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Cover

Detail of the upperside of the fore-wing of a Small Copper *Lycaena phlaeas* (photograph: A. Miquel).

Knapweed Fritillary resting on the orchid *Anacamptis pyramidalis* (photograph: J.M. Sesma).

Editorial

The BMS helps preserve European biodiversity

In the most recent editions of *Cynthia* we discussed how the CBMS helps to reveal the general trends operating within the biodiversity of Catalonia and Andorra. Based on the construction of multi-species bioindicators, data from the CBMS have shown how diversity has fallen in grasslands in contrast to the much more healthy situation found in our forests. These results coincide to a large extent with results from the Catalan Common Bird Survey.

Diversity indices are useful because they can synthesise in a reasonably understandable way a large amount of complex information obtained from the study of animal populations. This ability to generate and interpret data has led to butterflies being chosen by the European Union as a tool for evaluating the state of the continent's environment. During the last three years work has been in progress to combine data from the different European BMS networks to develop a single indicator that reflects the situation of butterflies in grasslands throughout Europe. The results reveal a generalised decline in butterflies – and possibly in other groups of insects – in this type of habitat and are discussed in the article on habitat management and conservation in this *Cynthia*. This conclusion should thus act as a launching pad for new environmental policies in the European Union.

In this number of *Cynthia* you will find all the habitual sections. The importance of the BMS itineraries outside of Catalonia is emphasised by the description of two itineraries from Andorra and Menorca. The gradual development of itineraries in the Pyrenees has encouraged us to devote one of the identification guides to the genus *Erebia*, the most characteristic group of high-altitude butterflies. The remaining species of this group will be described in future numbers of *Cynthia*. We also devote a whole article to the two species of the genus *Gonepteryx* that most of you who walk BMS itineraries will know and love. We hope that you enjoy this new number of *Cynthia* and all the fascinating material it contains.

The CBMS network

Current situation (2008) of the Butterfly Monitoring Scheme in Catalonia, Andorra and the Balearic Islands

In all, 70 stations, the same as in 2007, participated actively in the CBMS in its 15th season in 2008. Four new stations were incorporated and the counts in both Andorra (BMSAnd) and the islands of Menorca and Ibiza, six and four itineraries, respectively, have continued to operate well. In all 125,919 butterflies were counted belonging to 163 species.

During the 2008 season itineraries were walked at a total of 70 stations, 67 of which completed the annual counts (fig. 1). Regular non-BMS counts were also carried out at Folgueroles (Osona, 550 m) and Tren de Sang, near Berga (El Berguedà, 900 m), and it is hoped that these sites will be fully incorporated into the CBMS network in 2009. In the Pyrenees, counts continued at Planes de Son (1,400 m, El Pallars Sobirà) and Rec de l'Obac (Andorra, 1,500 m), while a trial year began at Llobera (Solsonès, 850 m). All these sites are rich or extremely rich in butterflies and are home to species such as Spring Ringlet *Erebia epistygne* and Twin-spot Fritillary *Brenthis hecate* (Llobera) and Purple Emperor *Apatura iris* and Large Blue *Maculinea arion* (Planes de Son). These stations are thus an excellent opportunity in coming seasons for improving the BMS network and the areas and species it covers.

The available annual series are shown in figure 2: as of 2008 there are now 35 stations with data series of eight years of more (with a high of 19 years for the Cortalet station); the data from these stations are now ideal for analysing faunistic and phenological changes in the framework, for example, of studies of the repercussions of climate change on indicator species.

New stations

Viladrau (Osona, 750 m), located on the outskirts of the village of Viladrau. The itinerary passes through a forest of holm and downy oaks, and then enters an area of pastures and hay meadows exploited with different degrees of intensity. The main interest of this itinerary is that it complements the already abundant information on the butterflies of the Montseny massif and, for the first time, will provide good data from the north face of this mountain range. This montane habitat should harbour a wide range of species, many of which will be typical of the humid habitats of the northern part of Catalonia. In the first year a number of interesting locally scarce species such as Mazarine Blue *Polyommatus semiargus*, Ringlet *Aphantopus hyperantus* and Lesser Spotted Fritillary *Melitaea trivia* (see photograph) were detected.

Argentona (Maresme, 200 m), in a Mediterranean holm-oak and pine forest, with alternating patches of different types of scrub. To a certain extent, this transect replaces the Pineda station and thus ensures that butterfly counts continue on the seaward side of the Corredor mountains. The first year of counts revealed the presence of a number of interesting species such as Green-underside Blue *Glaucopsyche alexis* (fairly abundant at this site), Provence Hairstreak *Tomares ballus*, Pearly Heath *Coenonympha arcania* (in one of the nearest-to-the-sea sites for the species in Catalonia), Lesser Purple Emperor *Apatura ilia* and Mediterranean Skipper *Gegenes nostrodamus*.

Mura (Bages, 600 m). Situated on the north side of the mountains of Sant Llorenç del Munt in a humid holm-oak and downy oak forest, complemented by the presence of abandoned pastures and croplands. This transect adds to the already notable BMS cover of the Sant Llorenç del Munt i l'Obac Natural Park and samples one of the richest and most diverse parts of this protected area. Its butterfly fauna is remarkable, and includes populations of species such as Spanish Festoon *Zerynthia rumina*, Duke of Burgundy Fritillary *Hamearis lucina*, Osiris Blue *Cupido osiris*, Chapman's Blue *Polyommatus thersites*, Catalan Furry Blue *P. fulgens*, Lesser Spotted Fritillary *Melitaea trivia* and Dingy Skipper *Erynnis tages*, which are scarce or absent from the southern side of these mountains.

Can Ponet (Vallès Oriental, 400 m), in the heart of the Montnegre mountains in a typically Mediterranean holm-oak and cork-oak forest. Although this itinerary essentially passes through forested land, in the future it is hoped that some of the former cultivated areas around the farm of Can Ponet will be restored and managed in a traditional way for their biodiversity. The BMS counts will monitor the changes in the area's butterfly fauna at the same time as the habitat improves.

During 2008 the itineraries at **Santa Susanna** (Vallès Oriental, El Montseny), **Vallgrassa** (Baix Llobregat; although this station operates on a rotational basis with the stations of Olesa de Bonesvalls and Olivella), **Torà** (Segarra) and **Vilert** (Pla de l'Estany; only temporarily, due to the pregnancy of the person in charge of the counts).

Habitats represented

The different habitats and plant communities represented in 2008 are shown in Table 1. There were few changes compared to the previous season: there continues to be a predominance of Mediterranean forest communities and a more modest presence – but increasingly important – of arid scrub and humid montane and subalpine habitats.

Species represented

The list of species recorded in 2008 and in previous years can be consulted in Table 2. In all, 163 species were detected in 2008, one more than in 2007 and 28 more than the average for the period 1994-2007 (fig. 3). Despite such a high total number of species, no new species was added to the CBMS list in 2008

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Fig. 1. Geographical situations of all the stations that have ever participated in the CBMS network (1994-2008), with their official number and name. Also shown are the generally accepted boundaries of the biogeographical regions present in Catalonia[1].

Fig. 2. Distribution of the complete annual series available for all the different stations that have participated in the project (period 1994-2008).

Fig. 3. The number of species detected annually in the CBMS network (1994-2008).

Table 1. Habitats and plant communities represented in the CBMS in 2008, with the number of stations they appear in. Classification of the vegetation zones and plant communities as per reference 1.

Table 2. Butterfly species recorded in any of the CBMS stations during the last ten years 1999-2008. Also indicated is the number of localities from which each species has been recorded during the CBMS monitoring (out of a total possible number of sites of 30 in 1999 and 2000, 42 in 2001, 41 in 2002, 46 in 2003, 51 in 2004, 52 in 2005, 64 in 2006 and 70 in 2007 and 2008). Taxonomy as per reference 2.

Photo 1. The mountains in the northern side of the Matagalls massif, as seen from the transect of Viladrau. Some interesting species typically found at the highest altitudes can also be found in these humid valleys (photo: A. Amat).

Photo 2. *Melitaea trivia* resting on *Ornithogalum umbellatum* (photo: J.R. Salas).

Fiftieth year of the CBMS
Summary of the 2008 season

The year 2008 began under the influence of a prolonged drought, which had reached historic proportions when it broke with the sudden arrival of heavy rains in May. Summer was normal in terms of temperatures, although rainfall patterns were somewhat irregular. All in all, the season was not good for butterflies and overall numbers were the second lowest since the beginning of the CBMS 15 years ago. The most severe falls in numbers were recorded in the Pyrenees and locally in L'Alt Empordà. On the other hand, in the arid south of Catalonia numbers were kept high by a significant migration of Bath Whites *Pontia daplidice*. In terms of habitats, the butterflies of scrub and open areas suffered the most, while generalist species appeared in average numbers. Forest species, on the other hand, despite declining significantly, still maintained relatively high numbers.

Weather and butterfly counts

The year 2008 will be remembered for the severe drought that came to an abrupt end in the form of a very wet month of May (see www.meteocat.com). The drought had lasted for almost three years, affecting the beginning of the 2008 season, and undoubtedly had negative effects on many butterfly species.

The previous autumn had been dry and cold, with long periods of stable weather and thermal inversions in central Catalonia. Winter began cold, but both January and February were warm or even very warm in some places. The anti-cyclonic weather gave rise to abnormally high temperatures in some upland areas (Pyrenees, Moianès and Lluçanès plateaus and the Montseny area) and to low rainfall (up to 30-70% below average), above all in the western pre-Pyrenees. The exceptions were the mountains of Els Ports de Tortosa-Beseït and the Tarragonès area, which received 200-300 mm more rainfall than average as a result of the gales that affected the central Catalan coastline from December through to February.

From the second week of April – and, above all, May – generous quantities of rain began to fall throughout Catalonia. The only exception was L'Alt Empordà, which remained dry. Temperatures in both spring and summer were around average and during the hottest part of the summer average temperatures were only exceeded on the central coast and in its hinterland. Rainfall was fairly irregular, with above-average figures in some areas (most of central Catalonia) and below-average figures elsewhere (above all, the Pyrenees, L'Alt Empordà and the Ebro Delta). September was dry (with the exception of the Ebro valley, the Maresme and some parts of the pre-Pyrenees) and cold throughout most of the country (apart from the central coastline).

In all, an average of 4.4 counts were lost per station, a slightly lower figure than the previous year (fig. 1a). Most lost counts were concentrated in May and the first fortnight of June (weeks 11 to 15) during the heavy rains that swept across the country (fig. 1b). A significant number of counts are always lost in March and April, largely because of the difficulties involved in walking itineraries in areas of extreme early spring weather.

Changes in abundances: general considerations

In 2008, butterfly numbers continued to fall in many localities of the CBMS network: of the 57 stations with comparable data from 2007 and 2008, in 39 cases numbers dropped and increased in only 18. Nevertheless, in absolute terms the changes are not that apparent since the notable increases in a few stations compensate for the general negative tendency over the rest of the country. Thus, a Student test for paired samples shows no significant differences in butterfly numbers for these two years (2007: 1,880.9 ± 1,483.1; 2008: 1,881.0 ± 1,905.9; t = 0.00, $P = 0.99$). Nor did the number of species detected per itinerary change significantly: 41.9 ± 17.7 in 2007 and 41.6 ± 17.2 in 2008 (t = 0.48, $P = 0.63$). Overall, though, data for the commonest species recorded in the network clearly reveal that 2008 was a very poor year for butterflies – on a par with 2005 – and was in fact the second-worse season ever out of a total of 15 seasons (fig. 2).

As has been seen on other occasions, a more detailed analysis reveals a complex situation, with fluctuations in populations obeying geographical criteria. High mountain itineraries, for example, recorded the greatest fall in numbers. On the other hand, counts from sites in dry southern Catalonia were up in terms of overall numbers, a fact that can be explained by high counts of the migrant Bath White *Pontia daplidice*. In the north-east of the country, there were notable falls in numbers in the *comarques* of L'Alt Empordà and Gironès, but there were significant upturns in La Garrotxa and El Pla de l'Estany, possibly as a result of the meteorological particularities of these areas.

Changes in abundances: fluctuations in populations

Although 2008 was fairly poor in general for butterflies, some species did in fact show notable increases. This positive trend was evident in multivoltine species that, in their later generations, were able to benefit from the recovery of the vegetation after the abundant spring rains. This was the case of Common Blue *Polyommatus icarus*, Berger's Clouded Yellow *Colias alfacariensis* and Wood White *Leptidea sinapis*, whose annual indexes were almost double those of 2007; in addition, Small Copper *Lycaena phlaeas*, Adonis Blue *Polyommatus bellargus*, Clouded Yellow *Colias crocea*, Provençal Fritillary *Melitaea deione* and Weaver's Fritillary *Boloria dia* also had good years (Tables 1 and 2).

The drought and then the heavy rains seem also to have affected those univoltine species whose larvae develop in the same year as the adults are on the wing. In species whose larvae complete their growth phases early in the spring, that is, when plants suffered the greatest hydric stress, tendencies were generally negative, for example in Black-veined White *Aporia crataegi*, Marsh Fritillary *Euphydryas aurinia* (see drawing), Purple Hairstreak *Neozephyrus quercus*, False Ilex Hairstreak *Satyrium esculi*, Spanish Gatekeeper *Pyronia bathseba*, Dusky Heath *Coenonympha dorus* and Lulworth Skipper *Thymelicus acteon* (Table 2). On the other hand, in species such as Gatekeeper *Pyronia tithonus*, Iberian Marbled White *Melanargia lachesis*, Meadow Brown *Maniola jurtina*, Pearly Heath *Coenonympha arcania* and Small Skipper *Thymelicus sylvestris* (Table 2) whose larvae concentrate their growth phases at the end of spring or early summer, tendencies were less negative and even positive in some cases. Aside from the two specialist nettle feeders, Peacock *Inachis io* and Small Tortoiseshell *Aglais urticae*, notable declines were also recorded in the species that winter as adults. Finally, 2008 was a poor year for migrant species, with the evident exception of Bath White (see drawing), which reached its highest numbers since the CBMS began.

In terms of the major habitat types, the populations of the typical species of open areas and scrub barely changed at all compared to 2007; likewise, there were no great changes in the common generalist species. Nevertheless, many woodland species suffered serious declines in numbers in 2008, although overall population numbers of these species are still high thanks to the strong positive tendencies in previous years.

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Fig. 1. (a) Coverage of the counts at the different CBMS stations, and (b) distribution of the lost counts during the official 30 weeks of the 2008 recording season (1 March – 26 September).

Fig. 2. Ranking of the CBMS seasons in terms of the general abundance of the 66 commonest butterflies in the CBMS network. The best year to date was 2002 and the worst 1998. Calculations were carried out using the methodology described in reference 1; annual indexes were calculated with the TRIM programme.

Table 1. Sum of the annual indexes and ranking of abundance for the 20 commonest species from the 2008 CBMS network compared to the corresponding figures from the 2007 season.

Table 2. Evolution of the overall annual indexes for the 65 commonest butterflies in the CBMS network (1999-2008), based on an arbitrary value of 1 for 1994. Annual indexes were calculated using the TRIM programme.

Drawing 1. In 2008 the Bath White *Pontia daplidice* reached its highest levels since the CBMS began. Unlike the case of most migrant butterflies that arrive in Catalonia during the spring, the greatest numbers of Bath Whites arrive in mid-summer. The counts from 2008 show sudden increases in this species, typical of dry environments, in the second and third weeks of July, above all in the Ebro Delta and in itineraries immediately northwards (El Segrià and La Ribera d'Ebre). This pattern suggests that most of the migrants of this species originate from

Africa and arrive in Catalonia having crossed the Mediterranean Sea. Subsequently, this species then disperses across the whole of the country, appearing almost anywhere and even in the high Pyrenees. Nevertheless, there are a small number of pupae that overwinter, from which a small March-April generation emerges well before the arrival of the summer migrants (drawing: M. Miró).

Drawing 2. The Marsh Fritillary *Euphydryas aurinia* is protected by European legislation due to the serious decline its populations have suffered in central and northern Europe[2]. In Catalonia and Andorra it is widespread, above all in Mediterranean environments (in which larvae feed on various species of honeysuckle *Lonicera* spp.). In montane areas, the Marsh Fritillary is rarer and is found in damp meadows with Devil's-bit scabious *Succisa pratensis*, as is the case in central and northern Europe. A third ecotype appears in alpine grasslands at over 2,000 m a.s.l., where the species is associated with either Devil's-bit scabious or gentians. Despite the regular and notable fluctuations that occur in the populations of this species, caused in part by the impact of the specific parasitoids of the genus *Cotesia*[3], in recent years there has been a clear negative tendency in the populations of the Marsh Fritillary (Table 2). This fall seems to be as much a result of a deterioration in habit quality (for example, damp meadows with Devil's-bit scabious becoming overgrown) as the negative impact of prolonged periods of drought, which cause high mortality rates in larvae in the pre-diapause period (drawing: M. Miró).

Habitat management and conservation

A European indicator for grassland butterflies*

* This article is based on the report by Van Swaay, C.A.M. & Van Strien, A.J., 2008: *The European Butterfly Indicator for Grassland species 1990-2007. Report VS2008.022.* De Vlinderstichting, Wageningen.

In previous numbers of Cynthia we used this section to discuss the habitat preferences of our butterflies and their roles as bioindicators in a series of habitats in Catalonia[1,2]. We argued that butterflies act as indicators of biodiversity in terrestrial ecosystems and that the data gathered by the CBMS itineraries can be used to represent in a very synthetic fashion the general trends affecting many species of butterflies.

Simplicity and ease-of-interpretation are two key elements of the development of this concept, which is becoming more and more accepted as a standardised method for detecting environmental changes over short periods of time[3]. Biodiversity indicators are based on long-term programmes that monitor bioindicator taxa and permit the calculation of a single multi-species index that reflects the general trends in the ecosystem or habitat evaluated. This index provides a quick and efficient way of detecting not only the direction of a trend but also its magnitude. The European Environmental Agency (EEA) of the European Union (EU) has adopted these indicators as a way of measuring the state of health of the environment. To date, the most popular and widely accepted such index is the *Farmland Bird Indicator*[3], although in light of the project SEBI 2010 (*Streamlining European 2010 Biodiversity Indicators*), the EEA has proposed the inclusion of up to 26 indicators[4] including the *European Grassland Butterfly Indicator* that has been developed in recent years on the basis of the European BMS networks. In this article we explain how this indicator works and the trends that it reveals at a European scale.

Geographical area and habitats of interest

Long-term butterfly monitoring programmes have increased greatly in number in Europe since the British BMS began in 1976. Currently, there are BMS schemes in operation in around 15 countries in Europe, with others on the point of beginning in the years to come[5].

In terms of European butterflies, open areas and, above all, grasslands have been identified as the region's most important habitat. Of the 436 European species for which environmental information exists, it is calculated that 280 (57%) are closely tied to grasslands[6]; within Europe the greatest butterfly diversity of all is to be found on calcareous grasslands (with 274 species regularly present), followed by subalpine grassland (261 species), montane grasslands (223 species) and siliceous grasslands (220 species). Moreover, grasslands are important habitats for many species of flora and fauna, including a large number of other insects and flowers. Within this complex interrelation of species, butterflies play a very important role as pollinators of flowers, as has recently been shown[7]. Thus, it is for these reasons that it was decided to use the data from the European BMS stations to develop a wide-ranging grassland indicator that would to a certain extent mirror the *Farmland Bird Indicator*.

Methodology

The *European Grassland Butterfly Indicator* uses the same methodology as the *Farmland Bird Indicator*. First, the most characteristic species are selected and then their population trends are combined into a single index of trends in biodiversity. When the positive and negative trends are balanced, the index is stable, but when either negative or positive trends predominate, then the index shows, respectively, a negative or positive trend.

The 17 characteristic species selected (Table 1) fulfil three criteria: they are 1) distributed over much of Europe; 2) present in most European BMS stations; and 3) grassland specialists or, at least, use grasslands as one of their preferred habitats. It is true to say that in some cases the chosen species' favourite habitats vary over their ranges and some of the butterflies selected are not typical grassland species in Catalonia (for example, Orange-tip *Anthocharis cardamines*, Large Skipper *Ochlodes venata* and Lulworth Skipper *Thymelicus acteon*). Nevertheless, these species are characteristic of grassland over most of Europe and given that it is designed to study trends on a very broad scale, this index is not affected by these anomalies.

The second step is to calculate the population trends at national level with the programme TRIM[8]. Previously, the national indices of each species were checked and short series and series based on only a few stations, as well as those associated with high standard errors, were discarded. To generate the supra-national indices of each of the selected species the relative contribution of each country in relation to the European distribution of each species was taken into account. Corrections based on the relative size of each country were applied and finally the indices of the species were combined by calculating the geometric average of the national indices. All the calculations were coordinated by Arco van Strien, at Statistics Netherlands.

Results

The supra-national trends of the 17 chosen species are shown in Table 2. On a European scale, 12 of the 17 species show significant declines, while only two show significant increases; one species is stable and the trends of a further two are unclear. The results are similar when only EU countries are taken into account.

The trend of the indicator index is shown in figure 1. The situation is alarming and indicates that there has been a general decline in butterfly populations of nearly 60% since 1990. It is worth highlighting a couple of differences from the *Farmland Bird Indicator* (in which there has been a significant decrease of around only 20% over the same period). Firstly, the butterfly indicator is not based on the results of transects that only pass through grasslands, but takes into account instead the general trends of the typical grassland species in each country. Secondly, in some countries itineraries in protected areas are over-represented, which implies that the decline in butterfly populations could be even more serious in Europe than the figures show.

Despite the fact that butterfly and bird indicators are not strictly comparable, both indicators show that there has been a serious loss of biodiversity in open habitats. The results reveal once again that butterflies are highly sensitive to a loss of environmental quality[9] or are, at least, the group that responds most rapidly to such changes. All in all, the results make it clear that more sustainable environmental policies are needed if the biodiversity of European grasslands is to be maintained.

Interpretation of trends

Grasslands are not a climax habitat in Europe and so they end up reverting to scrubland and forests if they are not actively managed. Traditional management practices and forms of exploitation such as extensive animal husbandry and the hand-cutting of meadows, tied to a minimal use of fertilisers and pesticides, not only will conserve grasslands but will generate optimal habitats for butterflies and other species.

In recent decades economic development has led to two easily identifiable processes: 1) the intensification of agriculture and grazing in the most productive areas and (2) the abandoning of land in the least accessible and unproductive areas. The first of these two processes has led to the conversion of grasslands into monospecific croplands, the widespread use of fertilisers and pesticides, an increase in the minimum size of fields, the destruction of hedgerows and an increase in the use of heavy machinery. In parts of central Europe practically all farmland is intensively exploited, with the result that the butterfly fauna of these areas has become extremely impoverished. Furthermore, it is possible that the most important population declines took place in the years before the 1980s, that is, before the BMS monitoring began. On the other hand, in the Mediterranean and eastern Europe the intensification of agricultural systems is still in its initial stages and the loss of traditionally managed land to intensive agricultural regimes is still an ongoing process. It is very possible that the decline in the grassland butterfly indicator is to a large extent a reflection of the loss of biodiversity linked to this process of intensification.

Grasslands are being abandoned above all in upland areas, where it is far more difficult to intensify production. This may initially favour biodiversity, but in a matter of a few years will lead to an impoverishment in butterfly communities as is occurring in many parts of Scandinavia and the Mediterranean[10].

Both intensification and abandoning of grasslands provoke greater habitat fragmentation, which in the mid- and long-terms also causes populations of butterflies to fall as the probability of the survival and recolonisation of local populations decreases[11].

Final thoughts

There are at least two aspects that must be taken into account when looking to generalize these findings. Firstly, the geographical scope of the BMS is limited and does not cover all of Europe. The indicator is based on data from a good number of countries in central and northern Europe, but there is a definite lack of data from eastern and southern Europe[5]. This problem can only be solved if the tendency in recent decades for the number of BMS programmes to increase continues.

In addition, in many of the continent's BMS programmes there is an imbalance in the selection of itineraries and the majority are in protected areas (for example, natural parks). This occurs because these areas are more diverse and their management teams are prepared to partially cover the costs of monitoring projects. This generates a bias in the indicator and rather implies that the trends that have been detected underestimate the seriousness of the situation (more positive trends are to be expected in protected areas). The indicator is thus fairly conservative.

Come what may, the overall conclusion is that there has been an alarming decline in the typical grassland butterflies of Europe in recent decades and that a serious long-term trend in the loss of biodiversity is currently occurring. We believe that in future years the BMS and the indicator discussed here will provide a great deal of very valuable information that may help to influence environmental policy in the UE. More specifically, both the Directive of Habitats (92/43/EEC) and of Species (79/409/EEC), as well as reforms in agricultural policy[12], are instruments that may help to improve this highly negative situation that has been detected as a result of the efforts of the participants in the butterfly monitoring schemes.

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Fig. 1. The *European Butterfly Grassland Indicator* declined significantly in the period 1990-2007, during which time the population of the selected species fell by almost 60%. This regression is much more significant than the annual variations caused by annual differences in the weather and is a clear indicator of the deterioration in European grasslands.

Table 1. The seven common species present throughout Europe and the ten clearly specialist species with more limited distributions selected to calculate the *European Grassland Butterfly Indicator.*

Table 2. Supra-national trends in the 17 species used to calculate the *European Butterfly Grassland Indicator* in the whole of Europe and in just the European Union (EU). A 'moderate' decline or increase refers to a significant change in population of less than 5% per year since the beginning of the study. A 'serious' trend corresponds to a change in population of over 5% (equivalent to an increase or decrease of 50% in 15 years). Significance: * $P < 0,05$; ** $P < 0,01$.

News
Sixth CBMS workshop

The CBMS network continues to grow and in a question of years has seen its original 10 itineraries and eight observers grow to 70 itineraries and over 100 observers. It is thus increasingly necessary to organise events in which all the CBMS participants can share their ideas, impressions and acquired knowledge. With this in mind, in 1998 the first CBMS workshop was organised, which by the time of the sixth workshop on 16 February 2008 had grown to an event of sizeable proportions.

The workshop was held in the Granollers Natural History Museum and was attended by around 50 people. The day's events were inaugurated by Josep Mayoral i Antigas, Mayor of Granollers. Toni Arrizabalaga then gave a brief welcome speech and thanked all concerned for their participation in the project.

The first part of the workshop was dedicated to the presentation of the current situation of the CBMS network and the main results obtained to date. Time was also spent on how the field sheets should be filled in and on solving the doubts that certain observers had.

After a break, workshops on the breeding and study of immature phases of butterflies and the identification of species of the genera *Erebia* and *Melitaea*, and the groups *Pieris-Pontia-Euchloe* and *Polyommatini* got underway, during which participants had time to join in a total of two out of the five sessions.

After lunch, the identification quiz was held, won by Roger Vila. Then, Elisenda Olivella spoke about the different projects being organised by the Catalan Lepidopterology Society (SCL) and encouraged those present who were not already members to join.

Next, a prize was awarded to Pere Luque, for his perseverance in continuing with the counts in La Tancada, Ebro Delta, the itinerary with least species of all, and then to Albert Miquel, for the itinerary with the most butterflies (El Pinetell in the Prades mountains)

In the second block of workshops, participants could choose between sessions on (1) butterfly photography and (2) the preparation of specimens and the creation of a reference collection.

The final session consisted of brief explanations of projects run in parallel to the CBMS: (1) butterfly DNA (Roger Vila); (2) butterflies and grasslands in the Alta Garrotxa (Mike Lockwood) and (3) distribution maps of Catalan butterflies (Marc-Anton Recasens).

The day's activities were closed with the showing of the CBMS DVD produced by the Granollers Natural History Museum. As a momento of the day's events, all participants were given a clipboard for use in the field.

Jordi Jubany

Catalan Butterfly Monitoring Scheme DVD

With the support of the Catalan Government, the Butterfly Monitoring Scheme in Catalonia (CBMS) was set underway in 1994. As a tribute to the work that has gone into the project, a DVD has been produced that provides a historical introduction to the project, with references to the similarities in philosophy and methodology with the well-known British butterfly monitoring project (from which the name was taken). Both projects aim to identify with a certain degree of precision changes in abundance in butterfly populations by means of weekly censuses along fixed transects, which can be related subsequently to different environmental factors. The DVD includes a video with a report on butterfly biology and ecology designed as a tool for those beginning the study of butterflies.

The DVD also includes seven two-minute reports on a number of different CBMS stations, as described by the observers themselves, which reveal the geographical implantation of the project throughout Catalonia, Andorra and the Balearic Islands.

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CBMS sites
El Barranc d'Algendar, a butterfly refuge

Menorca joined the CBMS network in 2001 and there are currently three active stations on the island, two in the S'Albufera des Grau Natural Park and a third in the Algendar gorge. This latter station differs from the others in its more humid and cooler microclimate and the shelter the Algendar gorge offers from the prevailing northerly winds.

The transect

Butterfly monitoring on Menorca began with the birth of the Observatori Socioambiental de Menorca (OBSAM) as an instrument for the gathering and analysis of information – both social and economic, ecological and environmental – on a local scale. The stations at Algendar and Es Grau were activated in 2001 and a third at Santa Catalina was added in 2005. At Algendar, the transect begins in an area known as Es Canaló and continues along the bottom of the gorge alongside the island's only permanent water course.

Menorca has an average annual temperature of 17ºC and average annual rainfall of 572 mm, distributed irregularly with peaks in spring and autumn and a summer drought. Nevertheless, special microclimatic conditions exist in the bottom of the small gorges in the southern half of Menorca, where relatively high humidity levels, cooler temperatures and more protection from the winds provide ideal conditions for ecosystems of great natural interest.

This transect has nine sections and an overall length of 1,975 m. The first section runs along a path on the left bank of the stream where the vegetation is dominated by vines, figs and ivy on walls, on one side and, on the other, well cared-for orchards. The transect then passes through these orchards and continues alongside another wall. From here on, ivy and ferns cover the wall, while on the other side of the path there are large banks of brambles. After a section alongside the stream, with reeds and aquatic vegetation (horse-

tails, irises, mint, bulrushes and bay trees), the itinerary begins to climb up one of the side gullies entering the main gorge and enters into a small holm-oak wood. Eventually, the humidity and coolness of the gorge disappear and the vegetation gradually changes to dry scrub dominated by grasses and wild olives. On top of the cliffs the transect passes through semi-abandoned fields with wild olives, lentiscs, thyme, thistles and other plants. The counts continue throughout October because of the small peaks in butterfly numbers that generally occur in this month.

The butterflies

During the period 2001-2008, 19,449 butterflies belonging to a total of 22 species were counted on this itinerary. The average annual number of butterflies and species counted was, respectively, 2,431 and 18, with an average density of 123 butterflies/100 m.

Owing to the gorge's special microclimate, butterfly counts at Algendar peak around the fourth week in June (fig. 1), two weeks later than at the other Menorcan stations. In addition, compared to the other two Menorcan stations, butterfly numbers remain higher throughout the summer and autumn and annual counts are higher. In terms of the number of species, the peak period is the month of June. There is a sharp drop in the number of butterflies at the beginning of August, although numbers recover at the end of the month and into September. Numbers rise again in October thanks to the populations of Speckled Wood *Pararge aegeria* and the autumn migration and autumn generations of species such as Large White *Pieris brassicae*, Clouded Yellow *Colias crocea*, Red Admiral *Vanessa atalanta* and Painted Lady *Cynthia cardui*.

The Speckled Wood is by far the most abundant species and accounts for 35% of all butterflies observed (fig. 2); Holly Blue *Celastrina argiolus*, Small White *Pieris rapae* and Cleopatra *Gonepteryx cleopatra* are the next commonest species. Speckled Woods are especially abundant in the woods and are the dominant butterflies in the section that runs through the holm-oak wood. Holly Blues increase in number during July and August and appear in great number on the ivy on the walls of the gorge, where in some years over 400 individuals are counted annually. Three-yearly cyclical fluctuations have been observed in this species that may be the result of the regulatory effect imposed by a parasitoid (fig. 3). Small Whites are commonest near the fields and orchards, while Cleopatras are more mobile and are found throughout the itinerary, although with a preference for the most open sections. They are very scarce in the section that passes through the holm-oak wood.

Management

The Barranc d' Algendar is classified as an Area of Special Natural Interest (ANEI Me-13), a type of protection defined by the Balearic Islands 1991 Natural Spaces Act. Although no specific management plans exist for these sites, in the case of Algendar 47% of the itinerary (sections 1-3) passes through land managed by a charity, Càritas Diocesana de Menorca, whose project '*Arbres d'Algendar*' (Trees of Algendar) aims to restore the cultivation of old varieties of Menorcan fruit trees. The management of the area has not changed in essence since the walk was begun and basically consists of the ecological cultivation of fruit trees and periodical clearing of the brambles and scrub that cover the dry-stone walls that line the orchards. Last year the scrub was cleared from some areas of abandoned fields, which are now cultivated. Section 4, which runs alongside the stream, is cleared periodically by a group of volunteers, who regularly remove all the vegetation that chokes the stream (horsetails, mint and reeds). The rest of the itinerary is not actively managed in any way, although the human influence in general is still marked.

For more information on the butterflies of Menorca, visit the page on nature tourism on the website of the l'OBSAM (http://turismenatural.obsam.cat/ papallones/), where there are data-sheets for all the species found in Menorca, with a description and details of their phenology based on eight years of BMS monitoring on the island.

Sònia Estradé & David Carreras

Fig.1. Phenological graphs of the number of individuals and species of butterflies detected weekly in the BMS itinerary at Algendar. Averages for the period 2001-2008 are shown.

Fig. 2. Average abundance (average of the annual indexes for the period 2001-2008) of the 15 commonest butterflies at Algendar.

Fig. 3. Annual index of Holly Blue *Celastrina argiolus* (2001-2007).

CBMS sites
Butterfly monitoring in the Vall de Sorteny (Ordino, Andorra) Natural Park

The first BMS transect in Andorra was started in 2004 in the Vall de Sorteny Natural Park and has become the reference for all other Andorran butterfly monitoring transects. The Sorteny station provides a good example of a subalpine Pyrenean butterfly community that includes a number of highly remarkable species.

The transect

After a talk on butterflies in 2004 given by Jordi Jubany and Jordi Dantart, organised jointly by the Biodiversity Centre of the Institute of Andorran Studies (IEA) and the Environment Department of the Andorran Government, the Sorteny Natural Park decided to begin what would become the first BMS itinerary in Andorra. That year, as part of its ongoing work studying and protecting the park's fauna, the park rangers began studying the local butterflies and regularly walking the BMS transect. A year later, coordinated by the Biodiversity Centre and in collaboration with the Natural History section of the Granollers Museum, a project to monitor the butterflies of Andorra (BMSAnd) was formalised, which included an agreement to increase the number of transects and publicise the project amongst local people. Today, the project is run by the Andorran Centre for the Study of Snow and Mountains (CENMA), and it is hoped that it will help improve knowledge of the butterflies and, in general, the overall state of conservation of the environment in Andorra. The BMSAnd follows the same protocol as laid down by the CBMS methodology and works closely with its instigators; currently there are seven BMSAnd itineraries, covering an altitudinal range between 900 and 2,250 m a.s.l.

The Vall de Sorteny Natural Park lies in the north of Andorra in the parish of Ordino. It was declared in 1999 to protect, highlight and improve knowledge of this interesting valley. It covers 1,080 ha and is characterised by a wealth of flora (over 700 species of flowering plants).

The itinerary is 970 m long and lies in a subalpine landscape between 1,900 and 1,980 m. There are eight contiguous sections in a circuit, which begins near the entrance to the Natural Park and runs through meadows, pastures and mountain pine forests. The route runs alongside the river Sorteny as far as the Sorteny mountain hut, and then returns to its starting point. Section 1 runs through mesophile siliceous grasslands dominated by various grasses, mainly alpine chewing's fescue (*Festuca nigrescens*) and common bent (*Agrostis capillaris*), and an abundance of great yellow gentian (*Gentiana lutea*), while section 2 is characterised by mesophile grasslands of mat-grass (*Nardus stricta*). The third section enters the mountain pine (*Pinus uncinata*) forest, where the understorey is dominated by bushes of bilberry (*Vaccinium myrtillus*) and alpenrose (*Rhododendron ferrugineum*); also present in this section are siliceous screes, colonised by forbs and ferns. Section 4 is similar to section 1. Sections 5 and 6 are more humid; in the former, there are peat-bogs with common sedge (*Carex nigra*) and tufted bulrush (*Scirpus caespitosus*), while in the latter hay-meadows and nitrophilous vegetation such as good King Henry (*Chenopodium bonus-henricus*) and monk's rhubarb *Rumex pseudoalpinus* dominate. This part of the itinerary receives an excess of nitrates due to the large number of cattle that congregate here at times in the autumn. This section ends at the Sorteny mountain hut. Section 7 passes through *Festuca paniculata* grassland, whose height in the summer makes counting difficult. This part of the transect coincides with the main path to the mountain hut and so suffers considerable human disturbance, especially in July and August and at weekends. The final section returns through the *Festuca paniculata* grassland and in its lowest part enters small acid peat bogs. This section is also part of the route to the mountain hut and it too is rather busy with walkers.

The butterflies

At an altitude of almost 2,000 m a.s.l. in the heart of the central Pyrenees, Sorteny enjoys a cool damp climate that limits the flight periods of its butterflies, to the extent that almost no butterflies are seen in March and April whilst there is still snow on the ground. The maximum abundances occur – as is to be expected – in July and August, when daily counts reach 50 butterflies belonging to around 25 species.

In the period 2006-2008, 1,669 butterflies of 65 species were counted (the data from 2004 and 2005 are not considered to be sufficiently accurate). It is likely that more species will be detected in future years as identification to specific level of some species is complex (blues and skippers). This itinerary is highly interesting in the context of Andorra as some of the species that have been recorded are known only from this park or just a few other sites in the whole of Andorra (e.g. Apollo *Parnassius apollo*, Clouded Apollo *Parnassius mnemosyne*, Mountain Dappled White *Euchloe simplonia*, Geranium Argus *Eumedonia eumedon*, Silvery Argus *Aricia nicias*, Large Blue *Maculinea arion*, Eros Blue *Polyommatus eros* and Bog Fritillary *Proclossiana eunomia*). Furthermore, a large number of ringlets (*Erebia* spp.) – Large *E. euryale*, Mountain *E. epiphron*, de Prunner's *E. triaria*, Common Brassy *E. cassioides*, Lefèbvre's *E. lefevbrei*, Autumn *E. neoridas*, Bright-eyed *E. oeme* and Piedmont *E. meolans* – also fly here. All these species are only found in high mountain areas and as such are of great conservation interest.

The data from Sorteny also provide interesting information on the biology of the most typical Pyrenean butterflies, which are poorly represented in the other, lower altitude BMS stations. A good example is Small Tortoiseshell *Aglais urticae*, which is the most abundant species on the itinerary. The presence of many nettles around the Sorteny mountain hut has enabled us to relate the abundance of adults of this species with aspects regarding its local breeding performance, which are essential for interpreting the altitudinal movements that this species carries out in the high Pyrenees.

This interesting butterfly community forms just part of the excellent overall floral and faunal diversity of the Natural Park. Some of the most interesting animal species in the park include Capercaillie (*Tetrao urogallus*), Ptarmigan (*Lagopus mutus*), Pyrenean Desman (*Galemys pyrenaicus*) and Pyrenean Newt (*Calotriton asper*), whilst amongst the plants it is worth highlighting mountain lentil *Astragalus penduliflorus*, xatardia *Xatardia scabra*, glacier crowfoot *Ranunculus glacialis, Potentilla frigida* and *Salix ceretana* that all appear in the Andorran Vascular Flora Red Data Book. All in all, the Sorteny Natural Park is a site of great biological interest that must be preserved.

Josep Palau & Carles Mújica

Aerial photograph. Route of the eight sections of the transect at Sorteny. The total length is 970 m, with each section averaging out at 121 m (range: 48-171 m).

Fig. 1. Average abundance (average of the annual indices for the period 2006-2008) of the 15 commonest butterflies at the Sorteny BMSAnd station.

The butterfly

The Brimstone *Gonepteryx rhamni* and Cleopatra *G. cleopatra*, the yellow butterflies that signal the end of winter

Heralding the onset of spring and warmer weather, these two well-known Pieridae end their hibernation right at the beginning of the CBMS season. Their bright yellow colours signal the arrival of the first flushes of spring and the end of the drab colours of winter. The males, above all, of these two species are amongst the best-loved and easiest-to-identify of all our butterflies.

Geographical distribution and situation within the CBMS

The Brimstone *Gonepteryx rhamni* is widely spread from north-west Africa, throughout the whole of Europe and westwards to Siberia, Kirguizistan and Mongolia[1]. It is also common throughout the Iberian Peninsula and has been recorded from all Spanish provinces and much of Portugal[2], although in the south of Spain it is found largely in upland areas. It is thought not to fly in the Balearic Islands[3], despite the presence of a few specimens captured in the 1980s[4] and preserved in a collection from Menorca that indicate that it may be present on these islands as an occasional migrant[5].

The Cleopatra *G. cleopatra* is a much more Mediterranean species[1]. It flies in north-west Africa (as well as the Canary Islands, where there are different forms that many authors regard as subspecies) and the countries on the northern and eastern shores of the Mediterranean Basin. It is present throughout the Iberian Peninsula and is especially abundant in the Balearic Islands.

Both species are amongst the commonest butterflies in the CBMS and BMSAnd counts and appear in the majority of stations thanks to their great mobility and dispersive capacity[6]. Overall, their relative abundances throughout the BMS network coincide with a predictive climatic model based on thermometric and pluviometric variables[7] and reproduce at a fine scale the biogeographical differences in distribution described above. The Brimstone is most abundant in humid montane areas such as the mountains of the Serralada Transversal, the pre-Pyrenees and the Serralada Prelitoral, both in the north and south of the country. It becomes scarcer as the climate becomes drier and hotter, although is still found in smaller numbers in the coastal mountains of the Serralada Litoral, but practically disappears from low-lying coastal areas and the Plana de Lleida where it is only noted very irregularly (fig. 1a). The Cleopatra, on the other hand, is commonest in lowland areas and the Mediterranean mountains of the serralades Litoral and Prelitoral and even in arid areas such as the massif of El Garraf and the lower areas of the mountains of Tarragona. Unlike its congener, the Cleopatra is regular on the coast and in the scrub in western and southern Catalonia (fig. 1b), but is rarer in the pre-Pyrenees and Pyrenees. It is worth highlighting the abundance of the Cleopatra in the Balearic Islands and on Menorca; for example, data from the CBMS reveal that it is one of the four commonest butterflies on the island.

Habitats and food plants

Although the Brimstone and Cleopatra are both generalist species[8] present in a wide variety of habitats in Catalonia (fig. 2), their chosen habitats do differ. The Brimstone tends to prefer forest environments and upland pastures where it flies in search of nectar, but foregoes dry open grasslands, scrublands and cereal fields. The Cleopatra, on the other hand, is much more frequent in open areas, including all types of flowery scrub and grasslands and agricultural areas. It too is common in forested areas, but has a predilection for Mediterranean holm-oak and Aleppo-pine forests.

In Catalonia both species lay their eggs on Mediterranean buckthorn (*Rhamnus alaternus*), although in the Pyrenees where this plant is absent there are records of female Brimstones egg-laying on alder buckthorn (*Rhamnus frangula*), a common food plant for the species in other parts of Europe. It is possible that other buckthorns are also used as food plants by these species, above all where the Mediterranean buckthorn is scarce.

Biological cycle and phenology

Both species overwinter as adults and are amongst the longest-lived of all our butterflies. They are usually the first butterflies to appear at the beginning of the season and it is not unusual for them to still be active well into the autumn. In Mediterranean areas, the first individuals appear during sunny days at the end of February, whilst in more temperate areas their appearance is delayed until March or the beginning of April. Males normally appear before the females as they have a lower thermal activity threshold than females[9].

Males are fertile as soon as they appear after hibernation since their testes continue developing during the autumn and winter. The gonads of the females, however, do not mature until winter is over[9] and so mating does not take place until after hibernation has finished. It is very rare to witness copulation in these species, although it is common to see females who have already mated performing upwards spiralling flights with males. These flights begin when a male detects a female nectaring one of the species' favourite plants[10]. Even if the female tries to reject the male's advances by raising her abdomen in a posture that is typical of the Pieridae family, the male's insistence will often lead to both butterflies spiralling upwards for 20 metres or more in a characteristic flight, with the male chasing the female from below. It is not uncommon to see females being pursued by two or more males or even by Cleopatra and Brimstone males. Despite having seen this performance on numerous occasions, we have yet to clarify whether or not the butterflies involved actually end up copulating.

Egg-laying takes place at the beginning of spring, although occasionally old females are seen laying at the end of May. Eggs are laid singly on the back of young leaves on the branches that project from the main bush; only now and again do females lay on the back of older leaves or on stems. Proportionally, small isolated bushes receive more eggs than larger ones. The eggs are ovoid in shape with well-defined ribs and when freshly laid are white, but within a few hours turn yellow; the larvae hatch in around six days.

The larvae pass through five stadia. During the first, they are pale yellow and spend most of their time on the upper-side of the young leaves, either on the edge of the leaf or on its central nerve. From the second stadium onwards the larvae are green, and then in the fourth stadium a white line appears along the side of its body. During this stadium and the final fifth stadium the larvae are easy to spot on the upper-side of the leaf in their characteristic resting position with the front of their bodies raised in a gentle S-shaped curve.

Larval development lasts for around 20 days. When about to pupate, the larva leaves its food plant and hides in the surrounding vegetation, although it is not unusual to find well-camouflaged pupae attached to the back of the leaves of the larval food-plant. Initially, the pupae are apple-green, but soon become darker and small dark spots appear. The yellow-green colour of the adult insect is easy to appreciate in the final few days before the butterfly emerges. In all, the pupal phase lasts 12-15 days and the emergence of the adults takes place in June-July.

This biological cycle is well reflected in the data from the CBMS. Both species peak first of all in March-May, when the butterflies fresh from hibernation enter fully into their breeding season (fig. 3). In some areas, nevertheless, only a few butterflies are detected during this period, possibly because certain areas are less suited for hibernation than others. It has been suggested that movements between hibernating and breeding areas occur in the Brimstone[11], although it would seem that this phenomenon also occurs habitually in the Cleopatra. The new annual generation becomes visible in many areas at the beginning of summer. If there are many nectar sources, the summer peak in abundance may be prolonged by the arrival of butterflies from other areas lacking nectar-giving flowers.

However, observations of adult behaviour and the development of the larvae and pupae indicate that this simple annual cycle is more complex in the case of the Cleopatra, which in some cases may act as a bivoltine species[12]. A second partial generation emerges at the end of July and beginning of August, but is often hard to detect as it overlaps with the butterflies from the first generation. The number of butterflies that actually breed again in the summer will vary from year to year depending on the weather and will fall to zero in drought years.

During the rest of the summer, the abundance of these two species gradually drops as butterflies begin their hibernation or leave in search of better areas for overwintering. Nevertheless, it is not uncommon to see active Cleopatras or Brimstones outside the BMS counting season on sunny autumn days. No precise information exists regarding these species' hibernation sites, although traditionally it has been assumed that they hide amongst the leaves of evergreen species such as ivy in wooded areas.

Altitudinal migrations

One of the least known aspects of the ecology of these two species is the tendency they have to make notable altitudinal migrations. Despite being commented upon by some authors[13], to date this phenomenon has never been rigorously documented. The concentrations of these species in the various CBMS stations in the Montseny mountain, as well as the weekly censuses conducted from a car along the road between Santa Margarita de Palautordera (300 m) and Collformic (1100 m), have provided detailed data regarding this behaviour (fig. 4), which has been confirmed by exhaustive sampling of larvae and pupae along an altitudinal gradient of 350-1000 m.

Firstly, important differences exist between the two species in their chosen hibernation areas: whilst the Brimstone uses a broad altitudinal range (from the base of the Montseny mountain up to at least 1250 m), the Cleopatra hibernates above all at the base of the mountain, between 330 and 650 m, in Mediterranean holm-oak forests. Although both species lay their eggs on Mediterranean buckthorn throughout its altitudinal range (up to about 1000 m), reproduction is concentrated at mid altitudes (between 350-650 m). The altitudinal migration is less obvious in the Cleopatra and a large part of its population remains all summer in its areas of emergence under 1000 m, possibly because these are the areas used for reproduction (according to the species' bivoltine behaviour described above). Even so, a notable number of Cleopatras do move to higher altitudes in the summer. These remarkable movements are due to the fact that adults need to store up reserves if they are to survive the long overwintering period. During the summer in the Montseny and the Mediterranean in general, the habitual summer drought ensures that there is a general scarcity of flowers at lower altitudes, in marked contrast to areas over 1000 m where many plants such as viper's bugloss (*Echium vulgare*), thistles, pinks (*Dianthus* spp.) and other species are still in flower. In these two butterfly species seasonal altitudinal migrations have

therefore evolved as an adaptive mechanism for exploiting an abundant and reliable resource that lies far from their main areas of emergence.

The only aspect of this phenomenon that is not well reflected in our data are the return flights to lower areas, which in theory take place at the end of August and beginning of September. This is above all the case in the Cleopatra and the most plausible explanation is that at the end of summer butterflies become increasingly less active and gradually harder to detect.

Natural predators

The larvae of both butterflies are attacked by three solitary specialist parasitoids, *Hyposoter rhodocerae* (Hymenoptera: Ichneumonidae: Campopleginae), *Cotesia gonepterygis* and *Cotesia risilis* (Hymenoptera: Braconidae: Microgastrinae)[14]. All three species, present in Catalonia and identified from material collected in the Montseny area, attack larvae in their first stadia and then kill them when they are half-grown. *H. rhodocerae* pupates inside the larva, which inflates as it dies. Its cuticle then hardens to form a 'mummy'-like case with a white horizontal band that is easy to find amongst the leaves of the food plant. The adult parasitoid emerges 10 days later. In the case of both *C. gonepterygis* and *C. risilis*, the parasitoid larvae leave the dead caterpillar and weave a silken cocoon in which they pupate. In *C. gonepterygis* the cocoon is a characteristic golden colour and the adult parasitoid does not emerge until the following spring, while in *C. risilis* the cocoon is white and less visible, and the adult emerges about a week later.

The eggs of both species are parasitized by *Trichogramma cordubensis*[15] and the pupae by *Pteromalus apum*[14], two generalist parasitoids that attack a large variety of other host species.

With their wings folded, adult Cleopatras and Brimstones are well-camouflaged and both species blend in well with the leaves of the plants they hibernate in. This is of fundamental importance if they are to avoid being preyed upon by insectivore birds during their long overwintering period. As well, both species indulge in thanatosis, that is, they feign death when captured or handled[16]. This immobility, which can last for a minute or more, is a mechanism designed to confuse predators and allows for a subsequent quick getaway.

Population trends

The Brimstone and, above all, the Cleopatra are two of the Catalan butterflies that most increased in number between 1994 and 2008 (fig. 5). The analysis of their annual indexes with the programme TRIM reveals a significant positive trend in both species ($P < 0.01$), with a calculated annual increase of 4.08% in the Brimstone and 10.12% in the Cleopatra. The ease with which both species can be detected and identified (calculations were made only with males to avoid possible confusion between the species), as well as their presence in most CBMS and BMSAnd stations, guarantee the reliability of these trends.

The generalist tendencies of both species – albeit with differences in their chosen habitats – would seem to indicate that the increases in their populations are not connected to the evolution of any particular habitat type. Nevertheless, two factors seem to suggest that the increase in the forest cover in Catalonia is the most probable cause of these positive trends. Firstly, their favourite food plant, Mediterranean buckthorn, is a typical element of holm-oak forests and as such has been favoured by the expansion in recent decades of this type of forest. Secondly, the increase in the forest cover will also be beneficial if, as seems likely, these two species hibernate in forests. All in all, the Brimstone and Cleopatra are two species whose populations are some of the healthiest in Catalonia, Andorra and the Balearic Islands.

Jordi Jubany & Constantí Stefanescu

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[5] The dispersive capacity of the Brimstone is beyond doubt, as a number of studies that have documented movements of dozens of kilometres have shown (see main text). Moreover, there are records of butterflies found on ships at sea, which indicate the species' ability to colonize islands (cf. Carreras *et al.*, 2004).

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[9] Wiklund, C., Lindfords, V. & Forsberg, J., 1996. "Early male emergence and reproductive phenology of the overwintering butterfly *Gonepteryx rhamni* in Sweden". *Oikos*, 75: 227-240.

[10] Both *G. rhamni* and *G. cleopatra* are attracted to purple, blue and pink flowers. Butterflies emerging from hibernation are often seen on the flowers of rosemary (*Rosmarinus officinalis*), but also on dandelions (*Taraxacum officinale*). In summer, large concentrations of both species and sexes can be seen on the flowers of *Echium vulgare* and thistles (*Carduus* spp. and *Cirsium* spp.), scabioses (*Scabiosa* spp. and others) and pinks (*Dianthus* spp.). Both species are also frequent in gardens, where they are attracted by the flowers of buddleia *Buddleia davidii* and aromatic labiates such as *Salvia* spp. and *Lavandula* spp.

[11] Pollard, E. & Hall, M.L., 1980. "Possible movement of *Gonepteryx rhamni* (L.) (Lepidoptera: Pieridae) between hibernating and breeding areas". *Entomologist's Gaz.*, 31: 217-220.

[12] The existence of a second generation has been proved by the observation of mating in June and July coinciding with the emergence of the first annual generation and by the presence of larvae in July in the Montseny area (J. Jubany & C. Stefanescu, obs. pers,).

[13] Larsen, T., 1976. "The importance of migration to the butterfly faunas of Lebanon, East Jordan, and Egypt (Lepidoptera, Rhopalocera)". *Notulae Entomol.*, 56: 73-83.

[14] Shaw, M.R., Stefanescu, C. & van Nouhuys, S., 2009. "Parasitism of European butterflies (Hesperioidea and Papilionoidea)". *In*: *Ecology of butterflies in Europe* (Settele, J., Shreeve, T.G., Konvicka, M. & Van Dyck, H., eds). Cambridge University Press.

[15] This species was determined by B. Pintureau from material collected at Sant Pere de Vilamajor.

[16] Dennis, R.L.H., 1984. "Brimstone butterflies, *Gonepteryx rhamni* (L.), playing possum". *Entomologist's Gaz.*, 35: 6-7.

Fig. 1. Relative abundances (expressed as the value of the annual index/100 m) in the different CBMS stations (1994-2008) for (a) the Brimstone *Gonepteryx rhamni* and (b) Cleopatra *G. cleopatra*. The abundances have been superimposed on a probability of occupation map calculated from a bioclimatic model combining thermometric and pluviometric data[7]. The white colour for Andorra and the Balearic Islands does not indicate a zero occupation probability; rather it is due to the fact that no climatic information layers are available for these areas.

Fig. 2. Population densities of (a) the Brimstone *Gonepteryx rhamni* and (b) Cleopatra *G. cleopatra* in the main habitats represented in the CBMS network.

Fig. 3. Phenology of the Brimstone *Gonepteryx rhamni* (a-b) and Cleopatra *G. cleopatra* (c-e) according to data from the CBMS (1994-2008). (a) and (c), Mediterranean environments in the mountains of the Serralada Litoral and nearby areas; (b) and (d), central European environments in the mountains of the Serralada Prelitoral, Serralada Transversal and pre-Pyrenees; (e) Menorca.

Fig. 4. Altitudinal and seasonal distribution of the Brimstone *Gonepteryx rhamni* (a-b) and Cleopatra *G. cleopatra* (c-d) in the Montseny mountains. (a) and (c), data from CBMS counts (1994-2008) from 8 stations situated between 250 and 1700 m; (b) and (d), data from counts from a car (2001-2008) along the road between Santa Margarita de Palautordera (300 m) and Collformic (1100 m).

Fig. 5. Fluctuations in the populations of the Brimstone *Gonepteryx rhamni* and Cleopatra *G. cleopatra* in Catalonia and Andorra in the period 1994-2008 calculated with the programme TRIM.

Identification
How to separate the species of the genus *Erebia* (1)

When one thinks of the most typical butterflies of the high mountains, the ringlets of the genus *Erebia* spring to mind first of all. In all, 16 species of this genus fly in Catalonia, of which four – de Prunner's *E. triaria*, Spring *E. epistygne*, Autumn *E. neoridas* and Piedmont *E. meolans* Ringlets – are found at lower altitudes and are the only ringlets to fly outside the Pyrenees and pre-Pyrenees.

Spring Ringlet *E. epistygne* is the most localised of these four species and to date has not appeared in the BMS counts. It is an atypical ringlet[1] inasmuch as it does not fly in the Pyrenees and occupies an altitudinal range of only 700-1.400 m a.s.l. in sub-Mediterranean mountains in the pre-Pyrenees, the east of the Central Depression and the mountains of the Serralada Transversal and Els Ports[2]. The other three species have been detected in 6-10% of the CBMS stations and their strongest populations are to be found in the Pyrenees and pre-Pyrenees, and secondarily in the mountains of the Serralada Transversal. De Prunner's Ringlet is common between 1,200 and 2,500 m a.s.l. and is also found in the Els Ports mountains in southern Catalonia; Piedmont Ringlet is found at lower altitudes, between 600 and 2.500 m, and flies in the highest part of the Montseny mountains; Autumn Ringlet, found between 700 and 2.000 m, flies from the Pyrenees to the extreme eastern end of the Central Depression (Moianès). All are univoltine and winter as larvae: Spring Ringlet flies in March-April and is

the only exclusively spring species of the genus; de Prunner's is on the wing from the end of May to the beginning of July; Piedmont Ringlet flies from June to early August and Autumn Ringlet, the latest of all, appears in July and is on the wing until September. All feed on different types of grass, above all of the genera *Festuca*, *Poa* and *Nardus*[3].

Jordi Dantart

[1] Nel, J., 1992. "Sur la plasticité écologique et la biologie de quelques Lépidoptères (Rhopalocera) du sud-est méditerranéen de la France (2e partie)". *Linn. belg.*, 13: 239-270.

[2] Dantart, J., 2008. "*Erebia epistygne*". In: *Invertebrats que requereixen mesures de conservació a Catalunya* [on line]. Barcelona: Institució Catalana d'Història Natural. http://ichn.iec.cat/pdf/PROT_INV_ICHN_2008(web).pdf

[3] Tolman, T. & Lewington, R., 2002. *Guía de las mariposas de España y Europa*. 320 pg. + 104 pl. Lynx Edicions, Bellaterra.

Drawings

DE PRUNNER'S RINGLET
Upperside (general): dark, with reddish postdiscal bands and black ocelli with white pupils.
Underside (general): dark, fore-wings with rusty postdiscal band; hind-wings with black spots and roughened appearance; postdiscal area paler (above all in females).
Marked with line:
Three ocelli at wing-tip co-linear.

SPRING RINGLET
Upperside (fore-wing): dark, with yellowish area in cell; postdiscal band yellowish, narrowing from the costa to the rear margin and with numerous large pupilled ocelli.
Underside (hind-wing): dark, with rusty postdiscal band with 4-5 pupilled ocelli.
Underside (general): fore-wings with rusty tones; wing-tip greyish; hindwings marbled with ash grey; the discal band is dark and the veins paler.
Marked with line:
Yellowish area in cell.

AUTUMN RINGLET
Upperside (general): dark, with orange postmedial band narrowing from the costa to the rear margin of wing and with three pupilled eyes; hind-wings with rusty patches and pupilled eyes.
Underside (general): dark, fore-wings with rusty postdiscal band and greyish wing-tip; hind-wings marbled with a paler postdiscal band. Females overall paler.
Marked with line:
Internal margin [of the post-medial patches on the fore-wings] straight; pale postdiscal band [underside of hind-wings].

PIEDMONT RINGLET
Upperside (general): dark, postdiscal bands reddish with white pupilled black ocelli.
Underside (general): dark, fore-wings with rusty postdiscal band; hind-wings uniform in colour (silky aspect) and postdiscal area slightly lighter coloured (above all in females).
Marked with line:
Two ocelli on wing-tip with third ocellus displaced towards margin.

The differences in these species' flight periods help in their identification, although in some periods of the year de Prunner's and Piedmont, and Piedmont and Autumn may be on the wing together. In Spring Ringlet, the yellowish patch in the cell and the broad yellow postdiscal bands on the fore-wings are very distinctive. De Prunner's and Piedmont Ringlets can be separated by examining the ocelli on the wing-tips: in the former species there are three co-linear ocelli towards the wing-tip, whilst in the latter there are generally only two and when there is a third (nearest the wing-tip), it is normally displaced outwards, towards the wing edge. As well, the underside of the hind-wings appear dark matt in De Prunner's Ringlet, but silky smooth in Piedmont Ringlet. Autumn Ringlet can be identified by its orange postmedial band on the fore-wing, which narrows from the costa to the lower margin; as well, the external edge of the postmedial patches on the hind-wings have straight edges and the underside of the hind-wings have a paler postdiscal band.

Identification

How to separate the species of the genus *Brenthis*: Marbled *B. daphne*, Twin-spot *B. hecate* and Lesser Marbled *B. ino* Fritillaries

All three European species of the genus *Brenthis* are present in Catalonia, albeit with very localised distributions. Despite certain similarities, details on the underside of the hindwings, above all, allow them to be reliably separated.

Marbled Fritillary *Brenthis daphne* is the most abundant species of the genus in Catalonia and flies commonly in the north of the country, but somewhat less frequently in the south; to date, it has been found in 21% of CBMS stations. Its favourite habitat consists of banks of brambles and other bushes in relatively humid montane areas (for example, the Pyrenees, pre-Pyrenees, and mountains of the Serralada Transversal and Montseny). Its larvae feed on brambles of the genus *Rubus*. On the other hand, Twin-spot Fritillary *B. hecate* is rare in Catalonia and in the CBMS network has only been found on the transect in the Mont-rebei gorge. Elsewhere in Catalonia it is found in isolated populations in the *comarques* (counties) of Pallars Jussà (Montsec mountains), Noguera, Solsonès, Osona and La Garrotxa in dry montane areas of open woodland with an understorey of tall grass with abundant dropwort *Filipendula vulgaris*, its larval foodplant[1]. Lesser Marbled Fritillary *B. ino* has yet to be recorded on the BMS counts, although it is very likely that it flies at Sorteny in Andorra. This species is found in the Pyrenees and only very rarely in the pre-Pyrenees, occupying a broad band of habitat between 1,000-1,800 m a.s.l. It normally flies in meadows with tall grass or woodland clearings, always in damp areas near streams. Its biology is poorly known, although its main larval foodplant is probably meadowsweet *Filipendula ulmaria*[2]. All three species are univoltine: Marbled and Lesser Marbled fly in June-July, whilst Twin-spot flies a little earlier in May-June. They overwinter as a newly to hatch larva inside the egg.

Vlad Dinca

[1] Nel, J., 1992. "Sur la plasticité écologique et la biologie de quelques Lépidoptères (Rhopalocera) du sud-est méditerranéen de la France (fin)". *Linn. belg.*, 13: 287-338.

[2] Tolman, T. & Lewington, R., 2002. *Guía de las mariposas de España y Europa*. 320 pg. + 104 pl. Lynx Edicions, Bellaterra.

Drawings

MARBLED FRITILLARY
Upperside (general): orange-brown, with irregularly sized postdiscal spots (spots in s2 and s3 are usually larger than the others).
Marked with line:
Upper side of fore-wing: postdiscal spots in s2 and s3 are normally larger.
Underside of hind-wing: submarginal spots are usually less well developed than in Lesser Marbled; s4 with orange-brown suffusion and a small yellow area touching the end of the cell.

TWIN-SPOT FRITILLARY
Upperside (general): orange-brown with the submarginal and postdiscal spots usually in a parallel row.
Marked with line:
Upperside fore-wing: postdiscal and submarginal spots in parallel lines. Postdiscal spots all relatively similar in size.
Underside hind-wing: parallel lines of postdiscal and submarginal spots well marked. s3 and s4 without orange colouration.

LESSER MARBLED FRITILLARY
Underside (general): similar to *B. daphne*, although the violet-brown on the hind-wings suffusion is generally less pronounced.
Marked with line:
Upperside fore-wing: postdiscal spots uneven in size, with the spot in s4 being smaller.
Upperside hind-wing: black spots at the ends of the veins normally merge into a continuous line.
Upperside fore-wing (female): normally has a pronounced black basal suffusion.
Underside hind-wing: submarginal spots normally better developed than in Marbled Fritillary. s4 with obvious yellow base (next to the end of the cell).

The key to separating Marbled from Lesser Marbled is the underside of the hind-wing: the space s4 (next to the cell) is almost completely orange-brown in Marbled Fritillary, whilst in Lesser Marbled it is clearly yellow. Twin-spot can be easily distinguished by the twin parallel lines of submarginal and postdiscal black spots on the underside of its hind-wing. The spaces s3 and s4 are both yellow, without any orange.

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