CBMS
Catalan Butterfly Monitoring Scheme

cynthia

Bulletin of the Catalan Butterfly Monitoring Scheme 2003 - no. 3

Cover illustrations

Detail of the hind-wing underside of the Spotted Fritillary (*Melitaea didyma*) (photo: A. Miquel).

A scarce butterfly in Catalonia, the Clouded Apollo (*Parnassius mnemosyne*) (photo: J.R. Salas).

Editorial
A bigger *Cynthia* and translated into English

This new edition of *Cynthia* incorporates two important novelties: we have increased the number of pages from 16 to 20 and now include the whole text in English in a central pull-out section.

The number of pages has been increased in order to double the space dedicated to the sites and the identification of difficult species. We believe that these are two of the most popular sections of *Cynthia* amongst CBMS workers since they provide important information on butterfly species-diversity in Catalonia and how to separate look-alike species. The CBMS stations described represent two very different habitats with highly dissimilar butterfly communities: on the one hand, we pay a visit to the deciduous woodlands that dominate the area of Catalonia with a more central European climate (Can Jordà, in La Garrotxa Volcanic Zone Natural Park) and then move on to the Rosemary and White Flax scrublands of the arid southwestern corner of the country (Sebes, near Flix). The identification guides in this edition of *Cynthia* centre on the Gatekeepers (genus *Pyronia*), common throughout Catalonia, and the so-called 'Golden Skippers' (genus *Thymelicus*), a genus that we hope all collaborators will start including in their weekly counts in 2004.

The decision to translate all the texts into English was taken because currently this language is without doubt the international *lingua franca* of scientific discourse and thus we hope that in this way the CBMS network will become better known further afield. If we manage to make our work known beyond the borders of Catalonia, we anticipate that our results will be used more extensively by more butterfly workers and in conservation management.

Aside from these novelties, you will find the habitual sections on the state of the CBMS network, the most significant results from the 2003 season and two reviews of specialized articles (one based entirely on data from the CBMS network on the effects of climatic change on flight periods, and the other on the situation of the two species of Wood White – *Leptidea sinapis* and *L. reali*), as well as a long article on the Two-tailed Pasha (*Charaxes jasius*). This butterfly, one of the most striking species in Catalonia, has been well-studied recently and we now have abundant information at our disposal regarding various aspects of its ecology.

Finally, we would like to take this occasion to thank all those who have provided us with texts, photographs and/or drawings, and to welcome all those who will be walking a CBMS transect for the first time during the 2004 season.

The CBMS network
Current situation of the Butterfly Monitoring Network in Catalonia in 2003

The CBMS celebrated its 10th anniversary in 2003. The number of transects has increased greatly compared to the previous year and now consists of almost 50 stations. The eight new incorporations in 2003 include a transect on the island of Ibiza and one in an extremely species-rich area in the Pyrenees. In all, 110,174 butterflies belonging to 137 species have been recorded.

During 2003 a total of 46 CBMS stations provided complete data (fig. 1) and in a further three the data recorded were not complete enough to calculate annual species indices. The number of transects in the Balearic Islands was increased by the incorporation of a new butterfly walk in the south of the island of Ibiza.

The annual series currently available are shown in figure 2. The six stations that have been operating since the beginning of the CBMS have now provided 10 years of uninterrupted records, while the number of stations with five or more years of records has now reached 26.

New transects

Sant Mateu (Maresme, 425 m). This transect runs through part of the Serralada Litoral - a range of medium-height coastal mountains – in the area around the summit of Turó d'en Baldiri (near the better-known Turó de Sant Mateu). This new site and the established sites at Can Miravitges (139 m) and La Conreria (300 m) make up an altitudinally very interesting series of transects that all lie on the south face of La Serra de Marina. The commonest habitats here are Mediterranean scrub and Holm oak woodland. The transect is partly financed by El Parc Serralada Litoral.

Sales de Llierca (La Garrotxa, 300 m). Located at the foot of the mountains of L'Alta Garrotxa (eastern Pre-Pyrenees) in an area in which Mediterranean and Eurosiberian habitats meet, this transect alternates between abandoned stony terraces, today lightly grazed, and mixed woodland. The butterfly fauna here is one of the most diverse of all the CBMS stations.

Godomar (La Garrotxa, 700 m). This site lies in Batet de la Serra, near Olot, and its transect passes through a series of traditional agricultural environments (cultivated fields and hay-meadows) that are being managed with an eye to increasing the area's biodiversity. This new station means that the CBMS in La Garrotxa Volcanic Zone Natural Park is represented by two sites, of which the Godomar transect is much more Mediterranean than the well-established transect at Can Jordà.

La Nou de Berguedà (Berguedà, 1,130 m). This new transect runs through part of La Serra de Catllaràs, a mountain range lying to the south of the better-known Serra del Cadí. The transect passes around a farm – El Reig – located between La Nou de Berguedà and Malanyeu, and includes grazing meadows and the typical forest formations of the area: Scots pine, Downy oak and Box or Beech and Box, depending on whether the sections run on the south or north side of the mountain. This is one of the richest stations in the CBMS network and boasts well-constituted populations of a significant number of butterfly species.

Aiguabarreig (Segrià, 200 m). Lying at the confluence of the rivers Segre, Cinca and Ebro within the Espai Natural Protegit of Tossals d'Almatret and near the town of Granja d'Escarp, the Aiguabarreig transect enjoys an extremely arid climate in an area dominated by Rosemary and White flax scrub. It is remarkable for being the only area of Catalonia in which the Greenish Black-tip *Elphinstonia charlonia* is known to fly, which here feeds on the crucifer *Boleum asperum*, endemic to this part of the Ebro valley. During its first year, this transect received a grant from the Fundació Territori i Paisatge.

Sal Rossa (Ibiza, 0 m). This first transect on the island of Ibiza is walked near the sea in an area of dunes, scrub, pine woodland and various types of pastureland. Despite the fact that the butterfly fauna is extremely poor, this station does provide valuable information about butterfly migration. It is the southernmost CBMS site and thus the first to receive migrant species crossing the Mediterranean from the north coast of Africa. During its first year the transect received financial help from the L'Escola Taller Hàbitat (an environmental workshop) dependent on the Ministry of the Environment of the 'Consell Insular' of Ibiza and Formentera.

Can Vilar (Vallès Occidental, 200 m). The well-preserved agricultural-forest mosaic near the city of Sabadell is home to this transect. This area could play an important role as a biological corridor within the Vallès plain and operates as a link between the Serres Litoral and Prelitorals (coastal and pre-coastal mountains) and the mountains of La Selva and El Penedès regions. It lies within an area that is part of a project – L'Espai Agroforestal de Llevant - being developed by a number of local town and city councils aimed at protecting the remaining natural areas of the Vallès plain. The most typical habi-

tats of the transect are agricultural, mixed pine and Holm oak woodland and scrublands.

UAB (Vallès Occidental, 200 m). This transect lies in the neighbourhood of the Autonomous University of Barcelona (UAB) and follows two pre-existing on-campus nature itineraries that pass through fallow and abandoned fields, mixed pine and Holm oak woodland and large areas of scrub. The functioning of this site is part of the activities promoted by the Environmental and Protection Service of the UAB and received a grant from La Fundació Territori i Paisatge during its first year.

Habitats represented

The different habitats and plant communities surveyed by CBMS transects in 2003 are shown in table 1. For each station only the dominant plant community has been taken into consideration and secondary communities (those that could be regarded as successional stages) are included within the corresponding climax community. Thus, in table 1, for example, *Cistus* or *Erica* scrub, or agricultural zones, do not appear, even though they may occupy a significant part of a transect. More detailed information concerning the plant communities present in each section of the transects (with their percentage cover) can be consulted in the CBMS database.

The Catalan BMS network is overwhelmingly concentrated in low-lying Mediterranean habitats, in areas dominated by Holm oak forests and by scrublands. Coastal and pre-coastal areas in northern Catalonia are well covered, and provide reliable information regarding fluctuations in butterfly populations in these areas. However, over the last few years there has been an important increase in the number of transects in arid and steppe regions in the southern part of the country and information from these environments is beginning to provide useful clues as to the tendencies of butterfly populations in other areas of Catalonia. Furthermore, a number of strategically placed sites along the Catalan and Balearic coastlines (for example, La Tancada in the Ebro Delta, the mouth of the river Gaià and La Punta de la Móra near Tarragona, and El Cortalet and Mig de Dos Rius in the Aiguamolls de l'Empordà) guarantee valuable information on migratory processes in butterflies. On the other hand, Eurosiberian and high-level subalpine and alpine habitats are under-represented in the CBMS.

Species represented

The list of butterfly species detected in 2003 and in previous years is given in table 2. Thanks to the incorporation of new stations, 2003 was the most species-rich season so far (137 species), although, of these species, only the Peak White (*Pontia callidice*) was new for the CBMS. A single example of this alpine species was recorded on the Campllong itinerary (at 1,300 m), an area that is well below this species' known altitudinal range in Catalonia (1,800 – 3,030 m) (ref. 2). This is thus a highly exceptional record and indicates that occasionally this species disperses great distances from its habitual breeding areas and, along with an imprecise record from La Vall de Peguera[2], suggests that one or more populations of this Pieridae may exist in the area of Els Rasos de Peguera.

On a broader scale, 61 species (51% of the total for 2003) have appeared in more than 10 transects (fig. 3). Given the large number of transects at low altitude, this means that we now possess much important data on the population dynamics of butterflies with predominantly Mediterranean distributions. In a European context, this information is extremely valuable and to a certain extent provides a good complement to the information gathered by BMS networks in northern Europe. A series of butterflies that are common in Catalonia but rare in Europe appear regularly in the CBMS. The following species appeared in more than 10 stations in 2003 (in brackets the SPEC category according to ref. 3 is given): Lulworth Skipper (*Thymelicus acteon*) (SPEC 2), Green-underside Blue (*Glaucopsyche alexis*) and Marsh Fritillary (*Euphydryas aurinia*) (both SPEC 3), Moroccan Orange-tip (*Anthocharis euphenoides*), Iberian Marbled White (*Melanargia lachesis*) and Grayling (*Hipparchia semele*) (both SPEC 4a), Essex Skipper (*Thymelicus sylvestris*), Berger's Clouded Yellow (*Colias alfacariensis*), False Ilex Hairstreak (*Satyrium esculi*), Black-eyed Blue (*Glaucopsyche melanops*), *Aricia cramera*, Provençal Fritillary (*Melitaea deione*), Dusky Heath (*Coenonympha dorus*), Tree Grayling (*Hipparchia statilinus*), Striped Grayling (*Hipparchia fidia*) and Great Banded Grayling (*Brintesia circe*) (both SPEC 4b).

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

[2] Viader, J., 1994. "Papallones de Catalunya. *Pontia callidice* (Hübner, [1800])". *Butll. Soc. Cat. Lep.*, 73: 63-71.

[3] van Swaay, C.A.M. & Warren, M.S., 1999. *Red Data Book of European Butterflies (Rhopalocera)*. Nature and Environment, 99: 1-260. Council of Europe Publishing, Strasbourg.

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

Fig. 1. Geographical situation of all the stations that have participated in the CBMS network (1994-2003), with their official number and name. Also shown is their position regarding the biogeographical regions of Catalonia according to generally accepted boundaries.

Fig 2. Distribution of the annual series that are available for the different stations that have participated in the CBMS (1988-2003).

Fig. 3. Number of CBMS stations in which the 119 species counted in 2003 have been recorded (excluding the skippers (Hesperiidae) because this group is not recorded in the same way in all transects).

Table 1. Habitats and plant communities represented in the CBMS in 2003, 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 one or other of the CBMS stations during 1994-2003. The number of locations in which the species has been detected during the CBMS monitoring is also given (11 possible sites in 1994, 18 in 1995, 20 in 1996, 25 in 1997 and 1998, 30 in 1999 and 2000, 42 in 2001, 41 in 2002 and 46 in 2003). Only those stations where it has been possible to calculate an annual index have been taken into account. Taxonomy according to ref. 4.

10th anniversary of the CBMS
Summary of the 2003 season

The year 2003 was climatically exceptional and Catalonia sweltered in its hottest-ever-recorded summer. These extreme conditions coincided with notable declines in many species, above all in the Satyrinae. Nevertheless, 2003 was a good year for strictly spring-flying species, for those that hibernate as adults and for some of the migrants from Africa. Of the 59 most widespread species recorded from the CBMS network, the annual index of 19 species increased but declined in the remaining 40.

Climate and butterfly counts

The hottest-ever summer recorded in Catalonia made 2003 climatically exceptional, a fact confirmed by data from weather stations with uninterrupted sequences of records[1]. The pattern was repeated throughout Catalonia and the situation came to a head during the first fortnight of August when a series of enormous forest fires broke out in the *comarques* of Bages, La Selva and El Segrià. Unfortunately, the two CBMS transects in the municipality of La Granja d'Escarp (El Segrià) were both devastated by the fires; the impact that they will have on the butterfly fauna of the area will only become clear in a few years time.

Just as Catalonia suffered an exceptional summer, the preceding winter was one of the coldest in recent years. The weather was still cold in March as the CBMS season got underway and many butterflies were not on the wing as early as in other years. However, once the February rains were over, rainfall was at best scarce during the rest of the season. From April onwards the weather took a change for the better: temperatures soared, resulting in one of the hottest springs in recent years – a mere prelude to what was to come.

From the point of view of butterfly counts, this fine weather was very beneficial and only 10% of counts were lost (fig. 1a), one of the lowest figures in the history of the CBMS. On average, only three counts were lost per station, as compared to 3.92 and 3.14 in 2002 and 2001, respectively.

The lost counts were evenly spread throughout the season with almost exactly a third being lost in each of the periods corresponding to weeks 1-10, weeks 11-20 and weeks 21-30. The only really problematical weeks were weeks 5 and 7 (corresponding to the first and third weeks of April) and 27 (first week of September), during which almost one in four stations failed to provide data (fig. 1b).

Changes in abundance: generalities

Climatic conditions in 2003 seriously affected butterfly communities. In general, we could say that these effects were positive in spring but clearly negative once summer had begun. However, given that the strictly spring species represent only a relatively small proportion of the butterflies counted in the CBMS, all in all 2003 was not a good year for butterflies in Catalonia (fig. 2).

Logically, the decline visible in figure 2 was reflected in lower counts from many stations (comparing the sum of counts for all species between 2002 and 2003: 12 increases *vs.* 20 declines: binomial test: $P = 0.053$). The stations where migratory species play an important part in the counts (for example, La Tancada, S'Albufera des Grau and la Punta de la Móra) were an easily explicable exception and were benefited by mass arrivals of Painted Ladies (*Cynthia cardui*). On the other hand, some itineraries in arid zones such as Torà and Olivella actually recorded more butterflies, largely

due to the abundance of the False Ilex Hairstreak (*Satyrium esculi*).

Unlike abundance, species-richness did not fluctuate in the network as a whole (comparing 32 stations, 15 counted more species, 12 fewer and five showed no change; binomial test for increases *vs.* decreases: P = NS).

Changes in abundance: fluctuations in populations

For the third year in succession the False Ilex Hairstreak was the commonest butterfly in the CBMS network and for the second year in a row it achieved the highest overall annual index for any butterfly since the project began (tables 1 and 2). In 2003 populations only rose slightly, but given the high indices recorded in 2002, this meant that once again this species was highly abundant in many stations.

However, in other dominant species 2003 saw a number of important changes in population numbers. For example, the Spanish Gatekeeper (*Pyronia bathseba*), the Small Heath (*Coenonympha pamphilus*), the Large and Small Whites (*Pieris brassicae* and *P. rapae*) and the Wood White (*Leptidea sinapis*) all decreased noticeably in number, while the Painted Lady (*C. cardui*), the Green Hairstreak (*Callophrys rubi*) and the Marsh Fritillary (*Euphydryas aurinia*) all increased spectacularly. Of the 59 commonest species in the CBMS network, the annual index dropped in 40 cases and increased in 19 cases (binomial test: $P < 0.01$), a proportion that differed greatly from the previous year and reveals the general negative tendency in the CBMS network in 2003 (table 2). Overall, the populations of these 59 species showed 442 increases and 653 decreases in annual indexes (binomial test: $P < 0.001$).

Table 2 shows that a certain regularity can be observed in the changes occurring in 2003. Firstly, most strictly spring species (for example, the Orange Tip *Anthocharis cardamines*, the Moroccan Orange Tip *Anthocharis euphenoides*, the Green Hairstreak *C. rubi*, the Panoptes Blue *Pseudophilotes panoptes* and the Marsh Fritillary *E. aurinia*) increased their annual indices. Secondly, there were significant increases (resulting in their highest-ever annual indices since the CBMS begun) in butterflies such as the Brimstone (*Gonepteryx rhamni*), the Nettle-tree Butterfly (*Libythea celtis*) and the Large Tortoiseshell (*Nymphalis polychloros*) that hibernate as adults. Finally, there was evidence of a general decrease in numbers of Satyirinae: 12 of the 13 species in table 2 decreased significantly in 2003, while some species such as the Tree Grayling (*Hipparchia statilinus*), the Striped Grayling (*Hipparchia fidia*), the Southern Gatekeeper (*Pyronia cecilia*), the Pearly Heath (*Coenonympha arcania*) and the Wall Brown (*Lasiommata megera*) dropped to all-time CBMS lows. The coincidence of these trends in Satyrinae is extremely interesting and the implication is that the climatic conditions are the cause. Nevertheless, we cannot be sure if butterfly populations responded in such a negative way to the particular climatic conditions present in summer 2003, to the remarkably high rainfall of summer 2002 (which could have affected female egg-laying) or to the combined effect of both factors. Whatever the cause, data from 2003 show how changes work in synchrony and, when further analysed with more sophisticated statistical methods, will undoubtedly reveal much more important information.

Finally, we should note that 2003 was an exellent year for migrant butterfly species. The Painted Lady stands out above other migrants and reached its second highest annual index since the CBMS began. The importance of the migration in 2003 is revealed by figures from 34 stations with comparable figures for 2002 and 2003: 32 of these stations showed increases and just 2 stations decreases in the annual index. As is habitual, the bulk of Painted Ladies were counted in May as they migrated north[2]. Nevertheless, unlike other years, there was also an important increase in Painted Ladies recorded at the end of summer, corresponding to butterflies migrating south.

Other migratory species that increased their annual indices were the Long-tailed Blue (*Lampides boeticus*), Lang's Short-tailed Blue (*Leptotes pirithous*) and the Plain Tiger (*Danaus chrysippus*). After three years absence, the Plain Tiger appeared again in the CBMS counts in three coastal stations (La Tancada, Mig de Dos Rius and El Cortalet). A parallel study of the butterfly was carried out in the breeding colony that established itself on L'Illa de Buda in the Ebro delta. It was shown that the migrants that arrived in July produced a first local generation during the second half of August that then subsequently gave way to a second local generation at the end of September and the beginning of October. Maximum numbers were observed on the coast during autumn as locally bred butterflies dispersed further afield[3].

[1] Gàzquez, A. & Prohom, M., 2003. "L'estiu de 2003 a l'observatori Fabra. Comparativa amb la sèrie 1914-2003". *Penell*, 16: 10-12.

[2] Stefanescu, C., 2002. "*Cynthia cardui*, una papallona migradora per excel·lència". *Cynthia*, 1: 14-15.

[3] P. Luque, Ll. Julià & C. Stefanescu, dades no publicades.

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

Fig. 1. (a) Degree of cover in the CBMS stations and (b) distribution of weeks without counts during the 30 official weeks of the CBMS season (March 1 – September 26).

Fig 2. Ranking of different CBMS seasons in terms of general abundance of the 54 commonest butterflies in the CBMS network. The best season was 2002 and the worst 1998. Calculations were made following the methodology described in ref. 4.

Table 1. Sum of the annual indices and order of abundance of the 20 commonest species in the CBMS network in 2003 compared with the 2002 season.

Table 2. Evolution of the overall annual indices of the 59 commonest butterflies in the CBMS network (1994-2003) on the basis of an arbitrary value of 100 for the 1994 season. Also indicated are the number of species that have risen and declined in each 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. In 2003 the annual index of the Nettle-tree Butterfly (*Libythea celtis*) increased throughout Catalonia and reached its highest level since 1994. This increase began in 1999 and has continued progressively, a fact that may indicate that this species displays cyclical abundance peaks. Normally, most butterflies of this species are seen in March-April, corresponding to hibernating adults born in May-June of the previous year. Just after leaving hibernation, they are often seen taking nectar from willow catkins before beginning an intense reproductive period during which females spend a long time around Nettle-trees *Celtis australis*, the larval food plant, on which they lay their eggs on buds that are about to open. Males also gather around these trees, waiting to mate with the females as they arrive (drawing: T. Llobet).

Photo. A large forest fire, declared on August 12 in the *comarca* El Segrià, burnt 1,900 ha, of which 1,500 ha belonged to the municipality of La Granja d'Escarp. The two transects that are walked here were both completely devastated by the fire, as can be appreciated from this photograph of the Aiguabarreig butterfly walk. It remains to be seen what impact the fire will have on the butterflies of the area, which is well-known as the only Catalan site of the crucifer *Boleum asperum* and the Pieridae the Greenish Black-tip *Elphinstonia charlonia* (photo: M.C. Roca).

CBMS sites

Can Jordà, a characteristic part of La Garrotxa Volcanic Zone Natural Park

The Can Jordà butterfly walk was one of the first transects to be incorporated into the CBMS network and has provided records since 1994. Despite lying at fairly low altitude, it is one of the group of transects located within more Eurosiberian habitats that boast the greatest wealth of butterfly numbers and species.

The transect

Although the Can Jordà transect is located at just 540 m above sea level, it still lies firmly within an area of central European climate with average annual temperature and rainfall of 12.5ºC and 1,098 mm, respectively. The vegetation present along the transect is determined largely by orientation and land-use. The first sections (1-6) are north-facing and are characterised by relatively humid pastureland, typical of montane habitats, mixed deciduous woodland composed of Downy oak (*Quercus humilis*), Ash (*Fraxinus excelsior*), Black poplar (*Populus nigra*), Small-leaved elm (*Ulmus minor*) and White willow (*Salix alba*), and clearings dominated by Common nettles (*Urtica dioica).* In contrast, the last few sections (9-13) are south-facing and for the most part cross an area of volcanic substrate clothed by a Montane holm oak (*Quercus ilex ilex*) forest interspersed with Broom (*Sarothamnus scoparius*) and Bracken (*Pteridium aquilinum*) scrub. The two central sections (7-8) bisect a series of ruderal environments consisting of periodically harvested fields of Maize (*Zea mays*) and Alfalfa (*Medicago sativa*), as well as mature hedgerows of Blackthorn (*Prunus spinosa*), Hawthorn (*Crataegus monogyna*) and Bramble (*Rubus ulmifolius*) (table 1).

The butterfly fauna

During the 10 years the transect has been operating over 45,000 butterflies belonging to 81 species (54% of all the species recorded from the CBMS network) have been detected. Annual averages are situated at around 4,500 butterflies (263.3 butterflies/100 m) and 59.6 species and, of the 15 commonest species (fig. 1), the first four are all Satyrinae.

Overall annual phenological patterns exhibit three marked groups of species peaking at three different moments of the year. The first group peaks in mid-April and corresponds to univoltine butterflies such as the Green Hairstreak (*Callophrys rubi*) and the Orange Tip (*Anthocharis cardamines*), as well as the first generations of the Scarce Swallowtail (*Iphiclides podalirius*), the Holly Blue (*Celastrina argiolus*), the Wood White (*Leptidea sinapis*) and the Map Butterfly (*Araschnia levana*). The second peak, with greater numbers of butterflies, comes at the beginning of July and typically includes univoltine species such as the Pearly Heath (*Coenonympha arcania*), the Ringlet (*Aphantopus hyperantus*) and

the Iberian Marbled White (*Melanargia lachesis*), as well as the first Meadow Browns (*Maniola jurtina*) and White Admirals (*Limenitis camilla*). The third peak becomes obvious at the beginning of August, above all when the Gatekeeper (*Pyronia tithonus*) begins to fly, at the same time as the Silver-washed Fritillary (*Argynnis paphia*) and the second generations of the Scarce Swallowtail (*I. podalirius*), the Short-tailed Blue (*Cupido argiades*), the Provençal Short-tailed Blue (*Cupido alcetas*) and the Small Heath (*Coenonympha pamphilus*).

Aside from the Gatekeeper, the most abundant species is the Meadow Brown. Despite being a univoltine species, its phenology is bimodal and two clearly separate peaks in the numbers of individuals are recorded in the counts. Most of the population emerges in late May and at the beginning of June; however, females begin to aestivate very soon afterwards and do not reappear until the heat of the first half of August has diminished. Males also aestivate, although in smaller numbers. This is a typical strategy in Mediterranean environments and ensures that eggs are laid when temperatures are lower and after the first end-of-summer rains have fallen, thereby guaranteeing that caterpillars find tender grass shoots when they emerge. It is interesting to note that the Meadow Brown uses this strategy in an area such as Can Jordà with an Atlantic-type climate.

Other typical species from the transect are Pearly and Small Heaths, the Iberian Marbled White and the Common Blue (*Polyommatus icarus*). All are closely tied to grasslands: Pearly Heaths and Iberian Marbled Whites choose areas of tall, dense grass, whereas Small Heaths are found in areas of shorter grass that have been grazed for many years. The Common Blue also appears in grazed sections wherever there are abundant nectar sources and appropriate conditions for its food plants Black medick (*Medicago lupulina*), Red clover (*Trifolium pratense*) and Bird's-foot trefoil (*Lotus corniculatus*).

Along with the Map Butterfly (see drawing), one of the most interesting butterflies recorded from the transect is the Chestnut Heath (*Coenonympha glycerion*), a scarce butterfly in Catalonia that is commonest in the Pyrenees and Pre-Pyrenees. At Can Jordà, there is a small and very localised population in section 5, which runs through an abandoned field, now covered by thick grass and gradually being invaded by Juniper (*Juniperus communis*), Roses (*Rosa* sp.), Blackthorns and Brambles. The CBMS transect will determine how this secondary succession is affecting the population of this butterfly and will thus be able to decide if management is needed (for example, the removal of invading shrubs) in order to prevent habitat change leading to the loss of the species.

The CBMS and pasture management

After analysing recent data by 1996 it had become obvious that overgrazing by cows was badly affecting the butterfly populations of the pastures in the transect. From that year onwards, a series of experimental counts were carried out in three parallel sections that were designed especially to see which type of grazing was the most beneficial for the butterfly populations. Counts were made in an overgrazed pasture, a field without cows and in a pasture subject to strictly controlled, low-pressure grazing. The fact that the first four sections of the transect, as well as the three experimental sections, run through an estate belonging to the natural park makes it much easier to carry out this type of experiment here than in a privately-owned estate.

The data obtained have shown that grazing in winter and for a few weeks before the summer encourage greater species-diversity (average 37 species), while overgrazing has negative effects (average of 24 species) and only favours generalist species. The non-grazed pasture tends to become more homogeneous, being dominated by tall grasses and then quickly invaded by bushes, and tends towards a loss of species-diversity.

These management techniques have been successfully applied in some of the sections of the main transect. As a result, species-richness has increased, demonstrating that areas affected by human activity can be managed to not only offset possible negative influences but also to positively benefit butterfly populations.

Jordi Artola

Fig. 1. Average abundance (average of the annual indices for the period 1994-2003) of the 15 commonest butterflies at Can Jordà.

Table 1. Environments represented in the Can Jordà transect with their corresponding values for species-richness and density (average of the group of sections within each environment ± standard deviation). Data from 2001-2003 have been used.

Transect route of Can Jordà. The transect lies within La Garrotxa Volcanic Zone Natural Park in the municipality of Santa Pau (near Olot, Girona province) and describes a circle around the farm of Can Jordà itself. It consists of 13 sections that, despite changes in land-use, have not been altered since 1994; the total length is 1,715 m, with an average of 132 m per section (range 68-260 m).

Drawing. The Map Butterfly (*Araschnia levana*) is one of the most characteristic butterflies at Can Jordà and is closely associated with banks of nettles growing in clearings in deciduous forests. Females have the peculiar habit of laying clusters of a dozen or so eggs in batches, one on top of each other, always on nettles. It is a polyvoltine species, with the main part of the first generation flying in April, the second on the wing during the first half of July and the third flying at the end of August (drawing: T. Llobet).

Photo. Section 1 of the transect of Can Jordà, in the summer 2003 (photo: J. Artola).

CBMS sites

Sebes, a site in an area characteristic of the arid environments of Catalonia

A transect in the Sebes natural reserve was incorporated into the CBMS in 2001 and, along with four sites in the Segrià region (Mas de Melons, Timoneda d'Alfés, Granja d'Escarp and Aiguabarreig), now provides valuable information regarding the butterflies of the most arid areas of Catalonia.

The walk

The transect passes through the dry surroundings of the Sebes natural reserve (municipality of Flix in the *comarca* of Ribera d'Ebre), a wetland located on the left-bank of the river Ebro. The average annual rainfall is just 369 mm and the mean annual temperature is 16ºC; climatic conditions are extremely xeric and there is a significant water deficit (calculated at 400-500 mm per year). Summer is exceptionally hot and, of all the CBMS itineraries, Sebes has the highest mean temperature for the hottest month of the year (26.1º C, July).

The best represented plant communities are dry grasslands (for example, calcareous therophytic communities, grasslands composed of Mediterranean false-brome (*Brachypodium retusum*), *B. phoenicoides* and Needle-grasses (*Stipa* spp.)), scrub dominated by Rosemary (*Rosmarinus officinalis*) and garrigue dominated by Holly oak (*Quercus coccifera*). Within these communities, common plants include *Cistus clusii*, *Thymus vulgaris, Rhamnus lycioides* and Phoenician juniper (*Juniperus phoenicea*). In floodable areas (sections 1 and 5), beds of Common reed (*Phragmites communis*) and Tamarisks (*Tamarix* spp.) appear, while the hillside in sections 7 and 8 consist of semi-bare calcareous areas with sparse or all but non-existent vegetation. Typical lowland ruderal vegetation appears here with Downy safflower (*Carthamus lanatus*) and grasses such as *Aegilops geniculata* and *Bromus rubens* present along the edges of olive and almond groves from the beginning to the end of the transect.

The Reserva Natural de Fauna Salvatge de Sebes was declared a protected area in 1995 and its management plan - drawn up by the *Fundació Territori i Paisatge* – aims to increase the overall biodiversity of the area. The reserve is run jointly by Flix Town Council and the *Departament de Medi Ambient de la Generalitat de Catalunya* (the Ministry of the Environment of the Catalan Autonomous Government) and *Grup de Natura Freixe*, a local naturalist group and non-governamental organisation. Most of the management work carried out in the reserve is centred on the marshland and barely affects the BMS transect.

The butterfly fauna

As is normal in areas of Catalonia subject to a severe hot climate, the butterfly fauna is not very diverse and population densities are low. During the three years the transect has been walked (2001-2003), 1,828 butterflies belonging to 45 species have been counted, with an annual average of 34 species. For the itinerary as a whole, we have calculated a density of 48.2 butterflies/100 m, almost 10 times less than some of the CBMS sites in the north of the country. The diversity and abundance of butterfly populations are similar to those of sites in the Segrià region and are fully representative of the butterfly communities present in southwest Catalonia.

A noticeable fact that sets this type of butterfly community apart is the concentration of activity during the first part of the season (fig. 1). Most butterflies are observed during April and May, from which point butterfly numbers drop, reaching minimum levels in August and September. This can be interpreted as an adaption to the severe summer drought that makes nectar sources and food plants all but impossible to come by from mid-June onwards.

This phenological peculiarity is reflected in not only a high pecentage of univoltine spring species (almost 30%), but also in a relatively greater abundance of butterflies of polyvoltine species in spring as opposed to summer generations. For example, 91% of Large Whites (*Pieris brassicae)* have been recorded between March and May, a fact that indicates that there are no summer generations in this area because butterflies migrate away from the area when conditions are unfavourable.

The commonest species are shown in figure 2: the most important are the Small White (*Pieris napae*), the Dappled White (*Euchloe crameri*), the Large White and the Bath White (*Pontia daplidice*), all members of the Pieridae that are closely associated with the crucifers growing in the low-intensity arable fields of the area. The Common Blue (*Polyommatus icarus*), the only relatively abundant Lycaenidae, is another opportunistic species and is found, above all, in ruderal environments where Clovers (*Tri-*

folium spp.) and Medicks (*Medicago* spp.) grow. The most representative Satyrinae are the Striped Grayling (*Hipparchia fidia*), the Wall Brown (*Lasiommata megera*), Spanish (*Pyronia bathseba*) and Southern Gatekeepers (*Pyronia cecilia*), the Western Marbled White (*Melanargia occitanica)* and the Dusky Heath (*Coenonympha dorus*), all commonly found in xeric Mediterranean habitats and feeding on the common grasses of therophytic grasslands such as Mediterranean false-bromes and Needle grasses.

This BMS transect, however, has also detected the presence of a number of butterflies such as the Sooty Orange Tip (*Zegris eupheme*), the Blue-spot Hairstreak (*Satyrium spini*), the Provence Hairstreak (*Tomares ballus*), the Spanish Marbled White (*Melanargia ines*) and the Mediterranean Skipper (*Gegenes nostrodamus*) that are only very locally distributed in Catalonia. Of special interest are the Provence Hairstreak and the Lulworth Skipper (*Thymelicus acteon*), the only two Catalan species of butterfly that are classed as SPEC2 species – a category that includes all those species whose global distribution is concentrated in Europe and which are considered threatened in Europe – in the Red Data Book of European Butterflies (see *Cynthia*, 2(2002): 12).

The beginning of entomological research in the Sebes reserve

The declaration of Sebes as a reserve saw the beginning of intensive entomological investigation in the area, the first such work carried out in the interior of Tarragona province, an area that up to then had almost been completely ignored by Catalan entomologists. Most work has been carried out on the insect communities inhabiting the wetland habitats of the left-bank of the Ebro river, although some studies have been made of the garrigue and olive-grove communities in surrounding areas. In all, this multi-disciplinary work covering as diverse orders as the Lepidoptera, Hemiptera, Coleoptera and Orthoptera has discovered over 500 species of insect in an area hitherto all but unstudied. Some discoveries, moreover, represent new species for both Catalonia and the Iberian Peninsula. A summary of all these studies can be found in the magazine *Aljub* published by the Flix naturalist group Freixe (http:/www.fut.es/~freixe; e-mail: freixe@tinet.fut.es).

Pere Josep Jiménez & Constantí Stefanescu

Fig. 1. Phenological curves of the number of individuals and species detected on a weekly basis in the Sebes BMS itinerary. The weekly averages for the three years the transect has been walked are shown.

Fig. 2. Average abundance (average of the annual indices during 2001-2003) of the 15 commonest butterflies in the Sebes CBMS site.

Transect route of Sebes. The average altitude of the itinerary is only 56 m and its total length is 1,264 m. Its nine sections, of average length 140 m (range: 48-252 m), begin alongside a reed bed, before climbing up onto the low hills that surround La Vall de Sant Joan.

Photo. The Sebes transect from the hill in section 7. On the right lies the river Ebro and its associated wetland habitats and, on the opposite bank, the chemical plants in Flix (photo: P. J. Jiménez).

Drawing. The Dappled White (*Euchloe crameri*) is one of the commonest and most representative butterflies in the Sebes CBMS site and other nearby semi-steppe areas. It is mainly on the wing in spring, with an abundant first generation in March-April and then a less abundant and partial second generation in May-June. This phenology means that the larvae can specialise on a specific and very nutritive group of food plants: the buds of the various species of crucifer (for example, *Sisymbrium irio, Biscutella laevigata, Brassica* spp., and *Erucastrum* spp.) that appear in dry arable fields at the beginning of spring (drawing: T. Llobet).

Review

Stefanescu, C., Peñuelas, J. & Filella, I., 2003

Effects of climatic change on the phenology of butterflies in the northwest Mediterranean Basin

***Global Change Biology*, 9: 1494-1506.**

Climatic change has evolved from just a hypothesis to a scientifically demonstrated phenomenon: temperature increases on a planetary scale are now an all but obligatory point of reference in any attempt at understanding the many changes occurring within our environment. The authors of this study have investigated the relationship between temperature rise and observed changes in butterfly phenology and show how in a mere 15 years the biological rhythms of many species have changed hand-in-hand with climate change.

This article - published by the prestigious journal *Global Change Biology* - is the first contribution by the CBMS to the body of knowledge concerning climate change. It also represents the first attempt at examining the effects of global warming on Mediterranean butterflies. Based on the relationship between changes observed in the phenology of 19 species of butterfly and temperature increases in the CBMS transect at El Cortalet (Aiguamolls de l'Empordà Natural Park), this study uses 15 years of records, the longest series from any CBMS site.

Butterflies are ideal insects for studying the effects of climate change given that they are poikilotherm creatures that cannot regulate their body temperatures metabolically and are thus much affected by environmental temperatures. Furthermore, BMS transects provide data series that are perfect for studying phenomena only detectable on long time scales: year in, year out they provide standardised data that permits exhaustive monitoring of the flight periods of the principal butterfly species in a particular locality.

Data from the weather station situated at the start of the transect at El Cortalet show that there was no significant variation in annual temperatures (average 15.2ºC) or annual rainfall (average 624 mm) between 1984 and 2002. However, the months of February, March and June did all become progressively warmer and November colder during this period.

Between 1988 and 2002 the timing of the flight period of 16 species of butterfly was earlier, and in five cases – the Holly Blue (*Celastrina argiolus*), the Silver-studded Blue (*Plebejus argus*), the Small Heath (*Coenonympha pamphilus*), the Wall Brown (*Lasiommata megera*) and the Large Skipper (*Ochlodes venata*) – this advance is statistically significant. One of the other phenological parameters studied – abundance peaks during first generations – also came earlier in 16 species, and significantly so in eight cases: the Green-veined White (*Pieris napi*), the Holly Blue, the Silver-studded Blue, the Iberian Marbled White (*Melanargia lachesis*), the Gatekeeper (*Pyronia tithonus*), the Small Heath, the Wall Brown and the Large Skipper. Finally, in three species – the Clouded Yellow (*Colias crocea*), the Small Heath and the Mallow Skipper (*Carcharodus alceae)* - flight period length increased on average by 1.5 weeks. These results suggest that phenological responses differ from one species to another and in certain cases patterns may be taxonomically defined. The clearest case is that of the Satyrinae, a group that has responded to environmental changes in a more marked fashion than any other.

Finally, the authors describe a negative relationship between the phenological variables mentioned above and temperatures in February and March, the months that immediately precede the emergence of adult insects in most of the butterfly species studied. This result is closely linked to the fact that there is a close relationship between environmental temperatures and larval and pupal development in insects and thus in the date of adult emergence.

It is still too early to make accurate predictions regarding the effects of climate change on Mediterranean butterfly populations. We should take into acount the fact that abundances are influenced by many factors such as alterations in habitat that all work simultaneously. Nevertheless, general patterns in climate change in the Mediterranean region are becoming increasingly clear. Aside from rises in temperature, there seems to have been an increase in the variability of precipitations, which could lead to increased aridity and greater subsequent risk of population extinctions[1]. In this context it is forseeable that environmental conditions will deteriorate for many species as summer droughts increase the length of unfavourable periods. The speed of climate change and genetic variability in species will be crucial factors in any explication of the extent to which new environmental scenarios are leading towards the decline or even disappearance of our butterflies.

[1]McLaughlin, J.F., Hellmann, J.J., Boggs, C.L. & Ehrlich, P.R., 2002. "Climate change hastens population extinctions". *Proc. Natnl Acad. Sci. USA*, 99: 6070-6074.

Sergi Herrando

Photo. Cover of the October 2003 issue of the journal *Global Change Biology* with the magnificent photograph by Josep Ramon Salas of an Iberian Marbled White (*Melanargia lachesis*) used to illustrate the article discussed in this section.

News

Leptidea sinapis and *L. reali*, sibling species as yet poorly known in Catalonia

Since it was realised in 1988 that the species hitherto known as the Wood White (*L. sinapis*) was in fact two different species, a considerable number of authors have provided data on the difference between these two taxa and their status in much of Europe. In the Iberian Peninsula, on the other hand, we are only just beginning to collate information about these two species of Pieridae.

Today evidence of all sorts points to the fact that *Leptidea sinapis* and *L. reali* are in fact two good species that are practically indistinguishable purely on the basis of their external morphologies. The first studies[1] into the question highlighted the fact

that constant differences in the two species in the male and female genitalia would seem to indicate the existence of a mechanical prezygotic mechanism that ensure reproductive isolation. This is an important factor given that the two species coexist in many areas and thus there seems to be a need for an isolating reproductive mechanism that will have led to a sympatric process of speciation. Further studies[2] have proven that this isolation is ethological and takes place before copulation, since females are able to recognise the males of their own species. It has been suggested that the males of both species emit different pheromones.

Ecological differences are far vaguer[2]. For example, in central Europe, there are established differences in the food plants used: Meadow vetchling (*Lathyrus pratensis*) in the case of *L. reali* and Bird's-foot trefoil (*Lotus corniculatus*) in *L. sinapis*. Nevertheless, the larvae of both species clearly prefer the second of these two plants and enjoy greater fitness when they feed on it. This and other observations would seem to indicate that the two taxa have only recently separated.

The most recent contributions to the debate have come from the field of molecular biology and are even more conclusive. In a very recent study[3] based on the analysis of variability in mitochondrial DNA, 16 enzymatic alleles and four morphological characters in the male genitalia, a strong correlation has been found between all these variables that fully support the validity of these two species.

A recent study based on a sample of 400 insects has provided the first data on the distribution and phenology of these species in Catalonia[4]. This study has shown that both species co-exist in many areas and adult flight periods overlap. In terms of distribution, *L. sinapis* is a more generalist species when it comes to ecological preferences and is found throughout Catalonia with a altitudinal distribution of 0 to 2,000 m, but preferably below 600 m. *L. reali*, on the other hand, is more of a specialist and prefers more humid environments and, despite the lack of data, would seem to be distributed in the northern half of the country. Although their altitudinal distribution is essentially similar, *L. reali* is especially abundant in montane (600-1,400 m) habitats. The phenology of the two species in Catalonia is as yet unclear, although it does seem that at lower altitudes both species are trivoltine, but that at greater altitude the number of generations is reduced. Regarding the food plants, it has been shown that, besides *L. pratensis* and *L. corniculatus*, *Dorycnium pentaphyllum*, *D. hirsutum*, *Vicia sativa* and *Trifolium dubius* are used[4], but it is yet unknown which plants are preferred by each species.

These preliminary conclusions will have to be analysed in more detail in the future and the CBMS network will shed further light on this question. The collection of samples from different itineraries will allow us to determine which species of *Leptidea* are present and provide information on phenology and habitat preference. It will also be interesting to observe female choice when egg-laying: the subsequent capture of these females will enable us to determine which food plants are used in Catalonia.

[1] Lorkovic, Z., 1993. "*Leptidea reali* Reissinger 1989 (=*lorkovicii* Réal 1988), a new European species (Lepid., Pieridae)". *Nat. croat.*, 2: 1-26.

[2] Freese, A. & Fiedler, K., 2002. "Experimental evidence for specific distinctness of the two wood white butterfly taxa, *Leptidea sinapis* and *L. reali* (Pieridae)". *Nota lepid.*, 25: 39-59.

[3] Martin, J.F., Gilles, A. & Descimon, H., 2003. "Species concepts and sibling species: the case of *Leptidea sinapis* and *Leptidea reali*". *In*: *Butterflies. Ecology and Evolution taking flight* (Boggs, C.L., Watt, W.B. & Ehrlich, P.R., eds), pp. 459-476. The University of Chicago Press, Chicago.

[4] Vila, R., Viader, S. & Jubany, J., 2003. "*Leptidea sinapis* (Linnaeus, 1758) i *L. reali* (Reissinger, 1989): dues espècies "bessones" a Catalunya i Andorra (Lepidoptera: Pieridae)". *Butll. Soc. Cat. Lep.*, 90: 25-47, làms 2 i 3.

Jordi Dantart

Photo. A pair of *Leptidea* sp. photographed in May 2003 in Perafita (Osona). In light of the known distribution, both *Leptidea sinapis* and *L. reali* could be present here (photo: J. Jubany).

The butterfly

The Two-tailed Pasha *Charaxes jasius*, a tropical butterfly in the Mediterranean

The fleeting sight in flight of a Two-tailed Pasha, the largest and most powerful flyer of all Catalan butterflies, is unforgettable and indelibly associated in many people's minds with the dense summer heat and pungent smells of Mediterranean scrub and forests. Better knowledge of its behaviour will help us appreciate even further this magnificent species that boasts abundant populations in Catalonia.

Geographical distribution and situation within the CBMS

The Two-tailed Pasha (*Charaxes jasius*) is an Afrotropical butterfly whose nominal form is distributed around the Mediterranean in a narrow, coastal band of territory[1,2]. Its range in Catalonia in general coincides to a large extent with that of its principal food plant, the Strawberry-tree (*Arbutus unedo*)[3,4]. It is evenly spread throughout coastal and pre-coastal areas, other than in those areas such as the Empordà plain, dry areas of the Garraf massif, L'Alt Penedès and Tarragonès, and the Ebro Delta, where the Strawberry-tree is absent. As we head inland from the coast, the food plant of the Two-tailed Pasha becomes rarer and disappears altogether from central and western Catalonia and the Pyrenees. However, it is worth remarking on an isolated population of Two-tailed Pashas in the Montsec mountains, 50 km from the nearest other colony, a fact explained by the presence there of a small population of Strawberry-trees.

As of 2003, the Two-tailed Pasha had been recorded in 37 of the 71 CBMS stations and is particularly abundant in the coastal mountains of the Serralada Litoral, above all in Les Gavarres, El Montnegre and Collserola (fig. 1). In the arid southeastern regions of Catalonia and in mid-altitude mountainous areas dispersing individuals, sometimes far from their breeding areas, turn up occasionally. Curiously, it has not yet been recorded from the CBMS transects on Menorca and Eivissa, despite the well-established colonies of this species that exist on all three of the major Balearic Islands.

Habitat and food plants

Although Two-tailed Pashasuse *Vaccinium corymbosum* (and perhaps *Osyris quadripartita*) regularly as a food plant[5] in the south of Spain, in Catalonia this species is essentially monophagous on Strawberry-trees and observations of females laying eggs on Bay (*Laurus nobilis*) are anecdotal at best[6]; this fact has no repercussions at population level.

The classic habitat of the Two-tailed Pasha is, in general, coastal evergreen oak forests and, in particular, Cork oak (*Quercus suber*) forests that have a more open structure than many Holm oak (*Quercus ilex ilex)* forests. It has been commented many times that forest fires favour this species since Strawberry-trees, a species that reshoots very quickly, are soon recolonised by Two-tailed Pashas after fires[7]. The typical scrublands of southern Catalonia are also good habitat, despite lower densities of Strawberry-trees.

Biological cycle and phenology

The Two-tailed Pasha is a bivoltine species flying in two, well differentiated generations (fig. 2). Adults are on the wing in May-June (first generation) and then from the end of July through to October (second generation)[8]. If winter is mild and spring warm, then the first generation can be brought forward considerably. As an example, from the transect at Turó d'en Fumet (fig. 2a) we have the exceptional observation of a Two-tailed Pasha on March 23rd, 2001, and from the whole of the Baix Llobregat area there are some other observations from the end of March. Likewise, the second generation can last until November in favourable years.

Population peaks in the two generations are separated by about 10 weeks, which is the time needed for a complete generation to develop at summer temperatures[8]. Also characteristic is the much greater abundance of adult insects in the second generation (fig. 2). This is reflected in the 'sawtooth' line in the graph showing the values of generational indices (fig. 3): the overwintering larvae that provide the first generations have a much longer development period (6-8 months) and suffer much higher mortality rates.

Potentially, the Two-tailed Pasha is polyvoltine; nevertheless, the arrival of low autumn and winter temperatures mean that the larvae of a possible third generation cannot complete their development before the following spring. Field work has shown that the larvae grow more and more slowly as the temperature drops until at around 12ºC, a threshold below which all activity ceases. Thus, in a typical winter, larvae usually in the third or fourth instars are inactive from November to February.

Larval behaviour

The larvae of the Two-tailed Pasha, measuring around 5.5 mm at birth and 5-6 cm on pupation, pass through five instars. They live on the upperside of the leaves of the Strawberry-tree, on a silk cushion that they weave around the central nerve of the leaf. This resting leaf is maintained throughout almost all the development of the larva and only in the final instars are changes of position more frequent. The caterpillar remains motionless on its silk cushion, only moving now and again to feed on neighbouring leaves. These movements increase with age and may eventually be quite considerable. After each feeding period, which lasts between 5 and 15 minutes, the larva returns to its resting leaf.

The larva's coloration and immobility provide excellent camouflage whilst it remains on its leaf. Undoubtedly, these characteristics have evolved as a result of predatory pressure from insectivore birds, and the taking of fourth and fifth instar larvae by Sardinian Warblers (*Sylvia melanocephala*) has been observed (C. Stefanescu, pers. obs.) and it is likely that Tits (*Parus* spp.) are also habitual predators of Pasha larvae.

First-instar larvae are, on the other hand, eaten by ants and spiders (Ll. Abós & J. Planas, pers. comm.). They are also attacked by generalist parasitoids such as the Tachinid fly *Compsilura concinnata* and the Braconid wasp *Meteorus pulchricornis* (J. Planas & C. Stefanescu, pers. obs.).

Although pupae can sometimes be found on the back of the leaves of the food plant, normally the larvae leave the Strawberry-tree and pupate in a well-hidden spot amongst the nearby vegetation.

Adult behaviour

Adult Two-tailed Pashas exhibit certain highly characteristic behavioural traits that make observation easy. Unlike most butterflies, their diet is based exclusively on sugars taken from ripe or rotting fruit, tree sap and animal excrements. In Les Gavarres, it has been shown that first generation adults feed above all on wild cherries, whilst the second generation feed on figs[3]. On occasions, this latter fruit attracts spectacular concentrations of dozens of adults; concentrations on excrements are also fairly common. Less commonly adults are attracted to substances of animal origin such as sweat, corpses and blood[9]. Furthermore, both males and females often drink water and are attracted to damp mud on river margins.

Males are territorial and have a strong tendency to practice hilltopping, above all during the central hours of the day. They can thus be easily observed on ridges and hills, even in areas that are far from their breeding sites (for example, Turó de l'Home in El Montseny, 1,712 m). Alternatively, males are also territorial around their food sources such as Fig trees (*Ficus carica*), to which females come to feed.

Females are more discrete and harder to observe. Nevertheless, they can often be seen during egg-laying, which usually occurs during the hottest part of the day. They search for an appropriate Strawberry-tree in a slow flight, only stopping briefly to lay a clearly visible yellow egg (1.5-2 mm diameter) on the upperside of a leaf. Often the female will lay more than one egg on the same tree, before leaving to find another appropriate tree. Eggs are normally laid at between 1 and 2 metres above ground level, almost always on branches facing south or southeast[3], as these will receive most insolation and thus enable larvae to develop more quickly.

Population trends

The Two-tailed Pasha is very abundant in some places in the coastal mountains of the northern half of the country. Over the last 10 years no clear trend, either negative or positive (fig. 3), in populations has emerged and in general there is no indication that this species is in any sense threatened or declining. Moreover, as we have already mentioned, forest fires, far from representing a threat, actually benefit this species.

As has been demonstrated by combining CBMS data and field studies of larvae, the one factor that does affect populations negatively is the cold[4]. Periods of intense cold lead to a generalised drop in the numbers of adults flying in the first generation caused by high larval mortality during the winter. Nevertheless, this natural factor only comes into play very occasionally and within a short space of time populations return to their normal levels.

[1] Larsen, TB, 1986. "Tropical butterflies of the Mediterranean". *Nota lepid.*, 9: 63-77.

[2] Tolman, T. & Lewington, R., 2002. *Guía de las mariposas de España y Europa*. Lynx Edicions, Barcelona.

[3] Abós, Ll., 1999. "Distribució i biologia de *Charaxes jasius* (Linnaeus, 1767) a Catalunya (Lepidoptera: Nymphalidae)". *Butll. Soc. Cat. Lep.*, 83: 37-58.

[4] Stefanescu, C. & Planes, J., 2003. "Com afecta el rigor de l'hivern les poblacions catalanes de *Charaxes jasius*". *Butll. Soc. Cat. Lep.*, 91: 31-48.

[5] Molina, J.M., 2000. "Notas sobre el uso del arándano americano (*Vacciniun x corymbosum* L), por *Charaxes jasius* (L., 1767) en el suroeste de Andalucía, España (Lepidoptera, Nymphalidae)". *SHILAP Revta lepid.*, 28: 91-96.

[6] Stefanescu, C., 1995. "Ovoposició de *Charaxes jasius* (Linnaeus, 1767) sobre llorer (*Laurus nobilis*) als Aiguamolls de l'Empordà". *Butll. Soc. Cat. Lep.*, 76: 23-24.

[7] Llimona, F., Jubany, J. & Tenés, A., 2000. "La regeneració del Bosc Gran després de l'incendi de 1994: una aproximació multidisciplinària". *In: I Jornades sobre la recerca en els sistemes naturals de Collserola: aplicacions a la gestió del Parc* (Llimona, F., Espelta, J.M., Guix, J.C., Mateos, E. & Rodríguez-Teijeiro, J.D., eds): 243-254. Consorci Parc de Collserola, Barcelona.

[8] Abós, Ll. & Stefanescu, C., 1999. "Phenology of *Charaxes jasius* (Nymphalidae: Charaxinae) in the north-east Iberian Peninsula". *Nota lepid.*, 22: 162-182.

[9] Travesí, R., 1999. "La mariposa vampiro". *Quercus*, 161: 34-35.

Fig. 1. Relative abundance of the Two-tailed Pasha (*Charaxes jasius*) (expressed as a value of the annual index/100 m) in different CBMS sites (1994-2003).

Fig. 2. Phenology of the Two-tailed Pasha (*Charaxes jasius*) at (a) Turó d'en Fumet (n = 412; data from 1996-2003), La Serra de Collserola (Vallès Occidental), where hilltopping males were counted; (b) at Can Riera de Vilardell (n = 507; data from 1994-2003), La Serra del Montnegre (Vallès Oriental); and (c) Darnius (n = 386; data from 1994-2003), in L'Alt Empordà.

Fig 3. Fluctuations in abundance in the Two-tailed Pasha (*Charaxes jasius*) in Catalonia, taking 100 as an initial arbitrary value for the 1994 second generation (the first year the CBMS was in operation). The number of sites used to calculate the overall annual index of each generation varies between 6 and 15 according to the year (after ref. 4).

Photo 1. A sight that is very hard to see in the wild: mating Two-tailed Pashas (*Charaxes jasius*). Typically, when a female enters a male's territory, both butterflies begin a courtship flight that ends when the female lands on the ground or on a bush and thus invites the male to copulate. In this photograph (taken in June 1990 in Fitor, Les Gavarres), the smaller male is on the left (photo: Narcís Vicens).

Photo 2. (a) Male Two-tailed Pasha (*Charaxes jasius*) holding territory, and (b-e) egg, first instar larvae, third instar overwintering caterpillars and a fifth instar caterpillar about to pupate (photos: a, J. Jubany; b-e, J. R. Salas).

Identification

How to separate the species of the genus *Pyronia*

Amongst the commonest butterflies in the CBMS network are the three 'Gatekeepers': the Spanish Gatekeeper (*P. bathseba*), the Southern Gatekeeper (*P. cecilia*) and the Gatekeeper (*P. tithonus*). Although their chosen habitats generally vary, the 'Gatekeepers' are also regularly found in the same places at the same time, a fact that leads to confusion, despite the morphological characters that enable the three species to be separated with confidence.

The Spanish Gatekeeper has been recorded from 70% of CBMS stations and flies in and around Holm oak formations with medium-level rainfall, although it can be abundant on occasions in more Eurosiberian habitats. The Southern Gatekeeper (the only one of the three to be found in the Balearic Islands) appears in 77% of the CBMS network and is most abundant in Holm oak formations and xeric scrublands; it is not found in colder and damper areas. The Gatekeeper has been detected in 58% of all transects and prefers Eurosiberian montane habitats, becoming rarer towards the Mediterranean; it is absent altogether from the most arid areas of the country. Despite these different ecological preferences, two or three of these species often fly together: Southern and Spanish Gatekeepers (recorded together in 62% of stations), Gatekeeper and Spanish Gatekeeper (52%), Gatekeeper and Southern Gatekeeper (43%) and all three Gatekeepers together (32%). All hibernate as larvae and are univoltine. The Spanish Gatekeeper begins to fly in April-May and peaks in May-June, while the Southern Gatekeeper appears in June and peaks in July. In the lowlands the Gatekeeper has a similar flight period to the Southern Gatekeeper, but appears in July and peaks in August in more montane habitats. During egg laying, females rest on grass stems and drop eggs into the surrounding vegetation. Caterpillars feed on grasses, above all those of the genus *Brachypodium*[1]. In Catalonia egg-laying by Spanish and Southern Gatekeepers has been observed on *B. retusum* and by female Gatekeepers on patches of grass dominated by *Poa* sp. and Bermuda grass (*Cynodon dactylon*). Larvae of the Spanish Gatekeeper have also been found on *B. phoenicoides*[2].

[1] Munguira, M.L., García-Barros, E. & Martín, J., 1997. Plantas nutricias de los licénidos y satirinos españoles (Lepidoptera: Lycaenidae y Nymphalidae). *Boln Asoc. esp. Ent.*, 21: 29-53.

[2] C. Stefanescu, unpublished data.

Drawings

SPANISH GATEKEEPER
Upperside (male): external half of fore-wing orange-coloured; internal half very dark brown.
Upperside (female): more uniform orange, although the basal area is sometimes dark-coloured.
Upperside (general): three eye-spots in the sub-marginal area of the hind-wing.

Mark with arrow:
Underside (general): cream-coloured discal band, with external border of visible white pupillate eye-spots.

SOUTHERN GATEKEEPER
Upperside (general): uniform orange colour, except for a wide dark-brown margin.

Underside (general): without eye-spots or any other spots, with alternating brown and grey-white areas.

Mark with arrow:
Upperside (male): dark brown androconia conspicuously split by orange-coloured veins.

GATEKEEPER
Upperside (general): uniform orange-coloured except for a wide brown-coloured wing margin and basal area of the hind-wing.
Underside (general): brownish coloration with reddish and yellowish hues.

Mark with arrow:
Upperside (male): dark brown androconia uninterrupted by veins.
Underside (general): yellowish discal area that normally includes 3-5 eye-spots reduced to just a white pupil.

All three species exhibit marked sexual dimorphism in the form of obvious androconia in males and the greater size of females. The pattern of the androconia and the underside of the hind-wing are most useful guides for separating the Southern Gatekeeper from the Gatekeeper. The Spanish Gatekeeper is easily separated from the other two species by the pattern on the upperwing and underwing: the cream-coloured band on the underside of the hind-wing is vaguely reminiscent of the Pearly Heath (*Coenonympha arcania*), although a close examination will always remove any doubt concerning the separation of the two species.

Identification

How to separate the species of the genus *Thymelicus*

The skippers (Hesperiidae) are often somewhat neglected in the CBMS transects due to the difficulty in separating one species from another and to their small sizes, dullish colouring and fast, nervous flight. The group of the so-called 'Golden Skippers' (*Thymelicus* spp.) are a good example of this since their distinctive features are hard to appreciate; furthermore, they often fly together in the same localities at the same time of year.

Despite flying together in some localities, the Lulworth, Essex and Small skippers are all distributed differently in Catalonia. The Lulworth skipper is more linked to Mediterranean habitats and, although it can be found in some parts of the Pyrenees, is commonest on or near the coast. On the other hand, the Essex and Small Skippers – incidentally the hardest to separate – often fly together in the Pyrenees, Pre-Pyrenees and coastal mountains of La Serra Transversal. Of these two latter species, only the Small Skipper can be found in the southern half of Catalonia where it flies in a number of atypical and isolated areas such as El Garraf and Aiguabarreig. It can be found together with the Lulworth Skipper in the extreme south of Catalonia in the mountains of Els Ports de Tortosa. All three are found in open spaces, preferably with patches of tall grass. Their food plants are various species of grass[1] and eggs are laid in small groups, well hidden between the leaf sheath and the stem of the grass. In Catalonia the Lulworth Skipper has been confirmed as laying on Cock's-foot (*Dactylis glomerata*), *Hyparrhenia hirta* and a number of unidentified dry grasses, while the Essex skipper is known to lay on *Brachypodium phoenicoides* and the Small Skipper on Cock's-foot, Yorkshire-fog (*Holcus lanatus*) and Alpine Timothy (*Phleum alpinum*)[2]. The Essex skipper hibernates as an egg, while the others do so as neonate larvae. All are univoltine and fly in May-June-July in lowland areas and in July-August in the Pyrenees.

[1] Tolman, T. & Lewington, R., 2002. *Guía de las mariposas de España y Europa*. Lynx Edicions, Barcelona.

[2] J. Dantart & C. Stefanescu, unpublished data

[3] Pye, M., Gardiner, T. & Field, R., 2003. "A behavioural study of small skipper Thymelicus sylvestris Poda and Essex skipper Thymelicus lineola Ochs. butterflies (Lep.: Hesperiidae)". *Entomologist's Rec. J. Var.*, 115: 1-12.

Jordi Dantart

Drawings

LULWORTH SKIPPER
Upperside (general): brown with pale markings arranged in an arc shape in the cell and in the post-discal regions (but in some males not very obvious).

ESSEX SKIPPER
Upperside (general): golden-brown colour without markings and broader black margin (not a very constant feature).

Mark with arrow:
Upperside (male): shorter and less visible androconia (between Cu1 and Cu2).
Underside (general): black underside to antenna tip.

SMALL SKIPPER
Upperside (general): golden-brown colour without markings and narrower black margin (not a constant feature).

Mark with arrow:
Upperside (male): androconia longer and more conspicuous (between Cu1 and the anal vein).
Underside (general): golden-brown underside to antenna tip.

The Lulworth Skipper can be identified by its brown colour with pale markings on the upperside. The Essex and Small Skippers are a more golden to orange colour and have no upperside markings. The males of all three species have an androconia on the upperside of the fore-wing, which can be used to separate the Essex and the Small Skippers. However, these two species can be separated with confidence by looking at the colour of the underside of the antenna tip. Field identification is complicated by the fact that all three species behave in much the same way and adults fly and take nectar from flowers – preferably purple – in a very similar fashion[3].

AJUNTAMENT DE GRANOLLERS
Museu de Granollers Ciències Naturals
Monitoring programme with the support of:
Generalitat de Catalunya Departament de Medi Ambient i Habitatge