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Cover

Detail of the underside of the hind-wing of Western Marbled White *Melanargia occitanica* (photo: A. Miquel).

Marsh Fritillary *Euphydryas aurinia beckeri* basking in the sun (photo: J.M. Sesma).

Editorial

A warning for Catalan butterflies?

In recent years many articles have been published that warn of the critical situation of butterfly populations in northern and central Europe, a confirmation of the generalised feeling that these wonderful insects are today becoming ever scarcer. The new European Red List of Butterflies published in 2010 evaluates the status of each and every butterfly species in Europe and a summary of the content of this important publication is included in the review section of this edition of *Cynthia*.

All the analyses of trends in European butterfly populations to date have been based exclusively on data gathered in northern Europe. The lack of comparable data meant that up to now it had never been possible to undertake similar analyses for the countries of southern Europe, somewhat of a paradox given that this region is the richest in Europe in terms of the number of butterfly species (and of endemic species). Thanks to the CBMS this situation has changed and this edition of *Cynthia* includes an exhaustive evaluation of the trends in an important fraction of the butterfly species of Catalonia. Regrettably, the results engender a certain sense of pessimism: over the last 15 years significant trends are revealed to have occurred in around half of the species analysed, of which the majority are negative. Just as has occurred in northern countries, data clearly show that habitat specialists are undergoing the severest declines. This trend is worrying since it indicates that changes in butterfly communities are leading to a predominance of generalist and common species to the detriment of the rarest species and those of greatest conservation concern.

Although the causes of these trends are complex, it seems clear that landscape changes are one of the main factors involved. Climate change also has a negative influence, above all due to the increasing frequency and intensity of periods of drought. The CBMS data are a clear warning and we must take good heed – our region is still one of the richest in Europe for its butterflies and we must do all that is within our power to ensure that it continues to be just as rich in the future.

The CBMS network

Current situation (2009) of the Butterfly Monitoring Scheme in Catalonia, Andorra and the Balearic Islands

A total of 66 stations, 64 of which provided complete data, participated actively in the sixteenth CBMS season. Three new stations began to operate, and regular preliminary counts were carried out in four others. All the stations of the BMSAnd and in Menorca and Eivissa continued to function. In all, 141,899 butterflies belonging to 160 species were counted in 2009.

During the 2009 season 66 butterfly walks were carried out, of which 64 managed to complete the annual counts (fig. 1). As well, preliminary counts were performed at Llobera (Solsonès, 850 m) and Planes de Son (Pallars Sobirà, 1,540 m), and new counts were started at Moià (Bages, 700 m) and L'Estany de Sils (La Selva, 70 m). The Moià area is especially interesting, and harbours many rare species. The first data from this transect indicate that in this area there are well-established populations of localised species such as Osiris *Cupido osiris*, Catalan Furry *Polyommatus fulgens*, Escher's *P. escheri*, Chapman's *P. thersites*, Mazarine *P. semiargus*, Adonis *P. bellargus* and Chalkhill *P. coridon* Blues, most of the *Melitaea* fritillaries and Essex *Thymelicus lineola* and Silver-spotted *Hesperia comma* Skippers.

The available annual series are shown in figure 2. There are currently a nucleus of 42 itineraries with eight or more years of data, a significant figure and one that allows us to perform robust analysis on population trends and changes in community structure. Likewise, it is worth remarking that the Pyrenean stations (for example, in Andorra) are still active and provide data from one of the environments that took longest to incorporate into the CBMS network.

New transects

Tramvia de Sang (Berguedà, 766 m). This transect lies between the town of Berga and the reservoir of La Baells, in a montane zone dominated by downy oak and box woodland. It consists of 11 sections combining woodland and traditionally grazed pastures. The butterfly community is rich, with a predominance of the typical species from the limestone pre-Pyrenees, but also with a notable presence of more Mediterranean species. Some of the most interesting species detected during the first year (and scarce in the CBMS network) include Provençal Short-tailed *Cupido alcetas*, Osiris *C. osiris*, Chequered *Scolitantides orion* and Catalan Furry *Polyommatus fulgens* Blues, Lesser Spotted *Melitaea trivia* and Spanish *Euphydryas desfontainii* Fritllaries and Spanish Festoon *Zerynthia rumina*.

Folgueroles (Osona, 566 m). Situated on the outskirts of the village of Folgueroles, this itinerary passes through a agricultural-forest habitat mosaic and its sections cover a range of habitats including woodland, pastures, hay-meadows and intensive agricultural cropland. Due to its proximity to the Plana de Vic, it is a fairly cold area and there is a good selection of more central European butterflies such as Brown *Thecla betulae* and Sloe *Satyrium acaciae* Hairstreaks, Short-tailed *Cupido argiades* and Chalkhill *Polyommatus coridon* Blues, Map Butterfly *Araschnia levana* and Marbled *Brenthis daphne* and Glanville *Melitaea cinxia* Fritillaries.

Deveses de Salt (Gironès, 70 m). This walk runs through the well-known park shared by the cities of Girona and Salt. It was begun in 2008, but 2009 was the first year to provide a complete set of data. The butterfly community is not very species rich and is dominated by generalist species, although it is of interest inasmuch as it is the first transect to be walked entirely in an urban park. Three of its most interesting species are Less Purple Emperor *Apatura ilia*, Camberwell Beauty *Nymphalis antiopa* and Glanville Fritillary *Melitaea cinxia*.

The number of CBMS stations was lower in 2009 than in 2008 as the walks at Martorell and Sant Ramon (El Baix Llobregat), Olesa de Bonesvalls (in the Garraf Natural Park), La Granja d'Escarp and Aiguabarreig (both in El Segrià), Vallforners (in the Montseny Natural Park), Alinyà (in L'Alt Urgell) and La Roca (in El Vallès Oriental) did not operate. The station at Olesa de Bonesvalls alternates annually with those of Vallgrassa and Olivella. The loss of the counts at Granja d'Escarp and L'Aiguabarreig is temporary and both are expected to re-start in 2010.

Habitats representated

The dominant environments and plant communities in 2009 appear in table 1. Mention should be made of the gradual increase in the number of transects walked in montane areas, which now represent 20% of all the itineraries and, thanks to the diversity of species that fly there, boast a very high number of species. On the other hand, in recent years there has been a gradual loss in the number of itineraries in dry environments dominated by scrub habitats. We thus must make an effort in the future to increase the CBMS cover in these areas in central and western Catalonia. The excellent cover of the coastal wetlands once again enabled us to detect with precision the phenology of the migrant species that were abundant in 2009.

Species present

The list of butterflies detected in 2009 and in previous years can be found in table 2. In total 160 species were detected, three less than the previous year, but 23 more than the average for the period (fig. 3). No new species for the CBMS appeared in 2009, although high-mountain species poorly represented in the CBMS network such as Bog Fritillary *Boloria eunomia*, Purple-edged Copper *Lycaena hippothoe*, Silvery Argus *Aricia nicias* and Eros Blue *Polyommatus eros* were all detected in 2009.

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[1] Folch i Guillèn, R., 1981. *La vegetació dels Països Catalans*. Ketres Editora, Barcelona.

[2] Karsholt, O. & Razowski, J., 1996. *The Lepidoptera of Europe. A Distributional Checklist*. Apollo Books, Stenstrup.

Fig. 1. Geographical situations of all the stations that have ever participated in the CBMS network (1994-2009), 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 1988-2009).

Fig. 3. The number of species detected annually in the CBMS network (1994-2009).

Table 1. Habitats and plant communities represented in the CBMS in 2009, 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 2000-2009. 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 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, and 66 in 2009). Taxonomy as per reference 2.

Photo 1. The itinerary at Folgueroles is representative of the agro-forestal landscape mosaic of the area surrounding the Vic plain (photo: R. Portell).

Photo 2. The presence of riverine forest in the itinerary of Les Deveses de Salt allows for the presence of Camberwell Beauty *Nymphalis antiopa* and Less Purple Emperor *Apatura ilia* in this urban park (photo: J. Pibernat).

Drawing 1. Although the Brown Hairstreak *Thecla betulae* is not rare in the northern half of Catalonia, its arboreal habits mean that its numbers are underestimated by the CBMS transects. In fact, it is much easier to census its populations in winter by counting its eggs, which are easy to find on the branches of sloe *Prunus spinosa* bushes (drawing: M. Miró).

Sixteenth year of the CBMS
Summary of the 2009 season

After a cold and rainy start to the spring, 2009 turned out to be one of the hottest years in recent decades. Other than in a few places, this did not favour most butterfly species and total counts remained low or very low as in the previous two years; in the end, globally 2009 was to be the worst CBMS to date (closely followed by 2008 and 2005). Nevertheless, the April rains favoured False Ilex Hairstreak *Satyrium esculi*, one of the dominant species in Mediterranean areas, which once again became incredibly abundant in some localities. Also of note was the exceptional Painted Lady *Cynthia cardui* migration, which during spring and part of the summer became the commonest butterfly over much of Catalonia and, possibly, Europe too.

Weather and butterfly counts

The year 2009 was to be one the hottest in recent decades, although this thermal anomaly did not become evident until May (see www.meteocat.com). Of the CBMS months, May, June and August were particularly hot, with monthly averages of up to 3ºC above the average. Rainfall, on the other hand, was irregular and in some areas above-average yearly figures were recorded (e.g. most of the western Pyrenees), while in others less than half of the yearly average rainfall fell (e.g. north of the Alt Empordà).

Chronologically, autumn 2008 (September to November) was cold, above all in the west of Catalonia. Rainfall was scarce in autumn in the north-east and along the central coast and the Ebro valley, but plentiful in almost all of the pre-Pyrenees, part of central Catalonia and El Baix Camp. A cold winter followed (above all, December and January), with abundant rains in the north-east and the mountains of Tarragona, but with little rain in the west of Catalonia and the Ebro valley. Mention should also be made of the heavy snow at relatively low altitudes on 6-9 January along the coast and extreme south of Catalonia, and the gale-force westerly winds that swept over most of coastal and pre-coastal areas on 23 and 24 January. April was cold and damp throughout Catalonia, with up to 200 mm of rain in some parts of the country, although things changed in May, which turned out to be very hot and dry. Subsequently, heatwaves were the tonic of the summer, with temperatures in many parts between 35 and 40ºC and with very little rainfall. In September temperatures returned to more normal levels and there were irregular stormy and rainy intervals.

In all, an average of 3.4 counts were lost per station in 2010, a lower figure than in 2009 due to generally drier weather (fig. 1a). Most counts were lost at the beginning of April, and in the summer months coinciding with the storms that affected much of Catalonia (fig. 1b).

Changes in abundances: general considerations

In general in 2009 more butterflies were counted than in the previous year, both in terms of the number of species and, above all, the number of individuals. Taking into account the 60 stations with data from both 2008 and 2009, the average number of species per itinerary was lower in 2008 (50.2 ± 19.6) than in 2009 (51.7 ± 20.8) (Student Test for paired samples, $t = -2.06$, $P = 0.04$). These differences were even more noticeable in the case of the number of butterflies: 2007.8 ± 1906.7 in 2008 and 2337.9 ± 1960.1 in 2009 ($t = -3.55$, $P = 0.001$). It is worth noting that this increase can be attributed to just two species that were extraordinarily abundant in 2009: False Ilex Hairstreak *Satyrium esculi* and Painted Lady *Cynthia cardui*. Together, over 30,000 (!) of these butterflies were counted, a record figure that is unlikely to be beaten in the coming years. On the other hand, the population levels of the remaining species were lower in 2009 than in 2008 in many cases and, indeed, for the 66 commonest species 2009 was the worst ever CBMS season with similar numbers to 2005, 2007 and 2008 (fig. 2). This classification reveals that the negative trends detected in recent years persist in many species, and that the extreme abundances of just a few butterflies are isolated cases and unrepresentative of trends occurring in the butterfly communities in Catalonia.

Changes in abundances: fluctuations in populations

There can be no doubt that the most remarkable event in the butterfly counts in 2009 was the extraordinary migration of Painted Lady *C. cardui*, one of the most intense such migrations in the last 50 years and one that also erupted across the rest of Europe.[2] Between mid-April and mid-May over much of Catalonia, Andorra and the Balearic Islands a series of migratory waves of this species were detected (e.g. weeks 7, 9 and 11). An expedition to Morocco identified the valley of Souss as one of the principal source areas of these migrants.[3] Exceptional winter rains had fallen over much of Morocco and provided the perfect scenario for the massive development of Painted Lady populations. The most spectacular migratory event took place on May 31 and June 1 and 2, and was detected by thousands of observers in central and northern Europe. On this occasion a large part of the great migratory wave possibly consisted of butterflies born in the Mediterranean (including Catalonia) beginning their northward movements. Painted Lady numbers dropped drastically during the summer, but in mid-August and then again in mid-September important return waves of migrants were noted, corresponding to butterflies heading back to Africa.[4]

The year 2009 was also exceptional for another migrant, the Plain Tiger *Danaus chrysippus*. The itineraries in the three principal coastal wetlands in Catalonia all had their highest ever counts of this species and, as is normal, the first Plain Tigers were detected in the Ebro delta (regular from mid-June onwards, although the first was observed at the end of May). By the end of July and beginning of August numbers were spectacularly high and dispersal to other areas of Catalonia possibly began in the Ebro delta. Strong populations of the species were established by August in the Llobregat delta and in Els Aiguamolls de l'Empordà, and many butterflies were also seen along the Ebro valley (e.g. Sebes and Granja d'Escarp), in south-west Catalonia (e.g. at Margalef and in the Lleida plains) and along the Catalan coast.[4]

The abundant and generalised rains in April, combined with the fine weather in May, also favoured species such as False Ilex Hairstreak *Satyrium esculi* (with veritable population explosions in some areas), and all the *Melitaea* fritillaries (see photo). These species all reached their best-ever CBMS totals (Table 2). By contrast, spring Lycaenidae such as Green Hairstreak *Callophrys rubi*, Panoptes Blue *Pseudophilotes panoptes*, Provence Hairstreak *Tomares ballus* and Black-eyed Blue *Glaucopsyche melanops* all had very poor seasons, possibly as a result of the serious drought that their larvae had had to withstand the previous year (see drawing).

Finally, the indexes of the summer species such as the majority of the Satyrinae were similar in 2009 to the previous year and these species in general continued to fly in low densities as in recent years (Table 2).

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[1] 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.

[2] Fox, R., 2010. "2009: The year of the Painted Lady". *Atropos*, 30 (in press).

[3] Stefanescu, C., Alarcón, M., Izquierdo, R., Páramo, F. & Àvila, A., in press. "Moroccan source areas of the Painted Lady butterfly *Vanessa cardui* (Nymphalidae: Nymphalinae) migrating into Europe in spring". *J. Lepid. Soc.*

[4] Exhaustive recopilations of observations of Painted Lady *C. cardui* and Plain Tiger *D. chrysippus* in 2009 in Catalonia and in Europe, which will help interpret the migratory phenology of 2009, will soon be published.

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 2009 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 2009. 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 2009 CBMS network compared to the corresponding figures from the 2008 season.

Table 2. Evolution of the overall annual indexes for the 66 commonest butterflies in the CBMS network (2000-2009), based on an arbitrary value of 1 for 1994. Annual indexes were calculated using the TRIM programme.

Drawing 1. Panoptes Blue *Pseudophilotes panoptes*, one of the earliest butterflies on the wing in the spring, was very scarce in 2009. In fact, its populations have been consistently low in recent years, possibly as a result of climatic factors that have affected the availability of its foodplant. The caterpillars of Panoptes Blue feed exclusively on the buds and flowers of the thyme *Thymus vulgaris*, a plant that is negatively affected by a lack of water in spring. The rains that fell in spring 2008 and thus put an end to almost three years of drought arrived too late for most populations of this blue, which fly in March and April (drawing: M. Miró).

Photo. At the same time, most of the *Melitaea* fritillaries increased in number in 2009 and Spotted

Fritillary *Melitaea didyma* had its best-ever CBMS year. The cause could have been the abundant rains in April, which led to good availabilities of the plantain *Plantago lanceolata* for larvae just as they completed their life cycles and emerged from winter diapause. Despite its excellent dispersive ability, this fritillary has fairly local populations, mainly restricted to grassland and fallow land where its food plant is abundant (photo: J.M. Sesma).

Habitat management and conservation

Trends in butterfly populations in Catalonia in response to global change

In this article we present a first global analysis of the trends operating in the populations of Catalan butterflies over the last 15 years. The results are worrying given that they reveal that almost two-thirds of butterfly species are in decline. Globally, this decline is more obvious in habitat-specialist species than in generalists. The exceptions are forest species, which have increased in number as the amount of land covered by forests has also grown.

In light of the growing interest in the ecology and conservation of European butterflies, in recent years numerous studies have been published regarding the worrying decline in the populations of many species. In general, the destruction and fragmentation of habitats have been identified as the main causes of these declines.[1] One of the most commonly observed patterns is the markedly greater decline in the populations of habitat-specialist species than in more generalist species.[1,2] This phenomenon implies changes in the structure of butterfly communities, which gradually become dominated by common species whose habitat requirements are simpler and which are of less interest from a point of view of conservation.[3] Although this pattern is fairly widespread, there is still a glimmer of hope inasmuch that a degree of geographical variability has been seen to exist in population trends due to differences, above all, in climate and land use in Europe. For example, the predictions and data available indicate that climate change will have a generally positive impact on the most northerly populations of some species, although the opposite will be true for species at the southern limits of their distributions in the Mediterranean region.[4-6]

Until very recently, estimates of trends had been conducted principally on the basis of data from countries in central and northern Europe, from where exhaustive data-series are available. Nevertheless, this geographical bias is of concern for the simple reason that the greatest diversity in butterfly species (and also in numbers of endemic species) is to be found in the Mediterranean area.[7] However, after 16 years of data-gathering, the CBMS can now begin to partially correct this bias and provide an accurate vision of the situation in one of the areas of Europe with the greatest diversity of butterfly species. In this article we use these data to describe the results of a detailed analysis of the trends in 78 species (an important fraction of all Catalan butterflies), and also discuss whether there is any correlation between the direction and size of these population trends, and the degree of habitat specialisation in each of the species studied. Finally, we interpret the results in light of complementary information provided by the habitat indicators generated by previous work on this data set.

Methodology

This analysis is based on data gathered between 1994 and 2008 at 95 BMS stations (CBMS: 89 stations, 1994-2008; BMSAnd: 6 stations, 2006-2008).[8] Although there has been a certain degree of turnover in the active stations, a large number have been active since the beginning of the project (for example, by 2008 37 transects had generated data series of seven or more years). Overall, the data correspond to an altitudinal range of 0-2275 m and a great variety of different landscape types (fig. 1).

In order to evaluate population trends, abundance data were used from the commonest species, arbitrarily defined as those that appear annually in seven or more transects. As an exception, data for Grizzled Skipper *Pyrgus malvoides*, Red-underwing Skipper *Spialia sertorius*, Chapman's Blue *Polyommatus thersites* and White Admiral *Limenitis camilla* were excluded due to the possibility of misidentification. On the other hand, data for a few rare species of special conservation interest in Europe (for example, Provence Hairstreak *Tomares ballus*, Purple-shot Copper *Lycaena alciphron*, Large Blue *Maculinea arion* and Chestnut Heath *Coenonympha glycerion*), that are common in a number of CBMS stations, were also included in the analysis.

The calculation of the population trends was conducted following the standard methodology: the annual indexes for each species at each station are combined into a single index for the whole area using the programme TRIM.[9] As often happens in monitoring networks based on volunteer work, some areas are better represented than others, which leads to significant biases and indexes that are unrepresentative for the country as a whole. To resolve this problem, the weight of each station was corrected in terms of the concentration of other stations in the neighbouring area.[10] Thus, the weight of each station was calculated as the quotient between the surface area of the *comarca* (county) in which it is located and the number of other stations also present in that *comarca*. (The resulting weights varied between 1 for the smallest *comarques* and for those with most stations in the CBMS network, and 14.8 for the largest *comarques* and for those with fewest CBMS stations.)

To test the hypothesis that habitat specialists are undergoing more serious declines than generalist species, the population trends were also analysed in relation to the degree of habitat specialisation for each species. This was done by using an index of habitat specialisation (IHS) based on the distribution of the densities of each species in the 17 habitat types that are best represented in the CBMS network.[11-12] The IHS is directly related to the number of habitats occupied by the species in question. Low IHS values correspond to the most generalist species that are found spread evenly across different habitats, while the high values are the specialists whose greatest numbers are found in just one particular habitat type. The possible relationship between population tendencies and habitat specialisation was tested using a linear regression between the slopes of the tendencies generated by the programme TRIM and the values of the IHS indexes.

Finally, using the same habitat indicators as before with up-to-date data for the commonest species, we also investigated whether or not trends in biodiversity were linked to any particular type of environment.[12] The trends for habitat indicators were calculated on the basis of a linear regression with years as the independent variable.

Population trends, habitat specialisation and types of environments

The specific values of the trends for the 78 species studied are given in table 1 and are depicted graphically in figure 2. Almost half of the species (37 or 47.4%) underwent significant population changes during the study period, with a clear predominance of population declines as opposed to increases (28 vs. 9 species). For 10 species, the programme TRIM revealed a very marked decline, but an equally significant increase was only detected in four species. Amongst the species without significant changes, 19 had undergone trends of uncertain direction (for example, due to insufficient data or marked interannual fluctuations). Nevertheless, of these species there was a clear predominance of species with negative as opposed to positive values (13 vs. 6), which would seem to suggest that the general regressive pattern will become more marked in the future. During the period studied, the populations of only 22 species (28%) remained stable.

A significant correlation was found between population trends and habitat specialisation (fig. 3.) In general, habitat specialists (that it, those with the highest IHS values) had more negative trends than the generalists, which confirms that the pattern observed in northern and central Europe is also applicable to our geographical region.

Yet, the habitat indicators clearly reveal that not all specialists have declined to the same extent. In fact, the direction of a trend in a species is closely related to the type of habitat it prefers (fig. 4). Whilst the species that are commonest in grassland and scrub have declined alarmingly in the last 15 years (grassland indicator: $F = 11.41$, $P = 0.0049$; scrub indicator: $F = 14.66$, $P = 0.0021$), forest species have increased marginally ($F = 4.55$, $P = 0.053$). By 2008, the indexes of grassland and scrub indicator species had fallen by 67% and 50%, respectively, compared to initial values from 1994. On the other hand, the woodland indicator increased by 115% compared to its initial figure. Mention should be made of the fact that the indicator for generalist species (that is, for the species with no clear habitat preference) remained stable during the whole period studied ($F = 0.00$, $P = 0.98$), thereby confirming the fact that the commonest and most generalist species are much less sensitive to environmental changes.

Interpretation of the results

This quantitative evaluation of the trends in a substantial part of the butterflies of Catalonia indicates that over the last 15 years there have been significant trends in the populations of almost a half of all the species analysed. Unfortunately, these trends are predominantly negative. Despite having only analysed 78 of the 200 Catalan species, the conclusions are possibly extrapolable to the whole set of Catalan butterflies. In fact, this analysis was conducted on the commonest species, that is, those that are characterised by greater ecological flexibility and resistance to environmental change. For rarer species, available information is still too fragmented to be able to carry out a similar exercise. Nevertheless, the data that are available already reveal that the species that have undergone the most serious declines are the true habitat specialists (that is, the rarest and most locally distributed species; fig. 3). For instance, mention should be made of the serious declines in populations of Large Blue *Maculinea arion*, Western Marbled White *Melanargia occitanica* and Chestnut Heath *Coenonympha glycerion*, all with narrow ecological niches and localised populations in Catalonia and Andorra. Thus, if the analysis had included the rarer species, it is very likely that the results would have indicated even more serious and generalised declines.

Our results show, moreover, that the habitual pattern in central and northern Europe, whereby butterfly communities become progressively dominated by generalist species,[3] also seems to be applicable in the Mediterranean. This finding is particularly worrying because the Mediterranean harbours the greatest concentration of endemic butterfly species in the whole of Europe.[7]

As has been mentioned on other occasions,[12] the analysis of habitat indicators provides a better understanding of which factors are responsible for observed patterns. The data clearly show that the tendencies differ from one group of specialists to another (depending on the type of habitat in question): whilst the typical species found in open areas (mainly grassland and sclerophyllous scrub) in general have been in serious decline for a number of years, forest species have in fact increased, although not quite to the same degree. It seems evident that these trends are related to the profound changes that have occurred in the landscape on the northern shores of the Mediterranean in recent decades; of these changes, it is worth highlighting the abandoning of traditional agricultural and stock-raising practices in upland areas,[13] as well as the loss of habitat to built-up areas and agricultural intensification in the most productive agricultural areas.[14] Together, these trends are leading to a drama-

tic loss of open habitats in Mediterranean areas and a rapid increase in forest cover, above all in upland areas. In a mere 100 years, the total forest cover of Catalonia has doubled (600,000 ha to 1,400,000 ha), while on a shorter temporal scale between 1987 and 1997 the increase in forest cover was in the order of 15,000 ha.[15]

These changes in the landscape are logically affecting our ecosystems and as such data from the CBMS enables us to show how woodland butterflies have benefited from this increase in the forest cover, just as has occurred in the case of birds.[15] The situation of open areas is radically different and is comparable with the situation in central and northern Europe. In Catalonia over the last 15 years there has been a regression in butterfly populations of similar magnitude to the rest of western Europe.[16]

Aside from habitat preferences, other ecological characteristics also affect the direction and scale of these population trends. It is interesting to remark on how trends vary significantly according to butterflies' overwintering strategies and the species that overwinter as adults have undergone the greatest increase in numbers (with the exception of Small Tortoiseshell *Aglais urticae*). This question should be examined in greater detail in the future to determine how each different environmental factors and the biology of each species affects population trends.

Climate change is another factor that must always be taken into account, even more so in light of the many studies to date that indicate that this phenomenon is one of the main causes of decline in butterfly communities.[5,6] This connection seems ever more plausible given the theoretical studies that predict a loss of species in our region to be a likely result of increasing temperatures and aridity.[4,17] Nevertheless, it would seem that in Catalonia changes in the landscape are having a greater effect on butterfly communities than climate change, although undoubtedly this situation could change in the future according to how these motors of global change evolve.

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Fig. 1. Main habitats and plant communities in the CBMS and BMSAnd networks in the period 1994-2008 in terms of the number of stations in which they are dominant.

Fig. 2. Positive (increases) and negative (declines) trends in 78 butterfly species in Catalonia and Andorra in 1994-2008. Trends classified by the programme TRIM as significant or not significant are separated. Amongst the species with non-significant trends, 22 species are classified as stable (see also table 1).

Fig. 3. Relationship between population trends and a habitat specialisation index (IHS) for the 78 species studied. A highly significant negative correlation exists between both variables ($r = -0.421$, $P < 0.0001$), which indicates the tendency for specialist species to undergo more serious regressions than generalist species.

Fig. 4. Environmental indicators based on population trends in the most characteristic butterflies in each habitat type. The indicator for grassland and scrub decreased very significantly during the study period, whilst there was a marginally significant increase in the forest indicator during the same period. The indicator for generalist species remained stable.

Table 1. Population trends in 78 butterfly species in Catalonia and Andorra in the period 1994-2008. The trend is equal to the slope of the regression line calculated with the programme TRIM. Also shown is a classification of the trend extrapolated for 20 years.

CBMS sites

The CBMS at Sales de Llierca (La Garrotxa)

The Sales de Llierca itinerary began to be walked in 2003 and has turned out to be one of the richest stations in Catalonia in terms of the number of species detected. Its most interesting habitats include dry grassland so typical of this *comarca* (county), a section of riparian woodland and the actual riverbed of the river Borró.

The transect

The second CBMS transect in La Garrotxa got underway in 2002 and was designed from the outset to complement the well-established Can Jordà transect in La Garrotxa Volcanic Zone Natural Park. After a previous frustrating year of counts along the river Fluvià near Sant Jaume de Llierca (in general, a transect that was too shady to be of much interest), the site near Sales de Llierca was chosen as representative of the other large protected area in the *comarca,* the Alta Garrotxa Area of Natural Interest. An area of abandoned pasture was located, which lent itself to a circular itinerary that could be linked to a more wooded area of grassland and a section of riparian woodland, which all in all would reveal eventually an exceptionally rich community of butterflies.

The itinerary is 1,663 m long, consists of 10 sections and is located at 250 m a.s.l. at the foot of the first mountains of the Alta Garrotxa. Sections 1-4 run through dry grassland that is gradually being invaded by scrub and woodland. Stands of grass alternate with patches of thyme (*Thymus* sp.), everlasting plant (*Helichrysum stoechas*) in stony areas, *Dorycnium pentaphyllum, D. hirsutum*, Mediterranean coriaria (*Coriaria myrtifolia*), wild privet *Ligustrum vulgare*, smooth-leaved elm (*Ulmus major*) and sloe (*Prunus spinosa*). Subsequently, section 5 runs between pines and deciduous and evergreen oaks, sections 6 and 7 are similar to 1-4, but with grassland with blue aphyllanthes (*Aphyllanthes monspeliensis*) as the dominant plant. Section 8 circumnavigates a small pine-shrouded pasture and links onto section 9, by far the shadiest of all, which passes through mixed woodland with beech, lime, wild service tree, holm oak and viburnum. Finally, section 10 runs over the pebbles of the bed of the river Borró, generally dry but with some water in spring

The butterfly fauna

In all, 90 species of butterfly have been recorded at Sales de Llierca, with an annual average of 70.9 species. During the period 2004-2009, 16,431 butterflies were counted, with annual averages of 2,347.2 exemplars and a density of 141 butterflies/100 m.

The seasonal graphics for both species and number of individuals are fairly trimodal, with secondary peaks in spring and September (in good years) and a maximum at the beginning of summer in weeks 17-18.

As at many other stations, the commonest species is False Ilex Hairstreak *Satyrium esculi*, whose annual index has varied between 139 and 412 over the years. The other commonest species are generally Satyrinae (Iberian Marbled White *Melanargia lachesis*, Speckled Wood *Pararge aegeria*, Wall Brown *Maniola jurtina*, Pearly Heath *Coenonympha arcania* and Gatekeeper *Pyronia tithonus*), although both Common Blue *Polyommatus icarus* and Wood White *Leptidea sinapis* are also abundant (fig. 1). At the other extreme of the scale, species such as Black-veined White *Aporia crataegi*, Ilex Hairstreak *Satyrium ilicis*, Blue-spot Hairstreak *S. spini* and Woodland Grayling

Hipparchia fagi appear annually but only in very small numbers. Of great interest is the population of Provence Hairstreak *Tomares ballus*, a SPEC species of community interest that appeared in 2003-2006. This attractive hairstreak is possibly extinct in the transect area since it did not appear in the counts in 2007-2009. The other SPEC species found on the itinerary, Green-underside Blue *Glaucopsyche alexis*, appears regularly each spring and shows no sign of decline.

The walk can be divided into two halves: the first four sections harbour a good collection of species and no family predominates. Here, most of the transect's Lycaenidae are counted, attracted by the low bushes of *Dorycnium hirsutum* (on which Provence Hairstreak lays its eggs) and other Leguminoseae plants (*Hippocrepis* sp., *Lotus* sp., *Medicago* sp., etc.). As well, the thyme and everlasting plant attract many species – above all hairstreaks *Satyrium* spp. and fritillaries *Melitaea* spp. – when in flower. These abandoned pastures are also excellent for species such as Glanville *Melitaea cinxia,* Knapweed *M. phoebe,* Provençal *M. deione,* Meadow *M. parthenoides,* Spotted *M. didyma,* Violet *Boloria dia* and Marsh *Euphydryas aurinia* Fritillaries.

On the other hand, sections 7-10 are much more wooded and are less species rich. Species such as Speckled Wood *Pararge aegeria,* White Admiral *Limenitis camilla* and Holly Blue *Celastrina argiolus* are abundant. Section 10 runs along the bed of the river Borró and the riparian woodland here attracts species such as Lesser Purple Emperor *Apatura ilia* and Camberwell Beauty *Nymphalis antiopa*, whilst others including Provençal Short-tailed Blue *Cupido alcetas* mud-puddle at the edges of the river; many large fritillaries *Argynnis* spp. gather on the large knapweeds (*Cirsium* spp.) that flower along the river.

Grassland management: to clear or not to clear?

The Alta Garrotxa is today a very forested area, the abandoning of the land having led to a loss of open areas and its associated biodiversity. As of 2009 the technical staff of the Area of Natural Interest – aware of the importance of the area's grassland and open areas – have begun to clear former pasture land to favour extensive grazing, and at the same time have set up a project to study the reaction of three faunal groups (bats, birds and butterflies). The decisions that have to be taken, however, are not always simple: in the case of Sales de Llierca, should sections 1-4 be cleared? They are no longer grazed and, despite their current excellent superficial appearance, will soon become overrun by bushes and scrub, and compared to the situation in 2003 are today much more dominated by low bushes. Provence Hairstreak seems to fly there no longer, possibly because it is a species that likes open stony ground. Likewise, the small population of Southern Gatekeeper *Pyronia cecilia*, concentrated in section 2 where the soil is thin and stony, could also be affected by the increase in woodland and shrubland cover. On the other hand, in 2010 Chapman's Green Hairstreak *Callophrys avis* was detected for the first time, possibly because of the increase in cover of Mediterranean coriaria *Coraria myrtifolia*, the food plant this butterfly uses in the Alta Garrotxa. Furthermore, along section 9 the forest has grown and in some places almost completely covers the path, and the small clearings used by the Speckled Woods and White Admirals are no longer as abundant as before.

At the end of the 2006 season and during the 2007 and 2008 seasons the owner of part of the transect completely cleared section 6 and part of section 7 in order to provide space to pasture horses (in the end said horses have never arrived). Initially there was a clear decrease in the number of butterflies counted, although this trend changed with the flowering of large numbers of plants of marjoram (*Origanum vulgare*) and field holly (*Eryngium campestre*). Counts in 2009 and the first part of 2010 indicate that the butterfly diversity of this section has recovered and is now even greater than before the clearing in 2006. This would seem to suggest that - at least in this sector of the Alta Garrotxa – the periodical clearing of open areas invaded by woodland and scrub is a useful tool in butterfly management.

Mike Lockwood and Rafa Carbonell

Fig. 1. Average abundance (average of the annual indexes for the period 2003-2009) of the 15 commonest butterflies at the Sales de Llierca station.

Aerial photo. The CBMS transect at Sales de Llierca, which consists of 10 sections and a total length of 1,663 m; average of 166.3 m per section (range: 66-315 m).

Review

Van Swaay, C., Cuttelod, C., Collins, S., Maes, D., López Munguira, M., Šašić, M., Settele, J., Verovnik, R., Verstrael, T., Warren, M., Wiemers, M. & Wynhof, I., 2010.

European Red List of Butterflies

Publications Office of the European Union, Luxembourg.

In Europe there are 482 species of butterfly, of which 142 are endemic. Over the last 10 years approximately a third of all European species have gone into decline and currently 8.5% are under threat. This publication evaluates objectively the status of every threatened European butterfly, describes the degree of threat they are under and proposes possible conservation measures.

This Red List is the last in a series of revisions of the conservation status of different groups of European plants and animals. Based on IUCN directives, the most threatened species are described in detail so that action can be taken to improve the current situation of their populations.

This project was coordinated and directed by the IUCN Species Programme and Butterfly Conservation Europe (BCE). Over 50 experts from all over Europe provided data and the knowledge needed to estimate the conservation status of all European butterfly species.

This publication details all the butterfly species found in Europe (except for those that only fly in the countries of the north of the Caucasus). The geographical area under study runs from Iceland in the west, to the Urals in the east, from Franz Josef Land in the north to the Canary Islands in the south. The Caucasus is not included, although the islands of Macaronesia (Canaries, Madeira and Azores) are; the final document uses two levels of analysis: Europe as a geographical entity, and the 27 members of the European Union (EU).

The status of each species was analysed using the IUCN Red List Categories and Criteria: Version 3.1 (IUCN 2001), which is the most widely accepted system for calculating risks of extinction. There are nine categories, which run from Least Concern for species that are not under threat, to those that are deemed Extinct. This classification is based on a series of quantitative criteria related to population trends, the size and structure of populations and geographical distribution. Species considered as Vulnerable, Endangered or Critically Endangered are considered to be under threat.

The publication is divided into six parts. The first part places the project in context and provides background information. The methodology is described in the second part: data were gathered using a questionnaire sent by the BCE to an expert or group of experts in each country, in which specialists were asked to revise the data for each species found in their countries. These data were used to bring the BCE databases up-to-date and to make an initial evaluation of the situation of each specie. Then, workshops were held during which 50 experts discussed these preliminary reports.

The results are included in the third part and conclude that 8.5% of European butterflies are endangered (0.7% are Critically Endangered, 2.8% Endangered and 5.5% Vulnerable). Moreover, 10% are also considered to be Near Threatened and require conservation measures to be adapted, and one species, *Aricia hyacinthus*, is now extinct in Europe. This section includes a table of threatened or near threatened species (see table 1, for information on Catalan species). Mention should also be made of the maps of species richness and endemic species in Europe that are provided. Both of these variables follow the same pattern and reach their highest levels in mountainous areas in southern Europe, principally in the mountains of the Pyrenees, Alps and Balkans. As well, the main threats to European butterflies are discussed: habitat loss and degradation in relation to land-use changes, particularly as a result of the increase in intensive agriculture and the abandoning of the land; likewise, climate change, which is currently affecting various species of butterfly, will probably become an ever-more relevant factor in the future. Finally, the document evaluates population trends and reveals that although 55% of species have stable populations, 31% are in decline and only 4% are increasing in number. For the remaining 10% the population trend is unclear.

The fourth part discusses conservation policy and contrasts the species considered as Threatened with their inclusion in the annexes of the Habitat Directive and the Bern Convention. While the majority of species included in these annexes can be classified as Threatened and require the application of conservation measures, of the 39 threatened European butterflies, only 12 are actually legally protected in Europe.

The fifth part consists of conclusions and recommendations, and makes proposals regarding protection measures to be carried out to improve the conservation of European butterflies and to reverse current negative trends.

Finally, there are four annexes, of which for CBMS workers Annex 2 is the most interesting: a Red List of European butterflies, in which all butterflies and their conservation status is given.

Jordi Jubany

If you would like to know more about the subject, visit http://ec.europa.eu/environment/nature/conservation/species/redlist/butterflies/introduction.htm, where you can consult or download this publication, or http://www.iucnredlist.org, where species-by-species information is available.

Table 1. Butterflies present in Catalonia that are classified as Threatened (EN: Endangered; VU: Vulnerable) or Nearly Threatened (NT) in Europe or in the EU (EU-27). The category LC corresponds to species of Least Concern. Species endemic to Europe or the EU are identified by an asterisk (*).

Review

100 numbers of bulletin of the Catalan Society of Lepidopterology

The year 2009 saw the publication of Bulletin 100 of the Catalan Society of Lepidopterology (SCL), the culmination of 32 uninterrupted years of work that began in 1977 with the publication of *Communications of the Lepidopterological Commission of the Catalan Institution of Natural History*. The Bulletin as such emerged from these communications from number 21 onwards, and was first published in January 1979. Since then, the structure and quality of the Bulletin has improved constantly, and has evolved from the first editions that consisted of just a few photocopied typed pages, to a document with over 100 machine-set and printed pages that is today the SCL Bulletin. Some of the Bulletin's sections have remained the same since the beginning, whilst others have evolved and others have been added. Ne-

vertheless, the most significant innovation has been in the actual content: from the simple list of the results of members' fieldwork in the first editions, the Bulletin now contains articles based on rigorous, modern data collection techniques presented in articles and notes that are increasingly more complex in style.

The scientific contribution of the SCL Bulletin to the study of the lepidopters of Catalonia is unquestionable. Its contribution to faunistic knowledge had always been important, but over the years contributions regarding butterfly taxonomy, monitoring methodologies, biology and ecology have all increased. In terms of the groups studied, most pages are occupied by articles and notes on moths, with a progressive increase in recent years in studies on micro-moths. In all, around 30% of all the information published deals with butterflies, which is the part of the Bulletin that will most appeal to CBMS collaborators. Of particular interest will be the section on the butterflies of Catalonia, which to date has described in detail 28 Catalan butterflies.

For those who are interested in this publication, a more detailed analysis of the first 100 editions was published in the Bulletin 100.

Jordi Dantart

The butterfly

The Marsh Fritillary *Euphydryas aurinia*, a butterfly with fascinating ecological adaptations

Within the complex group of the Melitaeini, the Marsh Fritillary *E. aurinia* is one of the most widely distributed species in Catalonia and Andorra. A careful search during the first days of spring will reveal its black caterpillars basking in the sun in large concentrations on the leaves of their food plants. By May and June the adults are on the wing, often in large numbers, and their attractive low gliding flight is a delight for all.

Geographical distribution and situation in the CBMS

The Marsh Fritillary *Euphydryas aurinia* is a widespread butterfly found in a few sites in the mountains of Morocco[1] and Algeria, most of Europe (except for southern Italy, Greece, the Mediterranean islands and latitudes above 62ºN) and eastwards towards temperate Asia and Korea.[2] In the Iberian Peninsula it is only absent from parts of the eastern coastline, the agricultural plains of La Mancha, Castille and the valleys of the river Ebro and Guadalquivir,[3] and is likewise lacking from the Balearic islands.

In Catalonia and Andorra this fritillary occupies a broad altitudinal range, from sea-level to alpine areas, where it even occasionally flies at 2,400 m. Within this broad distribution, populations of the Marsh Fritillary exhibit a series of ecological adaptations to the different environmental conditions of the habitats they choose to live in (for instance, the use of different food plants and adult morphology). To date it has been detected in 52 CBMS itineraries (approx. 50% of the total; fig.1), but has not yet been recorded from any of the BMSAnd itineraries despite the existence of a colony near the transect at Pessons at a height of 2,200 m. It is abundant in many areas of the mountains of La Serralada Litoral (e.g. El Garraf, La Serralada de Marina, Les Gavarres and El Montnegre), as well as in the mountains of Prades, Els Ports, La Serralada Transversal and even the pre-Pyrenees and inland Catalonia (e.g. La Conca de Tremp, El Bages and El Berguedà). In the Pyrenees proper it is a more local species, but can be common in places with appropriate habitat. On the other hand, it is much scarcer or extinct in areas of the Vallès plain and the Barcelona conurbation, where it has been affected by the growth in infrastructures and built-up areas. It is absent from the Central Depression, the Empordà plain and the coast of Tarragona.

Habitat and food plants

The Marsh Fritillary is polyphagous and its larvae are able to feed on a relatively large number of plants belonging to different families.[4,5] Nevertheless, on a local scale it is usually a strict monophagous specialist.[6] In Catalonia it has been observed to feed on the following plants: the Caprifoliaceae Mediterranean *Lonicera implexa* and Etruscan *Lonicera etrusca* honeysuckles, as well as very occasionally on Japanese honeysuckle *Lonicera japonica*; and the Dipsacaceae devil's-bit scabious *Succisa pratensis*, field scabious *Knautia arvensis* and small scabious *Scabiosa columbaria*. The choice of plant depends to a large extent on the habitat in which each population lives.

In Mediterranean areas the Marsh Fritillary is a specialist on both Mediterranean and Etruscan honeysuckles. It flies typically in open holm-oak woodland and the ecotones between forest and grassland (where these honeysuckles are common), as well as in shrublands and coastal scrub with wild olive and dwarf-fan palm (fig. 2a). It can be very common in shrublands that result from the destruction of holm-oak woodland by forest fires (as has been seen in La Serralada de Marina). In hot areas of south-east France monophagous populations feeding on *Cephalaria leucantha*[4,5] are known, although in Catalonia is seems that only the Spanish Fritillary *Euphydryas desfontainii* feeds on this Dipsacaceae.

In areas of more central European habitat the Marsh Fritillary is very closely tied to humid grassland with devil's-bit scabious, which is also the main food plant of most populations of this species in central and northern Europe. Very occasionally, this fritillary can be found in open, drier habitats with field or small scabious, but it is possible that these plants in Catalonia are not used by stable populations, but only by dispersing females that fail to locate their preferred food plants.

Finally, there is also a form of the Marsh Fritillary that inhabits alpine grassland at altitudes between 1,900-2,400 m in two types of habitat: humid grassland with devil's-bit scabious (e.g. various sites in Andorra and La Vall d'Aran; fig. 2b) and drier grassland where the trumpet gentian (*Gentiana acaulis acaulis* or *G. acaulis alpine*) is probably used as a food plant (e.g. Andorra to El Ripollès). Despite no specific observation of the use of this latter food plant on the southern side of the Pyrenees, its use is well documented in the eastern Pyrenees in France.[4]

This notable diversity of habitats and food plants is also associated with significant morphological differences. In fact, the Marsh Fritillary has sometimes been considered a super-species made up of various geographical races (subspecies) that differ morphologically and ecologically, but which hybridise in contact zones.[4] In Catalonia it is easy to separate the two subspecies *beckeri* and *debilis*: the former is found in Mediterranean environments and is large and brightly orange-red coloured, while the latter is alpine in habitat, smaller in size and darker and less eye-catching. Nevertheless, Marsh Fritillaries from humid montane habitats are intermediate in morphology, and resemble central European populations described as subspecies *aurinia*. It is interesting to note that genetic analyses of various Catalan and French populations have revealed a differentiation related more to food-plant use than to geographical separation. Populations that depend on devil's-bit scabious typically resemble the ssp. *aurinia,* even if they are situated just a few kilometres from populations feeding on honeysuckle, easily recognisable as belonging to ssp. *beckeri*. This implies that the food plant exerts a strong selection pressure on the phenotype of this species.[7]

Biological cycle and phenology

The Marsh Fritillary is a single-generation spring butterfly whose larvae enter hibernation once they reach the fourth instar. Its flight period is quite short and only lasts for around six weeks (fig. 3). In Mediterranean areas it is commonest in May, although it is not unusual to see adults on the wing in April if the spring is warm (fig. 3a). In areas of central European climate in the mountains of La Serralada Transversal, the first Marsh Fritillaries do not fly until the beginning of May and the annual peak occurs during the last week of May and first of June (fig. 3b). In high areas of the pre-Pyrenees the flight period is even later and most adults are not on the wing until June (fig. 3c). Lastly, populations of *E. aurinia debilis* fly in summer, with a peak at the beginning of July.

As occurs in the majority of univoltine butterflies, there is a marked protandry in the emergence of the adults, and males appear a few days before the females. In order to find virgin females, males combine patrolling with territorial behaviour. Males usually establish their territories in sunny clearings and along forest edges, and use a dominant branch or shrub as a vantage point. Females mate soon after they emerge; during mating, males secrete a substance that solidifies and seals off the female genital plate, thereby preventing her from mating again.

Eggs are laid in groups of 200-300 in various layers on the back of the leaves of the food plant. At first eggs are bright yellow, but after a few days turn a red-purple. Often just a few plants are chosen by many females as egg-laying sites;[5] these plants seem to be especially well sited (e.g. they stand out from the rest of the vegetation in sunny situations) and offer the best quality trophic resources for the larvae.[8,9] A recent study of a population of Marsh Fritillary in El Garraf feeding on Mediterranean honeysuckle showed that the leaves that are chosen for laying have concentrations of secondary iridoid compounds that are up to 15 times greater than neighbouring leaves without eggs;[10] it is possible that this build up of compounds is a defensive reaction in the plant caused by the egg clutches since the iridoids are toxic to generalist herbivores. Nevertheless, this response by the plant could benefit the fritillary larvae – as in other members of this genus - since they ingest the iridoids and use them as a defence mechanism against their natural predators.[11]

The eggs hatch within 3-4 weeks and the larvae immediately spin a silken web on the host plant. These nests can be very large, especially if they contain larvae from more than one clutch of eggs. After a couple of weeks, the larvae reach their fourth instar and build a denser nest, generally at the base of the food plant, where they overwinter. The larvae emerge again in February-April (the dates varies according to the site and the spring weather) and continue feeding gregariously until the sixth and last instar. Their black coloration enables them to absorb solar radiation very efficiently, thereby increasing their body temperature and speed of development.[12] To pupate, they normally abandon the host plant and hide in the leaf litter or under stones; this final stage before the appearance of the adult usually lasts around 2-3 weeks.

Natural enemies

The larvae and pupae of the butterflies of the genera *Melitaea* and *Euphydryas* are attacked by a large number of parasitoids, their principal natural enemies.[13] In the case of the Marsh Fritillary, the first studies in the twentieth century demonstrated the relevance of specialist Hymenoptera species belonging the genus *Cotesia*, which can cause serious mortality and provoke great fluctuations in Marsh Fritillary populations.[14] In Catalonia, various studies have confirmed the importance of these and other parasitoids, which attack the larval and pupal stages of the species.[15,16] Parasitoids on the larvae include the braconids (Hymenoptera) *Cotesia bignelii*, *C. melitaearum* and the tachinid (Diptera) *Erycia furibunda* (all specialists), while pupae are parasitised by the icneumonids (Hymenoptera) *Apechthis compunctor* and *Pimpla rufipes*, the pteromalids and chalcidoids (Hymenoptera) *Pteromalus puparum*, *Pteromalus apum* and *Brachy-*

meria tibialis (all generalists). On the other hand, populations of *Cotesia* are attacked in turn by secondary parasitoids, all of which leads to an extremely complex situation.[16] An experiment on mortality in the Marsh and Spanish Fritillaries suggests that other predators such as carnivorous Coleoptera and small mammals also have a serious impact on the pupae of these species.[17]

Population trends

The Marsh Fritillary constitutes a classic case of a species living in metapopulations that is negatively affected by habitat fragmentation.[18] This fragility has manifested itself in generalised declines in populations in recent decades in central and northern Europe, for which reason the species was included in Annex II of the Bern Convention and has been classified as Vulnerable (SPEC3) in the first edition of the Red Data Book of European Butterflies. Nevertheless, in the Iberian Peninsula and in general in southern Europe it is still common and its populations are widespread; as such it is not an endangered species.[19,20]

Nevertheless, the trend in Catalonia over the last 16 years is significantly and moderately negative (fig. 4a); a correct interpretation of this trend is difficult, in part due to the enormous natural fluctuations that this species habitually experiences. This is clear from the data generated by the itineraries that have been walked for sufficient years, which have revealed the existence of local extinctions and re-colonisations (fig. 4b,c). At the same time a certain synchronicity is obvious in population fluctuations at a large spatial scale, as for example the evident increase in numbers that occurred in many populations between 2003 and 2006, followed by marked declines in the following years. Traditionally it is thought that these large-scale synchronised fluctuations could be caused by an interaction between climate and parasitoids[21]: when the end of winter and beginning of spring are cold but sunny, the Marsh Fritillary larvae (which can raise their body temperature using solar radiation) develop more quickly than *Cotesia*, whose white cocoons remain hidden in the grass. Thus, many fritillary caterpillars can pupate before the adult parasitoids emerge, thereby avoiding being parasitised. Nonetheless, this hypothesis has not been confirmed by recent experimental work, not even with empirical data from the British BMS,[22] and must remain as speculative.

The serious declines that have been observed in many Catalan populations in recent years (e.g. in 1995 and 2004; fig. 4) may have been caused by serious drought in the preceding season, which could have led to abnormally high mortality levels in larvae during the pre-hibernation period. In other cases population declines could be associated with habitat degradation: at Can Jordà, for example, where the Marsh Fritillary is found in meadows with devil's-bit scabious, these meadows have become increasingly invaded by woody shrubs and the food plants of the larvae have become less accessible. This phenomenon is very common in central and northern Europe and has been well studied via detailed research into habitat loss and fragmentation, and how these processes affect metapopulation dynamics and the risk of local extinction.[18,23-24] In any case, it still remains to be seen whether the negative trends in the populations of this fritillary in Catalonia continue and whether they can be explained by a combination of climatic factors (increased drought) and the habitat change referred to above (meadows becoming more overgrown).

Constantí Stefanescu

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Fig. 1. Relative abundance (expressed as the values of the annual index/100m) of the Marsh Fritillary *Euphydryas aurinia* in different CBMS sites (1994-2009).

Fig. 2. Two characteristic habitats of the Marsh Fritillary *Euphydryas aurinia*. (a) Continental holly oak garrigue at Olivella, in the Garraf Natural Park; and (b) humid alpine grassland with devil's-bit scabious *Succisa pratensis* in La Vall d'Aran at 2,100 m (photographs: a, C. Stefanescu; b, J. Piqué).

Fig. 3. Phenology of Marsh Fritillary *Euphydryas aurinia* in the period 1994-2009. (a) Populations dependent on Mediterranean honeysuckle in coastal areas dominated by holm-oak woodland and shrublands (Montmell, El Garraf, Collserola and La Serralada de Marina; n = 2,438 butterflies); (b) population at Can Jordà dependent on devil's-bit scabious *Succisa pratensis* in an area of beech woodland at 450 m (n = 432 butterflies); (c) population at La Nou de Berguedà dependent on devil's-bit scabious *Succisa pratensis* in the pre-Pyrenees at 1,100 m (n = 529 butterflies). For each habitat type, the average flight date (DMV) is calculated, expressed as the CBMS week number by which 50% of all the butterflies of the species had been counted.

Fig. 4. Population fluctuations in the Marsh Fritillary *Euphydryas aurinia* (a) over the whole of the CBMS network during the 1994-2009 calculated with the programme TRIM; (b) at the itineraries at Darnius (CBMS-5), Can Ferriol (CBMS-8) and Can Jordà (CBMS-9), monitored without interruption from 1994 to 2009; (c) at Can Miravitges (CBMS-34), Sallent (CBMS-40) and Cal Puntarrí (CBMS-58), where this species is very abundant.

Photos. (a) Two egg batches on Mediterranean honeysuckle, *Lonicera implexa*, and (b) three egg batches on devil's-bit scabious, *Succisa pratensis*; (c1-c2) pre-diapausal larval nests on *S. pratensis* and *L. implexa*; d) 5th-instar larvae on *L. implexa*; (e) pupa; (f) a mating pair of *E. aurinia beckeri*, and (g) a female of *E. aurinia debilis* (photos: a-b, C. Stefanescu; c1-c2, J. Jubany; d-e, J.M. Sesma; f, J. Planas; g, J. Piqué).

Identification

How to separate the species of the genus *Erebia* (2)

Of the ringlets of the genus *Erebia* that in Catalonia are only found in the Pyrenees, Large *E. euryale*, Yellow-spotted *E. manto*, Water *E. pronoe* and Bright-eyed *E. oeme* Ringlets all fly from relatively low altitudes up to true alpine habitats. All are somewhat local in distribution and are fairly easy to separate in the field.

Yellow-spotted and Water Ringlets are confined to La Vall d'Aran (where there is currently no CBMS station) and fly – sometimes in abundance – between 1,600 and 2,100 m. Large and Bright-eyed Ringlets fly in La Vall d'Aran, but also in the eastern Pyrenees[1] between 1,400 and 2,100 m. Of these two latter species, the former has been recorded from two CBMS stations and three BMSAnd stations, whilst the second has appeared at Sant Maurici and also at Sorteny (Andorra). In terms of habitat, both Large and Yellow-spotted Ringlets are closely tied to clearings in coniferous forests, while Water prefers stony slopes with some vegetation and Bright-eyed damp grassland and peat bogs. All four species fly in a single summer generation. Bright-eyed flies from mid-June and throughout July; Large and Yellow-spotted are July species, while Water, the latest to appear, only flies at the end of July and in August. The Water Ringlet has an annual cycle, unlike the other three species, whose caterpillars hibernate twice during their biennial cycle and whose populations fluctuate from one site to another on a two-yearly basis.[2] Various different species of grass (above all genera *Festuca* and *Poa*) and sedges (*Carex* spp.) have been recorded as the food plants of these ringlets.[3]

Jordi Dantart

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Drawings

LARGE RINGLET
Upperside (general): very dark; reddish post-discal band; eye-spots normally blind.
Underside (general): dark brown in males, paler in females with characteristic white/yellowish post-discal band.
Marked with line:
Wing fringes chequered black and white.
Wing edges with shallow scalloping.
White/yellowish post-discal band [females]

YELLOW-SPOTTED RINGLET
Upperside (general): black or very dark brown; despite common English name, no spots or markings (in Catalonia).
Underside (general): very dark brown; despite common English name, no eye-spots; females have vestigial whitish markings in post-discal area of hind-wings.

WATER RINGLET
Upperside (general): very dark; twinned eye-spots at the apex of the fore-wing.
Underside (general): fore-wing dark with rusty-coloured post-discal band; hind-wing brownish with black marbling and a greyish post-discal band.
Marked with line:
Greyish post-discal band [hind-wings]

BRIGHT-EYED RINGLET
Upperside (general): very dark; white eye-spots ringed in orange.
Underside (general): uniform silky dark brown; white pupilled eye-spots ringed in orange.
Marked with line:
Twinned eye-spots at apex [upperside and underside of fore-wing]
Series of eye-spots in arc [underside hind-wing]

The Large Ringlet can be separated from the rest of the Pyrenean *Erebia* species by its chequered wing fringes, the lightly scalloped hind-wing margins and the rusty-coloured post-discal bands, which vary in width and extent and have black eye-spots (normally blind). On the underside of the hind-wings in females the white/yellowish post-discal band is distinctive. In the Pyrenees flies ssp. *constans* of the Yellow-spotted Ringlet, which is black and with no or only vestigial pale markings. The Pyrenean form of Water Ringlet (ssp. *glottis*) is very dark, with only a narrow post-discal band and just two obvious eye-spots near the apex of the fore-wing; the underside of the hind-wings have a characteristic greyish post-discal band. In the Bright-eyed Ringlet the uppersides of the wings are uniform silky black and the undersides uniform silky dark brown; the eye-spots always have white pupils and are ringed in orange, and the twinned spots at the apex of the fore-wing and the series of five spots in an arc on the underside of the hind-wing are both very characteristic.

Identification

How to separate Green Hairstreak *Callophrys rubi*, Chapman's Green Hairstreak *C. avis* and Provence Hairsteak *Tomares ballus*

These three licenids all fly in spring and often coincide in time and place. Although they are easy to confuse (above all, the two *Callophrys* species), with careful examination they can be reliably separated in the field.

The Green Hairstreak *C. rubi* is by far the commonest of these three species, and has appeared in 80% of CBMS itineraries. It is found in a wide variety of habitats, but is characteristic of shrubland and, above all, Mediterranean scrub. It is very polyphagous,[1] although in Catalonia its larvae mostly feed on narrow-leaved *Cistus monspeliensis* and sage-leaved cistus *C. salviifolius*, and common rock rose *Helianthemum nummularium*. Chapman's Green Hairstreak *C. avis* is much rarer and has only been recorded from 20% of CBMS stations. It is found in small numbers in the mountains of La Serralada Litoral and La Serralada Prelitoral, and is generally rarer in the southern half of Catalonia.[2] It frequents open areas with grassland and scrub where its larval food plants, strawberry-tree *Arbutus unedo* and Mediterranean coriaria *Coriaria myrtifolia*, grow. Provence Hairstreak *T. ballus* is also rare, and has been recorded from 30% of CBMS itineraries, normally in low numbers. It is well distributed throughout Catalonia in lowland and montane areas, preferably in limestone grassland or, more rarely, in areas of abandoned cultivation or waste ground. Leguminoseae of the genera *Astragalus*, *Trifolium*, *Ornithopus* and *Medicago* and, in Catalonia, *Dorycnium hirsutum* and *Anthyllis tetraphylla*,[3] have all been recorded as larval food plants. All three species are univoltine: Chapman's Green Hairstreak and Provence Hairstreaks fly from March to May, while the Green Hairstreak does so from March into June and even July in upland areas. All overwinter as pupae.[1]

Vlad Dinca

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Drawings

GREEN HAIRSTREAK
Upperside (general): both sexes grey-brown.
Underside (general): fore-wings green, more yellowish towards inner margin. Hind-wings green with white discal markings usually forming a white line that sometimes penetrates onto the fore-wing.
Marked with line:
Upperside fore-wing (male): oval sub-costal sex-brand
Underside (general): eyes bordered with a narrow white band

CHAPMAN'S GREEN HAIRSTREAK
Upperside (general): both sexes grey-brown, sometimes more reddish than in Green Hairstreak.
Underside (general): fore-wings green, more yellowish towards inner margin. Hind-wings like Green Hairstreak but with white markings that are usually more obvious, even on the fore-wings.
Marked with line:
Upperside fore-wing (male): oval sub-costal sex-brand
Underside (general): border of eyes reddish (without the white ring found in Green Hairstreak)

PROVENCE HAIRSTREAK
Upperside (general): male dark grey with small orange area at anal angle of the hind-wings (sometimes absent), and without sex-brand. Female very characteristic, with large orange patches on the fore- and hind-wings.
Underside (general): similar in both sexes. Fore-wings with broad dark-grey margins and the rest orange with black spots. Hind-wings with a broad green-blue basal suffusion (sometimes less obvious in male).

To separate Green Hairstreak from Chapman's Green Hairstreak it is necessary to examine the border of the eye (white in Green Hairstreak, but reddish in Chapman's Green Hairstreak). The underside of the wing is the key for separating Provence Hairstreak; as well, male Provence Hairstreaks lack the sub-costal sex-brand. The Green Hairstreak is the most generalist of the three species and the only one to appear in upland areas. Chapman's Green Hairstreak is normally found where there are strawberry-trees, whilst Provence Hairstreak frequents abandoned pastures and fields in limestone areas.

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