CBMS
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Cover illustrations

Detail of the fore-wing underside of the Clouded Yellow (*Colias crocea*) (photo: A. Miquel).

Wall Brown (*Lasiommata megera*) roosting on a spike of Pendulous Sedge (*Carex pendula*) (photo: J.R. Salas).

Editorial

The importance of the CBMS in the conservation of Catalan butterfly populations

During Butterfly Conservation's 5th International Symposium entitled "Lepidoptera as indicators of Biodiversity Conservation" (Southampton, April 8 to 10, 2005) the enormous worth of the BMS network for documenting and understanding the changes taking place in European butterfly populations was brought home to all participants. Its role in the conservation of these insects was highlighted over and over again and this essential objective is probably what stimulates most CBMS collaborators to walk their transects every week for seven arduous months of the year.

In order to contribute to the conservation of butterfly populations in Catalonia we must first identify the causes of increases and decreases in species' populations and, in a more general sense, analyse the main causes of the wonderful butterfly diversity found in our country. This is a complex task that requires a large database and the ability to use it to full effect. In this edition of *Cynthia* we have introduced a new section that will study this question in detail and provide a summary of much of the research based on our CBMS data. As a start, we will look at a recent study that for the first time has used data from the whole CBMS network to discuss patterns of diversity present in the butterfly populations of Catalonia.

The results once again make it clear that butterflies are insects that are highly influenced by climatic factors and as such act as excellent bioindicators of phenomena that include global warming. On a smaller scale and in connection with habitat management, our results also show the degree to which butterfly communities are becoming impoverished in regions surrounded by vast areas of agriculture and urban development. This tendency is highly worrying and provides evidence of the negative effects of increased agricultural intensity and urban growth. Moreover, the interaction of anthropic factors with the effects of climate change may make the situation even worse.

In this edition of *Cynthia* you will also find all the usual sections related to the workings of the CBMS network and to the biology and identification of our butterflies. For example, this number contains a long article about the Orange Tip, one of the earliest species on the wing in spring and whose colours provide a touch of happiness and herald the long-awaited arrival of spring.

The CBMS network

Situation of the Catalan and Balearic Islands Butterfly Monitoring Scheme in 2004

During the 11th CBMS season a notable landmark was reached: for the first time data was received from over 50 different stations. Almost all of the active stations in 2003 continued to be walked and were joined by the reactivated transect at Timoneda d'Alfés and three completely new transects. In all, 142,246 butterflies belonging to 135 different species were recorded.

In 2004, complete data was received from 51 CBMS stations (fig. 1) and preliminary studies were carried out in two sites with a great potential for butterflies: Alinyà (1,100 m, in the *comarca* of L'Alt Urgell) and La Vall d'Ordino (1,800 m, Andorra). It is hoped that these sites will soon enter the CBMS network, although because of the spectacular diversity of butterfly species present, the learning process for recorders is necessarily somewhat longer. Nevertheless, the wait will be well worth it as the CBMS has no data for high altitude species such as Clouded Apollo (*Parnassius mnemosyne*), Mountain Clouded Yellow (*Colias phicomone*), Purple-edged Copper (*Lycaena hippothoe*), Geranium (*Eumedonia eumedon*) and Silvery (*Pseudoaricia nicias*) Arguses, Lesser Marbled Fritillary (*Brenthis ino*), Small Pearl-bordered Fritillary (*Boloria selene*) and Common Brassy Ringlet (*Erebia cassioides*).

The annual data series currently available are shown in figure 2. The uninterrupted series of records from many sites means that the CBMS now has at its disposal a significant number of data sets, with around 15 stations having provided data from eight or more years.

New transects

Sant Daniel (Gironès *comarca*, 200 m): a transect that passes through an essentially agricultural landscape, consisting of a mosaic of fields, pastures, small fragments of Holm Oak woodland and calcareous scrub. The transect (length: 1,827 m) runs around the farm of Mas Miralles in the Sant Daniel valley near the city of Girona. It is an excellent example of an agro-pastoral area in a *comarca* which up to now had no CBMS transect. This station receives financial support from the Consortium of Les Gavarres.

Sant Ramon (Baix Llobregat *comarca*, 300 m): transect centred on the well-known sanctuary of Sant Ramon in the municipality of Sant Boi de Llobregat. It passes through an area of Holm Oak and pine woodland and scrub, and includes the peak of the hill of the same name where many species come to hilltop. This transect complements station nº 49, which runs through the bottom of the valley.

Oristrell (Bages *comarca*, 350 m): this transect lies in the easternmost part of the Sant Llorenç del Munt Natural Park in the municipality of Pont de Vilomara. The climate of the area is fairly continental and the landscape predominantly consists of scrub and fields, but with a highly diverse collection of butterfly species. This site is an important addition to the CBMS and it has already provided information about a number of scarce species that are of great interest within the context of Catalonia.

As well, we should mention that in 2004 recording recommenced in **Timoneda d'Alfés** (station nº 18) after four years of inactivity. This protected area is especially important for the relict populations of steppe birds and, although its butterfly populations are relatively poor, they do represent the species found in the dry-farming areas of the Lleida plains. Given that the enlargement of the small aerodrome that occupies the site has been ruled out, it is hoped that from 2005 onwards the area can be actively managed to favour some of the most important bird species (for example, Dupont's Lark *Chersophilus duponti*). The CBMS counts during forthcoming seasons, as well as data accumulated between 1995 and 1998, will provide valuable information regarding the response of the area's butterfly populations to the new management measures undertaken.

Three stations became inactive in 2004: Olivella, Santiga and the Autonomous University of Barcelona. Nevertheless, the first forms part of a rotational system with two other stations in El Garraf (Vallgrassa and Olesa de Bonesvalls) in which every year one station is 'rested': counts are only made for two consecutive years in each and next year Olivella will be active once again and Vallgrassa temporarily inactive for a season.

Habitats represented

The different habitats and plant communities surveyed by the CBMS transects in 2004 are shown in table 1. For each station, only the dominant plant communities have been taken into consideration and secondary communities (those that could be regarded as successional stages) are included within the corresponding climax community. Thus, table 1 is a simplification of the real situation: for example, under the category "Coastal Holm Oak woodlands" we find a great diversity of landscape types that, according to the station in question, include scrublands, pine woodland, fields, dry grasslands, and so forth. More detailed information con-

cerning the plant communities present in each section of the transects (with the percentage cover) can be consulted in the full CBMS database.

The vast majority of CBMS stations are found in lowland Mediterranean habitats, above all in the northern half of the country and in areas dominated by Holm Oak formations (50% of the transects). Arid and steppe-like habitats in south-west Catalonia are reasonable well represented and in 2005 will be complemented by the incorporation of stations from the *comarques* of La Terra Alta and El Priorat. As has been mentioned elsewhere, the stations at sea-level (including those in the Balearic Islands) provide plenty of good information on migrant species. In recent years, a special emphasis has been put on establishing stations in the Pyrenees and it is hoped that during 2005 and 2006 as many as four high-altitude stations will be added to the CBMS network.

Species represented

The list of butterfly species detected in 2004 and in previous years is given in table 2. In all, 135 species were recorded, two fewer than the previous year. Of great interest is the discovery of a new species for the CBMS and for Catalonia, the Desert Orange Tip (*Colotis evagore*), which appeared in the final count of the year at the Aiguabarreig station (Segrià *comarca*; see drawing). This strongly migratory species is very common in Africa and regularly colonises and establishes temporary populations in southern Spain. These reach their zenith in September-October and often give rise to dispersive processes that take the species far beyond its normal range. Up to 2004, however, the species had never been detected north of the province of Alicante.

In 2004, the frequency of appearance of the species in the network was broadly similar to that of 2003, with 53% of species present in more than 10 stations (fig. 3). As is to be expected, some of the 43 species detected in only 1-5 stations are also some of the rarest and most localised species in Catalonia; this is the case of the Large Blue (*Maculinea arion*), Mother-of-pearl Blue (*Polyommatus nivescens*), Meleager's Blue (*Polyommatus daphnis*), Cardinal (*Argynnis pandora*), Twin-spot Fritillary (*Brenthis hecate*), Spanish Fritillary (*Euphydryas desfontainii*) and Spanish Marbled White (*Melanargia ines*). There are other species, however, that are poorly represented because of the deficient coverage of their principal habitats - the Small Tortoiseshell (*Aglais urticae*), Pearl-bordered Fritillary (*Boloria euphrosyne*) and Mazarine Blue (*Polyommatus semiargus*) are all widespread in the Pyrenees, and the Ringlet (*Aphantopus hyperantus*), Provençal Short-tailed Blue (*Cupido alcetas*) and Short-tailed Blue (*Cupido argiades*) are relatively common in more central European-type habitats – and none is frequent in the CBMS counts. It is likely though that some of these species will appear in more stations over the coming seasons and that we will eventually have sufficient data to be able to analyse their population trends in Catalonia.

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Fig.1. Geographical situation of all the stations that have participated in the CBMS network (1994-2004), with their official number and name. Also shown is their position regarding the biogeographical regions of Catalonia according to generally accepted boundaries[1].

Fig. 2. Distribution of the annual series that are available for the different stations that have participated in the CBMS (1988-2004).

Fig. 3. Number of CBMS stations in which the 120 butterflies detected in 2004 (excluding the skippers (Hesperiidae), since this group is not recorded in the same way in all transects).

Table 1. Habitats and plant communities represented in the CBMS in 2004, with the number of stations they appear in. Classification of the vegetation zones and plant communities according to ref. 1.

Table 2. The butterfly species that have been recorded in any of the CBMS stations over the last 10 years (1995-2004). The number of locations in which the species has been recorded during the CBMS monitoring is also given (out of a possible total of 18 in 1995, 20 in 1996, 25 in 1997 and 1998, 30 in 1999 and 2000, 42 in 2001, 41 in 2002, 46 in 2003 and 51 in 2004). Only those stations where it has been possible to calculate an annual index have been taken into account. Taxonomy according to ref. 3.

Photo. The transect of Sant Daniel, in the area around Can Miralles, monitors a typical agro-pastoral landscape in this well-preserved valley on the outskirts of Girona. Species richness is high owing to the presence of pastures and the limestone outcrops that provide habitat for a number of calcicole species. Bearing in mind that it is relatively near the coast and lies at low altitude, some of the most interesting species that were recorded in 2004 are as follows: Black-veined White (*Aporia crataegi*), Berger's Clouded Yellow (*Colias alfacariensis*), Moroccan Orange Tip (*Anthocharis euphenoides*), Green-underside Blue (*Glaucopsyche alexis*), Chapman's Blue (*Polyommatus thersites*), Provence Chalkhill Blue (*Polyommatus hispana*), Weaver's Fritillary (*Boloria dia*), Marsh Fritillary (*Euphydryas aurinia*) and Red Underwing Skipper (*Spialia sertorius*) (photo: Consortium of Les Gavarres).

Drawing. On September 25 2004, Maria Cinta Roca identified a Desert Orange Tip (*Colotis evagore*) on the transect at Aiguabarreig (municipality of La Granja d'Escarp). This was the first-ever record for Catalonia[2] of this migratory African species, and represents a northward extension of its known range of some 350 km. The Desert Orange Tip feeds on the caper plant (*Capparis spinosa*) and occasionally establishes populations in southern Spain, which die out at the onset of winter (drawing: M. Arrizabalaga).

Eleventh year of the CBMS
Summary of the 2004 season

In 2004, spring was wet and summer mild, radically different weather from that of 2003, and as a result and in sharp contrast with preceding years, many species appeared later than usual. Nevertheless, the number of common species with a higher (28 species) or lower (31 species) annual index than in the previous year was similar to the respective figure from 2003. On the hand, a clear tendency towards more butterflies but fewer species per station was noted. Finally, it is worth highlighting the significant decrease in the numbers of migratory butterflies (in some cases reaching historically low minima) and the single-brooded spring butterflies counted; on the other hand, there was a remarkable increase in the numbers of False Ilex Hairstreak (*Satyrium esculi*), Small White (*Pieris rapae*) and the majority of satyrids.

Weather and butterfly counts

For most of the CBMS recorders 2004 was not nearly as tough a season as 2003, in which record summer temperatures in many parts of Catalonia caused a severe drought. In 2004 the opposite occurred: from February to the end of May abundant rain fell (above all in February and April) and the summer months were characterised by generally moderate temperatures with no marked period of drought. Proof positive of this is the absence of any important forest fires during summer 2004, a stark contrast to the rash of fires declared during 2003, one of the worst years in recent times.

In terms of the CBMS counts, the wet spring had a moderately negative impact on butterfly counts: 12.4% of counts were lost, a figure greater than that of 2003, but still within the normal range of other seasons (for example, in the wet year of 2002, 13.1% of counts were lost). Overall, an average of 3.8% counts per station were lost (fig. 1a), still an acceptable figure for calculating reliable annual species indexes. Moreover, around 50% of all lost counts were concentrated between March and the first half of May in the first 10 weeks of the season (fig. 1b). Taking into account the fact that this is the time of the season with fewest species on the wing and that the low spring temperatures were delaying the appearance of many species, the actual loss of data was less significant than the graph would seem to indicate. Throughout the rest of the season there were no problems with the counts, above all during the peak period for butterfly abundance in most stations (weeks 11-20).

Changes in abundances: general considerations

The exceptional weather in summer 2003 (high summer temperatures and severe drought over much of the country) presaged a poor year for butterfly populations in 2004. Nevertheless, when analysing figures from 2004, we see that the number of species with greater or smaller annual indexes than the previous year was practically the same (28 increases vs. 31 decreases: P = NS; taking into account the 59 commonest butterflies recorded in the CMBS). Thus, in terms of the league table of CBMS years, 2004 sits in seventh position alongside 2003 (the sixth best-ever season) (fig. 2). In part, as we discuss below, the wet spring was the cause of the majority of increases in annual species indexes.
Despite this apparent balance in the year's figures, the total numbers of butterflies and of species counted per station in 2004 were very different. In terms of abundance, out of 39 stations with comparable records from 2003 and 2004, there were 26 increas-

es and 13 decreases (binomial test: $P = 0.02$). Overall, in these 39 stations 22% more butterflies were counted in 2004 than in 2003, although to a large extent this increase can be put down to the spectacular rise in numbers of False Ilex Hairstreak (*Satyrium esculi*), Small White (*Pieris rapae*) and Meadow Brown (*Maniola jurtina*).

Curiously, the trend in the variation in the number of species (as opposed to abundance) was different, with only 7 increases and 28 decreases (binomial test: $P < 0.001$) and 4 stations without change. It is very likely that this loss of diversity - above all due to the extinction of a number of locally rare species - can be attributed to the negative impact of the previous summer's drought and the difficulties in detecting the early flying single-brooded spring species during the rainy spring.

Changes in abundance: fluctuations in populations

In 2004 and for the fourth year in a row, the False Ilex Hairstreak was the commonest butterfly in the CBMS counts and for the third successive year reached the highest annual index for any butterfly since the CBMS scheme began (tables 1, 2). This significant increase, combined with the high numbers recorded in 2003, provided spectacular numbers of this butterfly: in many transects in the mountains of the Litoral and Prelitoral mountains annual indexes were around 1,000 butterflies, and at the Vallforners transect in the Montseny in an area of coastal Holm Oak woodland, the annual index was 6,401 with 2,852 alone counted in week 20. This is the highest ever count for any butterfly in the CBMS. To some extent, the case of the False Ilex Hairstreak is similar to that of other woodland butterflies that undergo population explosions in certain seasons in line with increases in the availability of the larval food plant[2]. In the case of the False Ilex Hairstreak, larvae feed on the fresh shoots of Holm and Holly oaks, two trees that bud profusely in years when abundant rain falls at the end of winter and in early spring. Presumably, an abundant supply of the larvae's main food source increases survival rates and gives rise to increased adult emergence. As well, given that it hibernates as an egg, this species is well prepared to resist summer droughts such as that of 2003. It is worth mentioning that the noctuid Oak Yellow Underwing (*Catocala nymphagoga*), likewise a single-brooded specialist feeder on Holm Oaks, and a species that also hibernates as an egg, was also exceptionally common in 2004 in the same places as the False Ilex Hairstreak was remarkably abundant.

The annual indexes of most satyrid species increased (table 2), and Meadow Brown (*Maniola jurtina*) (see drawing), Great Banded Grayling (*Brintesia circe*), Tree Grayling (*Hipparchia statilinus*) and Wall Brown (*Lasiommata megera*) all reached their highest-ever annual indexes since the CBMS began. The synchronised changes in this group of species, all with similar biological traits (winter spent as larvae; larvae always feed on grasses), shows once more how climate influences butterfly populations. Mediterranean satyrids possess various strategies for combating summer drought (adult aestivation, delayed egg-laying, inactivity in the neonate larvae until after winter) and so are relatively unaffected by extreme conditions such as those of summer 2003 (ref. 3, 4). In single-brooded species (the majority), larval development is concentrated entirely at the end of winter and beginning of spring and so the conditions encountered during these periods will determine greater or lesser survival levels with respect to food-plant quality. Undoubtedly, the above average rainfall between February and May throughout Catalonia augmented the availability of grasses and was in part responsible for the general increase in the populations of these species. Further evidence of this is that the only two satyrids that suffered a decline in 2003 were the Speckled Wood (*Pararge aegeria*) and Pearly Heath (*Coenonympha arcania*), both species associated with more humid habitats that, as such, do not possess the adaptive mechanisms found in other species of satyrid.

Other species that increased notably in 2004 were the Small White (*Pieris rapae*), Small Copper (*Lycaena phlaeas*) and Nettle-tree Butterfly (*Libythea celtis*). The first two are multi-brooded opportunistic species that were possibly favoured by the lack of a summer drought and were thus able to complete all their annual generations without interruption. The Nettle-tree Butterfly has been increasing in numbers over the last few years, a trend that may form part of an abundance cycle affecting populations within a large geographical area[5].

Amongst the species that decreased most in 2004, we find the majority of migratory species and single-brooded spring butterflies (table 2). For example, 2004 was a bad year for the Large White (*Pieris brassicae*) (see drawing), Long-tailed Blue (*Lampides boeticus*) and Lang's Short-tailed Blue (*Leptotes pirithous*), which all reached their lowest levels in 2004 since the CBMS began. The reasons for these spectacular declines lay in the areas of origin of these migratory species and/or in the climatic conditions they encounter during migration. An apparent exception is that of the Bath White (*Pontia daplidice*), although the increase in the overall annual index of this species is essentially a result of the very high counts for the species in the two transects at Granja d'Escarp that were devasted by forest fires in 2003. As has been shown before, this butterfly colonises massively areas burnt by forest fires the year before and reaches unusually high population levels. This is the case in the stations at Granja d'Escarp and Aiguabarreig, where yearly counts rose, respectively, from 36 to 413, and 24 to 674. On the other hand, in nearby stations unaffected by forest fires (Mas de Melons and Sebes) the differences between 2003 and 2004 for this species were far less obvious or even null.

In the case of single-brooded spring butterflies (for example, Orange Tip (*Anthocharis cardamines*), Moroccan Orange Tip (*A. euphenoides*), Green Hairstreak (*Callophrys rubi*) and Panoptes Blue (*Pseudophilotes panoptes*), as well a number of others that do not appear in table 2), we have seen once again that populations decrease noticeably when spring is cold and emergence is retarded. The reason for this probably lies in the significant increase in pupal mortality rates given that the pupae are exposed to predation for a longer period of time. This is the case of the Scarce Swallowtail (*Iphiclides podalirius*[6]), which in 2004 reached its lowest-ever annual indexes in most stations as a result of the very poor spring generation.

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Fig. 1. (a) Coverage of the counts at the different CBMS stations, and (b) the distribution of the lost counts during the official 30 weeks of the 2004 counting season (March 1- September 26).

Fig. 2. Ranking of the CBMS seasons in terms of the general abundance of the 54 commonest butterflies in the CBMS network. The best year to date was 2003 and the worst 1998. Calculations have been carried out according to the methodology used in reference 1.

Table 1. Sum of the annual indexes and ranking of abundance for the 20 commonest species from the 2004 CBMS as compared with the corresponding figures for the 2003 season.

Table 2. Evolution of the overall annual indexes for the commonest 59 species of butterfly in the CBMS (1994-2004), based on an arbitrary value of 100 for the year 1994. Also indicated are the number of species that increased or decreased every season, as well as the proportions that are significantly different from equality (NS: not significant; * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$).

Drawing 1. The Meadow Brown (*Maniola jurtina*) reached its highest-ever CBMS abundances in 2004. In the 39 stations in which it was recorded, this species increased in 34 and decreased in just five. The phenological adaptations of Mediterranean populations[3] of this species is one of the keys for understanding this success, all the more surprising in light of the previous year's exceptionally severe drought. Although adult emergence and mating takes place mainly in May-June, females aestivate in July and August and do not become active again and lay until September. Males, on the other hand, normally die soon after mating. The species' neonate larvae enter diapause and do not start to feed until the end of winter, coinciding with the greatest availability of fresh plant shoots and thereby avoiding the summer drought (drawing: M. Arrizabalaga).

Drawing 2. The situation of the Large White (*Pieris brassicae*) during 2004 was diametrically opposed to that of the Meadow Brown: it declined in 37 stations and only increased in 5 (binomial test: $P << 0.001$), thereby reaching all-time CBMS lows. Nevertheless, the cause of this decrease lies in the species' migratory dynamics and not in any particular factor to be found in Catalonia that might affect native populations; to be specific, the low numbers of migrants from central Europe that reached Catalonia in September 2003 were the underlying cause of the low general abundance of the generations flying the following season (drawing: T. Llobet).

Habitat management and conservation

General patterns in the diversity of Catalan butterflies: a base for appropriate habitat management

The main objective of the BMS is to establish the relationship that might exist between changes detected in abundances in butterfly populations and environmental parameters. In addition, the knowledge gained from the application of the BMS methodology can be used in management to favour biodiversity. Without doubt, this second aim should be one of the principal objectives of the CBMS and thus this and future numbers of *Cynthia* will discuss some of the most relevant findings in this field.

Before beginning to discuss more practical aspects of the CBMS, it is worth looking at the underlying causes of butterfly diversity in Catalonia. The information obtained from the CBMS network is a first-class starting point, as a recent study based entirely on data from the CBMS[1] proves. Here, we aim to explain the results of this study since we believe that it is an excellent framework for tackling more specific subjects in future numbers of *Cynthia*.

Within Europe, Catalonia stands out as one of the most butterfly-rich regions. The almost 200 known species[2] speak of an extraordinary wealth of butterflies, comparable with the Alps, central France and parts of Greece[3]. Furthermore, Catalonia is the richest region in terms of species[4] in the Iberian Peninsula. Yet, this begs a question – why is Catalonia so butterfly rich?

Throughout its existence, the CBMS has documented with great precision the butterfly communities that reside in many Catalan regions: this is the base information for analysing the factors that determine our country's species richness. The potential conditioning factors can be divided into three large groups: (1) climatic and topographical features; (2) vegetation; and (3) human activity. Climate data have been taken from the Digital Climatic Atlas of Catalonia[5] and consist of five thermo-pluvial variables that define the predominant climate in each CBMS station.

Vegetation data consist of the number of plant communities along each transect and a soil acidity index based on the degree to which these communities are acidophil. Finally, we constructed two variables directly related with the incidence of human activity in the territory: the proportion of land-use that is given over to agriculture and built-up areas and associated infrastructures. Data for these calculations were extracted from aerial photos taken in 1997 by the Landsat satellite by adding the percentage of different land-uses in a 5 km radius around each CBMS station.

Our analysis showed clearly that the type of climate is the most important factor in determining butterfly species-richness in Catalonia. The maximum number of species are found in the cooler and wetter parts of the country (for example, the Pyrenees up to around 1,400 m and the mountains of La Serralada Transversal and the south and centre of the country), where environmental conditions for butterflies are optimum (fig. 1a). Once we start heading for the more arid and hotter regions of south-east Catalonia, species-richness drops rapidly, as occurs if we climb into the coldest and highest parts of the Pyrenees: in both cases, the climate (for opposite reasons) becomes a limiting factor for the development of the majority of species. It is worth pointing out that our model warns that we stand to lose a significant part of our species-richness in the coming years if predictions regarding climate change in the Mediterranean prove to be correct[6]. Studies show that we are moving inexorably towards an increase in aridity in more and more areas of Catalonia as a consequence of higher temperatures and increasingly irregular rainfall patterns. Remedies for the possible loss of species due to global warming are beyond the scope of specific butterfly management projects in Catalonia. Nevertheless, we must take this phenomenon into account when we attempt to interpret changes occurring in Catalan butterfly communities.

We also demonstrated that butterfly species-richness is partly determined by the proportion of the land around the CBMS station given over to agriculture: the greater the amount of agricultural land (including irrigated and non-irrigated crops), the fewer the species present (fig 1b). This finding should be seen in light of the important changes that occurred in agriculture and stock raising in Catalonia in the second half of the twentieth century, and in the negative impact that these processes have had on Mediterranean ecosystems. Intensive agriculture and stock-raising, in which production levels take second place to none in importance, have gradually won the day through the indiscriminate use of fertilisers and pesticides, non-native species and strains of crops, destructive heavy machinery, and so on. Unfortunately, non-sustainable agriculture is still increasing in our country, just as it has done in the centre and north of Europe to the detriment of local butterfly populations[7]. This message is truly worrying and, unlike in the case of global warning, must influence the planning and management of our countryside. Our results show that, for example, we must consider urgently the need to introduce widespread ecological agricultural practices - as is occurring in other European countries - as a means of halting the loss of biodiversity in agricultural regions[8,9].

The amount of built-up land also affects butterfly populations through the obvious mechanism of habitat destruction. In our study this factor appears as a secondary consideration given that the amount of built-up land in the environs of most of our CBMS stations is negligible or non-existent.

Curiously, the number of plant communities on a transect has no significant influence on butterfly species-richness. This result may seem surprising, although in fact it coincides with other studies carried out in other parts of the world[10] and is an indication of the irregular importance of some plants as food sources for butterflies. Some plant communities dominated by certain key plant species (for example, a number of calcicole species of legume) allow very rich butterfly communities to flourish, whilst other communities are more neutral in their effect on butterfly communities. This is confirmed by the fact that calcicole communities appeared as one factor that had a statistically positive (albeit weak) effect on species richness.

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Fig. 1. The relationship between butterfly species richness and two environmental factors: (a) climate (understood as the combination of five thermo-pluvial variables and the altitude of each station) and (b) the proportion of agricultural soil in a radius of 5 km around each CBMS station. In all, 73.7% and 4.4% of variation is explained by these two factors.

Photo 1. The abundance of butterflies in agricultural environments is largely determined by the presence of well-established margins and banks around the fields. In well-constituted field edges, bushes such as Sloe (*Prunus spinosa*), Hawthorn (*Crataegus monogyna*) and various other species of fruit tree act as food plants for the larvae of the Scarce Swallowtail (*Iphiclides podalirius*), a highly mobile species that quickly colonises favourable areas (photo: M. Miralles).

Photo 2. The extension of intensive agriculture is having negative effects on Catalan butterfly communities, as data from the CBMS network demonstrates (photo: J. Dantart).

CBMS sites

Darnius, a station bearing the brunt of the north wind

Since the beginning of the CBMS in 1994, the Darnius transect has provided data with exemplary regularity from a typically Mediterranean environment dominated by Cork and Holm oak woodland and grassland. Its butterfly fauna is diverse and includes a splendid variety of satyrids.

The transect

Lying close by the town of Darnius in the *comarca* of L'Alt Empordà, the Darnius transect lies at 183 m above sea-level and enjoys a climate with annual temperatures and rainfall of 14º C and 874 mm, respectively. However, the most notable aspect

of the local climate is the frequency and violence of the *Tramuntana,* the fierce northerly wind that often blows unrelenting for days at a time. The transect joined the CBMS network at its birth in 1994 and thanks to the unstinting efforts of Agnès Batlle has since then provided an uninterrupted series of data.

The transect is essentially Mediterranean and runs through stands of Cork Oak and formations of Holm Oak in various states of preservation. Elsewhere, the walk comes into contact with banks of Mediterranean Coriaria (*Coriaria myrtifolia*) and Bramble (*Rubus ulmifolius*), grassland dominated by *Brachypodium phoenicoides* and Mediterranean False-brome (*B. retusum*), scrub dominated by Sage-leaved (*Cistus salviifolius*) and Narrow-leaved cistus (*Cistus monspeliensis*), cultivated areas, dry grassland dominated by ruderal plants, riverine woodland and, lastly, plantations of Maritime (*Pinus pinaster*) and Umbrella (*Pinus pinea*) pines. None of the area is legally protected.

The butterfly fauna

During the 11 years the transect has been operating, 23,217 butterflies belonging to 68 different species have been detected (not counting skippers). The annual average is 2,111 butterflies and 53 species, with an annual density of 127.5 individuals/100 m.

The most outstanding characteristic of the butterflies of the area is the abundance of satyrids (fig. 1). Although this is a fairly constant feature throughout the CBMS network, at Darnius this subfamily contributes an exceptional 61% of all butterflies recorded, as well as the seven commonest species. This is largely due to the number of potential food plants (various species of grass) found in the grasslands and waysides of the transect, of which the most significant are the *Brachypodium phoenicoides* and *B. retusum* grasslands that are, respectively, the second and third most prevalent plant communities in the transect, and present in nine out of the walk's 12 sections.

Aside from the species associated with woodland and Mediterranean pastures, a number of more northerly species such as Black-veined White (*Aporia crataegi*), Sloe Hairstreak (*Satyrium acaciae*), Short-tailed Blue (*Cupido argiades*), Provençal Short-tailed Blue (*C. alcetas*), Camberwell Beauty (*Nymphalis antiopa*), White Admiral (*Limenitis camilla*), Small Tortoiseshell (*Aglais urticae*), Cardinal (*Argynnis pandora*), Weaver's Fritillary (*Boloria dia*), Glanville Fritillary (*Melitaea cinxia*) and Pearly Heath (*Coenonympha arcania*) have also occasionally been recorded. All these species occasionally wander from the nearby mountains of Les Salines and Les Alberes or possibly from relict lowland populations; as well, butterflies such as Spanish Festoon (*Zerynthia rumina*), Berger's Clouded Yellow (*Colias alfacariensis*), Provence Chalkhill Blue (*Polyommatus hispana*) and Adonis Blue (*P. bellargus*) also sporadically stray into the transect area, probably from small residual populations surviving on nearby calcareous outcrops.

Changes observed during the 11 years of records

Even though the route walked has not changed during the 11 years, the physiognomy of some of the sections has. For example, the Umbrella Pine plantation in section 5 has progressed from grassland with young trees barely 1 m high to shady woodland with 10-m-high trees. Likewise, since 2000 section 1 has started to be built upon and it will be interesting to see how such disturbances affect the transect's butterfly fauna.

The year 2002 saw a serious natural phenomenon upset some of the transect's resident species: on April 11 265 litres/m^2 of rain fell in 24 hours and as rivers burst their banks and the very tracks the transect passes along became raging torrents, numerous trees were knocked down, landslides occurred and parts of the transect were flooded. This exceptional weather coincided with the subsequent disappearance from the transect of three of the hitherto most abundant and stable species - Gatekeeper (*Pyronia tithonus*), Southern Gatekeeper (*Pyronia cecilia*) and Tree Grayling (*Hipparchia statilinus*)- and everything seems to suggest that the two events are linked. In the first place, no other CBMS station has ever seen such a drop in numbers in these species and, secondly, in 2002 in none of the other transects with similar climate that did not experience such dramatic flooding was there any parallel decline in these three species. Furthermore, none of the other abundant satyrids such as Spanish Gatekeeper (*Pyronia bathseba*), Meadow Brown (*Maniola jurtina*), Iberian Marbled White (*Melanargia lachesis*) and Great Banded Grayling (*Brintesia circe*) that have similar biological traits but earlier emergence dates were affected. In retrospect, the torrential rain probably caused abnormally high mortality amongst the larvae of the three species affected, which at that moment were hidden in the grass in their early stages of development. The other satyrids, on the other hand, were less affected as in these species with more advanced phenology the larvae had already pupated (for example, Spanish Gatekeeper and Meadow Brown) or were far larger (Iberian Marbled White and Great Banded Grayling) and thus able to withstand the brute force of the floods. The pupae are generally attached to rigid strata and the larger caterpillars can evidently attach themselves with sufficient strength to prevent themselves being swept away by floods. Lastly, we should add that these three species are all highly stationary and will only recolonise slowly from nearby areas, as the extremely slow recovery of the transect's populations of these species demonstrates (fig. 2). The data from the next few years will reveal just how these species recolonise the area: once again the value of the CBMS data in understanding natural processes becomes clear.

Agnès Batlle & Constantí Stefanescu

Transect route of Darnius. In all, the transect consists of 12 sections with a good variety of rural and woodland habitats. The total length is 1,655 m with an average of 138 m per section (range: 89-250 m).

Photo 1. The Great Banded Grayling (*Brintesia circe*) is one of the transect's most abundant species: in 2004 121 butterflies were counted in a single day, an extraordinarily high figure for the CBMS. As in the case of the Meadow Brown, this species has a single annual generation but with two discrete peaks: after the emergence of adults at the end of June and the beginning of July, and then in September when the adults re-emerge after aestivation (photo: J.R. Salas).

Fig. 1. Average abundance (average of the annual indexes 1994-2004) for the 15 commonest species at Darnius.

Fig. 2. Evolution of the annual indexes of the three species of satyrids that were badly hit by the exceptional floods of April 11 2002. All three species were very abundant in the area, showing the usual annual fluctuations in numbers: however, since the April flood their numbers have collapsed and have not yet recovered.

Review

Lewington, R., 2003

Pocket Guide to the Butterflies of Great Britain and Ireland

144 pages. British Wildlife Publishing, Hampshire.

This simple and very manageable guide is of the highest quality, as is to be expected from the pen of Richard Lewington. Inside you will find wonderfully detailed drawings of the eggs, larvae, pupae and adult butterflies of all the species that fly in Great Britain (almost all of which are present in Catalonia), as well as plenty of interesting and highly useful information about butterfly ecology. In other words, an essential addition to the library of any butterfly lover.

New field guides to the butterflies of Europe appear on the market every now and again and most follow the style of the classic guide written by Higgins & Riley[1], which combines drawings of adult insects and a short descriptive text with additional information on species distribution and biology. Initially, this type of guide was aimed at collectors as an aid for finding and then identifying species. However, the publication in 1997 of a new guide by Tolman & Lewington[2] marked a change in this tendency and for the first time a field guide included a much greater body of up to date information on the ecology of each species (above all, in the case of larval food plants). Furthermore, this new guide stood out for the exceptional quality of its plates, the work of Richard Lewington, possibly the best butterfly illustrator in Europe.

However, Richard Lewington is not only a wonderful artist, but also an expert in the biology of British butterflies. This aspect of his work is reflected in this new book, whose novel approach complements existing field guides and in its naturalist's view of butterflies fully reflects the British tendency to indulge in butterfly watching (as opposed to collecting).

The guide describes all the butterfly species found in Great Britain and includes drawings of all phases of the butterfly life cycle (egg, larva, pupa and adult) and illustrations of butterflies and larvae in their natural states. Each species is presented as an organism integrated into the habitat in which it lives, and not simply as a static adult insect included in a plate of drawings. Most species accounts cover two pages, and include – aside from the drawings – a distribution map for Great Britain, a phenological diagram showing at what time of year each phase of the life cycle is completed, conservation status and the essential morphological traits of each stage of the species. Of particular interest, are the comments about and highly accurate illustrations of the eggs, pupae and behaviour of the larvae (for example, how caterpillars hide on their food plants and the traces they leave behind). The last few pages of the book are given over to a brief account of migrant and vagrant species. The book itself is designed as a field guide, measuring only 19 x 12 cm and weighing 220 g.

Unfortunately, this guide only describes the butterflies of the British Isles, and so only covers around 35% of Catalan species. Nevertheless, it is of great use for all butterfly enthusiasts and I recommend it strongly. It is an excellent way of getting started in the fascinating world of butterfly behaviour and will make field work and the CBMS counts even more enjoyable. Aside from these more practical considerations, leafing through

the book and appreciating all the details it contains is a true pleasure and it stands up on its own as a simple work of art.

Constantí Stefanescu

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News

The Monarch *Danaus plexippus*, a new species for Catalonia

Records over the last two summers of Monarchs *Danaus plexippus* from the Ebro delta are the first ever for Catalonia. It now just remains to be seen whether these migrations will become regular or not, as they have done with the Plain Tiger *D. chrysippus*.

Since the beginning of the 1980s migrations of Plain Tigers have become more and more commonplace and in many summers this species has established breeding colonies in the Ebro delta. These colonies then 'export' dispersing butterflies to the Aiguamolls de l'Empordà, the Llobregat delta and even inland areas[1], although the onset of winter inevitably leads to the extinction of these outlier colonies. It seems likely that these migrations originate from the unstable colonies that exist in certain points on the Andalusian coast[2].

Since the1980s there have also been many records of Monarchs from the south of the Iberian Peninsula[3]. This species – famous for its extraordinary migrations across the Americas – establishes temporary breeding colonies along a coastal strip that stretches from Cádiz as far as Granada. This area is re-colonised by butterflies either from the Americas or, as is more likely, from the sedentary populations in the Canary Islands.

To the great surprise of Catalan lepidopterologists, the first ever Catalan Monarchs were recorded in July and August 2003 by Maria Teresa Sabaté and Carlos Loaso on the Illa de Buda[4]. As a result, the site was systematically monitored during August and September and low densities of Monarchs were recorded until September 5 (ref. 5). The observations in 2003 were repeated in 2004, with records from the end of September and October, above all in the area of L'Encayissada[5]. Many Monarchs were observed nectaring from the ornamental plant *Lantana glutinosa* in the garden of the restaurant L'Estany.

It is worth mentioning that the presence of Monarchs in Catalonia coincided with a notable abundance of the species in the area of Tarifa in Andalusia, where in both 2003 and 2004 many adults were seen and many larvae were found on the Asclepiadaceae Cottonbush *Gomphocarpus fruticosus*[6]. It is likely, therefore, that the Catalan Monarchs originated from these populations in Andalusia.

Constantí Stefanescu & Pere Luque

[1] The observations of Monarchs in Catalonia are presented in detail in the journal of the Catalan Lepidopterological Society.

[2] Fernández Haeger, J., 1999. "*Danaus chrysippus* (Linnaeus, 1758) en la Península Ibérica: ¿migraciones o dinámica de metapoblaciones? (Lepidoptera: Nymphalidae, Danainae)". *SHILAP Revta lepid.* 27(107): 423-430.

[3] García-Barros, E., Munguira, M. L., Martín Cano, J., Romo Benito, H., Garcia-Pereira, P. & Maravalhas, E. S., 2004. *Atlas de las mariposas diurnas de la Península Ibérica e islas Baleares (Lepidoptera: Papilionoidea & Hesperioidea)*. Monografías SEA, 11, Zaragoza.

[4] Sabaté, M. T. & Loaso, C., 2004. "*Danaus plexippus* (Linnaeus, 1758) en el delta del Ebro: especie nueva para Cataluña". *Butll. Soc. Cat. Lep.*, 93: 65-67.

[5] Pere Luque, unpublished data.

[6] Diego Jordano, personal communication.

Photo. A Monarch *Danaus plexippus* photographed on October 24, 2004 near the Casa de Fusta, L'Encayissada (Ebro Delta Natural Park) (photo: R. Ramos).

Fourth CBMS workshop

Every other year the CBMS organises a one-day workshop for all participants. The fourth such meeting took place on February 21 in the Granollers Museum of Natural Science, and around 40 people attended. The morning began with an evaluation of the CBMS network and the main scientific results that have been extracted from the data. Subsequently, various collaborators described some of the projects and activities they have carried out in relation with the CBMS network. The morning finished with a workshop on species identification and the presentation to all of a straw hat adorned with the CBMS logo. During the afternoon a competition of photographic recognition was organised and various prizes were presented to a number of CBMS participants. To end, a selection of photographs of the eggs of Catalan butterflies was discussed.

Photo. Participants in the 4th CBMS workshop in the garden of La Tela, the Granollers Museum of Natural Science (photo: A. Arrizabalaga).

The butterfly

The Orange Tip *Anthocharis cardamines*, the herald of spring

This attractive butterfly provides a touch of spring colour just as many plants start to flower. Easy to identify and observe in almost all the stages of its biological cycle, the Orange Tip has been widely studied and its biology is now well known. Its flight period is closely tied to the prevailing weather conditions and as such this butterfly is an ideal insect to use for studying climate change.

Geographical distribution and situation in the CBMS

The Orange Tip is found throughout most of the Palaearctic region and in Europe is found from the Arctic Circle in the north to the Mediterranean region in the south[1]. It is much scarcer towards the southern limit of its range and in the Iberian Peninsula[2], and above all in Catalonia, it is especially abundant in the north but much rarer towards the south, where it is confined essentially to water courses and mountain regions.

The presence of the Orange Tip in the CBMS network follows this pattern (fig. 1). As of 2004, it had appeared in 41 of the 74 stations: in the north it flies in most, whereas in the south it only appears in some transects in the pre-coastal mountains (for example, Montmell, Prades and Ports de Beseit) or in the coastal mountains of Collserola and Serra de l'Ordal. As conditions become drier, the Orange Tip disappears completely and has not been recorded from any coastal station or from the Ebro depression. Likewise, it is not found in the Balearic Islands.

Habitats and food plants

The Orange Tip is typically found in meadows and along woodland edges and rides in areas of humid montane, sub-Mediterranean or central European climate. It also reaches subalpine and lowland Mediterranean habitats, where it is most commonly associated with fluvial woodland.

It is an oliphagous species (that is, it feeds on plants from different genera, but always from the same family) that specialises on feeding on crucifers. Many host plants have been recorded in Europe (68 at the last count[3], including 18 in Catalonia), although despite a certain degree of local variety, the species does show a predilection for a number of species of plant. In the Montseny, for example, Garlic Mustard *Alliaria petiolata* in damp shady areas and Thale Cress *Arabidopsis thaliana* in drier areas are the most common food plants. It is likely, as occurs in northern Europe, that the species of the genus *Cardamine* are an important trophic resource in humid habitats in the Pyrenees, although at present little information exists on the subject.

Various studies from northern Europe indicate the Orange Tip is an oliphagous-polyphagous species: that is, in the same locality females lay eggs on many different species of crucifers[4,5]. This strategy would seem to be difficult to justify from an evolutionary point of view, above all if we take into account the fact that larval survival depends to a great extent on the host plant used and that in some cases is all but zero[6]. Nevertheless, if egg-laying females were highly selective, this would lead to a serious loss of fecundity if eggs are laid under adverse conditions, as often happens in spring[7]. Probably, evolution has favoured those females that lay many eggs, even if some are laid on plants on which larval survival rates are low. However, surprisingly, in Catalonia where springs tend to be mild, similar degrees of polyphagy have been detected[3], a fact that would question this hypothesis.

Phenology

The Orange Tip is a single generation spring butterfly whose actual flight period depends on the local climate and weather conditions. In more Mediterranean habitats in the coastal mountains (fig. 2a), the first adults emerge in March at the beginning of the CBMS season and reach their peak in April; a few adults remain on the wing until May. In more central European-type habitats (fig. 2b), on the other hand, the first butterflies and the peak flight period are around two weeks later, with some butterflies still flying in June. In subalpine meadows in the Pyrenees (fig. 2c), the emergence is even later and adults are still seen in July.

Weather conditions also play an important role in flight dates. For example, in the Puig transect (Montseny), in 1997 during an exceptionally warm spring, the first Orange Tip appeared in the second week of March, while in 2004 the first was not recorded until the end of April. In Catalonia, data from the CBMS has enabled us to analyse this phenomenon: average flight dates are

two weeks earlier for every one degree extra in the mean January-March temperatures (fig. 3)[8].

Biological cycle and larval behaviour

Eggs are laid one-by-one, generally on flower stalks. Recently laid eggs are white, but turn a characteristic and conspicuous reddish-orange within a day or so. Cannibalism amongst Orange Tip larvae has been cited many times and so this colouration has been interpreted as a way of warning females not to lay eggs on the same flowers[9]; nevertheless, it is probable that some type of pheromone is also involved in this process[10].

Eggs hatch within seven days and the freshly hatched larvae eat all or part of the corion. The larval phase consists of five stages and lasts approximately one month. The first instar larvae usually feed on flowers, but in later instars they begin to specialise more on siliques and their seeds and only occasionally eat leaves. The characteristics of the food plant also affect larval behaviour[6]. When the crucifer is too small or the fruit are too mature, larvae may have to change plant. This often occurs in the case of the Thale Cress, a delicate species that will not generally provide enough trophic resources for a caterpillar. On the other hand, the Garlic Mustard is a much more vigorous plant and larvae can complete their development on a single plant, thereby increasing in many cases survival rates.

There are practically no data from Catalonia regarding predators or parasitoids of Orange Tip larvae. Thanks to their green colouration they are well camouflaged on their food plants and remain there whether they are feeding or not. Furthermore, above all during the first instars, the larvae have glandular hairs that secrete a substance that possibly acts as a defence against the many ants that habitually visit the nectaries of crucifer flowers[6, 11].

The fully grown larvae are between 3.5 and 4 cm long and leave their host plants to pupate among the vegetation of the woodland floor. This part of the species' life cycle is the longest and the hardest to detect, since the pupae are cryptically coloured. In theory, the adult butterfly then emerges during the following spring, although in captivity some pupae overwinter for a further one or two years[10].

Adult behaviour

There is a clear sexual dimorphism between males and females and, as the CBMS counts have shown, the differing behaviour of the species means that males and females are not detected with the same frequency. Males patrol, flying up and down in search of females. They are generally more sedentary and tend to be found on woodland and path edges and are thus easy to detect. Females, on the other hand, are more mobile and having mated will move around in search of a food plant and will rarely return to the same area twice.

Population trends

As occurs in the rest of Europe[12], the Orange Tip is not a threatened species and population trends are stable. Within the area of the CBMS no significant changes have been observed in population abundances that might suggest any kind of regression.

It is worth remarking, however, that the Orange Tip has undergone a considerable expansion in recent years in much of its northern European range[13], coinciding with climatic warming. Although this phenomenon could well have negative effects on populations of this butterfly in the Mediterranean region, the lack of detailed information means that no conclusions can yet be drawn regarding this process. The CBMS will be able to provide important information over the coming years.

Jordi Dantart

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

[2] García-Barros, E., Munguira, M. L., Martín Cano, J., Romo Benito, H., Garcia-Pereira, P. & Maravalhas, E. S., 2004. *Atlas de las mariposas diurnas de la Península Ibérica e islas Baleares (Lepidoptera: Papilionoidea & Hesperioidea)*. Monografías SEA, 11, Zaragoza.

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[13] Parmesan, C., Ryrholm, N., Stefanescu, C., Hill, J. K., Thomas, C. D., Descimon, H., Huntley, B., Kaila, L., Kullberg, J., Tammaru, T., Tennent, W. J., Thomas, J. A. & Warren, M. S. 1999. "Poleward shifts in geographical ranges of butterfly species associated with regional warming". *Nature*, 399: 579-583.

Fig. 1. Relative abundance of the Orange Tip *Anthocharis cardamines* (expressed as the annual index/100 m) from the different stations of the CBMS network (1994-2004).

Fig. 2. Phenology of the Orange Tip *Anthocharis cardamines* in (a) Mediterranean environments (data from five stations: Fitor, Can Ferriol, Can Riera de Vilardell, Can Miravitges and Bosc de Valldemaria), (b) Central European environments (data from two stations: Can Jordà and El Puig), and (c) subalpine meadows (data from two stations: Fontllebrera and Campllong).

Fig. 3. Variation in the mean flight period of the Orange Tip *Anthocharis cardamines* (days from January 1 onwards) for the whole CBMS network (104 flight periods from 1994-2000), in terms of average January-March temperatures.

Photo 1. (a) A male Orange Tip at rest. Thanks to the patterning on the underside of its hind-wings, it is well camouflaged, above all when it sits on crucifer flowerheads (for example during bad weather or at night); and (b) Fourth and final instar larvae on *Arabis* sp. (photographs: J. R. Salas).

Drawing. Last instar larva and pupa of the Orange Tip on *Arabis* sp. (from Hofmann, E., 1893. *Die Raupen der Gross-Schmetterlinge Europas*. Verlag der C. Hoffman'Schen, Stuttgart).

Identification

How to distinguish the species of hairstreak of the genus *Satyrium*

A group of five similar species of hairstreak (White-letter Hairstreak *Satyrium w-album*, Blue-spot Hairstreak *S. spini*, Ilex Hairstreak *S. ilicis*, False Ilex Hairstreak *S. esculi* and Sloe Hairstreak *S. acaciae*) are recorded in many CBMS stations and at times can be difficult to separate. In many transects, two, three or even four of these species fly together and can cause confusion during counts, above all if the False Ilex and Ilex Hairstreaks are on the wing together.

The False Ilex Hairstreak appears in most CBMS stations, above all in those in Mediterranean areas (Holm Oak woodland and garrigue) where it often reaches very high densities, and less commonly in the pre-Pyrenees and the Pyrenees. The Blue-spot Hairstreak is far more local and occupies a variety of habitats, always in dry open areas, ranging from lowland Mediterranean to subalpine areas. The other three species are far more associated with central European-type habitats: the Ilex and Sloe Hairstreaks are abundant in the Pyrenees, pre-Pyrenees and the mountains of the Serralada Transversal, although they become rather more local in mountainous zones in southern Catalonia. The White-letter Hairstreak lives in the Pyrenees and the Serralada Transversal as far south as the Montseny mountains, as well as in the Empordà plain[1]. Owing to its liking for tree tops, it is much harder to detect.

The caterpillars of all these species feed on the leaves or buds of trees and bushes. The White-letter Hairstreak uses Elms[2,3] (Wych Elm *Ulmus glabra* and Small-leaved Elm *U. minor*); the Blue-spot feeds on various species of Buckthorn *Rhamnus*[2]; both the Ilex and False Ilex feed on oaks (the former prefers deciduous species such as Downy Oak *Quercus humilis*[4] and the latter Holm Oak *Q. ilex* or Holly Oak *Q. coccifera*); finally, the Sloe Hairstreak, as its names suggests, feeds on Sloe *Prunus spinosa*[4]. All have similar biological cycles: eggs are laid on the base of branches (for example, the Ilex Hairstreak[5]), where twigs join or at the base of leaf shoots. The larvae hatch in the spring to coincide with the spring growth of fresh leaves and pupate at the end of spring on the leaves or branches of the host plant. All fly in a single generation between May and July according to altitude.

Jordi Dantart

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Drawings

WHITE-LETTER HAIRSTREAK
Upperside (general): very dark brown with an orange spot in the rear corner of the hind-wing; tails longer than in other Hairstreaks.
Underside (general): paler, with a marked white postdiscal streak and submarginal orange lunules with a blue-black spot in S1 and a black spot in S2.
Marked with line:
Upperside (male): small, oval-shaped sex-brand (androconia) at the end of the cell.
Underside (general): a diagnostic white postdiscal line in form of a *w*.

BLUE-SPOT HAIRSTREAK
Upperside (general): dark brown with orange spots on the corner of the hind-wing and in S1 and S2 (often not very clear).
Underside (general): paler with a straight postdiscal line on both wings; orange submarginal lunules bordered with black on their inner margin.
Marked with line:
Upperside (male): small, oval-shaped sex-brand (androconia) at the end of the cell.
Underside (general): large blue submarginal spot bordered with black in S1.

ILEX HAIRSTREAK
Upperside (general): dark brown, with an orange spot in the corner of the hind-wings and sometimes in S2.
Underside (general): paler, with submarginal orange spots bordered with black on their inner and outer margins.
Marked with line:
Upperside (female): usually large orange postdiscal spot on fore-wings.
Underside (general): a white postdiscal line insinuating a *w* (not always evident, but it separates this species from False Ilex Hairstreak when it is).

FALSE ILEX HAIRSTREAK
Upperside (general): dark brown, with orange spot in corner of hind-wings.
Underside (general): paler, greyish in males and brownish in females.
Marked with line:
Upperside (female): females often lack orange postdiscal mark on fore-wings.
Underside (general): white transversal lines in S1b, S1 and S2 that do not insinuate a *w*.

SLOE HAIRSTREAK
Upperside (general): dark brown, with orange marks (not always present) in corner of hind-wing and in S1 and S2.
Underside (general): paler, light greyish, with a straight postdiscal line made up of a series of small white dashes.
Marked with line:
Upperside (female): a few black scales on the tip of the abdomen.
Underside (general): orange submarginal lunules, as well as a blue spot in S1 and a black spot in S2.

The distinctive features are all found on the underside of the wings. The White-letter Hairstreak is recognisable by the white postdiscal line forming an obvious *w*. The Blue-spot Hairstreak has a large blue submarginal spot bordered with black in S1. In the Sloe Hairstreak the submarginal series of orange spots includes a blue spot in S1 and a black spot in S2. Separating the Ilex and False Ilex Hairstreaks is more difficult: usually the white postdiscal line in S1b, S1 and S2 insinuates an open *w* in the Ilex Hairstreak, but not in the False Ilex; as well, the ground colour of the hind-wing in the Ilex Hairstreak tends to be darker.

Identification

How to separate the Catalan species of the genus *Colias*

One of the commonest species of butterflies in Catalonia is the Clouded Yellow *Colias crocea*. However, in limestone areas it can be confused with Berger's Clouded Yellow *C. alfacariensis*. A third *Colias* species, the Mountain Clouded Yellow *C. phicomone*, lives in alpine areas and can be separated from the other two species easily. The presence of Pale Clouded Yellow *C. hyale* in Catalonia, very similar to Berger's Clouded Yellow, has yet to be confirmed.

The Clouded Yellow has been recorded from all 74 CBMS stations that thus far have provided data. It is abundant in meadows and ruderal environments, from sea-level to alpine habitats and flies in various generations from the end of winter until well into autumn. The larvae grow rather more slowly in winter, but never actually enter into diapause: thus in mild winters it is not rare to see adult Clouded Yellows on the wing in January and February. Permanent populations survive in Catalonia and are reinforced by migrants from Africa in spring and at the beginning of summer, and then by migrants from northern Europe in September and October[1]. Eggs are laid on a variety of Papilionaceae species, although the most widely chosen plants are Lucerne *Medicago sativa*, Red Clover *Trifolium pratense* and Common Bird's-foot Trefoil *Lotus corniculatus*[2]. Berger's Clouded Yellow also lives throughout much of Catalonia and has appeared in 57% of CBMS stations. Nevertheless, this species only maintains permanent populations in areas of limestone substrata where its food plant Horseshoe Vetch *Hippocrepis comosa* grows and elsewhere only appears sporadically as a result of its dispersive capacity. Berger's Clouded Yellow is a multi-voltine species with up to three annual generations from spring through to autumn. The Mountain Clouded Yellow is an alpine species that lives in alpine meadows in the Pyrenees above 1,800 m.

Constantí Stefanescu

[1] Stefanescu, C., 2000. "El Butterfly Monitoring Scheme en Catalunya: los primeros cinco años". *Treb. Soc. Cat. Lep.*, 15: 5-48.

[2] C. Stefanescu, unpublished data.

[3] Lewington, R., 2003. *Pocket Guide to the Butterflies of Great Britain and Ireland*. British Wildlife Publishing, Hampshire.

Drawings

CLOUDED YELLOW
Upperside (general): intense yellow-orange with a broad black margin on fore- and hind-wings.
Upperside (f. *helice*): approx. 10% of females (the so-called *helice* form) are white rather than yellow.
Marked with line:
Upperside (male): no yellow marks within black margin.
Upperside (female): various obvious yellow spots within black margin.
Upperside (f. *helice*): broad black margin, very visible on hind-wing.
Upperside (f. *helice*): obvious suffusion of grey scales on hind-wing.

BERGER'S CLOUDED YELLOW
Upperside (male): Characteristic lemon-yellow colouration with yellow spots within the upper part of the black margin on the fore-wing.
Upperside (female): white, and similar to the *helice* form of the Clouded Yellow.
Marked with line:
Upperside (female): black margin on hind-wing reduced to a few marginal spots.
Upperside (female): little suffusion of grey scales on fore-wing.

MOUNTAIN CLOUDED YELLOW
Upperside (male): yellowish-green colour with heavy dark-grey dusting.
Upperside (female): whitish-green with less grey suffusion than in male.
Underside: clear contrast between both the yellow on hind-wing and on apex of fore-wing and the greyish-white of the rest of the fore-wing.

All three *Colias* species exhibit marked sexual dimorphism. Confusion can arise between white females of the *helice* form of the Clouded Yellow and females of Berger's Clouded Yellow, although the black margin and the amount of grey suffusion on the hind-wing clearly separate the two species. The lemon-yellow colour of the male Berger's Clouded Yellow is very different from the orange-yellow of the Clouded Yellow. The presence of Pale Clouded Yellow in Catalonia has yet to be confirmed as the adults are all but indistinguishable from those of Berger's Clouded Yellow, although their larvae are rather different[3]. The collection of eggs and the raising of larvae will help to sort out the confusing situation of these two species in Catalonia.

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