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Cover

Detail of the underside of Southern White Admiral *Limenitis reducta* (photo: A. Miquel).

Large Skipper *Ochlodes venata* feeding on excrement (photo: J.C. Vicente Arranz).

Editorial

Indicators of climatic change

Climatic change is without doubt one of the factors that will most affect the world's biodiversity in the coming years and in Catalonia many organisms – including butterflies – are already responding to this phenomenon. Biodiversity monitoring programmes such as the CBMS provide highly valuable information that enable us to analyse in detail the type and magnitude of these responses. In recent years a number of climatic change bioindicators, whose aim is to synthesize all this information into a manageable form, have been developed using data from bird and butterfly monitoring programmes. This number of *Cynthia* contains an article that explains which indicators are in use and what they are telling us about this question on European and Catalan scales. One such indicator has revealed the existence of a so-called 'climatic debt', although in the Mediterranean area a second indicator that also takes into account water availability provides a better reflection of the changes in species' populations that are occurring as a result of climatic change. The growing frequency and intensity of droughts, above all, seems to be seriously affecting the butterflies that are most typical of Mediterranean environments, as the sharp fall in their numbers in recent years testifies.

We are also delighted to be able to publish in this edition the first serious attempt to establish a list of common vernacular names in Catalan for all our butterflies. The proposal has been drawn up by a group of experts from the Granollers Natural History Museum and the Catalan Lepidopterological Society over the past two years. We hope that it will be well received and that these names will slowly begin to be used by butterfly enthusiasts to refer to the different species present in our country. We believe that this is an excellent way of further popularizing this group of insects amongst the general public.

Finally, in the regular sections of the journal you will find that 'The butterfly' discussed is the Glanville Fritillary, a species that has become one of the world's best-known butterflies in recent years. It was selected by Ilkka Hanski and his team as a model for the study of metapopulations and has contributed greatly to the development of this important concept, thereby earning itself an important place in modern ecology. We believe that this is an excellent example of the role that butterflies can play in the advancement of science.

The CBMS network

Current situation (2011) of the Butterfly Monitoring Scheme in Catalonia, Andorra and the Balearic Islands

In all, 67 stations provided complete data during the 18th CBMS season. Three new stations were incorporated into the Scheme, while at a further six stations regular preliminary counts were undertaken. The majority of the stations in the BMSAnd network and the four on Menorca and Eivissa continued to function. In total, 134,803 butterflies belonging to 159 species were counted in 2011.

During the 2011 season, of the 67 active stations all but one (Sadernes) provided sufficient data to calculate the annual indices of the species found (fig. 1). As well, preliminary counts continued at Moià (el Bages, 700 m) and new counts were set up at Puig Graciós (Cingles de Bertí, Vallès Oriental), Viladecans (Baix Llobregat), Betrén and Bagergue (Val d'Aran) and in the Tres Turons Park in El Carmel in Barcelona (Barcelonès). The Betrén and Bagergue itineraries are of special interest for the CBMS as they are the first to be established in La Val d'Aran and will provide more data from the hitherto poorly represented Pyrenean habitats. The station of Tres Turons is poor in species but is of special interest as a reasonably well-preserved habitat located within the heart of the city of Barcelona.

The available annual series are shown in figure 2. It is worth noting that there are now more than 30 stations that have provided data continuously for 10 or more years. The number of stations with seven or more years of data is 53, a figure that gives an idea of the possibilities that the CBMS database offers for the analysis of trends operating over time.

New transects

Llobera (Solsonès, 850 m). This walk takes place in a dry and fairly open oakwood with sub-Mediterranean herbaceous plant communities dominated by the flower blue aphyllanthes *Aphyllanthes monspeliensis* in most sections. As well, the walk incorporates areas of bare rock, stands of rushes and damp grassland. From a point of view of the butterflies, Llobera is an extremely diverse itinerary and during the first year with accurate data 62 species were detected. Nevertheless, this figure will undoubtedly increase in coming seasons. The communities of Lycaenidae are extremely rich and there is a mix of Pyrenean species such as Mazarine (*Polyommatus semiargus*), Amanda's (*P. amanda*), Chalkhill (*P. coridon*) Blues and other species such as Osiris (*Cupido osiris*), Chapman's (*Polyommatus thersites*) and Catalan Furry (*P. fulgens*) Blues that are more representative of upland Mediterranean areas. Nympalinae and Satyrinae communities are also diverse and there are well-established populations of locally rare species such as Twin-spot Fritillary (*Brenthis hecate*). The counts are carried out by Mati Morales.

Planes de Son (Pallars Sobirà, 1540 m). This itinerary runs around the Planes de Son Interpretation Centre in a typically Pyrenean environment dominated by grasslands – including Bromion-rich hay meadows and pastureland and damp grasslands – with subalpine forest in a few sections. The counts in the area began a few years ago but due to the complexity and diversity of the butterfly communities present the time needed for the counters to learn all the species was extended. This walk is extraordinarily interesting in a CBMS context given that subalpine environments have traditionally been lacking in the network. The subalpine meadows at Planes de Son are well-preserved and are host to populations of singular species such as Lesser Marbled (*Brenthis ino*), Pearl-bordered (*Boloria euphrosyne*) and Small Pearl-bordered (*B. selene*) Fritillaries, Amanda's Blue (*Polyommatus amanda*) and Bright-eyed Ringlet (*Erebia oeme*). The counts, the work of Francesc Rodríguez and Montse Ballbé, have also detected some of the classic Pyrenean species such as Apollo (*Parnassius apollo*) and Small Tortoiseshell (*Aglais urticae*), among others.

Castellbell Meander (Bages, 150 m). This station is situated in a meander of the river Llobregat in a typically Mediterranean environment that includes a certain amount of agricultural land. A fairly diverse butterfly community flies here that is totally dominated by Mediterranean species such as Southern (*Pyronia cecilia*) and Spanish (*P. bathseba*) Gatekeepers, Dusky Heath (*Coenonympha dorus*) and False Ilex Hairstreak (*Satyrium esculi*). As well, there are good populations of well-known species that include Marsh Fritillary (*Euphydryas aurinia*) and Provence Chalkhill Blue (*Polyommatus hispana*), without forgetting somewhat more locally distributed species such as Escher's Blue (*Polyommatus escheri*), Dingy Skipper (*Erynnis tages*) and Berger's Clouded Yellow (*Colias alfacariensis*). Gerard Farré is in charge of the counts.

Compared to 2010, the number of stations fell in 2011 but the total number was still over 60 and was one of the best years since the CBMS began. In 2011 counts were discontinued at seven stations: Vallgrassa, Punta de la Móra, Granja d'Escarp, Aiguabarreig, Gerri de la Sal, Les Alberes-1 and Les Alberes-2. The station at Vallgrassa alternates annually with those of Olesa de Bonesvalls and Olivella. In the other six cases those in charge of the counts were unable to continue, a loss that could be merely temporary at La Granja d'Escarp, Aiguabarreig and Gerri de la Sal. Even so, the loss of these three itineraries is a blow since the first two represent an extreme habitat that is under-represented in the CBMS network (arid western Catalonia), while the latter at Gerri is the most diverse of all CBMS stations and provides data for a vast range of species. On the other hand, counts were restarted at Olivella and Pineda, in the latter case by the rangers of the Montnegre-Corredor Park, which should guarantee their continuity.

Habitats represented

The main environments and plant communities represented in the 2011 counts are detailed in Table 1. In all, 75% of the itineraries are located in Mediterranean areas with an important presence of holm oak woodland (55% of itineraries). Counts in upland montane habitats continue at around 20% of all itineraries and, with the incorporation of the

Planes de Son, subalpine habitats now appear in 6% of the counts.

Species present

The list of butterflies detected in 2011 and in previous years can be found in Table 2. In all, 159 species were detected in 2011, four fewer than in the previous year but 19.1 more than the average for the period 1994–2010 (fig. 3). In 2011 no new species for the CBMS network were detected, although Mountain Clouded Yellow (*Colias phicomone*), Gavarnie (*Erebia gorgone*) and Lefèbvre's (*E. lefebvrei*) Ringlets (three true Pyrenean species) and Spanish Marbled White (*Melanargia ines*) (typical of western Catalonia), all absent from the counts in 2010 and general poorly represented in the network, were all refound.

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

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Fig. 1. Geographical situation of all the stations that have ever participated in the CBMS network (1994-2011), 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 (1994–2011).

Fig. 3. The number of species detected annually in the CBMS network (1994–2011).

Table 1. Habitats and plant communities represented in the CBMS in 2011, 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 the CBMS network over the last 10 years (2002–2011). The number of stations at which a species has been recorded is indicated (out of a possible total of 41 in 2002, 46 in 2003, 51 in 2004, 52 in 2005, 64 in 2006, 70 in 2007 and 2008, 66 in 2009, 69 in 2010 and 67 in 2011). Taxonomy as per reference 2.

Photo 1. The itinerary at Llobera, in an open dry oak forest with sub-Mediterranean grassland, generates data that are very representative of the butterfly fauna of the Lleida pre-Pyrenees. A highly diverse group of butterflies fly here, that include noteworthy species such as Twin-spot (*Brenthis hecate*), High Brown (*Argynnis adippe*), Lesser Spotted (*Melitaea trivia*) Fritillaries, Marbled Skipper (*Carcharodus lavatherae*) and many 'blues' (photo: J. Jubany).

Photo 2. Despite being widespread in the Pyrenees, outside of this area Amanda's Blue *Polyommatus amandus* is only found in isolated sites in the pre-Pyrenees, mountains of the Serralada Transversal, El Montseny and some of the highest mountains in the province of Tarragona. The Llobera station has a well-established population that is of great biogeographical interest (photo: J. M. Sesma).

Photo 3. Spanish Marbled White (*Melanargia ines*) is a typical Mediterranean butterfly that flies in North Africa and the Iberian Peninsula. Although it can be abundant in southern Spain, in Catalonia it is rather rare and only found in semi-steppe environments in the west of the country. In the CBMS network it is present in small numbers at the stations of Sebes and Timoneda d'Alfés. Adults fly in April and the beginning of May in grassland with feather grasses (*Stipa* spp.), their caterpillars' food plants (photo: J.M. Sesma).

Eighteenth year of CBMS
Balance of 2011 season

In terms of abundances, the 2011 season was similar to the previous year and the tendency of the last five years for low population levels in many species continued. This situation is exemplified by many of the Satyrinae that appear in the counts, whose numbers continue to fall, and in 2011 species such as Spanish (*Pyronia bathseba*) and Southern (*Pyronia cecilia*) Gatekeepers and Grayling (*Hipparchia semele*) reached their lowest registers since the CBMS counts began. An exception to this rule are the species that hibernate as adults, which in general increased in number. This fact, coupled with the positive trends the past two decades for many of these species, explains the highest-ever CBMS counts in 2011 for Peacock (*Inachis io*) and Nettle-tree Butterfly (*Libythea celtis*). For the second year in a row, counts of migrant species were very low.

Weather and counts

The year 2011 was hot throughout most of the country and average annual temperatures were slightly above or just below the averages for 2009, 2006 and 2003, to date the warmest years on record in Catalonia (see www.meteocat.com). Nevertheless, rainfall was very irregular: 2011 was wet in most of eastern Catalonia (above all along the central coastline and the mountains of El Montseny, Les Guilleries, El Collsacabra and the eastern Pyrenees) but dry in the western half (above all in the upper valley of the river Segre, the Tremp Basin, the Lleida Plains and the Ebro Delta). The previous autumn was generally cold, wet at the beginning but much drier at the end. Winter was characterized by normal or slightly warmer-than-average temperatures (e.g. February), but was dry or very dry in much of Catalonia (with rainfall 90% below climatic averages). The beginning of the CBMS season coincided with one of the hottest springs of the past decade, above all April, month in which new temperature records were set for many Catalan weather stations. Yet spring was also wet (above all, March) everywhere except along the northern coast and in the north-west of the country, which was generally dry. There was a respite from these high or very high temperatures during most of the summer: no heat waves occurred and July 2011 was the coldest in Catalonia since 1997. In the north-east summer was wet, a situation that was reversed in the second half of the year, which was marked by a long dry period from August to October and a warm dry month of September.

Overall, during the 2011 season only 3.8 weekly counts were lost per station, practically the same as in 2010. This figure enables us to calculate reliable annual indices for all species for the vast majority of stations. In fact, 87% of itineraries lost six or fewer counts and in only two cases were more than 10 weeks lost (fig. 1a). The most difficult periods for the counts were in spring (second week of March and third of April) and, surprisingly, in summer (beginning of June and end of July) during countrywide wet spells (fig. 1b).

Changes in abundances: tendencies

Although the number of both species and individuals in 2011 fell slightly compared to 2010, these differences were not statistically significant. The species richness (mean and standard deviation calculated for the 61 stations with comparable data) were 48.0 ± 18.5 species in 2010 and 47.3 ± 17.8 species in 2011 (Student Test for paired samples, t = 1.17, P = 0.25). For the abundance, the values were 2249.2 ± 2097.2 individuals in 2010 and 2045.4 ± 1493.5 in 2011 (t = 1.55, P = 0.25). The declines in many species are reflected in a lower position for the 2011 season in the historical rankings that are calculated using the annual indices of the 66 commonest species (fig. 2). This graph shows a considerable decline in numbers in many species of Catalan butterflies from 2007 onwards and, indeed, the last five years (2007–2011) of the CBMS were the worst of any years of the whole data series. This negative tendency is undoubtedly closely related to the severe droughts in 2006 and 2008. As been noted recently, in certain Iberian forest ecosystems, extreme droughts not only seriously affect the physiological state of trees but also have a knock-on effect on higher trophic levels such as the herbivorous insects that depend on them. Furthermore, these effects may last for many years[2]. Unfortunately, the slight recovery in counts that was intuited in 2010 did not continue in 2011, which was the third worse season since counts began in 1994.

Changes in abundance: population fluctuations

Apart from Camberwell Beauty (*Nymphalis antiopa*) and Large Tortoiseshell (*N. polychloros*), whose numbers dropped slightly, the 2011 season was particularly favourable for species that winter as adults. The other hibernating species such as the Nettle-tree Butterfly (*Libythea celtis*) and Peacock (*Inachis io*) reached by far their highest ever levels since the beginning of the CBMS (Table 1). The fluctuations in the numbers of Nettle-tree Butterfly in Catalonia are truly spectacular since its increase has been not only continuous but also widespread over much of Catalonia. The increase in the two *Gonepteryx* species, Cleopatra (*Gonepteryx cleopatra*) and Brimstone (*G. rhamni*), has also been notable, both reaching in 2011 their second highest figure for the whole data set. Even a species such as the Small Tortoiseshell (*Aglais urticae*), whose overall tendency was negative, increased markedly in 2011. As well, 2011 was also a favourable year for common 'whites' (Pieridae) such as the Large (*Pieris brassicae*), Small (*P. rapae*) and Green-veined (*P. napi*) Whites, above all in the former (Table 2).

Nevertheless, the majority of Satyrinae and two fairly common skippers, Small (*Thymelicus sylvestris*) and Lulworth (*T. acteon*) Skippers, all of which feed on various species of grass, suffered severe declines in 2011. Spanish Gatekeeper (Table 1) (*Pyronia bathseba*) and Grayling (*Hipparchia semele*) reached their lowest ever totals since the beginning of the CBMS. Other species such as Southern Gatekeeper (*Pyronia cecilia*), Dusky (*Coenonympha dorus*) and Pearly (*C. arcania*) Heaths and Western Marbled White (*Melanargia occitanica*) declined to a lesser extent, even though their general tendency in recent years is clearly negative and in 2011 their populations continued to fall. Although a more rigorous analysis still has to be conducted, it would seem that these falls in numbers mainly affect univoltine early-flying Satyrinae. Another group of species that declined conspicuously in 2011 were the polyvoltine Lycaenidae such as Common Blue (*Polyommatus icarus*), Spanish Brown Argus (*Aricia cramera*) and Small Copper (*Lycaena phlaeas*), all of which reached their second lowest ever totals for the CBMS period.

The year 2011 was not a good year for migratory species, which in general declined. For instance, for the second consecutive year since the great Painted Lady year of 2009, this species was rare in Catalonia. The three other well-known migrants in Catalonia, Red Admiral (*Vanessa atalanta*), Clouded Yellow (*Colias crocea*) and Bath White (*Pontia daplidice*) were all fairly scarce as the fact that all three reached their second worst ever CBMS totals demonstrates. Although a few migrant Plain Tigers (*Danaus chrysippus*) did reach L'Illa de Buda in the Ebro Delta at the end of July, the species did not appear at any BMS station, unlike the two previous years – above all 2009 – in which it was observed at six CBMS stations. As exceptions to this general rule for migrants it is worth mentioning the cases of Long-tailed (*Lampides boeticus*) and Lang's Short-tailed (*Leptotes pirithous*) Blues, which increased notably in number in 2011 (above all the latter). This increase could be due in part to the recovery of local populations that survived the mild winter rather than the result of the arrival of large numbers of migrant individuals.

Finally, despite the warm and favourable spring weather, it is worth highlighting the lack of change in many of the typical spring species such as Orange-tip (*Anthocharis cardamines*), Moroccan Orange-tip (*A. euphenoides*), Green (*Callophrys rubi*) and Provence (*Tomares ballus*) Hairstreaks, Panoptes Blue (*Pseudophilotes panoptes*) and Spanish Festoon (*Zerynthia rumina*).

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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 2011 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 1995, closely followed by 2002, and the worst 2008. Calculations were carried out using the methodology described in reference 1; annual indexes were calculated with the TRIM programme.

Table 1. Evolution of the annual indexes for the 66 commonest butterflies in the CBMS network (2002–2011), based on an arbitrary value of 1 for 1994. Annual indexes were calculated with the TRIM programme.

Table 2. Sum of the annual indexes and ranking of the abundance of the 20 commonest species from the 2011 CBMS season compared to the corresponding figures from the 2010 season.

Drawing 1. Peacock *Inachis io* has increased notably in the last two decades, and in 2011 it attained its highest ever levels since the beginning of the CBMS. Adults come out from hibernation at the end of winter or very early in the spring, this species being one of the first recorded in the season's counts. Larval nests on nettles are also very easy to detect along many transects, both in the spring and summer (drawing: M. Miró).

Drawing 2. Spanish Gatekeeper *Pyronia bathseba* is one of the commonest butterflies in Catalonia. In the CBMS is only absent from sites in the Pyrenees, along the sea-coast and in Minorca and Eivissa, in the Balearic Islands. Althought is normally one of the most abundant butterflies in open Mediterranean scrub, the last years have seen a strong decline of its populations due to the negative effect of drought (drawing: M. Miró).

Habitat management and conservation

Indicators of climate change in Catalan butterflies

This article discusses the climate change indicators that are being developed using data from the CBMS network. The Community Temperature Index (CTI) has been used to analyse in conjunction data from both bird and butterfly monitoring programmes, and has detected the existence of a so-called 'climatic debt'. Nevertheless, given that it does not include data on water availability, this index behaves abnormally in Catalonia. A second indicator taking into account this factor would thus seem to be a more appropriate way of understanding the effects of climate change in the Mediterranean.

In recent years the generation of indicators that can evaluate and quantify changes in natural systems has increased spectacularly. In many cases, these indicators are calculated using data on population trends in bioindicator species that are generated by biodiversity monitoring programmes. The data obtained from the various different European BMS networks, for example, have been used to calculate a European Butterfly Indicator for Grassland species, which is now used by the European Environment Agency as one of its reference indices for trends in biodiversity in the European Union[1,2].This indicator, along with its equivalent based on bird monitoring programmes[3], reveals how changes in land use (principally, due to the abandoning of traditional agricultural and stock raising methods, and agricultural intensification) are affecting negatively biodiversity at a European scale. Thus, the alarm has been raised regarding the need to adopt new strategies in environmental policies in the European Union that will help reverse this trend[3].

Aside from changes in land use, within the scientific community a broad consensus exists to the effect that climatic change is the other principal motor of global change affecting biodiversity. Changes in the distribution and phenology of many species have been well documented in recent years[4,5] and Catalan butterflies are no exception[6,7]. Such changes can lead to asynchrony of different elements of an ecosystem and cause species' populations to decline, as has been shown by a number of different studies[8,9]. The importance of this phenomenon in natural systems has motivated in recent years the establishment of indicators of climate change. In this article we describe two such indicators and discuss the results obtained from the CBMS data.

The Community Temperature Index and climatic debt

As commented above, the increase in temperatures that many species are experiencing as a result of global warming is obliging many species to shift their ranges northwards in an attempt to maintain optimum conditions *vis-à-vis* environmental temperatures. Presumably, these distribution changes will lead to changes at local scale in community structures, which will progressively become dominated by species that are better adapted to higher temperatures. A few years ago, Devictor and his team developed a method for testing this hypothesis and for quantifying changes in bird communities as a response to global warming[10].

They used data from long-monitoring programmes whose predictions were tested initially on French bird communities. It is based on the idea that both individual species and communities in a certain location can be characterized by means of a temperature index. The **specific temperature index** (STI) is calculated using data from the distribution of the species in question, that is, the average temperature of the area in which the species is present. For instance, in the case of European butterflies, the STI for typically Mediterranean species such as Two-tailed Pasha (*Charaxes jasius*) (STI = 14.77ºC), Chapman's Green Hairstreak (*Callophrys avis*) (STI = 14.57ºC) and Southern Gatekeeper (*Pyronia cecilia*) (STI = 14.06ºC) are much higher than those of species such as Silvery Argus (*Aricia nicias*) (STI = 4.14ºC), Mountain Clouded Yellow (*Colias phicomone*) (STI = 6,76ºC) and Pearl-bordered Hairstreak (*Boloria euphrosyne*) (STI = 6,95ºC) that have more boreal distributions. In a second phase, the temperature indices for the species at a specific locality (for example, a CBMS station) are used to calculate an average temperature for the community, weighted according to the contribution of each species in terms of its abundance. The result is the **community temperature index** (CTI), a simple way of measuring the rate of change in community composition in response to global warming that has been adopted as an indicator of climate change by the European Union[3].

Recently, this methodology has been used simultaneously with the vast databases generated by European bird and butterfly monitoring programmes to examine the consequences of global warming on these two bioindicator groups. Data from 9,490 and 2,130 bird and butterfly monitoring stations, respectively, have been analysed from Finland, Sweden, the United Kingdom, the Netherlands, the Czech Republic, France and Catalonia. The results we discuss here are the fruit of this collective work[11].

As was to be expected, the CTI varies at spatial level in both birds and butterflies, with lower values (that is, with a predominance of species with lower STIs) at higher latitudes (fig. 1a,b). This relationship is linear and highly significant in both groups: similar losses of 1.47 ± 0.08 x 10^{-3} ºC and 1.26 ± 0.01 x 10^{-3} ºC are observed in butterfly and bird communities, respectively, for every kilometre further north we go (fig. 1a,b).

Nevertheless, in the same way that the CTI varies spatially, variation also occurs over time as a result of climate change. As temperatures increase, the CTI at a site should also increase because the number of species that require higher temperatures will also rise. The data accumulated during two decades of European monitoring programmes (1990–2008) confirm this hypothesis: there has been an unmistakeable increase in the CTI of both butterfly and bird communities that mirrors temperature increases, once again with highly significant linear relationships: 9.3 ± 0.5 x 10^{-3} ºC per year for butterflies and 2.6 ± 0.19 x 10^{-3} ºC per year for birds (fig. 2a,b). During this period, the overall temperature in Europe has increased significantly in a linear sense by 5.50 ± 0.61 x 10^{-2} ºC per year (fig. 2c).

Using the spatial gradients shown in figure 1, it is possible to transform these trends in temperatures over time into spatial tendencies. For temperatures, the increases recorded in the period 1990–2008 are the equivalent to a northwards movement of 249 ± 27 km, whilst the increases in the CTI are the equivalent of northwards movements of 114 ± 9 km for butterflies and 37 ± 3 km for birds. The difference between the movement of the temperatures and of the CTI is known as the **climatic debt**: even if both bird and butterfly populations respond as predicted, their rhythm of change is not sufficient to keep up with the temperature change and these animals thus begin to accumulate a growing 'debt' in relation to their optimum temperatures. Currently, this debt stands at 135 km and 212 km for butterflies and birds, respectively. The existence of this climatic debt will presumably make animal populations more vulnerable to perturbation of all types. Furthermore, these two indicator groups are not responding to climate change at the same speed, which could lead to loss of synchrony in predator-prey interactions between butterfly and bird populations.

The Mediterranean paradox and a new climate change indicator

The results that we mention here are applicable at a European scale. Yet, if we look at the results for each country individually a surprise is in store: the pattern that we have identified fits central and northern European countries well, but not Catalonia (fig. 3). Here, the linear relationship is not significant for either birds or butterflies and, furthermore, in the latter group there is even a negative gradient that would seem to suggest that there is a slight tendency for communities to 'cool down', that is, to be increasingly dominated by species with lower STIs. This result has been confirmed by an analysis of the CBMS stations with the longest annual series[12].

This apparent paradox can be resolved in large part by using a new climate change indicator that takes into account not only temperature but also other climatic variables such as water availability. This new indicator, initially developed using European bird monitoring data[13], calculates the divergence in population trends between (a) species that should benefit from and (b) species that should be negatively affected by climate change according to the predictions of the so-called 'climate envelope' models. A positive tendency in the indicator means that the populations of the species benefitting from climate change – the 'winner' species – will have increased over time more than those of the 'loser' species. The climate envelope models explain the current distribution of species on the basis of a combination of just a few variables that define the principal abiotic limitations that organisms have to confront (e.g. minimum winter temperatures, available energy during the growing season and water availability), and project future distributions bearing in mind the values for these variables projected under general circulation climatic models (GCM).

When the climatic indicator of Gregory *et al.* (2009) is calculated for Catalan bird populations using the SOCC dataset, a significant increase in the period 2002–2011 occurs that confirms the expected response of Catalan bird communities to climatic change. If the same procedure is applied to the CBMS dataset, using the predictions of changes in distribution provided by the climatic risk atlas of European butterflies[14], a significant increase in the indicator for the period 1994–2011 also becomes apparent (fig. 4).

In contrast to the CTI, this new indicator matches predictions under a scenario of climate change. We believe that this difference is due to the fact that the models used by this second indicator to predict trends in species take into account both temperature and precipitation. The combination of these two variables reflects water availability (or degree of aridity), which is the key to understanding how Mediterranean ecosystems work. Thus, temperature acts as a limiting factor for many taxonomic groups (including butterflies) in ecosystems at higher latitudes in more northerly areas of Europe, whereas in Mediterranean systems aridity is the principal limiting factor[15].

All climate change models agree that recurring droughts and heat-waves in the Mediterranean will have an increasingly greater impact[16]. Climate envelope models that take into account water availability to explain the distribution of European butterflies predict that the species with the highest STIs, that is, the most typical Mediterranean species, will have their distribution areas reduced most of all. This prediction theoretically leads to a fall in the CTIs in the areas in which these Mediterranean species dominate and, at the same time, an increase in the climate indicator of Gregory *et al.* (2009). Both predictions are confirmed by the data from the CBMS network.

Amongst the challenges facing us in the near future is that of understanding how climate change and changes in land use combine to produce a generalized fall in butterfly numbers in Catalonia. Once this conundrum is solved, we must then design efficient proposals to minimize as much as possible this loss of diversity that we are already beginning to suffer.

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Fig. 1. Spatial tendencies in the CTI of butterflies and birds in Europe. Each point corresponds to a monitoring station in the year 2005. The temperature is the average in Europe in March–September in 2005. The X-axis indicates the distance of sites from the extreme south of Catalonia.

Fig. 2. Trends over time of the CTI of bird and butterfly communities and of European temperatures in the period 1990–2008. The temperature anomalies have been calculated using differences from the 1961–1990 average (according to ref. 11).

Fig. 3. Trends in the CTI of the bird and butterfly communities in the different countries used in the study. In all cases except for Catalonia tendencies are significantly positive.

Fig. 4. Climate change indicator for Catalan butterfly populations calculated using the method of Gregory *et al.* (2009). Thin continuous line: trends in species that, according to climate envelope models, will increase their distribution area; dashed line: species whose ranges will shrink; thick line: Climate Change Indicator calculated as the ratio between the two previous groups. The trend of the indicator is significantly positive for the period 1994–2011.

Photo 1. The Provençal Short-tailed Blue *Cupido alcetas* lives in scrub and grassland in the northern half of Catalonia, with its densest populations found in La Garrotxa. Climate envelope models predict that its area of distribution will expand under a scenario of climate change, a possibility that could be heightened by this species' known ability to disperse. In fact, the Provençal Short-tailed Blue is one of the few species that has become commoner in Catalonia in recent years and, in doing so, has confirmed the predictions of climate models (photo: J. Jubany).

The CBMS at Alzinar de Sant Martí (Sallent, El Bages)

Located in a lowland Mediterranean area on calcareous soils, this butterfly walk, active since 2000, runs through a growing holm oak forest (*alzinar*) and areas of mixed scrub. It is a very diverse area and to date 86 species have been recorded. The population of Striped Grayling *Hipparchia fidia* is the densest in the whole of the CBMS network and other Satyrinae species such as Dusky Heath *Coenonympha dorus* and Wall Brown *Lasiommata megera* are also very abundant. Of the rarer species, it is worth noting the presence of Spanish Fritillary *Euphydryas desfontainii* and Sage Skipper *Muschampia proto*. Although the diversity of species seems to have increased slightly in recent years, overall the abundance of the commonest species has fallen.

The transect

The butterflies counts at Alzinar de Sant Martí near the town of Sallent began in 2000 and were the first to be carried out in the *comarca* of Bages. Today, however, along the valley of the river Llobregat there are a good number of stations. The area chosen for the walk consists of a broad plateau lying at 520 m a.s.l. where arable land and woodland alternate with the scrub that has developed in areas of abandoned agricultural land and areas burnt by the 1986 forest fire. Nevertheless, this fire left some areas of the characteristic holm oak forest intact and today this forest is well established and in expansion despite the relatively small surface area that it covers.

The walk passes through three main types of habitat: open scrub (sections 1 and 4) with the grasses *Brachypodium phoenicoides* and *B. retusum* and blue aphyllanthes (*Aphyllanthes monspeliensis*); woodland in sections 2, 3, 5 and 7, with both evergreen holm oak and Aleppo pine (*Pinus halepensis*) and deciduous mixed woodland; and the scrub in section 6, rich in Mediterranean species. Some of the most important plant species for butterflies either as food plants or nectar sources that are common along the walk include *Dorycnium pentaphyllum*, bramble (*Rubus ulmifolius*), sloe (*Prunus spinosa*), hawthorn (*Crataegus monogyna*), Mediterranean buckthorn (*Rhamnus alaternus*), wild privet (*Ligustrum vulgare*), strawberry-tree (*Arbutus unedo*), Etruscan honeysuckle (*Lonicera etrusca*), horseshoe vetch (*Hippocrepis comosa*), *Cephalaria leucantha*, a sainfoin *Onobrychis supina* and Montpellier milk-vetch (*Astragalus monspessulanus*).

The butterflies

In all, 86 species of butterfly have been detected along the walk. The annual average is almost 64 species, with a minimum of 59 in 2006 and a maximum of 69 in 2009. Of the 10 most abundant species at Sallent (fig. 1), six are among the commonest 20 species in the whole of the CBMS network (as of 2010). The exceptions are Dusky Heath (*Coenonympha dorus*), Striped Grayling (*Hipparchia fidia*), Marsh Fritillary (*Euphydryas aurinia*) and Berger's Clouded Yellow (*Colias alfacariensis*), which all have sizeable populations in this itinerary. The most notable case is that of Striped Grayling, a common and widespread species in lowland Mediterranean areas that at Alzinar de Sant Martí reaches its greatest densities in the whole of the CBMS network. Likewise, the Marsh Fritllary can be highly abundant in certain years and, as in the case of the Striped Grayling, its patterns of annual variation closely follow those occurring elsewhere in Catalonia.

This itinerary has an excellent selection of the large summer Satyrinae species: aside from the Striped Grayling there are also good populations of Woodland (*Hipparchia fagi*), Tree (*Hipparchia statilinus*) and Great Banded (*Brintesia circe*) Graylings, commoner here than in many of the other CBMS stations. Of the abundant CBMS species, here too Wall Brown (*Lasiommata megera*) and, above all, Dusky Heath are common.

This itinerary also boasts a couple of the jewels that are enough to make any entomologist happy. In a woodland clearing in section 2, there are always a number Spanish Festoons (*Zerynthia rumina*) and at the beginning of the season their eye-catching but cryptic coloration is a joy to behold. The other delight is a small population of Glanville Fritillary (*Melitaea cinxia*) whose caterpillars are often easier to detect than the adults. Every year in section 1 we find the dense webs of their larvae on often rather stunted plants of ribwort plantain (*Plantago lanceolata*). Also of note are the Spanish Fritillary (*Euphydryas desfontainii*), a singular species that is found in few CBMS stations and is relatively abundant in the area. Finally, it is worth commenting on the regular presence of Sage Skipper *Muschampia proto*, not only because this skipper is uncommon in the CBMS network but because at Sallent it reaches its most northerly point of its Catalan distribution.

As occurs elsewhere, many of the total of 86 species such as Small Heath (*Coenonympha pamphilus*), Chapman's Green Hairstreak (*Callophrys avis*), *Amanda's Blue* (*Polyommatus amanda*) and White-letter Hairstreak (*Satyrium w-album*) have only ever been detected on a couple of occasions. Nevertheless, given the context of the local butterfly populations, it would be no surprise if species such as Chequered Blue (*Scolitantides orion*) turned up on the butterfly walk. Other species such as Small Heath are common in the area but were only ever counted during the first years of the counts.

Changes in land use and its effects on the butterflies

No important changes have occurred in the land use of the area during the years the butterfly walk has operated: a few tracks have been repaired and cleared, but no animals graze here and the forests are not exploited for their timber. No generalised or intensive efforts had ever been made to clear the undergrowth or the lower branches trees of the forests until the beginning of the 2012 counting season. Without doubt it will be interesting to analyse the changes that may occur as a result in relation to other similar stations as a means of evaluting whether the impact of these type of changes are positive or negative.

Initially, an unusual abundance of Marsh Fritillary was detected in section 2, possibly the result of the clearance work that could have forced butterflies to leave section 6 and head elsewhere. On the other hand, in 2012 for the first time in 13 years no Spanish Festoons were counted, although, fortunately, the species' foodplant, *Aristolochia pistolochia*, were found to be playing host as per usual to the caterpillars of this species.

The overall data from the 13 years of butterfly counts reveal that the diversity of the area has increased whilst abundances have dropped notably. A section-by-section study of the data in terms of both absolute and relative abundance and species richness show that the most wooded sections and sections with scrub on dry stoney soil have remained stable (sections 3, 4 and 5) over time, although their overall production is relatively low. Sections on which the forest grows more in height than in density (which was already there) have clearly suffered over the years (section 2), whilst, finally, in sections with scattered trees on more humid soils the tendencies are more encouraging (very positive in section 1, less so in section 6).

The Alzinar de Sant Martí station in relation to other butterfly studies

My interest in butterflies and desire to learn more about the biology of this group of insects has led me to more detailed field studies of the itinerary at Alzinar de Sant Martí and in neighbouring areas (e.g. El Guix, nearer the town of Sallent). I worked for many years on a study of the parasitism of the two *Euphydryas* species that fly in the area, for which I collected and bred hundreds of larvae to see which species of parasitoids would emerge. The results were spectacular and revealed the enormous amount of unseen life there is behind the world of the butterflies[1]. As well, in autumn-winter of 2001/02 I monitored meticulously around 150 larvae of the Two-tailed Pasha *Charaxes jasius* in a study of the causes of mortality in this species. The data from the CBMS network enabled us to show that extremely cold winter weather has a severe negative impact on this species [2].

Josep Planes

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Aerial photo. The CBMS transect at Alzinar de Sant Martí. Its total al length is 1676 m, and there are seven sections with an average length of 239 m (range: 106-388 m).

Fig. 1. Average abundance (average of the annual indexes during the period 2000–2012) of the 15 the commonest butterflies at the Alzinar de Sant Martí station.

News

Proposal for common names for Catalan butterflies

If you flick through some of the back numbers of the journal *Cynthia* you will see that the articles it contains talk of 'blavetes', 'papallona de l'arboç' or 'papallona del lledoner'. These are the common vernacular names that are used by many butterfly watchers and counters, as well as by other amateur naturalists from other fields. Interest in butterflies as a group has grown in recent years, as the number of CBMS counters testifies. More and more books on wildlife – including butterflies – are being published and natural history-related subjects have become commonplace in the mass media in recent years. For example, field guides, guides to protected areas and local wildlife walks providing information on local flora and fauna have proliferated and an interest in local natural history has become a popular past-time and is no longer seen as the sole preserve of scientists or of impassioned amateurs.

Thus, knowledge of the common names of our animals and plants will become not only important but necessary, and will complement – and in some cases, even substitute – the use of scientific names. This is almost the case already for vertebrates, and in other languages such as English an established body of common names for most species has existed for many years[1].

This situation has led to the need for a body of common names in Catalan to be developed for our butterflies. A group of experts from the Granollers Natural History Museum and the Catalan Lepidopterological Society has started the ball rolling by drafting a list of proposed common names for our butterflies, which it is hoped will be accepted by those who have an interest in using them. The adjoining list contains proposals for all the butterflies found in Catalonia and those wishing to learn more about how these names were chosen should consult the original article in which these names were presented[2].

A number of different criteria were used to establish the list of names. Initially, the few existing traditional names, mainly collated by Vilarrúbia[3], were all accepted. Wherever possible the new names were adapted to the classical binomial nomenclature used by Linnaeus such that species in the same genus have the same basic name, subsequently qualified to identify each species. In some cases, though, a single name was considered to be sufficient. The catalanization of the common names used in other European languages or even of the scientific names was another of the methods employed. Other criteria used include references to obvious morphological features of the species or its choice of food plant. A further set of names includes allusions to the species' choice of habitat or certain characteristic behaviour.

We hope that this list of names will help increase knowledge of and respect for our butterflies.

Francesc Vallhonrat

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The butterfly

The Glanville Fritillary *Melitaea cinxia*, a model for the study of metapopulation theory

Over the past two decades, the Glanville Fritillary *Melitaea cinxia* has become one of the most studied of all animals in the field of ecology. This butterfly lives in metapopulations, that is, in populations interconnected by the dispersion of adults. In Catalonia it is relatively common in open areas with plantains in uplands, above all in the northern half of the country. In spring, its eye-catching caterpillars – black with white-spots, and red feet and heads – are easily observed as they feed on plantains.

Geographical distribution and situation in the CBMS

The Glanville Fritillary lives over much of Europe, North Africa (Atlas Mountains in Morocco to Algeria), Russia and western Asia as far as the Amur region[1]. It is relatively common in the northern third of the Iberian Peninsula in a more or less continuous area running from the Pyrenees to the Cantabrian Mountains (including northern Portugal) and the mountains of the Sistema Ibèric, as well as in isolated lowland areas. In the centre of the Peninsula it flies above all in upland areas (mountains of the Sistema Central, Serra de Guadalupe and Serrania de Cuenca) but becomes much scarcer in the south where it is confined to the eastern ranges of Cazorla, Espuña, Sagra and Alfacar[2].

It is widespread in the CBMS network and appears in almost half of the stations, an accurate reflection of its distribution in Catalonia (fig. 1). It is found above all in the northern half of the country and is common in the Pyrenees (including Andorra), pre-Pyrenees and the mountains of the Serralada Transversal, Montseny and Sant Llorenç del Munt. It is much rarer and somewhat local in the Empordà and Girona plains and the northern part of the coastal mountains (Les Gavarres and El Montnegre). It becomes a rare species further south where local populations are only known from La Mola de Colldejou (Baix Camp) and the mountains of Prades and Els Ports de Tortosa-Beseït (although it has not yet appeared in the counts from the latter area). Of great interest are the occasional records from the CBMS stations at Granja d'Escarp and Sebes, two stations in arid areas that would seem to be unsuitable for the species. Nevertheless, relict populations of this fritillary must survive in these areas of south-western Catalonia.

In Catalonia this species has an extensive altitudinal distribution that ranges from sea-level (occasional records from the Aiguamolls de l'Empordà) to subalpine and even alpine habitats in Andorra, from where it has been recorded in the Sorteny and Pessons itineraries. Good population densities with annual indices of 20–50 occur in montane areas (e.g. in El Montseny at 700–1,110 m a.s.l.; fig. 2a), but also in lowland areas (e.g. Alta Garrotxa below 300 m a.s.l., fig. 2b) and high mountain areas (e.g. Sant Maurici at 1,600 m a.s.l.). Nevertheless, in almost a third of the stations in which the species has been detected its densities are extremely low (annual indices below 1) and very possibly these individuals correspond to butterflies in dispersion from nearby populations.

Habitats and food plants

The Glanville Fritillary lives in open areas, above all in grasslands with short swards and xeric in character, but also in more ruderal habitats (along tracks and paths) wherever there is an abundance of its main food plant, ribwort plantain *Plantago lanceolata*. As such it is totally absent from areas of intensive arable land and thick forests. It is thus a specialist species that has been greatly affected by both the abandoning of extensive grazing (which allows habitats to be invaded by scrub) and by the intensification of agricultural practices.

Although in other parts of Europe the caterpillars of this fritillary feed on both plantains and plants such as spiked speedwell *Veronica spicata*[3], in Catalonia it would seem to be completely associated with the former[4].

Biological cycle and phenology

The Glanville Fritillary is a typical univoltine species whose larvae hibernate during their fourth instar. Its flight period lasts from April to July, although, exceptionally, its populations are bivoltine and the first generation in April-May is followed by a second in July-August in the areas of L'Alta Garrotxa and Alt Empordà. This behaviour, possibly genetic in origin[5], is very localized and is well-documented from the CBMS stations at Sales de Llierca, Darnius and Els Aiguamolls de l'Empordà. Figure 3 shows the flight curves from various stations in the CBMS network with differing environmental conditions. In El Montseny and the mountains of La Serralada Transversal the first individuals appear in April, numbers peak in May-June and the generation lasts until the beginning of summer (fig. 3a). In upland areas of the Pyrenees, emergence takes place almost a month later but henceforth the flight curve is more synchronized. Maximum numbers are seen at the beginning of June and by the second half of July few are still on the wing (fig. 3b). Figure 3c shows the bivoltine phenology at the stations of Darnius and Sales de Llierca: the first generation flies earlier than in other localities and is concentrated in the second half of April and the first half of May, while the second is much poorer in numbers and may in fact only be partial. The first butterflies of this second generation appear in July and numbers peak in July–August. After that, numbers fall very quickly and only a very few are ever seen in September. At L'Estany de Sils (in what appears to be an isolated population), although the first butterflies appear likewise very early in the year, there is no second generation, possibly because the environmental conditions are unfavourable at such low altitude due to the summer drought.

This species has been studied to an extraordinary degree in recent decades owing to its role as a model species in the development of metapopulation theory (fig. 4)[6,7]. Thus, we have an unmatched knowledge of its biology. As in other Melitaeini species, eggs are laid in dense batches (between 25 and 250 at a time) on the underside of the leaves of its food plant. It has been calculated that a female can lay up to seven egg-batches during her life time, with progressively fewer eggs each time[8]. Eggs are laid preferably on small plantains in hot microclimates, often in areas of bare ground. Females also tend to select plants with high concentrations of iridoids, a secondary metabolite in the plantain that accelerates the development of the larvae and reduces the impact of its specific parasitoid *Cotesia melitaearum*[9,10]. Caterpillars hatch within 2–4 weeks and immediately build a silken web on the food plant. Once they have moulted out of their fourth instar (mid-summer), the caterpillars enter into diapause and hibernation, which will last the whole winter, in a denser web spun at the base of the host plant. Although they are hard to detect in Catalonia, these winter webs are much more visible in northern Europe and are often used in population surveys. In March–April the larvae finish hibernating (photo b), abandon their winter webs and enter a solitary phase. They are easily seen when warming themselves on dried up vegetation (photo c). Due to their dark colour they are able to increase their body heat substantially and thus speed up their growth rates. Once the sixth instar is complete, the caterpillar pupates. The chrysalis remains hidden suspended in the vegetation (photo d) for around 1–3 weeks until the adult butterfly finally hatches.

When searching for mates, males combine patrolling and territorial behaviour. As in the other Melitaeini species there is a certain degree of proterandry (males emerge before females), which is explained by the shorter development time in the post-hibernation larvae that become males[8]. In general, females only copulate once, just after emerging, although on occasions females with two spermatophores that must have mated twice are found.

Metapopulational structure

The Glanville Fritillary is a paradigm of a species that lives in a metapopulation. Its distribution over space is not uniform but rather is fragmented into populations that occupy well-defined patches of favourable habitat (in this cases, grassland with plantains). These populations exchange individuals via dispersal processes and the set of these interconnected populations is known as a metapopulation[6]. Populations may be somewhat unstable and may often die out due to various causes. Nevertheless, population extinctions are compensated for by the establishment of new populations in unoccupied patches by individuals dispersing from other populations. The fraction of the habitat patches that are occupied by a metapopulation depends above all on the size of the patches and the distance between them. As a rule, the larger the patch, the less likely it is that the population that occupies it will die out; and the smaller the distance between patches, the greater the probability that individuals dispersing from another population will compensate for any extinction that may occur. Metapopulation theory has been greatly developed over the past 20 years by Ilkka Hanski and his team on the basis of the Glanville Fritillary populations on the Åland islands in south-east Finland (fig. 4)[11].

The metapopulation model can be generalized to other animals (including many butterfly species) and has very important implications for biodiversity conservation[12]. It has been repeatedly shown that the persistence of metapopulations is threatened when changes in land-use lead to the fragmentation and reduction in the size of habitats. When this occurs, habitat patches shrink and become more isolated, thereby increasing the risk of local extinction[13,14]. Beyond a certain threshold, the number of occupied patches becomes insufficient and the metapopulation structure collapses, thereby causing the complete disappearance of the species in the area where it was once present.

Natural enemies

Parasitoids are especially important natural enemies of the Glanville Fritillary and have been studied in great detail in Finland[15]. The most typical such parasitoids are two specialist icneumonids, *Cotesia melitaearum* and *Hyposoter horticola*, that attack the caterpillars, a variety of generalist chalcididoids that attack the chrysalis (above all, *Pteromalus apum* and *P. puparum*), and various species of secondary parasitoids belonging to the genera *Gelis* and *Mesochorus* that attack the primary specialist parasitoids. The situation seems to be similar in Catalonia, where the two primary specialist parasitoids have been detected[16]. The impact of these parasitoids on Glanville Fritillary populations has been studied on numerous occasions (see reviews in refs 17, 18) and continue to be one of the main lines of research in the metapopulation system on the Åland islands. Of particular interest is the case of *H. horticola*, which parasites the host larvae when they are still in the egg (photo a). To do so, the females of this icneumonid search for the butterfly egg batches, memorize their position and revisit them periodically until the larvae are about to hatch. Normally this icneumonid only parasitizes a third of the eggs in each batch, but nevertheless is still able to locate almost all the egg batches in a population. The result is that this parasitoid kills a more or less fixed proportion – around a third – of the Glanville Fritillary populations[19]. Aside from these parasitoids, certain carnivorous insects feed opportunistically on this fritillary's eggs (e.g. lacewings, ants and ladybirds) and caterpillars (e.g. bugs)[17].

Population trends

Due to its metapopulation structure, the Glanville Fritillary is particularly sensitive to landscape changes, above all if they lead to a reduction in the open areas where populations are located. Given that the loss of these open spaces is one of the main causes of the overall regression in Catalan butterfly populations in recent decades[20], a fall in Glanville Fritillary populations in Catalonia is also to be expected.

CBMS data indicate that numbers in most of the monitored populations fell sharply in the period 1994–2008. Subsequently, the species has recovered somewhat and in 2011 its tendency was classified by the TRIM programme as 'uncertain' (fig. 5). The recovery between 2009 and 2011 could be due to a certain relaxation in density-dependent mortality factors such as parasitization by *Cotesia melitaearum* (which generally only has serious effects when host densities are high)[21]. Nevertheless, this recuperation could also be related to favourable climatic conditions and a series of wet springs and summers could have favoured larval survival just before and after diapause. The importance of this latter factor should not be underestimated in this species given that various studies have shown that species with similar ecologies are seriously affected when the synchronization between larval and food-plant development periods is altered[22]. The fact that most Glanville Fritillary eggs are laid on plantains in hot microclimates, which are thus prone to withering, makes this hypothesis even more plausible.

Come what may, the CBMS data reveal the possibility of a general decline in this species in Catalonia (fig. 5), which would be most evident in isolated populations and in those situated in areas with the most extreme Mediterranean climate. Examples of such threatened populations include those at Sils, those in the mountains in Tarragona and those that are scattered in the western *comarques* of Segrià and Ribera d'Ebre, whose viability may well be put to test in the mid-term under a scenario of climate change and the growing impact of recurring droughts.

Constantí Stefanescu

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[4] The numerous observations of egg-laying on ribwort plantain *Plantago lanceolata*, as well as post-hibernation caterpillars feeding on plantain in various parts of the Pyrenees, mountains of La Serralada Transversal and El Montseny, indicate that this plant is the main food plant for most populations. Nonetheless, a solitary observation of a female egg-laying on spiked speedwell *Veronica spicata* on the Puig itinerary in El Montseny suggests that locally this plant may be used on occasions, as occurs in northern Europe.

[5] In breeding experiments under similar environmental conditions, the bivoltine populations from L'Alta Garrotxa and L'Alt Empordà maintain their marked tendency to produce a second generation in the laboratory. In the other univoltine Catalan populations this phenomenon is highly exceptional (but not unheard of) (M.C Singer, com. pers.).

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Fig. 1. Relative abundance (expressed as the values of the annual index/100 m) of the Glanville Fritillary *Melitaea cinxia* in different CBMS sites (1994–2011).

Fig. 2. Two of the typical habitats of the Glanville Fritillary in Catalonia. (a) Grassland with annual plants in an upland holm oak forest at 750 m a.s.l. on the Santa Susanna itinerary in El Montseny Natural Park, and (b) open habitat, glades and rides within evergreen oak forest, in Sales de Llierca itinerary (photos: a, M. Miralles; b, M. Lockwood).

Fig. 3. Phenology of the Glanville Fritillary in different habitats in Catalonia. (a) Populations in the mountains of El Montseny (itineraries at Santa Susanna, El Puig and Pla de la Calma) and in the mountains of La Serralada Transversal (itinerary at Sant Feliu de Pallerols) at heights of 350–1,100 m a.s.l. (n = 2,079 individuals, 1994–2011); (b) population at Sant Maurici in a subalpine habitat at 1,600 m a.s.l. (n = 342 individuals, 2006–2011); (c) bivoltine populations at Darnius and Sales de Llierca (n = 1,057 individuals, 1994–2011).

Fig. 4. The Glanville Fritillary is one of the best studied butterflies in the world and has been used as a model for the development of metapopulation theory. In the books by I. Hanski and P. R. Ehrlich the results of this ecological research into this species' metapopulation structure, along with other aspects of its life history, are explained in detail.

Fig. 5. Population fluctuations in the Glanville Fritillary in the CBMS network in the period 1994–2011 calculated with the programme TRIM.

Photos. (a) Egg-batch on a ribwort plantain *Plantago lanceolata* being inspected by the icneumonid parasitoid *Hyposoter horticola*; (b) group of caterpillars leaving their winter web in the Pyrenees; in warmer parts of Catalonia the species apparently does not spin such conspicuous winter webs; (c) caterpillar in its sixth and last instar warming itself on a dry leaf; (d) chrysalis; (e, f) adults showing the characteristic black spots on the submarginal band of the hind-wing, visible on both the upper- and under-wings. (photos: a, S. Van Nouhuys; b, J. Piqué; c, e, J.M. Sesma; d, J.R. Salas; f, J. Jubany).

Identification

How to separate the species of the genus *Erebia* (4)

Once we reach the heights of the Pyrenean peaks and ridges, the commonest ringlets (*Erebia* spp.) are usually Mountain (*E. epiphron*), Gavarnie (*E. gorgone*) and, above all, Silky (*E. gorge*) and Lefèbvre's (*E. lefebvrei*) Ringlets. The description of these four species completes the revision of the Catalan ringlets.

Of the species that fly at great altitude, only Mountain (*E. epiphron*), Gavarnie (*E. gorgone*) and Lefèbvre's (*E. lefebvrei*) Ringlets have ever been detected in the CBMS-BMSAnd network – and, at that, only very sporadically. Of the three, Mountain Ringlet has appeared most often in the butterfly counts due to its wide altitudinal range (1,400 to 3,000 m a.s.l.); on the other hand, Gavarnie Ringlet only flies above 1,850 m a.s.l. and Lefebvre's is confined to true alpine habitats above 2,400 m a.s.l., where it often flies with Silky Ringlet (*E. gorge*). These four species have similar ranges in the Catalan Pyrenees, from La Val d'Aran, El Pallars Jussà, El Pallars Sobirà through L'Alt Urgell and La Cerdanya as far as El Ripollès, where the easternmost populations of these species are found[1]. Gavarnie Ringlet, endemic to the Pyrenees, and Mountain Ringlet fly in subalpine and alpine grasslands, while Silky and Lefèbvre's Ringlets are commoner on screes and rocky slopes. All four species are univoltine, with population peaks in July and August; Mountain Ringlet is the first to fly (at the end of June), while the last to fly is Gavarnie Ringlet, which is sometimes found at the end of August. The biological cycle of Gavarnie Ringlet is unknown, whilst the other three are known to have bi-annual cycles due to the rigorous climate of the areas they inhabit[2]. In terms of food plants, the larvae of Mountain Ringlet feed on *Festuca*, *Poa* or *Deschampsia*, those of Silky Ringlet on *Festuca* or *Poa* and those of Lefèbvre's on *Festuca*[3].

Jordi Dantart

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Drawings

MOUNTAIN RINGLET
Upperside (general): very dark brown or black, matt or with the odd metallic reflection
Underside (general): similar to the upperside, but with paler, greyer or browner tones
Marked with line:
Quite pointed apex; postdiscal golden-brown band interrupted by dark veins and blind black eye-spots; series of round golden patches with blind black eye-spots; series of black spots directly on background

SILKY RINGLET
Upperside (general): brown in the basal, discal and post-discal areas
Underside (general): fore-wing predominantly red-brown; hind-wing marbled grey and black
Marked with line:
Broad postdiscal band, generally reddish and silky in appearance; two apical black eye-spots with white pupils; reddish post-discal band with a series of four pupiled black eye-spots; discal area darker; post-discal area with a series of pupiled eye-spots

GAVARNIE RINGLET
Upperside (general): very dark brown
Underside(general): fore-wing reddish mahogany brown; hind-wing marbled with a paler postdiscal band
Marked with line:
Mahogany postdiscal band that only stands out poorly from background; small black eye-spots with white pupils; marbled grey-brown background; pale postdiscal band without obvious spots

LEFÈBVRE'S RINGLET
Upperside (general): black, females generally with post-discal band, but males generally without
Underside (general): under- and upper-sides are similar in males, but in females underside is brownish
Marked with line:
Post-discal band absent; black eye-spots with white pupils directly on background; often with a rusty red post-discal band and black pupiled eye-spots; brownish tones; hind-wing with paler post-discal area

These species are easy to separate, although both Mountain and Lefèbvre's Ringlets and, to a lesser extent, Silky Ringlet have considerable individual variation and marked sexual dimorphism. Mountain Ringlet is the smallest and is easily recognisable by the pointed apex to its fore-wing and its small black eyes-spots that lack any white pupils. In Silky Ringlet the broad reddish post-discal bands and the series of four large white-pupiled eye-spots on the hind-wing are distinctive. Gavarnie Ringlet has broad reddish post-discal bands that do not stand out well against the background, while the underside of the hind-wings have a characteristic marbled texture against which the veins and pale post-discal bands are obvious. Lefèbvre's Ringlet is the blackest of the Pyrenean ringlets; in addition, in males often only the white pupil of the black eye-spots is visible against the dark background.

Identification

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

Two species of the genus *Hipparchia*, Woodland (*H. fagi*) and Rock (*H. hermione*) Graylings, are found in Catalonia. Their similarity is so great that to separate the two species it is essential to examine external genital characteristics. Nevertheless, their ecological requirements are quite different. Superficially, they also resemble the Great Banded Grayling (*Brintesia circe*) and confusion between them is possible.

The Woodland Grayling (*Hipparchia fagi*) inhabits Mediterranean woodlands and is moderately common in open holm oak and pine woodland throughout much of Catalonia (but is absent from the Pyrenees). Its maximum numbers are recorded from the mountains of the Serralada Prelitoral and dry areas of the pre-Pryenees. On the other hand, the Rock Grayling (*H. hermione*, also known as *H. alcyone*) is characteristic of open upland areas and is well distributed throughout the Pyrenees and the pre-Pyrenees, but is only local in La Serralada Prelitoral. Its populations can reach important densities on peaks and ridges such as on El Turó de l'Home and Les Agudes in El Montseny. The Great Banded Grayling (*Brintesia circe*) is very common everywhere in Catalonia, from sea level to subalpine forests. It prefers grassy areas near woodlands. None of these three species are found on the Balearic Islands and all three are univoltine. Both the Woodland and Rock Graylings appear in June and are commonest in August or even September. The Great Banded Grayling, however, appears in May–June and has a bimodal flight period since the majority of individuals aestivate in July–August. Eggs are laid from the end of summer through to the beginning of October.

The males of all three species are territorial and often await females perched on trees or rocks. Their larvae have been reported to feed on a variety of grasses[1] (see ref. 2-3 for more details on their life-cycles).

Constantí Stefanescu

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Drawings

WOODLAND GRAYLING
Upperside (general): dark brown, almost black with white postdiscal band
Underside (general): similar to upperside
Marked with line:
Androconial scales with velvety appearance; grey-white band; more regularly curved white band

ROCK GRAYLING
Upperside (general): dark brown, almost black with white post-discal band
Underside (general): similar to upperside
Marked with line:
Androconial scales with velvety appearance; grey-white band; curved white band with a marked dog-leg

GREAT BANDED GRAYLING
Upperside (general): black, with a white post-discal band interrupted on the fore-wing
Underside (general): similar to upperside
Marked with line:
Androconial scales with velvety appearance; marks on post-discal band are pure white; additional white discal band

All three species have broad white post-discal bands on the upper-wings, although in both Woodland and Rock Graylings this band is a smoky grey-white, almost yellow, in colour. The Great Banded Grayling can be separated from the other two species by the short white band in the discal region on the underside of the hind-wing. This feature is easy to appreciate when the butterfly is perched with its wings folded. Woodland and Rock Graylings are very similar and can be easily confused, although the former is slightly larger (length of fore-wing in Woodland Grayling = 33 mm, but in Rock Grayling = 32 mm). The males can be reliably separated without dissection by examination of the Jullien's organ (see drawing in ref. 4). In Catalonia the two species only fly together in the pre-Pyrenees and in these sites it is recommendable to regularly confirm the identification of males by an examination of the Jullien's organ.

Ajuntament Granollers

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