Bulletin of the Royal Entomological Society Volume 38 (4) 2014

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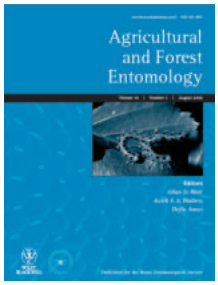

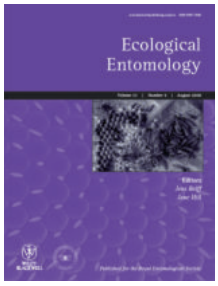

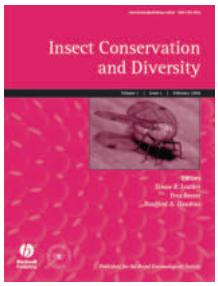

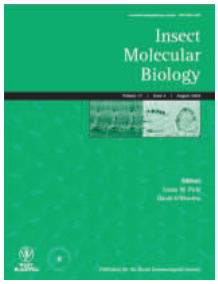

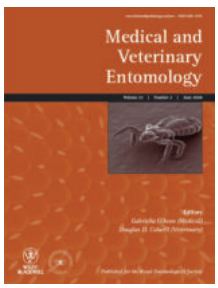

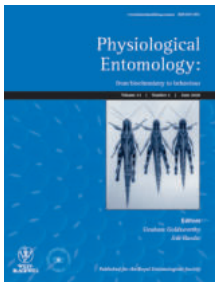

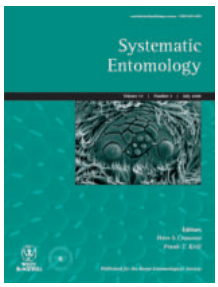

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2015 print or online prices: UK £740, Euroland €942, USA $1,368, Rest of World $1,594
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Ecological Entomology publishes top-quality original research on the ecology of terrestrial and aquatic insects and related invertebrate taxa. Our aim is to publish papers that will be of considerable interest to the wide community of ecologists.
2015 print or online prices: (with Insect Conservation and Diversity) UK £1,227, Euroland €1,563, USA $2,274, Rest of World $2,652
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Medical and Veterinary Entomology is the leading periodical in its field. The Journal covers all aspects of the biology and control of insects, ticks, mites and other artropods of medical and veterinary importance.
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Systematic Entomology encourages the submission of taxonomic papers that contain information of interest to a wider audience, e.g. papers bearing on the theoretical, genetic, agricultural, medical and biodiversity issues. Emphasis is also placed on the selection of comprehensive, revisionary or integrated systematics studies of broader biological or zoogeographical relevance.
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Antenna (Bulletin of the Society). Free to Members/Fellows. Published quarterly at an annual subscription rate of £40 (Europe), £42 (outside Europe), $70 (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.

Handbooks for the Identification of British Insects. This series now covers many families of various Orders. Each Handbook includes illustrated keys, together with concise morphological, bionomic and distributional information. A full list of Handbooks with order form is available. See website www.royensoc.co.uk

Symposia. Nos. 1-3 were published by the Society; Nos. 4-10 by Blackwell Scientific Publications: Nos. 11-17 by Academic Press and No. 18 by Chapman & Hall, No. 19 by Kluwer, No. 20, 21, 22 and 23 by CABI.

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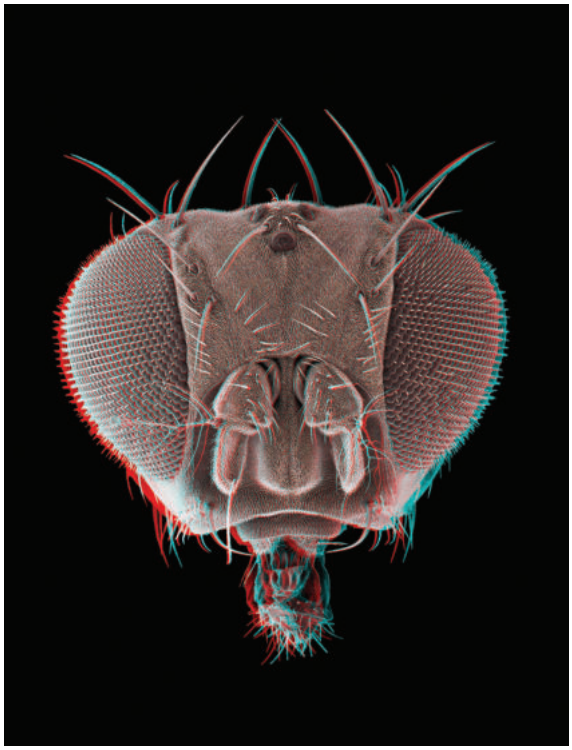

COVER PICTURE

3D image of a fruit fly head (Diptera: Drosophilidae).
Imaging by Alan Shaw

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

Editors:
Peter Smithers
(University of Plymouth)
and
David R. George
(Stockbridge Technology Centre)

Editoral Assistant:
Jennifer Banfield-Zanin

Consulting Editor:
Prof Jim Hardie

Assistant Editors:
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The Royal Entomological Society
The Mansion House, Chiswell Green Lane,
Chiswell Green, St. Albans, Hertfordshire AL2 3NS.
Tel: 01727 899387 • Fax: 01727 894797
E-mail: info@royensoc.co.uk

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Subscription Rates 2014
The following are the subscription rates due on 1st March 2014: Fellows £54; Members £48; Students £25; Fellows and Members over 65 £32. The journals of the Society are available to individual Fellows and Members at preferential rates via the Subscriptions Department at The Mansion House. *Antenna* is supplied free of charge to Fellows and Members not in subscription arrears. **Cancellation of Journal subscriptions must be notified to Subscriptions Department before the 31st October in the year preceding cancellation.**

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EDITORIAL

Hello and welcome to *Antenna* 38(4). After a 'big' year for Entomology in the UK, we're pleased to bring you an equally 'big' *Antenna*, packed with a range of articles and other copy that we hope will keep you entomologically-entertained through the holiday season.

This year saw the European Congress of Entomology return to York. To commemorate the 2014 ECE we have been working hard to bring you a separate Special Issue of *Antenna* featuring perspectives and selected summary articles from the meeting. For completeness, the current 'standard' issue of *Antenna* also includes one entomologist's personal 'diary' of the ECE; that entomologist being the RES's very own Honorary Secretary, Archie Murchie. Also in Society News, Chris Jeffs reports on his series of podcasts for NIW 2014 (the 'biggest' NIW yet), Grace Twiston-Davies provides a summary of the Linking Biological and Cultural Diversity in Europe conference, and Jorge Noriega gives us his account of the First "European" Scarab Symposium, held at the NHM.

This issue also features a wide selection of articles, spearheaded by Sarah Beynon's contribution on the science that won her the RES Wallace Award. Peter Cranston and Penny Gullan, with input from Douglas Williams, then take us from Sarah's dung beetles to insect-derived dyes in their piece on Canary cochineal insects. Reflection of circularly polarised light in the Lepidoptera is the subject of J. David Pye's article, where, using a highly impressive array of insect imaging techniques, David seeks to ascertain whether or not this "peculiar physical phenomenon" is limited to scarab beetles. Insect imaging is also the basis for Alan Shaw's offering, which includes a selection of the author's extensive collection of 3D scanning electron micrographs of invertebrate subjects. As a system engineer working with electron microscopes, Alan has generated hundreds of these images in his spare time; we hope to see more of them in the future at RES events including the York Insect Festival 2015. Regular contributor and RES Honorary Treasurer, Hugh Loxdale, provides another thought provoking article centred on insect (and avian) observations in Germany. In a timely contribution, Chris Lyal then reports on 'Managing the impact of the Nagoya Protocol on insect collections and research'; a must-read piece for many. Insect collections are also the topic of our final article, with Richard Kelly continuing his tour of UK entomological collections and reporting from the National Museum Cardiff.

In other news, 2014 has also been a 'big' year for insects in the US, with two entomologists, Prof May Berenbaum (University of Illinois) and Prof Jerrold Meinwald (Cornell University), being independently awarded the National Medal of Science. As the nation's highest scientific honour, these awards attest to the continuing significance of Entomology in modern science.

Returning to the UK, Professor John Owen has requested that we inform you all of a 'big' opportunity to acquire a number of back issues of *Antenna* and the *British Journal of Entomology & Natural History*. These are free to a good home but must be collected from Epsom, Surrey. Anyone interested can contact Professor Owen on 'jaowen1@btopenworld.com' for more information.

Finally, I'm pleased to report that we're continuing to make changes to *Antenna* following your recent suggestions for improvement. As of this issue we aim to make our Diary Section more prominent and next year should see further development of the *Antenna* webpage. This will feature the usual author guidelines and aims and objectives, also featured on the back cover of this issue. We also aim to make this webpage a vessel for online dissemination of an 'Editors Choice' article from each issue. More on this 'big' development in 2015.

Wishing you all season's greetings and a happy and prosperous New Year.

David 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 – Entomological Club Bursaries

With invitations to the 2015 Annual Meeting of the Verrall Association of Entomologists (to be held on Wednesday 4th March at the Rembrandt Hotel, South Kensington) due to be sent out in January, the Entomological Club is advertising its bursaries for registered students. Each bursary funds the 2015 subscription for membership of the Association (which includes the Verrall Supper) as well as up to £40 towards travelling expenses.

Applications for bursaries should take the form of a letter of recommendation from the academic supervisor and should be e-mailed to the Club (entclub@yahoo.co.uk or sleather@harper-adams.ac.uk). The number of bursaries available for the 2015 event and the deadline for receipt of applications will be advertised on the "What's extra" page of the Club's website (entomologicalclub.org) at the start of November 2014.

The award of a bursary is a recognition of merit from the oldest entomological society in the world, and therefore makes a useful addition to a student's CV. Recipients of bursaries are introduced to other members of the Association at the supper.

Helmut van Emden

Hon. Treasurer, The Entomological Club

Eucalypt leaf beetle

Dear Editor

Good article in *Antenna* by William Hentley on entomology at University of Western Sydney, but marred by a wrong name. The eucalypt leaf beetle was called '*Chrysophtharta*' *m-fuscum*. This Australian species is a significant pest or beneficial biocontrol agent (depending on viewpoint) of eucalypts in California, and since 2006 has been in the genus *Paropsisterna* (Reid 2006). I draw attention to this because I sometimes wonder why we taxonomists bother. We do the taxonomic research (Reid 2006), put up online catalogues (Reid 2012; Anonymous 2014), identify stuff for our colleagues in forestry (Reid & De Little 2013), and pay for the page charges so that the articles are free online (Reid 2006; Reid & De Little 2013), but it seems that people can't be bothered to use what gets put out. Bit hard for us to argue with our managers and politicians that our work is relevant to society, as we are constantly having to at present. It doesn't take much to do a little name checking.

Otherwise keep up the good work.

Chris Reid
(former Fellow and current grumpy old man)
Principal Research Scientist
Entomology
Adjunct Associate Professor, University New South Wales

Anonymous 2014. Atlas of Living Australia. http://bie.ala.org.au/ search?q=m-fuscum

Reid, CAM 2006. A taxonomic revision of the Australian Chrysomelinae, with a key to the genera (Coleoptera: Chrysomelidae). *Zootaxa* **1292**: 1-119.

Reid, CAM 2012. Subfamily Chrysomelinae Latreille 1802. http://www.environment.gov.au/biodiversity/abrs/online-resources/fauna/afd/taxa/Chrysomelinae/names

Reid, CAM & De Little, DW 2013. A new species of *Paropsisterna* Motschulsky, 1860, a significant pest of plantation eucalypts in Tasmania and Ireland (Coleoptera: Chrysomelidae: Chrysomelinae). *Zootaxa* 3681(4): 395-404.

Figure 1. Some of our British dung beetles D. J. Mann, OUMNH ©

Wallace Award Article

Sarah Beynon

University of Oxford, Department of Zoology, South Parks Road, Oxford, OX1 3PS / Dr Beynon's Bug Farm Ltd, Lower Harglodd Farm, St Davids, Haverfordwest, Pembrokeshire, SA62 6BX

sarah@thebugfarm.co.uk

Twitter: @thebugfarmUK

www.thebugfarm.co.uk

To be totally honest, I grew up thinking that dung beetles were only found in the tropics. Never did it cross my mind that these fascinating insects would be living alongside me back home on the farm in Pembrokeshire, West Wales. I remember seeing my first British dung beetle when showing one of my family's Welsh Black cows in our local county show. The large dung beetle (that I now know to be *Geotrupes spiniger*) buzzed into the cattle shed and crash-landed on our prize cow, Tyddewi Katherine. Therein began a long-term fascination with insects that eat faeces! That initial interest never waned and the more I learnt, the more I came to respect our charismatic scarabs.

Here in the UK, there are more than 50 species of dung beetle in the Superfamily Scarabaeoidea (Skidmore, 1991) dominated by the Scarabaeidae (Aphodiinae endocoprids (dwellers) and Scarabaeinae paracoprids (tunnelers)) alongside large Geotrupidae paracoprids. Unfortunately, we lack the true telecoprids (rollers), but our dung invertebrate fauna is richer for this: the slower rate of dung removal compared to tropical climes allows a successional communality of invertebrate species to utilise dung.

By feeding on, tunnelling within and burying dung, dung beetles and other dung-utilising invertebrates deliver a host of ecosystem functions and services. These include reduced pasture fouling by livestock (Lee & Wall, 2006), increased herbage yields (Bang *et al.*, 2005) and improved soil hydrological properties (Brown *et al.*, 2010). Dung beetles also serve as an essential resource for insectivorous farmland birds and a range of other invertebrate predators (e.g. McCracken, 1993). The action of dung beetles can also reduce livestock parasite burdens (Gronvold *et al.*, 1992) and may reduce greenhouse gas emissions from livestock dung (Penttilä *et al.*, 2013). The value of these services has been estimated rudimentarily to save the US cattle industry more than

year (Losey & Vaughan, 2006) and in the UK, dung decomposition in agricultural grasslands has been identified as a key ecosystem service of high policy relevance (Sutherland *et al.*, 2006). However, dung beetle declines are well documented (Davis *et al.*, 2004; Lobo, 2001) largely due to changes in habitat, agricultural intensification and the associated practice of treating livestock with chemical parasiticides to control their internal and external parasites.

Research Inspiration

Every now and then you meet a person who enthuses you to such a degree that it alters the path your life is taking. That person for me was Darren Mann, who is now Head of Life Collections at the Oxford University Museum of Natural History and whom I am now lucky enough to count as a great friend. During my time as an undergraduate at Oxford, Darren opened up the cabinet of curiosities that is entomology and turned what could have been a hobby into a career path.

As a naïve graduate armed with a University of Oxford Varley Gradwell Travelling Scholarship and guidance from Darren, I headed off to Zambia for my first sole research project to investigate the impact of cattle farming on dung beetles. To be honest, it should have put me off fieldwork for life. I was held at gun-point, had my tent trampled by an elephant (when I was in it), my entire fieldwork site was burned to the ground half way through the experiment, my specimens were seized by customs and, oh yes, I caught malaria! However, strangely enough I caught the fieldwork bug (in more ways than one)! Numerous self-funded fieldwork projects in the UK, as well as South- and Central America ensued, with each one marginally less disastrous than the last.

Completing a doctorate was always on the Bucket List and I never once considered applying for a ready-made PhD: I always thought that half the excitement was having the opportunity to design and implement my own research. I went through a whole host of wildly overambitious ideas before meeting another inspirational individual: Pembrokeshire farmer and conservationist Roger Mathias. Whilst carrying out a ground beetle (Coleoptera, Carabidae) survey on his farm (yes, he paid out of his own pocket for a ground beetle survey) I thought it would be interesting to include a small dung beetle survey. I floated the beetles out of dung from three groups of cattle: a group that had been treated recently with the broad-spectrum parasiticide ivermectin; a group that had been treated with ivermectin once during the year and an untreated group. Dung beetle abundance was fourfold higher in dung from the untreated group than in dung from cattle treated regularly with ivermectin. Roger asked: "so if I need to control the parasites in my cattle and ivermectin is killing the dung beetles, what else can I do? Are there any other options?" I began looking into other parasiticides as well as alternative products used for livestock parasite control. I found many gaps in our knowledge, not least that, as the alternative products are not marketed as veterinary medicines, they require no efficacy or environmental safety testing. However, many are sold and used extensively, largely by smallholders, horse owners and organic farmers. Surprisingly, the data on potential non-target environmental impacts were almost non-existent. My research question was sorted!

Research Overview

Never one to learn from my mistakes, I initially planned the fieldwork to be back in Zambia, working-up the project with parasitologist Richard Wall at the University of Bristol. However, the funding was not forthcoming and I saw an advert for the Professor Sir Richard Southwood Scholarship in Insect Ecology at the University of Oxford. I approached ecologist Owen Lewis to be my supervisor and, with his help, I managed to win the scholarship for my UK-based doctorate, entitled: 'Factors affecting ecosystem services by dung-associated invertebrates'. I wasn't sure how much I liked the term 'ecosystem services' but I firmly believed that being able to demonstrate the benefits of wildlife from an anthropocentric perspective was an important tool to enable us, as scientists, to influence conservation policy.

I was interested initially in testing non-target environmental impacts of alternative products used for livestock parasite control but, over the four years, my research grew in scope (and scale) to investigate impacts of a number of human-led disturbances on the dung invertebrate community. Working alongside my supervisor

Figure 2. My grandmother, Dorothy Beckwith, surveying her garage full of bags of dung ready to be frozen.

Figure 3. Mixing dung in my parents back garden.

Figure 4. An experimental dung pat.

Figure 5. Emergence trap.

Figure 6. Emergence traps.

different angle, using my study system to explore more general ecological concepts and theories. I was also greatly influenced by the work of, amongst others, John Finn, Tomas Roslin and Eleanor Slade.

Despite an abundance of primary literature on non-target impacts of some parasiticides on dung fauna and functioning, I felt initially that there was a need for some timely review articles on the topic. My co-authored review of the non-target impacts of macrocyclic lactone parasiticides with Richard Wall (Wall & Beynon, 2012) highlighted gaps in the knowledge for many parasiticides other than ivermectin and identified the need to bridge the gap between field and lab studies. We also stressed the importance of long-term experiments: much of the data are from short-term experiments looking at non-target effects on a small number of common species of dung beetle. Data on sub-lethal effects are often ignored. The literature on non-target effects of parasiticides excreted in sheep dung is even sparser with most work generalising from the cattle literature. This observation generated two additional review papers (Beynon, 2012a, b).

Luckily, as I was a partner in my family's livestock farming business, I didn't need to look far for a main fieldwork site! Over the years, I had also built up a strong network of farming contacts, so I knew whom I could approach and talk into helping me! During the time between my undergraduate degree and my doctorate, I remember my mother asking me regularly "why is 'getting contacts' so important? What about making money?!" Well mum, this was one of the reasons for all that hob-knobbing!

The first year of my doctorate was dominated by large field experiments. In order to collect dung, cattle were randomly separated into groups in different paddocks and fresh dung was collected from each group (pre-treatment dung). The cattle in each group were then treated with a different parasiticide, fed an alternative 'product' or left untreated. Dung was collected again at the time of peak faecal excretion of each treatment or product (post-treatment dung). This ensured that I took into account differences in dung quality due to differences amongst cattle or pastures,

Figure 7. Dung-baited pitfall trap.

which is often ignored. Dung was then frozen until required. I say this lightly, but freezing over two tonnes of dung at one time is no mean feat! To the rescue came my wonderful grandmother, who gave over her garage to dung freezing central (Fig. 2)!

Once thawed, dung was homogenised with a mortar mixer. Again, this sounds simple, but the dung was mixed in my parents' back garden. They do not live on a farm or a research station, but in a house on a residential street. My dung mixing days always seemed to coincide with days on which their elderly next-door neighbour was wheeled into the garden in her wheelchair and left to enjoy the summer weather. I would like to take this opportunity to apologise for the terrible smell that must have engulfed her on numerous occasions! (Fig. 3)

During my first year, I had two undergraduate students working on projects for me. Therefore, not only was I learning myself, but also teaching them at the same time. I learnt a number of important lessons during that year: (1) earthworms smell hideous when cooked (I pushed past the drying oven and accidentally turned up the temperature to 200°C); (2) if you make a homemade pour-on product from stewed garlic following an Australian patent, it will explode all over you and your lab and the smell will linger… for months; (3) don't let your mother anywhere near your emergence trap samples. She will tip them up to the light to have a better look and spill them all over the shed floor and follow with an "oops" and (4) don't expect other people to follow your instructions: I'll never forget one student coming to me and saying: "I've combined all the control samples and put them into the same pot. I'll start to identify them now. Is that ok?" You might want to look out for the phrase "there was no control treatment in this experiment" in one of my papers!

Despite all this, the first fieldwork season was largely a success. Experiments were each composed of three separate studies: (1) standard size and mass dung pats from each group of cattle pre- and post-treatment were laid in a grid in the field and dung-dwelling invertebrates were allowed to colonise naturally (Fig. 4). Pats and the underlying soil cores were collected in after 5 days and placed in emergence traps (Fig. 5, 6). Invertebrates emerged over the course of more than a year. This allowed me to measure treatment effects on invertebrate survival and offspring emergence. (2) Pats (as per (1)) were placed over pitfall traps (Fig. 7) to measure dung attractiveness and (3) pats (as per (1)) were weighed regularly over one year to measure dung decomposition rates.

These experiments provide the first evidence that alternative products for parasite control, in this case 'Bug A Tub' (a free-choice mineral lick containing <5% diatomaceous earth and undisclosed plant oils) and potentially a copper bolus, can affect insects colonising dung, highlighting a need for tests on the environmental safety of alternative products (Beynon *et al.*, 2012b).

Zambia was still on the brain and during the winter of 2010, Richard Wall and I received Darwin Initiative funding to head out on a scoping project to investigate ideas for my post-doc. After an extremely unpleasant anaphylactic shock (no malaria this time), it was back to the UK. Unfortunately, our timing coincided with the period when funding was suspended and so my Zambia dream went on the back boiler again and it was back to the doctorate.

Figure 8. Experimental mesocosms.

I lost over a stone of weight during my second field season and gave myself sciatica, but I also generated some really nice data! Whilst continuing with field experiments, I moved towards the use of semi-field mesocosms (Fig. 8) to facilitate manipulation of the system. Mesocosms were made from black plastic buckets filled with soil and topped with a turf mat, onto which I placed my dung pats (collected as per year 1). I could manipulate the dung and species added to each bucket, which was then sealed with fine mesh. Rearing mesocosms were then turned into emergence traps with the addition of a collecting bottle and light-reducing material (Fig. 9). This enabled me to look at responses including adult survival and offspring emergence as well as dung removal.

I was interested in interspecific variation in responses to parasiticides, in particular ivermectin, only hinted at in the literature. Interspecific variation was indeed high: dung beetle species varied in sensitivity to ivermectin and impacts of ivermectin on functioning were also species-specific.

Species-rich communities have been shown to deliver enhanced functions and services (Cardinale *et al.*, 2006). I wanted to know more about the relationship between dung beetle species richness and dung removal. I was also curious as to the form of this relationship when the system was disturbed, as disturbance is very common in agricultural ecosystems. Mesocosms were constructed with either monocultures, 2- or 3-species polycultures, replicated with three different functional groups of dung beetle (dung-ovipositing endocoprids, soil-ovipositing endocoprids or paracoprids). In order to look at an effect of disturbance, the experiment was replicated with dung from untreated cattle (undisturbed system) as well as dung from cattle treated with ivermectin (disturbed system). In the short term, species-rich assemblages sustained functioning in the context of disturbance with ivermectin, but functioning of species-rich assemblages did not differ from that of species-poor assemblages in undisturbed conditions. This suggests that apparent functional redundancy of species in agro-ecosystems should be interpreted cautiously in the context of disturbance. However, in the long term, there was a significant, positive effect of species richness on dung removal irrespective of disturbance (Beynon *et al.*, 2012a).

In collaboration with Christina Marley at Aberystwyth University, I looked at effects of grazing chicory for livestock parasite control on non-target invertebrate survival and functioning. I am still to write up these data as well as data from fieldwork and mesocosm experiments on numerous alternative products, including the fateful garlic pour-on, as well as diatomaceous earth, the nematode-trapping fungi *Duddingtonia flagrans* and the herbal product Verm-X. I have data on dung beetle responses to the new monepantel parasiticide Zolvix, as well as some very interesting data on non-target effects of moxidectin – a parasiticide that is marketed as 'dung beetle friendly'. I had a Glamorgan University MSc student looking at effects on soil macrofauna and mesofaunal functioning and currently have a PhD student repeating a refined version of my experiment before we publish these results. I also had an undergraduate and an MSc student (both from the University of Oxford) researching the importance of dung- and soil invertebrates as food for the chough *Pyrrhocorax pyrrhocorax* on RSPB Ramsey Island. Ground beetles, cranefly larvae (Diptera, Tipulidae) and dung beetles (in particular the dung beetle *Geotrupes spiniger*) drove chough foraging patterns at different times of the year.

I managed to squeeze in a short, third fieldwork season to further explore my year two data. I wanted to investigate functional outcomes of realistic dung beetle extinction scenarios driven by sensitivity to ivermectin. The data from this mesocosm manipulation experiment showed that losing those species most sensitive to ivermectin severely retarded short- and long-term

functioning. The potential lack of density compensation (i.e. less sensitive species filling vacated niche space) assumed in all this manipulation experiment, and potential multiplicative impacts of numerous disturbances common in agricultural systems, suggest that functional impacts may be even greater than predicted.

From the start of my doctorate, I wanted to deliver research that had a policy-relevant, applied outcome without compromising on the scientific interest and quality of research. I would like to think that winning the Wallace Award suggests that I have been successful in my mission. I have since set up my own business, Dr Beynon's Bug Farm Ltd, to deliver "conservation through research, innovation and education". Whilst I'm still not sure how I feel about placing a monetary value on nature, I do believe that it is an important way forward if we are to influence decision makers. To that end, I have been supervising an MSc project with Mike Christie at Aberystwyth University putting an economic value on ecosystem services provided by dung beetles. The preliminary results are looking great. In addition, alongside Richard Wall, I am running a NERC Impact Assessment Award to deliver the outcomes of our research to farmers, horse owners and vets. Oh, and perseverance does pay off: this year I got the project in Zambia funded via a NERC CASE Partnership with Richard Wall. I'm off to Zambia in the New Year!

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Fig. 1

A dyeing business? Canary cochineal insects

Peter Cranston
and Penny Gullan
with contributions from
Douglas Williams

Division of Evolution,
Ecology and Genetics,
Research School of Biology,
The Australian National University,
Canberra, 2601, Australia

The cultivation of the cochineal scale insect, *Dactylopius coccus* Costa (Coccoidea: Dactylopiidae), on *Opuntia* cactus for production of the natural dye carmine has been referenced in each edition of our entomology textbook ('The Insects', Wiley-Blackwell). With a contractual obligation to verify and update everything for a new edition (5th, October 2014) it was time to review the topic. Much good detail of the nomenclature, history and location of cultivation, as well as the uses for the carmine dye derived from these insects, can be found in Wikipedia (http://en.wikipedia.org/wiki/Cochineal). Amy Butler Greenfield covers the ground up until 2005 in a fascinating book, *'The Perfect Red'*. However, recent developments, including issues of 'synthetic' versus 'natural' colourants, consumer activism and industry responses, suggested we assess the current situation. This report particularly relates to the Canary Islands, where Dr Douglas (Doug) Williams, doyen of coccidologists, had observed the cochineal production some four decades ago, and which we visited in May this year.

First we need to consider some background on the insects. *Dactylopius* has a life cycle typical for a scale insect. Dispersal is via tiny 'crawlers' (first-instar nymphs) that settle and then feed on the host cactus by sap sucking, and develop through a further one to three nymphal instars (according to sex) before moulting to the adult stage. The globular adult females are wingless and nymph-like, compared with the much smaller, winged adult males (see Fig. 1). All ten or eleven species of *Dactylopius* are from the New World, and synthesise protective chemicals including carminic acid in the haemolymph and cuticular waxes that deter predators and parasitoids. *Dactylopius coccus* produces minimal wax, and the substantial amounts of carminic acid give the body a deep crimson colour. The pigments of congeners are of lesser quality than those of *D. coccus*.

Dactylopius coccus is native either to Mexico or Peru (with early trade transfer between one and the other) and has been cultivated for its range of stable red to crimson colour for more than a thousand years. The dye was used by Pre-Columbian cultures (Inca, Pre-Inca, Paracas and Nazca) for colouring both ceremonial and necropolis garments, rugs and blankets. The Aztecs called it "nocheztli" or "blood of the cactus", and their rulers, including Montezuma, demanded large quantities as tribute. It was in Mexico that the Spanish invading conquistadores came to realise the value of the product, hijacked the tribute, and started the Spanish monopoly of the production and export to Europe. The annual value of exports was second only to silver. Piracy on the high seas of Spanish ships was not only for bullion - in 1597 Walter Raleigh brought three Spanish ships carrying twenty-seven tons of cochineal to Queen Elizabeth.

Expansion of cochineal insects and their host cacti from Mexico has a complex (and not fully understood) early history. The Spanish prevented

export of live insects and even encouraged the erroneous belief that the dye came from the cactus itself! The value of cochineal in Europe and further east was so high that in 1776 the French government botanist, Thiéry de Ménonville, disguised himself to enter Oaxaca and, risking death for espionage, smuggled the prized 'domesticated' cochineal insects, their host plants and the local know-how he gained, from 'under the noses of the Spanish'. His tactics included claiming to be seeking a remedy for gout, and using a coffin with false bottom and with 'trash' plants and fruits as cover for export of his illicit harvest. Commercial production was established in San Domingo (that was to become modern Haiti) where already there was a modest native 'wild' cochineal industry. Subsequently carmine dye became more valuable to the French government than '10 ships laden with silver and gold'.

Acquisition of cochineal by piracy was unsustainable and several other countries sought to farm and harvest cochineal insects. The pioneering economic botanist and advocate of the development of Australia, Joseph Banks (1743-1820), was a life-long proponent of cochineal production in the British colonies. In the late 18th century, imports from Mexico via Spain into Britain were reported to be equivalent to at least 150,000 lb (c. 70 metric tonnes) per annum at a value of some £200 million, by a rough conversion to current value. A major use for cochineal dye, especially during the 18th century European wars, was for the British army 'redcoat' uniforms. Thus when Arthur Phillip, the founder of Sydney and first governor of New South Wales, brought the earliest (mostly involuntary) European settlers to the continent with the First Fleet in 1787-8, Banks insisted cochineal and cactus be sought en route. Phillip's diary of the voyage reports his visit to Rio de Janeiro, where he obtained coffee, indigo, cotton and the 'cochineal fig'. The latter is identified in a footnote as C*actus Cochinilifera* of Linnaeus (now treated as a synonym of O*puntia ficus-indica*). Many subsequent authors infer that Phillip brought cochineal-infected cladodes (cactus pads) but this is not stated in the diary. Even if some scale insects had been associated with the transported cactus, they could not have been *D. coccus* (cultivated or wild-type) because the Portuguese had not obtained the species and it was not present in Brazil. Whatever, no scale insects survived, whereas the cactus eventually became responsible, at least partially, for the subsequent prickly pear invasion of eastern Australia. Some seven years later, *Dactylopius* was sent from the same location (Rio) to India, again with assistance from Banks. Doug Williams inferred these to have been *D. ceylonicus* (Green), a species which, despite the name, is native to South America, and which produces quite inferior pigment. These enterprises were not amongst Banks' successes – no British colony ever produced commercial cochineal, but instead Australia gained the first of several noxious weedy cacti – the prickly pear. Somewhat ironically, several species of *Dactylopius* became minor components of an eventually successful Australian biocontrol programme that is well documented, albeit often over-simplified and often with erroneous taxonomy of cacti and insects.

By 1820, political unrest in Mexico led the Spanish to deliberately unwind their already failing monopoly and commercial risk was spread through new cochineal cultivations in the Caribbean, Guatemala, Nicaragua, southwards to Colombia, Ecuador and Peru, and ultimately across the Atlantic in the Mediterranean, North Africa, peninsular Spain and, in 1826, the Canary Islands. Here the European production of cochineal was most successful, although initially the Canary islanders were conservative and very reluctant to abandon their previous horticultural production, mainly of wine grapes. However, with the arrival of phylloxera and consequent destruction of the grape vines, tending of cochineal insects increased dramatically. The dry climate, especially of Lanzarote, proved highly amenable to cochineal production free of disease and pests. Furthermore production was 'pure', without contamination by other species of *Dactylopius* as was the case in South America. Within 40 years the islands were exporting several million kilograms of cochineal each year. Sadly such high levels of production there and in Java, Guatemala and Mexico coincided with a crash in prices as the first synthetic red dyes started to penetrate the colourant market at an ever more discounted price relative to natural dyes.

The Canary islanders found themselves returning to poverty, with only a developing banana production, especially in Gran Canaria, giving some families a sustainable living. Production of cochineal as a dye did not cease entirely with demand continuing for the 'high end' natural dye, including for Persian carpets, with a sought-after shade that could not be created authentically by organic chemists. Furthermore, even in the mid-19th century, the new range of synthetic reds was argued to lack authenticity, durability and cause skin irritation.

The downturn in demand for carmine was global, but especially hit Mexico where production costs were higher due to vagaries of weather and a range of natural enemies of *Dactylopius* scale insects. Production there declined until restricted to small settlements in the Oaxaca area. Traditional fabric dyeing continued in the mountains, but export ceased. Although production in Tenerife (Canary Islands) also declined, it did provide dye for traditional users in Europe and the Middle East. Output in Peru increased thanks to cheap labour and the usual absence of disease. Throughout the 20th century use of carmine as a fabric dye declined, but use as a colourant for food and cosmetics grew. The insect-based dye continued to be supplied predominantly from Peru, the dominant producer.

Essentially that was the situation when Doug Williams visited the Canary Islands in the mid-1970s, bearing his camera. Doug photographed the cultivation, harvesting and preservation of the insects, and documented the local factory production of the carmine dye. Cochineal production was restricted to Mala and Guatiza, villages in northern Lanzarote where the dry climate and moisture-trapping black volcanic gravels (picón) otherwise support only strangely pruned vines of wine grape. Then, as now, cacti belonging to several species were abundant throughout the islands, but these feral plants mostly derived from cultivation for fruits, and never did, or no longer provide commercial *Dactylopius*.

Doug's photographs (Fig. 2) show successively (clockwise from top left) a picón field planted with young cactus nopales (cladodes, pads) (Fig. 2A), the finger-like bags (Fig. 2B) hung on mature nopales to transfer *Dactylopius* crawlers to new sites, the scraping of mature adults from the nopale into a tray (the milana) (Fig. 2C), a harvester dressed in protective clothing and

Fig. 2

Fig. 3

holding a scraper and milana (Fig. 2D), the bucket containing a day's harvest (Fig. 2E) and then the sun drying of the cochineal insects (Fig. 2F).

Doug documented that after sieving the cochineal insects (Fig. 3A) carmine production seemingly involved much 'bucket' chemistry with open vats of steaming red liquids (Fig. 3B,C). A document from the U.S. Department of Health in Doug's possession (with imperial units of measurement) shows that processing initially involved boiling 300 lbs of cochineal insects in 800 gallons of water to which was added 12 lbs of citric acid. The supernatant was drained off and filtered, and another 800 gallons of water added to the residue with a lesser amount of citric acid. The twice-boiled insect remains then were discarded and the combined acidic extraction liquids passed to a precipitation tank. Here calcium acetate, aluminium sulphate and sodium bicarbonate were boiled with the scarlet brew (Fig. 3C). Subsequent addition of a further 'white base' comprising more aluminium sulphate and sodium bicarbonate, and further boiling completed the chemical processing when the aluminium salt of carminic acid was again precipitated. After cooling, the precipitate was filtered in a press (Fig 3D), and the trays of damp carmine then sent to a dryer overnight (Fig 3E,F). A pulveriser was used to prepare the powder, which is the commercial grade product, carmine. The number of treatments of boiling arose because of fears that the product, which had pharmacological uses in the USA, could be contaminated by bacteria unless so treated.

If you are considering doing this at home, a warning: it takes some 80 to 100 thousand dried cochineal insects to make a kilogram of carmine. But it does go a long way: a single drop will stain everything that comes in contact, including human skin. In the Canaries, Doug was told that a major user of carmine as food dye at that time was Campari™ and probably other beverage producers, of both alcoholic and non-alcoholic drinks.

Earlier this year, Penny Gullan and Peter Cranston joined a guided botanical tour of the Canary Islands, organised by the Cactus and Succulent Society of America (CSSA). Aside from seeing the extraordinary diversity of endemic succulents (remember that all cacti are non-native), we saw a chance to view cochineal production when we were on Lanzarote. A scheduled visit to local architect César Manrique's beautiful Cactus Garden, took us into the villages of Mala and Guatiza. Most feral cactus on all islands had some infestations of *Dactylopius*, so this was far from our first sighting of cochineal insects. The difference was that the *Opuntia* generally were restrained behind stone walls, somewhat aligned in rows to allow passage without being pierced by spines, and with high densities of scale insects on many nopales. However, in contrast to the photographic evidence of Doug Williams, and a report in *Antenna* from John Cloudsley-Thompson (1986), all seemed neglected. Stone walls were crumbling, many cactus plants were senile or dead, with unfilled gaps, and unlike in Fig. 2A, no new fields were visible anywhere in the valley. Could this area, which had produced 12,000 kg of cochineal for export in 1997, have declined to nothing? It certainly looked like it – especially knowing of the many defunct web sites associated with the industry. These sites included those linked to the Asociación Milana (Centro de Interpretación de la Cochinilla de Lanzarote) which seemed to have fought a rearguard action to interest tourists in the artisanal production of cochineal as a native dye for other artisanal producers of fabrics as recently as 2010.

We spotted across the road from the forlorn fields and beside the parking for the Cactus Garden, a lady dressed in traditional clothes, standing before a small demonstration of the very same equipment that Doug had photographed 40 years earlier (Fig. 4A). Accompanying some infested nopales, a scraper and milana, were some samples of cochineal insects and carmine in liquid. With the aid of one of our group fluent in Spanish (Nels Christianson), we asked her some questions concerning local production. Yes, we had been looking in her fields, and yes, production was way down, but not out. These farmers have lived with the fickle market for cochineal for a long time. Harvest took place according to the market price, and because the sun-dried cochineal insects keep very well, sales could be delayed until the price rose. Sales were of unprocessed (dry) cochineal insects only, via the local cooperative to a 'pharmacy in Germany'. The maximum production she could recall was in the 1970s when cochineal fetched US$1000 per kg (this would have been when Doug visited). She told us that production in the Canary Islands essentially ceased until 'an earthquake in Peru' revived production in 2002. The current price (June 2014) of €100 per kg was just above her 'break-even', after a period of less than this price when it was not worth harvesting. When not producing cochineal insects, cacti were valued for their prickly pear fruit, called either 'la tunera' or 'higo picón', from which marmalade / jam was prepared. As more tourists arrived at her little 'stall', our initially reluctant but now enthusiastic 'insider' finished by identifying the local use by butchers' shops (carniceria) of cochineal to colour their meat 'fresh red'.

Back on our minibus, we started northwards from Guatiza to Mala talking about how we seemed to have

Fig. 4

misinterpreted the 'neglected' fields. Hardly had we started when we saw a young man with cochineal harvesting equipment in his front yard. We returned to park near the unsuspecting local, who found himself the object of a dozen cameras recording his dress, with gauntlets and homemade leg protection (Fig. 4B). When questioned by Nels (Fig. 4C), he was enthusiastic that people cared about what he was doing, and although confirming that prices were low, was optimistic that another failure in Peru would bring higher prices for cochineal.

So where is the trade right now? Is extinction nigh? It seems not, as the production in Lanzarote can be ramped up quickly, as has happened in the past. However with prices hovering around €100 per kg, there is little incentive to do more than supplement the incomes of a few cultivators.

There are reasons why increased demand might be expected, but countered by other factors that reduce regain of its significance. Increasing demand for 'natural products' in our foods and cosmetics, and a rejection of synthetic dyes is stated often as a reason to check out the colouring agents in a range of consumer products. The long-standing designation for cochineal/ carmine as E120 by Europe, dating back to the 1960s, allows consumers to choose this over coal-derived red colouring. Belatedly in 2011, the US Food and Drug Administration introduced a requirement to label cochineal in products. However this requirement seemingly derived more from a few cases of allergic response to carmine than to differentiate it from synthetic reds. For the health conscious consumer the choice between a rarely allergenic 'natural' dye derived from an insect (with 'ugh' or 'ick' response) and a known carcinogenic, coal-derived, red dye is a mildly amusing dilemma. God forbid we should eat strawberry yoghurt that is truly 'natural' in colour (dull brown). This surely is an issue for vegans and those with religious taboos (kosher and halal) concerning eating insects, and epitomises Starbucks™' dilemma. In March 2012 a pressure group revealed that the Strawberries & Crème Frappuccino® was not naturally red, but derived its colour from cochineal. The unannounced switch from synthetic colour had been part of a praise-worthy plan to get away from artificial ingredients – but they didn't inform the vegans, who exerted their growing power of protest. Almost immediately Starbucks announced that they would transition to lycopene, a red colour derived from tomatoes. Next the yoghurt producer Dannon (Danone elsewhere) was 'outed' by the so-called 'Center for Science in the Public Interest' as using 'bugs' (or 'unnamed creepy crawlies') to colour their dairy products. Thus far, the company has stood by its product arguing that the labelling was clear, and yes, carmine does come from insects and is harmless. None-the-less, an anti-carmine campaign continues, accompanied by widespread misleading denigration of the insect-based dye. Aside from lycopene derived from the excess tomato crop, alternative 'natural' products are being sought amongst other vegetable-based anthocyanins, including black carrots and red cabbage. However, cessation of using carmine in drinks need not come from consumer sentiment – seven years ago Campari™ ceased to use carmine due to vagaries in 'supply and demand'. As of 2011, Martini™ continue to use it in their Bitters). Such a scenario predicts a bleak future for Canary Island producers of cochineals, although tempered perhaps by some developments in South America. Usually Peruvian growers have produced 10-fold more carmine than the Canary Islands. Some Peruvians are transitioning away from cactus growing to the more financially rewarding production of quinoa (*Chenopodium quinoa*). This crop is no longer a meagre subsistence fare for the local market but is exported for health conscious foodies, especially in North America. As a result the price paid for carmine has already doubled in 2014 due to Peruvian shortfall of cochineal. Some speculate on the role of El Niño climate in strongly reducing Peruvian production, as in 2010 when heavy rainfall destroyed the cochineal insects thereby driving up the price paid for Canary Island product. However, it is difficult to see the Lanzarote producers doing better than subsisting by supplying specialist artisanal fabric dyers, and an occasional elevated demand due to Peruvian shortfall. Furthermore, there is a potential for entry into the market of Ethiopia, perhaps capitalising on the spread of cochineal insects into the cactus-fruit growing areas of Tigre. Globally cochineal was and continues to be a very dynamic trade, justifying the

Fig. 5

Fig. 6

Espionage, and the Quest for the Color of Desire'. The fragility and vicissitudes of production, as originally encountered in Mexico due to climate (rainfall), politics and speculation, did not cease when the Spanish lost their monopoly two centuries ago. Nevertheless, it is highly unlikely that the scales will tilt back to anything like the fantastic prices that were obtained prior to artificial dyes.

In our research both original documents and on-line resources reveal much confusion. The taxonomy of opuntioid cacti is complicated with substantial synonymy at both generic and species level. Thus Phillip could not have known exactly what he brought on board in Rio de Janeiro, nor for a time did Australians know which cactus it was that they sought to eliminate. Confusion derives also from ambiguity in the meaning of the name cochineal. Cochineal in Spanish is usually referred to as "grana cochinilla" but often just referred to as cochinilla. In English, cochineal is restricted to *Dactylopius*, the producer of carmine, but cochinilla (Spanish), cochinelles (French) and cochonilha (Portuguese) all refer to scale insects in a broader sense (i.e. Coccoidea). In the 15th century there were excuses for identification issues as these were pre-Linnaean times. Nonetheless, some Spanish colonial interests extended beyond conquest for silver and gold, and biological resources were documented sometimes with surprising accuracy. Thus Gomez de Cervantes' painting from a codex from 1599 shows a diversity of pests of cochineal in Mexico (Fig. 5). Such identification skills did not extend to many subsequent reports – including persistent misnaming of the cochineal as a beetle. This extends even to the Royal Botanic Gardens, Kew, the formal establishment of which was a personal project of Sir Joseph Banks. Visitors to the cactus section of the Princess of Wales Conservatory are shown not only a completely imaginary insect (Fig. 6A), but also a statement that the food colour derives from a 'scaly beetle' (Fig. 6B). This nonsense was compounded by an official response to a complaint that 'this makes it easier for laymen to visualise the creature' and a refusal to emend. Banks would be turning in his grave.

Acknowledgments

Doug Williams (Hindhead, Surrey) provided us with his pictures from the Canaries from 40 years ago, and has been a discussant on matters coccidological for longer still. We thank him for his continuing enthusiasm. We also thank Demian (Takumasa) Kondo (CORPOICA, Palmira, Colombia) who reviewed this article and guided us to Spanish names and literature. Valerie McAtear, RES librarian, tracked down Cloudsley-Thompson's article in a non-digitally available volume of *Antenna*. The British Museum gave permission to reproduce a figure from Gomez de Cervantes' 1599 codex. Nels Christianson was our translator in the Lanzarotean cactus fields, and Susan Mahr took many photographs of cochineal insects. We thank both, who were members of the eclectic group of botanical tourists shepherded by organiser Dan Mahr under the auspices of the Cactus and Succulent Society of America. Dave Karraker willingly informed us on the cessation of use of cochineal as colourant in Campari, but others in the trade were more circumspect. Commercial in-confidence matters prevented a wider discussion with several interesting people in the food dye industry.

Further Reading

There are simply too many sources of information available on the web, including complete scans of the diaries of Arthur Phillip, the great opus on dyeing by Ernest Bancroft, the papers of James Mease, the Botanical Magazine of William Curtis and John Sims, and most of the sources that these works cite. Nearly all are available searchable and free at 'books.Google.com'. Many Canarian web sites arose when the cochineal price came back in 2010 but now are inactive, whereas others relate to small-scale tourism ventures associated with artisan dyeing workshops. Here we cite just a few sources, including more obscure and recent ones of interest.

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Figure 1. Common Rose Chafers (*Cetonia aurata*) as seen through a left-handed circularly polarising filter (L) and a right-handed filter (R). In the green forms of this species the reflected light is 70-80% left-hand polarized. The images with the left-handed filter appear entirely normal (like everything else one sees) while those through the right-handed filter are much darker and virtually devoid of colour.

Butterflies seem not to reflect circularly polarised light

J.David Pye
FLS, FZS, FInstP, Hon FRi.

Emeritus Professor of Zoology,
University of London.

Email: dpye6@aol.com

Until recently, scarab beetles were thought to be unique in displaying one peculiar physical phenomenon – some of them reflect left-handed circularly polarised light (compare Figures 1L and 1R). Circularly polarised light (CPL) is not widely known because, although it is easy to create, it hardly exists in nature – *except* for the scarab beetles (astronomers often observe much weaker CPL and it can also occur under very specific conditions, just below a water surface).

The theory is really quite simple. Ordinary, unpolarised light consists of waves that oscillate in random directions about the direction of propagation, just as a rope can be wiggled in any direction, side-to-side or up-and-down, to send waves along it. But in polarised light, the oscillations are fixed in only one direction, like water waves that can only go up and down. Now, such 'linearly polarised light' (LPL) can also be given a twist so that it rotates as it goes and the wave then resembles a corkscrew, which looks like a wave when viewed from any side but also rotates in 3D. Of course it can rotate either clockwise or anticlockwise, giving left-handed or right-handed circular polarisation. A simple way to achieve the necessary twist is to pass linearly polarised light through a certain thickness of cellophane film, maybe a CD wrapper (for more details, see Pye, 2001). But strangely, there is no natural source of strongly circularly polarised light (CPL) apart from the scarabs. I surveyed all the Scarabaeoidea in the Natural History Museum (19,000 species and subspecies, Pye, 2010). A large number of forms from nine Subfamilies show such polarisation, always left-handed, and in some of them the reflection is more than 95% polarised, which makes them physically unique in the known universe.

But in the last few years it has been suggested or implied that certain butterflies may also reflect circularly polarised light (Michielsen & Stavenga., 2007; Saranathan et al., 2010; Saba et al., 2011; Schröder-Turk et al., 2011). This prediction was made by chemists on the basis of the molecular architecture of green wing scale cuticle from the lycaenids *Callophrys rubi* (Figure 2),

Figure 2. The normal appearance of a Green Hairstreak Butterfly, *Callophrys rubi*: the under surface of a male as seen by unpolarised visible light. This is the most studied species in previous literature and it shows the largest area of green colour whose nature was investigated. It is also the prime subject of the present study.

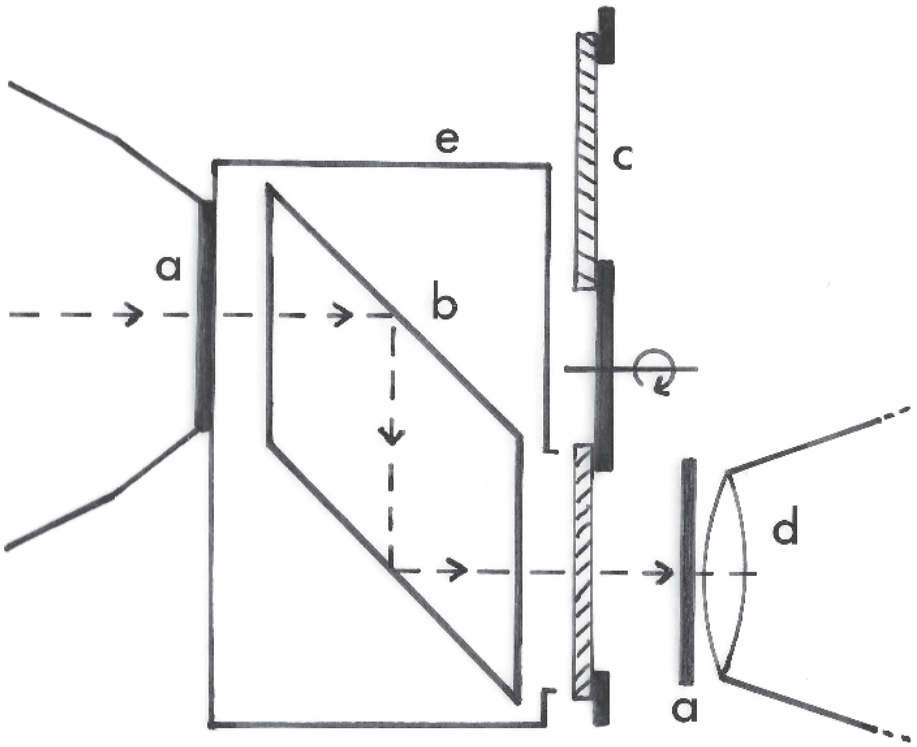

Figure 3. The basic elements of the circular polariscope developed to examine near-ultraviolet wavelengths. (a) a 'black' UG1 or a bonded UG1+BG39 filter, blocking visible light but admitting near ultraviolet (UVA) - this filter could be placed in front of the prism but was generally fitted on the front of the camera lens; (b) a double reflection prism to convert circular into near-linear polarisation; (c) two linear polarising filters on a rotating mount, with their polarisation directions set at opposite diagonals to the vertical; (d) a digital camera sensitive to UVA wavelengths; (e) light-proof casing with two 'windows'.

C. dumetorum, *C. (Mitoura) gryneus*, *Cyanophrys remus*, *C. herodotus* and *M. siva*, and the papilionids *Parides sesostris* and *Teinopalpus imperialis*. The polarisation was predicted to occur in the near-ultraviolet (UVA) region of the spectrum, around 340-390 nm wavelength (Schröder-Turk *in litt.* 2012); it was uncertain whether the circularity is left-handed or right-handed (Schröder-Turk *in litt.* 2012) or even a mixture of both (Saranathan et al., 2010), in which case an equal, 'racemic' mixture would result in no observable polarisation. No attempt appears to have been made to observe the polarisation itself so I thought it would be worthwhile to investigate whether it does exist in these butterflies by attempting to observe it and its basic properties.

Unusual Optics Needed

There seem to be no circularly polarising filters that can work in the UVA band and even linear polarising filters for these wavelengths are rare (and generally extremely expensive). I therefore constructed a polariscope for detecting circular polarisation in the UVA by using a prismatic method (see eg Pye, 2001). The arrangement of the instrument is shown in Figure 3. A glass prism giving two internal reflections, each at 45° incidence, is used to convert circular to nearly linear polarisation. Despite much prejudice to the contrary, glass is essentially transparent to the UVA (ie wavelengths from around 400 nm down to about 320 nm). For perfect conversion from circular to linear polarisation, the prism should really be a 'Fresnel rhomb', with internal reflections at around 54° incidence, depending on the glass used, but 45° gives a rather close approximation, quite sufficient for qualitative observations, and I happened to have such a prism to hand. Tests showed that in conjunction with a sheet of linear polaroid this prism is very effective at selecting circular polarisation of either handedness and rejecting the other.

The direction of the linear polarisation produced by the prism is diagonally at 45° left-to-right for one direction of circularity and at right-angles to this for the other. This direction is detected by two linear polarisers, set in the appropriate two directions, mounted on a rotating disc so that either can be deployed in turn. The polarising filters are cut from

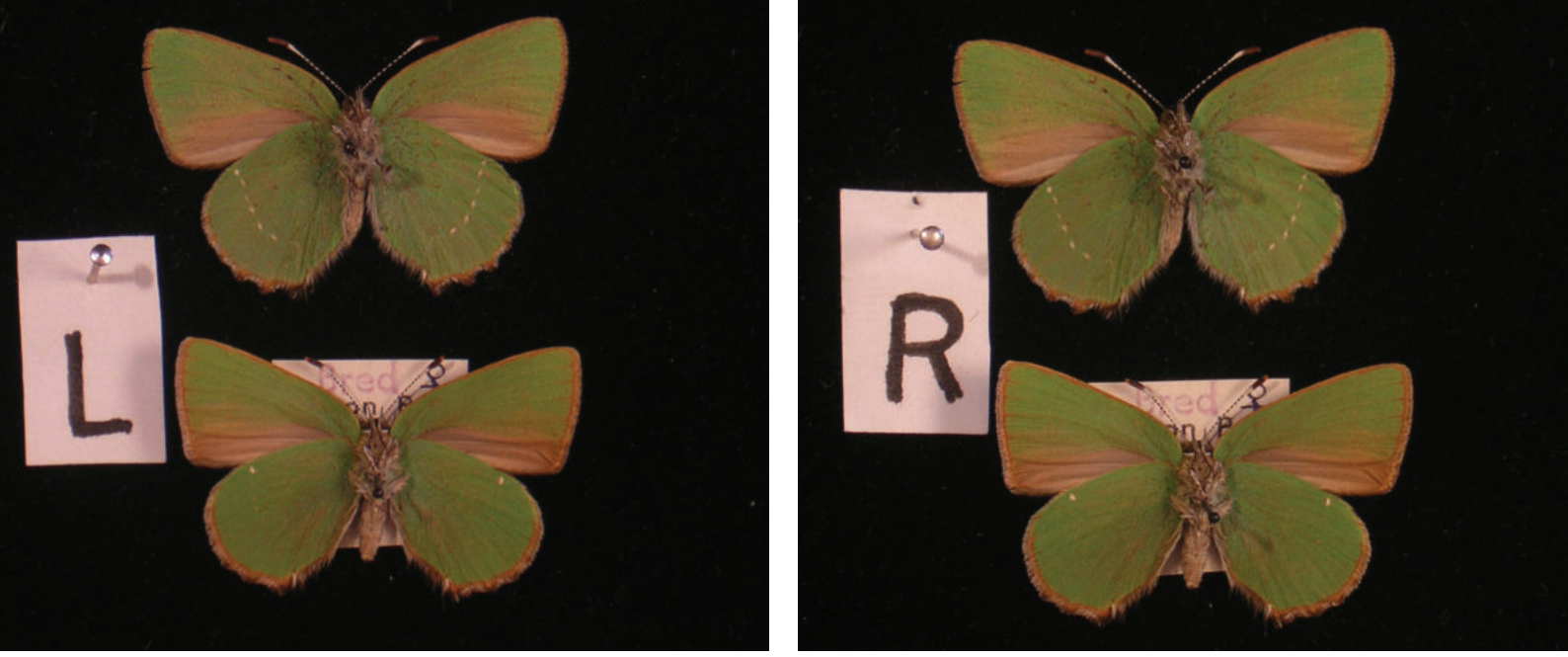

Figure 4. Male (above) and female (below) specimens of Green Hairstreak Butterflies, *Callophrys rubi*, mounted to show their green undersides. Figure L shows the specimens as photographed through a left-handed circularly polarising filter and Figure R is the same but with a right-handed filter in visible light. There is no apparent difference between the two sets of images; compare with the Rose Chafers in Figure 1. The slight brown cast is due to the polaroid filter.

XP38IR film made by ITOS GmbH of Mainz, Germany, which was very kindly sourced and supplied by David Payne of Optical Filters Ltd, Thame, Oxfordshire OX9 3XA, UK. Although ostensibly made for use in the infrared region, this material is also usable throughout the UVA band. An 'ideal' polaroid filter would pass, and polarise, rather less than 50% of incident unpolarised light and it would absorb rather more than 50% (ie. all light of the opposite polarity plus a little more, as is inevitable with any transparent material).

XP38IR passes around 40% from 450 nm to above 800 nm, but it also passes around 30-35% throughout the UVA band of 320-400 nm. Standard linear polarisers are generally opaque in the UVA although certain specimens show a real but much lower transparency: around 7%.

Observing and Photographing

To view the invisible UVA image I used a Panasonic NV-V10B camcorder which happens to be sensitive to UVA radiation and displays the image visibly either through an eyepiece (at low resolution) or on its 4-inch (10 cm) LCD monitor screen. Photographic records were made with a Nikon Coolpix 2200 digital camera that is also sensitive to the UVA. The CCD sensors in electronic cameras are inherently sensitive to UVA but this is usually blocked by an internal filter to avoid 'contamination' of the image by otherwise invisible components. Presumably this filter is omitted in certain models such as these two. Incidentally, this photography in circularly polarised UVA may well be a 'first' – partly because of the unusual techniques required and partly through lack of motivation to use them in a world that generally lacks such waves.

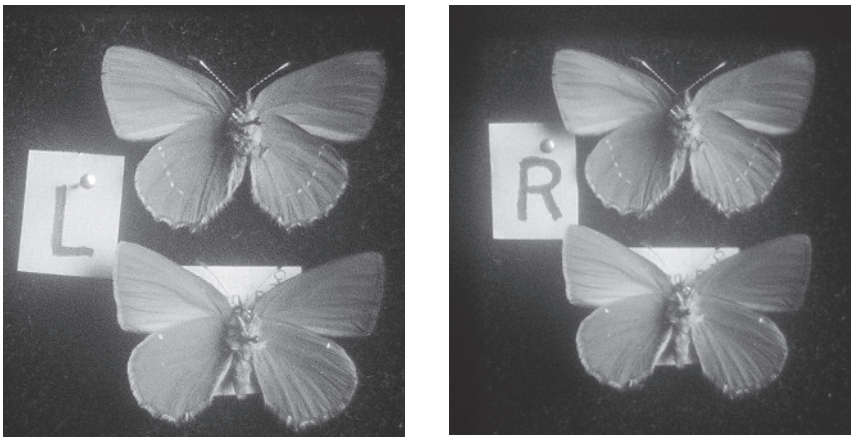

Figure 5. The same as Figure 4 but photographed by near-ultraviolet (UVA) light. Again there appears to be no difference in apparent brightness between these paired images. Actual L and R brightnesses as measured through the circular polariscope with a photometer (see text) were identical, although much higher for visible than for ultraviolet light.

With both cameras and the polariscope, visible light was blocked by a 'black' UVA-pass UG1 filter. This filter is quite transparent across the UVA but effectively blocks visible light apart from a small degree of 'leakage' in the far red (around 700 nm). For critical purposes, this leakage can be blocked by a BG39 filter, which is blue-green (+ UVA) and can be bonded directly onto the UG1. The filter could be placed either in front of the prism (it was shown not to affect polarisation) or between the polariser and the camera (Figure 3).

Various UVA sources were tried for illumination. The butterflies had a rather low albedo (reflectivity) in the UVA so that, for photography, a strong source was needed in order to get clear images. The standard 'blacklight' discharge tubes are extended sources of UVA that cannot be focused onto a small area, while sunlight was too fickle although it worked well when available and suitably positioned. The source eventually used was a Wotan Ultravitalux 'sunlamp', a strong source of UVA sold for therapeutic or cosmetic purposes. It was focused to create a more intense area by a large plastic Fresnel lens.

Direct Measurement

Unfortunately the photographs obtained in this way may show differences in brightness since the simple automatic camera offers no manual control over the exposure (more versatile cameras always seem to screen out UVA). This renders the images unsafe for quantitative comparison so I measured the relative brightness of the left- and right-handed

reflections directly, using a photometer that replaced the camera at the window of the polariscope. This instrument uses a selenium photocell that is insensitive to ultraviolet, so to measure UVA the aperture of the cell was covered by a bonded UG1+BG39 filter backed by a yellow fluorescent screen (an Anopore silica filter membrane impregnated with yellow highlight ink) that converts UVA to visible light.

The Observations

After performance tests on physical subjects, the circular polariscope was set up in the Lepidoptera Department of the Natural History Museum, South Kensington, London. Dr David Lees FRES showed great kindness and patience, producing specimens of all eight species named in the previous literature as well as several related species for good measure. Several specimens and both sexes of each species were examined on both dorsal and ventral aspects. Visual examination through normal circular polarising filters (as used for my previous scarab survey; Pye, 2010) and also with the prismatic polariscope without a UVA filter, showed no detectable difference between the appearance through left-handed and right-handed filters in visible light. Figures 4L and 4R show the images obtained for *Callophrys rubi*. This is the best species to examine because, as stated earlier, the undersides of both fore and hind wings are almost uniformly green (Figure 2) presenting a large area where circular polarisation has been predicted to occur. It is also the species most studied in the literature. The overall reflectances in each case, as measured by the photometer, were identical for this species. Similarly with the UVA-sensitive circular polariscope fitted with a simple UG1 filter, and 'weak' UVA illumination, no detectable differences were seen by eye or with the photometer.

To assess the UVA reflectivity of these surfaces, the butterflies were matched against a series of papers of known UVA reflectivity (a stepped reflectivity gradient) using the cameras for observation. Direct measurements were also made with the photometer. Both methods indicated a general albedo value of about 25% compared with barium sulphate powder (a standard UVA 'white').

Further tests were then done with the Ultravitalux lamp and bonded UG1+BG39 filters. There was a perceived risk of bleaching any pigments in the specimens and also of heat damage with this 'fierce' illumination, so I did not perform these tests on specimens belonging to the Museum. Instead, I acquired captive bred, pinned specimens of *Callophrys rubi* from a commercial dealer and dedicated them to this project. These specimens did, however, survive unscathed and are now retained by me as personal property for reference.

Once again images taken through the L and R settings of the circular polariscope appeared to be indistinguishable (Figures 5L and 5R). The relative brightness of the two UVA reflections was measured with the photometer through the L and R settings of the polariscope and gave identical values within the resolution of the meter (better than 2%). The readings were taken with the butterflies almost filling the field of view of the photometer, against a background of matt black flock paper. These readings were only five times that of the black flock paper alone, again indicating a very low albedo in the UVA.

Discussion and Some Conclusions

This 'disappointing' null result, failing to observe circular polarisation, at least on a macro scale, has four possible implications. (1) It may be that the instrument itself was in some way inadequate or inappropriate for the job, although physical trials were all very reassuring. (2) It may be that circularly polarised reflection occurs at some other part of the spectrum than the visible or UVA regions examined, at least in dried, pinned specimens. (3) It may be that the published prediction of circularly polarised reflection is incorrect and that it does not in fact exist. (4) It may be, as Saranathan et al. (2010) have suggested, that both left-handed and right-handed circularly polarised reflections are combined due to the presence of both left- and right-handed structures; if they exist in an equal, 'racemic' mixture, they would cancel each other out in any gross observation. This last possibility seems to be the most likely but then the function of the molecules becomes a problem in itself. The presence of molecular structures with rather special optical properties would suggest some functional, optical significance, yet a 'racemic' mixture would render the polarisation undetectable.

Mille et al. (2013) claim to have demonstrated 'optical activity', both left-handed and right-handed, *in visible light* within tiny domains on the scales of *Callophrys rubi*. But as their results were obtained under illumination by linearly polarised light, it would seem that they actually showed the presence of optical retardation (which can turn linear into elliptical or circular polarisation) rather than reflection of circular polarisation itself.

The molecular structure may, of course, confer some other, perhaps mechanical, advantage. It will be interesting to see whether further research on the molecular architecture can help to resolve the matter. Meanwhile it seems that the scarabs, or some of them at least, remain unique in showing this strange physical phenomenon.

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Discovering the Microcosm 3D SEM's of insects

Alan Shaw

alanshaw7@virginmedia.com

As a system engineer working with electron microscopes I first came across examples of "3D electron microscope images" about five or six years ago. I had not seen anything like this before and thought they were quite stunning. The magnification of the samples was about the same as when using a light microscope (approx. 60 to 300 times mag), but the depth of view and detail revealed using electrons as opposed to photons was incredible. In these images details can be seen which have not been revealed previously by normal light photography. The increased depth of view means that at high magnification most of the image is in focus whereas at these magnifications using optical equipment the majority of the image appears to be out of focus.

These "blew me away" and I then realised that I wanted to take my own images and see where I could take this form of "photography". Strictly speaking they should not be called photographs as they are produced using a different part of the electromagnetic spectrum. Such images are more correctly referred to as micrographs.

I started to explore how to create these images, but unfortunately the crucial bit of kit I needed, an SEM, was not easily accessible and was expensive to get hold of and use. Then, about four years ago, I was given access to two of these systems to use in my spare time. This is when I started experimenting and, over the next few years, with lots of practice, I believe I have obtained some interesting images. To produce these I take two slightly different images of the same subject and then combine the two to create the 3D image using standard photo editing software.

It has taken a lot of time, experimentation and many failed attempts to obtain decent images. There are many variables which affect both the subject and the environment the subject is imaged in.

The physics involved in electron microscope imaging means that the subject has to be imaged in a high vacuum, and a beam of electrons is fired at the subject with accelerating voltages of up to 30,000 Volts and with a variable current. This can cause charging on the sample which means the image is unstable and can ground out, akin to having a lightning strike hit your sample, thereby destroying it.

In any case these issues can be overcome by varying vacuum pressure, coating the sample with a conductive layer and changing the current and accelerating voltages of the E beam.

Having said all that, when I produce a "cracking" image the effort required to produce it all becomes worthwhile. It is almost unbelievable to see these extraordinary little animals in such minute detail.

I can't speak for other people, but my experience on viewing a successful image is one of amazement and wonder at the range of "alien" life forms that exist in this miniature world. I have images of little beasts which would put Hollywood monsters to shame and a lot of these are taken of species from my back garden and windowsill!

I know that this 3D format is not unique, and there are also many very good 2D SEM images of insects available, but I believe by taking extremely high resolution images and then using the 3D format a whole new viewing perspective can be obtained to allow better appreciation of the wonders of this miniature world.

Aside from their aesthetic appeal, because the images are taken at such a high resolution I also believe they could be used as major educational aids. The images can be magnified to almost cinematic proportions without losing the 3D effect. Talking to long-suffering friends, family and other "trial" audiences, the general consensus is that the bigger the image on display, the better the viewing experience.

The first image I produced in 3D was a centipede and more by luck than good technique I believe it is still one of my best images. When I looked at it in 3D the alien "monster" coming out of the screen absolutely fascinated and amazed me. This "monster" was not created from the big budgets and special effects of Hollywood studios, but was REAL; and I was looking at it in 3D. This monster was not from outer space, but is a part of our everyday world which we (non-entomologists) tend to ignore.

From that first image I knew I was hooked, this would be my hobby for the rest of my life. If this is my first attempt at 3D micrographs and I am "blown away" what else would I find to amaze me. Every SEM session I undertake still fascinates, often frustrates, but always amazes and delights me.

Since then I have taken many different images of a range of insects and I am consistently astonished by their bizarre and unfamiliar forms. The incredible "engineering" associated with these little creatures, revealed at high resolution and in 3D is genuinely staggering. Weevils, for example, look to have ball joints instead of knees – at least to an engineer such as myself!

I have images of moths and bean weevils that can only be described as beautiful, and yet those of ticks and an unidentified beetle (I call it "spikey-mouth") are the stuff of nightmares, but fascinating nonetheless.

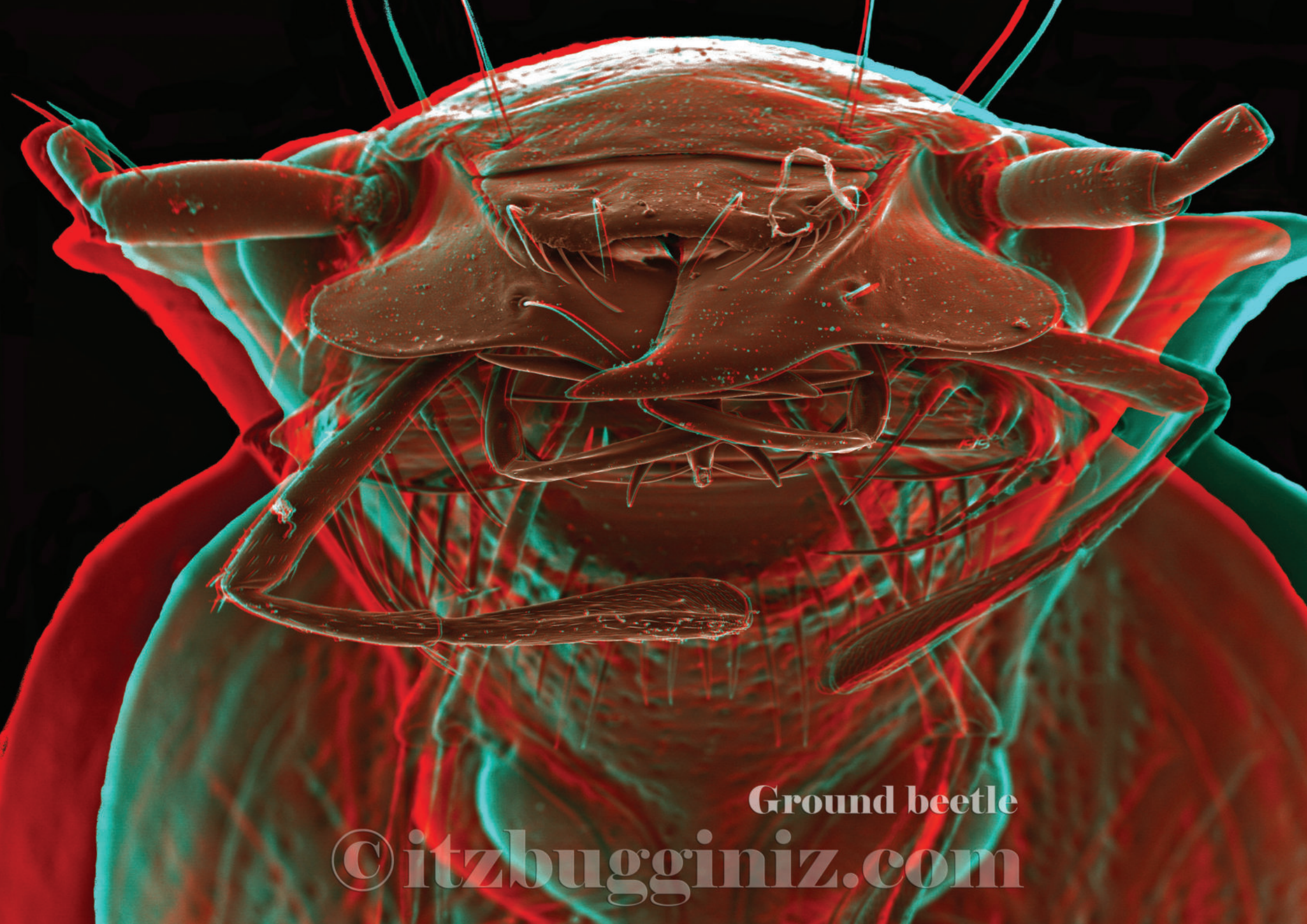
Over the last few years I have compiled a large portfolio of 3D images, specifically insects and other invertebrates. It is a very time-consuming and frustrating procedure (involving a lot of failures before a great image can be captured) but I have some spectacular images. I like to think of this collection as scientific art (if there is such a category), which I believe has significant aesthetic, scientific and educational potential just waiting to be explored.

Currently I have approximately 250-300 high quality images which include, but are not limited to, the invertebrate groups:- ants, bees, carpet beetles, spiders, crickets, earwigs, flies, larder beetles, weevils, millipedes, centipedes, woodlice, head lice, ticks, moths, bedbugs, fleas, mosquitoes, wasps and silverfish .

For some groups I may only have one or two images, while for others, which I think are more "photogenic", I have taken up to 10-12 images.

Friends and family who have seen the images have convinced me to try and open them up to a wider audience, hence this article. Since sending out a few images to obtain feedback I have been encouraged and amazed at the positive response and am now putting together material for exhibitions. I have also recently launched a website "itzbugginiz.com" to showcase some of my best images and will be updating with new content every few weeks.

I would like to think that once these images are published they will encourage general amazement and engagement with the entomological world that surrounds us, and which many of us don't really appreciate and take for granted. Hopefully, through this work people will be more aware of these incredible life forms, and maybe this will make them think twice before "squishing" that bug.


Ground beetle
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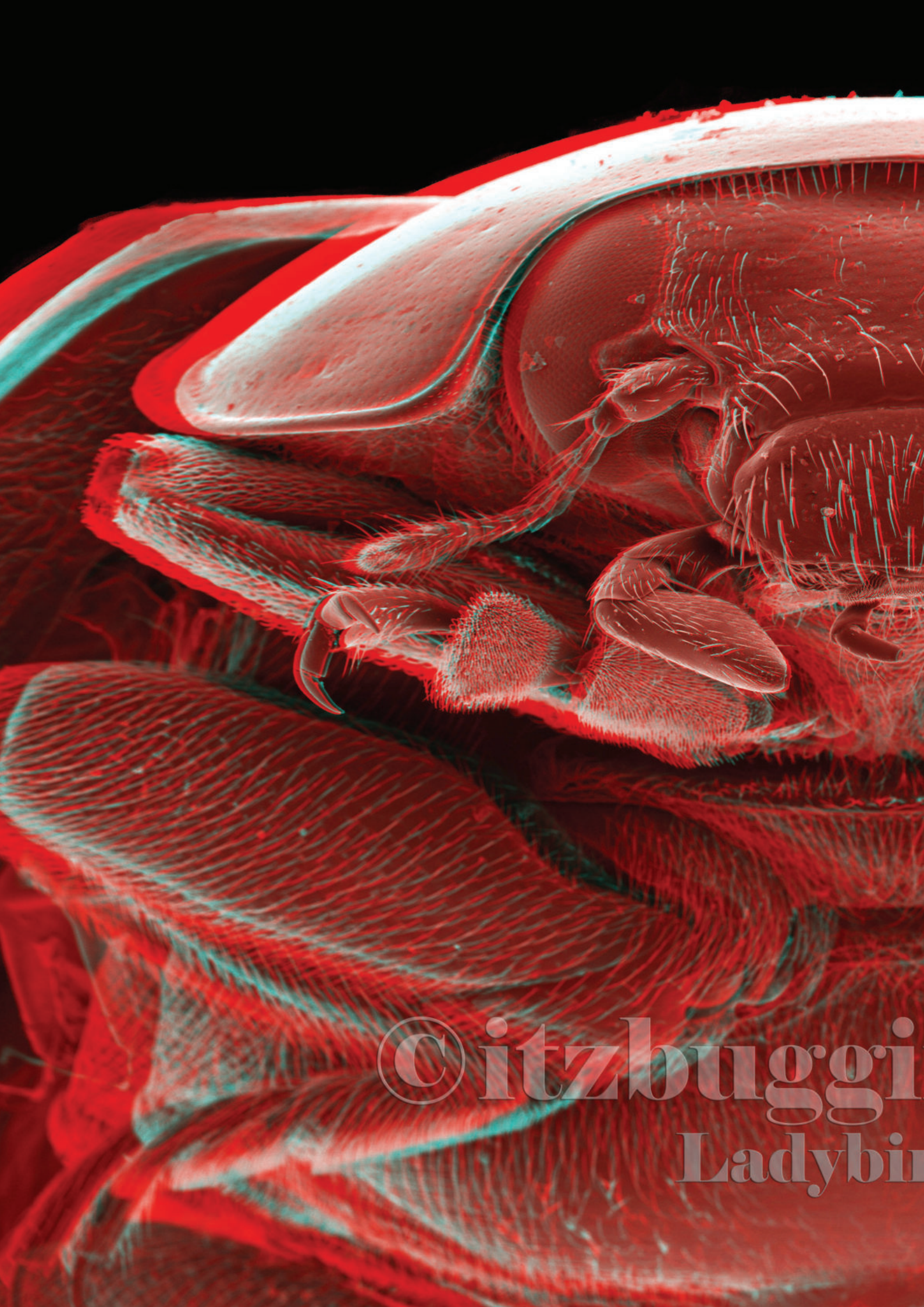
March Fly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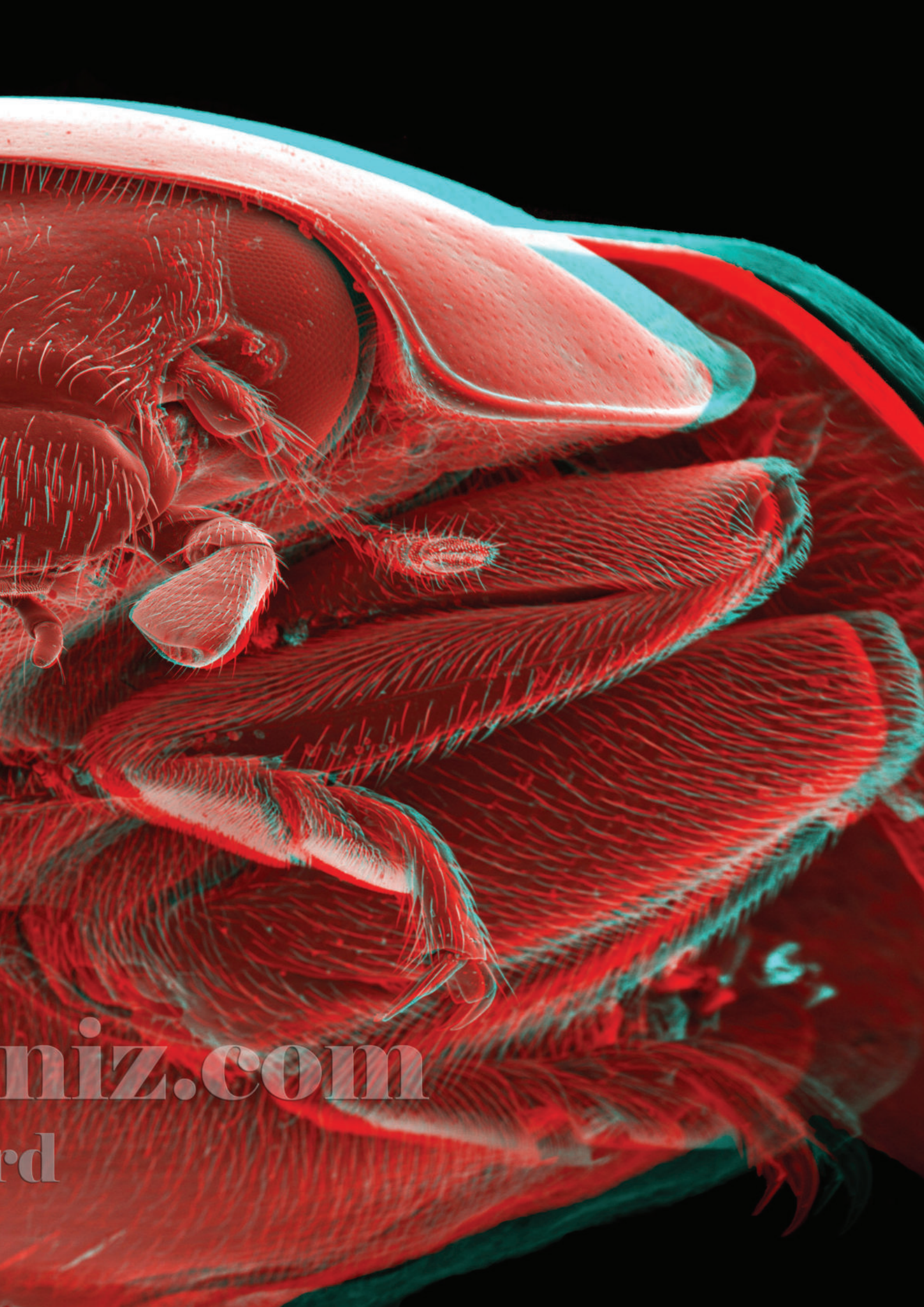


Fruitfly
©itzbugginiz.com
Red Ant
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Figure 1a. Red Admirals sunning themselves before flying down to feast on the fruit below (Fig 1c). Photo : HDL

Figure 1b. Comma butterfly, *Polygonia c-album*. Photo: © The Wildlife Trust

Musings on the birds and bees . . . and flies and butterflies too

Hugh D. Loxdale

RES Hon. Treasurer

A few months ago, on a sunny September day round about lunchtime, I was sitting on the veranda of a wooden summer house at Utting, by the lake of Ammersee in Bavaria, Germany, watching the comings and goings of insects feeding on the ripe and fermenting plums that had fallen from a large plum tree in the garden (Fig. 1c). There were quite a few Red Admiral butterflies, *Vanessa atalanta* (L.) (Fig. 1a), present along with Peacocks, *Inachis io* (L.), and even the occasional and somewhat more restive Comma butterfly, *Polygonia c-album* (L.) (Figs. 1b, d). In addition to these gorgeous butterflies, all Nymphalids, were a host of large and small flies and wasps, and one or two hornets, *Vespa crabro* L (Hymenoptera: Apocrita) feasting on the fallen fare. The butterflies were slowly getting 'drunk' and tended to stay longer and longer on the fruit. Even so, they would, every now and then, open their wings to display their finery, but usually soon shut them again. This happened especially when a cloud passed overhead and briefly obscured the sun, the butterflies effectively disappearing against the background of grass and dark fruit due to their highly cryptic underside camouflage, almost black in the case of the Peacocks and like a dead leaf in the case of the Comma (Fig. 1d).

The next morning, I happened to be sitting on the same veranda eating my breakfast. The sun was out and shining brightly, but its rays still had little warmth. Mists were gently rising from the damp and dewy ground, but the butterflies were already returning to their favourite spot; two bowls filled with fermenting plums which my wife Nicola had put out for them. There were also by then some flies, wasps and even a few hornets in attendance. However, it was clear that because of the lack of ambient warmth, relative to my previous midday observations, the insects were generally very much less active and some of the Diptera and Hymenoptera were hardly moving at all. Perhaps they had indeed got 'drunk' and had slept out overnight in the bowls (rather like the midnight

Figure 1c. Plum tree at Utting, Bavaria with butterflies, mainly Red Admirals and Peacocks and the occasional Comma butterfly, plus flies, wasps and hornets (not visible) feasting on the fallen rotting fruit below. Photo : HDL

Figure 1d. Comma underside showing incredible cryptic camouflage mimicking a dead leaf with a hole in it.
Photo: ©Urban Butterfly Garden 2010-2014

revellers in the parks of some UK cities!), or it was just too cool for them to move very much? I cannot say for sure. Meanwhile early morning birds visiting the plum tree, also for breakfast, including Great Tits, *Parus major* L.), Blue Tits, *Parus caeruleus* (L.), and especially European Nutchatches, *Sitta europaea* L., were every now and again dropping down from the trunk and overhanging low branches and taking a juicy fly as it crawled laboriously over the surface of the fruit, very much a free meal for the birds. Yet they mostly avoided taking the aposomatically coloured wasps and hornets, or the butterflies themselves, most of which were sitting still, just probing the damaged fruit with their long proboscises and with their wings firmly closed above them.

It then occurred to me that because of the general poikilothermy of insects, low temperature may be a driver for the selection and evolution of cryptic camouflage in such arthropods, more especially as protection against the foraging of endothermic birds and mammals. Birds and mammals can generally forage for food at far lower temperatures than many insects. Whilst bumblebees, moths and some flies, such as spring flying Bee-flies (*Bombylius major* L.), can generate the heat necessary for take-off and active flight even at low ambient temperatures (say < 10°C) by first vibrating their flight muscles and/or beating their wings prior to departure, many insects are seemingly numbed by the cold until the sun directly and physically warms them. Some diurnal insects, such as migrating Red Admiral butterflies (as found in Rothamsted Insect Survey light trap samples; HDL pers. obs.) and aphids (Berry & Taylor, 1968; Ward, 1964), can of course fly at night on warm nights, whilst many other insects have diurnal and nocturnal flight periodicity as shown by the studies of Lewis & Taylor (1964) investigating a range of small flying insects in the UK. Usually, however, most essentially diurnal insects tend to remain generally inactive during night-time, cold or inclement weather, or even on sunny days when the sun is obscured behind clouds, as one can observe with, for example, Meadow Browns, *Maniola jurtina* L. and Ringlets, *Aphantopus hyperantus* (L.) (Family Satyridae) when flying in European grassy meadows during June and July. Perhaps the dark underside of butterflies such as Peacocks, Commas, and Small Tortoiseshells, *Aglais urticae* (L.) (Family Nymphalidae) is an aid to warm them up (effectively acting as solar panels) in the early morning when the rays of the sun are lacking the necessary amount of energy for immediate activity on the part of these insects. It is certainly known that many species of insects, including Lepidoptera, tend to be darker at increasingly higher latitudes approaching the Arctic Circle, perhaps as a direct result of the necessity of insects to absorb solar radiation as early and as efficiently as possible (Ford, 1957; Downes, 1964; Danks, 2004).

Assuming that temperature is indeed a driver for the evolution of cryptic camouflage in butterflies and other insects, it is also likely to act in the tropics as here in temperate zones; the tropics tending to have cool nights, and in hot sandy deserts, cold nights, sometimes below freezing. I could not find any reference to this idea in either Hugh Cott's famous book on animal camouflage *Adaptive Coloration in Animals* (1940) nor in the much more recent book by Gilbert Waldbauer delightfully entitled *How Not To Be Eaten: The Insects Fight Back* (2012), which also discusses insect camouflage.

Figure 2a. Electric junction box on side of wooden house showing entrance hole for bumblebee nest (where wire goes through).
Figure 2b. (top left). Close up of Fig. 2a showing large-size *Bombus lapidarius* worker about to enter nest hole.
Figure 2c. (bottom right). Chilled large size *B. lapidarius* worker showing pollen baskets on hind legs. Photos: Nicola Loxdale

which also discusses insect camouflage. Nevertheless, it seems such an obvious idea that I cannot believe it has not been thought about and developed by other natural historians, including swarms of entomologists.

Whilst on the subject of butterflies, I also noticed another thing relevant to their survival in the wild. For just over two years (2011-13) my wife and I lived in Augsburg, some 50 km north-west of Munich. Nearly every day we would walk south along the foot path that runs besides the River Wertach, one of the two rivers that more or less skirt the city, the other being the River Lech which it joins just north of Augsburg. We usually got to a 'waterfall' near the bridge by the village of Göggingen (actually water issuing from a sluice gate in the weir built to prevent flooding of the adjacent land by the river, especially during the winter months) some two kilometres downstream before heading back home. During the first Spring of our stay, i.e. 2012, I noticed many male and some female Orange Tip butterflies, *Anthocharis cardamines* (L.) as well as Wood White butterflies, *Leptidea sinapis* (L.) (both Family Pieridae) flying along by the footpath, especially near the woods situated towards the conclusion of our outward journey, as well as other familiar butterflies such as Speckled Woods, *Pararge aegeria* (L.) (Family Satyridae). However, the March of the year following, 2013, was one of the six coldest ever recorded in Germany since records began in 1881 and the second coldest March in 50 years, behind only 1987 (website 1). Subsequently that spring, I only saw four Orange Tips in total, three males and one female, and one Wood White male during the entire flight period lasting into June. I then realised that were two such severe winters to follow one another consecutively, it would probably spell the end for these butterflies over large regions of the country, and assuming they survived in warmer regions moderately geographically close by (say within 100 km), then any re-colonisation would have to occur from such areas and may take decades or centuries to complete, assuming that the butterflies would be likely to expand their range over time, which if the example of the Speckled Wood in the UK is anything to go by (Hughes *et al.*, 2003), possibly they could. But then I had a further thought. In the ongoing and tiresome debate concerning so-called 'Intelligent Design' (Jones, 2008; website 2), it is clear that whether these butterflies were created by the hand of The Almighty or by the mechanism of natural selection, à la Messrs. Darwin and Wallace, ultimately selection is *always* likely to impose itself on any and all natural populations of living organisms. If that be so, as most biologists, including myself, accept, then these far-sighted gentlemen, of course, win the day! (see also Bell, 2008 and Schluter, 2000)

As for the bees in the title, whilst we were staying in the wooden house by the Ammersee this summer (2014), we noticed that a colony of red-tailed bumblebees, *Bombus lapidarius* (L.) (Family Apidae) (website 3, 4, 5), had taken up residence in a hole cut in the side of the house to exit electricity cables to a junction box (Figs. 2a, b). We noticed that the colony seemed to be quite large, probably 50-100 individuals, and was very active, flying in all weathers, even on cool, wet days. The bees would start flying soon after day break (certainly by around 6.20am when I observed the first workers leave), and would continue on until dusk, at around 9.30pm. Nicola and I recorded the activities of individuals exiting and returning to the hive and clearly saw that at the start of the day, more left than returned (none of course returned initially, only left the hive), but by dusk, the proportion was reversed until finally all were safely home inside their concealed nest. We also noticed that there seemed to be two sizes of workers, small and large. At first I thought the larger of these forms might be a cuckoo bee species, such as *Bombus rupestris* (F.) (website 6), but on catching a specimen it did apparently have pollen baskets (Fig. 2c; website 4), so this was not the explanation. We often saw the small workers returning with pollen attached to their hind legs, and eventually saw bigger workers arriving home with some pollen, but not as much as the smaller workers. Perhaps the bigger ones specialised more on nectar collection than the smaller workers. Subsequently, I found two articles (Couvillon & Dornhaus, 2010; Couvillon *et al.*, 2010) relating to bumble bee worker size polymorphism in the common eastern bumblebee, *Bombus impatiens* Cresson, a North American species abundant across many of the eastern States of the USA (website 7). In these papers it was revealed that the body mass of workers can vary up to ten fold, and that there appears to be a division of labour related to body size. It was also found that "The average size of bumble bee workers did not change with colony age, but variation in body size tended to decrease over time." (Couvillon *et al.*, 2010). This size difference may have adaptive value; the smaller bees potentially lasting longer in times of food (nectar) shortage (Couvillon & Dornhaus, 2010).

A further point of interest was how fast and high the bees flew on leaving and returning to the nest. They often flew steeply up and over the aforementioned plum tree, some 10 metres high, probably not flying higher in order to maintain visual contact with the ground and their goal in terms of flowers to visit. I would watch them shoot away and soon become invisible; ditto, I would suddenly see them returning as they dropped over the tree to orientate and land back at base. We noticed that any re-arrangement of objects near their entrance hole, including our chairs nearby, would seemingly disorientate them, and they would fly around as if lost until finally homing in on the hole in the wall. Perhaps because a spider had once spun a web near the hole, certain larger workers were very cautious about entering and would first land below the hole on the wooden planking and then crawl the last few centimetres or so until they reached the nest entrance. We also noticed collisions as bees landed simultaneously directly at the hole, or a bee entered just as one left! So besides the fact that their activity reminded me of the comings and goings of planes at Luton Airport near where we used to live in Hertfordshire, in contrast, they compared rather poorly in terms of the timings of take offs and landings! Watching these bees busily go about their business in such a determined manner brought home to me the fact that this is very much a communist system of enterprise; the workers, besides getting food and shelter, toiled apparently unceasingly from dawn to dusk purely for the good (survival) of the colony, all dying in the autumn, including the males and the old queen, with only the newly-reared queens surviving the winter to found new colonies the following spring. This is the second time in a few years that bumblebees (*B. lapidarius*) have used this particular nest site. Thus by chance, two queens have in different years found the same entrance hole and decided to set up home there (cf.

Figure 3a (above). Hoverfly wasp mimic *Temnostoma vespiforme* photographed through an upturned glass at Utting.
Figure 3b (right). Same specimen as Fig. 3a, but showing how the dark front legs are raised when danger threatens to appear as wasp antennae and thereby increase the fearsome pretence to a would-be attacker.

Goulson, 2003, for more information about the biology of bumblebees).

I would also like to mention in passing, again in relation to insects and their avian predators, foraging by birds from car registration plates, a behaviour I only observed recently upon stopping at a service station in Luxembourg with Nicola *en route* home from Bavaria. As I sat there watching the world go by, drinking a cup of black tea that Nicola had just handed me, I suddenly observed a couple of House Sparrows, *Passer domesticus* (L.), hopping around on the pavement near the front bumpers of parked cars in the car park. Every now and again, and much to my amazement, they would briefly fly up (more of a flutter actually) to grab a semi-squashed fly or other small insect in their beak from the surface of the vehicle's registration plate. Clever clogs I thought! And since more than one bird had learnt this trick, at least at this place, then it is likely to be adaptive in a broad sense, from being copied by other birds, particularly closely related ones, e.g. offspring or ex-nest mates. It certainly saves them from having to actively pursue their living quarry, and thereby they are likely to save energy, whilst also finding a readily available (and in the spring and summer months, plentiful) supply of insects to feed themselves and their young. Hence this may be an example of behaviour being important in evolution. Indeed, behaviour may be a driver in evolution, and one of the major ones, as recently argued by Dick Vane Wright (2014), butterfly guru and Honorary Fellow of this Society.

As for temperature being a driver of cryptic camouflage, if this is so then selection is certainly the mechanism at play, driven by predation. On this score we also noted, at Utting this summer, a hoverfly, *Temnostoma vespiforme* (L.) (Diptera: Syrphidae), so perfect in its mimicry to fool both of us until we captured it under a drinking glass and had a good butchers at it, close up and personal (Fig. 3a,b; *cf.* also Van Veen, 2004). To our astonishment, not only was it a true fly, with only one pair of wings, it also looked, walked and generally behaved like a wasp, with apparent confidence in its disguise, a disguise perfected even down to the front legs having evolved to look like the antennae of wasps (cf. Waldbauer, 1970)! An amazing deception and one honed no doubt by countless rounds of selection, perhaps over countless aeons. Its evolution may have been very much faster of course, since whatever evolution is, it is an essentially an ecological process happening in real time and space, i.e. every second and minute of the day, and governed by chemical processes, especially including DNA copying and repair (during which mutations occur), the speed of which is unimaginable to the human mind (Loxdale, 2010a,b). Perhaps then such mimicry only took hundreds of years of selection, not millions. Either way, natural selection is an amazingly powerful and imaginative creator, so that it is no wonder that some folks, many in the USA especially (Miller *et al.*, 2006; Yoon, 2009), believe absolutely that what we see in such cases is an act of 'Special Creation' (Loxdale & Lushai, 2003), made by an all-powerful, all seeing divine hand. Truly, the selective-evolutionary process is mind boggling. And why such a degree of perfection, to such a level? This suggests that the forces of selection involved are incredibly intense, and that the vision of birds, and other major diurnal predators of insects, is incredibly adept at discriminating prey.

And so, from simple acorns (here mental ones) large oak trees may grow.... metaphorically speaking. At least I hope they might, assuming my deductions as expounded have some scientific validity. For sure, one of the observations as described here has been recently documented, i.e. the size polymorphism of worker bees. Perhaps no one can say for certain whether or not God created butterflies along with the rest of Creation, but it may be possible to predict whether Orange Tips and Wood Whites are liable to expand their range in Europe and over what time scale this is likely to happen, more especially in the face of predicted, generally warming climate change over the 21st century (*cf.* Hill *et al.*, 2002 for their estimates for 51 butterfly species in the UK, including these particular Pierids). Since Wood Whites have been recently found to show a clear west-east cline in terms of chromosome karyotype in mainland Europe (Lukhtanov *et al.*, 2011), possibly related to locally evolved adaptive traits, it seems that populations of this slow flying butterfly show considerable degrees of habitat fidelity and are thus unlikely to move that much between regions, at least under their own steam!

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Can we keep it? Managing the impact of the Nagoya Protocol on insect collections and research

Chris Lyal

Department of Life Sciences,
the Natural History Museum,
Cromwell Road, London SW7 5BD
c.lyal@nhm.ac.uk

Biodiversity loss: the problem and the policy

In 1993 the World changed. The animals, plants, microorganisms and fungi that had been the common heritage of humanity fell under the sovereign rights of the states in which they occur. For biologists this meant that we could no longer go to any country we chose, collect what we wanted and bring it back for research and deposition in our collections. Instead, an increasing and sometimes impenetrable forest of regulations and requirements for permits has grown up. In many cases it is difficult to know what permits are required, and often our local colleagues encourage us to believe that national requirements do not apply. By the time you read this article, the World will have changed again.

1993 was not a sudden biological *coup d'etat*, but part of a complex political negotiation that led to the Convention on Biological Diversity (CBD)[1] – a policy response to the biodiversity crisis that is still ongoing. The CBD, now ratified by 194 Parties, recognises the sovereign rights of countries as a means to provide incentives for them to address the three overarching objectives of the Convention: Conservation of Biological Diversity, Sustainable Use of its Components, and Fair and Equitable Sharing of the Benefits arising out of the Utilization of Genetic Resources. The third of those objectives, otherwise known as Access and Benefit-sharing (ABS) is what concerns us now.

ABS: the rise of the permits

While collecting permits were not a new thing in 1993, since then there has been an increasing development of Access Legislation in countries as they implement the CBD. Such legislation is intended to regulate *Access* to *Genetic Resources* so that countries can ensure that *benefits* arising from their *utilization* are shared equitably. Since we are dealing with legal matters, it is as well to know what those italicised terms mean. *Access* in this context is *in-situ* collecting (although may also be from *ex-situ* collections), and *genetic resources* are "genetic material of actual or potential value" (which basically means any genes, which of course in practice means any organism or other biological sample that may be collected). I will come back to what the other italicised terms mean. The question "Insects are being killed all the time so why should I need a permit to collect them?" misses the point; permits are not about allowing scientists to kill specimens, they are to help the provider country manage the risk of biopiracy – analysis of genetics without the consent of the country that delivers a valuable product without the country benefitting. Biopiracy is not always intentional – academic study of an Ecuadorian frog in 1999 identified a chemical with potential medicinal properties; a company saw the research and developed a valuable painkiller based on that chemical, but Ecuador (and the indigenous people who already used the frog) did not benefit.

The permit is effectively a bilateral contract, usually between the country and the researcher or the researcher's institution. It is issued once the researcher has Prior Informed Consent ('PIC' – agreement on what the researcher is going to collect and what she will then do with the material) and Mutually Agreed Terms ('MAT') are reached – the conditions on which this will take place. These conditions usually include the *benefits*. Benefits are not always monetary, but frequently include things like return of specimens

[1] http://www.cbd.int/

or research results, joint publication, training etc. An indicative list of monetary and non-monetary benefits is listed in the Annex to the Nagoya Protocol[2], of which more shortly. One issue that worries countries is change of use – how can they be sure that specimens accessed for non-commercial biodiversity research do not get transferred to business and, as in the case of the Ecuadorian frog, money being made by an entity with which they have no contract? This concern may have led in some cases to an apparently over-emphasised bureaucracy and a restriction on transferring specimens to third parties.

The Nagoya Protocol on ABS

In 2010 the Parties to the CBD agreed the *Nagoya Protocol on Access and Benefit-Sharing*[3], which sets a stronger global legal framework around ABS, including requiring all countries to ensure compliance. While permits may be contracts, until now they have not been easily enforceable outside the providing country. However, under the Nagoya Protocol UK authorities are required to take appropriate action to ensure genetic resources being utilized have been accessed with PIC and MAT, and to enable a provider country to take legal action in cases of non-compliance with permit conditions by a researcher in the UK. The EU has ratified the Protocol, although this does not mean that all Member States automatically ratify it at the same time. However, the UK is expected to ratify within a few months, along with most if not all other EU Member States; so far 52 countries have ratified globally. To implement the Protocol the EU Parliament has brought in a Regulation[4], which came into force 13th October 2014 across the EU, whether individual Member States have ratified or not. This will be followed by an Implementing Act from the European Commission covering Articles 4, 7 and 9 of the Regulation (which do not come into force until October 2015) and national legislation by the Member States. All of this will inevitably mean changes for research, and there are serious implications for biological collections and research, influencing not only what we collect but also what we can do with it when we bring it into the EU and thus how we manage research, collections and staff actions.

There are several limitations, although to an extent their significance is equivocal. The Protocol (and consequently the EU Regulation) applies only to material accessed from a Party to the Nagoya Protocol[5]. However, more countries are expected to Ratify over the next few years, so to be confident of the legal position users will have to continually watch the ratifications. In any case, it may be more cost-effective to put in management systems for ABS compliance with all countries, irrespective of whether they have ratified or not, since many countries that have not ratified still have Access legislation and may require permits. Even if under the Regulation compliance cannot be monitored in the EU for non-Nagoya Protocol Parties, this does not remove an institutional requirement to operate in compliance with national legislation in another country. The Regulation applies only to specimens collected after October 2014, when the Protocol comes into force, not new utilization of those that were collected earlier. That means, of course, that from October this year all specimens accessed from a Nagoya Protocol Party will need to be appropriately documented (and the documentation must accompany them), and at some stage reports on their utilization may be necessary (see below). Not all countries accept this restriction; many countries in the African Union, for example, take the view that the Protocol should apply to new utilization of any genetic resources whenever they were originally accessed. How this view is implemented remains to be seen, although there are unofficial suggestions that what is perceived as inappropriate utilization will be met by sanctions on future access. In any case, if benefits are to be obtained from such utilization, there is an ethical case for sharing these with the providing country, even if there is no legal compulsion.

The EU Regulation has provisions for checking whether researchers are in compliance with permits at two points in the workflow: a declaration of due diligence on receipt of research funding and a more complex declaration at "final development of a product developed via the utilisation of genetic resources or traditional knowledge associated with such resources". Declarations will need to be made to the national 'Checkpoint' from October 2015. Precisely what this will entail and how the triggers for notification will be determined is currently unclear, and to be covered by the Implementing Act. Receipt of research funding, for example, is often before access or utilization, and consequently outside the scope of the Protocol, so while a 'declaration of due diligence' as required in the Regulation may be possible, anything more detailed is unlikely to be possible. This brings us back to '*utilization*'; the definition in the Protocol (as in the EU Regulation) is unclear in detail - "conduct research and development on the genetic and/or biochemical composition of genetic resources, including through the application of biotechnology as defined in Article 2 of the Convention". 'Research and development' is usually a term associated with commercial activities, but at present it cannot be taken for granted that non-commercial research is somehow exempt. Similarly, "final development of a product" is unclear. The UK consultation by Defra that took place early in 2014 suggested that this related only to commercial applications, but there are unofficial indications from the European Commission that they may consider non-commercial products as falling under this heading. It will be helpful to know quite how the Article relates to, say, sequencing the DNA of insects as a part of phylogenetic analysis, or to understand some aspect of their biology. Under Article 8a of the Protocol Parties are required to "create conditions to promote and encourage research which contributes to the conservation and sustainable use of biological diversity", and it is to be hoped that the implementation of the Regulation follows this line.

[2] http://www.cbd.int/abs/text/articles/default.shtml?sec=abs-37

[3] http://www.cbd.int/abs/

[4] Regulation (EU) No 511/2014 Of The European Parliament And Of The Council of 16 April 2014 on compliance measures for users from the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization in the Union. Text at: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32014R0511

[5] http://www.cbd.int/abs/nagoya-protocol/signatories/default.shtml

The reporting requirement brings a focus on how we manage access and use of biological / genetic material in our research, and how we manage the documentation (e.g. permits) and data that go with the specimens. Do we have legal certainty that we can hold the specimens and sequence their DNA? How do we discover what the legislation and permit requirements are in a country where we wish to work? While we have permission to sequence an insect, for example, does this extend to its gut contents? If we transfer specimens to another institution, can we check that the permit allows us to, and do we have the relevant documentation to pass to the recipient as required by the Regulation? How can we be sure that we have done all we agreed to under the original permits? How do we know what we are holding, and where it came from? If we are approached by a commercial entity for specimens what obligations do we have to renegotiate PIC/MAT for change of use? There turn out to be considerable challenges in effective management, not just for individuals but also for managers and supervisors. To meet these challenges at institutional level an organisation will need to examine its policies (as they apply to its staff, authorised visitors, associates and students) and procedures to ensure that in every case where there might be an ABS implication a procedure is available, and that the procedures are sufficient to manage compliance and reporting.

The way forward

One problem encountered by researchers is discovering where to obtain permits in a country they plan to visit, or indeed what permits to acquire. The CBD is developing the 'ABS Clearing-House' to provide this information. In addition, countries may publish the existence of permits issued on the ABSCH as 'Internationally-Recognised Certificates of Compliance' that can give legal certainty to the provenance of biological material.

The EU Regulation offers two avenues for improving compliance.

One is the development of sectorial best practices; under Article 8 of the Regulation interested parties may submit an application to the EC for "a combination of procedures, tools or mechanisms, developed and overseen by them" to be recognised as a best practice. Since the activities of checkpoints are to be conducted on a risk basis and recognition of a best practice is seen as reducing risk, this may reduce reporting burden. Perhaps more importantly, the process of devising and implementing a best practice can help identify means of managing institutional and individual workflows effectively, and reducing risk of non-compliance. Some providing countries are signalling that the adoption of such Codes of Conduct will be beneficial for granting permits. Networks such as the Consortium of European Taxonomic Facilities (CETAF) are in the process of developing Codes of Conduct and Best Practice and common policies and procedures to go with them. In addition, CETAF and others are developing tools to assist management. These include a standard Material Transfer Agreement under which samples can be transferred either permanently or on loan while maintaining legal certainty and clarity on use for both parties, a Material Access Agreement for specimens entering an institution for the first time, and a 'use of material' statement, covering what is going to happen to biological material being accessed, as a means of facilitating obtaining PIC.

Another EU proposal is the 'Register of Collections'; under Article 5; collection holders adopt particular principles and processes, and users acquiring genetic resources from such collections are considered under the Regulation to have exercised due diligence in obtaining legal certainty of provenance, thereby being relieved of some of the administrative burden. This model has had some success in Australia. Clearly material accessed for non-commercial research cannot be transferred to a third party that has the intent of commercialisation without someone seeking renewed PIC and MAT from the providing country to accommodate this change of purpose. However, this managed workflow might be considered as a benefit by providing countries. In a non-commercial research context, researchers in institutions that do not hold collections may find being able to source research material from registered collections useful in reducing reporting burden.

How these proposals are turned into smoothly-operating workflows is a matter of some urgency. The relevant EU Regulation Articles do not come into force for another year, but given the widespread lack of knowledge about ABS itself, let alone the Nagoya Protocol, that is not a great deal of time. There will inevitably be an increased administrative cost and a need for training, and we face the challenge of how to minimise these costs while developing effective workflows. It is to be hoped that there will be benefits, in making our fieldwork and joint research with other countries easier, and less fraught with legal and bureaucratic uncertainties. Overall, we need to ensure the continued development of our science, and its ability to deliver insights into biodiversity, and tools for its conservation and sustainable use – the other two objectives of the CBD.

Continuing the tour of insect collections in the UK – National Museum Cardiff (Amgueddfa Genedlaethol Caerdydd)

Richard Kelly

richard.kelly.nh@gmail.com

@Worldwide_Richi

In the first article of this series we visited the Cole Museum of Zoology, a small but nationally important collection from the early 20th century located on the Whiteknights campus of the University of Reading. The Cole is a great example of the important role small museums play in the national landscape of heritage institutes, both for the collections it holds and its history. Set up in the early 20th century by Professor Cole the collections have been developed to keep up with current research on comparative zoology, although active collection largely ceased after Professor Cole passed away. The specimens held in this collection are also important for the students at the university and are used in the training of new generations of zoologists and ecologists.

In this next instalment on our journey through the insect collection of the UK we see inside the National Museum Cardiff (NMC), one of the larger museums that hold specimens as part of the UK's national collection. This is a museum on a different scale to the Cole but, as noted in my last article, this series is not written to compare museums with the view of ranking them in any sort of order. Each museum develops its displays and collections as best as it can with the means available to it and so each is special in its own right. This series is simply written to show how different institutes work with their insect collections in the hope of spreading knowledge of such collections and for sharing ideas. With this in mind NMC was chosen to visit next because it should allow a comparison of different 'styles' of museum (university-based and national). Cardiff is also the place to be for heritage in 2014, with the

Figure 1 (left): The entomology section of NMC houses impressive displays about insect ecology; Figure 2 (right): Each display case contains a mixture of pinned specimens and macro photos.

Millennium Centre hosting this year's Museums Association conference in October.

NMC is part of the larger government body known as the National Museum Wales (Amgueddfa Cymru) which comprises nine museums throughout the country. NMC was the first location of NMW and was officially opened in 1927 (NMC website). It is the largest of the nine locations and holds collections from natural history, geology, archaeology and art. The first day of my visit was spent in the museum as a regular visitor. The displays on offer are described below with a focus on their entomological content. The second day was spent behind the scenes with Dr Mike Wilson, the head of the entomological department and the focus of this issue's interview.

Collections on display

The Evolution of Wales

The first thing a visitor encounters as they enter the natural sciences section of the museum is the history of Wales told over geological time scales. It is a fascinating journey through the formation of the country as it travelled from the Southern Hemisphere to form part of the current British Isles. There is an informative and enjoyable path written through the evolution of life in the country, from the early marine worms (for example: Priapulids) through marine Mollusca and Cephalopoda to terrestrial fauna. This leads to an extensive display on the dinosaurs leading through to mammals (mammoths, mastodons and woolly rhinos leading to hyenas) and modern reptiles. There was an impressive array of animals represented in the fossil record on display, but there were no true fossil insects even though, as we will see later, the palaeontology department has an impressive collection of them. This is perhaps an indication of the rarity of palaeoentomological expertise in the UK. There was, however, a charming little display towards the end of the tour with insects caught in amber.

Figure 3: The trails of damage caused to common ash by the common ash bark beetle/chwilen risgl yr onnen (*Leperisinus varius*).

Entomology section

Above the rather striking natural scenes of the Welsh landscape from the seashore to woodlands, complete with badger set and birds of prey, we find the entomology section (fig. 1), a sizable exhibit with several display cases and associated wall panels. The lighting in this section is dimmed and the cases are lit rather brightly from underneath making the displays difficult to photograph. There are display cases for: wood and bark borers; galling insects; leaf miners, predators and parasites; moths and camouflage; leaf chewers; sap feeders and a specific case for the Hemiptera of Britain. There is a pleasing mixture of pinned specimens and blown-up photographs (fig. 2) which seems a good way to tackle the problem of displaying small specimens in a way that visitors can enjoy. As well as the specimens themselves each case holds examples of the effects these insects have on their immediate environments. For instance, in the wood boring case there are examples of common ash bark in which the common ash bark beetles/chwilen risgl yr onnen (*Leperisinus varius*) have caused damage (fig. 3). There are also sections showing the different life stages; there are, for example, specimens of the larval, pupal and adult stage of the goat moth/y gwyfyn drewllyd (*Cossus*

Figure 4: The three life stages of the goat moth/y gwyfyn drewllyd (*Cossus cossus*) are brought together in the case to illustrate the whole life cycle.

represented in this case are: wood wasps/cacwn pren (Siricidae) and spruce longhorn beetles/chwilen hirgorn y spriwsen (*Molorchus minor*).

Other displays

Several other displays containing insects are dotted around the museum. In the natural history section there is a display case with specimens and information on insects that live in sand dunes, including the burnet moth/gwyfyn greulys (*Zygaena spp.*), digger wasp/y wenynen feirch dyllu (*Ammophila sabulosa*) and tiger beetles/teigr chwilen (Cicindelinae). Further around the same area there is a rather beautiful display of jewel beetles (Buprestidae), again with a collection of pinned specimens and examples shown in blown-up photographs (figure 5). This display explains the importance of museum collections in the naming of new species and how insects are described by comparing new specimens with existing museum collections. Following this there is an example of research being carried out at the museum by the coleopterist Brian Levey, who has described 26 new species of *Melobasis* according to the display.

From an entomological perspective a particularly interesting display is that based on the classic example of natural selection in action, whereby changes to peppered moth/gwyfod brith (*Biston betularia*) population dynamics are driven by differential predation resulting from variation in environmental pollution (Tutt, 1896). The display shows examples of 'normal' bark with associated lichen and a polluted piece of bark where the lichen has disappeared (fig. 6). Specimens of both the light and dark form of peppered moth are shown to illustrate how different colourations have the evolutionary edge depending on the levels of pollution, and how this can alter population level morphology. There are a couple of other trays of insect specimens dotted around the display areas that give some examples of the more visually spectacular insects, for example: *Goliathus* beetles (Scarabaeidae) and *Lucanus* beetles (Lucanidae), and some of the less visually spectacular, including *Minettia* and *Meiosimyza* flies (Lauxaniidae) (fig. 7).

Behind the scenes

As with most museums, the majority of the collections are kept behind the scenes because there isn't the space to feature displays for all of the specimens. It would also be impractical from a research perspective to have all of the specimens out on display. A dedicated team of entomologists (employed or retired) carry out research on the collections behind the scenes, including development of collections with specimens collected in their spare time. Dr Mike Wilson is the head of the entomology department and I spoke with him about his research, the collections and how accessible they are to both the scientific community and the wider public.

The entomology department at the NMC holds some 1 million insect specimens. Half of these are of British origin and have 70-80% taxonomic coverage. Unlike the Cole Museum, which was described as a snapshot of early 20th century collections, the entomology department at NMC is still actively collecting with approximately 10,000-20,000 specimens being added each year. These specimens are either donated or are collected during field work carried out by staff in the department. Dr Wilson explains that in his opinion a museum is the natural setting for entomological research, but that active field work is an integral part

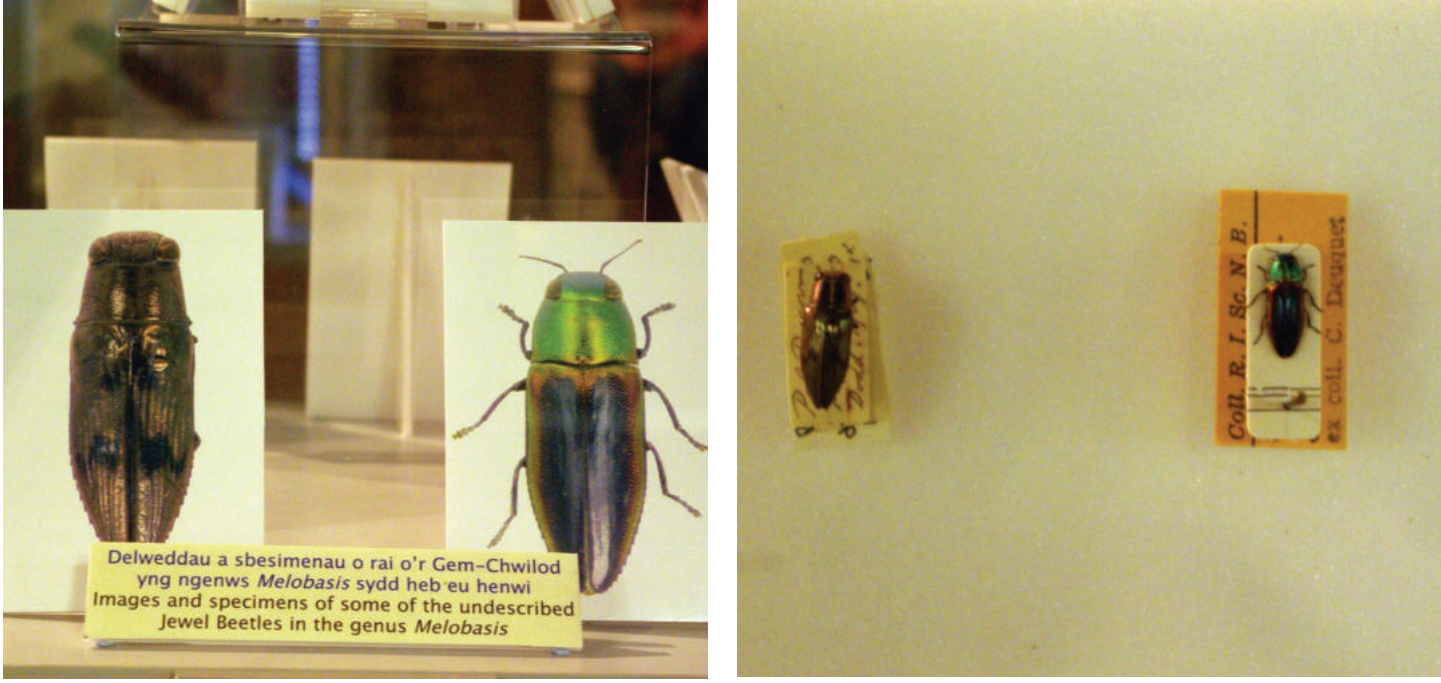


Figure 5: Jewel beetles are displayed similarly to collections in the entomology section with pinned specimens and macro photos.

of the process. Doing your own field work, he explains, allows the researcher to see specimens in their natural habitat and deepens understanding.

New editions to the collection are processed as quickly and efficiently as possible with all specimens being accessioned, pinned or re-pinned as necessary and incorporated into the existing collection in the correct taxonomic position. This tells of another interesting contrast between the uses of collections in different museums. The Cole largely maintained many of its collections as discrete entities, often labelled by the collector, whereas the NMC integrates all of the specimens into an overall taxonomic list. Thus, the Cole is a collection of historical specimens aiming to portray a particular time in the past, whereas the NMC collections are constantly being developed for current and future research.

In both the British and non-British collections there are large numbers of Diptera (fig. 8), Hemiptera (fig. 9), Coleoptera (fig. 10) and Lepidoptera (fig. 11). Dr Wilson explains that the focus of the department tends towards the former three of these, with his particular interests lying mainly with the Hemiptera. There is a good British collection of Lepidoptera, but this area is not a focus of research at the NMC and the collection is not actively developed as a result. Although there is no active development of this collection, holding specimens for posterity is equally as important as conducting current research. We can never know when a researcher is going to need to look back at historical specimens. For example, global environmental changes can be monitored by investigating differences between past and present entomofauna. This also highlights the importance of continued collecting for future researchers who will need data pertaining to our current faunas. There are also collections of other insect orders including Odonata (fig. 12) and Hymenoptera (fig. 13).

Not all of the specimens are digitised or available online due to a shortage of funds or manpower for such a large task. The focus for NMC has been to digitise those specimens of high conservation concern. With the current state of austerity measures and the subsequent cut-back in workforces, museums must prioritise their focus to concentrate on those key areas that they deem to be of optimal importance. Unfortunately this means that other, arguably equally important, tasks must necessarily be left unfinished. At the entomology department in the NMC the focus has been on developing the taxonomic value of the collections rather than digitising historical specimens. However, a request for such information, if time allows, may result in certain specimens being digitised *ad hoc*.

Another consequence of the paucity of funding is that those wanting to enter museum-based research are finding it increasingly difficult, with lack of career stability likely to be seen as off-putting by many. The sector as a whole may find problems in attracting the next generation(s) of specialists if these austerity measures are not addressed.

Figure 6: The classic example of natural selection in action illustrated with sections of bark and the different colouration patterns of the peppered moth/gwyfod brith (*Biston betularia*).

Figure 7: Random trays of insects can be found dotted around the museum.

Figure 8: Hoverflies (Syrphidae) as examples of the Diptera collection.

When asked about the accessibility of the collections, Dr Wilson states that they are completely open to anyone wanting to use them for research, whether professional scientists or amateur enthusiasts. He reiterates the point I made in the first article that the main purpose for museum collections is to allow people to use them and learn from them. It is always important to remember that museums such as the NMC are custodians of the dispersed national collection and as such are holding collections in trust for the public. The rules may be slightly different for independent or private collections, but national museums at least should be completely open to any interested parties. This should, however, be accepted as a *quid pro quo* arrangement, with visiting researchers sharing their data where it may develop the collections they are using; for example by assisting in identification of previously undetermined specimens.

Fossil insects

Figure 9: Examples of the large collections of British (Reduviidae and Pentatomidae) and non-British (Cicadidae and Belostomatidae) Hemiptera.

Figure 10: Examples of British (Scraptiidae) and non-British (Scutelleridae) Coleoptera.

Fossil insects

Moving away from extant insects, the NMC holds an impressive collection of fossil insects, found within the palaeontology department (fig. 14). The majority of these, and the ones that are on display in the museum, are insects trapped in amber (fig. 15), but there is also a significant collection of insects fossilised in rock throughout geological time (fig. 16a and 16b). These are important specimens for my own current research, having recently started a PhD research project investigating insect extinction patterns across the end Triassic mass extinction event. Although many museums hold collections of fossil insects, it seems that they receive only a small amount of attention. Indeed, as far as I know there aren't any museums with dedicated palaeoentomology displays, but please do let me know if I'm mistaken! It could be argued that, although not particularly popular, studying fossil insects is as important as studying extant insects. Building up a picture of what past environments were like allows an understanding of how our environments change over time, and, given the rate of current extinctions, understanding what has gone before may allow us to make viable predictions on what is to come.

Public interest

Dr Wilson describes a barrier he has observed between the public and engagement, where people do not think it possible for them to go behind-the-scenes or to get involved. To tackle this problem with public perception the entomology department at the NMC holds regular behind-the-scenes tours for members of the public. There are also various levels of training courses in topics such as: hoverfly identification; introduction to beetles; and workshops for kids to handle specimens. Anyone who is interested is encouraged to attend these events and to get as involved as possible.

There is much public interest in insects at the museum but there are difficulties in how to display specimens and disseminate information in a way that is informative, that doesn't upset people and that is easily viewable for smaller species. Visitors can respond negatively to a mass of dead butterflies, or can easily lose interest if the specimens displayed are too small to see clearly. Therefore you will not find large numbers of butterflies (or any single group) out on display at the NMC, but rather strategically placed specimens to highlight the message of the display. The specimens are usually

enhanced with large macro photos (fig. 17a and 17b) so visitors can compare the size of the actual specimen with an up-close look at its features. As well as the thought that has gone into the physical layout of the displays, NMC employs an OPAL community scientist. OPAL is acronym for Open Air Laboratories and is a UK-wide citizen science initiative attempting to get people involved with their environment and natural sciences (OPAL website).

This instalment on our tour of insect collections in the UK has allowed the comparison of two very different museums and a look at the different way collections can be maintained and utilised for different purposes. In the next instalment, the tour hops back across the border into England to visit Birmingham Museum and Art Gallery at the invitation of the curator. Although the running of the museum was passed over to an independent charitable trust in 2012, the museum and its collections remain the property of the local council and so should be an example of a local-authority museum. Hopefully this will allow further interesting comparisons and a wider view of the extent of insect collections on our islands.

If you are the curator of a natural sciences collections with an entomological/palaeoentomological element then please do get in touch to talk about bringing the tour to your museum. I would be especially interested to hear from collections in Scotland and Northern Ireland before returning to England and Wales to find out what other treasures are hidden in museums yet to visit.

Further Reading

NMC Entomology
www.museumwales.ac.uk/120/
OPAL
www.opalexplorenature.org/

Reference

Tutt, J.W., (1896). *British Moths*. London: George Routledge.

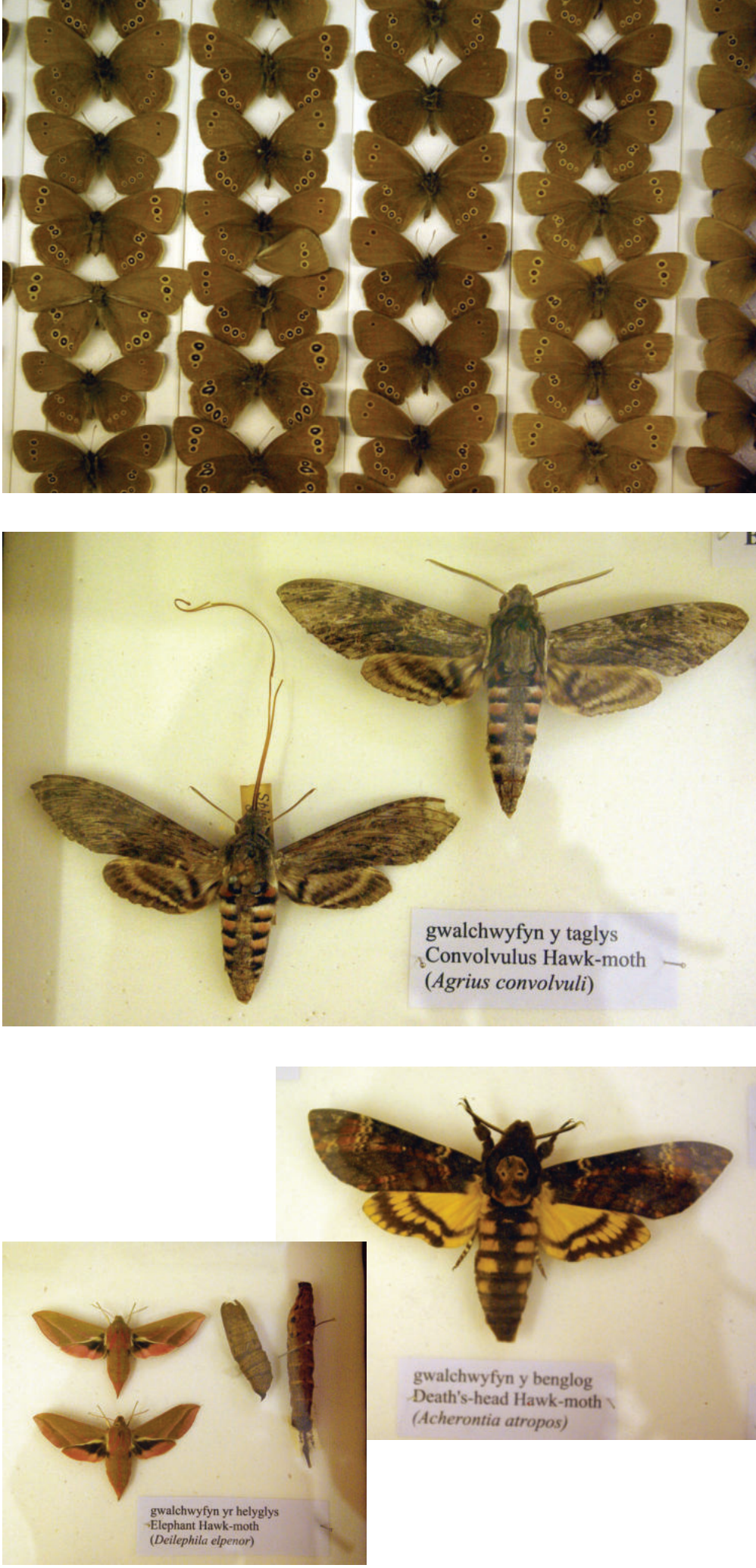


Figure 11: Examples of the Lepidoptera collection with a tray of British butterflies and three examples of large British hawkmoths.

Figure 12: Hawker dragonflies/gwesyn gwas y neidr (Odonata: Aeshnidae). Figure 13 (inset): Great wood wasp/mawr cacwn pren (*Urocerus gigas*) (Hymenoptera: Symphyta).

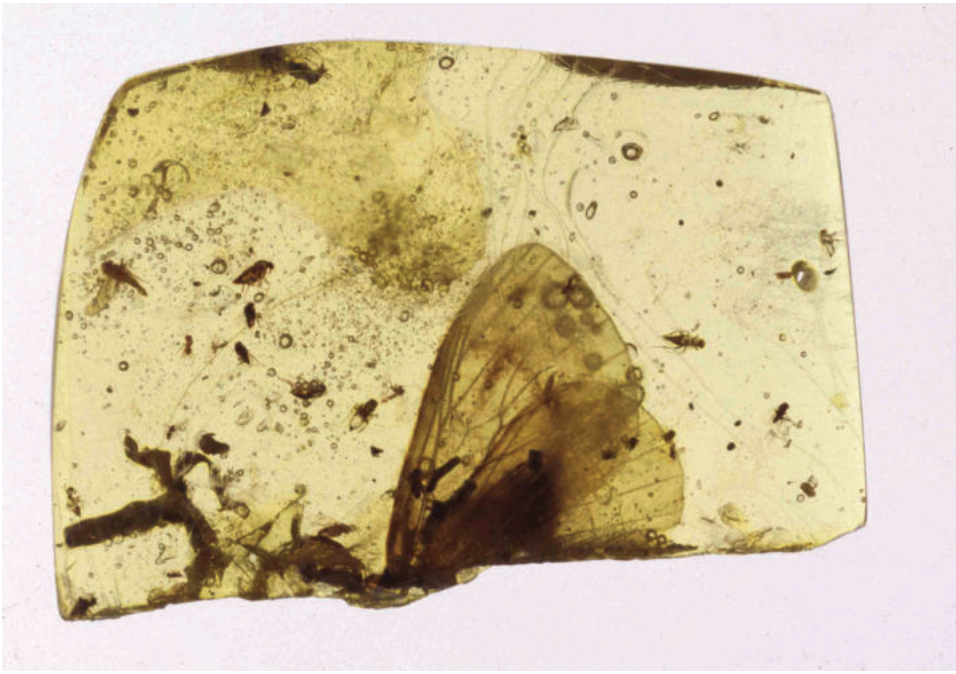


Figure 14 (left): Examples of palaeoentomological specimens in the palaeontology department.

Figure 15 (above): Example of a moth caught in amber, one of many specimens of this sort in the department.

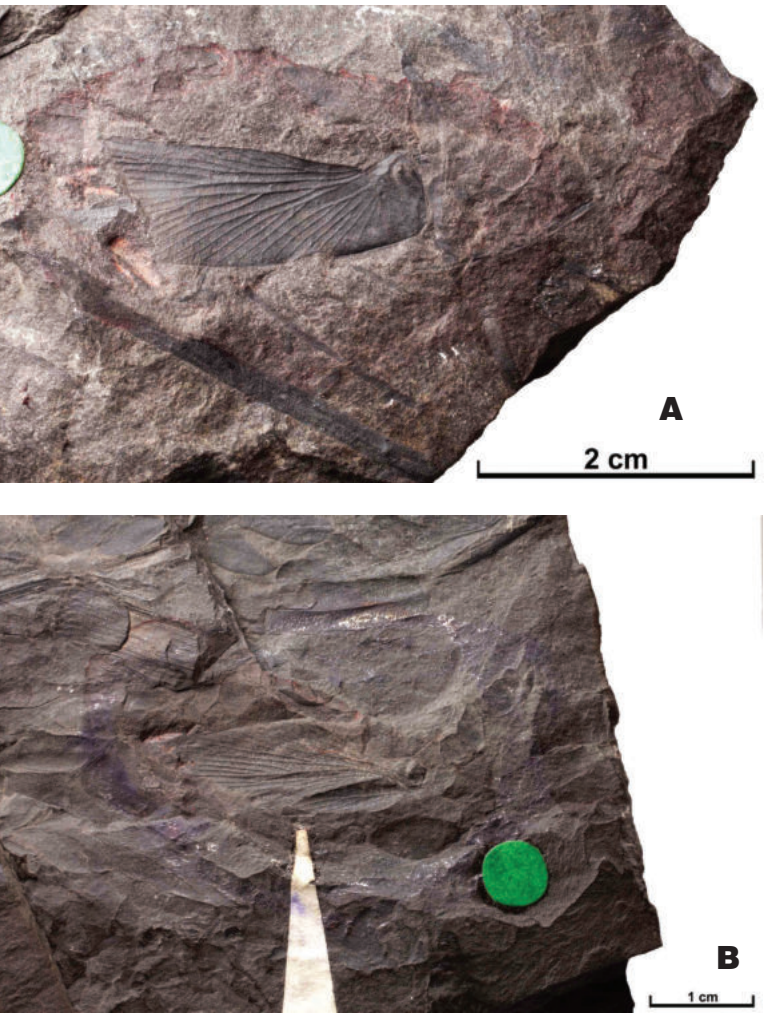


Figure 16: Examples of two fossilised cockroach wings: a) *Mylacris abrupta* b) *Soomylacris northi* (Blattodea: Mylacrididae).

Figure 17: Examples of macro photos used in the museum to enhance pinned specimens: a) Larval green lacewing (Neuroptera: Chrysopidae) b) tiger beetles/teigr chwilen (Coleoptera: Cicindelinae).

Society News

10th European Congress of Entomology University of York 3-8 August 2014: A diary

Archie K. Murchie

(RES Honorary Secretary)

I don't have as far to travel as some people, with just a short hop across the Irish Sea to Manchester and then the train to York. Having been involved on the periphery of the organisation of the Congress, I feel a mixture of excitement with a touch of nervousness. There are about 680 delegates, with representation of 68 countries and I have been copied into many emails about scheduling, rooms, themes, costs, etc. Stuart (Prof Stuart Reynolds), Klaus (Dr Klaus Reinhardt), Bill, Kirsty, Luke and all the Royal Entomological Society staff have worked wonders to pull everything together. As the train pulls out, I feel myself unconsciously starting to play spot the entomologist: beard [check…], pony tail [check…], poster tube [check…], walking trousers [check…], air of general distraction [check…]. As we cross the Pennines, the weather is clearing and it is warm (for GB).

Here we go: a quick glass of wine and then up to the cavernous exhibition centre. Scott Johnson (President of the ECE) starts the ball rolling. Almost 25 years ago the ECE was held in the University of York, so it is something of a homecoming. Scott explained that with 360 pubs in York and 50 churches, you can virtually drink every night and repent every Sunday, in presumably a different church. Prof. Debbie Smith, Pro Vice Chancellor, then welcomed delegates to the University and the city; explaining her own interest in agriculture, agricultural conservation and disease. Last of the grandees was Prof. John Pickett who as Royal Ent Soc President welcomed delegates on behalf of the Society and declared the 10th European Congress of Entomology officially open.

Sue Hartley introduced the first plenary speaker, a local – Prof. Chris Thomas from York, whose talk was 'Insects, Climate Change and Conservation'. Prof. Thomas explained that the University of York used to be under ice. Due to climatic changes, e.g. warming, the species have already completely changed; what we see today are not part of a fixed entity. With global warming, we expect to see retreat of northern and mountain species and expansion of southern lowland species... and this is exactly what has happened. For example, the Comma butterfly *Polygonia c-album* has expanded northwards, but interestingly with other adaptations as well including a host plant switch to nettles. However, range expansion depends on habitat availability. How do you conserve as species move? We still need to provide habitat, and need stepping stone habitats as well. Landscape heterogeneity can give rise to patchy extinction gradients, and past survival is no guide to the future. A fascinating talk and a great start to the conference.

Monday: first day proper and the weather in York is holding. One of the American delegates from the southern States commented that he liked the cool British weather: I laughed and said this was hot for us. The next plenary speaker was Prof. Bruno Lemaitre. On a different tack to the earlier plenary this was on *Drosophila* immune response. There have been up to 500 papers on the *Drosophila* immune system and understanding its functioning provides fundamental insights into competition between host and pathogen. However, the insect immune system is different from ours, with three mechanisms: phagocytosis, melanisation and antimicrobial peptides. Prof. Lemaitre explained how *Drosophila* mutants were key to tease apart the immune response. Regulation of the immune response was also vitally important, as many allergies and autoimmune diseases in humans illustrate. Switching on and turning off by negative feedback. An interesting question was asked about the difference between the larval and adult immune responses. What happens in the pupa, however, is a 'black box'.

Coffee time: a chance to catch up with 'old' colleagues and receive a welcome drop of fluid to compensate the *drouth* after sampling some of York's hostelries. Now the tricky part - deciding what sessions: there are six parallel sessions to choose from with sessions organised in themes throughout the Congress. The format for each session is one keynote talk of 30 minutes followed by six 15 minute talks. Realising that I can't possibly do justice to every talk (nor would the Editors of Antenna want me to do so), I decide to report on facts that tickled my fancy. I apologise in advance if I have picked up some things wrong.

To start, I plump for 'IPM and Invasive Species'. This starts with Kris Wyckhuys talking about invasive pests of cassava. Approximately, 40 million people are dependent on cassava for food, animal feed, biofuel and starch production. Cassava used to have the highest yield in SE Asia. Now, however, 25% of yield is lost due to pests and diseases. The pests are mainly invasive mealy bugs and there is now an international project in Asia, with research and extension to introduce biocontrol agents. Rob Johns showed an outbreak of spruce budworm in Canada being cleared away with a tractor loader. Ronald Cave described biological control of cycad scale in Micronesia. The only hope to conserve cycads is a curious-looking ladybird, *Phaenochilus kashaya*, which feeds exclusively on armoured scales: well worth a Google.

Now for the first big test of the Congress. What is the food like? The bacon carbonara hits the spot, certainly.

My next session was the eclectic mix of 'Open Topics 1'. Roland Mühlethaler

gave a fascinating account of how leafhoppers hear and produce sound. What was remarkable was that a description of sound producing organs and a hearing organ in the abdomen of leaf hoppers had been given in a PhD thesis some 65 years earlier, but it had been published in Czech and had gone unnoticed until the present. Lin Field, (RES Hon Editorial Officer) who chaired the session, made the astute comment that not everything could be found on the web.

Christopher Lyal from the Natural History Museum in London gave a thoughtful presentation on the impact of EU Regulation on Genetic Resources, which comes off the back of the Convention on Biological Diversity and the 2014 Nagoya Protocol. As Chris reports earlier in this issue, this requires fair and equitable sharing of the benefits from genetic resources (which includes virtually all biological specimens). The result of this will almost certainly be increased emphasis on collecting permits, but it could also have serious implications for historic collections and their use (see article on page 226).

The final talk of the day that I attended was by Ranajit Das and was on the potential for termite mounds to be used as an architectural model. Termite mounds have a natural air conditioning system and buildings such as the Eastgate Centre in Harare, Zimbabwe seek to use similar principles. The speaker proposed a low-cost design using local materials.

Tuesday dawned with another lovely day. It started off well. I heard in the news that the Lendal Bridge bus lane fines were going to be refunded. Having fallen foul of that charge on a previous visit to York to discuss the Congress, I am delighted and a bit astounded. The opening plenary is by Vojtech Novotny. The talk starts with a short video of entomologists commuting to work; only in this case these were tropical entomologists working in Papua New Guinea (PNG) and they were flying into a rainforest. A bit more hair-raising than most of our commutes to work, although the M1 has its moments as the Honorary Treasurer (Prof. Loxdale) can attest.

Prof. Novotny addressed the question of 'Why are there so many species in the tropics?' Even knowing how many species is very difficult. Wallace and Bates started the work, estimating 25,000 species in 6,000 ha of tropical forest. Estimates vary considerably though, depending on different techniques for estimating total number of species. The insect species per plant species gave the best match. Westwood used this method back in 1833 to estimate 0.5 million insects. Current estimates suggest about 6 million. This gives a massive number of interactions in a food web. However, there are dominant species. For example, only 95 insect species represent half of all individual insect leaf feeders in a food web comprising 227 abundant tree species. So can we justify biodiversity by ecosystem services? Also niche theory does not help in this case, as there was greater diversity in generalist feeders rather than specialists. It is clear that there is greater insect diversity in the tropics. Is this because there are more plant species in the tropics? Or is there greater host specificity in the tropics? Answering these questions empirically is difficult, not least because of limited access to the forest canopy. However, Prof. Novotny showed a slide with the most impressive cherry-picker I've ever seen.

The second part of the talk was about the practicalities of working in Papua New Guinea at the Binatang (Insect) Research Center. The tribal people own the forest and are inclined to conservation, but logging provides money. However, in some limited cases, conservation research can provide income for local tribes. Due to safety issues with carrying large amounts of cash in PNG jungle, the Center issued receipts, with arrangements to dispense cash later. However, when the time came, to the surprise of Center staff only a few people turned up - but carrying many receipts. It turns out that the accepted receipts had developed as a currency and the tribes' people had started trading with them.

Finally, Prof. Novotny expressed some thanks to the ECE and York. At the last Congress here, he was speaking to Dr Yves Basset in a pub in York and this provided the germ of an idea that was to grow into the Binatang Research Center.

Now a clash and hence the tricky dance of moving between sessions. In 'Insects and climate change', I listen to Scott Johnson who described how root herbivores induce defensive chemicals that can affect above ground herbivores, e.g. more aphids on plants with vine weevils. However, it can be difficult to separate out what is happening as decreased plant quality may increase compensatory feeding. In the 'Insecticide resistance' session, Christoph Zimmer and Ralf Nauen spoke about pyrethroid resistance in oilseed rape pests in Europe. Pollen beetle resistance was first detected in 1999 in France, now causing about 30 million euro damage in Germany. Finally, in 'Open topics 2', Anthony Wilson gave an account of mechanical transmission of livestock disease by large vectors ('flying pins'), as distinct from biological transmission. For mechanical transmission to be epidemiologically important there needed to be a high degree of environmental stability, a short interval between vector feeds and the vector had to have large mouthparts. Phew, glad all the speakers kept to time and I was able to sneak in the back of the lecture theatres.

Teja Tscharntke gave a presentation at the 'Aphids and their natural enemies' session on how local landscape affects aphid natural enemy food webs. Are complex landscapes of more benefit to natural enemies than simple landscapes? Providing habitats for natural enemies, e.g. flower strips at the edge of fields, does increase natural enemies but does this spillover into biological control on the crop? It does, but the results are not consistent. In an examination of the relationship between yield and biological control in 1,350 wheat fields, crops with higher yield had fewer plant species, therefore there were ecological versus economic trade-offs. This point was also made by Klaus Birkhofer in a later talk: that the benefits of greater biodiversity on the crop can come at the cost of greater weed coverage.

Wednesday's plenary was by Prof. Nancy Moran on obligate nutritional symbionts, in particular an examination of the role of the honeybee gut microbiota. The honeybee genome published in 2006 gave an impetus to understanding the genomics of gut microbial communities. Historically, studies on honeybee gut bacteria had been limited to bacteria that could be cultured. In the honeybee, there are relatively few bacteria at eclosion so it is likely that exposure to faecal material transfers bacteria. Bacteria are possibly beneficial to the host: they could produce nutrients and protect against intestinal parasites (e.g. trypanosomes). Parallel to human gut microbiota, there are lots of strains but relatively few deeply diverging lineages. Each strain, though, has hundreds of unique genes,

so could be performing different functions. G*illiamella* use sugars and have genes that can degrade pectin. This could be an important function as pectin is a component of the pollen grain wall. Prof. Moran made the comment that beekeepers routinely use antibiotics such as tetracycline to prevent diseases such as foulbrood. Perhaps not surprisingly, bacteria in the guts of honeybees are resistant to tetracycline. Paradoxically, if gut microbiota are conferring some protection against disease then prophylactic use of antibiotics may be counter-productive.

Profs Alvin Simmons and Walter Leal representing the Entomological Society of America took the opportunity to invite everyone to the International Congress of Entomology in Orlando Florida 25-30 September 2016. The keynote speaker is Prof. Peter Agre, winner of the 2003 Nobel Prize for chemistry and Director of the John Hopkins Malaria Research Institute. This aims to be the largest gathering of entomologists in history and will be student-friendly with low registration fees. Orlando also promises to be great for those visiting with spouses and family. All delegates were exhorted to '*Follow the Buzz*' on Twitter and Facebook.

After spectacular thunder storms the meadow field trips were cancelled due to wet weather.

My next choice of session was on honorary insects known as ticks and mites. Daniel Sonenshine gave an overview of ticks and tick-borne diseases, explaining that it would take two pages of text to cover the diverse disease agents vectored by ticks. The headline grabber however was probably Lyme disease. He detailed the complex and fascinating life cycle of ticks, for example mating requires not just specific pheromones but a specific sequence of pheromones. In terms of control, pheromones may be useful for 'attract and kill technology'… euphemistically known as 'fatal attraction'. This could include impregnated tail tags on livestock that combined pheromones and acaricides. Other innovative control measures included the development of a 'Tick Bot'. Somewhat akin to automated lawn mowers, this is a robotic tick collector that systematically covers an area of ground removing ticks.

I am duty-bound to mention two further talks in this session: one by Andrew Cuthbertson on the predatory whirligig mite, *Anystis baccarum*, in Northern Irish apple orchards that was conducted in my lab. The other was on poultry red mite by David George who, as Co-Editor of *Antenna*, will have to read this. Fantastic talks the pair of you!

The Congress Dinner was on the Wednesday night and fully booked with over 400 delegates attending. The set menu (for the carnivores) was baked goats cheese, rack of lamb, treacle tart, followed by coffee and *petit fours*. Due homage must be paid to the University of York catering staff. Given the numbers, I had been dreading a staggered serving, with some tables getting their desserts as others got their starts. However, not only did we have a fabulous meal but the service was fantastic with everyone served at the same time. As is now customary at Royal Ent Soc science meetings, the Society's Obligation Book was made available for Fellows to sign, provided of course they had cleaned the residue of treacle tart from their chops. The Obligation Book is unique, containing the signatures of Queen Victoria, HRH Queen Elizabeth II, Darwin, Wallace and many famous entomologists. The Registrar and Librarian guard it with their lives. After the dinner the suitably entomological 'With the Beatles' Tribute Band entertained the well-fed crowd. It was an excellent set up and I was delighted that people were up and dancing straight away. As a crap 'dad dancer', I didn't feel out of place.

Despite the previous evenings Congress Dinner, the Thursday morning plenary had a healthy audience. Prof. Janet Hemingway spoke on 'Mosquitoes, Malaria and Man'. The Gates Foundation has made it a goal to eradicate malaria. The cost of vector control represents 30% of malaria eradication costs. In addition, insecticide resistance is a growing threat. To address these issues required a multifaceted approach, involving academia, NGOs, Government and crucially the pesticide industry. To this end the Innovative Vector Control Consortium (IVCC) was established in 2005. Prof. Hemingway described the approach a bit like climbing Mount Everest – a daunting task that must be broken down into manageable segments. The aim is to establish three new insecticides designed for vector control. Perhaps surprisingly, there has never been a vector insecticide developed from scratch: most are modified agrochemicals. The hurdles are immense. The cost of registering a new insecticide is $15-20M, and it takes 6 years purely for regulation. Industry potentially benefit from the project through subsidised development of new compounds… but specifically highly novel compounds that they might not otherwise develop. Also, because of the emphasis on malaria control, there may be a streamlined regulation process reducing the time to market. The IVCC has three novel active ingredients in development and the whole exercise has reinvigorated the vector control industry. Prof. Hemingway's talk was nuts and bolts, practical life-saving science and it was salutary to see laid bare all the regulatory, practical and political difficulties associated with such work.

After the plenary, there was the election of the next Presidium of the Congress. I then had planned to attend the 'Entomological Outreach' session but I couldn't get in the door, it was absolutely bunged. This did, however, allow me to attend the fascinating 'Mosquito Olfaction' session. Walter Leal pulled out the stops with a brilliant cartoon mosquito. As a Brazilian, his image of what 'Christ the Redeemer' (the giant statue overlooking Rio de Janerio) looked like after Germany beat Brazil in the World Cup was a hoot. The science was pretty good too.

One of the benefits of attending conferences is meeting people you only know through their papers. Such was the case with Brad Mullens who has spent 35 years working on C*ulicoides* midges as vectors of livestock diseases. This work gained much local importance in the British Isles in 2006–2010, with the outbreak in Europe of the midge-vectored bluetongue virus in cattle and sheep. It was a pleasure to hear Prof Mullens speak in person.

The final plenary of the Congress was given by the Royal Ent Soc's very own Prof. John Pickett. Walter Leal gave an overview of Prof. Pickett's career and achievements. [Despite John's numerous accolades, the image of him with his chest hair on fire is the one that stays with me.] Prof. Pickett gave a presentation of his work on semiochemicals and the application of the 'push-pull strategy' to pest management. Plants contain many mechanisms to resist insect herbivores. For example, the genes for the

production of the insecticide permethrin are in the plant. Permethrin was then used as the basis to develop the synthetic pyrethroids, one of the most widely-used classes of insecticide. Careful integration of chemical or GM control with natural enemies of pests can provide control whilst maintaining ecosystem services. A 10-year study, on Bt-cotton in China, found more natural enemies on the GM crops compared to their conventionally treated counterparts. Prof. Pickett then explained his own input into the development of GM wheat for aphid control. The main component of the alarm pheromone of many aphids is (E)-ß-farnesene. The aphid alarm pheromone causes other aphids to react in a defensive manner, e.g. dropping from the plants. However, it also acts as a kairomone attracting in natural enemies. Transgenic wheat plants were developed using genes from peppermint and cattle. Prof. Pickett explained that the latter gene is common in many plants and animals, so it is not specifically a 'cow gene'. Nevertheless, this did not prevent the anti-GM lobby from producing some quite colourful literature involving cows and bread. Prof. Pickett spoke about the need to engage with those who have legitimate concerns about GM and get a positive message across in the press. Having developed transgenic plants, those with the highest (E)-ß-farnesene emission were chosen for the field trial; the results of which are being analysed at the moment.

Prof. Pickett also spoke about his work in east Africa in association with the International Centre for Insect Physiology and Ecology (ICIPE). This involved the principles of 'push-pull' but by the mechanism of companion cropping. Maize stemborers and the parasitic weed *Striga* cause substantial losses for African subsistence farmers. Intercropping maize with *Desmodium uncinatum* repels pests and chemicals exuded by *Desmodium* roots inhibit the attachment of *Striga* to maize roots. Furthermore *Desmodium* is an edible legume and it fixes atmospheric nitrogen aiding soil fertility. This push-pull strategy has now been adopted by 89,000 farmers in sub-Saharan Africa and there is even an African version of the Archers (Radio Soap), which has been encouraging uptake. Prof. Pickett's work demonstrates how an overarching principle ('push-pull') can be implemented using both high-tech and low-tech approaches to achieve real practical solutions for farmers.

Following on from Prof. Pickett was the Wallace Award winner, Dr Sarah Beynon. The Wallace Award is presented by the Royal Ent Soc for an outstanding entomological PhD thesis. Sarah showed a picture of Andy the Bull who produces 9 tonnes of dung per year. Dung is a nutrient rich resource and one that is recycled by dung beetles, amongst other invertebrates. Sarah's thesis was on 'Ecosystem Service Provision by Dung Associated Invertebrates', and in her presentation she spoke about the importance of dung beetle biodiversity and the sometimes adverse effects of veterinary antihelminthic compounds, which pass through livestock into their dung (see article by Sarah on page 196).

Sarah also spoke about her television work, including appearances on Countryfile and Springwatch. Her most recent work has been on 'Cloud Lab' and she showed some great pictures, including paragliding with a Harris Hawk. Although this did have a downside as she crash-landed on a nudist beach. Sarah also demonstrated her entrepreneurial spirit explaining how she had bought back the family farm in Pembrokeshire and was opening a restaurant, which will serve insects as food, named appropriately 'Grub'.

The penultimate session I attended was on management of red palm weevil. Victoria Soroker spoke about the difficulty of locating palm weevils in palm trunks and described various methods of detection including acoustic detection, visual and thermal imaging. However, the use of sniffer dogs turned out to be most suitable. The palm weevil session finished early, so I took the opportunity to hear the last few talks in the 'Biological Control' session. John Holland mentioned the difficulty in getting natural enemies at the margins to penetrate into crops and also the relationship between weed cover and biodiversity. He also said dolichopodid flies were important predators but very understudied in this respect. Geoff Gurr concluded the session and hence my Congress experience with a talk on conservation biological control. He used the acronym SNAP to get the message across. This stood for **S**helter, **N**ectar, **A**lternative prey, **P**ollen. In a similar vein to Prof. Pickett's talk, he showed how wild rice supported a non-pest leafhopper, which in turn was attacked by a mymarid parasitoid that is an important natural enemy of the brown planthopper, a pest of cultivated rice. He also presented the principle of 'Attract and Reward'. This involves the use of plant volatiles to attract natural enemies into the crop and then the provision of floral resources as a 'reward' to keep them there.

I hope that this report-come-diary has given you a flavour of the Congress in York. By my reckoning I attended about 59 out of 337 (or so) talks at the Congress, so my experience represents only 17% of the Congress. It is also completely biased. I enjoyed virtually all of the talks I listened to. There were a few I did not understand, but that's my problem! Also, I didn't get to the Film Nights organised by Peter Smithers, nor any of the tours organised by Luke Tilley. And then there are the 371 posters…

I certainly learned a lot and was exposed to many new ideas. I met old friends and hopefully made some new ones. The Congress was big enough to provide something for everyone, but not so big as to make you feel anonymous. Once again, hearty congratulations and thanks are due to all the people who helped make this Congress a success: in particular Stuart Reynolds, Klaus Reinhardt, Bill Blakemore, Luke Tilley, Kirsty Whiteford and the University of York (the catering was excellent). Here is to next Congress in Naples in July 2008. Please attend if you can. You never know, you might be inspired to build a tropical research station: stranger things have happened!

The joys of making the National Insect Week 2014 Podcasts

Chris Jeffs

One of the greatest joys of working with insects is the continual discovery of something new and fascinating. In order to highlight and celebrate their diversity, I had the enviable job of interviewing a broad range of top insect enthusiasts – from academic to artistic backgrounds – for a twelve part series of podcasts as part of this year's National Insect Week.

Although only taking me as far as Telford and St Albans (twice) in geographic terms, my exploration of the entomological world was far more extensive. I explored areas as diverse as insect cinematography, invertebrate rearing for zoos, to how railway verges can be valuable for butterfly conservation. Overall, I hope the podcasts were able to showcase for both established entomologists and budding insect enthusiasts some fascinating areas of entomology. Personally, I also learnt a lot along the way, including some remarkable features of our fantastic field and community.

Chris Jeffs and mantis friend – photo credit Graham Smith

Learning The Ropes

Starting from a purely practical side of things, I had no previous experience of conducting and editing interviews. Therefore, whilst aiming to keep the final podcasts a short and punchy 15 minutes, due to my magpie-like attention span I typically meandered away from my planned questions into the unknown. This resulted in mountains of good material, but also the dilemma of how to cut it all down from being an hour long. Despite the late nights of editing that ensued as a result of an inability to keep to plan, the side-tracks yielded the most spontaneous stories and thus some of the highlights of the series. For instance, how could I resist asking Graham Smith, of invertebrate suppliers Metamorphosis, more about his recent encounter with a giant Thai mantis with an apparent taste for his flesh, or be able to include all of Dr George McGavin's incredible TV exploits (which yielded so many fascinating stories) in anything but a two part edition?

I also learnt the hard way during my second interview that you should always check through *the whole* recording before leaving. After visiting Prof. Simon Leather at Harper Adams University to discuss applied research and the future of entomology, I made a horrible discovery on the train ride home. Despite having checked the first and last minutes of the recording directly after the interview, I hadn't realised the middle section was purely static. My stomach sank. I didn't have enough material for a podcast. It took me a month before I could sheepishly contact Simon to ask to meet again.

The Interdisciplinary Nature of Entomological Research

Entomological research is clearly at the forefront of leading issues facing modern society – biodiversity loss, infectious disease, food security. Whilst I understood certain areas of applied entomology before conducting the interviews, talking to Prof. Lin Field of Rothamsted Research highlighted to

George McGavin in his 'bee hoody' whilst filming for 'Ultimate Swarms' - image copyright © Jonny Rogers/BBC

Graham Smith's giant new mantis species from Thailand with an apparent taste for flesh - image copyright © Graham Smith

Darren Mann setting up traps for dung beetles - image copyright © Darren Mann

me the true complexity of applied research and the efforts needed to put its findings into action. For example, the battle to control crop pests involves collaboration by scores of researchers and institutions covering the full spectrum of chemical, genetic, behavioural, and ecological knowledge, not to mention the economic and political factors vital in such fields. This was particularly demonstrated by an impassioned and strong view from Prof. Field on the current, controversial debate on bee health and the use of neonicotinoid pesticides which could have easily had its own podcast. The challenging and rewarding nature of applied entomology repeatedly appeared over the course of the series and served to reaffirm my understanding of the critical, global importance of insect research.

Inspiring Moments

Some of the best moments whilst conducting the series were seeing transitions in those I was interviewing from giving answers in a manner clearly conscious of being recorded, to telling stories filled with scarcely-contained passion for their vocation. These moments were studded throughout the podcasts, such as with Darren Mann of the Oxford University Museum of Natural History whirling his desk chair around the office grabbing old tomes and specimens from shelves with incredible stories attached, with Prof. Jane Memmott of the University of Bristol reading with pride a printed letter from a local resident delighted with the flower meadows planted within the city for her research, and the obvious joy BBC cinematographer Rod Clarke gains from lining up the perfect shots for our most beloved Attenborough documentaries (despite having to lie face first in trails of biting army ants on the march). These were the sections I was hoping for and most loved to hear and to share: the moments where their passion and fascination for insects becomes apparent over all else. Seeing such energy from these leading insect enthusiasts only helps reinforce your own decision of why you chose to study insects in the first place.

A Fantastically Friendly Community

Another factor that became even more apparent to me was just how pleasant and welcoming the entomological community is, particularly in showing great enthusiasm and willingness to contribute to insect outreach. For instance, with a drafted email invitation already prepared, by complete chance in the hallway outside my office I bumped into Nobel prize winner Prof. Camille Parmesan of Plymouth University. Despite having a very full schedule and sacrificing a break, Camille was more than happy to spend half an hour talking to me about her leading research on insects' responses to climate change.

This accommodating kindness was epitomised by Dr Sarah Beynon who even offered a camping space on the site of Dr Beynon's Bug Farm in Pembrokeshire, although eventually I managed to catch Sarah in the Natural History Museum in London during the launch event of National Insect Week itself! The entomological community clearly seems to possess a deep-rooted pleasure in discussing our work to inspire others and share our interests - a trait essential to the continuation of our fields in generations to come.

Overall, travelling to meet so many fascinating people and broadening my understanding of the many ways in which we can work with insects was an incredibly rewarding and enjoyable experience. Thank you to all of those who took part, the RES for supporting the project, and all of those who took the time to listen. If you haven't had a look before, please feel free to visit the National Insect Week website to see which podcasts may interest you. If you enjoyed the series, make sure to spread the word at coffee breaks to colleagues, on social media to friends, or even to fellow students in order to showcase all the wonderful world of insects!

Listen to all 12 podcasts online at http://nationalinsectweek.co.uk/podcasts
Could your research, profession or hobby be ideal for a future podcast?
If so, please get in contact with me at christopher.jeffs@zoo.ox.ac.uk
or on Twitter (@CTJeffs) with any ideas or feedback

Aphid Special Interest Group

Harper Adams University 3rd September 2014

Simon R Leather, Harper Adams University

A beautiful sunny September morning, a rural setting in the Shropshire countryside, what better venue for the 2014 Aphid SIG? Despite the lack of a main-line station (Newport was one of the victims of the Beeching cuts in the 1960s), twenty six aphidophiles arrived at Harper Adams University and made their way to the Frank Parkinson Education Centre to be greeted by copious amounts of coffee, tea, assorted biscuits and some of the resident entomologists: myself, Tom Pope, Rob Graham and Fran Sconce.

My aim, having accepted the challenge of organising the 2014 Aphid SIG, had been to convene a meeting covering a wide range of topics and bringing together aphidologists just starting their careers with those with many decades in the field. I think the programme reveals that I succeeded.

Tony Dixon - *Role of thermo-biology in the distribution of aphids in space and time*

Ailsa McLean - *Endosymbionts in aphids: variation in effects on defence against parasitoids.*

Julia Ferrari - *Interactions between multiple symbionts in the pea aphid*

Richard Harrington - *The Rothamsted Insect Survey: golden years of aphid monitoring*

Helmut van Emden - *White black bean aphids and other "Tales of the Unexpected".*

Jennifer Banfield-Zanin - *Drought stress and populations of green spruce aphid on Sitka spruce: an effect of stress frequency and intensity*

Henriett Elek – *Role of hydroxamic acid in wheat resistance to aphids*

Victoria Wickens - *Local and landscape effects on aphids and their natural enemies*

Tony Dixon, who was my PhD supervisor, started the meeting with a very thoughtful talk about thermal limits, feeding sites and rarity and abundance in aphids. He reminded us of the importance of taxonomy in understanding ecology, showing us pictures of some of the great aphid taxonomists that he had known, many of whom are, sadly, no longer with us. Ailsa McLean from Oxford was up next. Incidentally, Ailsa is the daughter of yet another of Tony's former students, Ian McLean, and I remember meeting her when she was a small baby. How time flies. Ailsa, and Julia Ferrari from York University who followed her, both enthralled us with the internal ecology of aphids, spinning tales of detailed experiments involving antibiotics, plant genotypes and interactions with natural enemies; not so much tri-trophic interactions as multi-trophic interactions. Yet another indication of what complex organisms aphids actually are. Richard Harrington took us up to the lunch break, giving an amusing and informative account of the history of the Rothamsted Insect Survey, again with many reminiscences of the many late and great entomologists involved with setting up, what I consider to be, one of the modern wonders of the world – an extremely long-term data-set. Something that we should all hope and pray will receive uninterrupted and enhanced funding from the BBSRC in the future.

Lunch was the usual splendiferous Harper buffet. The sausage rolls, made from pigs raised on the University Farm, are fantastic, and those of you attending ENTO16 will also get the chance to taste these wondrous savouries.

As the sun was still shining I then led a campus tour including a visit to our new Entomological Research Building, the official opening of which is in January, but which we will actually take possession of before the end of September. Back in the lecture theatre,

Left: Julia Ferrari, Ellie Heyworth and Fran Sconce; Right: Jen Banfield-Zanin (sadly bisected by my poor photography), Liam Harvey, Tony Dixon, Richard Harrington and James Bell.

Lunch time – sausage rolls and other goodies being consumed with great enjoyment!

Speakers and convener: Victoria Wickens, Tony Dixon, Simon Leather, Helmut van Emden. Richard Harrington, Ailsa McLean, Julia Ferrari and Jen Banfield-Zanin

Janine Heath in action, Ailsa McLean being filmed.

Richard Harrington read out an obituary of Georges Remaudière sent to us by one of our French colleagues, Charles Dedryver. Georges, who died on July 22nd, was one of the world's leading aphid taxonomists and he will be greatly missed.

Van kicked off the afternoon session with an amusing account of unexpected discoveries that he and his students had made whilst conducting research that had not been constrained by Research Council funding and milestones, or as Van put it, millstones! Next up was one of my former students, Jen Banfield-Zanin, who, in her usual self-deprecating style, explained about the complicated interactions between green spruce aphid and water stressed Sitka spruce plants. Henriett Elek was next discussing the possible role of hydroxamic acid in conferring resistance, or not, against my favourite aphid, *Rhopalosiphum padi*. The final, and youngest speaker, both in age and stage of career, was Victoria Wickens who spoke about aphids, field margins and natural enemies. I should add that all the speakers were warmly welcomed and that lively discussions followed each talk. In my opinion, the meeting met all my expectations and has, I hope, stimulated future collaborations.

We also discussed a proposal that Jean-Christophe Simon had put to us that the next Aphid SIG should be a joint affair between the French Aphid Research Network and the Aphid SIG and be held in Paris next year. I am certainly in favour of this proposal.

Another first for an Aphid SIG, I am sure that readers will let me know if it isn't so, was that our PR and Media Relations Manager, Janine Heath, who has a soft spot for entomologists, popped down with her video equipment and interviewed some of the speakers.

Search on-line for *Harper Adams Aphid SIG* to hear what they said.

Many thanks to all speakers and delegates and I hope that they all enjoyed the day as much as I did. Hope to see you all and more, next year.

Conference Participation Fund Article

Linking Biological and Cultural Diversity in Europe, 8-11 April 2014, Florence, Italy

Grace Twiston-Davies

As we sat sampling red wine in the vineyard with a backdrop of the sunny Tuscan landscape, I thought how privileged we are as research scientists to have the opportunity to travel the world attending conferences and sharing our research; a major perk of this is of course the field excursions! However, it wasn't all fine-wine and stunning scenery as we had earned our break from four days of a multidisciplinary conference on linking biological diversity and cultural diversity and its many opportunities and challenges.

My personal highlights of the conference were the venue, the food, the Violet Carpenter bees (*Xylocopa violacea)* and the opportunity for breakthrough multidisciplinary collaboration between natural and social scientists. With assistance from the Royal Entomological Society Conference Participation Fund I was able to attend the 1st European Conference for the Implementation of the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the Convention on Biological Diversity (CBD) Joint Programme on Biological and Cultural Diversity.

This first breakthrough conference was part of a visionary plan to explore biological and cultural diversity in an EU context, linking people with places and culture with nature with CBD acting as the global focal point for biological diversity and UNESCO acting as a global focal point for cultural diversity. The vision of this collaboration is for a world in which the global community sustains biological and cultural diversity for present and future generations.

I had just handed in my PhD Thesis and, therefore, it was a pivotal time in my career to present my research and make new connections. The Conference Participation Fund enabled me to present my work at this ground-breaking, multidisciplinary conference and to be an entomological ambassador championing the importance of insect biodiversity.

My presentation described the grassland restoration project at the Stonehenge World Heritage Site, Wiltshire, UK, the impacts this has had on butterfly biodiversity and the potential of this to link up previously isolated populations. Butterflies are biodiversity indicators and therefore can represent trends in other invertebrates, animals and plants. They also have a high cultural value, highlighted by the success of projects such as the Butterfly Conservation's Big Butterfly Count. However, this particular aspect was not covered by my research, so I was especially keen to see if there was any research on this.

The take home message from the opening session of the conference was that "*cultural diversity is as important for humans as biological diversity is for nature*".

After a lunch buffet of exceptional, fresh Tuscan food it was time for us all to plan what talks to attend for the duration of the conference. Strategies for conference talk attendance differ between participants and this is always a great first day talking point; do you stick to one session or risk running between talks? The parallel sessions were Methods and Management Strategies and Historical Patterns of Natural and Cultural Landscapes. I

Conference poster.

Conference venue, the inside of the courtyard garden where we took our coffee breaks.

opted for the latter for the duration of the conference and this session predominantly described case studies of traditional land management in Europe showcasing traditional agricultural practices and the benefits of encouraging this sort of management for both cultural and biological diversity. These case studies were in stark contrast to the situation in the intensified agricultural landscape in the UK, especially as many of the traditional mainland EU agricultural landscapes have been abandoned.

Coffee breaks were taken in the garden courtyard where I first sighted a stunning purple iridescent insect which on first sight looked like a Carabid beetle and was later identified as the Violet Carpenter bee (*Xylocopa violacea*), one of the largest bees in Europe.

There were only two other presentations which used insects as study organisms at the conference; one on bee keeping and another using beetles as indicators of biodiversity in the UK. This meant that it was especially crucial for me to attend the conference and represent the importance of habitat restoration for insect biodiversity and the use butterflies as indicator taxa.

Speakers in the scientific sessions had Thursday afternoon off while the expert group discussed the main conclusions of the sessions. I took this opportunity to explore Florence and visited the Uffuzi gallery; here I searched for entomological art-works. The still-life paintings especially flaunted the beauty of invertebrates, these included Dutch Rachel Ruysch 1711 "Still life with fruit" and Otto Marseus van Schrieck 1972 "Undergrowth with Flowers, Insects and Snakes", both were painters and naturalists who had scientific and almost taxonomical accuracy in painting their subjects. An afternoon stroll around the city showcased the world renowned and exquisite architecture as well as affording a couple of brief sightings of the Scarce Swallowtail butterfly (*Iphiclides podalirius*).

On the final day we were treated to a field excursion to a traditional terraced vineyard in Lamole, Tuscany. Here we discussed the importance of the traditional wine making practice for both cultural and biological diversity and the conservation of this traditional landscape. Unfortunately a major challenge of conserving these landscapes is the lack of a new generation willing to continue traditional practices. As we had lunch and sampled some of the produce we were once again treated to the iridescent presence of many Violet Carpenter bees (*Xylocopa violacea*) buzzing around the roof of the restaurant, some more Scarce Swallowtails (*Iphiclides podalirius*) and many tiny male Orange-tips (*Anthocharis cardamines*).

I was privileged to be selected to talk at this visionary European conference, to represent the UK and insect biodiversity and be supported by the Royal Entomological Society. I would advocate more outreach, research and communication on the importance of insects for both interlinked biological and cultural diversity as this is an emerging topic as demonstrated by this first collaborative conference organised by UNESCO and SCBD. The importance of insects in a cultural context was not explicitly discussed and more work on this area would be beneficial.

In my opinion there was a lack of applied ecological studies with the focus being mainly on describing rather than measuring traditional land management. This demonstrates that the representation of ecological, and particularly entomological research at future conferences dealing with the links of Biological and Cultural diversity should be encouraged to further understanding in this area.

Grace Twiston-Davies is a final year PhD candidate at the University of Reading whose research focuses on landscape ecology and restoration, and is interested in pursuing research in incorporating cultural aspects into landscape scale conservation.

Contact details grace.twiston-davies@hotmail.com, @Ec0l0gy.

For more information see http://www.unesco.org/new/en/natural-sciences/special-themes/biodiversity-initiative/biodiversity-culture/unesco-cbd-joint-programme/

Meeting Reports

First "European" Scarab Symposium at the NHM

This report is dedicated to the memory of Henry F. Howden (1925 - 2014), one of the greatest contributors to scarab systematics

Jorge Ari Noriega A.

Laboratorio de Zoología y Ecología Acuática - LAZOEA, Universidad de Los Andes

jnorieg@hotmail.com

The superfamily Scarabaeoidea contains a highly diversified cosmopolitan group of beetles including scarab beetles, bess beetles, stag beetles, hide beetles, rain beetles and many others. This group includes 14 families with approximately 2,200 genera and 35,000 species. Possibly the most well known features of this group are their segmented lamellate antennal clubs and their strong legs equipped with teeth, which are an important adaptation for digging. They have a varied diet, containing among them necrophagous, coprophagous, herbivorous, fungivorous, saprophagous, xylophagous and also a few predatory species. Some of them are agricultural pests while others are used as indicators of ecosystem health.

At a worldwide level, several meetings are organized related to this superfamily, including RELAS (Reunion Latinoamericana de Scarabaeoideologia – Latin American countries every two years since 1993), SOLA (Sacred Order of the Lamellate Antennae – USA every year since 1998) and JSS (Japanese Society of Scarabaeoidology – Japan every year since 2000). However, a specific meeting that deals with this taxonomic group did not exist in Europe in the past. Considering the importance of this superfamily, Maxwell V. L. Barclay, the curator and collection manager of the Coleoptera collection in the Department of Life Science at the Natural History Museum (NHM), decided to organise the first European Scarab Symposium which took place between the 31st July - 1st August 2014 at the NHM in London.

The two-day event took place in the Neil Chalmers Seminar Room in Darwin Centre II. Over two days, sixteen researchers from different countries and continents delivered interesting and exciting talks covering a wide range of topics, ranging from alpha-taxonomic studies to molecular phylogenetics and including subjects such as morphology, physiology, ecology, inventories, evolution and natural history. Using the words of Max Barclay: "the Symposium had a very diverse and varied schedule". Abstracts of talks, with a full summary, are available by email from Max Barclay.

Max Barclay opened the Symposium on Thursday with a warm welcome and charming talk about the Coleoptera collection, showing some amazing specimens collected by Darwin (Fig. 1). This was followed by Brett C. Ratcliffe who presented a collaborative work with Ronald Cave: "A biotic survey and inventory of the Dynastinae scarab beetles of Mesoamerica, the West Indies, and North America: a review of a long-term, multi-country project" (Fig. 2). After that Mary Liz Jameson gave an exquisite presentation of work with Anderson Puker: "Scarabs associated with termites and first report of a leaf chafer-termite association". Afterwards, Ronald D. Cave presented a complete analysis of: "Scarabaeoidea of Honduras". Later, Matthew R. Moore presented: "Exploring phylogeny and host plant shifts in Cyclocephalini (Scarabaeidae: Dynastinae)". The next talk was by Frank-T. Krell who presented a controversial study by various authors including Robert Angus and Tomas Roslin: "Making the cryptic visible - resolving the species complex of *Aphodius fimetarius* (Linnaeus) and *Aphodius pedellus* (de Geer) (Coleoptera: Aphodiidae) by three complementary methods". Thereafter, Jason F. Mate presented: "Detrivory to coprophagy: the Aphodine perspective". Finally that day, Robert B. Angus presented: "To chew or not to chew? Unexpected variation among Psammodiine mouth parts".

Figure 1. Max V. L. Barclay showing an entomological box with scarabs collected by Charles Darwin.

Brett C. Ratcliffe

Mary Liz Jameson

Ronald D. Cave

Frank-T. Krell

Jason F. Mate

Darren J. Mann

Alberto Ballerio

Conrad Gillett

Figure 2. Some of the speakers giving their talks at the Symposium.

Figure 3 (left). During the "icebreaker" party with all the amazing food and some jars of Pimms!!! **Figure 4 (right).** At the nice open roof garden in the Darwin Common Room.

Figure 5 (left). Even during the party there was always time to review some data. (L to R): Jason F. Mate, and Darren J. Mann. **Figure 6 (right).** Looking at some chafer beetles. (L to R): Matthias Seidel, Hitoshi Takano, and Milan Krajcik.

Figure 7 (left). Traditional London Friday pub lunch. (L to R): Robert Angus, Max Barclay, Brett Ratcliffe, Mary Liz Jameson, Hitoshi Takano, David Oram, Malcolm Kerley, Beulah Garner, Matthew R. Moore, Ronald Cave, and Maria Fremlin. **Figure 8 (right).** The "dung beetles" team. (L to R): Frank-T. Krell, Conrad Gillett, Darren J. Mann and Jorge Ari Noriega.

Figure 9. The whole group of speakers and assistants trying to do the customary "SOLA" salute.

During the afternoon, Robert Angus kindly showed some delegates the photography studio of the NHM and in the evening there was an "icebreaker party", an informal refreshments gathering in the Darwin Common Room, with a nice open roof garden (Figs 3-6). There was so much food and drink that there was enough left over for a second celebration the following day.

The meeting continued on Friday morning with a talk by myself: "Population effect of the invasion process of *Digitonthophagus gazella* (Coleoptera: Scarabaeinae) on native assemblages in Colombia". Then Darren J. Mann gave an entertaining and amusing talk: "Hope you like Scarabs: stuff we do in the Hope Entomological Collections". After that, Alberto Ballerio presented a much awaited talk that involved various authors like Frank Krell and Olivier Montreuil: "An enigma of scarabaeidology revealed: the re-discovery of *Belohina inexpectata* in Southern Madagascar, and its placement in Scarabaeoidea". Later, Hitoshi Takano presented a remarkable tribute to some important explorers with his talk: "Through the Dark Continent: Africa's Great Explorers and their scarabs". Afterwards, David Oram presented an inspiring talk in terms of collecting abilities: "Flower chafers of the genus *Eudicella*, subgenus *Cyprolais* from the Republic of Zambia". Thereafter, Matthias Seidel presented: "Molecular phylogenetics and evolution of the sub-Saharan Cetoniinae genus *Eudicella*". The next talk was by Conrad Gillett who presented an interesting work by various authors including Alfried P. Vogler: "Bulk *de novo* mitogenome assembly uncovers the root of all weevils (and potentially all scarabs!)". Finally, the last and most touching talk was by Malcolm Kerley who presented: "Concluding words: Informal reminiscences of 40 years in curation at the Natural History Museum".

Following a busy schedule we went for a traditional London Friday "pub lunch" (Figs 7-8). Other activities during the Symposium included visits to the Coleoptera collection, the entomological library and the rest of the Museum. In addition, there were some impressive exhibitions at the NHM like: "Britain: One Million Years of the Human Story", "Sensational Butterflies" and "Mammoths: Ice Age Giants". There were also a couple of posters presented at the meeting, including one from Conrad Gillett and other authors, including Darren J. Mann, titled: "Field parataxonomy vs Expert taxonomy: A preliminary comparison of their effects on interpreting community ecology in Ecuadorian dung beetles (Coleoptera: Scarabaeinae)".

It is also important to mention a selection of non-presenting delegates who attended the meeting and contributed with questions and in the discussion sessions: Alfried P. Vogler, Milan Krajcik, and Maria Fremlin. Any meeting like this involves a lot of effort in planning and organisation by many people. All the participants are thankful for the excellent logistics of the "NHM Coleoptera Team" composed of: Beulah Garner, Lydia Smith, Lucia Chmurova, Jessica Hughes and Friederike Gebert. Finally, a very special mention goes to Max Barclay, as this meeting would not have been possible without his important support and incredible coordination.

In conclusion, this first Scarab Symposium at the NHM was a great opportunity to meet other colleagues and arrange some academic collaborations, as well as catch up with old friends (Fig. 9). All the talks were nicely illustrated and organized, and the whole Symposium was an outstanding update of some of the latest research findings and the newer topics in Scarabaeoidea investigation. The meeting was phenomenal, everyone had a great time and I hope that the enthusiasm generated at this event leads to a second meeting next year!

Acknowledgements

I would like to thank the following people for providing me with information to complete this article: Beulah Garner, Lydia Smith, and Lucia Chmurova. To Conrad Gillett and David Oram for checking this report. To Conrad Gillett for sharing the photo

SCHEDULE OF NEW FELLOWS AND MEMBERS

as at 5th August 2014

New Honorary Fellows
Professor Christer Wiklund
Professor Paul R Ehrlich
Professor Bert H lldobler
Dr Robert M Pyle
Dr Alan J A Stewart
Dr Richard Harrington

New Fellows (1st Announcement)
Mrs Sally-Ann Barbara Mary Duchesne Spence
Professor Murray B Isman
Dr Youssef Dewer
Dr Andrew Spencer
Dr Sushil Kumar Jalali

Upgrade to Fellowship (1st Announcement)
None

New Fellows (2nd Announcement and Election)
Dr József Vuts
Professor G ran Arnqvist
Dr Himender Bharti
Dr Eleanor Slade (as at 4.6.14)

Upgrade to Fellowship (2nd Announcement and Election)
None

New Members Admitted
Dr Hong-Heng Goh (as at 4.6.14)
Dr Robert Iain Graham
Dr Juliane Marie Graham
Mr Peter Robert Eeles
Mr Arthur Elliott Matthewson

New Student Members Admitted
Mrs Ekhlas Al-Shareefi (as at 4.6.14)
Mr Andrew Gherlenda
Miss Celine Delabre
Miss Rachel Mary Wiltshire
Miss Elizabeth Donkin
Miss Victoria Wickens

Re-Instatements to Fellowship
Mr Trevor Beer M.B.E.

Re-Instatements to Membership
Dr John Baird

Re-Instatements to Student Membership
None

Deaths
Dr J C Woodward, 1991,County Durham

SCHEDULE OF NEW FELLOWS AND MEMBERS

as at 1st October 2014

New Honorary Fellows
None

New Fellows (1st Announcement)
Dr Dimitrios N Avtzis
Dr Joel González-Cabrera
Dr Elham Mohamed Ahmed Salama

Upgrade to Fellowship (1st Announcement)
None

New Fellows (2nd Announcement and Election)
Mrs Sally-Ann Babara Mary Duchesne Spence
Professor Murray B Isman
Dr Youssef Dewer
Dr Andrew Spencer
Dr Sushil Kumar Jalali

Upgrade to Fellowship (2nd Announcement and Election)
None

New Members Admitted
Mr Joe Gray
Mr Joseph James Monks
Mr James Birchall
Mr Dennis Fullwood
Dr Barbora Konopova
Dr Enric Frago

New Student Members Admitted
Mr Nicholas Hesford
Miss Ailie Robinson

Re-Instatements to Fellowship
None

Re-Instatements to Membership
None

Re-Instatements to Student Membership
None

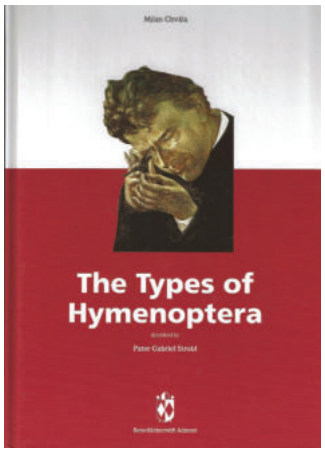
Deaths
None

Book Reviews

The types of Hymenoptera described by Pater Gabriel Strobl

By Milan Chvála

Benediktinerstift Admont, 2014, 152 pp. 49 plates.



As a young novice, Gabriel Strobl (1846–1925) entered the Benedictine Monastery of Admont in Austria at the age of 20 and remained there until his death. He was originally charged with rebuilding the monastery's natural history collection, which had been totally destroyed during a disastrous fire in 1865. This he did over the following decades, in addition to his many duties as a priest, and as part of this he also collected insects and rapidly became a specialist in the Diptera. He described some 902 Diptera, mainly from Austria but also from Spain, the Balkan Peninsula and other parts of the old Austro-Hungarian Empire. Professor Milan Chvála of Prague University spent several years curating Strobl's Diptera collection and in 2008 published an account of the Diptera types (*Studia dipterologica*, *Supplement* 17, 281 pp.).

Less well known is Strobl's activity as a hymenopterist, and now Professor Chvála, ably assisted by his wife, has written a magisterial account of Strobl's Hymenoptera types, comprising 279 species described in 19 papers published between 1895 and 1904. This is the result of numerous visits over four years to the monastery at Admont, and has also involved taxonomic collaboration with Hymenoptera specialists Dr Stephan Blank (Müncheberg, Germany) on the Symphyta and with the late Dr Klaus Horstmann (Würzburg, Germany) on the Ichneumonidae.

The opening chapters of this magnificent book describe the history of the Benedictine Monastery together with Strobl's life and activities within the monastery, and deal in some detail with Strobl as a hymenopterist and his Hymenoptera collection. There is also an overview of the collecting sites for Hymenoptera, arranged by country. The core of the book, almost 100 pages, is an enumeration of all the species of Hymenoptera described by Strobl, arranged alphabetically. Each species entry contains the original family assignment, the original combination and reference to the original description, a verbatim citation of the original locality(ies) and specimen(s), a detailed discussion of the type material including its condition, labelling, subsequent revisions, etc, and finally the current identity of the name. This section is followed by a list of the localities from which Strobl's Hymenoptera were described, giving their precise location, and four appendices: a systematic list of Strobl's species, an alphabetical list of Strobl's genera, the types in the collection of species described by other authors, and the taxa named after Strobl. A full list of references completes the account.

This is a beautifully illustrated book, with 47 mostly colour plates showing the monastery, the collection, and many of Strobl's collecting localities. For this alone it deserves to be not only in every Hymenopterist's library but also in every entomologist's library. Professor Chvála is to be congratulated on this outstanding and comprehensive tribute to the life and work of Strobl as a hymenopterist. Furthermore, the Benedictine monastery at Admont merits the appreciation of every entomologist for having recognised the value of Strobl's scientific work, for having carefully preserved his collection during the years since his death, and not least for underwriting the publication of this book.

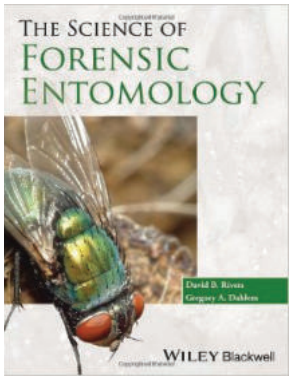
Adrian Pont, Oxford University Museum of Natural History

The Science of Forensic Entomology

David B Rivers & Gregory A Dahlem

Wiley Blackwell

ISBN 978-1-119-94037-1 Paperback £37.00 Hardback £95.00



This book forms a useful introduction to the science of forensic entomology and complements other textbooks that are currently available. It covers a relatively broad range of topics, some of which are perhaps less related to what is thought of as traditional forensic entomology, including topics such as 'insects as weapons of war and threats to national security' and 'deadly insects'. Whilst such chapters may be of a more sensationalist nature, this book also goes into some detail on areas which are fundamental to gaining an understanding of this applied science, with sections on the biology of the maggot mass and temperature tolerances, for example. However, given the importance of the collection and preservation of insect evidence in forensic entomology, this should perhaps have been given a chapter in its own right rather than being relegated to an appendix.

There are plenty of colour illustrations and photographs which help to bring the text to life. Each chapter is well structured and geared towards learning, with an overview and 'big picture' before the main body of the text followed by a review and tests with varying levels of difficulty. The review sections may possibly have benefitted from being more succinct. This book also forms a useful gateway into the research and more advanced literature that is available to the more interested reader, with plenty of references and supplementary reading listed throughout.

Overall, this book is a good introductory textbook to forensic entomology both for students and forensic practitioners who may be new to the field.

Dr Andrew Hart
Senior Forensic Scientist at Forensic Science Service Ltd

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

2015

Feb 16-17 **2015 Postgraduate Forum**
Venue: London School of Hygiene & Tropical Medicine
Convenor: Francisca Sconce (fsconce@harper-adams.ac.uk)

Mar 4 **Verrall lecture by Prof. Sue Hartley, University of York**
Venue: The Flett lecture theatre, NHM
Convenor: Dr Archie K. Murchie

May 26 **Joint Meeting of the Insect Ecology & Insect Conservation Special Interest Groups**
Venue: Rothamsted Research
Convenor: Dr Jenni Stockan (jenni.stockan@hutton.ac.uk)
Confirmed speakers:
Prof. Francis Ratnieks
Prof. Lotta Sundström

June 3 **RES AGM**
Venue: The Mansion House, St Albans

Sept 2-4 **Ento' 15 Annual Science Meeting and International Symposium**
Insect Ecosystem Services
Venue: Trinity College Dublin
Convenors: Drs Jane Stout, Olaf Schmidt, Archie K. Murchie, Eugenie Regan, Stephen Jess, Brian Nelson
Speakers confirmed to date:
Janne Bengtsson (Uppsala, Sweden)
Sarah Beynon (Pembrokeshire)
Jerry Cross (East Malling)
Tom Bolger (Dublin)
Dave Goulson (Sussex)
Alexandra-Maria Klein (Freiburg, Germany)
Simon Leather (Harper-Adams)
Craig Macadam (Buglife, Stirling
Sarina Macfadyen (CSIRO, Australia)
Jane Memmott (Bristol)
Charles Midega (ICIPE, Kenya)
Michael D. Ulyshen (USDA – Forest Service, USA)

2016

Sep 5-8 **Ento'16**
Venue: Harper Adams University College, Shropshire
Convenor: Prof. Simon Leather

Other Meetings

2014

13 Dec **Terrestrial Heteroptera to Family Level**
British Entomological and Natural History Society
Venue: Natural History Museum
Convenors: Jim Flanagan (Yorkshire), Tristan Bantock (London)
Introduction to the identification of true bugs covering most of the members of families commonly encountered such as shieldbugs and plantbugs and particularly those that are easy to identify in the field. There will be collections of specimens to examine and some identification keys to try out.
Contact: Dr. Mike Edwards, BENHS Indoor Meetings Secretary (m.edwards787@btinternet.com)

2015

13 Jan **Aberdeen Entomological Club – Katie Murray "The march of the harlequin ladybird"**
Venue: The James Hutton Institute, Aberdeen (3.30pm)
Contact: Dr Jenni Stockan (jenni.stockan@hutton.ac.uk)

17 Jan **Terrestrial Heteroptera to Family and Species Level**
British Entomological and Natural History Society
Venue: Dinton Pastures, Reading
Convenors: Jim Flanagan (Yorkshire), Tristan Bantock (London)
Intermediate level identification of true bugs covering several of the more popular families, but we will be able to cater for a variety of levels of knowledge of the group on the day. There will be collections of specimens to examine and identification keys will be available to try out for many groups.
Contact: Dr. Mike Edwards, BENHS Indoor Meetings Secretary (m.edwards787@btinternet.com)

24 Jan **An introduction to leafhoppers and allied groups**
British Entomological and Natural History Society
Venue: Dinton Pastures, Reading
Convenors: Alan Stewart (Sussex) and Tristan Bantock (London)
An intermediate-level workshop on the identification of leafhoppers, planthoppers, froghoppers and treehoppers (Auchenorrhyncha). We will start with a short presentation to help with some of the more challenging diagnostic characters used to identify these insects, after which participants will be able to work through their own material or specimens made available on the day and have their identifications verified.
Contact: Dr. Mike Edwards, BENHS Indoor Meetings Secretary (m.edwards787@btinternet.com)

31 Jan **Tachinidae identification workshop**
British Entomological and Natural History Society
Venue: Dinton Pastures, Reading
Convenors: Matt Smith (Winnersh), Chris Raper (Reading)
An introduction to sampling and identifying Tachinidae, with new draft keys for a revised RES Handbook available for testing and the chance to have your specimens checked and verified by the organisers of the National Recording Scheme.
Contact: Dr. Mike Edwards, BENHS Indoor Meetings Secretary (m.edwards787@btinternet.com)

7 Feb **XII Coleopterists' Day**
British Entomological and Natural History Society
Venue: University Museum of Natural History, Parks Road, Oxford
Starting with talks in the morning there will also be updates on beetle recording and discussions. During the afternoon those attending can display exhibits on beetles, consult the library and collections, purchase publications from Pemberley Books or catch up with the latest beetle news.
Contact: Dr. Mike Edwards, BENHS Indoor Meetings Secretary (m.edwards787@btinternet.com)

14 Feb **An Introduction to the Identification of British Curculionoidea**
British Entomological and Natural History Society
Venue: Dinton Pastures, Reading
Convenors: Peter Hodge (Lewes), Roger Booth (NHM)
An introductory workshop that will introduce the superfamily for those just starting the Curculionoidea. It will concentrate on separating families, subfamilies and larger tribes. Species from typical genera will be used to illustrate the major differences between these groupings.
Contact: Dr. Mike Edwards, BENHS Indoor Meetings Secretary (m.edwards787@btinternet.com)

17 Feb **Aberdeen Entomological Club – Iain Lawrie "Insect photography: macrophotography skills and techniques for use in the field"**
Venue: The James Hutton Institute, Aberdeen (3.30pm)
Contact: Dr Jenni Stockan (jenni.stockan@hutton.ac.uk)

21 Feb **Staphylinidae identification workshop**
British Entomological and Natural History Society
Venue: Dinton Pastures, Reading
Convenors: Roger Booth (NHM), Peter Hodge (Lewes)
The leaders will introduce the family for those just starting Staphylinidae, concentrating on separating subfamilies in the morning, and going on to tackle the identification of some of the more difficult groups in the afternoon.
Contact: Dr. Mike Edwards, BENHS Indoor Meetings Secretary (m.edwards787@btinternet.com)

28 Feb **IV Hemipterists' Day**
British Entomological and Natural History Society
Venue: Dinton Pastures, Reading
A mixture of talks and informal discussions, as well as an identification clinic to help with problem specimens. Please book with Mike Edwards so that we know in advance how many will be coming to this meeting.
Contact: Dr. Mike Edwards, BENHS Indoor Meetings Secretary (m.edwards787@btinternet.com)

7 Mar **Ground Beetle (Carabidae) identification workshop**
British Entomological and Natural History Society
Venue: Dinton Pastures, Reading
Convenors: Mark Telfer (Bedfordshire), John Walters (Devon)
Workshop will help beginners and experts alike to find and identify British and Irish carabids. The programme will start with a brief talk covering new topics of interest, followed by an identification session helping beginners to identify carabids to genus, as well as providing tuition on some of the more difficult genera for more advanced carabidologists. We can cover the key techniques (carding, dissection, and handling carabids for field identification) and cover any identification problems, with a little prior notice.
Contact: Dr. Mike Edwards, BENHS Indoor Meetings Secretary (m.edwards787@btinternet.com)

10 Mar **Aberdeen Entomological Club – Catriona McIntosh "Cat fleas: new approaches to a familiar pest"**
Venue: The James Hutton Institute, Aberdeen (3.30pm)
Contact: Dr Jenni Stockan (jenni.stockan@hutton.ac.uk)

Mar 14-15 **Introduction to Fly families (Diptera)**
British Entomological and Natural History Society
Venue: Dinton Pastures, Reading
Convenors: John and Barbara Ismay (both Long Crendon), Dipterists' Forum
This workshop introduces the order to beginners and we will place emphasis on the families for which Recording Schemes exist. Dipterists' Forum has produced a draft key, which BRC will print for each participant. The workshop includes tutorials throughout the two days, mostly on identification, but also on habitat preferences. Collection techniques and basic advice on how to store specimens will be covered.
Contact: Dr. Mike Edwards, BENHS Indoor Meetings Secretary (m.edwards787@btinternet.com)

28 Mar **Sawfly identification workshop**
British Entomological and Natural History Society
Venue: Dinton Pastures, Reading
Convenors: Andrew Halstead (Woking), John Grearson (Ashton Keynes), Guy Knight (Liverpool)
The workshop will deal with the identification of adult Sawflies for beginners, as well as helping those wishing to tackle more difficult genera.
Contact: Dr. Mike Edwards, BENHS Indoor Meetings Secretary (m.edwards787@btinternet.com)

11 Apr **An introduction to the Hymenoptera aculeata**
British Entomological and Natural History Society
Venue: Dinton Pastures, Reading
Convenors: Mike Edwards (Midhurst), Graham Collins (South Croydon)
Day will start with an illustrated discussion of the main life-histories within group and then move to the microscopes for identification of these; using specimens held at Dinton Pastures, but also anything brought along by participants. It is not likely that much species-level identification will be covered. Keys to help you get to the aculeate groups will be provided.
Contact: Dr. Mike Edwards, BENHS Indoor Meetings Secretary (m.edwards787@btinternet.com)

18 Apr **Ichneumonidae general surgery**
British Entomological and Natural History Society
Venue: Dinton Pastures, Reading
Convenors: Gavin Broad (NHM), Mike Fitton (NHM)
Please bring along any ichneumonid specimens that you have tried to identify and would like confirming. Covering the nocturnal species, following recent work on species complexes, and answering any ichneumonid problems, as far as we are able.
Contact: Dr. Mike Edwards, BENHS Indoor Meetings Secretary (m.edwards787@btinternet.com)

13-15 May **Benefits and Risks of Exotic Biological Control Agents**
Venue: Bornholm, Denmark
Contact: Dr Peter Brown (peter.brown@anglia.ac.uk)
The IOBC (International Organisation for Biological and Integrated Control) was established to promote environmentally safe methods of pest and disease control in plant protection. This is an open conference of an IOBC Working Group on the Benefits and Risks of Exotic Biological Control Agents. Exotic insects (particularly predators and parasitoids) are the main study area; the use of ladybirds as biological control agents is a key theme. The conference will take place on the island of Bornholm, an unusual and beautiful location.
See here for more information: http://exoticbca2015.wordpress.com/

31 May-5 Jun **XIV International Conference on Ephemeroptera and XVIII International Symposia on Plecoptera**
Venue: The James Hutton Institute, Aberdeen
Convenors: Craig Macadam (craig.macadam@buglife.org.uk), Dr Jenni Stockan (jenni.stockan@hutton.ac.uk)
Keynote speakers: Dr Ben Price, Prof. Steve Ormerod, Dr William Darwall, Robert Boyle
See http://www.hutton.ac.uk/events/international-conference-ephemeroptera-and-plecoptera for more details

Royal Entomological Society Postgraduate Forum

16th - 17th February 2015
London School of Hygiene & Tropical Medicine

A two-day meeting for early-career postgraduate researchers in entomology

To register visit:
www.royensoc.co.uk/meetings

Confirmed Speakers:

Professor Adam Hart
Uni. of Gloucestershire

Dr James Logan
LSHTM

Dr Erica McAlister
Natural History Museum

Richard Jones
Author & Blogger

Dr Mary Cameron
LSHTM

To submit a talk or poster abstract (<250 words) or for more information, contact Joe Roberts:
jroberts@harper-adams.ac.uk

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antenna
author guidelines

Aims and scope
As the Bulletin of the Royal Entomological Society (RES), *Antenna* publishes a broad range of articles of relevance to its readership. Articles submitted to *Antenna* may be of specific or general interest in any field related to entomology. Submissions are not limited to entomological research and may, for example, include work on the history of entomology, biographies of entomologists, reviews of entomological institutions/methodologies, and the relationship between entomology and other disciplines (e.g. art and/or design).
Antenna also publishes Letters to the Editor, Meeting Reports, Book Reviews, Society News, Obituaries and other items that may be of interest to its Readership (e.g. selected Press Releases). *Antenna* further includes details of upcoming entomological meetings in its Diary Section and features information and reports on RES activities including National Insect Week, Insect Festival and National, Regional and Special Interest Group meetings. Details of RES Awards and recipients are also covered, as is notification of new Members (MemRES), Fellows (FRES) and Honorary Fellows (HonFRES).

Readership
Antenna is distributed quarterly to all Members and Fellows of the RES, as well as other independent subscribers.

Instructions for authors
Standard articles are normally 2,000-6,000 words in length, though shorter/longer submissions may be considered with prior approval from the Editorial Team. The length of other submitted copy (e.g. Letters to the Editor and meeting reports) may be shorter, but should not normally exceed 2,000 words. The use of full colour, high quality images is encouraged with all submissions. As a guide, 4-8 images (including figures) are typically included with a standard article. Image resolution should be at least 300 dpi. It is the responsibility of authors to ensure that any necessary image permissions are obtained.
Authors are not required to conform to any set style when submitting to *Antenna*. Our only requirement is that submissions are consistent within themselves in terms of format and style, including that used in any reference list.

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Review and publication process
All submissions are reviewed and, where necessary, edited 'in-house' by the *Antenna* Editorial Board, though specialist external review may be sought in some cases (e.g. for submissions that fall outside the Editorial Boards expertise). Receipt of submissions will be provided by email, with submitting authors of accepted articles being offered the opportunity to approve final pdf proofs prior to publication. Where appropriate, authors will be requested to revise manuscripts to meet publication standards.

Submission process
All submissions should be sent electronically to 'antenna@royensoc.co.uk', preferably in MS Word format with images sent as separate files (see above). Image captions and figure headings should be included either with the text, or as a separate file.

Editorial Board