itineraries walked in the Balearic Islands – especially on Mallorca – will allow us to calculate in a not-too-distant future population trends for these islands.

Finally, one of the most important initiatives during the past year was the beginning of a project whose aim is to create butterfly microreserves that will ensure the conservation of a number of threatened species. One of the main lines of work of the project, run by Paisatges Vius in collaboration with the Natural Sciences Museum of Granollers, is the establishing of a protocol for identifying and characterising the populations of the most threatened species of butterfly in Catalonia; this is the first step along the road to setting up the microreserves where the effective protection of populations of threatened species can be guaranteed. Initially, a list of 25 species (out of the 46 considered to be threatened in Catalonia) was drawn up as a means of developing effective conservation methods. The aim is to establish stewardship agreements with landowners to guarantee management techniques that will favour these threatened species. To date, the methodology has been tested with the Large and Alcon Blues but it is hoped to extend it to the other listed species to prevent local extinctions caused by habitat deterioration (e.g. recover traditional management techniques and increase the availability of food plants).

The CBMS and BMSAnd network

Situation of the Butterfly Monitoring Scheme in Catalonia, Andorra and the Balearic Islands in the years 2019 and 2020

During the twenty-sixth and twenty-seventh seasons there were, respectively, 113 and 116 active stations in the CBMS-BMSAnd network. Twenty-five new stations were incorporated and for the first time ever over 100 stations operated. Of note is the increase in the number of stations on the island of Mallorca and in the Pyrenees. In all during these two seasons, 408,935 butterflies belonging to 174 species were recorded.

For the first time in the history of the CBMS, in the 2019 and 2020 seasons counts were performed at over 100 stations (113 and 116, respectively) (fig. 1 and 2). Almost 20 stations were added to the 2018 network, which, in terms of the number of stations, had hitherto been the best-ever year since the project began (fig. 2). On the island of Mallorca the single station of Raixa was joined by seven others, while four new stations were set up in the Pyrenees (three in the county of El Ripollès and one in Alta Ribagorça). These new stations on Mallorca and in the Pyrenees have greatly improved the coverage of the network on the Balearic Islands and in subalpine habitats. In part, the setting up of these new butterfly walks is attributable to improvements in our data analyses that allow for trends to be calculated reliably based on fewer sampling days (see the article on methodology), and for less accessible areas to be monitored more easily. Furthermore, this better geographical cover has meant that population trends can be calculated for climatic regions, a possibility that was unrealistic just a few years ago but which now enables us to understand more precisely the problems butterflies are having to confront in our region. In addition, in the future we may be able to calculate trends for islands given the good number of stations on both Menorca and Mallorca.

The available annual series are shown in figure 3. Of the 181 stations that have ever been active, 72 (40%) have generated data for 10 years or more, and 39 for 15 years or more. These long data series are essential for understanding and studying subjects as relevant as how climate change is affecting butterfly phenology, and how climatic extremes are leading to population fluctuations.

New stations

Roques Blanques (CBMS-161, Baix Llobregat, 110 m). Itinerary situated on the north side of the Serra de Collserola in the county cemetery of Roques Blanques in the town of El Papiol. It is 784-m long and has eight sections. It runs through the gardens of the cemetery and forms part of a project aimed at creating a butterfly garden dominated by nectar-giving Mediterranean plants such as lavender, rosemary and thyme. Some sections also run through areas of more natural vegetation, with lentisc scrub and dry grassland, and herbaceous and scrub vegetation. The counts (2019–2020) were carried out by Andreu Ubach.

Alòs de Balaguer (CBMS-162, Noguera, 276 m). Itinerary located in the Aiguabarreig-Segre-Noguera Pallaresa protected area in the county of La Noguera. It has 10 sections covering a length of 1,897 m. It runs through Lusitanian oak and ash woodland, as well as through abandoned terraces currently dominated by rosemary and grasses, and along dry herbaceous field margins. Bare rocky ground also appears, with associated rock-loving plants. The counts, began in 2019, are carried out by Ferran Turmo.

El Croscat (CBMS-163, Garrotxa, 633 m). Itinerary in La Garrotxa Volcanic Zone Natural Park between the town of Olot and village of Santa Pau. There are 12 sections that give a total length of 1,592 m. It is located on the north-east face of the famous volcano of Croscat in a large area of dry well-conserved montane pastures. The walk also passes through holm oak woodland and up a track lined with ruderal vegetation. An important population of Large Blue (*Phengaris arion*) has been detected, associated above all with the marjoram and thyme that grow here. The counts are carried out by Mike Lockwood and Jordi Joan Esquerda.

Montsagre (CBMS-164, Baix Ebre-Terra Alta, 927 m). Station located in Els Ports Natural Park, between the villages of Horta de Sant Joan, Paüls and Prats del Compte, in the counties of Baix Ebre and Terra Alta. It consists of 10 sections and covers 2,113 m. The walk monitors the highest sector of these mountains, where the rocky ridges are covered by vegetation dominated by montane aphyllanthes, thyme and grassland communities. To a lesser extent there are also stands of Phoenician and prickly juniper and black pine. In terms of butterflies, the highlights are the populations of Western Marbled White (*Melanargia occitanica*) and of two localized upland species, Dusky Meadow Brown (*Hyponephele lycaon)* and de Prunner's Ringlet (*Erebia triaria*). Counts have been carried out since 2019 by Marisa Huguet and Ismael Monsonís.

Els Plaus (CBMS-165, Ripollès, 1,488 m). Itinerary situated in the Freser-Setcases National Hunting Reserve near the village of Queralbs, county of El Ripollès. It has 10 sections and covers 1,382 m. The walk passes through an area with upland pastures and hay-meadows on both calcareous and basic strata. Much of the terrain is steep and is surrounded by stands of Scots pine, box and hazel. Cross gentian (*Gentiana cruciata*) is abundant and associated with a population of Alcon Blue (*Phengaris alcon*). The association Paisatges Vius manages this walk, carried out by Irene Figueroa, Anna Planella and Blanca Font since 2019.

Ribera del Catllar (CBMS-166, Ripollès, 1,255 m). A low-effort itinerary walked near the village of Vilallonga de Ter in El Ripollès. It has 12 sections and a length of 1,658 m. Located in the lower part of Vall del Catllar, where there are three other itineraries, it runs through subalpine pastures near the confluence of the Ribera del Catllar and the river Ter. It also includes sections with hazel and fluvial woodland alongside the Ribera. The butterfly fauna thus has numerous species associated with this type of woodland, as well as a strong population of Ringlet (*Aphantopus hyperantus*), which is abundant throughout this valley. The counts have been carried out by Mike Lockwood and Jordi Artola since 2019.

Toirigo (CBMS-167, Alta Ribagorça, 1,510 m). Itinerary running through the buffer zone of the Aigüestortes i Sant Maurici National Park with a length of 1,491 m and eight sections. It monitors mainly an area of subalpine valley-bottom pastures, which boast typical Pyrenean butterfly communities including an abundance of Small Tortoiseshell (*Aglais urticae*). Also present are Scarce Copper (*Lycaena virgaureae*) and various members of the genus *Erebia.* Begun in 2019, this itinerary is walked by Javi Santos and Maria Farré.

Pla de les Forques (CBMS-168, Alt Urgell, 786 m). Itinerary begun in 2011 but only officially part of the CBMS network since 2019. It is 1,400 m in length and has 12 sections. It is situated on low, south-facing hills just north of the town of La Seu d'Urgell, and runs through Mediterranean-type grassland, as well as upland deciduous woodland. Despite its proximity to the Pyrenees, low-level and thermophilous butterflies such as Panoptes Blue (*Pseudophilotes panoptes*) and Great Banded Grayling (*Brintesia circe*) are abundant. In 10 years, a total of 72 species have appeared in the counts carried out by Eduard Boldú, A. Vidal and Jordi Dalmau.

Binifaldó (CBMS-169, Mallorca, 605 m). The itinerary at Binifaldó takes its name from a publicly owned estate in the centre of the mountains of Serra de Tramuntana. This walk was started in 2019 and consists of eight sections covering 1,375 m. Holm oak woodland predominates thanks in part to the abundant water in this part of these mountains. There are also areas that have been cleared as firebreaks, which have been colonized by rock-roses acting as pioneer species, along with cypresses, rosemary and lentisc. Pau Colom carries out the counts.

Es Burotell (CBMS-170, Mallorca, 225 m). The itinerary at Es Burotell lies in the western sector of Serra de Tramuntana between the towns of Calvià and Puigpunyent at an altitude of 200–300 m. It was first walked in 2019 and has nine sections and a total length of 1,640 m. It runs through private agricultural land with almond groves accompanied by an array of different vegetation types including scrub and rock-rose formations. Pau Colom carries out the counts.

Es Comú de Muro (CBMS-171, Mallorca, 4 m). Itinerary situated just over one kilometre from the sea in S'Albufera de Mallorca Natural Park in the north of the island. It was first walked in 2019 and has eight sections covering 1,524 m. It runs through an area of pinewoods and dune vegetation. Pau Colom carries out the counts.

Reserva des Galatzó (CBMS-172, Mallorca, 262 m). Located in the west of Serra de Tramuntana at an altitude of 300–400 m, this butterfly walk was only active in 2019. It has seven sections covering 1,080 m. It runs through an area of pine woodland with rock-rose scrub in a private estate. Pau Colom carried out the counts.

Ses Puntes (CBMS-173, Mallorca, 1 m). This walk takes place in S'Albufera de Mallorca Natural Park in the north of the island, near the coast. It has eight sections covering a length of 1,670 m. A number of different environments are found here: pine woodland, fresh- and salt-marshes, agricultural fields and old farm buildings. Pau Colom has carried out the counts here since 2019.

Sant Antoni de Vilamajor (CBMS-174, Vallès Oriental, 223 m). Itinerary situated in the county of Vallès Oriental near the village of Sant Antoni de Vilamajor. It has 11 sections covering a length of 1,757 m and runs through an agroforestry mosaic in the area of El Baix Montseny. Mediterranean holm oak woodland dominates and the only open areas consist of lineal clearings under power lines and above a subterranean gas pipeline. Two sections run through cultivated fields and another along a gully, Riera de Vallserena. There are strong populations of Large Tortoiseshell (*Nymphalis polychloros*) and Nettle-tree Butterfly (*Libythea celtis*). The counts have been carried out since 2019 by Erika Sanfidel, Jan Ichter and Andreu Ubach.

Can Pere de l'Om (CBMS-175, Vallès Oriental, 218 m). Short itinerary near the town of Franqueses del Vallès that runs around a farm, Can Pere de l'Om. It has just five sections and a total length of 670 m. The counts, begun in 2020 in the vicinity of a family home during the Covid-19 restrictions, monitor an agroforestry mosaic with Aleppo pines, an olive grove and mixed holm and deciduous oak woodland. The counts are carried out by Antoni Arrizabalaga.

Can Moragues (CBMS-176, la Selva, 100 m). Located near the town of Riudarenes, this CBMS walk has seven sections covering 1,643 m. It runs through an agroforestry mosaic with a mix of open fields, waysides, Mediterranean pastures and Aleppo pine and holm oak woodland. This itinerary runs around the headquarters of Fundació Emys, who also sponsors it. Since 2019, the counts have been carried out by Ona Font.

Can Gimferrer Nou (CBMS-177, la Selva, 90 m). This itinerary is walked near the town of Caldes de Malavella through the holm oak and pine woods of the Prelitoral hills. Its 13 sections covering 2,034 m also run through open areas with rock-rose scrub. Its butterfly fauna consists of typical Mediterranean forest species including False Ilex Hairstreak (*Satyrium esculi*), Speckled Wood (*Pararge aegeria*), Southern White Admiral (*Limenitis reducta*) and Marsh Fritillary (*Euphydryas aurinia*). The counts have been carried out since 2019 by Xavier Munill and Pere Barnés.

Can Jornet Xic (CBMS-178, Vallès Oriental, 104 m). Located near the town of Mollet del Vallès in Els Gallecs, an area where extensive farming techniques are still practiced, this itinerary has seven sections and a total length of 984 m. It runs through areas dominated by ruderal vegetation and croplands, but also Mediterranean grassland and holm oak and other types of Mediterranean woodland. This walk was designed to sample an area in which sustainable agriculture is being practiced and provides a contrast to the following walk (Carena dels Bandolers) that, despite being close by, is situated in an area of intensive agriculture. It was set up in collaboration with Barcelona Zoo in 2020 and the counts are carried out by Albert Lleal and Marc Gallardet.

Carena dels Bandolers (CBMS-179, Vallès Oriental, 114 m). Located between the towns of Mollet del Vallès and Santa Perpètua de Mogoda, this short walk has six sections covering 912 m. It runs through an open area characterized by intensive agriculture, wasteland, fruit trees and a few areas of reasonably mature Mediterranean grassland. This walk runs through Els Gallecs and was designed to be compared with the previous walk, Can Jornet Xic. It was set up in collaboration with Barcelona Zoo in 2020 and the counts are carried out by Albert Lleal and Marc Gallardet

Es Tudons (CBMS-180, Menorca, 90 m). This walk is located near the town of Ciutadella on the island of Menorca in an estate used for sustainable agricultural trials. It has 11 sections, is 2,722 m in length and runs through a flat area grazed extensively by 100 sheep and 30 cows, all belonging to local Menorcan breeds. The grazing land is characterized by psammophilous vegetation growing on fairly well-compacted sandy soils. The woodland sections have Phoenician juniper (*Juniperus phoenicea*), wild olive (*Olea europaea* var. *sylvestris*) and Aleppo pines (*Pinus halepensis*). The Southern Blue (*Polyommatus celina*) is common. The counts are carried out by Josep Mercadal.

Capçaleres del Catllar (CBMS-181, Ripollès, 1,492 m). This low-effort itinerary, walked near the village of Vilallonga de Ter in the county of El Ripollès, was first walked in 2020. It is run by Apatura SLU, an environmental research company, and is one of four CBMS walks in Vall del Catllar. Its 14 sections covering 1,891 m run alongside the Ribera del Catllar through areas in which woodland has been cleared to favour the presence of butterflies and other pollinators. It is walked by Mike Lockwood and Jordi Artola.

Turmadèn (CBMS-182, Menorca, 100 m). This walk is situated near the town of Alaior and has nine sections covering 1,990 m. Monthly walks began in 2016 but since 2020 it has operated as a low-effort station with twice monthly walks performed throughout the whole year. It runs through the estate of Turmadèn des Capità, which consists of a mosaic of pastures and wild olive woodland. The most low-lying areas, which rest on Quaternary sediments and are liable to flooding, are grazed extensively by 20 Menorcan cows, while in more humid areas thickets of blackthorn (*Prunus spinosa*) and hawthorn (*Crataegus monogyna*) thrive. This itinerary is sponsored by the Menorcan Biosphere Reserve Agency and the Menorcan Socio-environmental Observatory (OBSAM), and the counts are carried out by Josep Mercadal.

Sa Ràpita des Trenc (CBMS-183, Mallorca, 8 m). This walk takes place in the south of the island of Mallorca in Es Trenc Natural Park near the town of Campos. It has seven sections and covers 1,373 m and since 2020 has formed part of the CBMS network. Es Trenc boasts one of the most important dune systems in Mallorca and six of the seven sections of this walk sample dune habitats. The itinerary follows easily accessible paths through the dunes, partly on the public foreshore and partly in a private property that has given permission for the walk to take place. The counts are carried out by Estrella Rodríguez, Laura Bover and Gràcia Salas.

Sentmenat (CBMS-184, Vallès Occidental, 233 m). This itinerary runs around the outskirts of the town of Sentmenat in the north-east of the county of Vallès Occidental. It has eight sections covering 828 m, and passes through periurban wasteland, agricultural fields, stands of mixed woodland and, towards its end, an abandoned almond grove. The counts are carried out by Eugènia Hernández.

Jardí d'en Perelló (CBMS-185, Mallorca, 221 m). This itinerary is walked in the southern part of the island of Mallorca near the town of Felanitx. It runs through an agricultural and forestry estate near the Sanctuary of Sant Salvador. Although it has been walked since 2019, it was redesigned in 2020 and incorporated into the CBMS network. Its 10 sections and 1,783 m monitor an area of fruit trees, pine and sclerophyllous woodland, low scrub and herbaceous crops centred around a gully. The counts are carried out by Jason Moss.

Species present

In the 2019 and 2019 seasons, respectively, 170,359 and 238,576 butterflies were counted belonging to 170 species (fig. 4). These species represent 85% of all Catalan butterflies; in the past 10 years, 91% of Catalan butterflies have been detected on CBMS counts (Table 1).

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Fig. 1. Geographical situation of all the stations that have ever participated in the CBMS (1994-2020) network, with their official number and name. Also shown are the three climatic regions used in the analysis of regional trends in Catalonia.

Fig. 2. Evolution in 1994–2020 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 are data from the stations of Rubina and Vilaüt, active in 1988 and 1989, respectively, before the official start of the CBMS counts.

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

Table 1. All the butterfly species recorded from any of the CBMS stations in the 10-year period 2011–2020. Also indicated is the number of stations in which each species was recorded each year. Taxonomic order follows the criteria suggested by Fauna Europaea (www.fauna-eu.org).

Photo 1. The pastures on the Croscat CBMS walk are the richest part of the itinerary and boast a strong population of Large Blue (*Phengaris arion*) (photo: J. Esquerda).

Photo 2. The few open areas in the agroforestry mosaic of Sant Antoni de Vilamajor are a consequence of the clearings produced by power lines and the passage of underground gas, and are associated with the sections with the richest species of the itinerary (photo: A. Ubach).

Photo 3. Es Comú de Muro is a dune system in S'Albufera de Mallorca Natural Park. It is the first Balearic CBMS walk to monitor a stable population of Wood White (*Leptidea sinapis*) (photo: P. Colom).

Photo 4. The Plain Tiger (*Danaus chrysippus*) has appeared in the majority of the CBMS walks on the Balearic Islands, thereby increasing notably the number of populations of this attractive butterfly that are monitored by the CBMS network (photo: O. Massana).

Twenty-sixth and twenty-seventh years of the CBMS

Balance of the 2019 and 2020 seasons

The year 2019 was very poor for many butterflies and the counts of almost 15% of species fell to their lowest levels for almost three decades. The weather was the cause of this decline as the whole country was affected by drought, especially in spring, and suffered from an exceptionally hot summer. Things improved in 2020 as temperatures returned to normal and spring was relatively wet. Common species such as Speckled Wood (*Pararge aegeria*) and Clouded Yellow (*Colias crocea*) reached record levels. Even so, both 2019 and 2020 are amongst the seven worst years for butterflies in the 27-year series of CBMS counts.

Weather and counts

The year 2019 was hot throughout Catalonia (the fifth hottest since 1950) and the average annual temperature was 0.5ºC above the average for the period 1961–1990 (see www.meteocat.com). Only in a few areas in Muntanyes de Prades, the pre-Pyrenees and Pyrenees were temperatures typical. The most serious temperature anomalies were registered in areas of the counties of Baix Ebre, Ribera d'Ebre and Montsià, as well as in the pre-Pyrenees, El Montseny and Alt Empordà. February–March, mid-summer and part of the autumn (September–October) and December were especially hot, while January, May and November were generally cool. Two heatwaves hit the country in the summer: the first on 25–30 June was caused by an entry of an African air mass that provoked record and persistently high temperatures throughout Catalonia (up to 43.8ºC at Alcarràs); the second struck on 22–25 July but was less severe, with the highest temperatures being recorded on the coast. Also of note were the high temperatures on 21 December, which hit 20ºC in many areas and reached historical levels of 23.2ºC in El Montsià.

The year 2019 was dry throughout except for some areas of the pre-Pyrenees and Pyrenees, and parts of the central coast. It was particularly dry in inland areas of the province of Girona, in the Ebro valley, in the first third of the year and in June. Almost everywhere, only in December was rainfall above average. In general, snow depths in the Pyrenees were much less than normal (apart from the month of December).

Compared to 2019, 2020 was much wetter and rainfall was clearly greater than the historical average. Even so, it was another hot year – 0.5ºC above the historical average – that failed to buck the trend of the last 30 years towards ever hotter temperatures. Indeed, thermal anomalies were constant throughout the year, except for October (one of the coldest in recent decades). February was exceptional, with up to four episodes of record highs or lows, as was May, with a significant hot spell in the second half of the month. Nevertheless, there

were no summer heatwaves apart from a single period in late July in eastern Catalonia. Worth noting are the record high temperatures on November 1 and 2: over 25ºC in the coastal hinterland and 28ºC in the Ebro valley.

Rainfall in 2002 was generous but somewhat irregular. The areas with the greatest rainfall were Els Ports (over 1,900 mm, more than anywhere in the Pyrenees), inland in the north-east (headwaters of the river Muga in the counties of Alt Empordà and La Garrotxa), the coast, the central coastal hinterland, and the counties of El Maresme and Vallès. By contrast, rainfall in the Central Depression, the western pre-Pyrenees and the Pyrenees was fairly normal or even somewhat less than the average. Overall, winter, spring and summer in 2020 were rainy but autumn was dry. January was particularly wet with the arrival of storm Glòria on 19–23 January giving record rainfall in some areas and totals that were 10 times above the average. To find similarly wet months in January you have to go back to 1979 or 1996. After a dry February, the months of March and, above all, April were very wet, and around Barcelona, for example, it was the wettest April in the 107 years for which records are available. During the rest of the spring and much of the summer, rain fell in reasonable amounts, albeit somewhat irregularly. From September onwards, however, rainfall was clearly below average throughout most of Catalonia with the exception of the far north-east and south-west in November.

In 2019 and 2020, 5.8 and 9.6 counts, respectively, on average were lost per station, although these figures include the low-effort stations where counts are only made every two weeks (fig. 1 a,b). The percentage of lost counts in 2020 was almost twice the yearly average and is the highest for any CBMS season. Evidently, this loss is closely related to the Covid-19 pandemic and the obligatory lockdown during the first part of spring. Thus, between the end of March and mid-April 2020, only 19% of counts were carried out (fig. 2b), essentially those that run through private estates where, exceptionally, counters could continue their fieldwork. In 2019, the number of lost counts was typical, with a maximum number of lost weeks at the beginning of the season (fig. 2a) due to adverse weather conditions. It is worth bearing in mind that in upland areas, counts do not begin until May once the snow has disappeared.

Changes in abundance: an overview

The years 2019 and 2020 were among the seven worst of the 27 years of CBMS counts. The 2019 season was particularly poor (fig. 3) and the numbers for nine of the 66 species used to calculate trends were the lowest since the CBMS project began. Things improved notably in 2020 and only two species hit record lows (Green-underside Blue *Glaucopsyche alexis* and Marsh Fritillary *Euphydryas aurinia*), while two had record highs (Clouded Yellow *Colias crocea* and Speckled Wood *Pararge aegeria*). Nevertheless, due to the inertia of the previous decade, dominated by falling butterfly numbers, the populations of most species remained below their average values (fig. 3).

Changes in abundance: fluctuations in populations

The 20 commonest species in the CBMS network in 2019 and 2020 are shown in Table 1. The False Ilex Hairstreak (*Satyrium esculi*) was once again the most abundant species in 2019 (after also being the commonest in 2018 and second commonest in 2017) and was the numerically dominant butterfly in the CBMS network, which is evidence of the positive trend in this species in Catalonia (Table 2). Nevertheless, its populations fell by half in 2020 and it seems likely that this decline will be even more notable in 2021.

The dominant species were the same in 2019 and 2020 and tended to be generalists such as the Small White (*Pieris rapae*), Speckled Wood, Meadow Brown (*Maniola jurtina*) and Common Blue (*Polyommatus icarus*). Of note is the abundance of Wall Browns (*Lasiommata megera*), which, with 13,000 counted in 2020, doubled its 2019 total. The year 2020 was also especially good for another generalist, the Clouded Yellow, which reached its highest values since the CBMS project began. A similar case is the Southern Blue (*Polyommatus celina*), very abundant on some walks in both Menorca and Mallorca, and currently monitored at over 15 sites in the CBMS network.

In general, the weather in 2020, characterized by a wet spring and almost no summer drought throughout much of Catalonia, was good for multivoltine generalist species whose successive generations benefitted from plentiful trophic resources that enabled them to increase as the season progressed. Aside from the examples already discussed, species such as Small Copper (*Lycaena phlaeas*), Wood White (*Leptidea sinapis*) and Green-veined White (*Pieris napi*) doubled their numbers in 2020 compared to 2019. The single-generation Satyrinae benefitted from the wet spring, although, apart from the Speckled Wood, their population increases were not that marked. This was the case of the Iberian Marbled White (*Melanargia lachesis*), Southern and Spanish Gatekeepers (*Pyronia cecilia* and *P. tithonus*) and Pearly Heath (*Coenonympha arcania*), amongst the commoner species, although this pattern can be applied to the remaining species of this group.

The year 2020 was fairly good (very good in the case of Lang's Short-tailed Blue) for migrant species such as Long-tailed Blue (*Lampides boeticus*), Lang's Short-tailed Blue (*Leptotes pirithous*), Bath White (*Pontia daplidice*) and Red Admiral (*Vanessa atalanta*), as all increased their numbers compared to 2019. The exception was the Painted Lady (*Vanessa cardui*), which was more abundant in 2019 than in 2020. Nevertheless, there was a significant – almost historical – arrival of Painted Ladies in areas such as the Balearic Islands and some upland areas in northern Catalonia (e.g. El Montseny) coinciding with the heatwave at the end of June. This migration was remarkable, above all, for its timing as it was one of the latest-ever massive arrival of African butterflies in Europe, as was confirmed by monitoring in southern Andalusia.[3]

These two years have also confirmed mid-term trends that have begun to become visible over the past two decades (Table 2). On a positive note, numbers of Cleopatra (*Gonepteryx cleopatra*), Great Banded Grayling (*Brintesia circe*) and False Ilex Hairstreak were amongst the highest ever for these species since monitoring began. The increase in these species can be attributed to their ecological characteristics as heat-loving species associated with closed woodland environments. On the negative side of things, the very worrying and much more widespread problems facing certain declining butterflies were patent in 2019 and 2020, as shown by the continued fall in the numbers of species such as Black-eyed and Green-underside Blues (*Glaucopsyche melanops* and *G. alexis*), Marsh Fritillary (*Euphydryas aurinia*), Western Marbled White (*Melanargia occitanica*), Small Heath (*Coenonympha pamphilus*) and Large Skipper (*Ochlodes sylvanus*), which in one or another of these two years reached their lowest-ever numbers since CBMS counts began. Other butterflies that have also declined drastically during these years are Gatekeeper and Spanish Gatekeeper (*Pyronia tithonus* and *P. bathseba*), Southern White Admiral (*Limenitis reducta*), Knapweed Fritillary (*Melitaea phoebe*) and Panoptes Blue (*Pseudophilotes panoptes*), which all had clear negative trends in Mediterranean areas.

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[1] Schmucki, R., Harrower, C.A. & Dennis E.B., 2021. rbms: Computing generalised abundance indices for butterfly monitoring count data. R package version 1.1.0. https://github.com/RetoSchmucki/rbms

[2] Greatorex-Davies, J.N. & Roy, D.B., 2001. *The Butterfly Monitoring Scheme. Report to recorders, 2000*. 76 pàg. Centre for Ecology and Hydrology, Natural Environment Research Council, Huntingdon.

[3] Cuadrado, M., 2021. Assessing year-round phenology and reproduction of the migratory painted lady butterfly, *Vanessa cardui* (Lepidoptera: Nymphalidae), in a Mediterranean area in southern Spain. *Eur. J. Entomol.*, 118: 288-296.

Fig. 1. Coverage of the counts at the different CBMS stations in (a) 2019 and (b) 2020.
The 'low-effort' stations, which due to their fortnightly cycle (or monthly in initial trial years) lose up to half of the possible 30 counts, are also included.

Fig. 2. Distribution of the lost counts during the official 30 weeks (1 March–26 September) of counts in (a) 2019 and (b) 2020.

Fig. 3. Ranking of the CBMS seasons in terms of the general abundance of the 66 commonest butterflies in the CBMS network. The best season was 2002 and worst (in descending order) 2016, 2015 and 2012. Calculations were carried out using the methodology described by Greatorex-Davies & Roy (2001)[2] using species' annual indices calculated with the rBMS program.

Table 1. Sum of the annual indices and ranking of the abundance of the 20 commonest species in the CBMS network in the 2019 and 2020 seasons.

Table 2. Evolution of the overall annual indices for 108 butterflies recorded in the CBMS network calculated using the rBMS program.[1] Also indicated are the number of stations that provided data for each species and the population trends detected by the program.

Photo 1. Thanks to the Directive of Habitats, the Marsh Fritillary (*Euphydryas aurinia*) is one of the few butterflies that is legally protected in Europe. Although it is not considered to be endangered in

Catalonia, its numbers have declined sharply over the past three decades, possibly due to the fragmentation of the habitats in which it lives (photo: A. Ubach).

Drawing 1. The abundant rainfall in 2020 benefitted generalist multivoltine and migratory butterflies such as Long-tailed Blue (*Lampides boeticus*), Lang's Short-tailed blue (*Leptotes pirithous*) and Clouded Yellow (*Colias crocea*) (drawing: M. Franch).

Methodology

Calculating trends in different climatic regions

With more stations in high mountain areas and in the arid interior of Catalonia, CBMS data now allow us to calculate population trends for different climatic regions. The Regional GAM methodology, specifically developed for analysing CBMS data, is explained here.

Flights curves and abundance indices

The BMS methodology was designed to estimate numerical changes in butterfly populations. Thus, for each year and for each species an annual index of abundance is calculated that includes estimated values for the weeks without counts. The estimation of these missing counts can be performed accurately by modelling species' flight curves using the Regional GAM methodology.[1] A phenological curve is calculated for each region and season that, if adapted to the abundance of each species at each site (fig. 1), allows us to estimate the counts for weeks in which counts were not performed. The sum of the real and estimated counts gives a annual species index for a particular site.[2] Both the phenology and the population dynamics of butterflies are significantly affected by climate[3,4] and so data are analysed on a regional basis using the three climatic regions in Catalonia that determine the regional phenological curve for the species in question. Given that temperature is the main factor affecting butterfly phenology, the climatic region of an itinerary is established according to thermal criteria – specifically, the accumulated number of degree-days (DDG) – calculated according to the number of hours annually in which temperatures exceed 21ºC (data provided by the Servei Meteorològic de Catalunya). Thus, we can define three climatic regions in Catalonia: **alpine and subalpine** (≤ 0-150 DDG), **humid Mediterranean** (150–400 DDG) and **arid Mediterranean** (≥ 400 DDG), which correspond closely to the bioclimatic regions defined by Metzguer et al. (2013)[5] that are widely used in ecological models.

Regional annual index

Before the advent of the Regional GAM methodology, we calculated a trend for every species based on all the CBMS stations in the network. Now, however, with this new analytic tool we can also calculate a regional annual index that groups together all the stations located in one of the three climatic regions. To collapse into a single value all the data from all the relevant transects, the regional annual index is estimated using a Generalized Linear Model (GLM).

For the CBMS, the regional population trends are only calculated if there is a minimum of four years of continued calculated or estimated data, and only if the first year of the series used in the regional index can be calculated using data from at least five itineraries. For more information on this methodology, and the CBMS data-processing protocol, visit https://www.catalanbms.org/ca/analisi/

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Fig. 1. The large skipper (*Ochlodes sylvanus*) has very different phenologies in the alpine and humid Mediterranean region. While in the alpine region it shows a univoltine cycle, with a generation peaking in July, in the humid Mediterranean region it behaves as a bivoltine species, with a first generation in spring and a second in late summer. The species occurs only occasionally in the arid Mediterranean region, for which there is insufficient data to calculate a common phenology (drawing: M. Franch).

Habitat management and conservation

Butterfly microreserves: targeting Catalonia's most threatened species

A new project run by the association Paisatges Vius in collaboration with the Natural Sciences Museum of Granollers is promoting conservation and habitat management aimed at safeguarding 25 of the 46 Catalan butterfly species whose populations are considered to be threatened. The aim of the project is to create microreserves that will act as effective management tools for these species at local scale. Together with habitat management, a protocol for prospecting and monitoring these species has been designed. This pioneer project hopes to establish a solid base for the conservation of the butterflies that are most under threat in Catalonia.

Introduction

The current decline in insect populations worldwide[1-2] has been highlighted by a number of studies focussing on butterflies[3-6] and, in light of this, in various parts of Europe projects are being developed in an attempt to put a halt to this trend. In England and Finland, amongst other countries, successful conservation projects have been undertaken in recent decades.[7-9] In Spain, for example, a document was drawn up in 2019 that included technical indications for conserving butterfly species included in the European Habitat Directive.[10] Data from Catalonia reveal negative trends for 70% of its butterflies,[11] due to both climate- and landscape-related factors.[12-13] The distribution maps in the recent publication *Guide to the Butterflies of Catalonia*[14] have revealed objectively for the first time the true conservation status of the 201 butterfly species known from Catalonia. Using this as a baseline, a series of threat categories was drawn up by adapting IUCN criteria to a regional scale, which the Catalan Government has subsequently employed as the basis for a decree aimed at protecting wildlife in Catalonia.[15] In this Decree, 46 species of butterfly are categorized as threatened, of which 29 are considered to be Vulnerable (VU), 15 Endangered (EN), 1 Critically Endangered (CR) and 1 Regionally Extinct (RE). The distribution and conservation status of these threatened species are currently poorly known in Catalonia, even though the amount of knowledge in this regard has increased enormously over the past decade thanks to the birth of citizen-science portals that compile observations of wildlife (e.g. ornitho.cat, Biodiversidad Virtual, iNaturalist, amongst others).

Despite the variety of factors that have led to the decline in butterfly species and to their current worrying situation, there are a group of species that are threatened, above all, by changes occurring at landscape scale in their ranges. Many of these species fly in close-knit networks of local populations connected by dispersal processes (i.e. metapopulations). Furthermore, in many cases these butterflies are specialist species that are associated with

one or just a few food plants that require active habitat management to ensure sufficient plant densities in appropriate environmental conditions. Both factors – the local distribution of these butterflies and the need to maintain a specific habitat structure – have led to the creation of **microreserves** as a tool for the conservation of these species. These areas are small (varying in size between a few square metres to a few hectares) and represent sites where management will take into account the target species' requirements to ensure they successfully complete its life cycle. The establishment of a microreserve always involves the participation of the landowner or land manager, either as the promotor of the project or as a participant in a stewardship agreement reached with a conservationist group. Thus, if the target species disappears, the microreserve also ceases to exist. To increase a butterfly's area of occupation locally, stewardship agreements can be also signed with nearby landholdings to apply management methods to favour the habitats required by the target species (landscape-scale management). If the target species colonizes this managed area, then it too becomes a microreserve.

Management actions

The project *Butterfly Microreserves* aims to define a conservation strategy for Catalan butterflies based chiefly on the establishment of a network of microreserves via a series of coordinated agreements with landowners, conservationist and research groups, and public administrative bodies. In the first phase of the project a series of planning actions are performed that act as a baseline strategy.

Selection of target species. Of the threatened butterfly species included in the Decree to protect native Catalan wild animal species (at the time of writing it is awaiting its final approval), the project only targets 25 (Table 1). These 25 coincide with those that can be managed via the establishment of microreserves.

Conservation datasheets. For each target butterfly species, a conservation datasheet has been drawn up containing the necessary information for establishing and managing microreserves: distribution, population status, biology, ecological requirements, threats, habitat-management actions, and recommendations to favour the butterfly's conservation.

GIS. A Geographical Information System with detailed, up-to-date information on the distribution of the threatened target species and the priority sites for its conservation is designed. This GIS will be continually updated with fresh information over time. Although not open-access, this GIS is available to public and private bodies wishing to set up microreserves.

Stewardship agreements. Although microreserves can be set up by landowners, typically the promotors will be a conservationist or scientific body, or the public administration, who will reach agreements with the owners of the site of interest. To facilitate this process, a series of model agreements and technical management documents have been drafted for use by promotors.

Pilot microreserves. The first two pilot microreserves have been created by the conservationist body Paisatges Vius to protect populations of Large *Phengaris arion* and Alcon *P. alcon* Blues (Box 3).

Protocols

When creating a microreserve, standardized methodologies are required with protocols for prospections, population characterization and monitoring that will permit the detection of possible threats and propose ways of combatting them.

Prospections: to guarantee full knowledge of the status of a threatened species it is vital to undertake active searches throughout its potential range. Without this, the situation of a threatened species will only ever be partially known and in many cases will be incomplete or biased. To plan efficient sampling activity, all known data regarding the target species' distribution must be compiled, the food plants it uses in Catalonia identified, and its peak flight time defined to maximize sampling efforts. Finally, it is also crucial to design a monitoring protocol for fieldwork to ensure that as much of the potential habitat is sampled as possible, and to establish a methodology that will enable abundances between different areas to be compared (Box 1).

Characterizations: Once the target species has been chosen, it is important to characterize the conditions that enable it to thrive, as well as those that may lead to its absence. A landscape-based description of the study area should be performed, the abundance of the food plant and other trophic resources should be assessed, and the way the site is managed should be studied. The study of the butterfly's population must include aspects relating to its behaviour and, at the same time, should also establish the boundaries of the space to be protected and try and delineate its metapopulation structure. All this information should be integrated into the proposal to create the microreserve (Box 2).

Monitoring: It is essential that a monitoring methodology is used that will provide objective information regarding the evolution of the population/metapopulation over time and act as a guide for establishing the best management methods for the microreserve. In most cases, the most reliable and efficient methodology will be monitoring using the BMS methodology focussed on the target butterfly species. The monitoring period can be reduced greatly to coincide with the flight period of the butterfly population under study. We propose monitoring the species' population during the whole of its flight period if the method used in the CBMS project to calculate the annual index of abundance is to be applied. Thus, we recommend that monitoring takes place during at least five weeks, which will include the three weeks with maximum butterfly numbers. In some cases, immature stages (i.e. eggs) can be used as an alternative or complement the monitoring of the adults — provided that any such counts reflect faithfully the size of the target butterfly's population.

Conclusions

The project *Butterfly Microreserves* represents an active conservation strategy for threatened butterflies in Catalonia based on proper territorial management. Gaps in the knowledge of these butterflies and the conservation status of their populations must be eliminated using well-designed protocols. Despite the obstacles that will inevitably arise, this type of work will become key in coming years if we are to manage efficiently for these species. Visit the webpage of the project for more information: www.conservacio-papallones.org

Box 1
Prospections for the Sooty Orange-tip (*Zegris eupheme*) in eastern Catalonia

The Sooty Orange-tip is considered to be Nearly Threatened in Europe[4] and has been classified as Endangered in the decree aimed at protecting wildlife in Catalonia. Nonetheless, very little recent information on this species is available. CBMS data include five records since 2000, the most recent in 2007 at Timoneda d'Alfés. A revision of butterfly collections has revealed a mere 100 records over 50 years from the Lleida plains, some of which include 'replications' from the same location by different collectors in different years.[16-17]

On 17–18 April and 2 May 2021 a total of 30 people undertook a large-scale simultaneous search of as many sites as possible throughout much of the area in which this butterfly has been recorded in the past 50 years in Catalonia (fig. 1). In all, 111 sites were visited using a standardized monitoring methodology of one hour per site, designed specifically for this particular butterfly.

Of the 111 sampled sites, the Sooty Orange-tip only appeared at one, in the county of Ribera d'Ebre, at what was a new site for the species. No records were made from any of the sites at which it had been observed in the past. The area in which it was located had been affected by the Torre de l'Espanyol forest fire in 2019 and consists of a valley bottom dominated by Mediterranean grassland with scattered almond and olive trees. During the first visit, the crucifers *Erucastrum nasturtiifolium* and, to a lesser extent, *Biscutella auriculata*, *Rapistrum rugosum* and field mustard *Sinapis arvensis*, were abundant and in full bloom. Of these species, only *R. rugosum* is mentioned in the literature as a possible food plant for this butterfly. The results of the fieldwork thus highlight the critical state of the Catalan populations of the Sooty Orange – which has become the species with the greatest extinction risk in Catalonia – and underline the need to improve knowledge of its ecology in our region (i.e. which food plants it uses). The article by Ubach & Stefanescu (in press) includes an update of the map of known sites for this butterfly and discusses some of the factors that have led its populations to such a critical state.

Box 2
Characterization of the Twin-spot Fritillary (*Brenthis hecate*) (Status: Vulnerable)

Site: Castellterçol, county of El Moianès

Habitat: Moianès plateau to the east of town of Castellterçol. Stands of open oakwoods on thin stony calcareous soils, once grazed by sheep but currently abandoned. Habitat mosaic with patches dominated by therophytes such as

Satureja montana, Thymus vulgaris, Aphyllanthes monspeliensis and *Stipa offneri* (communities 34.5131, 34.6322+ – both of community interest – and 34.721 in the Catalan Habitat Manual published by the Catalan Government's Ministry of Territory and Sustainability). Of note, the presence of dropwort *Filipendula vulgaris* and *Cephalaria leucantha*. More shrubs and trees flourish on deeper soils.

Description of the metapopulation: consists of at least three different populations associated with the three largest habitat patches (fig. 2). Sampling in 2021 revealed an emergence from 20 May onwards, with a peak around 13 June (maximum of 15 butterflies in patches 1 and 2). A more systematic monitoring project is needed to be able to define the size and extent of the metapopulation of this butterfly.

These populations in El Moianès are isolated from those in the counties of El Solsonès, El Pallars Jussà and Osona. This site near Castellterçol is the only place the Twin-spot Fritillary has been observed within a radius of 30 km over the past 25 years. Prospections in other parts of this county have not detected any other populations, although the presence of other nuclei cannot be ruled out.

Threats, impact and management:

Threats: the intensification of cattle grazing in the county is affecting sites in the vicinity of the Twin-spot Fritillary habitat and could eventually damage some of its populations.

Impacts: part of the habitat has been replaced by a holm oak plantation used for truffle collecting, while another part has been destroyed by a golf course. Other parts of the same municipality with similar habitats have already been totally modified.

Management: currently, this site is not managed in any way. That said, the abandoning of sheep grazing does not seem to be a threat in the short term given how slowly change occurs on these thin soils.

Box 3
Creation of microreserves for the Alcon Blue (*Phengaris alcon*)

The Alcon Blue is considered to be Vulnerable in Catalonia, in part due to its complex life-cycle that depends on a single plant, the cross gentian (*Gentiana cruciata*), and an ant host (ants of the genus *Myrmica*), in whose nests the larvae complete their development.

The main threat to this butterfly is the transformation of its habitats (grassland, hay meadows, and woodland edges and clearings on calcareous strata at 800–2,000 m a.s.l). Modifications to its habitats include encroachment by scrub and then bushes and trees but, above all, overgrazing or changes in hay-cutting cycles (earlier and more often). This intensification means that fewer gentians flower and so this plant could eventually disappear. The Alcon Blue begins its flight period just as the flower buds begin to appear on the gentian plants; eggs are laid near the buds so the larvae can bore into them to begin feeding.[18] Thus, intensive pasturing and early cutting prevent gentians from completing their flowering and interrupt the butterfly's life cycle. Hay cutting often takes places when the eggs are still on the gentians or when the small caterpillars are still in the flower buds and before they fall to the ground to be collected by the ants that feed them inside their nest.

In 2020 members of the association Paisatges Vius discovered that one of the most important populations of Alcon Blue in the county of El Ripollès, near the village of Pardines, was threatened by the imminent transformation of a number of hay meadows (and field edges) into grazing for cows. To prevent this from happening, Paisatges Vius reached a stewardship agreement with the landowner and farmer whose aim is to preserve the Alcon Blue and to set up the first butterfly microreserve in Catalonia. The agreement states that two fields and their edges (3 ha) will be managed with the butterfly in mind to increase the density of cross gentian plants and make them more visible.

Paisatges Vius have also established a stewardship agreement with a landowner at Plaus, near Queralbs, which aims to encourage the Alcon Blue to colonize this area after habitat improvements. Currently, the plant is only present in two fields (a couple of hundred metres from Plaus) managed by the same farmer, and so any change in how he manages these fields could lead to the disappearance of the gentian. The fact that the Alcon Blue depends on different landowners and farmers probably means that its populations are more resilient in this area. At Plaus, the areas with calcareous strata were selected and the distribution of the *Myrmica* ants is being studied. These ants generally have a territory that consists of a 4-m radius around their nests and are essential for the survival of the Alcon Blue. Cross gentians were planted around one of the ant nests (Photo 1), some as seedlings (which will take some years to flower), some as translocations of plants from areas of intensive hay-making that no longer flower (which it is hoped will flower the following year). If the Alcon Blue begins to breed in this farm, it will become a new microreserve.

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Fig. 1. Localities prospected in 2021 aimed at defining the current situation of the Sooty Orange-tip in Catalonia. The yellow star indicates the site of the only observation of the species.

Figure 2. Map of the metapopulation structure of the Twin-spot Fritillary (*Brenthis hecate*) at Castellterçol based on the Soil Map of Catalonia. The white patches represent appropriate habitat where dropwort *Filipendula vulgaris*, this butterfly's food plant, grows. Twin-spot Fritillaries have been observed in sectors 1, 2 and 3.

Table 1. List of the 25 butterfly species taken from the list of threatened species in Catalonia chosen to form part of the project.

Photo 1. Cross gentian *Gentiana cruciata* planted at Plaus. This management action forms part of the project aiming to favour the food plant in the habitat in which the Alcon Blue is present, thereby helping to strengthen butterfly numbers (photo: Paisatges Vius).

Photo 2. Twin-spot Fritillary males (like this one photographed in Castellterçol) are patrollers and actively look for newly emerged females during the short flight period of the species (photo: A. Ubach).

Photo 3. Hay meadows in Els Plaus stand out for their spectacular diversity and, very particularly, for the presence of the Alcon Blue (*Phengaris alcon*) (photo: Paisatges Vius).

The station

Alòs de Balaguer, an itinerary between the lowlands and the foothills of the pre-Pyrenees

Situated where the river Segre flows between the mountains of Saborell and Carbonera to the south, and of Poll and Penarreba to the north, and just before it enters the gorge of Congost del Mu, this itinerary lies within the Aiguabarreig-Segre-Noguera Pallaresa protected area in the county of La Noguera. It is perfectly placed between the lowlands and first foothills of the pre-Pyrenees, and is rich in species including rarities such as Mountain Small White and Mother-of-Pearl Blue.

The itinerary

The Alòs de Balaguer CBMS station (CBMS-162) lies at 300 m a.s.l. in an area of arid Mediterranean climate influenced by its proximity to the Catalan Central Depression and the mountains of the pre-Pyrenees (e.g. Serra de Sant Mamet, 1,394 m). The average annual rainfall is 535 mm and average annual temperature 14ºC (with extremes of -8ºC in January and 38ºC in July and August).

The itinerary is lineal (1,897 m) and is divided into 10 sections, six of which run alongside the river Segre and the four others through a cultivated field, an abandoned field, an area of rosemary scrub and a gully with deciduous oaks. The landscape is one of ridges cloaked in Lusitanian, downy and holm oaks, box, field and Montpellier maples, Mediterranean buckthorn and Aleppo pine. Alongside the river, the riparian woodland consists of ashes, elms, poplars, willows, nettle-trees and alders, complemented by an understorey of brambles, ivy, hawthorn and other shrubs. Parts of this itinerary run through more open areas dotted with rosemary, lentisc, turpentine tree, Phoenician juniper, blackthorn, bladder-senna and thyme, or through abandoned terraces dominated by grasses. Rocky areas hold important food plants such as burnt candytuft and birthwort. Overall, this is an area in which traditional agricultural practices (cereal, almond and olive cultivation) survive alongside abandoned fields that are no longer viable for farming.

The butterflies

Over the past three years (counts began in 2019) 81 species of butterflies and over 26,000 individuals have been recorded, with annual averages of 70 species and 8,925 butterflies. The first species to fly after the winter are Green Hairstreak (*Callophrys rubi*), Large Tortoiseshell (*Nymphalis polychloros*), Cleopatra (*Gonepteryx cleopatra*) and Nettle-tree Butterfly (*Libythea celtis*). A little later appear Spanish Festoon (*Zerynthia rumina*), Orange-tip and Moroccan Orange-tip (*Anthocharis cardamines* and *A. euphenoides*), followed by Green-underside and Black-eyed (*Glaucopsyche alexis* and *G. melanops*) Blues. The rest of the year flies by in a haze of blues, fritillaries and graylings. The commonest species include Small White (*Pieris rapae*), Common Blue (*Polyommatus icarus*), Wood White (*Leptidea sinapis*) and False Ilex Hairstreak (*Satyrium esculi*). Diversity peaks in June and July, when up to 38 species and 1,200 butterflies can be counted in a single day. Brambles and marjoram in flower are magnets for species such as Spanish and Southern (*Pyronia bathseba* and *P. cecilia*) Gatekeepers, Wall Brown (*Lasiommata megera*), Southern White Admiral (*Limenitis reducta*) and Iberian Marbled White (*Melanargia lachesis*). As summer progresses, butterfly numbers drop to a minimum at the beginning of September, although a short-lived rise in numbers occurs later on in the month when the winter savoury (*Satureja montana*) comes into flower.

One of the riches of this area is the abundance of food plants that encourage the presence of vulnerable or threatened species such as Mountain Small White (*Pieris ergane*), Meleager's (*Polyommatus daphnis*) and Mother-of-Pearl (*P. nivescens*) Blues, and Twin-spot Fritillary (*Brenthis hecate*). Occasionally, Chapman's Green Hairstreak (*Callophrys avis*), High Brown Fritillary (*Fabriciana adippe*) or Mediterranean Skipper (*Gegenes nostrodamus*) drop by. In the years before the itinerary was walked, Iolas Blue (*Iolana debilitata*) had been observed in the area, while in the most recent count, Catalan Furry Blue (*Polyommatus fulgens*) and a number of skippers – Cinquefoil (*Pyrgus cirsii*), Safflower (*P. carthami*) and Oberthür's Grizzled (*P. armoricanus*) Skippers – were noted mudpuddling near the route of this butterfly walk.

The future of butterfly populations in light of agricultural abandonment and droughts

If you climb up to one of the peaks that overlook this walk, you'll see below an enormously rich and attractive landscape. Around 13,000 years ago at the end of the Palaeolithic a group of humans established a temporary setlement in a cave known today as Cova del Parco. In around the tenth century the Arab inhabitants of the area built a fortress that was converted into a castle in the eleventh century. By 1877, Alòs had 1,026 inhabitants but today has only 132. This population decline and changes in agricultural techniques have led to the abandoning of many terraced hillsides, which have become dominated by grasslands where today Wild Boar and Roe Deer graze. In time, the forest will swallow up these open habitats. At the same time, droughts are ever-more persistant and have serious effects on the vegetation and on the butterflies that depend on these plants. Thus, in recent years butterflies such as Small Tortoiseshell (*Aglais io*), Comma (*Polygonia c-album*) and Camberwell Beauty (*Nymphalis antiopa*) have all disappeared. Moreover, it remains to be seen how tourism will affect the area as increasing numbers of people now come to walk through the gorge, El Congost del Mu, or to climb or ride local paths and tracks on quad-, scrambling- and mountain-bikes.

Alòs de Balaguer, where the river Segre flows through the Congost del Mu, lies at the meeting of the lowlands and the pre-Pyrenees. This itinerary is thus an essential place for studying both stable butterfly populations and those that are being displaced due to the effects of climate change.

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Fig. 1. Abundance (average annual indices 2019–2020) of the 15 commonest butterflies at the Alòs de Balaguer station.

Photo 1. The itinerary runs between steep hillsides next to the river Segre through a diverse and fascinating landscape (photo: F. Turmo).

Aerial photo. Route of the butterfly walk at Alòs de Balaguer, La Noguera.

The station

Raixa, a decade counting butterflies in the Serra de Tramuntana in Mallorca

Raixa is one of the best-known public estates in the Serra de Tramuntana and a place where natural and the typical agro-ecological habitats of the Mallorcan landscape co-exist. This was the first CBMS to be set up on Mallorca and the first to generate 10 years of uninterrupted results. As well, in the past three years the interactions between butterflies and plants have been studied in greater detail.

The itinerary

Raixa (CBMS-155) was the first-ever CBMS station set up on Mallorca. Counts began in 2010 and data have been validated since 2012. This station is thus the first on Mallorca to have generated a 10-year data series. Henceforth, as a series of new stations are being set up on the island, far more knowledge of trends in Mallorcan butterfly populations over the coming years will become available.

The itinerary is walked in a public estate, Raixa (Bunyola), which lies at a relatively low altitude (160 m a.s.l.) in the central part of the mountains of Serra de Tramuntana. The estate covers 140 *quarterades*, equivalent to around 100 hectares. It was bought in 2002 by the Consell de Mallorca and the restoration of its gardens and agricultural land began in 2009.

The itinerary is 2,427 m in length and has seven sections that run through a typical Mallorcan landscape dominated by pines with a understorey of woody shrubs, mixed holm-oak, pine and wild olive woodland, and riparian woodland in a gully. As well, the estate contains agricultural habitats including olive and almond groves, and fields where non-irrigated cereal and leguminous crops are grown.

Finally, next to the house there are a series of gardens with fruit trees and ornamental plants.

The butterflies

During the 10 years of counts at Raixa, 24 of the 28 butterfly species recorded on Mallorca in the twenty-first century have been observed. Only very local species such as Wood White (*Leptidea sinapis*) and Cardinal (*Argynnis pandora*), or rare species such as Pygmy Skipper (*Gegenes pumilio*) and Camberwell Beauty (*Nymphalis antiopa*), are yet to be recorded on this CBMS walk. On average, annually 19 species and just under 1,300 butterflies are recorded. Numbers increase steadily from May onwards and peak at the end of June, when around 50 butterflies per 1000 m belonging to 11 species are observed. The number of individuals falls as summer progresses and reaches a low at the beginning of September. Typically, however, numbers recover at the end of this month with the arrival of several migratory species. In recent years, counts have continued throughout October and notable abundances have been recorded at the beginning of autumn.

Due to the types of environments found at Raixa, the commonest species are those that are associated with agro-forestry mosaics such as Speckled Wood (*Pararge aegeria*), Southern Gatekeeper (*Pyronia cecilia*) and Small Heath (*Coenonympha pamphilus*). The Speckled Wood is the commonest and most frequent species over the year, above all in section 4, which runs along a gully that is the shadiest and most humid part of this walk. The second commonest species is the Southern Gatekeeper, which dominates in the summer and at Raixa flies in its highest densities in any Balearic CBMS walk.

Counting interactions with plants

The poor butterfly species-richness on the Balearic Islands simplifies the butterfly counts and allows counters to gather additional information. Since 2019, information on butterfly visits to flowers has been gathered systematically at Raixa and at the other CBMS stations on Mallorca and Menorca. Each time a butterfly is seen to take nectar from a flower (i.e. if its proboscis is extended and nectar-gathering is confirmed), the information is recorded.

During the past three years at Raixa around 50 plants have been seen to be used by adult butterflies as nectar sources. In spring, the most-visited flowers are purple milk thistle (*Galactites tomentosa*) and fringed lavender (*Lavandula dentata*), two plants that are abundant at Raixa at this time of year. Far less abundant is felty germander (*Teucrium capitatum*) but, when it flowers at the end of spring, it becomes one of the most attractive flowers for butterflies. In summer, the number of flowers in bloom falls but some plants such as lavender-cotton (*Santolina chamaecyparissus*) and various species of bindweed (*Convolvulus* spp.) thrive and become important trophic resources for adult butterflies.

The number of visits and the diversity of interactions between butterflies and flowers reaches a peak in May and June, which is also when most species are on the wing. Although they are not the commonest species at Raixa, Small White (*Pieris rapae*) and Southern Blue (*Polyommatus celina*) are the two butterflies that are most often observed visiting flowers. Both seem to be generalists when obtaining nectar as they have been observed on 16 and 14 different flower species, respectively. In summer, the Southern Gatekeeper is the species that is most often seen on flowers and, aside from its visits to plants of felty germander and lavender-cotton, it is also attracted to saffron thistle (*Carthamus lanatus*) and clustered carline thistle (*Carlina corymbosa*).

The incorporation of this type of information gathering into the CBMS methodology will enable us to estimate indirectly the diversity of resources that are available to butterflies on the Balearic Islands. Furthermore, it will help us understand the trophic preferences and specializations of the adults and larvae of each species, and analyse long-term trends in the synchronization between butterfly emergence and plant flowering.

Pau Colom and Matilde Martínez

Fig. 1. Abundance (average annual indices 2012–2020) of the 15 commonest butterflies at Raixa.

Photo 1. The Raixa estate, with the mountains of Serra de Tramuntana in the background (photo: M. Martínez).

Aerial photo. Route of the butterfly walk at Raixa in a low-lying area in the central part of Serra de Tramuntana, Mallorca.

The butterfly

The Brown Hairstreak, *Thecla betulae*, a life in the tree-tops

One of the most attractive and, at the same time, most difficult to observe butterflies in Catalonia is the Brown Hairstreak, which, of our Lycaenidae species, is only surpassed in size by the Large Blue. It emerges at the beginning of summer and males and females concentrate on the crowns of trees where they feed (mainly on aphid honeydew) and mate. Most observations, however, take place at the end of September and in early October when the females leave their tree-top havens to come down to lay their eggs on the blackthorn bushes that grow along the edges of fields and woods.

Geographical distribution and situation in the CBMS

The Brown Hairstreak is widely distributed throughout Eurasia, from northern Portugal to Korea.[1-2] In the Iberian Peninsula, it is present in the northern third and, more rarely, in the centre where there are scattered populations in the mountains of the Sistema Ibèric and Sistema Central.[3] In Catalonia (fig. 1) it is only found in the northern third, even though its food plant is widespread throughout. It is common – but never abundant – at low and mid-altitudes in the Pyrenees, pre-Pyrenees, the Serralada Transversal, El Montseny, Les Guilleries and El Moianès. It is much scarcer and local in the Vallès area, in some parts of La Serralada Litoral (e.g. El Montnegre) and in the counties of La Selva and Bages.[4-5] It was recorded in 1980 at El Santuari dels *Àngels* in the mountains of Les Gavarres (Gironès) and, at the beginning of the twentieth century in Blanes (La Selva), but it is doubtful that these populations are still extant, above all the latter. In the CBMS network it is a rare species (or, leastways, difficult to detect) and it has only appeared at 19 stations (10%) up to 2020, always in small numbers. Its altitudinal range runs from just above sea level (observation at Sils at 65 m) to around 1,700 m (observations at Sant Maurici at 1,694 m), with a maximum at around 1,000 m.

Habitats and food plants

The Brown Hairstreak is a specialist feeder on blackthorn (sloe) (*Prunus spinosa*) and most of its populations are closely associated with this shrub. Nevertheless, occasionally eggs are laid on other plants of the genus *Prunus* such as plum (*P. domestica*), damson (*P. insititia*) and wild cherry (*P. avium*). Other species such as peach (*P. persica*) cannot be ruled out[3,6-7] and in captivity it has been reared successfully on other *Prunus* species such as cherry plum (*P. cerasifera*).

The Brown Hairstreak's strict dependence on blackthorn, a typical shrub of thickets, means that this butterfly has a marked preference for closed habitats such as tall scrub and woodland edges, but also for agricultural areas where mature hedgerows with abundant blackthorn still stand. This preference for closed environments is reflected in its TAO index (closed vs. open index), which is the second lowest for all Catalan butterflies and makes it one of the most woodland of all our butterflies.[8]

Phenology and biological cycle

Like the two other Lycaenidae from the tribe Theclini present in Catalonia (Purple Hairstreak *Favonius quercus* and Spanish Purple Hairstreak *Laeosopis roboris*), the Brown Hairstreak is a univoltine species that winters as an egg.[9] Adults have a long flight period – almost three and a half months – that lasts approximately from July to mid-October. The earliest records are from the end of June and are invariably male butterflies. In the humid Mediterranean region (fig. 2a), the number of observations increases quickly through July and then levels out or, even, decreases slightly until the end of September. Most observations, however, occur at the end of this month and the very beginning of October, at which point the number of adults seen drops off rapidly and the latest Catalan record is from 12 October. The flight date curve indicates that in this region adults emerge chiefly in July but egg-laying (when this species is easiest to detect) mainly takes place during a short period at the end of September and beginning of October. In the subalpine region (fig. 2b), emergence occurs a month later, although the egg-laying period closely coincides with that mentioned above. The latest observation in this climatic region is 17 October.

Its egg-laying behaviour is characteristic and relatively easy to observe in areas where

blackthorn grows and conditions are appropriate. Various studies[9-11] and our own observations reveal that young blackthorn plants up to around three years of age are generally selected, while old bushes with lichen-covered branches are generally rejected as laying sites. Once on the chosen blackthorn, females begin to walk along the branches, often facing downwards, as she feels and tests the plant with her front pair of legs, antennae and abdomen tip. Eggs are laid at the base of spines or where two branches join, generally at heights above ground level of 80 cm to 2 m, with an optimum height of a little over a metre;[10] occasionally we have found eggs laid at only 25 cm above the ground. Although most are laid singly, around 10% are laid in batches of two or even three eggs. The selected blackthorns face in any direction, although north-facing bushes are usually avoided, especially in central European populations.[10-11]

On blackthorns growing in hedgerows, the structure of the hedge and the arrangement of the bushes determine to a large extent female choice. They prefer the blackthorns that grow in undulating hedgerows to those growing in straight lines, possibly because in the former case the more complex profile of the hedge creates warmer microclimates that are preferred as egg-laying sites.[11] As well, the blackthorns that grow on the ends of hedgerows are clearly selected over those that grow in the middle surrounded by other blackthorns. This may be due to the greater detectability of the blackthorns in the former case, above all when females arrive from nearby woods.

The emergence of the larvae and the appearance of the blackthorn leaves seems to be closely synchronized as the result of a compromise between two opposing selective forces. On the one hand, it is essential that the larvae don't appear too early before the blackthorns come into leaf, which would lead to massive larvae mortality; on the other hand, if the emergence is postponed excessively the quality of the leaves drops rapidly and so a late emergence will be risky for the young larvae. Monitoring of various Dutch populations has shown that larval emergence takes place one-to-three months after the blackthorns have come into leaf.[12] It has been suggested that climate change, with increases in winter temperatures, could induce a loss of synchronicity between larvae and leaves. However, this idea has been challenged by an experiment in which it was shown that an increase by 5ºC in winter temperatures leads to an advance in both the hatching of the eggs and in the date of appearance of the leaves. Nevertheless, the larval emergence dates were to some extent restricted, unlike the date of appearance of the leaves, which could lead to a loss in quality of the food resource available for the newly hatched larvae.

Once the larva leaves the egg, it hides in an unfurled leafbud for a couple of weeks until it enters its second instar.[9] Then, it lives unprotected, feeding at night and resting by day on a silken pad attached to the underside of a blackthorn leaf. Its passes through four instars and takes at least a month-and-a-half-to-two months to complete its growth. Unlike other Lycaenidae, only very rarely do Brown Hairstreak larvae interact with ants, which is logical as they have very simple myrmecophile organs (PCO; *pore cupola organs*).[7] Despite this, at a site in El Baix Montseny mutualist relationships with ants have been observed on several occasions in third and fourth instar larvae attended by two ant species, *Formica rufibarbis* and *Lasius grandis*.[7]

When the larvae have finished growing, they change to a mottled purple colour and usually abandon the host plant to pupate on the ground, sometimes in a crack in the soil or perhaps under dead leaves. This phase lasts about one month. In captivity, it has been observed that the chrysalid, which emits noises like other Lycaenidae, is very attractive to ants[9] and it has been suggested that under natural conditions the chrysalids may be taken by ants into their nests, where they would be well protected.

Under natural conditions, the cycle from egg to adult takes between two-and- a-half-to-three months[9], although it is likely that in warm Mediterranean environments this period is shortened. Indeed, in three larvae reared in captivity, hatching to the emergence of the adult butterfly only took around two months, with a minimum of 58 days and a maximum of 64.[13]

Adult behaviour

The most notable characteristic of adult Brown Hairstreaks is its arboreal lifestyle, which make them very difficult to observe. Both sexes feed principally on honeydew, the secretions that aphids make on tree leaves,[9] and so rarely need to descend to search for nectar. Nevertheless, in the Pyrenees (not in Mediterranean environments) adults – above all males – visit flowers more often. We have noted Brown Hairstreaks nectaring on wild mint *Mentha longifolia*, lesser burdock *Arctium minus*, hemp-agrimony *Eupatorium cannabinum*, field holly *Eryngium campestre* and brambles *Rubus* sp. We also know of an observation of a fresh butterfly, of sex unknown, feeding on a mature mulberry. Occasionally, females are seen drinking water, either as dew on leaves[6] or from stones next to mountain streams.

Another characteristic arboreal behaviour of males is their selection of a 'master tree' that serve as meeting places for the sexes.[9] Males congregate on these trees and wait there for the females to arrive. The first such trees identified as master trees were all ashes (*Fraxinus excelsior*), which were generally relatively tall and situated on woodland edges.[9] In more recent times, an intensive study of this butterfly located 40 more master trees that were used to a greater or lesser extent over two seasons.[14] In Catalonia we have four observations of master trees, three from El Montseny and one from the Pyrenees. On Pla de la Calma in El Montseny this behaviour was first observed in August 2003 at 15.00 on a small holm oak growing in a clearing on a slope. Another case is of observations made over a period of at least 17 years (2005–2021) on the edge of a forest track, always at 11.00–13.00.[6] Males originally concentrated on a 7-m-tall whitebeam (*Sorbus aria*) but, after it had been cut down, they took to concentrating on several holm oaks that were growing behind it. The males (one, two or three at the same time) rested with their wings folded in the upper-middle part of the crown of the whitebeam on the branches overlooking the track, which gave a good view of the surrounding area. If they were disturbed, they made short flights but returned a few seconds later to take up their observation points. They often shared the crown of the whitebeam with male Speckled Woods *Pararge aegeria* and Purple Hairstreaks *Favonius quercus*, with which they interacted frequently. In summer 2015, the same territorial behaviour was observed in a gully on the western side of the mountain of Matagalls, also in El Montseny, in this case on an old hawthorn, around 5-m high, that was growing on the edge of a stream. Between 12.00 and 13.00 on 22 July there were two males present, and on 10 August at least five males, all worn and with their colours faded. Numerous interactions between males were observed, consisting of males making vertical flights, spiralling upwards, before returning to the crown of the tree. Finally, observations were also made on a group of three trees (a 6-m-high hazel, a 8-m-high ash and a 11-m-high poplar) growing on the banks of the river Noguera Pallaresa (Alt Àneu) on 22 August 2021. Between 12.00 and 13.00, up to nine males were present and, as at the other sites, the sun beat down directly on the trees on which the butterflies were concentrating.

Mating is more difficult to observe and in the literature we have only found one reference, by J. A. Thomas, who reports an observation on a master tree that he was monitoring. We can add an observation from the CBMS itinerary of El Puig from 19 August 2018. On this occasion, a male was observed flying around the crown of a beech. At 11.00, a female arrived, which the male immediately followed. They soon stopped on a leaf on the same tree around 10 m above ground level and within a few seconds started to mate. Then they moved to the underside of the leaf where they remained motionless, and very well camouflaged. With binoculars it was possible to see that the pair consisted of a worn male and a relatively fresh female.

According to Thomas, after mating females remain on the master trees for around 6–10 days and then disperse to begin egg-laying.[9] Nonetheless, the observation at El Puig was made a good month before females are seen egg-laying in this area and so it is likely that females remain more or less inactive for long periods after mating.

Natural enemies

In a detailed ecological study carried out of a population in Surrey (England),[9] it was estimated that around 80% of larvae are predated upon by spiders and harvestmen in their first month of life, and by insectivorous birds such as warblers and tits when they are more fully grown. Albeit based on laboratory work rather than observations in the field, mice, shrews and, to a lesser extent, beetles have also been cited as important predators of the chrysalids of this hairstreak.

The collection of material from Pla de la Calma for captive-rearing has revealed that a small percentage of eggs are attacked by a solitary parasitoid chalcid wasp. As well, two cases of larval parasitism by tachinid flies have been recorded. In these cases, the laboratory-reared larvae, born from eggs collected in the wild, were parasitized after ingesting the micro-eggs

laid by the tachinids on the leaves of the blackthorn bush. Once they had pupated, the larvae were killed by the parasitoid.

Conservation

The poor detectability of Brown Hairstreak makes it impossible to calculate population trends using CBMS data. In other countries, these trends are based on egg counts in winter, which is a reliable and precise way of estimating this butterfly's abundances.[10] This census method has been adopted by the Dutch BMS scheme.

Despite the lack of data, the Brown Hairstreak in Catalonia is not threatened,[5] even though it may be rare or, at best, uncommon. It is probably present over much of the northern third of the country, even in agricultural areas, but always in low densities. In fact, this seems to be a characteristic of this species, as a study in Surrey has demonstrated: despite occupying a surface area of 30 ha, the annual number of butterflies counted was just 40–300,[9] an exceptionally low number if compared to most other butterfly species.

In certain European countries, the areas of occupation of the Brown Hairstreak have shrunk in recent years due, above all, to the intensification of agricultural methods that lead in many cases to the digging up of hedgerows with blackthorn.[11] Even if the area occupied by hedgerows remains the same, the widespread practice of clearing blackthorn scrub mechanically with hedge strimmers destroys many eggs and can lead to serious population declines.[9] The study by Merckx & Berwaerts (2010) has identified the best ways of managing for this species in agricultural areas. First, the hedgerows and forest edges should undulate as females prefer this type of hedgerow over straight lines. Secondly, it is important to favour the growth of young blackthorn bushes by cutting them back periodically and in rotation to encourage new shoots. In this way, egg-laying can be encouraged on the young plants that have sprouted in the past 2–3 years. Through the application of these two simple strategies, the Brown Hairstreak population in Catalonia could almost certainly be favoured in agricultural areas. It is possible that in upland areas in Catalonia the Brown Hairstreak has increased in number in recent years as many terraces that were once grazed have been abandoned and rapidly colonized by blackthorn.

Constantí Stefanescu and Jordi Jubany

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[8] The Brown Hairstreak has a negative TAO value of -0.2072, which is indicative of a preference for woodland habitat. The only species of the 158 for which this index has been calculated with a preference for more closed environments is the Speckled Wood, *Pararge aegeria*.

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Fig. 1. Distribution of the Brown Hairstreak in Catalonia. The map has been compiled from CBMS data (182 records used to estimate population densities), 123 records published by Viader (1994) and 70 observations collected on the Ornitho platform (up to 2021).

Fig 2. Phenology of the Brown Hairstreak (a) in the humid Mediterranean region (n = 146 observations); (b) in the alpine and subalpine region (n = 159 observations). The bulk of the data have been collected between 1994 and 2021, but the historical citations collected in Viader (1994) are also included.

Photo. The Brown Hairstreak is one of the most spectacular Lycaenids of our fauna but, at the same time, one of the most difficult to see. In addition to its arboreal habits, it remains motionless in the trees for long periods, showing no kind of activity, even in good weather. Binoculars are an indispensable tool for observing this species (photo: J. Jubany).

Plate. (a) First instar larva just emerged from an egg laid at the base of a small lateral branch; (b) at day time, grown larvae remain upside down on a silk pad spun on the underside of a leave, perfectly camouflaged; (c) when ready to pupate, the larvae becomes a mottled purple colour and usually leaves the host plant seeking for a pupation site on the ground; (d) detail of a captive breeding pupa; (e) an empty egg that had been parasitised by a Chalcicid wasp, showing the emergence orifice left by the parasitoid; (f) a perching territorial male on a master tree; (g) basking female showing the large orange bands on forewings, that easily distinguish her from the predominantly dark male (h) (photos: J. Jubany).

Identification

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

Five species of fritillary belonging to the genus *Boloria* fly in Catalonia: Violet (*B. dia*), Pearl-bordered (*B. euphrosyne*), Small Pearl-bordered (*B. selene*), Shepherd's (*B. pales*) and Bog (*B. eunomia*). Other than the Violet Fritillary, all are upland species only found in the Pyrenees. Despite resembling each other in flight, a series of characteristics make them easily identifiable when observed with their wings closed. Here, we concentrate on the three commonest species.

The Violet Fritillary (sometimes known as Weaver's Fritillary) is a widespread butterfly in Catalonia,[1] although it becomes scarcer to the south where it is restricted to upland areas in the counties of Baix and Alt Camp, Conca de Barberà, Ribera d'Ebre, Alt Penedès and Baix Llobregat. It is absent from coastal areas, the Empordà plain and, apparently, from the mountains of Ports de Tortosa. Although its altitudinal range extends from almost sea level to around 2,000 a.s.l. (and exceptionally even higher), it is commonest in scrub and woodland clearings in montane areas (400–1,000 m). It is multivoltine, flying in three generations throughout spring and summer. In Mediterranean areas it flies as early as March. The Pearl-bordered Fritillary is relatively common in the Pyrenees, with a few small colonies present further south in the pre-Pyrenees and Montsec.[2,3] It flies over scrub, in woodland clearings and pastures, in both subalpine and alpine areas but only very rarely below 1,000 m a.s.l. It has a single, prolonged generation that begins in May (occasionally in April) and lasts until the beginning of August. The Small Pearl-bordered Fritillary is likewise a Pyrenean butterfly but rarer than the two previous species (it is considered to be Near Threatened in Catalonia) and is only very occasionally recorded from the pre-Pyrenees.[2,3] Its altitudinal range is very similar to that of the Pearl-bordered and it too flies in woodland clearings and humid pastures. It flies in a single generation in June-August. All three species are specialist feeders on violets *Viola* spp. They lay their eggs on the plant's leaves or, more often, on dead plants near the hostplant.[1,2]

Constantí Stefanescu

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[3] Records from ornitho.cat, downloaded on 16/11/2021.

Drawings

VIOLET FRITILLARY

Upperside: orange with striking black markings

Underside: pink-mauve coloration on underside of hind-wing.

Marked with line

sharp angle; bright white patches; large black postdiscal spots

PEARL-BORDERED FRITILLARY

Upperside: orange with striking black markings

Marked with line

rounded angle; elongated bright white patch in centre of wing; large anvil-shaped patch

SMALL PEARL-BORDERED FRITILLARY

Upperside: orange with striking black markings

Marked with line

rounded angle; postdiscal series of smaller, uniform bright white spots; black submarginal spots more obvious

The underside of the Violet Fritillary, with its pink-mauve colour and bright white patches and large dark postdiscals spots, is very distinctive. The hind-wing angle at vein v8 is sharp, almost right-angled. The other two fritillaries have more rounded hind-wings and a well-marked black discal spot on the underside of the hind-wing. In the Pearl Bordered Fritillary, the underside of the hind-wing has a postdiscal band consisting of yellowish patches, in the middle of which there is a bright white patch that is larger than the other patches. As well, the mark in space 2 is anvil-shaped. In the Small Pearl-bordered Fritillary, the marks on the postdiscal band are bright white also, but smaller, while the black submarginal spots are better marked than in the Pearl-bordered Fritillary.

Identification

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

Six species belonging to the genus *Lycaena* fly in Catalonia and Andorra: Small (*Lycaena phlaeas*), Purple-shot (*L. alciphron*), Sooty (*L. tityrus*), Purple-edged (*L. hippothoe*), Scarce (*L. virgaureae*) and Violet (*L. helle*). Of these six coppers, the first is widespread but the other five are only found in upland habitats. Of these latter five, all but the Purple-shot are restricted to the Pyrenees.

The Small Copper is widespread and common throughout Catalonia and, as a multivoltine species, is on the wing almost all year. It is a habitat-generalist species found in ruderal and anthropic environments. The Purple-shot Copper is absent from lowlands but is found in the main non-Pyrenean upland areas in Catalonia such as Els Ports, Muntanyes de Prades, El Montsant, El Montseny and the county of El Moianès, as well as throughout the pre-Pyrenees and Pyrenees. It is univoltine and males often practice hill-topping at midday. The Sooty Copper is bivoltine, with a first generation in May–June and a second in July–August. It is found above all in sunny montane meadows. All three species lay their eggs on various species of docks (*Rumex* sp.).

Andreu Ubach

Drawings

SMALL COPPER

Marked with line

rounded angle; variable number of brilliant blue scales; brown background with no marked black dots

PURPLE-SHOT COPPER

Marked with line

violet iridescences (male); dots arranged in bands; no violet iridescences (female); metallic orange; rounded angle; black spots on orange background; grey background with black dots (underside)

SOOTY COPPER

Marked with line

black spots; dark background (male); metallic orange; dark brown (female)

submarginal orange band; black submarginal spots (underside)

As their names indicate, this group of Lycaenidae butterflies have a characteristic orangey-copper colour. In the Small Copper, the upperside of the fore-wing is orange with black spots, while the upperside of the hind-wing is dark with just a few small brilliant blue scales. It is the only one of these six butterflies whose hind-wing undersides have no black spots, which are patent in both the Purple-shot and Sooty Coppers. The Purple-shot Copper is slightly larger than its congeners and males are instantly recognizable by the orange iridescence on the upperside of both wings; as well, it is the only copper with black spots on the upperside of the hind-wings (a characteristic that helps identify the females). Male Sooty Coppers are simple to identify due to the black spots that stand out from a dark background, and the yellowish background colour on the underside. It is also the only copper that has an orange submarginal band on the underside of the hind-wings.

Ajuntament Granollers

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