Bulletin of the Royal Entomological Society Volume 41 (4) 2017

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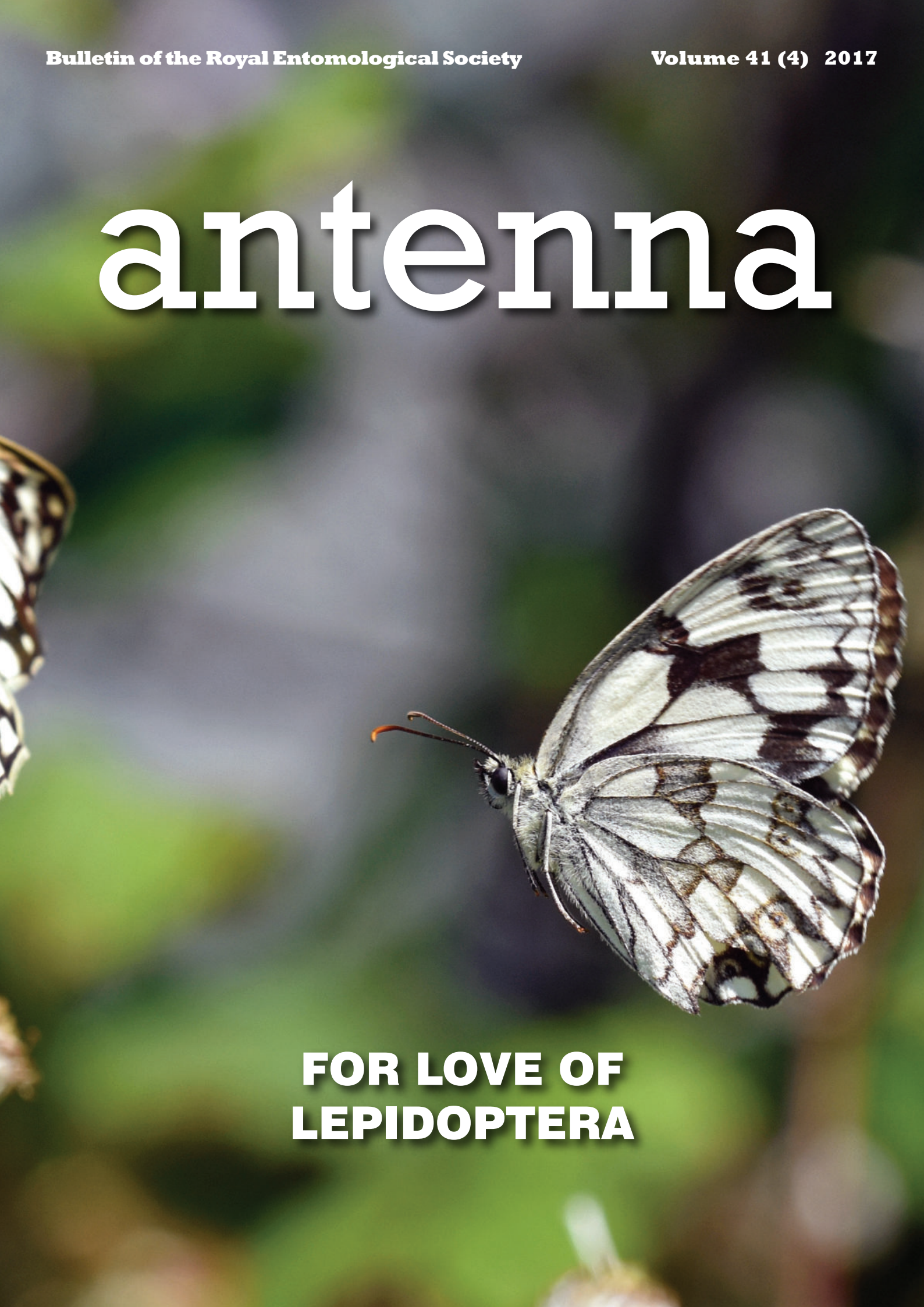
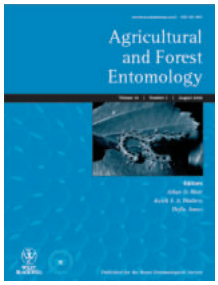
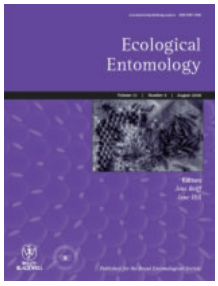
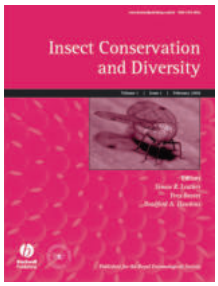
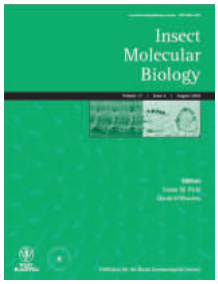


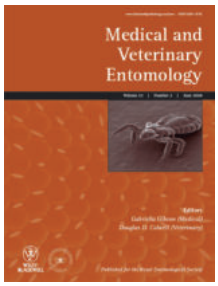
FOR LOVE OF LEPIDOPTERA

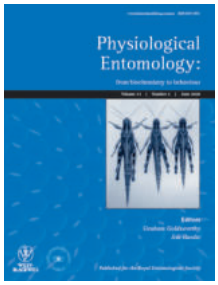


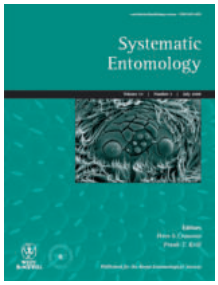












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Antenna (Bulletin of the Society). Free to Members/Fellows. Published quarterly at an annual subscription rate of £50 (Europe), £55 (outside Europe), $90 (United States). This journal contains entomological news, comments, reports, reviews and notice of forthcoming meetings and other events. While emphasising the Society's affairs, *Antenna* aims at providing entomologists in general with a forum for their views and news of what is going on in entomology. Subscriptions and advertising enquiries should be sent to the Business Manager at The Mansion House, Chiswell Green Lane, Chiswell Green, St. Albans, Hertfordshire AL2 3NS and any other enquiries to the Editors.

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COVER PICTURE

Iberian marbled white (*Melanargia lachesis*) courtship. Male approaching from the right. Galicia, Spain.

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EDITORIAL

Hello and welcome to *Antenna* 41(4). By the time this issue reaches you, the year will be nearing its end. With results from the 2017 'Big Butterfly Count' now in, it's good to see that many UK species looked to have fared better this year than in 2016 (a notably bad year for UK Lepidoptera), though it appears to have been a difficult year for some groups, including our native common whites. Another butterfly that's been challenged in 2017 is the native British swallowtail. As reported by the local and national media, multiple caterpillars of this rare species (along with their equally rare host plants) were stolen from the Norfolk Broads over the summer. Our native swallowtail is perhaps our most impressive lepidopteran, and one that I personally took great pleasure in observing regularly whilst working for the How Hill Trust in Ludham, an Environmental Study Centre that has recently celebrated its 50th anniversary. With the saddening news of these thefts in mind, I was particularly pleased to receive an email from Mark Collins back in September to inform *Antenna* about the recent creation of the 'Swallowtail and Birdwing Butterfly Trust', a new charity created in the UK on 4th August 2017 for the purpose of conserving and protecting species of the Papilionidae family worldwide. For those keen to learn more, the Trust's website went live at the end of August and can be found at 'www.sbbt.org.uk'.

As the formation of the 'Swallowtail and Birdwing Butterfly Trust' and the content of this issue shows, Lepidoptera are a key focal group within entomology. All of the articles in this *Antenna* focus on butterflies and moths, with offerings covering a range of topics. The first of these takes us far afield and high above sea level, with Pritha Dey's article on 'Mothing in the mountains: From the Himalaya to the Andes'. This is followed by Daniel Hackett's taxonomically-themed offering on identification issues in the genus *Helicoverpa*. This will be of particular interest to anyone working with *H. armigera*, which, as the title (and content) of this article attests, is indeed 'An Obscure Pest'. Ray Cannon then provides a vivid account of mating behaviour in butterflies, accompanied by a stunning selection of his own images that are sure to brighten even the very longest and darkest of winter days. These are only the tip of the iceberg of Ray's entomo-photographic portfolio, more of which can be viewed online by typing 'Ray Cannon's Nature Notes' into Google (or any other search engine of your choice). Finally, John Burton provides his account of 'Gilbert White the entomologist', drawing upon the 18th Century parson-naturalist's journal entries (which include numerous references to Lepidoptera) to evidence his interest in insects.

In keeping with our lepidopteran theme, we also feature five book reviews in this issue, the majority devoted to publications on butterflies and moths. These include a long-overdue review of Richard Pyle's 'Mariposa Road' – a book on a butterfly 'big year' that I'd recommend to any entomologist, and just about everyone else to boot! Lepidoptera even pop up in the correspondence section, with this group appearing in an erratum from Richard Jefferson to his article on insects and bryophytes in *Antenna* 41(3). Society News too has a lepidopteran feel, with *Antenna*'s own Peter Smithers getting this section underway via an interview with Honorary Fellow and 'Ambassador of Butterflies' Clive Farrell. Society News also features a report on the RES 2017 Annual Meeting, held at Newcastle University and featuring at least a talk or two on Lepidoptera, as well as a report on the International Entomological Congress 2016, held in Pakistan and with a full day focus on pink bollworm. Butterflies and moths also receive mention in Jorge Noriega's light-hearted report on entomological attire observed adorning delegates at the ICE in Florida. Somewhat surprisingly perhaps, the Lepidoptera have been pipped to the post by another insect taxa when it comes to frequency of occurrence on items of 'entomo-clothing'. Nevertheless, if the content of this issue is anything to go by, the Lepidoptera are securely holding onto top spot when it comes to recent *Antenna* copy flow!

Dave George

Guidelines for submitting photographs

To maintain a high quality we suggest that submissions for *Antenna* be presented via e-mail or on CD. Files must be in a PC-compatible format preferably in MS Word.

Electronic images can be embedded in the Word document but we will also require separate electronic images. These images should be at least 300dpi at an image size that is either equal to, or greater than the expected final published size.

Please do not submit images that have been printed from a computer on a domestic inkjet or laser printer. Even if the camera is a good one and photo quality paper is used, the graininess is very hard to deal with. If plain paper is used, the prints are virtually unusable.

Photos taken on film should ideally be submitted as slides or as reasonable sized prints for us to scan or alternatively they can be scanned in by authors provided the scanner is capable of scanning at up to 1200dpi.

If an image is intended for the front cover then the photograph should be in portrait format (i.e. the shape of the final image) and will need to be quite a large file size (at least 5,000kb) or a good quality slide or print.

To give an idea as to what happens when the image is not of sufficient size, take a look at these two photographs. One is 300dpi and the other is 72dpi.

300dpi

72dpi

CORRESPONDENCE

Verrall Supper Bursaries for 2018

From the "van Emden Bursary Fund", the Entomological Club will award up to three bursaries to registered students and other early-career entomologists in connection with the Verrall Supper on Wednesday 7th March 2018. The aim of the scheme is to introduce to the Verrall Association promising young entomologists who are likely thereafter to wish to continue their membership themselves. A bursary funds a one year membership of the Association and the Supper, as well as up to £40 of any travelling expenses incurred. Perhaps more importantly, the award recognises merit, and can be included on future CVs.

Proposals for bursaries must come from academic supervisors or other relevant managers with some standing in entomology, and proposals should be submitted to entclub@yahoo.co.uk by 10th February 2018. There is no prescribed format for proposals. One side of A4 may well be enough, and the following list gives guidance as to what might be included:

Name, date of birth, postal and e-mail address of person proposed.

Subject of research study or other entomological work, stage reached, source of funding and achievements so far, evaluation of future promise.

Any evidence of interest in entomology at an earlier age and any previous practical involvement.

Helmut van Emden
Hon. Treasurer, Entomological Club
(www.entomologicalclub.org)

Field and identification skills

Dear Editor,

Having read the very interesting article by Clive Betts *et al.*, in *Antenna* (41: 65-73), which mentions the continuing and worrying decline these days in field and identification skills, I must confess that I find it surprising that students who intend to find work post university in nature conservation have not already taught themselves some identification skills, at least in those wildlife groups that most interest them. I suppose that the answer partly lies in their not having developed such a serious interest in fieldwork until they have actually started a university course.

As one whose interest in wildlife began at an early age in 1940 (I'm now 86), I very quickly learnt to identify through my own efforts many species in the field as my initial interest in birds, mammals and reptiles, rapidly widened by 1946 to include plants and insects. And there was nothing in those days like the extensive library of identification field guides available today. As soon as I was aware of its existence I joined the London Natural History Society and participated in their field excursions, thereby benefiting from the knowledge, experience and helpfulness of their specialist members. Joining their local natural history society or wildlife trust is surely what students intending to make a career in nature conservation should do. In my case it led me from being an amateur naturalist to a professional career in natural history. Now long in to retirement I am an active amateur naturalist again!

Your faithfully,
John F. Burton
(FRES, FZS)

Erratum

In the article by Jefferson in *Antenna* Volume 41 (3), pp 108-119, the statistics for the numbers of scarce and threatened species in the Conservation section (page 112) should read:

'Of the specific bryophyte feeding insect species identified in Appendix 1 and that have had their conservation status assessed, 24 species (33%) are nationally rare, scarce or notable. Of these, 12 species are moths, one of which, the Scarce Brown Streak (*Aplota palpellus*), is listed on Section 41 of the Natural Environment and Rural Communities Act 2006 as a species of principal importance for the conservation of biological diversity in England (Priority species).'

Richard G Jefferson

Minilivestock Producers and Edible Insect Stockmanship: An Exploration of Invertebrate Farming in Europe and North America

Do you have any experience of rearing/farming insects for food? If so, would you like to participate in social science research that explores the emergence of invertebrate farming in Europe and North America? At this stage, participants are being asked to complete a short profile survey prior to being interviewed at a time that is convenient to them (e.g. via Skype or phone). For more information about the study, please contact Dr Rhoda Wilkie at the University of Aberdeen (Scotland, UK): r.m.wilkie@abdn.ac.uk

Mothing in the mountains: From the Himalaya to the Andes

Pritha Dey
Zoologische Staatssammlung München
Wildlife Institute of India

I have spent the last three years studying moths in the Himalaya, having the most wonderful experiences in getting to know this lesser known group of insects in habitats from pristine forests to the most disturbed and heavily touristed areas. These extremely diverse habitats, the uniquely diverse moth species within them, and the warmth of the local people have shaped my experiences in the most unforgettable way. The goal of my studies was to contribute to an inventory of moths for the area. An inventory is of primary importance as a part of biodiversity conservation, particularly in threatened and fragmented landscapes like the Western Himalaya. Such an inventory for the Western Himalaya is, however, scattered and incomplete, despite the intrinsic interest of the unique biodiversity of the region. A record of moth fauna based on both morphological and molecular characteristics from the Western Himalaya would add greatly to the existing data and assist further work into moth diversity in this area.

Earlier this year (2017) I had the opportunity to visit Chile, South America, catching, watching and learning about the moths that reside in the foothills of the longest mountain range in the world, the Andes. This activity formed part of a conference and field trip where I represented my German supervisor, Dr. Axel Hausmann, under whom I am pursuing a part of my doctoral degree (which also includes work in India).

The team inside the sclerophyllous forest, Chile.

Chile is a country of contrasts, like nowhere else. With a zig-zag coastline of about 4,000 miles, it is packed between the Andes and the Pacific Ocean, with the Atacama Desert in the north. Highly diverse in climate and vegetation regimes, it is attractive to scientists all over the world as a study site. Both tropical and temperate influences converge in this part of the planet, constituting a powerful evolutionary drive. A natural mosaic of landscapes exists throughout the country, enclosed by geographical barriers that have given rise to a scale of endemism currently unknown elsewhere. In the third largest insect order, Lepidoptera, it is estimated that some 50% endemism exists in this region at the species level, with most species restricted to central Chile and the oceanic islands.

For the first time, Forum Herbulot (a global gathering of Geometridae moth experts organised every two years in remembrance of the great taxonomist Claude Herbulot) was taking place in Latin America, in the land of the Puma and the Andean Condor. This was the IXth Forum Herbulot, held in January 2017. Two field trips were included, one on the peninsula of Hualpén, in the coastal sclerophyllous forest of Central Chile, the other in the mountainous temperate forests of Cordillera de Chillán (Las Trancas) in Southern Chile, both of which afforded the opportunity to sample the local Lepidoptera.

On our first night of sampling, we took a 1.5 hour bus trip from Concepción to a drop-off point towards the coast. We then progressed on foot to reach our light trapping site, through a maze of sclerophyllous forest dominated by species including Peumo (*Cryptocarya alba*), Boldo (*Peumus boldus*) and Mayten (*Maytenus boaria*). We walked for nearly two hours, observing the forest change as we neared the coast. The vegetation structure was a mesmerising mosaic, and to me everything was new and unknown. En route to our destination, we came across the most exquisite tiny red flowers, a find which got everyone photographing excitedly; it was the Copihue, the national flower of Chile! And all the time we were looking for moth caterpillars too. Whilst picking our way through the leaves of shrubs, my supervisor Dr. Hausmann stumbled upon a stunning Saturniidae caterpillar, *Ormiscodes socialis*, on a *Chusquea quila* (a local bamboo species). The Saturniidae family is comprised of the larger bodied moths, like the Atlas or the Luna, and this particular family is known to have many endemics from this region.

We meandered our way to the light trap points and started erecting the traps, though with the long days in this part of the planet it would be past 21:00 before we would start seeing any moths. With so many of us present, and all of us fuelled by excited anticipation, chaos reigned around the light trapping session; someone kicked over the generator (used to run the light trap), someone tripped and someone fell! For the first hour, nothing arrived at the light trap. We speculated that it might be the sudden dip in the temperature. No sooner had that first fruitless hour passed, however, than the light trap started filling up, with other insect groups also making an appearance (mostly beetles). Everyone got busy photographing and catching them, with the session standing out from others I've taken part in on account of both the sheer diversity of species visiting the trap, and the differences between the species caught here as compared to my normal sampling sites, up in the

Landscape overlooking the sclerophyllous forest (Hualpén).

Landscape of Hualpén (inset: light-trap at Hualpén).

Ormiscodes caterpillar which feeds on *Nothofagus*.

Ormiscodes socialis caterpillar on *Chusquea quila*.

Hike in Reserva Ñuble.

Himalaya. Moths are enormously difficult to positively identify at a light trap, however, so I had to wait for the next day to exercise my taxonomic skills, when the specimens would be sorted.

For our next trip, the following day, we ventured away from the coast, from Concepción to Chillán. This location is perhaps best known for being home to the Nevados de Chillán chain of volcanoes, which contains one of the country's most active volcanoes. It is part of the Southern Volcanic Zone of the Andean Cordillera. Disaster had last struck via an eruption in 2009, and the area was on high alert during our visit, with one of our group even capturing a photo of the 'smoking' volcano! We reached our sample site at around 20:00, which just gave us time to put up our light traps before sunset. While putting up the light traps, I noticed black thorny caterpillars almost everywhere on the ground! On closer inspection, these turned out to be caterpillars of the Saturniidae moth genus *Ormiscodes*, which feed exclusively on the *Nothofagus* tree, a Gondwanan relict species found in this region! We caught continuously throughout the night and again found some amazing moth species visiting our traps.

The next day we hiked 20 km into the Reserva Ñuble. As a keen amateur bird watcher, I was very eager to see the Andean Condor, the National Bird of Chile. I even asked one of the guides to keep an eye out for one for me! Within the first twenty minutes of our hike there it was, flying so high that I had to strain my eyes through the binoculars to catch a glimpse of this majestic raptor. With the day having already returned such a wonderful sighting, we felt almost spoilt when a few minutes later the endemic day-flying moth, *Castnia eudesmia* (the only Lepidoptera species with a vulnerable status in Chile), came and perched on my colleague's arm! What a delightfully spectacular moth it is! I happily took photographs until it alighted and fluttered away. We returned from the hike and, with this being last day of this fantastic experience, I returned to Germany and my PhD, albeit with a wish to visit this area again to (re)experience mothing the Latino way!

My visit to Chile was a short but enthralling experience for a moth ecologist like me! I would like to thank Dr. Luis Parra and his amazing team for such wonderful organization of the meeting. Getting to learn more about the global diversity contrasts of this lesser known insect group enriched me and gave me an even greater impetus to work towards a career in moth conservation. As I always say, no mountain is too high!

Reference

http://www.worldatlas.com/webimage/countrys/samerica/chile/clland.htm

An Obscure Pest?

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The saying "keep your friends close but your enemies even closer" (probably first used in the film The Godfather II) has its application in entomology too. We study our friends in great detail, down to their habitat and biotype requirements, in order to promote their long-term survival and conservation. The Large Blue butterfly is a good example, as published in the last issue of *Antenna* (Thomas, 2017).

Our enemies, in this case agricultural pests, generate far greater amounts of literature on their bionomics. Some species go by various common names, but their scientific names are somewhat more stable, being more restricted. We are upset by name changes, particularly when the species we know as "x" is redefined, usually by the "splitters" of the taxonomic world. If it's a simple swap it is not too bad; we slowly start using the new name, which is most often at generic level, if we see the point. This happened with the genus *Heliothis* after Hardwick published his monograph on "the Corn Earworm Complex" in 1965 (reference below). The Corn Earworm is strictly a single species of the New World, (*Helicoverpa zea)*, so one could say Hardwick was being partial or even facetious, since the *Heliothinae* contain some of the most polyphagous moths in the world, and get given common names depending where you are and on what crop they are feeding on. Tomato Fruitworm and American Bollworm, for example, are but two of many common names applied to *Helicoverpa armigera*.

Hardwick's contribution was to erect not only a new genus (*Helicoverpa*, the species of which are anatomically different from the other *Heliothinae*), but new species (and subspecies), previously confused with other, better known ones. In Africa there were two species of *Heliothis (armigera and assulta)*, but these were renamed *Helicoverpa* and both gained subspecies status *(a. armigera and a. afra*). Additionally, two more species of *Helicoverpa* were described *de novo* from the world collection he examined (*fletcheri* and *toddi*). The new name *Helicoverpa* was resisted by many and publications calling their insect *Heliothis* continued at least up until 2000.

I class the rest of this article as part reminiscence and part attempt to

Plate 1. *Helicoverpa fletcheri* Hardwick reared from Sorghum and Artificial Diet in Wad Medani, Sudan in 1978.
Photos c/o Tim Lewis-Bale

elucidate the status of the "lesser bollworms" by drawing the situation to the attention of the reader. It is clearly necessary to be aware of identity problems in entomology. I seek explanations as to why little or no new material of these species of insects has come to light. My first, perhaps presumptuous guess is that no-one is looking, as virtually no-one is aware of these species. Maybe ecological survey work is not going on at the right level; probably field entomologists are just seeing eggs and larvae on the more valuable crops and reaching for a spray. The field situation in Africa could be the subject of several more articles. Even with trained taxonomic input it could indeed turn out to be the case that *Helicoverpa armigera* is the dominant culprit for the crop damage witnessed. But if so, what then are the sibling species' host ranges and why are they less successful, or successful only under certain circumstances?

Helicoverpa fletcheri Hardwick revisited

My PhD study, carried out in Sudan and at Bangor University (Hackett, 1980) included a chapter on diapause in *Helicoverpa armigera* (Hübner) along with its congener, *H. fletcheri* Hardwick. The latter is a much less known insect than the former. Hardwick (1965) had named *fletcheri*, a new species, after examining the world collections of *Heliothinae*, creating the new genus *Helicoverpa*. In his monograph he named eleven new species and two subspecies altogether. It took some time for the entomological world to accept that *Helicoverpa* was a valid genus and there are still some cases of it being misapplied to *Heliothis* spp.

Plate 2. *Helicoverpa armigera* (Hubner) reared from Sorghum at Wad Medani, Sudan in 1977.

As one might expect, distinguishing a new species amongst a very common pest is fraught, since in this case the differences appear slight and laborious to examine. Nevertheless, *H. fletcheri* is believed to be a "good" species. One of the locations for *H.fletcheri* was given as "the White Nile, Sudan, collected by Captain Yardley" in Hardwick (ibid). There was no date given for the Sudan record in the monograph, but I have tracked down an expedition to that area (Hamann and Klemm, 1962) which Yardley was part of, with the help of Brian Taylor. This makes my specimens from my rearing experiments on sorghum and an artificial diet in 1978 the first new records for over 15 years. No other entomologist known to me in 1978 had seen (or heard of) the *H. fletcheri*. The simple presumption had been that '*Heliothis*' (the old name for *Heliothis* and *Helicoverpa*) larvae, as well as eggs, would be *H. armigera*. This situation was corrected by sending adult specimens from my rearing to the NHM where they were identified definitively as *H. fletcheri* by Martin Honey.

Since then, Matthews and Jago (1993) working on Millet in W. Africa (1985-87, vouchers deposited in the NHM) state that *H. fletcheri* and *H. armigera* occur together in the Sahel. Other collectors: G.Popov, 1965, Zinder, Nigeria, J.C.Deeming, 1972, Sokoto, Nigeria and Terril, 1979, Sokoto, Nigeria, have also deposited specimens of *H. fletcheri* in the NHM, indicating that this species is quite frequent in (at least) that area. A distribution map of known locations (before 1965) is given in Hardwick (ibid.)

Seasonally speaking, the *H. fletcheri* NHM specimens collected by Matthews in 1986, by light trap, range from 11 July to 3 October, which fits in with the observation, first stated by Hardwick, that this species is only active in the Sahel (in this case W. African) rainy season. My observation in the Sudan, which has a similar rainy season, was that pupal diapause incidence was high (74%, n=92) in September and that adult emergence took place from June to August the next year (Hackett and Gatehouse, 1982). This confirms the idea that long term diapause is this species' survival mechanism in the area, rather than migration out of it. This was/is quite unlike *H. armigera* which has no pupal diapause in the area at that time of year. Intriguingly, earlier observations in the Sudan Gezira on the "American bollworm" by Cowland (1936) (citing short cycle, shallowly buried pupae and long cycle, deeply buried pupae, interpreted by him as a features of non-diapause or diapause) stated diapause did occur in October (38%), rising to 100% in March. It now seems likely that he had to be referring to *H.fletcheri* mixed with *H. armigera*. The latter species does not diapause in October; it is far too hot then. Some *H. armigera* probably do diapause in January and February in the field after feeding on vegetables, when the Gezira is at its coldest and days are shortest (Hackett and Gatehouse, 1982). Balla (1970), who appears to have been working on pure *H. armigera* in Sudan, found no diapause, which could be explained if he kept larvae indoors, rather than in cold damp soil, so probably averting this behaviour. The contrast of observations in diapause incidence in the late 60s compared with the late 30s could also imply that there has been a change in dominance between the two species over the years, with *H. fletcheri* becoming locally rare, or simply undetected. Is *H. fletcheri* going undetected these days? This hinges on the methods by which it would be detected, as well as an awareness of the possibility of its occurrence in the first place.

Hardwick's monograph (ibid) entitled "the Corn Earworm Complex" is still the key reference for this group of moths. But it is long out of print and contains small, blurry habitus photographs of two each of his type specimens. Not surprisingly, considering the moths vary greatly in size, colouration and markings, (which were described), the habitus only amounts to a guide. Therefore, species recognition, and the creation of new species plus subsequent determinations, leans heavily on dissection of the genitalia, particularly of males, by everting the vesica. This organ's morphology, particularly the layout of the spines and basal pouch diverticula, he stated, was definitive, although he included more general characteristics like size, colour and markings of each species of moth for diagnosis too. Under these circumstances detecting the occurrence of a second species amongst *H. armigera* would be very unlikely and laborious. Most field entomologists, often prescribing chemical sprays based on egg and larval counts whilst being unaware of the second species' existence (as I was), could maintain that its presence would make no difference: all will be killed by the spray. This is short sighted if natural enemies are part of the scouting checklist, however, or if pesticide resistance develops. If effort could be devoted to rearing these larvae through to adults and dissecting them, *H. fletcheri* (and other *Helicoverpa- assulta afra* and *Helicoverpa toddi* - see below), and possibly even *Heliothis* spp. may turn out to be present. Indeed, Matthews and Jago (1993) (ibid.) even found that *H. fletcheri* was often dominant over *H. armigera* in Mali.

Images of *H. fletcheri* and *H.armigera* can be seen on Plates 1 and 2. There are size differences, but both *H. armigera* and *H. fletcheri* can vary in size within themselves, according to their larval feeding experience. There are also forewing background colour differences (sexual dichromatism), but these are subjective and therefore hard to describe. In addition, colours are prone to fading in old specimens, although I believe mine are not faded. When taking a photograph there are also light quality and camera colour sensitivity factors to consider, as well as background contrast. Perhaps the most clear-cut difference between *H. armigera* and *H. fletcheri* habitus is that there are prominent forewing spots with a greater white component in the post medial fascia of *H. fletcheri*. These may nevertheless vary; being very small in some *H. fletcheri* individuals. Plate 2 shows that *H. armigera* can also have small spots in this zone! In short, there are no clear, consistent, objective, confirmatory external characters, only trends in a series. Therefore dissection, particularly of males, is necessary. Hardwick does also point out internal characters in females, such as lack of spiculation in the lumen of the appendix bursae, to distinguish *H. fletcheri* from *H. armigera*, but like so much of the above, these must be regarded as relative.

Helicoverpa fletcheri is recognised as a pest of Bulrush millet (*Pennisetum*), and perhaps millets in general, therefore including *Sorghum* (Matthews and Jago, 1993). It has been reared on *Sorghum* in Sudan, though to date has not been found on this crop in the wild. According to records from Sudan and Mali, it also feeds on Sesame, *Sesamum indicum* (Hackett and Gatehouse, 1979), wild Sesame *S. alatum* (Matthews, 1991), *Heliotropium spp.* (Hackett, 1998), *Zornia glochidiata* (Leguminosae) and *Hibiscus* (Matthews, 1991). Its occurrence on Sesame has been picked up on the CABI website and Wikipedia page for this species, but it could easily co-occur with *H. armigera*, rather than be one of the main pests on this crop. The way these references state this species' hostplant record imply it is restricted to that plant, and not an important pest of other crops.

It seems premature, considering a). the problems of recognition and the lack of tests rearing this species on various foodplants, and b). lack of rearing and dissection of adults of presumed *H. armigera* from the various potential hosts, to set the limits of *H. fletcheri's* biology. Indeed, it is possible that *H. fletcheri* might have been a pest of cotton in Sudan in the late 70s, since the approximately 25% of *H. fletcheri* that did not diapause from my rearing experiments in September 1978 (Hackett and Gatehouse, 1982) would have to move to a new hostplant, and cotton was the only widespread flowering plant in the vicinity in October. As mentioned above, Cowland (1936) stated that "*Heliothis obsoleta*", an early name for *H. armigera*, (as well as *H. fletcheri*), was found at that time on cotton in the Gezira in October.

H. armigera's lack of diapause in September and October (the end of the rainy season) (Hackett and Gatehouse, 1982) means that local breeding may continue at low population levels on vegetable plots and along the Nile bank gardens, potentially from November to March as cited by Balla (1970). The bulk of the population, however, appears to leave the Gezira southwards at the end of October, assisted by northerly winds. There they may still find *Sorghum*, this crop often being planted later in wetter areas south of the Gezira. There is also a possibility that migrating moths reach Uganda, where year-round breeding has been recorded.

After my time in Sudan and Bangor University I moved on to a two-year ODA posting in Tanzania, mainly testing pyrethroids, which were newly released at the time, on cotton. My previous experience and curiosity led me to collect more *Helicoverpa* from various hosts in my spare time, including two specimens of the distinctive, yellow *H. assulta afra*; one from a light trap at Ilonga, Kilosa, near Morogoro and one reared from a larva found locally on Okra *Hibiscus esculentus* in 1981. I was also hoping to see *H. toddi* (Hardwick), which has been recorded from E. Africa (Tanzania and Kenya) and Madagascar (Hardwick, 1965). It may be in my collection, hard to recognise from the habitus description and photographs in Hardwick, or even those on the Afromoths website. Dissection calls!

With 35+ years having passed since my fieldwork, I was wondering what advances in our knowledge of these moths might have occurred, for example in the form of new records or new specimens of African *Helicoverpa* spp. that might be found in museums or other repositories. Maybe there would be new tools by now, even a molecular test, to back up that tricky dissection. Apparently not!

An antibody test (Trowell et al. 1993), dubbed Lepton, was developed to distinguish all life stages of *H. armigera* from *H. punctigera* in Australia (which co-occur on cotton there), but it has seemingly gone out of use. Whether such a test would be applicable to dried, older adult specimens is not known, and *H. punctigera* is only endemic to Australia anyway. In theory biochemical tests could aid other *Helicoverpa* species verifications if this was seen as a priority. DNA barcoding, at least for the main *Helicoverpa* pest species, has been published on GenBank.

This article has been facilitated by visits to the NHM where I have viewed the collection of African *Helicoverpa*, with the kind permission of Alberto Zilli. I have seen the types, as well as other specimens, of the four relevant species in the main collection bearing determination labels. There are, of course, plenty of *H. armigera* types, 78 *H. fletcheri*, (including many added by Matthews), 95 *H. assulta afra* and 17 *H. toddi*. There are also many other, "in limbo", as yet un-determined specimens in the collection of supplementary accessions, with enough spotting on the forewings to suggest they may not be *H. armigera* (but perhaps *H. fletcheri*). These dubious specimens would currently require dissection for species determination. They are old, valuable and fragile, and if they turn out to be species other than *H. armigera*, they might yield new country, season and hostplant records (although most seem to be from light traps). Beyond the NHM, there is an *H. fletcheri* specimen in a collection in Zimbabwe (Vengai Mafirakurewa, Zimbabwe Plant Protection Research Institute, pers.comm. det. J.Holloway, 1981) that I have been sent a photograph of. This suggests a new country record, but it still retains its abdomen. *H. toddi* is recorded for "Southern Rhodesia" in Hardwick, but this species lacks prominent forewing spots.

Perhaps readers have '*H. armigera*' specimens in their collection they are doubtful about, or my photographs suggest might be another species. If so, please get in touch as I'd love to hear about them. I have come across three correspondents so far (two PhDs on *H. armigera* parasitoids in E. Africa and one cotton pest species surveyor in Madagascar), who have worked in the field 1980 to present, but who were not aware of the possibility that more than one species of *Helicoverpa* might be 'out there'. Clearly theories on any aspect of pest biology, their natural enemies and their management rest on correct species identification. But in the case of "*H. armigera*", there is enough information to raise suspicion that mix-ups are likely to occur under certain circumstances. Are we talking about *H. armigera* s.s. or s.l.? Progress would be made if more vouchers were kept and critically examined, and easier to use detection methods were available.

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Photo 1. *Danaus chrysippus bataviana* male nectaring and showing abdomen. Bali, Indonesia.

Photographing courtship and mating behaviour in butterflies

Ray Cannon

Finding a mate is one of the biggest challenges facing any animal which relies on sexual reproduction. For butterflies, the process of finding, recognising and attracting a mate usually rests on a combination of sight and scent (Vane-Wright and Boppré, 1993). The task of finding, or locating a mate is usually carried out by males, although females can facilitate the process by placing themselves in the vicinity, for example flying past perching males who then give chase.

Photographing stationary insects, for example when they are nectaring on flowers, is relatively easy and produces some satisfying rewards (Photo 1). Capturing images of behaviour and motion is an altogether more challenging prospect and requires a good deal of patience, perseverance and luck. It is, however, very rewarding to try and can sometimes produce interesting results.

Perching and searching

Male butterflies can either sit and wait for a female to come to them (Photo 2), or they can actively search for receptive partners within a wider area.

Photo 2. Perching butterfly. Probably the Knight (*Lebadea martha*). Thailand.

These two strategies are not mutually exclusive and some species utilise both perching and patrolling behaviour depending on the weather or the time of day. The small heath butterfly, *Coenonympha pamphilus*, (Photo 3) is highly territorial, but as temperatures rise the males abandon their perches and start searching for females over wider areas (Wickman, 1985).

Territorial contests

Butterflies do not usually compete over access to resources such as food and shelter, but they are competitive – and often highly aggressive – over access to mates. Some, but not all, species are territorial and compete in non-contact interactions over a site or territory. These are the characteristic spiralling flights, seen in so many species all over the world, but devilishly difficult to photograph!

Such circling flights, where two males interact in a territorial dispute, have been called 'wars of attrition'. The resident male almost invariably wins (Takeuchi and Imafuku, 2005). Holding on to a territory in this way greatly increases a male's chances of locating a mate. Some researchers have, however, questioned whether such male-male interactions are true wars of attrition (Takeuchi et al., 2016; 2017). Male butterflies are notoriously poor at determining the sex, or even the species, of intruding insects.

Photo 3. Small Heath (*Coenonympha pamphilus*). Galicia, Spain.

The contests between males are almost always non-violent; indeed, you might think it would be difficult for one butterfly to inflict violence on another! Nevertheless, the rare and endangered Homerus swallowtail – also called the Jamaican giant swallowtail, *Papilio homerus* – engages in what can only be described as full-blown fighting. Males clash with each other, with audible impacts as they collide (Lehnert et al., 2013), in what appear to be territorial disputes. These interactions can result in considerable damage, with a male potentially losing more than 90% of his wings. Such battles are, we must assume, rather rare, and perhaps only occur in this butterfly because of its considerable size; it has a wing span approaching 15 cm (Emmel & Garroway, 1990). Now that would be amazing to photograph!

In perching species, the males occupy prominent vantage points – typically sitting on top of a leaf high off the ground – surveying the immediate surroundings and waiting for potential mates. The speckled wood butterfly, *Pararge aegeria* (Photo 4), is a typical perching species, although males also patrol a wider area, carrying out what is called a 'fly-and-search strategy' (Velde et al., 2012). When a perching male spies a passing female, he takes off rapidly and attempts to intercept her. If she is interested, she lands and he alights close by. There then follows a sequence of species-specific courtship

Photo 4 (left). Speckled Wood (*Pararge aegeriea*) perching. Galicia, Spain; Photo 5 (right). Speckled Wood (*Pararge aegeriea*) in sunspot. Galicia, Spain.

Photo 6 (left). Lang's Short-tailed Blue (*Leptotes pirithous*) on yellow flower. Galicia, Spain; Photo 7 (right). Lang's Short-tailed Blue (*Leptotes pirithous)* courtship. Female attached to gorse bush. Galicia, Spain.

behaviour, followed by copulation (Wiklund et al., 2003).

In temperate, forest-dwelling species such as the speckled wood butterfly, *Pararge aegeria*, males are typically seen defending sunlit patches of the forest (Photo 5), waiting to rendezvous with passing females. The sunlit spots are chosen by the males to facilitate their perception of passing females and, simply, as places to warm up. Although females are not attracted to these sunlit territories *per se*, they are much more visible, or apparent, to resident males as they fly though these natural spotlights (Bergman, 2007). Consequently, resident males are much more successful at mating than non-resident males; not because they are any more attractive, but rather because the territory itself gives them an advantage in terms of detecting and pursuing females.

Research into butterfly behaviour is challenging, to say the least. Butterflies can fly very fast and detailed observations on territorial disputes, mating success and so on are sometimes impossible, other than in artificial areas. Copulation often occurs well away from the territorial arena – for example, in the tree tops or deep in the undergrowth – and it can be very difficult to follow individuals as they move through their three-dimensional natural environment. Following butterflies with a camera is a good way of observing behaviour, as well as discovering how mobile they are, although this varies with the weather. Cooler overcast days are often more rewarding for butterfly watching/photography, as they spend more time perching and basking, compared to hot, sunny days when they fly around continually!

Courtship and mating

Researchers have categorised male courtship patterns into a number of separate phases. The precise details vary greatly from species to species, but typically consist of a series of distinct modular phases which can be terminated at any stage by either party. Progression from one stage to the next is elicited by both visual and olfactory cues, or stimuli, some of which work at different ranges, or distances (Li et al., 2017). Potential mates are identified by sight and confirmed by smell, so to speak! There is a spectrum of courtship behaviours, from simple to complex, depending on species and to some extent, individual receptiveness.

Although there is a great diversity of different courtship behaviours, female butterflies 'almost never fly towards males to mate' (Scott, 1974). Males initiate courtship – for example, in the common blue butterfly (*Polyommatus icarus*) this involves a display of fluttering wings – but the sequence is very often terminated prematurely in the face of female indifference or

Photo 8. Lang's Short-tailed Blue (*Leptotes pirithous*) courtship. Male fluttering above female (with partially unfolded left hindwing). Galicia, Spain.

Photo 9 (left). Iberian marbled white (*Melanargia lachesis*) courtship. Male approaching from the right. Galicia, Spain; Photo 10 (right). Iberian marbled white (*Melanargia lachesis*) courtship behaviour. Male approaching from the right. Galicia, Spain.

Photo 11 (left). Iberian marbled white (*Melanargia lachesis)* courtship behaviour. Male above female. Galicia, Spain; Photo 12 (right). Iberian marbled white (*Melanargia lachesis*) courtship behaviour. Female with wings closed. Galicia, Spain.

Photo 13. Painted Jezebel (*Delias hyparete indica*) male flying towards stationary female. Thailand.

Photo 14. Painted Jezebel (*Delias hyparete indica*) male flying towards female resting on flower. Thailand.

Photo 15 (left). Comma (*Polygonia c-album*) male. Beds, UK; Photo 16 (right). Green-veined white (*Pieris napi*) rejection posture by female, below. Gaicia, Spain.

Photo 17 (left). Green-veined white (*Pieris napi)* rejection posture by female, below. Galicia, Spain; Photo 18 (right). Green-veined white (*Pieris napi*) resting male. Galicia, Spain.

refusal and mostly does not progress to copulation (Knüttel and Fiedler, 2001). The male butterfly cannot force himself upon a female (see later), so there is an element of choice by both sexes.

I photographed a possible courtship sequence in Lang's Short-tailed blue (*Leptotes pirithous*) (Photo 6) where the male was fluttering around a largely stationary female (Photos 7-8) who was sitting on a gorse bush (Link 1). Elucidating exactly what is going on during courtship such as this is no easy task. Typically, following an initial *interception*, there is a *courtship flight*, after which the pair *alight* somewhere. The male typically moves in front of the female, facing her head on whilst *fluttering* vigorously and emitting pheromones. But perhaps the habitat restricts and modifies the behaviour? The male then usually takes up a position beside the female, still fluttering his wings, and moves the tip of his abdomen to make genital contact with the female (based on Cordero, 1993).

In practice, butterflies may repeat short sequences of courtship behaviour multiple times, so what one sees is a sort of dance, which may or may not proceed beyond a certain stage. In a population of butterflies, there must be numerous short interactions between males and females as they go through the business of assessing each other's desirability! Typically, a female is perched, or sitting on the vegetation, whilst a male is flying around her and presumably trying to stimulate her into a state of receptivity.

I have photographed a female Iberian marbled white (*Melanargia lachesis*) sitting on a bramble bush being approached and touched by a male in what appeared to be a courtship sequence (Link 2). The female opened and closed her wings and changed position (Photos 9-12). To really understand what is going on would require taking a video recording and analysing the movements closely. The technology certainly exists for such studies. I photographed a similar sequence in Thailand, where male Painted Jezebel (*Delias hyparete indica*) were flying around a female which was sitting on a flowering bush (Photos 13-14; Link 3).

A fascinating element of butterfly courtship is that in almost all species, females can resist and reject attempts by the male to mate (Wiklund et al., 1993). In other words, males cannot force a mating if the female is unreceptive. There is, however, one well known exception in the Monarch butterfly, where the males grab females in mid-air and fall to the ground where copulation occurs (Pliske, 1975). This ability to decide whether to mate with a potential suitor gives females the ability to select mates in a manner which maximises their own individual

Photo 19. Rock Graylings (*Hipparchia hermione*) Courtship. Galicia, Spain.

Photo 20. Bowing behaviour in the Rock Grayling (*Hipparchia hermione*). Galicia, Spain.

Photo 21. Bowing behaviour in the Rock Grayling (*Hipparchia hermione*). Another male looking on. Galicia, Spain

fitness and, therefore, female mate choice is a key driver in the evolutionary process. It may be true to say that the male also has a choice, i.e. whether to terminate a copulation prior to passing on an ejaculate (Wiklund and Kaitala, 1995), though even where a male chooses to mate his efforts may be negated by post-coital female decision making. There are, for instance, mechanisms by which mate choices can in effect be made by the female after copulation (Eberhard, 1996).

Cryptic female choice, as it is called, involves mechanisms that are not fully understood, but involve the female making assessments of male quality after copulation. In some species, such as the Comma butterfly (*Polygonia c-album*) (Photo 15) females appear to be able to adjust their reproductive investment in relation to the quantity of nutrients received from the male (Wedell & Cook, 1998). In other words, she tailors her utilisation of his sperm in relation to the size of the nuptial gift he provides!

In highly receptive females, some of the later phases of courtship may apparently be shortened. Most female butterflies mate soon after emerging from their pupae and some actively solicit males, for example by flying up in front of them. Nevertheless, unsuccessful courtships are frequently observed and the process can be terminated at any stage, including whilst in copula. It is not easy to say which sex initiates termination in many cases, but it is likely that both males and females can evaluate their partner and make choices about whether to continue, at any stage of the courtship (Cordero, 1993). In some common species, including *Polygonia c-album*, *Aglais urticae*, *Inachis io* and *Vanessa atalanta*, courtship is reportedly a lengthy affair, with the male following the female for hours before mating occurs ('Wiklund pers comm.' quoted in Bergman, 2011).

The release of pheromones by males is a crucial element in courtship and the effect is to increase the receptivity of the female and make her more likely to accept her suitor. Key aspects of the courtship are carried out by the male with the aim of bringing his pheromone-emitting structures into contact with the female, so that she can receive the chemical messages they convey (Andersson et al., 2007).

Photo 22. *Danaus chrysippus bataviana* male and female in copula. Bali, Indonesia.

A female who has already mated and wants to put a stop to further attentions or harassment from males has a number of options. Butterflies in the family Pieridae (Whites, Sulphurs, Yellows) have evolved a very specific piece of behaviour, or body language, called the mate refusal posture: the wings of the female are held wide open – at or below the horizontal – and the abdomen is raised up, almost to a vertical position, often with the genitalia extruded (Obara, 1964; Itoh & Obara, 1994). I photographed this happening in a pair of Green-veined whites (*Pieris napi*) on a rather overcast day in northern Spain (Photos 16-18). The rejection posture by the female is unmistakable! (Link 4). Simply closing their wings also functions to deter males from mating with females in some species (Ide, 2011).

Another, slightly more drastic, mate refusal tactic is adopted by some butterflies, such as the Speckled wood, *Pararge aegeria*, where the females reject mating by 'playing possum'. They close their wings and pretend to be dead; if the male persists, the female will let go of the substrate on which she is standing and fall to the ground. In some cases, even this is not sufficient to deter the male who will pursue the female onto the ground and persist in trying to enforce copulation; reportedly for over a minute in the Speckled wood (Shreeve et al., 2006)!

Bowing in Graylings

The great Dutch biologist Niko Tinbergen first described the stereotypic courtship behaviour of the Grayling butterfly, *Hipparchia semele*, which was common on a dune area in the centre of the Netherlands, Hulshorst sands – on the shores of the Zuider Zee – where he was carrying out research on digger wasps. The complex courtship sequence carried out by the male Grayling involves a series of moves and manoeuvres which, if successful, end in copulation. The key element of the sequence he called 'bowing' and this is also exhibited by other Grayling species, including the Rock Grayling (*Hipparchia hermione*) (Photo 19).

Working in the Central Apennines (Rieti, Italy), Manuela Pinzari of the Department of Biology, University of Rome "Tor Vergata", showed that the general pattern of sexual behaviour in the Tree Grayling (*H. statilinus*) was almost identical to that of the Grayling

Photo 23. Gatekeeper butterflies (*Pyronia tithonus*) in copula; female on top basking.

Photo 24. Gatekeeper butterflies (*Pyronia tithonus*) in copula; female on top.

Photo 25. Gatekeeper Butterflies (*Pyronia tithonus*) in copula; female on top basking.

(*H. semele*) (Pinzari, 2009). The only differences appeared to be in the 'presence/absence, order and performance of steps' in the courtship sequences. Building on the pioneering studies by Tinbergen (1941, 1972), Pinzari (2009) described six patterns of behaviour in the courtship sequences of both the Grayling (*H. semele*) and the Tree Grayling (*H. statilinus*). Without going into details these are as follows: Fanning, Circling, Bowing, Antenna orientation, Copulation attempt and Clasping. These behaviours are beautifully illustrated in a series of sketches in Fig. 2 from Pinzari (2009) (reproduced here as Fig. 1 with permission from the author).

The bowing behaviour by the male is a sudden rotation of the body forward on the sagittal axis, levering upwards on the posterior legs; whilst his head is brought close to the ground (Photo 20). Or as Tinbergen (1984) describes it (for *Hipparchia semele*):

After alighting near the female, he walked round until he faced her. Then with curiously jerky movement, he raised his forewings step by step, quivering them, and with one final forward jolt hit the female with them. All the time the wings were kept almost or completely folded.

Whether the courtship progresses to copulation is largely dependent on the female and the courtship sequence itself is often interrupted and restarted again at an earlier point in the cycle (Pinzari, 2009). A female can reject or discourage persistent males by becoming inactive, or by flapping and opening her wings (Pinzari & Sbordoni, 2013). Pheromones (scents) produced by the male play a major role in courtship and the bowing behaviour is thought to be a way of exposing the female to these scents and thereby stimulating her into a state of receptivity. During bowing 'the male bashes and strokes the female antennae between his forewings on the androconial scales' (Pinzari & Sbordoni, 2013). The bowing behaviour is quite a jolt. It looked to me, at first, like a butterfly head-butt!

Manuela Pinzari, together with co-worker, V. Sbordoni, went on to investigate the courtship behaviour of a subspecies of the Rock Grayling (*H. hermione genava*) (Pinzari & Sbordoni, 2013). Although the overall pattern of sexual behaviour was like that in the other species, there were some significant differences regarding

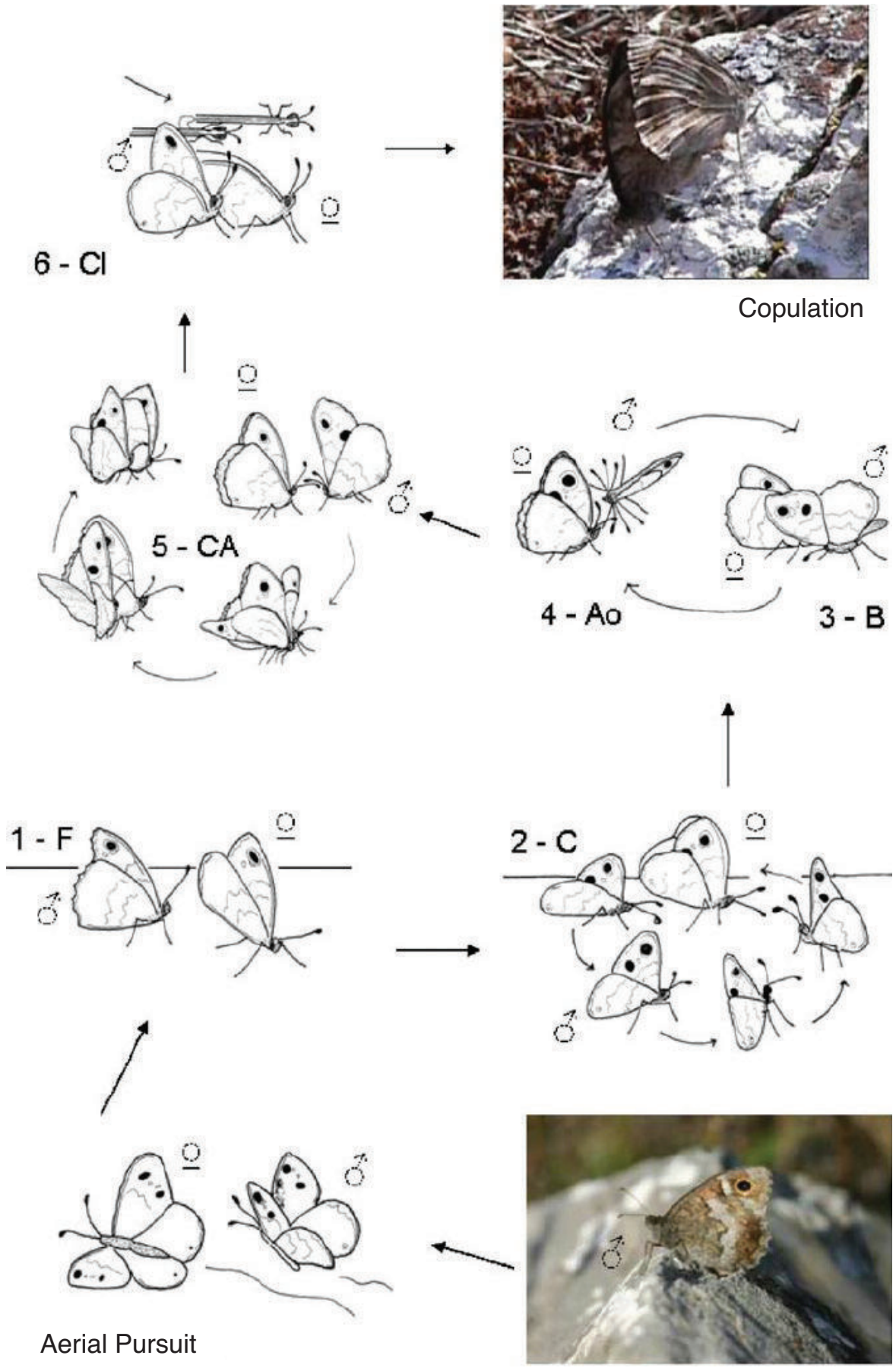

Fig. 1 (being Fig. 2 from Pinzari, 2009). Courtship sequence in *H. statilinus* (Fanning (F); Circling (C); Bowing (B); Antenna orientation (Ao); Copulation attempt (CA); Clasping (Cl). With permission from the author. *Journal of Insect Behavior* 22(3), 227-244. Springer.

the courtship behaviour by Rock Graylings in terms of when the steps are carried out and in what order (Pinzari & Sbordoni, 2013).

A key finding of these studies is that, when interrupted, a male can re-start the courtship from any step of the sequence. In only some 10% of cases did a single courtship sequence end in copulation. In other words, the males courted the females repeatedly, meaning that one is very unlikely to see the whole courtship sequence, from start to copulation, in the field. The *Bowing* and *Antenna orientation* behaviours could be repeated many times in a row (up to 25 times in the Rock Grayling). So, certain relatively short sequences of behaviour can be repeated numerous times, perhaps with interruptions by other males (Photo 21), before reaching a conclusion (Link 5).

Copulation

Butterflies remain *in copula* for very variable amounts of time, from the brief (20 minutes) to the lengthy (27 hours) (Shields and Emmel, 1973). The mating pairs may be stationary and cryptic, or relatively mobile, flying about whilst locked together. One individual, usually the largest sex in dimorphic species, does the carrying. In species of about the same size, the individual flying and carrying the other can be of either sex, although one sex usually predominates in this role. I came across a pair of Plain tigers (*Danaus chrysippus bataviana*) *in copula*, in Bali (Photo 22). In this case the male was carrying the female and flying rather laboriously until they landed. The reason for the movement whilst *in copula* may be to allow the individual who is doing the carrying to feed, or even to bask. I have also photographed a pair of mating Gatekeepers (*Pyronia tithonus*) in flight (Photos 23-25). In this case the somewhat larger female was carrying the male.

Wood whites

Wood Whites (*Leptidea sinapis*) have a characteristic courtship display where the male lands opposite the female, sways his head, and waves his antennae backwards and forwards with his proboscis extended (Wiklund, 1977) (Photos 26-27). Charmingly, the male does not attempt to mate with the female until she has shown some sign of accepting his advances, which she does by lowering her abdomen so that it becomes visible between her wings (Friberg et al., 2007). She also bends her antennae backwards until they touch her wings (Wiklund, 1977).

Newly emerged, virgin females are usually highly receptive and courtship is brief. With females that have already mated, however, there appears to be no obvious rejection behaviour by which the female Wood white butterfly can signal her unreceptivity (Link 6). This is thought to be the reason why courtship displays by the male are often highly protracted, with lots of antennae and proboscis waving, but rarely resulting in copulation. When it does occur, the act of mating itself is quite long-lasting: between 25 and 55 minutes, before the male releases himself and flies away (Wiklund, 1977).

The situation is in fact even more complicated in Wood Whites because there are thought to be two cryptic species, largely overlapping in their habitats, but virtually identical and only distinguishable by microscopic observation of their genitalia (Dinc et al., 2011). In regions like northern Spain, where these photographs were taken, the two species (*L. sinapsis* and *L. reali*) may occur together, and it appears that only the females can tell whether the male is of the same species as herself; the males do not seem to be able to determine which species they are courting (Friberg et al., 2007) (Link 7).

Polyandry

It is easy to understand why males would want to mate more than once; by doing so they leave more offspring and increase their fitness. Females on the other hand might be better off mating just once, then concentrating on egg laying, choosing the best sites for the survival and development of their offspring (Wiklund, 1982). So, there appears to be a conflict of interest between the sexes in terms of how many times they need to mate to maximise their reproductive success. This conflict is resolved to some extent via nuptial gifts from the male to the female.

The number of times a female butterfly has mated can be determined in wild-caught butterflies by counting the number of spermatophores, or residues, inside her reproductive tract. Such studies have revealed that, contrary to what was once thought, females in most butterfly species mate more than once (Watanabe, 2016). There is probably a continuum between, on the one hand, species where females almost all mate just once, and on the other, species where the females almost all mate multiple times. In between, there are species which exhibit a mix of mon- and poly-androus behaviour. Some species, like the peacock butterfly, *Inachis io*, and the orange tip butterfly, *Anthocharis cardamines*, are largely monandrous – but a small proportion of females mate more than once, producing an average mating frequency slightly greater than one (Wiklund et al., 2003; Wiklund and Forsberg, 1991). Likewise, female ringlet butterflies, *Aphantopus hyperanthus*, generally mate just once, and actively avoid males after doing so (Wiklund, 1982).

The comma butterfly, *Polygonia c-album* (Photo 15), is a good example of a polyandrous species, where females mate between two and three times (*c.*2.4 in one study in Sweden), on average per life-time (Wiklund et al., 2003). The average number of mating's performed by eleven different pierid species was approximately 1.5 (Svärd & Wiklund, 1989).

Females gain directly from multiple matings in many ways, including the receipt of nutrients, increasing the genetic diversity of their offspring, and replenishing their supply of sperm. The overall effect of multiple matings is to increase their production of offspring during their lifetime, as well as their own longevity (Wedell et al., 2002). Yet despite these obvious advantages – e.g. from male ejaculates – the average number of female matings is often relatively low in the field, indicating the existence of an optimum mating rate. Mating is a risk; copulating pairs are relatively inactive and therefore vulnerable to attack by predators. Nevertheless, in butterflies – as with the majority of insects (Arnqvist and Nilsson, 2000) – most species are polyandrous (mate multiple times) and there are advantages to both sexes in being so.

In polyandrous species the males usually deliver heavier and more nutrient-rich ejaculates – spermatophores – than in species which only mate once (Karlsson, 1996). In these situations, the sperm from different males is in effect in competition. It is a bit like buying lottery tickets (!), a male's chances of

Photo 26. Wood white (*Leptidea sinapis*) butterflies courting – male on the left waving his proboscis back and forth. Galicia, Spain.

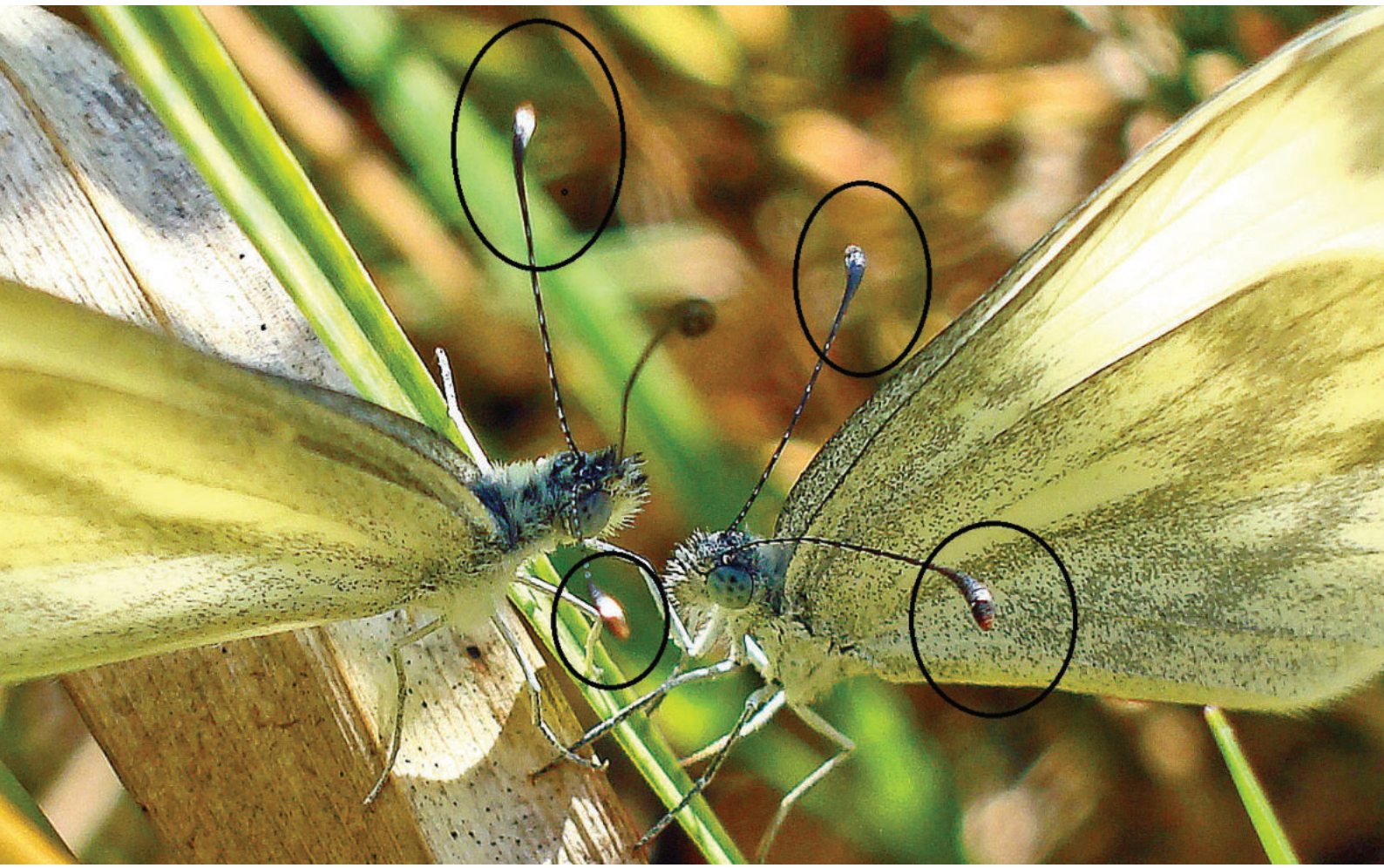

Photo 27. Wood white (*Leptidea sinapis*) butterflies courting with antennal tips highlighted. Male on the left (crop of Photo 26).

winning – fertilising the female's eggs – are increased if he transfers more sperm during mating. So-called sperm competition results in adaptations – both behavioural and physical – which maximise an individual male's ability to achieve fertilisations, i.e. increase his evolutionary fitness. Likewise, the females which will be selected by evolution are those that maximise their genetic reward in the next generation, regardless of the consequences for individual males. This illustrates the fact that the reproductive 'interests' of the sexes are not necessarily identical. The optimal rate of mating is usually higher for males than for females. This can lead to conflict between the sexes, a situation which has been called an evolutionary arms race, or sexually antagonistic coevolution (Kemp and Rutkowski, 2004; Wiklund et al., 2001). There must, however, be a continual balancing of conflict and cooperation between the sexes over time as they struggle to reconcile their somewhat different needs

Aphrodisiacs and anti-aphrodisiacs

When a male finds a potential mate, the outcome is not a foregone conclusion and depends on the predilection – receptivity and choosiness – of the female. She must respond positively to the bouquet of chemical signals (pheromones) released by the male when he comes close to her. His courtship serves to increase her receptivity. The pheromones produced by the male provide signals containing a wealth of information by which females can determine his health and status – and hence desirability (Vane-Wright and Boppré, 1993). In this way, she can make her choice from the pool of available suitors.

Male butterflies usually make a significant contribution to the reproductive process in the form of a large spermatophore, which has been called, somewhat prosaically, a 'nuptial gift'. The size of the male contribution is commensurate with that of the female in some species, and because of this (usually) large investment – and to deter rival males – some male butterflies produce chemicals to accompany their nuptial gifts which make the female appear unreceptive and unattractive to other suitors: an 'anti-aphrodisiac' (Andersson et al., 2000; 2003). Such anti-aphrodisiacs, produced by males and transferred to females during mating, have been identified in at least three pierids: *Pieris napi*, *P. brassicae* and *P. rapae*. The semiochemicals involved, however, differ from species to species.

In the green-veined white (*P. napi*) (Photo 18), the anti-aphrodisiac pheromone is a volatile ester called methyl salicylate (Andersson et al., 2004). Remarkably, once transferred, this chemical is then emitted by female *P. napi* butterflies if they are courted by other males, and released whilst she is performing the 'mate refusal posture'. It appears that the anti-aphrodisiac is gradually depleted by such activity and as such she gradually becomes more attractive to would-be suitors. Her receptivity therefore returns and she is ready to mate again after a period of between three and seven days in *P. napi*. These chemicals are called 'honest signals' by biologists, because they accurately communicate the reproductive status of the female and allow other males to curtail their courtship and focus on receptive females.

It is not difficult to imagine why such systems to deter subsequent suitors evolved, because it is in the interests of both sexes to defer rematings, at least for a while. The male benefits by preventing the female from remating, and thus ensuring she only utilises his sperm. The female benefits by avoiding having to fend off the attentions of other males whilst she deposits her already fertilised eggs. Egg laying and mating make conflicting demands on the female; both require a substantial amount of time – pairs can for instance remain locked *in copula* for up to 21 hours, in pierids – and both need warm sunny weather (Andersson et al., 2003). The mutual arrangement breaks down after a short period however, and both males and females remate in polyandrous species.

Spermatophores and nuptial gifts

What are butterflies doing whilst they are locked together like this? The male is making and transferring a spermatophore. As already noted, male butterflies usually make a significant contribution to the reproductive process in the form of a large spermatophore. The size of the male contribution is sometimes so large it is commensurate with that of the female's investment – in terms of eggs – in some species. Spermatophores can represent over 20% of a male butterfly's body weight, but the mass is significantly reduced when a male comes to mate a second time.

The ejaculate transferred to the female during mating contains sperm, nutrients, anti-aphrodisiacs and hormones (Wickland et al., 2001). Most of the sperm are so-called apyrene sperm – without a nucleus – and play no role in fertilisation. A smaller proportion, 10-15%, are genuine (eupyrene) sperm which are capable of fertilising eggs. The smaller anucleate sperm are in effect a protein contribution from the male to the female: his parental investment in the reproduction process; a sort of protein meal for her if you will.

Spermatophores are composed of a tough, indigestible outer envelope, an inner matrix, and a bolus of sperm. The spermatophore itself is formed inside the female, in a receptacle called the bursa copulatrix, during mating. Remarkably, the physical effect of the spermatophore in stretching the bursa of the female changes her behaviour, such that she is no longer receptive to other males, at least for a while (Meslin et al., 2017)!

Closing comment

As I hope I've shown here, mating behaviour in butterflies is a fascinating and diverse topic. With multiple stages of mate selection often being visually oriented - i.e. relying on visual cues - in these incredible insects, butterfly mating behaviour is not only a subject of intrinsic scientific interest, but also a challenging, yet highly rewarding, target for the entomological photographer.

Links

Link 1 – https://rcannon992.com/2017/08/30/langs-short-tailed-blue-courtship-behaviour/
Link 2 – https://rcannon992.com/2017/08/06/iberian-marbled-white-courtship-sequence/
Link 3 – https://rcannon992.com/2016/12/21/courting-jezebels/
Link 4 – https://rcannon992.com/2017/07/23/butterfly-body-language/
Link 5 – https://rcannon992.com/2017/09/02/rock-and-roll-grayling/
Link 6 – http://www.learnaboutbutterflies.com/Britain%20-%20Leptidea%20sinapis.htm
Link 7 – https://rcannon992.com/2016/08/09/wood-whites-go-a-courting/

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Fig. 1. Woolmer Forest, June 2003.

Gilbert White the entomologist

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Although he was primarily interested in birds, the 18th century parson-naturalist Gilbert White (1720-93) was a competent botanist and, perhaps because of his enthusiasm for horticulture and interest in farming, he had also learned a good deal about insects associated with plants, especially those species regarded as pests. A study of botany is certainly one avenue by which an interest in insects may be aroused, even if only because so many are the agents of plant fertilisation. A perusal of his *Garden Kalendar*, kept between 1751 and 1773, reveals how his concern for insect pests on his garden plants gradually extended from his middle years to a wider interest in insects, especially the nectar and pollen feeders – then eventually to the more noticeable species inhabiting the countryside around Selborne.

The local Field-crickets *Gryllus campestris* and Mole-crickets *Gryllotalpa gryllotalpa* aroused his curiosity in their habits. As a result, his field studies of these species, included in the *Natural History of Selborne* (1788) (hereafter referred to simply as the *Natural History*), are quite outstanding and show that he had the makings of a first-rate entomologist. His accounts of them in his famous book and his journals (Greenoak, 1986-89) compare well with the published observations of the leading entomologists of his time; indeed, they compare well with modern published studies. It would, moreover, be difficult to improve on the clarity and elegance of his English prose. He also wrote accurately and charmingly about the habits of House-crickets *Acheta domesticus;* in those times much more common inhabitants of homes, especially around the kitchen hearth, than they are nowadays.

As well as his observations of crickets, those he made of various other insects, although often less detailed, were, nevertheless, both acute and useful. Anyone reading through his journals, even more than the *Natural History,* cannot fail to be impressed by his capabilities as an observant and

Fig. 2. The Short Lythe, Selborne, May 2002; the site of Gilbert White's Field-cricket colony in the 18th century.

inquiring naturalist. His achievements are all the more remarkable when one bears in mind that he did not have access to a vast array of identification books such as the modern entomologist enjoys. Furthermore, despite his occasional visits to London, he seems to have lacked contact with the largely London-based entomologists of the 18th century. Many of these, however, were mainly interested in butterflies and moths, and it is noticeable that White made scant reference to these insects in his journals and none at all in the *Natural History*. This was rather a pity as there were some good books available, such as those of Benjamin Wilkes (1747-49) and Moses Harris (1766, 1986), whose beautiful and accurate coloured illustrations would have enabled him to recognize a good many species. Nevertheless, he occasionally recorded, altogether, 18 species of butterflies in his journals (all, except for the Glanville Fritillary *Melitaea cinxia* and Swallowtail *Papilio machaon*, still to be seen around Selborne): the Comma *Polygonia c-album*, Painted Lady *Vanessa (Cynthia) cardui*, Red Admiral *V. atalanta*, Peacock *Aglais* (*Inachis) io*, Small Tortoiseshell *Aglais urticae*, Silver-washed Fritillary *Argynnis paphia*, Glanville Fritillary *M. cinxia*, Grayling *Hipparchia semele*, Speckled Wood *Pararge aegeria*, Wall Brown *Lasiommata megera*, Small Copper *Lycaena phlaeas*, Large, Small and Green-veined Whites *Pieris brassicae*, *P. rapae* and *P. napi*, Brimstone *Gonepteryx rhamni*, Orange Tip *Anthocharis cardamines*, Clouded Yellow *Colias croceus* and, especially interesting, the Swallowtail *P. machaon*, so it is, perhaps, possible that he did in fact possess or had access to at least one of these works. Indeed, there is a sudden spate of butterfly records in his journal for the year 1769, a mere three years after the publication of the first edition of Moses Harris's book; so it is not beyond the bounds of possibility that White had just acquired a copy.

During the 18th century the Swallowtail Butterfly appears to have been well established in the southern counties of England, but died out during the early years of the 19th, probably as a result of a series of dreadfully sunless summers. Judging by the varied habitats in which it flew and the variety of umbelliferous plants on which its caterpillars were found, this southern English population belonged to the *gorganus* race, which inhabits neighbouring parts of the European mainland. This race still occasionally reaches southern England from Belgium or France and, during the series of fine summers in the 1940s, temporarily re-established itself in east Kent and is currently showing signs of doing so again in the south-eastern counties.

Gilbert White stated in volume 2 of his Journal, page 318, that the Swallowtail was rare in the Selborne district, but 'more common' in Essex (probably the British race *britannicus)* and Sussex (*gorganus)* than in his part of Hampshire. Altogether, he saw Swallowtails at Ringmer, Sussex (14 September 1769) and on four occasions at Selborne (2 August 1780, 14 July 1781, 18 August 1782 and 14 July 1784), two of them in his garden. Swallowtail butterflies, probably of the *gorganus* race, are still occasionally seen in Hampshire, though some, unfortunately, may have been bred and deliberately released by well-meaning, but misguided persons who thus distort the historical records. One, for example, was seen in July 1935 near Selborne in the neighbourhood of Liss; in this case, probably a genuine wild immigrant.

Of the other butterflies seen by White, almost all in his garden, his sighting of a Grayling *Hipparchia semele* at Selborne on 15 August 1769 is a little surprising as the nearest colonies nowadays are on the heathlands of Woolmer Forest **(Fig 1)**, though it is possible that, in his time, a population of the paler chalk form existed on the chalk downs near the village. However, Graylings sometimes wander considerable distances (up to 13.7 miles or 22 km, in my experience) and therefore it is well within them to fly from Woolmer to Selborne, a distance of only three miles (4.8km).

Another butterfly, the Glanville Fritillary *Melitaea cinxia*, recorded at Selborne in Gilbert White's journal entry for 3 August 1769, may seem surprising and difficult to believe as, nowadays, this species is largely confined to the south coast of the Isle of Wight, except for occasional temporary colonizations farther north on the island and on the Hampshire mainland. Deliberate introductions have, however, been made elsewhere, as for example in Gloucestershire and north Somerset. In Gilbert White's lifetime the Glanville Fritillary was locally plentiful in and around open woodland in south-eastern England as far north as Lincolnshire, where it was first discovered in Britain by Eleanor Glanville (*c.*1654-1709).

The Glanville Fritillary normally appears on the wing in England from late May to mid-July, depending upon the earliness or otherwise of the season. In favourable years a small second generation flies in August, as it does more frequently on the European mainland, and it is possible that White's entry for 3 August 1769, noting '*Papilio cinxia'* might have been a second generation butterfly (though, alternatively, it might have been a late-flying individual of the first generation). The weather at Selborne in 1769 was fine from the middle of April to the end of June, then warm and dry until early August, which suggested the season was a favourable one. On the whole, though, the 1760s and early 1770s, plus 1779, were wetter years than normal and may have led to the subsequent decline and contraction southwards of the breeding range of this butterfly, which had become very marked by the 1840s. The gradual

Fig. 3. Woolmer Pond, June 2003.

change in the climate from about 1850 from a previously more continental-type climate to a milder and wetter, maritime-type one (lasting to about 1950) may have led to its disappearance from Kent by the 1860s and its confinement to the Isle of Wight.

The butterfly mentioned most often by Gilbert White is the Brimstone *Gonepteryx rhamni*, presumably because it is one of the first species on the wing in the spring and the conspicuous bright yellow wings of the male readily attracted his attention. Indeed, he noted it often enough in his journals spanning the years 1766 to 1793 to enable one to analyse the first date of appearance at Selborne over this period. The average was 69 days from 1 January (10 March), which can be compared with the data I have collected for the 1980s and 1990s, which averages out at 63 days (4 March) and 36 days (5 February), respectively. The 1990s and the years since have, of course, seen a period of pronounced global warming. The 18th century was generally colder than the 20th, falling as it did within the so-called 'Little Ice Age'. At that time, England experienced a 'continental-type' climate with more frequent cold, often severe, winters, but often hotter, drier summers. Tim Sparks, formerly of the Institute for Terrestrial Ecology at Monks Wood, near Huntingdon, to whom I sent the data that I extracted from White's journals, found a significant relationship with the records of first appearance of Brimstones in Norfolk, kept by the Marsham family near Norwich over much the same period of the 18th century as Gilbert White.

The first appearance on the wing each year of the Small Tortoiseshell *Aglais urticae* was also quite frequently recorded by White and an analysis of these for the same period as the Brimstone averages out at 68 days from 1 January (9 March). The average date from my data for the 1980s and 1990s gives an average for these decades of, respectively, 50 (19 February) and 19 days (19 January).

Moths (or *Phalaenae* as he usually called them), do not seem to have attracted Gilbert White's attention to anything like the same extent as butterflies, except perhaps in the winter months when he was rather puzzled by the appearance at night of those species, such as the November Moth *Epirrita dilutata*, Winter Moth *Operophtera brumata*, Mottled Umber *Erannis defoliaria*, Scarce Umber *Agriopis aurantiaria*, Early Moth *Theria primaria* and December Moth *Poecilocampa populi*, that normally fly at this time. For instance, on 16 December 1774, he comments that '*Phalaenae* come out in the evening: they seem to be hardier than the *papiliones* (butterflies), appearing in mild weather all the winter thro'. Also on 25 November 1775, he remarked '*Phalaenae* appear. Strange that those nocturnal *lepidopterae* should be so alert at a season when no day-*papilios* appear, but have long been laid-up for the winter!' On 2 December 1776, he noted that *phalaenae* come out when the thermometer is 'at 50' (Fahrenheit). These winter moths certainly seem to have been abundant around Selborne in White's day, in some years at least: he wrote of many on 12 December 1772; of them swarming in the hedges on 30 November 1777, and flying 'in abundance, about my hedges' on 17 December 1778. In fact, he mentioned the appearance of winter-flying moths in the hedgerows on many occasions. He also mentioned moths flying in late April 1784 and stated that they are hunted along the sides of the hedges by bats. These may have been such spring moths as the Dotted Border *Agriopis marginaria*, March Moth *Alsophila aescularia*, Early Thorn *Selenia dentaria*, Early Tooth-striped *Trichopteryx carpinata*, Early Grey *Xylocampa areola*, and Brindled and Oak Beauties *Lycia hirtaria* and *Biston strataria*.

In the warmer months of the year, it was the occasional sighting of a large moth, such as one of the hawkmoths, which warranted an entry in his journal. Thus, on 29 June 1776, he noted the arrival in his garden of a '*Sphinx forte ocillata*? A vast insect; appears after it is dusk, flying with an humming noise, & inserting it's (sic) tongue into the bloom of the honeysuckle: it scarcely settles on the plants but feeds on the wing in the manner of humming birds.' Walter Johnson (1982) in his book *Gilbert White*, and Francesca Greenoak (1986-89) in a footnote in her edition of White's journals, both suggested that it was a Hummingbird Hawkmoth *Macroglossum stellatarum*, but this was plainly not the case as this moth is not a 'vast insect', is less likely to fly after dusk and is not strongly eyed-spotted as White's Latin description indicates. It was, in fact, clearly an Eyed Hawkmoth *Smerinthus ocellata*, which flies from May to July with a louder humming sound than that made by the Hummingbird Hawkmoth.

Most exciting of all was White's discovery of a Death's-head Hawkmoth *Acherontia atropos* at Selborne on 11 September 1777, 'a noble insect, of a vast size.' He mentioned the well-known squeaking sound it makes by forcing air through its proboscis, stating that when 'handled it makes a little stridulous noise.' This impressive moth is nowadays, as then, an irregular immigrant in small numbers to Britain. On 3 June 1780, he recorded the appearance of 'The *Phalaena*, called the swift night-hawk.' It is not possible to be certain of its actual identity, but it may well have been a Privet Hawkmoth *Sphinx ligustri*, still a fairly common but local species in Hampshire, even though it has declined a good deal since the 1950s.

Although Gilbert White may not have been particularly interested in moths, he did sometimes take the trouble to go out at night, at least in his

Fig. 4. Ancient cottage in Selborne village, May 2002.

garden, and see what was astir; for instance, in one of his journal entries, in the *Garden Kalendar* for 21 August 1765, he comments that 'The night-moths, & earwigs, I find, feed on the flowers by night, as the bees and butterflies do by day: this I found by goings-out with a candle.' A charming picture for one to visualise! On 1 September 1769 he made the entry '*Phalaena russula*' without comment. This is a scientific name bestowed in 1758 by the famous 18th century Swedish naturalist Carl von Linné, (Linnaeus) on the Clouded Buff moth, now known as *Diacrisia sannio*, an attractive species of which the female normally flies after dark, while the male readily flies in sunshine, especially in hot weather, when disturbed from the low vegetation in which both sexes hide. It inhabits chalk downs and heaths, habitats much in evidence around Selborne. In the 1950s it was described as common at nearby Whitehill, when a late example was recorded on 27 August 1955. White's date is also a late one, as the moth usually flies as a single brood in June and July in Britain. However, on the European mainland a partial second brood flies in July and August, and White's record (and the 1955 one) seem to indicate that it occurs here, too, from time to time. Indeed, in the more continental-type summers of 18th century southern England partial second broods may have been of regular occurrence.

Gilbert White sometimes referred to another moth that he called the '*Sphinx filipendulae*', but wrote that it was generally known as the saint-foin fly because in its 'crawling state (it is) said to be very pernicious to that plant.' Sainfoin *Onobrychis viciifolia* was a common fodder plant in the 18th century. Saint-foin flies are more familiarly known nowadays as burnet moths (indeed, they were so by 18th century entomologists like Moses Harris) and three common species of these colourful and conspicuous red and black, day-flying insects are to be found in north-east Hampshire, including the Selborne district. These are the Five-spotted Burnet *Zygaena trifolii*, the Narrow-bordered Five-spotted burnet *Z. lonicerae* and the Six-spotted Burnet *Z. filipendulae*. The last-named is the most widespread and numerous, but, judging by the dates of appearance recorded by White it seems most likely that the actual species he saw was the chalk downland race *palustrella* of the Five-spotted Burnet, which nowadays flies from late May to the end of June. White's dates were the 13 June 1771, 18 May 1775, 3 June 1785, 4 June 1791 and 17 June 1792. However, it is possible that the Narrow-bordered Five-spotted and Six-spotted Burnets were present as well, although these do not usually appear on the wing before the end of June. The caterpillars said to feed on sainfoin, a chalk-loving plant, are most likely to have been the Narrow-bordered Five-spotted as this is the only one of the three species which is not confined to feeding on species of Bird's-foot Trefoil *Lotus corniculatus*, the caterpillars feeding on other trefoils and also on various clovers and vetches, including Sainfoin. Moreover, the pupal cocoons are usually spun high up on grass stems and other vegetation, which fits in quite well with White's statement that they are fixed to dry twigs in hedges.

Other references to moths in White's journals can also be identified with some accuracy. Thus a note of *Phalaena pacta* on 31 August 1769 almost certainly refers to the large and handsome Red Underwing *Catocala nupta*; while one of *Tinea vestianella* on 26 February 1770 is equally certain to have been a specimen of the Coleophorid moth *Coleophora vestianella*, one of the case-bearers. These moths are so-called because the larvae move around in a case (shelter) constructed from their foodplant, in this instance Common Orache *Atriplex patula*. A moth recorded on 3 June 1768 and described in Latin as *Alis caeruleo-atris, antennis corpore duplo longioribus* (with dark-blue-black wings and antennae which are more than twice the length of its body) may have been the attractive Green Longhorn *Adela reaumurella*. The dark wings of this little moth glow metallic green and blue-black in the sunshine as the males swarm in mating flight around hedgerows and wood borders from April to June, as they still do around Selborne and on Selborne Common.

In view of his love of gardening and general interest in agriculture, it is not surprising that Gilbert White made frequent reference in his journals to those moth caterpillars that attack cultivated plants, such as his apricot trees and gooseberry bushes. Foremost among these, judging by the frequency of mention, were the caterpillars that attacked his precious apricots from late April to early June, infesting the foliage, '.....which they tye together with their webs', he complained on 5 June 1777, '& gnaw & deface in a bad manner. We wash the trees with the garden-engine.' Reporting another big infestation of his large apricot tree on 14 May 1783, he mentioned that the caterpillars '.....twist & roll-up the leaves; these we open, & destroy the maggots, which would devour most of the foliage. These maggots are the produce of small spotted *phalaenae*.' It would appear that at least one of the species responsible was one of several kinds of small ermine moth (*Yponomeuta*), most probably the Orchard Ermine *Yponomeuta padella*, which usually attacks trees of the plum family, such as Hawthorn *Crataegus monogyna*, Blackthorn *Prunus spinosa*, Cherry Plum *P. cerasifera* and cultivated plums, of which the apricot is a member. As well as spraying the apricot foliage with water from his 'garden-engine', White and his general handyman-cum-gardener, Thomas Hoare, relied mostly and painstakingly on picking out the caterpillars from the webs by hand to destroy them.

The caterpillars that White reported were attacking his gooseberry bushes in May 1781 and May 1792 were most probably those of the Magpie Moth *Abraxas grossulariata*, still a common species in Selborne and elsewhere in England. The caterpillars, pupae and moths are all warningly coloured and distasteful to most, if not all, birds. As he implied that the black caterpillars which infested Mr. Pink's field of turnips in August 1781 were hairy, by mentioning that he had 'known whole broods of ducks to be destroyed by their eating too freely of hairy caterpillars' when referring to Mr. Pink turning 80 ducks into the field to eat them, it seems quite possible that these were the larvae of the White Ermine *Spilosoma lubricipeda*, another common moth in England. These caterpillars feed on the foliage of a wide range of low-growing herbaceous plants and would probably include turnip leaves in their diet, but not the roots. The latter would be attacked by the non-hairy caterpillars of the Turnip Moth *Agrotis segetum*.

Another species of moth that Gilbert White regarded as a pest, as many people still do today, in this case of oak trees, is the Green Oak Roller *Tortrix viridana*. He described the ravages of their small green caterpillars, which feed within the shelter of rolled-up leaves, when they occur in spring in such immense numbers as to leave the oaks 'quite naked of leaves.' This still happens on occasions in the Selborne district today.

At the very beginning of this article I made mention of Gilbert White's delightfully detailed observations of the Field-crickets *Gryllus campestris* and Mole-crickets *Gryllotalpa gryllotalpa* at that time inhabiting Selborne. Both these insects have long since vanished from the district as they have indeed from much of Britain, apart from a colony or two of Field-crickets in Sussex (recently expanded to other sites by conservationists and successfully introduced to Shortheath Common near Selborne as part of a species recovery programme), and the tantalizing reports from time to time that a few Mole-crickets have been found in recent decades in southern England, culminating in its rediscovery in the New Forest, Hampshire in recent years (Brock, 2017). Mole-crickets may, however, still be surviving here and there in suitable habitats elsewhere in England. White's Field-cricket colony was situated on the south-facing slope of the Short Lythe at Selborne **(Fig. 2)**. He considered it to be extinct there by 1791. In any case, in the 19th century this hillside was largely covered by a plantation of beech trees, rendering the site totally unsuitable for the sun-loving Field-crickets. In May 1970 I searched for them in fine weather in other possible places around the Short Lythe and elsewhere in Selborne, but, not unexpectedly, without success. During a visit to Woolmer Forest and Pond **(Fig. 3)** that same month I listened, also unsuccessfully, for the shrilling of these intriguing insects. In 1785, and again in 1789, White had stated in his journal that he had heard Field-crickets stridulating around and on the edge of 'the forest', by which he presumably meant Woolmer.

White's Mole-crickets used to occur in the 'moist meadows' and 'swampy ground' along the Oakhanger Stream near Dortons (Journal entry for 1 May 1792) as well as in his garden at 'The Wakes', where they damaged his flower and vegetable beds by burrowing into the roots of the plants. Such damage was also reported from market gardens around Farnham, not far outside the Selborne area, where one of the last known Mole-cricket colonies, if not the last, in that area survived. They damaged a potato crop at Tilford, south-east of that town, as late as July 1951. A casualty of modern hygiene, the House-cricket is the only one of the trio to have survived in some strength over much of Britain, although in much diminished numbers compared with 200 or even 100 years ago. W.H. Hudson (1903), writing in his book *Hampshire Days* of a visit to Selborne in July 1901, mentioned that 'cottages **(Fig. 4)** on both sides of the street seemed to be alive with them'. Some may well still frequent a cottage or other old, suitably heated building here and there in and around the village, although recent enquiries of mine have not revealed any instances of this.

Gilbert White's observations, as recorded in his Journal entries, were not confined to crickets and butterflies and moths: he also made notes of a variety of other insects, including dragonflies and damselflies, earwigs, cockroaches; Cockchafers *Melolontha melolontha*, Summer Chafers *Amphimallon solstitialis* and Rose Chafers *Cetonia aurata*, Stag Beetles *Lucanus cervus*, dor beetles *Geotrupes* spp., and Death-watch Beetles *Xestobium rufovillosum*, Glow-worms *Lampyris noctiluca*; flesh-flies, blow-flies and house-flies, bee-flies, drone-flies and horse-flies, flat-flies (parasitic on House Martins, Swallows and Swifts); warble-flies, bot-flies and nostril-flies (especially troublesome pests of farm animals in his day); bugs such as pond-skaters and plant-bugs (aphids); ants, ichneumon wasps, spider-hunting wasps, social wasps, Hornets *Vespa crabro*, Honey Bees *Apis mellifera* and wild bees. The list is impressive, and I could have added a lot more to this article. Nevertheless, I hope I have done enough to show that Gilbert White's entomological knowledge bears comparison with that of at least some of the leading entomologists of his period.

Acknowledgement

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Society News

Honorary Fellow Interviews

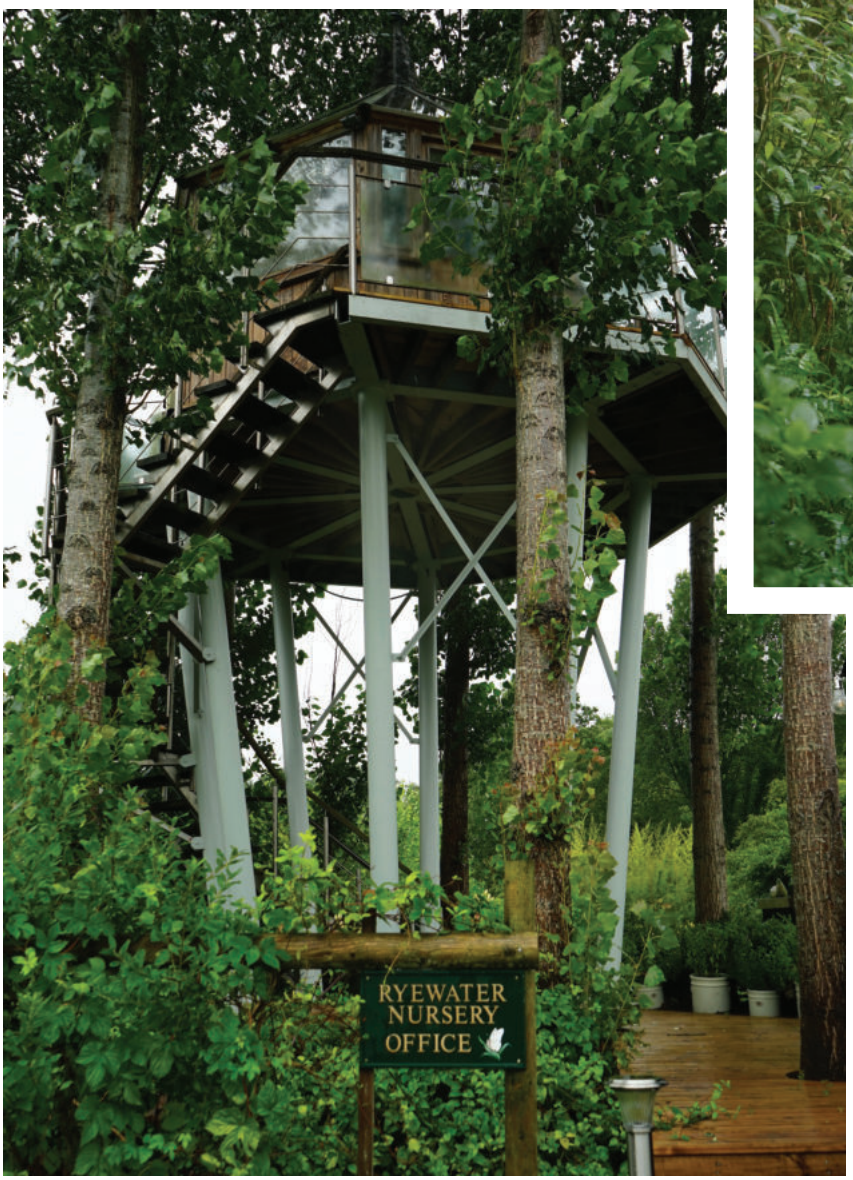
Clive Farrell

The Ambassador of Butterflies

by Peter Smithers

The rain was still hammering on my windscreen as I drove into Ryewater Nursery, all hope of a stroll around the fabled 'Dragon's Lair' washed away by the British summer. But dragons were not my main goal today; I had come to meet the dragon's master, Clive Farrell. Once in the grounds, I found myself in a maze of small lanes, and looking for signs of life I stopped at a large shed to ask for directions. The door swings inward and I received a warm welcome from Leslie Pattenden who is Clive Farrell's head gardener. The term shed is misleading, it's a warm and comfortable office with an impressive library on one wall. Leslie gives me directions to Clive's office and I am on my way again, a few meanders and I have arrived. To say that the office is unconventional is an understatement. It stands on metal struts 20ft in the air, nestling into the canopy of a ring of poplar trees, a heptagonal room accessed by a spiral staircase that hugs the frame. A rustic shepherd's hut on iron wheels stands guard at its base. Climbing the stairs, I am impressed with the ever-improving views of the grounds. Then, wet and windswept, I arrive at the office door but before I can knock, the door opens and Clive Farrell beams his famous smile, "Come on in". The room is flooded with light that is filtered through the poplar leaves, the rain drums an incessant tattoo on the roof and the crests of the poplar trees gyrate wildly in the wind, but inside a calm pervades the room. Clive asks, "Is this OK? We can go to my house if you prefer", but no, the eyrie from which he surveys his garden realm is the perfect place to discuss Clive's life and his passion for butterflies.

Clive is the ambassador of Lepidoptera, a theme that has run through his life from an early age. As a boy, an encounter with a hairy caterpillar roused his curiosity, so encouraged by his father he kept it in a jam-jar feeding it until it pupated. Then by chance he was there at the very moment it emerged from its pupa, and a fascination was triggered. It is as strong today as it was then, a fascination that began as a hobby but has evolved into the driving force in his life. Clive's father felt he should have a good, honest career and so he went into law, becoming an articled clerk to a



firm in London. While there, he rented a bedsit in Hampstead where he reared silk moths in his spare time, making nocturnal forays around the local streets to harvest privet from the hedgerows of his neighbours' to feed his caterpillars. That is, until his horrified landlord discovered his lepidopteran companions and put a stop to it. Once he was qualified Clive realised that he did not want to be a solicitor for the rest of his life so he took what we now recognise as a gap year and went travelling. As his father was a flying instructor with BEA he could obtain discounted flights, and so travelled all over Europe and once managed to fly to Fiji for £20. His most dramatic journey was a trip to Libya, hitchhiking back via Algeria, Morocco, Tunisia and Spain; a journey he would not have undertaken had he realised the potential dangers. This was a time filled with adventures and "interesting" encounters, but these are stories that remain within the Farrell family archive. On his return, he went into the property business, running a flat letting agency with a friend who ran a junk shop. The local landlords were delighted to have a solicitor drawing up their contracts and business flourished. Then one of the landlords suggested they join forces and go into business together. This venture went extremely well and a substantial property portfolio was accrued.

Butterflies had been in the background of Clive's life until this point. Then, a chance connection via his brother led to his introduction to the agent of the Duke of Northumberland, who wanted to develop a site at Syon park in South London. Clive's love of butterflies surfaced once more as he saw an opportunity to fulfil a dream, and a large glasshouse filled with tropical plants and butterflies was planned. Permissions and funding acquired, the structure was soon underway, but Clive's resolve began to waver as he contemplated the mammoth task of keeping the glasshouse full of butterflies. At this point he met Miriam Rothschild, who had heard of the project and sought him out. She encouraged him and introduced him to experts who could help with breeding butterflies in large numbers. Cyril Clarke bred Helicionids at Liverpool University, Brian Gardiner reared large numbers of large whites and Claud Rivers reared moths at Oxford University, so between them the problem of rearing and maintaining large numbers of butterflies was solved. Many other species were sourced overseas. There were also plans for displays of other invertebrates, such as spiders and stick insects, in the glass-house to appeal to a wider audience, but would anyone come to see it?

At this point Sir David Attenborough got wind of the project and approached Clive, regarding making a programme about it for the BBC. As many of the butterflies in the house were supplied by farms in Malaysia, the programme started there and then moved to the butterfly house and its visitors. The programme, entitled "A Touch of the Butterflies", was hugely popular and as a result long queues formed at the gate of the butterfly house. Fired up by the success of Syon Park, Clive built other butterfly houses, at Edinburgh, Weymouth and Stratford-upon-Avon, then overseas in Florida and Switzerland. An empire of butterflies had emerged from his passion and enthusiasm.

His next project was to establish a butterfly farm in Belize with Ray Harbard, who was also an experienced butterfly breeder. They visited Belize together but Clive left early, leaving Ray there with the instructions, "Don't come home until you have found a suitable site". Ray of course did so, and they set up 'Fallen Stones' as a butterfly farm and lodge. The lodge did not work out but the farm has been a raging success, supplying Clive's butterfly houses and many others around the world. The output is staggering: 2,000 Blue morpho pupae are produced every week, and over 2016 900,000 pupae of various species were sold to butterfly houses around the world. 'Fallen Stones' is a major producer of butterflies for exhibitions and is also a major contributor to the local economy, employing local people to run it and farming the butterflies sustainably.

Almost incidentally while building his butterfly empire, Clive bought the old mushroom farm at Ryewater Nursery in Dorset, a ten-acre site that he has subsequently increased to one-hundred acres. Here was a blank canvas on which he could play with ideas. The abandoned nursery and neighbouring fields have been transformed into a magical land, a garden of delights, including "Here be dragons" (possibly the longest one in the world and thankfully asleep). There is also a series of themed gardens, but not gardens as you know it. These include the Island of Dreams, the Nightmare Garden and a Plant Prison where botanical thugs (the more aggressive plant species) are kept under lock and key. Whilst these are beautiful, humorous and fascinating horticultural landscapes, collectively these flights of imagination form an important nature reserve that is an ark for local wildlife. Clive has recreated habitats that have long since vanished from the area and to his surprise the associated flora and fauna have recolonised the site. The Adonis and Chalk Hill Blues have both returned, and the Marsh Fritillary is back after an absence of fifty years. Additionally, the Narrow-bordered Bee Hawkmoth has recently begun to breed on site and the Small Blue now thrives here, having migrated from the nearest site five miles away. As Clive says, "the thought of a small blue butterfly hurtling out of a summers sky in search of its food plant, fills one with hope". The hundred-acre landscape also has a more personal aspect. Most men buy their wives bunches of flowers, but Clive has created an entire meadow dedicated to his wife Rajna, which is in the shape of a giant R (see top-left in the image above).

Clive has always been a risk taker, and in this spirit the St Albans project was an attempt to build a butterfly house on a larger scale than anything that had been done before. There was enough money to build the gardens but not for the giant dome that would house the butterflies. Confident that backers could be found, the gardens were built and lottery money was promised to fund the dome. Then a double setback occurred. The UK was to host the next Olympic games and lottery money was diverted to support this event; furthermore the financial crash caused backers to withdraw from the project. Facing huge debts Clive regrouped and sold the embryonic Butterfly World to the company that had built it. The gardens ran for several years but finally closed in 2016. But all was not lost, as several of the ideas that had been destined for the St Albans site have now been realised in the Stratford butterfly house. As part of a major refurbishment last year Mayan artefacts and sculptures have now been built, and a colony of leaf cutter ants have been transferred from St Albans to Stratford where they are now one of the main attractions. Occasional introductions to the butterfly house can be a problem, and in the early days unwanted terrapins were introduced to the ponds. This was okay when numbers were low but when they began to eat butterflies they had to go. There have even been budgerigars and canaries released by well-meaning members of the public and feral stick insects can also be a problem. Clive's solution is to offer a bounty to sharp-eyed school children, paying a penny for each stick insect spotted.

The ambassador of butterflies has turned dreams into reality, adding magic to nature and sharing his love of butterflies and the wider natural world with anyone who will take the time to stop and look. "If it's right for butterflies, it is also right for many other plants and animals, including us." Clive's journey from articled clerk to the empire of butterflies has been a rollercoaster ride, with massive highs and terrifying lows, but in his own words, "this butterfly journey has taken me on many adventures and enabled me to live out my dreams", dreams that enhance the lives of everyone they touch. Like the sleeping dragon in his garden, long may he continue to dream.

Report on International Entomological Congress 16-18 December 2016 Pakistan

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A meeting was held 16-18 December 2016 at the University of Agriculture, Faisalabad, Pakistan. The official report of the meeting can be found at: http://uaf.edu.pk/EventDetails.aspx?eventum+371. Although it was called an International Entomological Congress, one exclusive day was devoted to the current scenario and management of pink bollworm. The official report called it the "first of its kind in the country" due to the emergency that brought it about.

The pink bollworm, *Pectinophora gossypiella*, was blamed for the loss of 5 million bales of cotton in 2015, mostly in the Punjab region. This loss reduced the annual historic average yield of 14 million bales to 9 million. As a result, the large textile industry in Pakistan had to import cotton from elsewhere to supply their mills. Cotton fibre and cotton products contribute 1.6% of the GDP (Gross Domestic Product) and 55% to foreign exchange earnings in Pakistan.

In response to this crisis, the Government of Punjab Province in Pakistan established a committee under the convenorship of the Vice Chancellor of University of Agriculture, Faisalabad (UAF), Iqrar Ahmad Khan. The Vice Chancellor of UAF asked the Chairman of the Department of Entomology to organize a meeting on Pink bollworm and entomology in general under the umbrella of the Pakistan Entomological Society based in the Department of Entomology, UAF (http://www.pakentomol.com/images/CB2016UAF.pdf)

Figure 1 shows the banner announcing the congress, with executive organizers, indicating how important the event was to the government of Pakistan and Punjab Province in particular. Significant funding was provided by the Punjab Agricultural Research Board (PARB), an autonomous body in addition to

Figure 1. Podium in Lecture Hall, University of Agriculture, Faisalabad. Left at the podium are Rashad Khan and Abid Ali. Seated at the top table are Muhammad Amjad, Noor Ul Islam and Hafiz Qayyum. The banner shown features Muhammad Naeem Bhabha, Shebaz Sharif, Iqrar Khan, and Mahammad Mahmood.

Figure 2. A. Feza Can and Zhaozhi Lu (right) waiting for lunch in the food tent on the UAF campus. B. students surround Feza Can and Soo-ok Miller.

Figure 3. Student dancers provided entertainment on the evening after the second day of lectures, also in the tent.

Figure 4. Armed police escort with Tom and Soo-ok Miller (the ones without the guns and commando logos).

UAF under the Punjab Government. Funding was also provided by major pesticide and related agricultural companies, both national and international.

Three of the authors were invited as plenary speakers from USA, Turkey and China and asked to give talks on cotton pest resistance management in China, pink bollworm control and cotton production in Turkey, eradication of pink bollworm from the USA and northern Mexico and toxicology and physiology of pink bollworm. The Punjab governorship was openly talking about pink bollworm eradication. They may have never considered anything that drastic before.

The congress was held on the UAF campus in a lecture theatre on the ground floor of the Vice Chancellor's building. All food was catered by the biggest hotel in town, the Serena, and all was served in a giant tent erected on one of the campus lawns a short walk from the lecture theatre. The leadership and honored guests were served food on couches (Figure 2A), the students and attendees went through buffet lines and sat at large round tables. The foreign visitors were often mobbed by students eager to learn anything from abroad (Figure 2B).

The final day of the Congress (Dec 18) was devoted to a "field trip." Attendees were loaded onto two buses and set off to Multan, Pakistan in the southern Punjab to visit the Neelum Seeds Company(Pvt.) Ltd., hosted by the owner, Syed Hassan Raza. We were preceded by a small truck manned by a contingent of armed provincial

policemen (Figure 4) who waved our two buses through the crowded two-lane roadways.

At the Neelum Seeds Company, Mr. Raza gave a presentation about how bad the cotton crop had been in 2014 and especially the total loss of 2015 in Punjab. Outside of blaming everything on pink bollworm, Mr. Raza also claimed that another pest, whitefly, was now resistant to all known insecticides, which horrified everyone. He then had a staff member report research results on the effectiveness of the pheromone confusion technique.

The plenary speakers present were asked to make comments. By this time, it was abundantly clear that both India and Pakistan had used Bt cotton varieties without adequate resistance management strategies and generated pink bollworm strains resistant to Bt cotton; even the cotton varieties with two endotoxin genes present were ineffective. The one hopeful piece of news was that the pheromone confusion technique was shown to work in Pakistan, as it had in the USA and Turkey.

The trouble with Bt cotton is that it represents 100% selection pressure, meaning every pink bollworm infesting the cotton is selected. If expression of the endotoxin drops, which has been reported as cotton plants age, resistant pink bollworm are the only survivors. This is why resistance strategies are so important.

We moved on to view Neelum Seeds company machinery and then to lunch on Mr. Raza's lawn in the center of his property.

Figure 5. Street scene as buses make their way out of Faisalabad.

Figure 6. Professor Jalal Arif (left) and Syed Hassan Raza (right) invite visitors to fill their plates at lunch at Mr. Raza's estate.

One final event that occurred at the meeting was the formation of the Ali Baba Club. The authors of this report decided at one breakfast meal during the meeting to continue to collaborate in the future. We decided to do this by borrowing the concept of the Entomological Club. This group of 8 entomologists was formed in 1826 by George Samouelle in the UK. The original intent of the small group was to meet yearly to collect insects and then have dinner nearby. This practice has morphed into the annual Verrall Supper held on the first Wednesday of March just after the annual Verrall Lecture organized by the Royal Entomological Society.

The intent of the Ali Baba Club is not to have dinner or lectures or meetings, but to provide support for crises like that of pink bollworm in Pakistan that prompted the congress of 16-18 December 2016 in Faisalabad. Having constituted ourselves as a group now in continual communication, we are offering advice and recommendations or identification of experts by proxy in a manner very similar to the role we played at the Faisalabad congress. The authors are members, along with student member Abdullah Jalal of Faisalabad. We have also recruited Helmut van Emden, Emeritus Professor of Horticulture, Reading University (and a member of the venerable Entomological Club), Graham Matthews, Emeritus Professor of Pest Management, Imperial College, Celso Omoto, Professor of Entomology, University of Sao Paulo, Brazil, Yupa Hanboonsong, Associate Professor of Entomology, Khon Kaen University, Thailand and Patricia Pietrantonio, Professor of Entomology, Texas A & M University, College Station, TX.

The club fosters agriculture and public health globally by focusing on entomological problems and offering advice and experience. Since insects do not respect international boundaries, we encourage collaboration between neighbours and regions to solve difficult problems.

Meeting Reports

ICE 2016: How "freaky" are we?

Jorge Ari Noriega

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With 6,682 registered participants from 102 countries covering five continents and 5,396 oral presentations, the XXV International Congress of Entomology - ICE 2016 celebrated in Orlando Florida, USA (Sept. 25-30) - was without a doubt an overall success. The congress brought together diverse disciplines and areas of knowledge related to insects. Great speakers and several symposia for every taste. By all means a select group of people with a very special interest in common.

On the first day, while registering for the congress, I came across Dennis Kopp who has become an institution in the congresses of The Entomological Society of America (ESA). Truly an excellent entomologist and, quite honestly, a fascinating character. As is evident from Fig. 1, Dennis takes his love for insects to the next level, metamorphosing himself into what is colloquially referred to as an entomological "freaky" (in the very best of senses). I must point out that the use of the term "freaky" here has a wholly positive connotation, assigned as a badge of respect to describe only admiration for the commitment shown by many an entomologist who chooses to display his or her love of their chosen field via their choice of attire. For the purpose of political correctness, however, I'll coin and adopt the synonym 'Entomological Externaliser' (EE) for the remainder of this article! But how many entomologists display this EE trait? An event like the ICE offers a rare opportunity to quantify the level of EE in entomologists. Could this even be an ideal platform to investigate possible relationships between EE, gender, geography and academic level? There could be only one way to find out!

Figure 1. Dennis Kopp and the author in the main hall the inauguration day of the congress.

To tackle these burning questions, I dedicated my lunch hours, from 12-14h, throughout the full five days of the congress, to photographing anyone that I considered was wearing clothing alluding to an insect group. This observation slot had been carefully selected to ensure optimum returns per unit of sampling effort, since at this time most people would be leaving the conference rooms in search of something to eat. To ensure consistency and repeatability within my methodology, I only considered full garments as sufficient proxies for EE (i.e. blouses, shirts, trousers and skirts), ignoring accessories (e.g. scarves, buckles, hats, bags, and other things) given that these were less 'committal' and also harder to observe in the 'field' (I would surely miss many of them). For each EE observed, photographic evidence was obtained and the following information recorded: 1) gender, 2) academic level (student or professional), 3) geographic origin, and 4) insect order to which the clothing made reference. In cases where a garment depicted more than one insect order (e.g. bees and butterflies or a collage of many insect groups), it was classified as displaying 'general insects'.

After five days and 10 hours of entomological observation, I had amassed a total of 93 photographs. I must confess, dolefully, that I expected to find a larger cohort of my experimental population adorned with insect-related clothing. Ninety-three individuals out of >6,000 entomologists that had attended the congress makes for a little less than 1.5%, a very low value. I do not discard having missed some EEs, however, so this figure should be considered as a conservative estimate of the true level of EE's present in my experimental population. Similarly, it could be possible that people wearing entomological attire had not left the conference rooms and/or hadn't gone out to eat at lunchtime. There is even the possibility that under their elegant suits and dresses, a proportion of the population had concealed entomological under-garments! Nevertheless, a more logical explanation for my figure of 1.5% could be that the dress-code imposed by an international event of this extent had dissuaded, and perhaps in some cases even restrained, entomological spontaneity in terms of wardrobe choices.

Despite low overall levels of detected EE, it was very interesting to observe that the majority of people that wore some sort of insect-related garment were women (n=71–76%, Figs. 2, 3A). Very few men exhibited insect-related clothing behaviour, and when they did it was typically a t-shirt (Fig. 4). Could it be that entomological fashion is more feminine? Or is it that the big-name brands don't believe that men will wear clothes featuring bees and butterflies? Maybe this gender imbalance reflects that women care less about perceived dress-code? Of all the men that I came across wearing clothes concerning entomological themes, I must give a

Amanda Whispeli

Charity Owings

Constanza Jucker

Lauren M. Weidner

Mariela I. Lobo

Melissa Sánchez

Nancy Miorelli

Patricia Prade

Yasmine Antonini

Figure 2. A small selection of some of the women who wore clothing related to insects during the congress.

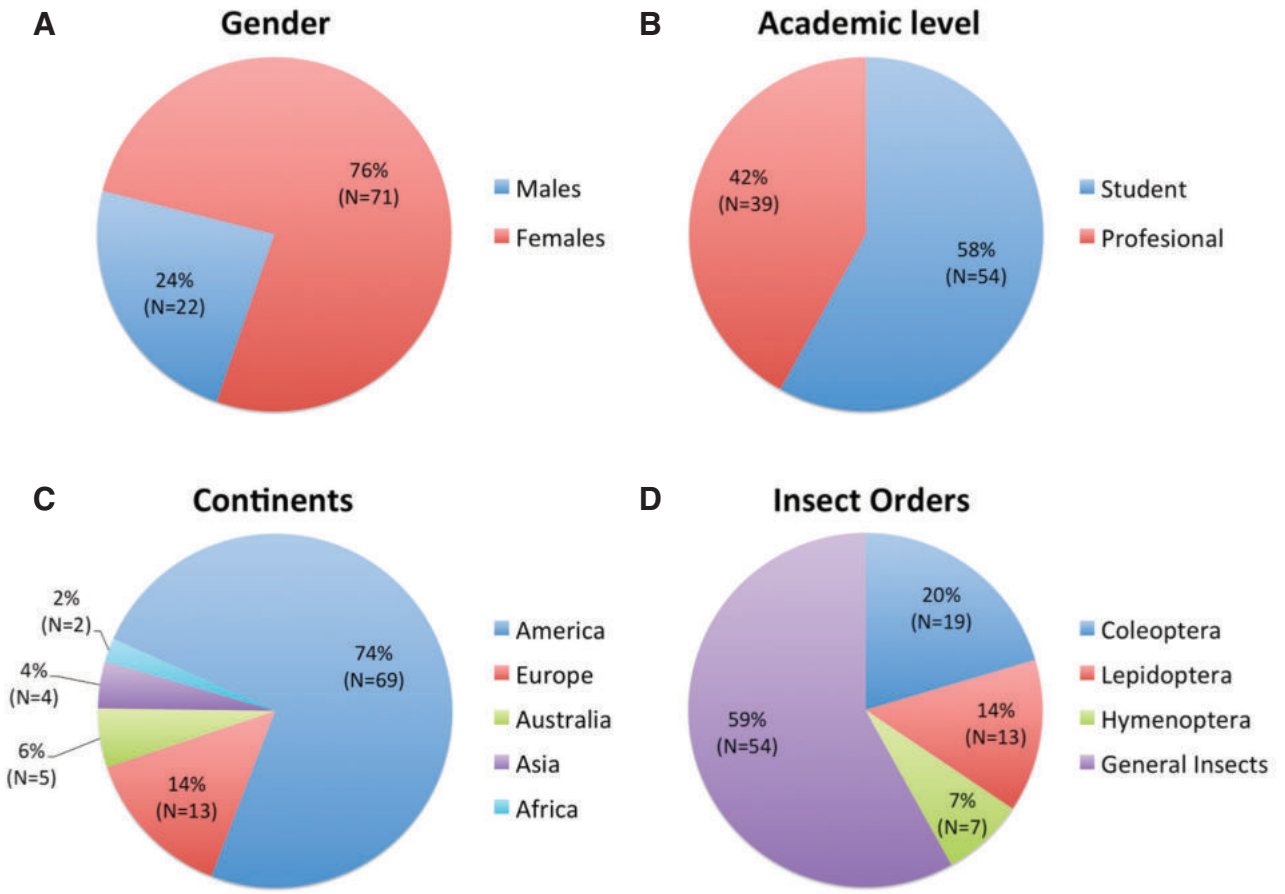


Figure 3. Analysis of the people photographed wearing some entomological-related clothing during the congress. Grouped by A) gender, B) academic level, C) continent of origin, and D) insect order.

special mention to Jack C. Schuster; a devout Passalidae researcher who always includes something EE in his personal attire, be it in his hat, belt buckle, or clothes, related to this interesting group of coleopterans (Fig. 4).

Most individuals that wore entomological clothing were students (n=54–58%, Fig. 3B). Are students more uninhibited and/or spontaneous than professionals in terms of dress sense. Additionally, most entomological-related clothes wearers came from countries of the American continents, especially from Latin America (n=69–74%, Fig. 3C). One could hypothesize that as Latin Americans generally use more vivid colours in their apparel, this perhaps promotes entomological garment selection more frequently?

Matthew Nielsen Jack C. Schuster

Figure 4. Two men dressed in entomological clothes during the congress: Matthew Nielsen and Jack C. Schuster.

In terms of large entomological orders, it was without question that the more diverse groups dominated the entomological garments on show. Coleoptera, Lepidoptera, and Hymenoptera were the most popular, to the point of finding clothes where there were only representatives of these groups featured (Figs. 2, 5). These groups are probably the most charismatic and colourful of all insects; coincidentally perhaps they draw the most attention from entomologists and designers alike. The order that I found in the greatest number of garments was the Coleoptera, followed by the Lepidoptera and the Hymenoptera (Fig. 3D). The majority of entomo-clothes, however, featured a variety of groups, from combinations of two, three, or more orders. Indeed, certain garments, mainly t-shirts, attempted to represent all orders of insects in some

type of collage (Figs. 2, 4). Further research should perhaps look to ascertain as to why no t-shirts featuring thrips, webspinners, or barkflies were observed? Could being EE or not have something to do with the order of insects that you work with? Are EEs only associated with the big orders?

Though I'm somewhat biased in favour of coleopterans (being a dung beetle 'freaky' myself), the most colourful and beautiful items that I saw during the congress certainly belonged to this order. Without a doubt two of my favorites were a blouse and a dress of two lovely female entomologists (Fig. 5).

It is worth noting that very few entomological garments that I recorded had been customized by their owners. For the most part they were widespread designs bought at stores, none of them elaborated exclusively by their proprietor. Nevertheless, two people, Dennis Kopp and Gwen A. Pearson, stood out throughout the full length of the ICE, given that every day I saw them they were wearing some sort of entomological-related clothing (Fig. 6). Beyond doubt, I think they deserve recognition for their courage and passion for the world of insects... had there been a prize for the title of "Entomological Externaliser", Denis and Gwen would have almost certainly shared it between them.

In conclusion, the proportion of entomologists at the ICE who exteriorised their passion for insects and adorned some form of entomological clothing was relatively small. I propose that for the next congresses the dress-code be that all delegates wear at least one garment related to some group of insects!

Acknowledgements

I would like to thank the organizing committee of the XXV International Congress of Entomology, for its excellent and exhaustive work. To all the "freakies" that attended the congress, and especially to all those people who allowed me to photograph them and feature them in this article. Thanks also to Javier Santos for checking the English version of this article.

Natalie K. Boyle Carl Ritzenthaler

Figure 5. Two of the most attractive Coleopteran garments of the entire congress: Natalie K. Boyle and Carl Ritzenthaler.

Figure 6. One of the most perseverant female entomologists to wear entomological-themed garments throughout the length of the congress: Gwen A. Pearson.

Ento'17, 12-14 September 2017, Newcastle University

Darren Evans, James Gilbert & Gordon Port
(Ento'17 convenors)

Ento'17 was held at Newcastle University in September 2017, in part to mark twenty years of the Annual Science Meetings of the Royal Entomological Society (RES); the first one, Ento'97, was also in Newcastle. Every two years the Science Meeting is linked to a symposium and the theme for Ento'17 was Entomological Networks, with presentations from invited speakers examining networks in all different aspects and scales of entomology. A selection of the presentations has been published in a special edition of Ecological Entomology (http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1365-2311/issues?year=2017) and we hope to make many of the talks available online. The networks theme was devised by the convenors Darren Evans and Gordon Port at Newcastle University, in collaboration with James Gilbert at the University of Hull. Sixteen keynote presentations covering aspects of ecology, behaviour and evolution of insects ran throughout the three day meeting (Table 1) with sessions of offered presentations running alongside.

Presenter	Theme
Lars Chittka (Queen Mary, University of London)	Insect Intelligence
Jenny Hodgson (University of Liverpool):	Networks to enable species to survive climate change
Catherine Reavey (Oxitec)	Nutritional complexity and its role in the mediation of host-parasite interactions
Claire Rind (Newcastle University)	Great minds don't all think alike: locusts see differently
Sarah E. Barlow (University of Utah)	Distasteful nectar toxins deter floral robbery
Nina Wedell (University of Exeter)	Sex, conflict, and selfish genes
David M. Shuker (University of St Andrews)	Reproductive interference in insects
Angharad M. R. Gatehouse (Newcastle University)	New Technologies and Molecules for Crop Protection
Ana B. Sendova-Franks (UWE)	Ants as a Model of Social Interaction
Audrey Dussutour (Université Toulouse)	Recent Advances in the Integrative Nutrition of Ants
Janice S. Edgerly (Santa Clara University)	Silk as Armor and a Web of Adaptation (the Order Embioptera)
Ramiro Morales-Hojas (Rothamsted Research)	How can molecular ecology help us improve monitoring insect pests of agricultural importance?
Yoshifumi Yamawaki (Kyushu University)	Decision-making and motor control in the praying mantis: To attack or not to attack.
Nicola Nadeau (University of Sheffield)	How did the butterfly get its colours? The evolution and genetics of colour and pattern in *Heliconius* butterflies
Mathieu Lihoreau (University of Toulouse)	Nutritional interactions in insect societies
Darren Evans (Newcastle University)	Merging DNA metabarcoding and ecological network analysis to understand and build resilient terrestrial ecosystems

Table 1. Keynote Presentations at Ento'17 showing presenter and theme.

Over 100 participants from around the world attended the meeting. The international nature of Ento'17 was remarked upon by Professor Richard Davies, Pro-Vice Chancellor for Internationalisation and Engagement, when he welcomed everyone to the University of Newcastle at the President's Wine Reception during the first evening.

On the afternoon of the second day there was the inaugural meeting of the Public Understanding of Entomology Special Interest Group (SIG) convened by James Gilbert and Luke Tilley. A range of speakers gave presentations on various aspects of the communication of Entomology to different audiences. Topics included production of podcasts, engagement with policymakers, school children and citizen scientists, and the pitfalls and possibilities of entomological subject matter when communicating science generally.

The conference dinner, at the Centre for Life in Newcastle, was a lively evening. After the formal dinner the President, Prof. Mike Hassell, awarded some of the prizes from the RES. Mike Morris (Marsh Award for Conservation), John Simaika (Marsh Award for an Early Career Entomologist) and K B Rebijith (Wallace Award) received their awards at the dinner, while Roger Key (Honorary Fellowship of the Royal Entomological Society) was unable to attend and was given his award during the SIG meeting.

After dinner the ceilidh band, The Angels of the North, took the entomological theme to heart; one of their pieces was based on The Canadian

Left: David Shuker explaining some curious insect mating behaviours; Right: Janice Edgerly demonstrating how Embioptera conduct an elaborate 'dance' while spinning their webs.

Fellows signing the Obligation Book at the conference dinner. L-R Mike Hassell, Lin Field, Roy Sanderson, Darren Evans, Ramiro Morales-Hojas, Mike Morris.

Barn Dance with dancers asked to do an impression of an insect. A panel of expert judges awarded the prizes (contributed by the band and the RES) to Catriona McIntosh and Roy Sanderson for their impression (through the medium of dance) of a spittle bug!

Excellent catering for the meeting was provided by Newcastle University and the food was supplemented by insect snacks.

The final day of the meeting had a special session devoted to Important Invertebrate Areas (IIAs) – a tool to conserve the UK's invertebrates. IIAs aim to identify the key sites around the UK for our most scarce and threatened invertebrates. They will be a vital tool for the conservation of our most threatened species and the maintenance of sustainable populations of declining species, identifying a network of sites to direct invertebrate conservation and initiatives.

As usual, presentations by students were considered for prizes and the winners were:

Ellen Moss (Newcastle University) First prize for her poster: *Impacts of simulated climate-warming on wildflowers and pollinating insects.*

Eleanor Drinkwater (York University) Second prize for her poster: *How does individual personality modulate colony level personality? A study in* Myrmica rubra.

Aidan O'Hanlon (NUI Galway) First prize for his presentation: *Predators, pests and protected species: Behavioural interactions between carabid beetles (Coleoptera: Carabidae) and the EU-protected Kerry slug* Geomalacus maculosus *(Gastropoda).*

Vicky Senior (University of Sheffield) Second prize for her presentation: *Understanding the mechanisms underlying insect-host plant phenological mismatch: a focus on sycamore and two associated aphid species.*

The competition was very close and all of the student presentations were of a high standard.

Ento'17 was supported by the RES and Newcastle University and we would like to thank the staff from the RES and the team of helpers for making the meeting such a success.

Prizewinners Catriona McIntosh and Roy Sanderson with their insect impression through dance. Do you know what it is? (See text for answer).

SCHEDULE OF NEW FELLOWS AND MEMBERS

as at September 2017

New Honorary Fellows
Sir David Frederick Attenborough
Dr Roger S Key
Sir Hugh Charles Jonathan Godfray
Mr Terence John Dillon

New Fellows (1st Announcement)
Dr Malaiyappan Raja
Dr Samuel John William
Dr Timothy Cockerill
Dr Casper Nyamukondiwa
Professor Arthur Gary Appel
Dr Mark John Ingraham Paine
Professor Michael Robert John Boots

Upgrade to Fellowship (1st Announcement)
None

New Fellows (2nd Announcement and Election)
Mr Graham Leslie Smith
Mrs Janice Mary Smith
Dr Mostafa Rezk Sharaf (as at 7.6.2017)

Upgrade to Fellowship (2nd Announcement and Election)
Dr Lara Ellen Harrup

New Members Admitted
Dr Matthew Ewart Studley
Ms Katie Blain
Dr Ferenc Varga
Mr James Holden

New Student Members Admitted
Mr Ewan Richardson (as at 7.6.2017)
Mr Athanasios Ntelezos (as at 7.6.2017)
Mr Ki Woong (Victor) Kang
Mr Thomas William Aspin
Miss Rachel Davies
Mr Thomas Ifor David
Ms Christin Manthey
Miss Abigail Enston

Re-Instatements to Fellowship
None

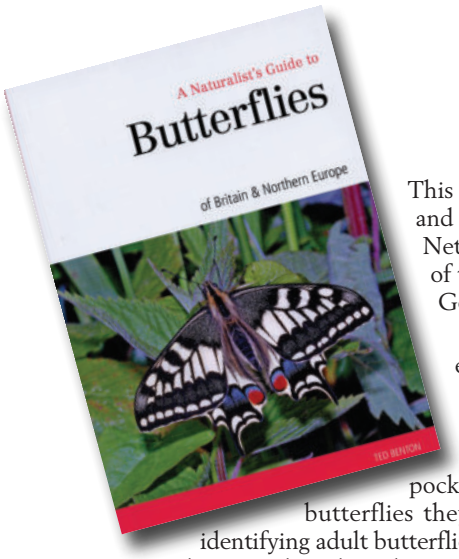
Re-Instatements to Membership
Mr Pawan Patidar (as at 7.6.2017)
Mr Gabor Pozsgai

Re-Instatements to Student Membership
None

Deaths
Dr C Tingle, 1996, UK
Dr S Mcneill, 1967, UK
Mr T Beer, 1999, UK
Dr D M Minter, 1956, UK
Professor M P Pener, 1965, Israel
Mr P A Michel, 1988, UK

Book Reviews

A Naturalist's Guide to Butterflies of Britain and Northern Europe



T. Benton
John Beaufort Publishing 2016
Paperback 13 x 18 x 1 centimetre
ISBN 978 1 909612 45 7

This photographic guide covers the 158 species of butterfly found regularly in northern Europe and will enable identification to the species found in Britain, Ireland, Scandinavia, Belgium, Netherlands and the Baltics. It also covers the majority of species likely to be encountered north of the Alps, so will also be very useful to naturalists visiting other countries such as France and Germany.

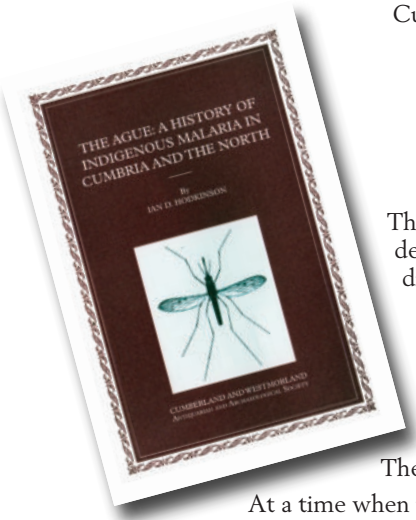
An introduction to butterflies is given with sections on anatomy, life cycles, behaviour, enemies and friends, including some species complex relationships with ants. An overview of the broad habitats types follows. This highlights the species associated with each and some of the current threats to their populations.

The bulk of the book deals with the individual species accounts. As its title suggests this pocket- sized book is aimed at naturalists who would like to identify and learn more about the butterflies they encounter. Brief notes are included on the early stages but an emphasis is made on identifying adult butterflies. An introduction to each family is given before the concise species accounts, which include up to three good quality photographs of each species. These are all taken in the field and show the upper- and under-side features most likely to be seen in the field. Notes on distribution, habitat and flight seasons are given. Before the index a taxonomic list of all species is included.

Obviously some families present difficulties in identification in the field e.g. some of the blues and fritillaries. These drawbacks to identification are highlighted and as much information on discriminating these is given as possible within the scope of this book. The Further Reading section lists books and websites which will provide more detailed information on identification and ecology. The author of this is an excellent guide and is a well-known naturalist with over 35 years' experience of studying insects in the field. Hopefully he will inspire readers to want to learn more about these beautiful insects and the others which will be encountered alongside them such as grasshoppers, crickets and bees.

John Walters

The Ague: A History of Indigenous Malaria in Cumbria and the North



Ian D. Hodkinson
Cumberland and Westmorland Antiquarian and Archaeological Society
Tract Series 26
74 pages
ISBN 978 1 873124 74 1
£8.50

The book opens with a brief survey of what has been written on ague in Britain, followed by a definition of the disease and the role of mosquitos as vectors for its transmission. The past distribution of ague in Britain and Ireland is then discussed before focusing in on Cumbria.

In this section, an in-depth account is offered of the occurrence of ague across the region, quoting from documents of the day and providing copies of some of these. The effects of the ague on rural populations is discussed along with early ideas as to its cause.

There follows a large section dealing with folk remedies for the disease and a brief history of our current understanding of its causes and the evolution of modern treatments.

The book closes with a discussion of the reasons for the decline of the ague in Britain.

At a time when the return of malaria to the UK is being seriously discussed, a knowledge of its history may help to achieve a better understanding of current threats. 'The Ague' is a fascinating insight into an unhealthy past and offers a warning against complacency when dealing with possible new threats to the nation's health.

'The Ague' is fully referenced and indexed.

Peter Smithers

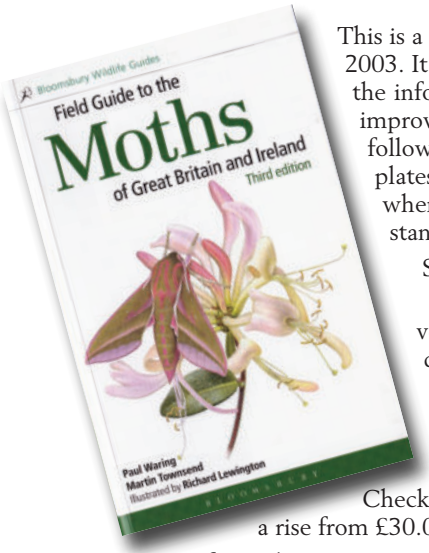
Field Guide to the Moths of Great Britain and Ireland 3rd edition

Paul Waring, Martin Townsend. Illustrated by Richard Lewington

Published by Bloomsbury

£50.00

ISBN 978-1-4729-3030-9



This is a book that needs no introduction; it has been a classic in its field since it was first published in 2003. It is pocket sized, illustrates all the UK macro-moths in their resting positions and is full of all the information that might be required in the field. The convenience of this field guide was a huge improvement on its predecessors. I remember my copy of South arriving and the frustrations that followed as I flicked back and forth through the two volumes to locate the desired slightly fuzzy plates. Skinner was a relief with its large clear plates but was an awkward size for field work. So, when Waring & Townsend combined detailed paintings with portability it instantly became the standard work on British moths.

So how does the third edition differ from its predecessors?

It is twenty pages longer which may not seem much but this slight increase in size belies the very significant update that the third edition offers. The most obvious change is the inclusion of distribution maps for each species which are based on the Provisional Atlas of the UK's Larger Moths which was published in 2010. Other changes are not so obvious, such as the number of illustrations. Richard Lewington has added fifty-five new paintings covering nineteen new species that have recently been recorded in the region, so those recent arrivals can now be easily spotted. Another significant change is the updating of the taxonomy to follow the new Check List of the Lepidoptera of the British Isles published in 2013. The final change is one of price, a rise from £30.00 to £50.00, which could be a factor if moths are only of peripheral interest.

Apart from this minor point the third edition has taken a field guide that was universally acclaimed as excellent and transformed it into something even better. This third edition will ensure that Waring & Townsend will remain the standard work on UK moths for the foreseeable future. If you don't have a copy of an earlier edition, now is the time to add it to your library.

Peter Smithers

Mariposa Road

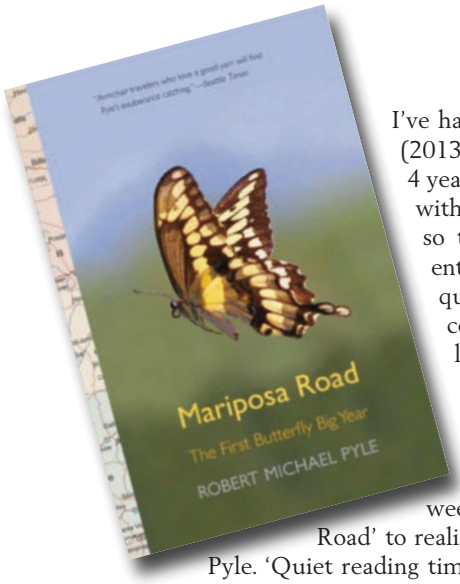
Robert Michael Pyle

576 pages

Yale University Press; Reprint edition (March 19, 2013)

ISBN-10: 0300190972

ISBN-13: 978-0300190977



I've had this book a while now, and that's an understatement. A look at the publication date (2013) suggests it probably arrived into my care shortly after my youngest daughter did (now 4 years old), and at around the time I began editing *Antenna* with Peter for the RES. As anyone with a young family will attest, demanding offspring don't mix well with 'quiet reading time', so though I had enthusiastically agreed to review Robert Pyle's 'Mariposa Road', this enthusiasm waned somewhat when it arrived in my pigeonhole; nigh-on 600 pages seemed quite the challenge for someone whose interest in Lepidoptera is normally limited to controlling cutworms and cabbage whites. Nappy changes and preconceptions in mind, I lacked the immediate inspiration to open the cover and 'crack on', only doing so a couple of years ago when I was gifted a quiet hour on Saturdays when my eldest (then 5 years old) took up gym class.

One trip to Tadcaster Leisure Centre later, and the first few chapters in, I was hooked. Unfortunately, said eldest's interest in gymnastics didn't last long, and I quickly lost my weekend reading slot. Nevertheless, by this point I had made a big enough dent in 'Mariposa Road' to realise that I didn't need to be a 'butterflier', nor an American, to thoroughly enjoy reading Pyle. 'Quiet reading time' remained an issue, though from this point on Pyle, somewhat fittingly, became my regular travel companion – waiting patiently in my travel bag for occasions when I could steal a few chapters in an airport lounge, or an hour or so on a train to London.

It's testament to Pyle that he takes a topic with potentially limited appeal - i.e. a 'butterfly big year', essentially a checklist of all species recorded over a 12 month period – and presents it as an addictive tale of adventure and adversity, focused at least as much on the journey as the butterflies encountered. Herein lies the brilliance of 'Mariposa Road'; far from being a checklist, Pyle has produced the story behind the checklist, recounting the high and lows of a year spent on the road in pursuit of his quarry.

And with Pyle a 'year on the road' is exactly that. For the most part he covers the miles to and from basecamp to the far reaches of the US, not with a plane or train ticket, but behind the wheel of his 1982 Honda, "Powdermilk". Pyle's reliable steed serves not only as transport, but often as a roof to sleep under, joined on their journey by butterflying kit (e.g. nets, binoculars and field guides) of similar age and charm. Modern technology has no place here, and the use of tools such as the internet and social media are shunned for local knowledge, instinct and Pyle's own experience and expertise. In the closing chapters Pyle himself admits that embracing the internet would have almost certainly increased his final species count, though in my opinion to do so would have compromised the 'soul' of this book and the integrity of Pyle's achievement. This is a book about the achievements and journey of a man seeking to test himself against a goal, using only himself (and an '82 Honda) to do so. Should others want to follow in Pyle's footsteps and attempt their own 'big year', embracing planes, trains and the worldwide web would be an obvious way to look to beat Pyle's count. In my own opinion, though, such a figure would be incomparable to Pyle's. Furthermore, the task of producing a book of the quality and readability of 'Mariposa Road' based on such work would be all but impossible.

Pyle writes in an engaging and often humorous style, presenting his topic in a way that will appeal to the lepidopterist, entomologist and armchair adventurer of any profession alike. The focus on US species represents an occasional challenge for the non-US (non-lepidopterist) reader in places, but this is a small price to pay. I'd recommend this book to anyone with an interest in entomology or travel. It would make a great holiday read, though is equally suited, as in my case, to being a long-term companion. Indeed, having had an extended 'relationship' with 'Mariposa Road', always looking forward to those rare moments when I could steal a chapter or two, I'll miss not having it in my travel bag.

Dave George
Stockbridge Technology Centre

Wood Ant Ecology and Conservation

Edited by Jenni A. Stockan and Elva J. H. Robinson
Cambridge University Press, published in the Ecology, Biodiversity and Conservation series
£47.00
ISBN 9781107048331

For those of us who are fans of ants but live in temperate climates it is hard not to be envious of tropical myrmecologists. Not only is ant diversity so much greater in the tropics, but tropical ecosystems seem to have far more "exciting" ants than we have here in the UK for example. The weaver ants of Asia live in great arboreal nests of leaves held together with silk squeezed from larvae; the army ants of the New World and the driver ants of Africa rampage through fields and forests in search of prey; the leafcutting ants of the American tropics have great cities underground in which they tend a fungal crop. Overall, when faced with this tropical glut of ecological and taxonomic diversity, the humble pavement ant *Lasius niger* or the yellow meadow ant *Lasius flavus* seem a little, well, ordinary. However, when it comes to spectacular ants there is one temperate group that can truly hold its own against the big players – the mound building wood ants.

Widespread throughout the Holarctic, wood ants can form mounds up to 2m high and their inter-linked colonies spreading through the forest can contain more than 400 million individuals. Their sheer numbers, as well as their predatory habits, make them a numerically and ecologically dominant species in many temperate forest ecosystems. With such impressive numbers and ecological significance on their side, the wood ants clearly deserve a place among the "spectacular" ants of the world and this latest book from the excellent 'Ecology, Biodiversity and Conservation' series from Cambridge University Press is a fantastic manifesto for them.

Edited books on particular species or groups of species tend to work best when they draw together scattered literature to provide a one-stop-shop for those wanting to get their teeth into the topic. On the other hand, edited works can fall down badly if the balance of chapters and content drift from what was initially planned to what can be pragmatically put together once authors drop out or miss deadlines. This book has the feel of a collection of chapters that was very much Plan A – everything hangs together beautifully.

The early chapters focus on the nuts and bolts of the group from the basics of who they are and what they do through to their social systems and population genetics. The mid-section deals with more complex ant-focused ecological interactions, including colony and species recognition within the group, competition and coexistence with other colonies and species, and aphid mutualisms. From there, the book explores wider ecological interactions and ecosystem function before moving into the final chapters, which deal with conservation issues, including monitoring, threats, management and future directions. Each chapter works well as a stand-alone review of a particular topic, and in practice that is the way many of us tend to approach edited works, but the flow and interconnections between the chapters are such that the book also works if you like to read from the beginning to the end. Nicely illustrated throughout with figures, photos and tables, the text is engaging, well-written, well-edited and thorough. Overall, this is 'must-have' book for anyone interested in getting to grips with the temperate zone's most charismatic ants.

Professor Adam Hart, FRES
University of Gloucestershire

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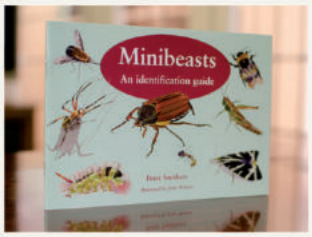






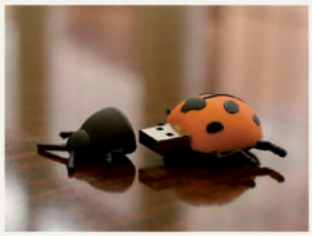



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Take a look on **www.royensoc.co.uk/shop** and see what you can find to take your insect interest to a whole new level. Visit today!

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Diary

Details of the Meetings programme can be viewed on the Society website (www.royensoc.co.uk/meetings) and include a registration form, which usually must be completed in advance so that refreshments can be organised. Day meetings typically begin with registration and refreshments at 10 am for a 10.30 am start and finish by 5 pm. Every meeting can differ though, so please refer to the details below and also check the website, which is updated regularly.

Special Interest Group meetings occupy either a whole day or an afternoon (check www.royensoc.co.uk/meetings for details).

Offers to convene meetings on an entomological topic are very welcome and can be discussed with the Honorary Secretary.

MEETINGS OF THE ROYAL ENTOMOLOGICAL SOCIETY

2018

Mar 7 **Verrall Lecture by Dr Amoret P. Whitaker, University of Winchester**
Fabulous Fleas
Venue: Natural History Museum
Convenor: Dr Archie K. Murchie
Due to their parasitic lifestyle, the much maligned flea has always had a close association with humans. However, it has also been celebrated in poetry, art and entertainment. This talk will consider some of the many ways in which this fascinating insect has been portrayed - including their use in flea circuses, as curiosities and as love tokens.

Mar 14 **Insect Behaviour SIG**
Venue: Rothamsted Research, Harpenden
Convenors: Jozsef Vuts (jozsef.vuts@rothamsted.ac.uk)
Jason Lim (jason.lim@rothamsted.ac.uk)

Apr 6 **SW Region Annual Bristol Meeting**
Venue Bristol University, 6.00pm
Convenor: Peter Smithers (psmithers@plymouth.ac.uk)
Talks include:
The ecology of web construction in UK spiders
Tropical forest beetle assemblages and fine scale speciation: lazy Lycidae?
Program details are available from psmithers@plymouth.ac.uk

Apr 11 **Electronic & Computing Technology SIG**
Venue: The Mansion House, St Albans
Convenor: Mark O'Neill (TechSIG@tumblingdice.co.uk)

Jun 18-24 **National Insect Week 2018**
http://www.nationalinsectweek.co.uk/

Aug 29-31 **Ento'18 Annual Science Meeting**
The good, the bad and the ugly - exploring the importance of lesser studied insects
Venue: Edge Hill University, Ormskirk
Convenors: Anne Oxbrough (anne.oxbrough@edgehill.ac.uk)
Clare Strode (clare.strode@edgehill.ac.uk)
Plenary speakers:
Professor Stefan Scheu - Georg August University Göttingen
"The Good - Belowground goodies: Ecology and evolution of soil microarthropods"

Professor Richard Wall - Bristol University
"The Bad - Ticks and tick-borne disease"

Dr Jason Dombroskie - Cornell University Insect Collection
"The Ugly - Yes that's nice...but look at this! Challenges of generating interest in and relevance to the non-charismatic microfauna"

For more information visit: https://www.royensoc.co.uk/meeting/ento-18

Other Meetings

2017

Dec 12 **Aberdeen Entomological Club seminar**
"Buglife's Peatland Restoration work in Scotland: Bogs for Bugs", speaker Scott Shanks (Buglife)
Venues: Macaulay B, James Hutton Institute, Craigiebuckler, Aberdeen; and screened live to New Seminar Room, James Hutton Institute, Invergowrie, Dundee.
Convenors: Jenni Stockan (jenni.stockan@hutton.ac.uk)
Jennifer Slater (Jennifer.Slater@hutton.ac.uk)

2018

Jan 9 **Aberdeen Entomological Club seminar**
"Resistance in Scots pine trees to the pine tree lappet moth", speaker Glenn Iason (James Hutton Institute)
Venues: Macaulay B, James Hutton Institute, Craigiebuckler, Aberdeen; and screened live to New Seminar Room, James Hutton Institute, Invergowrie, Dundee.
Convenors: Jenni Stockan (jenni.stockan@hutton.ac.uk)
Jennifer Slater (Jennifer.Slater@hutton.ac.uk)

Feb 13 **Aberdeen Entomological Club seminar**
"Plant-Aphid-Environment Interactions", speaker Daniel Leybourne (James Hutton Institute)
Venues: New Seminar Room, James Hutton Institute, Invergowrie, Dundee; and screened live to Macaulay B, James Hutton Institute, Craigiebuckler, Aberdeen.
Convenors: Jenni Stockan (jenni.stockan@hutton.ac.uk)
Jennifer Slater (Jennifer.Slater@hutton.ac.uk)

Mar 13 **Aberdeen Entomological Club seminar**
"Rare invertebrates in the Cairngorms project: one year on", speaker Gabrielle Flinn (RSPB)
Venues: Macaulay B, James Hutton Institute, Craigiebuckler, Aberdeen; and screened live to New Seminar Room, James Hutton Institute, Invergowrie, Dundee.
Convenors: Jenni Stockan (jenni.stockan@hutton.ac.uk)
Jennifer Slater (Jennifer.Slater@hutton.ac.uk)

Apr 10 **Aberdeen Entomological Club seminar**
"Fleas", speaker Norman DeFoe
Venues: Macaulay B, James Hutton Institute, Craigiebuckler, Aberdeen; and screened live to New Seminar Room, James Hutton Institute, Invergowrie, Dundee.
Convenors: Jenni Stockan (jenni.stockan@hutton.ac.uk)
Jennifer Slater (Jennifer.Slater@hutton.ac.uk)

Jul 2-6 **European Congress of Entomology**
Venue: Expo Convention Centre, Naples, Italy

2020

Jul 19-24 **XXVII International Congress of Entomology (ICE2020)**
Entomology for our planet
Venue: Helsinki, Finland

RES STUDENT AWARD 2017

Write an entomological article and WIN!

www.royensoc.co.uk

REQUIREMENT

Write an article about any Entomological topic that would be of interest to the general public. The article must be easy to read and written in a popular style. It should be no more than 800 words in length.

WHO CAN ENTER?

The competition is open to all undergraduates and postgraduates, on both full and part-time study.

PRIZES

First Prize: A £400 cheque and your article submitted for inclusion in *Antenna*.

Second Prize: A £300 cheque and your article submitted for inclusion in *Antenna*.

Third Prize: A £200 cheque and your article submitted for inclusion in *Antenna*.

ENTRIES

You can send electronically via e-mail to: **kirsty@royensoc.co.uk**

Alternatively, complete the entry form, and submit it with five copies of your entry to:

The Deputy Registrar,
Royal Entomological Society,
The Mansion House,
Chiswell Green Lane,
St Albans, Herts
AL2 3NS

For further information telephone: 01727 899387

Please include:

- Your name and address (including postcode)
- Your e-mail address
- The name and address (including postcode) of your academic institution
- Evidence of your student status

THE JUDGES

The judges panel will be made up of three Fellows of the Royal Entomological Society. The judges decision is final.

CLOSING DATE

The closing date for entries is 31 December 2017. The winner will be announced in the Spring 2018 edition of *Antenna* and on our website.

PLEASE CUT AND RETURN THIS PORTION WITH YOUR ENTRY

Articletitle: _____

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Studentname: _____

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Address: _____

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Telephone: _____

E-mail: _____

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Name of academic institution:

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Alfred Russel Wallace Award 2017

For post-graduates awarded an outstanding PhD in Entomology!

Photo credit: Wallace's Cyriopalus beetle (*Cyriopalus wallacei*) by Tim Cockerill

Requirement

For post-graduates who have been awarded a PhD, and whose work is considered by their supervisory team to be outstanding. The research involved should be a significant contribution to the science of entomology.

Who Can Enter?

All post-graduates who have been awarded a PhD degree, on the basis of a thesis written in the English language, within the period 1st October 2016-31st December 2017.

Prizes

First Prize: £800 plus Certificate, plus one year's free Membership to Royal Entomological Society. The winner will also be required to present their work at a Society Meeting (all expenses paid) and submit an article to *Antenna*.

Runners-up: Up to four runners-up will have their names and abstracts published in *Antenna*.

Entries

The candidate's supervisor or external examiner should complete the entry form available on the awards pages of our website, have it signed by the Head of Department, append a copy of the abstract of the thesis, and send it to:

The Registrar, Royal Entomological Society,
The Mansion House, Chiswell Green Lane,
St Albans, Herts, AL2 3NS
E-mail: bill@royensoc.co.uk

Please do not send the thesis itself until requested to do so.

The candidate will at that stage be asked to provide a 500 word statement expressing in layman's terms the contribution that their work has made to entomology and selected entries will be asked to submit their theses.

Following thesis submission, up to 5 candidates will be invited to The Mansion House in person (UK travel will be paid), or virtually if not UK-based, to deliver a 20 minute presentation and engage in a 20 minute question/answer session with the judges.

The Judges

The judges' panel will consist of a group of senior Fellows of the Royal Entomology Society. The judges decision is final.

Closing Date

The closing date for entry is 31st December 2017. Winners will be announced in the Spring 2018 edition of *Antenna* and on the RES website **www.royensoc.co.uk**