Antenna

Volume 46(4) | 2022

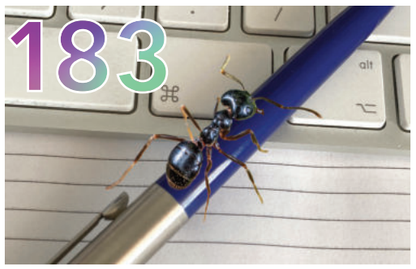
Royal Entomological Society

CONTENTS

Volume 46(4) | 2022

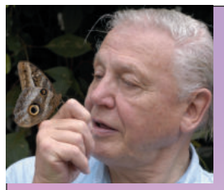
Members' memorials – John Walton's window

Getting a handle on the big picture: how habitat loss and climate change impact insects globally



Exam ant-ticks

Two societies, similar aims



Antenna's Author Guidelines are published in full online at www.royensoc.co.uk/antenna-author-guidelines

Submissions are made by email to *antenna@royensoc.co.uk* and reviewed by *Antenna's* editorial team. There are no page charges for publication in *Antenna*, where we encourage use of full colour figures and photographs to accompany text. Standard articles are normally 1,000–3,000 words in length and submitted with four to eight images (file should be original size of image taken and not reduced in size nor cropped heavily).

Cover Picture: Weaver ant is trying hard to cross to the other side. Image by Alland Dharmawan.

Editorial

In this issue our Librarian and Archivist, Rose Pearson, outlines the history of our Society's long relationship with our late Patron, Her Majesty Queen Elizabeth II. Our Archives hold several items associated with this period in our history, which are available to view on request.

Ian Hodkinson, in a further historical article, pays tribute to John Walton, who was elected to our Society in its foundation year and subsequently became its President. A stained-glass window in a Knaresborough church is dedicated to him. Ian is "…left wondering how many similar unrecognised gems are associated with our past members". Entomologists can pop up in surprising places, such as when I discovered that the GP surgery I attend was founded by the noteworthy coleopterist Alan Easton, who became a Fellow of the Society in 1940. Further information on Easton and other notable coleopterists may be found in the rich online resource assembled by Michael Darby – well worth a browse, as some of you might even be in it! (https://www.coleoptera.org.uk/biographical-dictionary).

Also in my locality are three entomologists who are dental surgeons, and getting one's teeth into insects is the subject of the report on the 2022 Insects as Food and Feed SIG (p. 199). A further report on a somewhat related use of insect breeding, by Luke Tilley, describes his visit to the FERA Science insect conversion unit at York, which processes the conversion of food waste into Black Soldier Fly larvae.

The continuing activity and enthusiasm of our Society is abundantly clear from the articles in this issue, with reports of both scientific and outreach meetings ranging from ENTO22, EntoSci22 and ICE22, as well as grant award winners. Richard Harrington reports on a particularly interesting joint meeting with the Royal Aeronautical Society, for which insects can pose particular problems.

On the important topic of invertebrate conservation, Charlie Outhwaite summarises the results of her group's research at UCL, originally published in *Nature*, into the effects of land-use change and climate change, and of their interactions, on insect biodiversity. Broadly, their evidence suggests that the pursuit of less intensive agriculture in areas where there are nearby natural habitats holds out the best hope for the future.

Finally, of particular interest is the summary of member benefits on page 226, along with the announcement of an additional benefit from the New Year: something to cheer us up a little as we move into the British midwinter.

I take this opportunity to wish you all a happy festive season, wherever you are in the world.

Dafydd Lewis

Antenna

Index and online copies

Index

All articles, correspondence, obituaries and meeting reports published in Antenna from 1977-1983 and from 2002 onwards are indexed and can be searched within the Library Catalogue, Heritage Cirqa. Issues from 1984-2002 are currently being indexed. You no longer need to log-in to view the catalogue. To search the indexed articles, visit http://heritage.royensoc.co.uk, select the "Advanced" option and select "Antenna" from the 'Media type' box. To expand your search to other sources, change the media box to 'All Media'. Please contact the librarian (library@royensoc.co.uk) if you have any queries.

Online issues

Antenna issues can be found at www.royensoc.co.uk/publications/antenna. Issues over five years old can be accessed by anybody. Newer issues can only be accessed by Fellows and Members. To log in for the first time please follow the instructions at www.royensoc.co.uk/how-to-log-in-to-our-new-website. Thereafter, logging in at www.royensoc.co.uk/my-account will allow you access to all available issues – and a host of other services.

Antenna

Bulletin of the Royal Entomological Society

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

General enquiries:
Tel: +44(0)1727 899387
E-mail: info@royensoc.co.uk

Editors
Dr Richard Harrington (UK)
Dafydd Lewis (UK)
Dr Tom Pope (Harper Adams University, UK)

Editoral Assistant
Dr Jennifer Banfield-Zanin (UK)

Associate Editors
Dr Jesamine Bartlett (Norway)
Andrew Boardman (University of Hertfordshire, UK)
Benjamin Chanda (Zambia)
Kimberly Gauci (Open University, Malta)
Prof. Jim Hardie (RES)
Prof. Adam Hart (University of Gloucestershire, UK)
Dr Richard Jones (UK)
Dr Louise McNamara (Teagasc, Ireland)
Dr Alice Mockford (University of Kiel, Germany)
Sajidha Mohammed (University of Calicut, India)
Moses Musonda (Broadway Secondary School, Zambia)
Jane Phillips (Royal Agricultural College, UK)
Prof. Stuart Reynolds (University of Bath, UK)
Dr Josh Jenkins Shaw (Natural History Museum of Denmark)
Peter Smithers (UK)
Patrick Vyvyan (Chile)

COPY DATES
For *Antenna* **47**(1) – 1st January 2023
For *Antenna* **47**(2) – 1st April 2023

Subscription Rates 2022
For the latest rates please visit www.royensoc.co.uk/membership

Printed by Andrew Smith Print Ltd
Chelmsford, Essex
e-mail: andrew@asmithprint.co.uk

Letter from the President

I'm writing this letter as our extremely hot UK summer seems to have come to an abrupt halt and we embrace autumn. For many of us in the northern hemisphere, this move to autumn and winter ends our interactions with insects for another year. This summer has been exceptionally hot and dry, and it will be important to understand how these climate-driven changes in our environment are affecting insects, and how the RES can help support insect science to understand trends and so help boost biodiversity. Of course there is variation in which insects are increasing and declining during the Anthropocene, and which locations are seeing most changes. This leads to important discussions about which insect species and habitats to focus research and resources on, and how we can gain a better understanding of how to support species that we 'like', *i.e.,* those that have cultural and ecosystem service benefits, such as pollinators, decomposers, predators and rare iconic species, as well as controlling those species we 'dislike', such as crop pests and insect vectors of disease.

As a Member or Fellow of the RES, I don't need to convince you of the importance of insects, but it is clear that we need to do more to instil the excitement of entomology to the wider public, and to inspire them to engage with insects and understand how 'formidable and valuable' insects are, which of course is at the heart of one of the RES's Strategic Priorities. Understanding how people connect with entomology, and what sparks their interest, is important. Living in York, it's great that Tansy Beetles (*Chrysolina graminis*) have become associated with the city, given that this was the only place in the UK where they were found. I'm not sure how many people notice the mural, or appreciate its significance, but it's great to have such an amazing insect as public art – and its iridescence reminds me of the revamped RES logo and branding. Of course, the city of Manchester is probably much better associated with an insect given its well-known bee emblem, which the city's Victorian forefathers thought well represented the city's industrious workers. These bee symbols are found in many places around the city, and as a past student of the University of Manchester I'm delighted it's also on the University's coat of arms. Thus, insects are embedded in many parts of our lives, even when the summer has passed, although, unlike other animals such as birds, insects rarely appear as pub names – the Chequered Skipper pub being an exception.

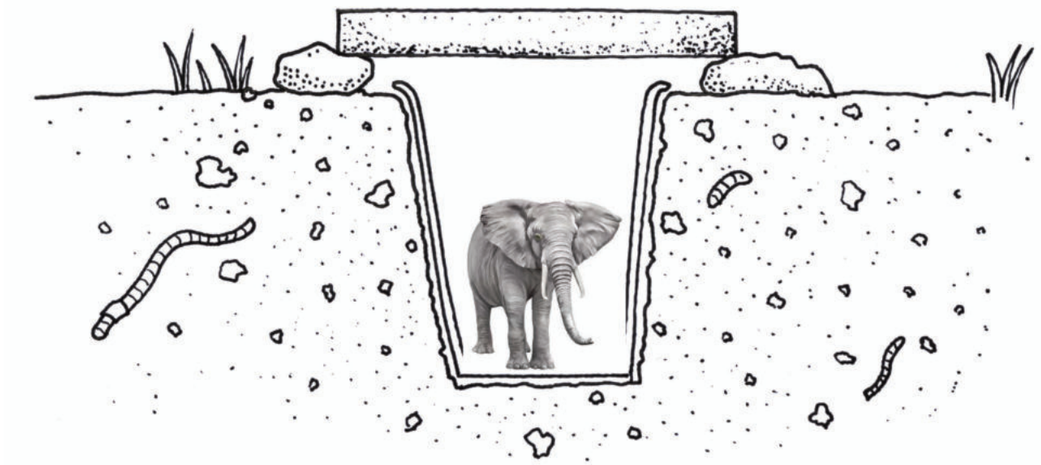
Tansy Beetle mural in York (other hotels are available!)

It was great to meet up with so many entomologists at #Ento22 at the University of Lincoln. There were so many exciting talks and posters, and for many people it was one of the first times they have been able to meet up in person. Running the meeting in a hybrid way was great to ensure that meetings (or at least the talks) were open to as many people as possible, and it will be interesting to see how these hybrid meetings can be improved in future. I'd like to thank the organisers at Lincoln, as well as all the RES staff, for organising such a great event, and all the speakers and people who offered posters for presenting such inspiring research. I'd particularly like to thank the plenary speakers – Sylvain Pincebourde, Jessica Ware and Nalini Puniamoorthy - and don't forget, you can listen to their talks on YouTube if you weren't able to attend Ento22. If you are keen for more exciting insect science, don't forget to join the new programme of online evening talks, which are being held on the first Wednesday of most months – check the RES web site for more details.

Manchester bee.

Jane Hill
President
Royal Entomological Society

Correspondence



Confessional

Reading Van's enjoyable piece on the vagaries of PhD theses and vivas ('Exam ant-ticks', this issue) brought to mind one for which I was responsible and to which I now confess. I will keep names out of it. In my early days at Rothamsted, whilst still writing up my own PhD and grappling with my first paid employment, my boss asked me to identify a large number of aphids caught in pitfall traps by a student of a friend of his at Durham University. I was a little miffed but, being a thoroughly decent (meek) sort of chap and not wanting to incur any wrath, I obliged. Irritation, though, got the better of me and, into the list of aphids which I provided, I slipped '*Loxodonta africana* – 1'. I did get to look at the thesis and was delighted to see that said student's pitfall traps had captured one African Elephant. Does anybody else have any confessions?

Richard Harrington

Royal Wanderer: King William III, King Charles III and the royal reign of the Monarch Butterfly

Photo courtesy of Kenneth Frank

With the passing of HM Queen Elizabeth II, the longest-reigning monarch in British history, the monarchy has entered a new chapter with the ascension of King Charles III. A beloved butterfly that has reigned for millions of years was also bestowed royal status. The Monarch Butterfly was named for King William III, also known as the Prince of Orange. The orange-black coloured butterfly is also referred to as The Wanderer. The Monarch migration patterns and its beauty capture our imagination and touch our hearts. The Monarch Butterfly was recently designated as endangered by the International Union for the Conservation of Nature, due to threats to its habitat and climate change. We have a duty to protect the environment, and to ensure that the Monarch will thrive.
This lovely photo was taken by fellow physician Kenneth Frank, friend of my physician/entomologist mentor Martin Heyworth. The photo highlights the Royal Wanderer in its travels across America, sipping nectar in the heart of this orange flower during its long journey.

Mary Rorro

The ‘silo’ mentality in research

Fig. 1: *Orius laevigatus* a predator of thrips and other soft-bodied pests. From **45**(2): 169. Image: ©Tom Pope

The article by Leather *et al*. lamenting the lack of wider collaboration in Integrated Pest Management (IPM) in *Antenna* 46(2) was ‘music to my ears’, especially when I read “…collaborative working will be essential if IPM programmes are to become more than a sum of their parts…”. In statistical analyses, when the effect of two or more treatments is greater than additive, we say there is positive ‘interaction’. This was the theme of my presidential address to the Society nearly 40 years ago, entitled *Pest management - routes and destinations* (van Emden, 1983; *Antenna* **7,** 163–168). In my address I took three pest control tools: insecticides, biological control and host plant resistance, to demonstrate unexpectedly large positive synergism between them in all paired combinations as well as in the three-way interaction. IPM indeed has its origin in a perhaps unexpectedly positive interaction between biological control and insecticides that controlled pesticide-resistant Alfalfa Aphids in California (Stern *et al*., 1959; *Hilgardia* **28**, 81–101). At the time this was called ‘integrated control’, but B.P. Beirne in Canada later captured the bandwagon under the IPM banner, where IPM was defined as “the reduction of pest problems by actions selected after the life systems of pests are understood and the ecological as well as economic consequences of these actions have been predicted, as accurately as possible, to be in the best interests of mankind” (Rabb, 1970; Introduction to Rabb & Guthrie, eds, *Concepts of Pest Management*, South Carolina State University, Raleigh). If you bear in mind that the word ‘pests’ in this definition includes diseases and weeds as well as insects, then it was sadly inevitable that IPM moved the momentum from practical solutions for farmers to a nebulous concept of aspiration. Not surprisingly, interactions between insect, disease and weed control have been even less explored than interactions between insect control measures.

So, I applaud Leather *et al.*’s article for urging applied entomologists to abandon the ‘silo’ mentality, for that is the route from IPM as a concept to IPM as a recipe.

Helmut van Emden
University of Reading
h.f.vanemden@reading.ac.uk

The intrinsic benefits of polymorphism

Sir,

It was a pleasure to read Stuart Reynolds’ recent piece on insect polymorphism (Reynolds, 2022), which neatly outlined some very interesting history of the topic and introduced me to the intriguing case of red-green polymorphism in aphids. Towards the end of his article, he considers the notion that polymorphism in a population may be intrinsically advantageous—an idea he considers unpersuasive. While I do not wish to disagree with his primary assertion that polymorphism need not be in and of itself advantageous to explain its widespread occurrence in insects, I do think that there is at least the potential for this to be true in certain circumstances. Dobzhansky (1951) argued that a polymorphic population may be at an advantage over a monomorphic population where environmental conditions are variable or changing. I don’t think that it is fair to call this group selectionist, as Professor Reynolds suggests, though the concept is perhaps poorly expressed and in such a way as to give that impression. Indeed, it seems to me that the criticisms levelled at this idea by Cain *et al.* (1954) and Fisher (1958) were largely semantic. Fisher, for example, writes that:

“[It is] my personal opinion that Dobzhansky (*op. cit*., p. 290) was right in regarding polymorphism as very often properly described as an adaptation to the conditions of life in which a species finds itself, but for reasons quite distinct from the direct action of Natural Selection, by which the polymorphism is maintained, or indeed from Natural Selection as it acts among the individuals of any one interbreeding population.”

In other words, it is justifiable to regard polymorphism as an adaptation, but polymorphic populations are not selected for or directly favoured over monomorphic populations—natural selection, Fisher contended, acts at the individual level to promote polymorphism, and often for different reasons. To bring us back to insects, E.B. Poulton considered dimorphism in the caterpillars of the Large Emerald Moth *Geometra papilionaria*:

“I believe that it is a benefit to the species that some of its larvae should [be] brown and others green [so that their] foes have a wider range of objects for which they may mistake the larvae, and the search must occupy more time, for equivalent results, than in the case of other species which are not dimorphic” (Poulton, 1890, p47).

That is to say, a dimorphic population is at an advantage over a monomorphic one, but it is not at the population level that selection is taking place. An individual benefits from being part of a variable population such that selection does not eliminate the alleles giving rise to that variation. In these examples, polymorphism *per se* is advantageous, but it is not (necessarily) selected for at higher levels.

In environments which are highly variable and/or unpredictable, high levels of phenotypic variation can be favoured among the offspring of a single individual as a diversified bet-hedging strategy to maximise geometric (though not necessarily arithmetic) fitness (Dempster, 1955; Cohen, 1966). Fisher (*op. cit.*) himself makes essentially this point: that sometimes, even at an individual level, variety and deviation from the mean is the best strategy. Continuous environmental variation can also maintain analogous phenotypic variation (via ‘portfolio effects’; Schindler *et al*., 2015) — this, in turn, could provide a pool of genetic variation for selection to act on under changing future conditions. Whether it makes sense to consider such a variable (or genetically polymorphic) population as inherently ‘better adapted’ by dint of its potential evolvability in the face of future change is open to question, but it can certainly be thought of as *buffered* against future changes (Weir, 2022).

Professor Reynolds briefly mentions apostatic selection (Bond, 2007) as a force driving the evolution of colour polymorphism in the wild—a topic I have written on at some length (Weir, 2018, 2021). A related but subtly distinct situation, whereby individuals derive benefit through polymorphism itself, is the ‘protective polymorphism hypothesis’ (Karpestam *et al*., 2016). If insects occur in dense enough populations such that a potential predator can view many prey items simultaneously in their field of vision, then variation in prey colouration could contribute to the visual complexity of the environment which predators must process in order to find them. Due to inherent limits on attention and processing abilities, prey colour polymorphism means that predators take longer to find their prey (and perhaps find fewer). Here the protective effects of polymorphism act only when in a large group of variable individuals (*i.e*., the group-level polymorphism confers the benefits), even though the resulting selective pressure is for variety and distinctness at the individual level—in isolation (in a more dispersed population) this particular mechanism would not operate. Protective polymorphism is distinct from apostatic selection where predators *fail to perceive* certain specific prey items which differ from their pre-formed expectation (their ‘search image’).

The extent to which these different mechanisms operate to generate variation in nature is far from fully understood. Nonetheless, I think it is reasonable to maintain that it can make sense to think of polymorphism as an adaptation which can be beneficial in and of itself under certain circumstances. But the way in which these benefits translate themselves into individual-level selective advantage, as in the case of diversified bet-hedging, for example, is often rather complex.

Jamie C. Weir
University of Edinburgh
Email: Jamie.Weir@ed.ac.uk

References

Bond, A.B. (2007). *Annual Review of Ecology, Evolution, and Systematics* **38**, 489–514.

Cain, A.J. *et al.* (1954). *The American Naturalist* **88**, 321–326.

Cohen, D. (1966). *Journal of Theoretical Biology* **12**, 119–129.

Dempster, E.R. (1955). *Cold Spring Harbor Symposia on Quantitative Biology* **20**, 25–32.

Dobzhansky, T. (1951). *Genetics and the origin of species*. Columbia University Press, New York.

Fisher, R.A. (1958). *The Journal of Ecology* **46**, 289–293.

Karpestam, E. *et al.* (2016). *Scientific Reports* **6**, 1–10.

Poulton, E.B. (1890). *The Colours of Animals: their meaning and use especially considered in the case of insects*. Kegan Paul, Trench, Trubner, & Co. Ltd., London.

Reynolds, S. (2022). *Antenna* **46**, 60–68.

Schindler, D.E. *et al.* (2015). *Frontiers in Ecology and the Environment* **13**, 257–263.

Weir, J.C. (2018). *Journal of Evolutionary Biology* **31**, 1109–1126.

Weir, J.C. (2021). *eLS* **2**, 1–10.

Weir, J.C. (2022). *Buffering and trophic mismatch in spring-feeding forest caterpillars*. PhD thesis, University of Edinburgh.

Members' memorials – John Walton's window

The lives of the more illustrious members of our Society are celebrated by conspicuous and well-known memorials. Charles Darwin is buried in Westminster Abbey where his commemorative slab is accompanied by a bust and wall plaque; a bronze statue of the young Darwin, by Anthony Smith, sits outside Christ's College, Cambridge. Alfred Russel Wallace is similarly celebrated by a bronze statue, crafted by the same sculptor, which gazes upwards outside the Darwin Centre at the Natural History Museum in London.

What about our less feted members? While researching the correspondents of Thomas Coulthard Heysham (*Antenna* 46(2) 73–77) I stumbled across a magnificent stained-glass window dedicated to John Walton of Knaresborough (1784–1863), who was elected a member of our Society in its foundation year 1833, became Vice-President (1840–41 and 1846–47) and served three terms on Council (Neave, S.A. *et al.*, 1933). He was also an active member of the Entomological Club.

Born into a wealthy family in Knaresborough, Yorkshire, Walton moved to Islington, London, where he worked in his uncle's business before returning permanently to his home town around 1856. Obituaries were published in our Society's *Proceedings* and in those of the Linnean Society, to which he was elected in 1845 (Anon., 1863a, b). His initial entomological forays were with Lepidoptera but around 1835 his attention turned to Coleoptera, particularly weevils (Walton, 1835). Over the next 20 years he re-wrote our understanding of the British weevil fauna in a series of around 20 papers, published primarily in the *Entomological Magazine* and the *Annals and Magazine of Natural History* and culminating in a checklist of the British species published by the British Museum in 1856 (Walton, 1835–1865, 1856). Summaries of several of these papers were published in German in *Entomologische Zeitung*.

John Walton's memorial window (see figure) sits at the east end of the south aisle of Holy Trinity Church, Knaresborough, where it was installed three years after his death, thereby escaping the immediate attention of his obituarists (Anon., 1866, 1867).

Ian D. Hodkinson
Liverpool John Moores University
(i.d.hodkinson@ljmu.ac.uk)

An accompanying brass plaque bears the inscription:

> To the Memory of John Walton ob^{t} January 3rd 1863
> Æ78 years and Eliza Walton ob^{t} April 28th 1843 Æ 39 years
> This Window is affectionately inscribed
> by John Walton their son

The ornate window "consists of two lights, the subject being the raising of Lazarus, and Mary at the feet of Jesus". The artists were Messrs Ward and Hughes of London whose more famous works include the east window of Lincoln Cathedral (Anon., 1866, 1867).

One is left wondering how many similar unrecognised gems are associated with our past members.

Acknowledgements

I thank Denise Cullingworth, churchwarden at Holy Trinity, for sending me images of the Walton window and plaque, with permission to publish. Rose Pearson, our librarian, kindly searched the archives for confirmatory details of Walton's addresses while living in London.

References

Anon (1863a) *Proceedings of the Entomological Society of London*, 125–127.
Anon (1863b) *Proceedings of the Linnean Society*, 24 May 1863, xliv–xlvi.
Anon (1866) Trinity Church Knaresborough, *Yorkshire Post and Leeds Intelligencer*, 31 December 1866, 3.
Anon (1867) Trinity Church, *Richmond and Ripon Chronicle*, 5 January 1867, 4.
Neave, S.A. *et al.* (1933) *The History of the Entomological Society of London, 1833–1933*, London.
Walton, J. (1835) *Entomological Magazine* **1**, 205–212 & 277–280.
Walton, J. (1835–1856) For full publication list see https://www.biodiversitylibrary.org/search.
Walton, J. (1856) *List of British Curculionidae with Synonyma*, British Museum, London, UK.

Getting a handle on the big picture: how habitat loss and climate change impact insects globally

Large Red Damselfly, *Pyrrhosoma nymphula*. Image: Charlie Outhwaite.

I know that I am stating the obvious to *Antenna* readers, but we know that insects are incredibly important. They are not only a unique form of life on our diverse planet, but are also the providers of numerous essential functions and services that we humans often take for granted. From pollination and pest control to decomposition and nutrient cycling, insects are invaluable to our planet; and luckily, word of their importance is spreading to those outside of our insect-loving community!

The number of papers assessing large-scale changes in insect biodiversity has been increasing over recent years, with many of these hitting the headlines of various media outlets. Stories of an 'insectageddon' or 'insect apocalypse' have been driven by studies showing dramatic declines in certain insect populations. Some of the big changes reported include a 75% decline in flying insect biomass in German protected areas (Hallmann *et al.*, 2017), an 80% decline in butterfly occurrence in the Netherlands (van Strien *et al.*, 2019), and apparent declines in biodiversity in Puerto Rican and Costa Rican tropical rainforest systems (Lister & Garcia, 2018; Janzen & Hallwachs, 2021).

As we might expect considering the sheer diversity of insect life, their trends over time are quite variable. That is to say, not all groups are declining. Research by myself and others (van Klink *et al.*, 2020; Outhwaite *et al.,* 2020) has shown that the trends of some freshwater taxa have shown improvements over recent years. Most of the locations where these positive changes are happening are in temperate areas such as the UK, where a lot of work has been done to improve water quality. These observations are inspiring since they show that positive change can occur when we reduce the pressures on the environment, in this case water pollution. But for many regions and species groups the news is not so positive, and in many cases we just don't know enough about the state of insect biodiversity to get a good handle on what is changing and why.

Where are the knowledge gaps?

Data limitations are most strongly felt among the less well-studied taxonomic groups and in the tropical regions of the world. These two gaps in knowledge are a problem. The tropics are a highly diverse region, thought to contain most of the diversity of life. It is therefore rather alarming that we should have so little information on the status and trends of species found there. Similarly, there are groups of insects on which there are more data available than others; butterflies and bumblebees are much better covered than many other taxa. This leaves us with a relative black hole when it comes to knowing how several insect groups are faring.

Charlie Outhwaite
Centre for Biodiversity & Environment Research, UCL
(charlotte.outhwaite.14@ucl.ac.uk)

Insects are not only a unique form of life on our diverse planet, but are also the providers of numerous essential functions and services that we humans often take for granted

Not only is it important to fill these gaps in knowledge but also to understand why the changes we are seeing are taking place. What are the factors driving these changes? For biodiversity in general the major drivers of change have been identified as land-use change (such as the conversion of land for agriculture), pollution, over-exploitation, invasive species, and climate change. The same is true of insects (Wagner, 2020). Importantly, however, these drivers of change do not work alone and can interact with each other, often causing greater changes in diversity than if they were acting independently. These synergistic effects would be missed if we only assessed one driver of change at a time. A good example of drivers acting together to affect biodiversity is that of land-use change (often resulting in the loss of natural habitat) and climate change (Newbold *et al.*, 2019). Land-use change can affect how species respond to climate change, since the loss of natural habitat often removes areas of shade which can act as refuges, helping species to cope with increasing temperatures. Similarly, climate change can affect how species respond to land-use change.

Assessing global insect responses to land-use and climate change

In our recent study, Dr Tim Newbold and myself, along with Peter McCann, at the time a Master's student, set out to try to assess the interacting effects of land-use and climate change on insects, whilst also trying to improve upon the taxonomic and geographical coverage of previous large-scale studies. This work is now published in the journal *Nature* (Outhwaite *et al.*, 2022) and the key points are summarised below (if you do not have access to *Nature* but would like to see the full article, please get in touch).

We set out with three questions. 1. How does the conversion of land to agriculture and the intensification of agricultural areas impact insect biodiversity? 2. What are the combined impacts of land-use change and climate change? 3. Can the availability of nearby natural habitat help to buffer the negative impacts of climate change?

To answer these questions, we used a database called PREDICTS (Hudson *et al.*, 2017). PREDICTS is a publicly available database that consists of a collection of studies that have monitored biodiversity (not only insects) at sites of differing land uses and/or land-use intensities. For example, a study might be comparing biodiversity between sites based in primary vegetation, such as forest, with biodiversity in nearby cropland. We used the insect data from this database and focused on sites that looked at primary vegetation (intact natural vegetation), secondary vegetation (recovering natural vegetation) and agriculture. This subset of the database consisted of data from 264 studies covering 6,095 locations and almost 18,000 insect species including butterflies, moths, bees, dragonflies, beetles, flies, and a number of other groups. The data were spread across the globe with many sites from tropical regions (Figure 1).

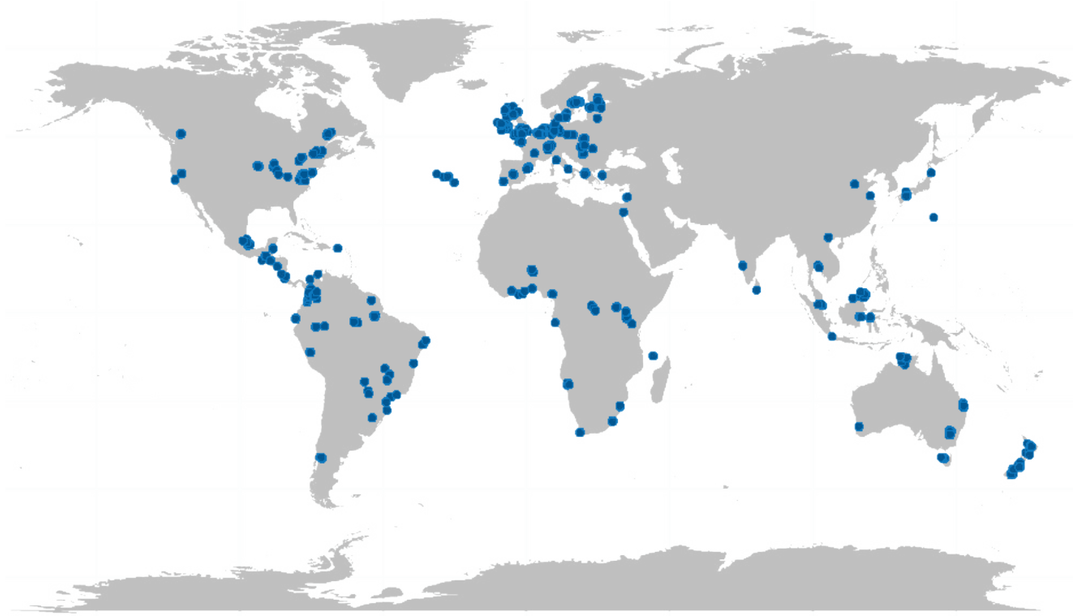


Figure 1: Map of the world highlighting the locations of the sites analysed. Adapted from Outhwaite *et al.* (2022).

The taxonomic and geographical spread of the data was considerable, so we hoped that this work would give us a much more representative insight into the response of insect biodiversity to two of the major drivers of change. Alongside these data, we used a climate dataset called the Climatic Research Unit Time Series (CRU TS) dataset to determine a metric of climate change. This dataset provides estimates of temperature for each month from 1901 to 2018 for grid cells across the global land area. We used this information to assess how temperatures have changed at each site, comparing the year the data were collected with a baseline period of 1901–1930. We then took this difference and standardised it using the variation in temperatures experienced at the location during the baseline. We did this to try to account for the differences in seasonality that species in tropical and non-tropical regions might experience. We only used data for months where average temperatures were 10°C or more, assuming that this would be representative of when most insects are active and so likely to be affected by these temperatures.

I won't go into the methods in much detail here, please do look at the paper if you are interested, but we used mixed effects models to assess the relationship between our response variables: insect abundance (the number of individuals), or insect species richness (the number of unique species), and our explanatory variables: land-use category and climate-change metric.

Q1: How does the conversion of land to agriculture and the intensification of agricultural areas impact insect biodiversity?

To look into our first question, we compared the abundance and species richness of insects between sites of more natural habitats, including primary and secondary vegetation, with agricultural sites which we split into 'low' and 'high' use. Use intensity is a broad categorisation of how heavily the land is used. For agricultural sites, this is based on aspects of management such as field size, pesticide and fertiliser use, irrigation, and mechanisation. As you can see from Figure 2, as land use becomes more impacted by humans, the diversity of insects is reduced. In particular, in high-intensity agriculture, abundance is 45% lower and richness 33% lower than that in primary vegetation. Agricultural land use alone, particularly that which is intensively managed, is associated with very large reductions in insect biodiversity.

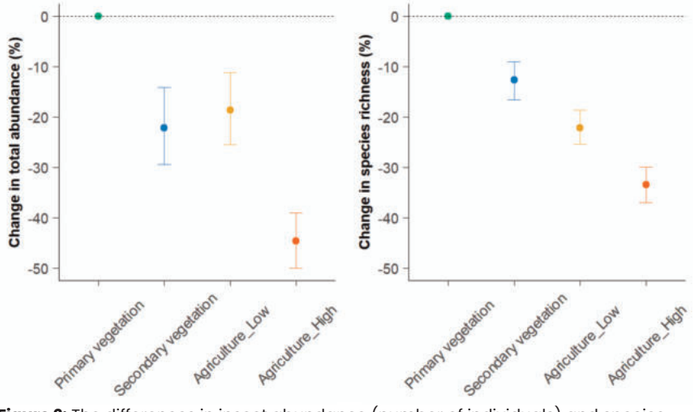


Figure 2: The differences in insect abundance (number of individuals) and species richness (number of unique species) between sites of varying land use and land-use intensities. Values are the percentage difference compared to the diversity in primary vegetation sites. Adapted from Outhwaite *et al.* (2022).

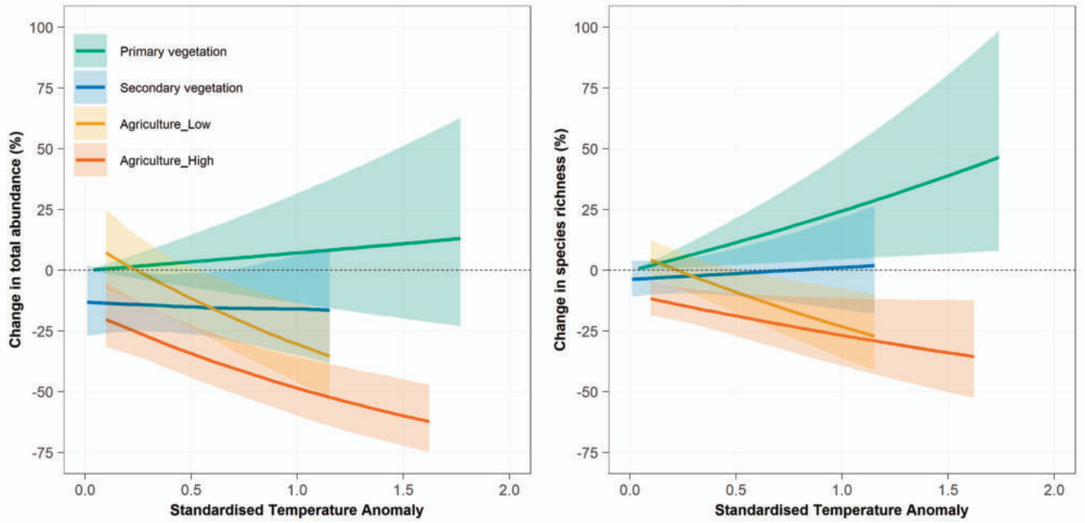


Figure 3: The difference in insect abundance (number of individuals) and species richness (number of unique species) associated with different values of climate-change metric (here named the standardised temperature anomaly) for sites in each of the four land-use classifications. Adapted from Outhwaite *et al.* (2022).

Q2: What are the combined impacts of land-use change and climate change?

To answer the second question, we introduced another variable into our models: our climate-change metric (which we called the standardised temperature anomaly). As described above, this metric aims to represent the difference in temperatures experienced in the present compared to our baseline in the past (1901–1930), whilst considering the fact that locations around the world experience differences in variation of temperature across the year (*i.e.*, seasonality). When we include the climate-change metric in our models, we find that those sites that are in high-intensity agriculture and that have experienced substantial climate-change have seen the greatest reductions in both insect abundance and richness (Figure 3). In sites of high-intensity agriculture where the climate anomaly is 1 (high levels of climate change), abundance was reduced by almost 50% and richness by 27% compared to that of primary vegetation where there has been little climate change (an anomaly value of 0). The impact of climate change is not so great in low-intensity agriculture for insect abundance at least. This shows that reducing the intensity of agricultural sites, for example by reducing pesticide application and moving away from monocultures, could help to mitigate the negative impacts of climate change on insect biodiversity in these areas.

Angle Shades Moth, *Phlogophora meticulosa*. Image: Charlie Outhwaite

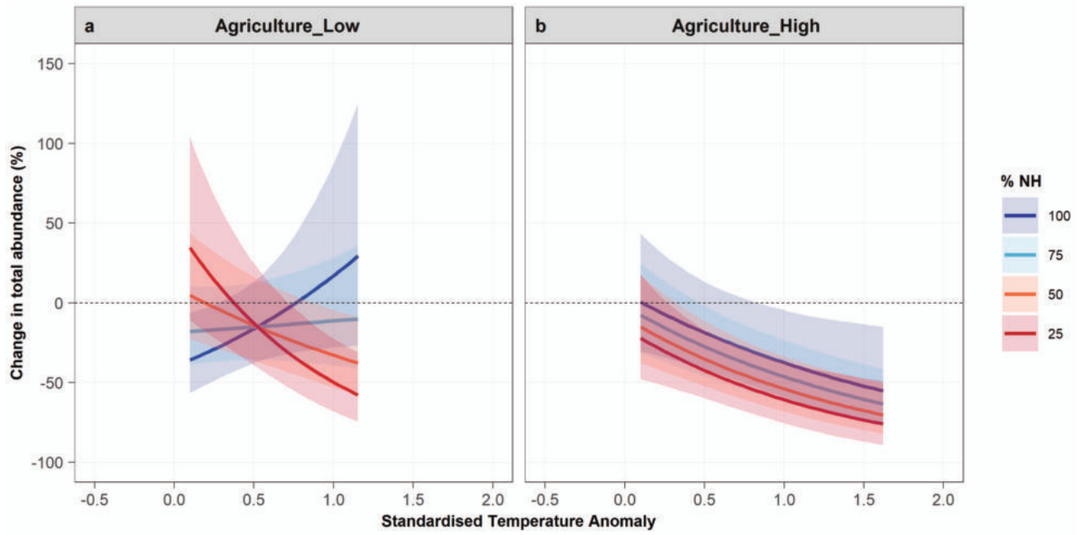


Figure 4: The difference in insect abundance (number of individuals) and species richness (number of unique species) associated with different values of the climate-change metric for sites in (a) low- or (b) high-intensity agriculture, with varying levels of natural habitat (NH) in the area surrounding the site. Adapted from Outhwaite *et al.* (2022).

Q3: Can the availability of nearby natural habitat help to buffer the negative impacts of climate change?

In smaller-scale studies, the availability of nearby natural habitat has been shown to be beneficial to insect biodiversity in human-impacted systems such as agriculture. To see if this was true at the global scale, we looked only at the agricultural sites to see if the response to the climate-change metric differs depending on how much natural habitat is found in the surrounding landscape. Looking at Figure 4, we can see that there is a difference between what happens in low-intensity agriculture and in high-intensity agriculture. In areas of high-intensity agriculture, no matter how much natural habitat there is in the surrounding landscape, there will always be a reduction in insect abundance associated with climate change. However, in low-intensity agriculture, the response to climate change differs depending on the amount of natural habitat: where little natural habitat is available there is a reduction in abundance, but as natural habitat availability increases, the negative impact lessens and then becomes positive.

A glimmer of hope

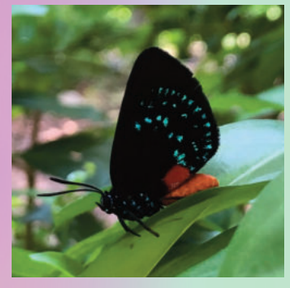
The positive influence of nearby natural habitat offers some hope for insect biodiversity. If we reduce the intensity of agricultural practices and provide alternative resources in the environment for insects to use, then there is a chance that the negative impact of climate change can be reduced. Maintaining patches of forest in agricultural landscapes is one way this can be done, although there are many alternative approaches as well.

These results are important in the context of the role of insects in food production. Insects are important for agriculture in several ways, including pollination and pest control. Maintaining insect biodiversity within agricultural systems is therefore going to be key for the resilience and security of food production both now and into the future. I for one do not want to lose out on my favourite chocolate fix because all the midges that pollinate cocoa have been lost!

Our paper has had an incredible and quite unexpected reaction. Over the course of a few weeks, I was interviewed by journalists for written pieces and radio shows from all over the world! Broader audiences are finally taking an interest in insects. So now, we should take advantage of this interest and spread the word of not only the important things that insects do, but also the joy that they can bring when you finally stop and take a moment to admire their beauty and diversity.

References

Hallmann C.A. *et al.* (2017) *PLoS ONE* **12**: e0185809.
Hudson, L.N. *et al.* (2017) *Ecology and Evolution* **7**, 145–188.
Janzen, D.H. *et al.* (2021) *Proceedings of the National Academy of Sciences* **118**, e2002546117.
Lister, B.C. *et al.* (2018) *Proceedings of the National Academy of Sciences* **115**, e10397–e10406.
Newbold, T. *et al.* (2019) *Emerging Topics in Life Sciences* **3**, 207–219.
Outhwaite, C.L. *et al.* (2020) *Nature Ecology and Evolution* **4**, 384–392.
Outhwaite, C.L. *et al.* (2022) *Nature* **605**, 97–102.
van Klink, R. *et al.* (2020) Science **368**, 417–420.
van Strien, A.J. *et al.* (2019) *Biological Conservation* **234**, 116–122.
Wagner, D. (2020) *Annual Review of Entomology* **65**, 457–480.



Atala Butterfly, *Eumaes atala*. Image: Charlie Outhwaite

Exam ant-ticks

"Mr XXX, during your three years' study on the biology of nabid bugs, did it never occur to you that they might be night-active?" This shattering opening salvo by the external examiner in a PhD viva must have come as a shock to the candidate, but he did have the pluck later to relate this bad start to his viva to his fellow students at Imperial College. I have to say that my PhD viva was far less challenging; indeed, to all intents and purposes, it was a non-event. The examiners were my supervisor and the external examiner. They had clearly known each other and their respective wives for a considerable time, as they just went on and on chatting to each other, reminiscing about the past. My supervisor had no questions on my thesis, and the external examiner only made two criticisms. One was that a paper written by his wife and referred to in the text had been omitted in the bibliography; the other was that he objected to the phrase "build-up of populations" as an Americanism. Quite honestly it was a farce.

As many older/retired colleagues in other universities will testify, I took my external examining duties far more seriously. And I did a lot of it, at both undergraduate and postgraduate level for 34 universities apart from my own. I once accidentally overheard an assessment of my performance – "He gives them hell in the viva but usually passes them".

It occurs to me that some of the more bizarre experiences I had as an examiner might be worth sharing.

One summer, as an external examiner for another university, I realised that I was missing the dissertation for one candidate for whom I had scripts. On arrival at the university, I was handed a scruffy handwritten wad of about 20 pages and was told there was doubt that this candidate had even done the work submitted, since he had never been seen using a gas chromatograph. The Head of Department, as he left me, added "But be careful, his father's a solicitor". To me the results did seem improbable. The land-snails assayed had been killed by the rather questionable technique (based on a reference from the 19th century) of drowning them in a tightly stoppered bottle of water for three weeks. I found it hard to believe that the corpses would have yielded the enzyme data presented! My mark reflected this; I never heard from the solicitor.

Another year, a dissertation on Stable Flies arrived with no second internal mark. When I arrived at the university in question, the second marker came to see me. He was sure that the data were entirely fictional. The student had spent the summer in London working at premises owned by his girlfriend's father and claimed to have travelled over 300 miles each way every weekend to carry out the work at the university field station. Perhaps unfortunately for him, the second marker also worked on Stable Flies at the same field station and had never seen the student at any time during the summer vacation. The student had submitted a remarkably extensive set of mark and recapture data. These actually had all the hallmarks of being genuine. They were very variable and difficult to interpret; why would anyone make up numbers that didn't work out? However, the Stable Fly population had been very low that year, making it unlikely that the student had been able to mark the number of flies he claimed. Just in any one weekend he had marked more flies than the second marker had caught in the entire summer. There was another problem. The student had immersed samples of straw in a vat of water and counted the floating pupae as the straw sank. The second marker pointed out that if you did this it would be the straw that floated and the pupae that sank! The supervisor, however, had given a mark of 85%, which I agreed was justified if the data were genuine. When I interviewed the student, he became most upset and assured me that the work had been done. My suggestion, with which the second marker agreed, was that the student should demonstrate his techniques to prove that they worked. I made it clear to the local staff that they then had the choice of awarding a mark of 85% or sending the student down. I later heard that a mark of 52% was eventually awarded. That can't be right.

In order to launch our new MSc in the Technology of Crop Protection at Reading in the 1960s, we rather relaxed our entry requirements just for the first year, and the main criterion for overseas applicants was that they were able to fund their studies. One such student arrived with the inside breast pocket of his suit bristling with Parker 51 fountain pens, which he handed out to all staff members as he met

Helmut van Emden
Emeritus Professor of Horticulture
The University of Reading
e-mail: h.f.vanemden@reading.ac.uk

You appear to have left this £5 note in your answer book

them with a sort of "Have a cigar" flourish! At the exam, that same student's answer book for my paper was entirely blank, but with a £5 note wedged in the binding. Naturally, I sent the money back to the student with a note "You appear to have left this £5 note in your answer book". I resisted the temptation to send back a more educational note – "You appear to have left this £1 note in your answer book".

Some years later on the MSc course, I was marking a question on biological control, and was amazed to find two answers which were absolutely identical. Not only was this word for word, but the candidates had crossed out the same words and phrases when, apparently, they had a change of mind. As required, I presented this evidence of collusion to my Dean, who undertook an immediate investigation. The first surprise was that the two candidates had sat in quite different parts of the examination hall and had never left their seats. The Dean therefore interviewed them separately and both told the same off-the-wall story. I have to admit that I had used that same question in several previous years. Having spotted this the students, who were both from overseas and had been challenged by my idiomatic lecturing style, had persuaded a British student to write a model answer for them. This he had done, changing his mind at intervals and therefore crossing out words and parts of sentences. The students had then memorised this model answer photographically and reproduced it accurately in the examination including the crossed-out bits. The Dean ruled that this was not cheating, and that they both deserved the mark I was prepared to award for the model answer. My maximum generosity would have been to give each student one-half of that mark.

Examining at an African university, I encountered a serious case of plagiarism in an undergraduate dissertation on nematodes. The supervisor had given the work a good mark, but there was no other member of staff competent to act as second marker. The dissertation was therefore given to a nematologist at a government research station located on the university campus. This lady's husband had done his PhD on nematology in the UK but was out of the country at the time. She had helped her husband with his thesis, and so immediately recognised the photographs and verbatim text reproduced from that thesis. We therefore placed this information before the Dean of the Faculty, who asked what we would do in Reading. I said, "We would chuck him out". "Oh, we can't do that", was the reply, "You'll just have to give a zero mark". A quick mental calculation suggested that this would only drop the student from a 2i to a 2ii. It got worse. Apparently, he could repeat the dissertation module and get back to a 2i. To prevent this, the supervisor and I agreed to give the minimum pass mark of 40%, which also left the candidate with a 2ii but precluded any second attempt.

That same university presented me with another problem. Students took a large number of modules in the first year, fewer in the second, and fewer again in the final year. Because all modules were weighted equally in the final assessment, any student whose performance deteriorated during their studies got a better degree than was deserved at the end, and any student who improved with time got a downgraded degree. Thus, one student with no previous biological background had struggled in the first year but had given uniformly first-class answers in finals and presented a quite outstanding dissertation in molecular biology. Yet his actuarial average across all modules gave him only an upper second class degree. There was nothing I could do to persuade the local staff to rectify this iniquity. But I was able to tell the student that I would be happy to write him a reference explaining what had occurred should he need this for his career. Sometime later he told me he wanted to apply for a PhD in molecular biology, and I was only too happy to provide a reference. The student completed his PhD, has kept in touch and has since enjoyed an excellent research career path.

Those were the days! When I joined the Horticulture Department at Reading in 1961, students in the three Departments of Agriculture, Horticulture, and Agricultural Botany took a substantial course in 'Plant Pests', comprising 25 hours of lectures and 50 hours of practical. This course was given by Dr Ian Crichton in the Zoology Department. The examination annually gave Dr Crichton the challenge of marking about 300 answers. One year, knowing of my interest in aphids, he invited me to mark the 60 scripts on the life cycle of the Black Bean Aphid. I would never have guessed how many permutations of the same aphid life cycle could be crafted by the ignorance of 60 students. Indeed, with no two accounts in the first 20 scripts being identical, I became so confused that I had to refresh my memory of the life cycle from Imms' *Textbook of Entomology*.

When Dr Crichton retired, I was asked to take over the course. The examination included a three-hour practical of which a major part was the identification to Family of three fresh insect specimens. Following the precedent set by Dr Crichton, and in order to prevent a guess based on the crop, insects were collected from wild plants on the campus. Finding 100 suitable specimens of three insects could prove difficult, and a staple that I often included was the Dock Leaf Miner. In spite of having been told that identification of the plant was unnecessary, students often had a go. One year an Agriculture student identified the dock leaf as a maize leaf (I wonder what degree class he was heading for?), a Horticulture student was not much better in suggesting it was an apple leaf, and an Agricultural Botany student played safe and identified it as a "large leaf".

Now, I would have thought it was obvious that the insect used as a 'spot' in a three-hour practical exam would need to be confined in some way. Yet one student ignored the large, pale and obvious leaf mine and complained to the invigilator that a small red mite had run off the leaf before he had the time to identify it! And my inclusion of the Solomon's Seal Sawfly, inviting confusion with Lepidoptera, was far too subtle for one student who identified it as a "typical heteropterous nymph".

Ten per cent of the practical mark was based on a collection of 20 set and mounted insects, identified as far as possible and handed in at the start of the examination. We soon learned to recognise specimens that were regularly handed down from one year to the next. A particularly old friend was a large African Longhorn Beetle, claimed each successive year to have been caught on the university campus, and whose tarsal formula decreased with wear and tear through the years. One student banked on my sense of humour when he glued the head, thorax and abdomen of insects from three different Orders together and identified it as in the Order Emdenoptera.

One summer, two female students came to see me after I had announced the requirement for an insect collection, arguing they thought it was not ethical to kill insects for such a flippant reason as an examination. I thought their understanding of insect population dynamics somewhat lacking in depth, but nonetheless accepted their strong feelings and suggested that they could, instead of a collection of mounted insects, submit a herbarium of plant damage with the causal insect identified but not included. What did I get? A collection of leaf miners, stem borers *etc*. splatted in a plant press!

PhD examining has also provided unique memories. As external examiner, I was the first to spot that, in a thesis on plant resistance to mites on two bean cultivars, the cultivar names on the column headings on every table had been reversed so that the data appeared to show the exact opposite of the stated conclusions. And how was it that another candidate studying Carrot Fly had not picked up from the literature that this insect flies close to the ground, and had positioned his yellow sticky traps at the height of five metres above the crop?

At the end of a perfectly passable thesis, mainly on modelling of parasitoid efficiency, I found a page with just three words – 'The Field Experiment'. There followed the weirdest experiment I have ever been faced with. The student had used four field cages, each containing one cabbage plant, for an unreplicated experiment with four ratios of parasitoids to Cabbage Aphids. And how was the level of biological control of the aphids quantified? The only recorded datum per cage (incidentally the plants were never watered) was "the day the plant died". I came to the viva prepared with a razor blade and made passing the thesis conditional on the student cutting out 'The Field Experiment' from all four copies and leaving the pages with me for destruction. On reflection, I suspect I was breaking some university ordinance by modifying a submitted thesis in this way, but perhaps it could count as 'minor revision'?

He glued the head, thorax and abdomen of insects from three different Orders together and identified it as in the Order Emdenoptera

And while it's confession time, here's another one. My student in Brazil, working for the Australian government on the biological control of *Lantana* weed, spotted the 'let-out' phrase in Reading's PhD regulations that "a viva will normally be held". Quoting the "normally", he wrote to the Registrar asking that, because of the cost of travel to the UK, he should only be required to attend a viva if it was neither a clear pass nor a clear fail. The Registrar made it quite clear to me that travel costs did not justify 'non-normality'. While the thesis was being typed at Reading, I was suddenly alerted that the student had been called to Canberra and could break his journey in London if that would be helpful. The external agreed to holding a viva, and I booked the library at the Society's then HQ in South Kensington. All I could send the external were unbound pages without the discussion. It was all a wild rush, and it only occurred to me after the viva, when I realised I had no forms to be signed, that 1) the thesis had never been officially submitted and 2) the external had never been approved by Faculty Board. Fortunately, the Registrar was both sympathetic and inventive. We would simply wait for the form to be signed and dated till after the complete thesis had been bound and sent to the, by then approved, external. Simple!

PhD theses have rarely made me smile, but I did so when I read that "the insects were moved with the aid of a camel's hairbrush". I also thought "aphid condoms" were unnecessary for parthenogenetic populations; the phrase turned out to stem from the uncritical acceptance of a spellchecker's suggested correction for 'cornicles'.

These tales of the careless (I'm in there somewhere), the clueless and the deceitful are dredged from the memory of just one university career. I can't believe my experience is unique. Surely other academics must have similar stories to tell but, if they relate to entomology at the University of Reading between 1961 and 1999, I'd rather not hear them!

ARTICLE

Two societies, similar aims

BRITISH CACTUS AND SUCCULENT SOCIETY
Let's Grow Together

An interdisciplinary approach to research is something I have always viewed as extremely important. I have never approached my active participation in entomology and my research into succulent plants over many years as disparate parts of my life. Perhaps it is not surprising, therefore, that I see parallels between the aims and objectives of the Royal Entomological Society and the British Cactus and Succulent Society (BCSS). Both cater for and encourage participation in each of the two natural science disciplines by amateurs, students and professionals. The BCSS, like the RES with *Antenna*, publishes a quarterly journal of a less formal nature, *CactusWorld*. It also publishes a yearbook comprising more 'technical' papers, *Bradleya*, which parallels the various RES science journals. I took over as editor of *Bradleya* with issue 39 in 2021. It was by coincidence or fate that papers with a considerable entomological content started to be submitted. This delighted me, of course, as it combined two of my great passions. It was with some trepidation that my entomological side rose to the fore when I decided to use an illustration of a bee pollinating a cactus plant on the cover of *Bradleya* issue 40. To my delight, the cover was extremely well received and declared by some as 'the best ever'.

George Thomson FRES
School of Humanities,
University of Glasgow,
1 University Gardens,
Glasgow G12 8QQ, Scotland
(email: bradleyaeditor@gmail.com)

Gordon Rowley, the great populariser of the study of succulents, expressed his regret that very little research into pollinators of succulent plants, including cacti, had been undertaken (Rowley, 1978). It was well known that bees and ants were among the principal pollinators of diurnal flowering succulent species, including most of the Cactaceae, as were moths and bats of nocturnal species such as the Saguaro (*Carnegiea gigantea*) and epiphytic cacti (*Epiphylum* spp.). In the 1970s species-specific insect pollinators were little known in the case of succulent plants. In the fifty years or so that have passed, we have learned a little but not a significant amount (Grant and Grant, 1979; Petit, 1995; Valiente-Banuet *et al*., 1997; Fleming, 2000; Holland and Fleming, 2002; Mizrahi *et al*., 2004; Valiente-Banuet *et al*., 2004; Ibarra-Cerdeña *et al*., 2005; Dar *et al*., 2006; Munguía-Rosas *et al*., 2009; Larrea-Alcázar and López, 2011; Alonso-Pedano and Ortega-Baes, 2012; LeVan, 2014). Submission of papers to *Bradleya* on this subject was, therefore, very welcome.

Three papers in *Bradleya* 40 reported the outcomes of studies of pollination by insects. With the permission of the authors, I reproduce here a summary of the paper by Razo-León *et al*. (2022) entitled 'Flower visitors and efficient pollinators of *Opuntia joconostle* F.A.C.Weber.'

"The animals that visit the flowers, pollinators and reproductive system of *Opuntia joconostle* were studied. The objectives of the work were to identify its floral visitors, to determine which are the most effective pollinators and to evaluate the importance of floral visitors to seed production. To determine the richness and frequency of the animal visitors, five study visits were made from May to June 2017, during which the animals that interacted with the flowers were recorded and collected for a period of thirty minutes for each hour between 10am and 4pm, after which the pollen grains were removed from the bodies of the collected specimens. For pollination efficiency, the pollen deposited by a specific pollinator in a single visit on the stigma and by self-pollination was counted and seed production from flowers where pollinator visits were avoided and another group with no restrictions were compared. A total of 2,261 floral visitors were recorded, belonging to four orders, eleven families, and twenty-seven species. Bees were the most abundant floral visitors with 98% of the records; the species with the highest number of visits was *Apis mellifera* with 90%, followed by *Diadasia australis* with 5%. A higher number of pollen grains per insect was recorded in *D. australis* than in *A. mellifera*; *D. australis* deposited more pollen per visit than *A. mellifera* and by self-pollination. Flowers that received pollinators produced significantly more seeds per fruit than flowers where visitors were prevented. *Opuntia joconostle* flowers are used by many animals, however, the majority are bees, particularly two species: *A. mellifera* and *D. australis*, the former having a higher frequency of visitation. However, *D. australis* carries and deposits more pollen.

Figure 1. The cover of *Bradleya* 40 with the Chimney Bee (*Diadasia australia*) visiting the flower of *Opuntia joconostle*.

Joconostle seems to have a mixed autogamy/xenogamy crossing system, as self-pollination was recorded, although it negatively affected seed production. Thus, cross-pollination is important for the conservation of this species, increasing its chances of reproductive success by seed and preserving genetic diversity."

Two other summaries of papers with entomological and botanical content demonstrate how close our disciplines can be. The first is by Eggli and Giorgetta (2022) and is entitled 'The pollination ecology of *Phemeranthus punae* (Montiaceae) in southern Bolivia'.

"*Phemeranthus punae* is a perennial geophytic [succulent] herb from the pre-Puna vegetation in the Andes of SW Bolivia and NW Argentina. Flowering plants have been observed for several seasons. Flowers are almost exclusively visited by at least three species of ants (Formicidae: likely *Forelius pruinosus*, *Linepithema* sp. and *Camponotus bruchi*). The ants move freely and rapidly on the plants and switch to neighbouring plants within less than five seconds. Pollen grains adhere to legs and bodies of the ants, which visit the flowers to feed on the nectar. The low stature of *P. punae*, its horizontally spreading to ascending inflorescences and the small flowers conform to the ant pollination syndrome characteristics formulated by Hickman. It is concluded that the observed ants are the pollinators of the species in the study area."

De Menezes and Sampaio (2021) studied 'The ecological relationship between sap beetles and *Pilosocereus* Byles and Rowley (Cactaceae) in Northeastern Brazil':

"The sap beetles of the genus *Nitops* (Nitidulidae, Coleoptera) are often found in flowers of columnar cacti like *Pilosocereus* (Cactaceae). Little is known about the conditions in which these infestations occur and their effects on cacti. The first record of the genus *Nitops* in northeastern Brazil is presented and different aspects of the ecological interaction between the beetle and columnar cacti of the region are analysed. Quantitative analyses of infestations were performed on 141 samples of flowers, fruits and flower buds collected in the field. A single species of sap beetle (*Nitops* aff. *pilosocerei*) was observed in 33% of the flowers (fruits and flower buds did not present infestation). The number of beetles per flower varied from 1 to 126 (average: 12.9 beetles/flower). The male to female ratio was approximately 1:1. Several beetles were found with pollen attached to their exoskeleton. The number of beetles per flower reported is up to 3–4 times greater than other records in the literature. The ecological interaction between beetle and plant is discussed."

As 2022 was the fortieth anniversary of the publication of *Bradleya*, at my suggestion the BCSS permitted me to publish a special extra edition based on the

Figure 2. Sweat Bee (*Agapostemon* sp.) visiting the flower of *Opuntia joconostle*.

Figure 3. The cactus *Opuntia joconostle,* Tierra Bianco, Mexico.

theme of conservation. This was extremely well supported by authors and was distributed to all members of the Society free of charge. I am expecting many more papers on insect/plant relationships in future. It is encouraging that publications of the BCSS are still very well-supported by authors. It is also satisfying that high standards and academic rigour are maintained while making published articles and papers as accessible as possible to a wide spectrum of readership such as ours. If anyone would like to obtain a copy of *Bradleya* please contact Suzanne Mace (suzanne@paperweight-mall.com).

All papers published in the yearbook can be accessed on BioOne. I thank the authors of the papers mentioned above for permission to reproduce their summaries, and Alvaro Razo-León and Marcelo de Menezes for permission to use their photographs.

Figure 4. Sap beetles (*Nitops* aff. *pilococerei*) in the nectar chamber of a *Pilococereus* cactus.

References

Alonso-Pedano, M. and Ortega-Baes, P. (2012) *Plant Systematics and Evolution* **298**, 1671–1677.

Dar, S. *et al.* (2006) *Annals of Botany* **97**, 423–427.

De Menezes, M.O.T. and Sampaio, V.G. (2021) *Bradleya* **39**, 36–44.

Eggli, U. and Giorgetta, M. (2022) *Bradleya* **40**, 99–112.

Fleming, T.H. (2000) *American Scientist* **88**, 432–439.

Grant, V. and Grant, K.A. (1979) *Plant Systematics and Evolution* **133**, 29–37.

Holland, J.N. and Fleming, T.H. (2002) *Oecologia* **133**, 534–540.

Ibarra-Cerdeña, C.N. *et al.* (2005) *American Journal of Botany* **92**, 503–509.

Larrea-Alcázar, D.M. and López, R.P. (2011) *Plant Systematics and Evolution* **295**, 129–137.

LeVan, K.E. (2014) *Oecologia* **174**, 163–171.

Mizrahi, Y. *et al.* (2004) *Annals of Botany* **93**, 469–472.

Munguía-Rosas, M.A. *et al.* (2009) *American Journal of Botany* **96**, 1887–1895.

Petit, S. (1995) *Biotropica* **27**, 538–541.

Razo-León, A.E. *et al.* (2022) *Bradleya* **40**, 19–26.

Rowley, G. (1978) *The Illustrated Encyclopedia of Succulents*. Salamander, London.

Valiente-Banuet, A. *et al.* (1997) *American Journal of Botany* **84**, 452–455.

Valiente-Banuet, A. *et al.* (2004) *American Journal of Botany* **91**, 850–855.

Royal Entomological Society

Society News

Troops on the move. Credit Milton Barbosa

News from Council

Meetings of Council

Council met on 27th July and 13th September 2022. Council members took decisions on new grants, awards and bursaries, membership grades and Editor-in-Chief positions. Several RES committees and event organisers reported back to Council. There were also standing items focusing on the risk register, health and safety and the website.

Committee Review

At the July meeting, Council received initial feedback from Lucy Devine, governance consultant, who had been undertaking a review following the overarching governance review in 2020 and 2021, with a view to the Society achieving success with the 2022–2025 strategy. The recommendations were discussed in detail before further review. At the September meeting, final decisions were taken as to the new structure and format of committees. The decisions included the introduction of a Science, Policy and Society Committee (that will also include conservation) and an Education and Training Committee. Over the remainder of the autumn the terms of reference will be written for each committee in consultation with committee chairs and members.

Vice Patrons

At both meetings, discussions of a new structure for Vice Patrons were considered. Included in these were the number of Vice Patrons, how long they would serve for, what we would require of them and how this could be most impactful for the Society and its global membership. Further recommendations and decisions will be taken at a Council meeting later in 2022.

At the time of the September discussions, there had been the sad news of the death of Her Majesty Queen Elizabeth II. As our Patron, we acknowledged the support she had given and that the RES would be included in the process for appointing new Royal Patrons in due course.

Vote of Thanks

At the end of the September meeting huge thanks were given to Helen Roy, who was moving from the role of President to Past President, and to Julie North, Vice President, who was stepping down as a trustee.

Simon Ward
Chief Executive Officer

Journals and Library

Our Royal Patronage

Rose Pearson
RES Librarian and Archivist

Following the recent death of Her Majesty Queen Elizabeth II, we look back on the more than 70-year relationship between the RES and its Royal Patron.
The Entomological Society of London was first granted royal patronage in 1885, when Queen Victoria became its Patron. In the Society's centenary year of 1933, King George V granted the right to the Society to call itself Royal, and The Entomological Society of London became the Royal Entomological Society of London. Patronage then passed to the Queen's father, George VI, then to the Queen herself.

A small cutting from the Daily Telegraph in 1952, kept in the RES archive, announces: 'Societies and Institutions which enjoyed the patronage of King George VI or of the Queen before her Majesty's accession, may now apply for consideration for the grant of the Queen's Patronage.' The Society applied and royal patronage was granted on 22nd July 1952. A letter from the Palace confirms "It will now be in order for the words 'Patron – Her Majesty the Queen' to appear in future under the name of your Society in all correspondence."

The Society was in regular contact with Buckingham Palace, sending telegrams congratulating Her Majesty on her marriage, and on the births of her children and grandchildren, with the Palace in return acknowledging their gratitude for the 'kind messages' sent.

The Society has given Her Majesty several entomologically-themed gifts throughout her patronage. In 1977, to mark her Silver Jubilee, the Society sent a watercolour landscape by entomological illustrator and Fellow of the Society, Brian Hargreaves.

PRIVY PURSE OFFICE
BUCKINGHAM PALACE
22nd July, 1952.

Dear Sir ,

I am commanded by The Queen to inform you that Her Majesty has been graciously pleased to grant her Patronage to The Royal Entomological Society of London.

It will be in order for the words "Patron—Her Majesty The Queen" to appear in future under the name of your Society on all correspondence.

Yours truly,

Keeper of the Privy Purse.

The President,
Royal Entomological Society of London,
41 Queen's Gate,
South Kensington. S.W.7.

Letter granting the Queen's Patronage to the RES in 1952.

Hargreaves was given permission to paint this picture within the palace gardens. The work shows Buckingham Palace from the lawns of Grosvenor Place to the west and features six species of butterfly found within the palace grounds.

The Society gave another painting, also by Brian Hargreaves, to the Queen for her Golden Jubilee in 2002.

Viewing the exhibition set up to commemorate the centenary with President Richard Southwood. Photo from the 'Reception to commemorate the Centenary of the Granting of the Royal Charter' on Thursday 30th May 1985, held at London Zoo.

The Queen is presented with artwork from the RES Archive. Photo from the 'Reception to commemorate the Centenary of the Granting of the Royal Charter' on Thursday 30th May 1985, held at London Zoo.

Looking pleased with her gift of artwork from the RES Archives. Photo from the 'Reception to commemorate the Centenary of the Granting of the Royal Charter' on Thursday 30th May 1985, held at London Zoo.

The subject, *Maculinea arion* (Large Blue butterfly) was chosen for its beauty and rarity, and to highlight the work of the RES in helping to conserve its habitat and to reintroduce it to the UK. The picture was later reproduced on the cover of *Antenna*. The Registrar personally delivered the painting to the Chief Clerk in the Private Secretary's Office at Buckingham Palace in June 2003. A letter from the Palace, held in the RES archives, states that 'Her Majesty was delighted with the choice of the Large Blue butterfly and much appreciates the workmanship involved in such a piece. The Queen has asked that her warm thanks be conveyed to you and your members for your thoughtfulness, and to Brian Hargreaves for undertaking this project.'

It was not just artworks that were given as gifts. For Her Majesty's Diamond Jubilee in 2012 the RES produced 70 special signed editions of The Royal Entomological Society Book of British Insects which were sent to the Palace and to countries throughout the Commonwealth.

On Thursday 30th May 1985, 200 members of the Society and their guests were given a rare opportunity to meet the Queen in person when she attended 'A reception to commemorate the Centenary of the Granting of the Royal Charter' held at London Zoo. Tickets were available to purchase by members only, for £12, on a first come first served basis. An advertisement in *Antenna* gave advice on the expected dress code when meeting royalty. Men were advised to wear lounge suits. For women: "It is understood that the Queen will be wearing a cocktail type dress (short), gloves, but no hat."

The then President of the Society, Professor Sir Richard Southwood GOM, DL, FRS, presented the RES Council and past Presidents to the Queen, and she presented the Wigglesworth medal to Prof. John Kennedy and Dr Miriam Rothschild. The Queen also viewed the exhibition set up to commemorate the centenary of the Royal Charter, and the 150th anniversary of the Society, which until recently had been on display at the Natural History Museum. Two gifts were presented to her: plates from the RES archive, aptly depicting the Monarch butterfly (*Danaus plexippus*) and the Prince William butterfly (*Papilio machaon mauretanica*). She signed a large colour photo of herself, which today hangs at the

Presenting the Wigglesworth Medal to Prof. John S. Kennedy FRS. Photo from the 'Reception to commemorate the Centenary of the Granting of the Royal Charter' on Thursday 30th May 1985, held at London Zoo.

Society's headquarters at The Mansion House, St Albans, as well as signing the RES Book of Obligations. This book, dating back to the founding of the Society, was signed by the first members of the Society in 1833, and is still signed by Fellows of the Society today, most recently at the ENTO22 conference. Her signature joined that of her great-great-grandmother, Queen Victoria - then still a Princess - as well as those of many famous members of the Society, including Charles Darwin and Alfred Russel Wallace.

Over thirty years later, members of the Society again had the opportunity to see the Queen in person, when representatives from each of the more than 600 charities of which she was patron were invited to a Patron's Lunch on the occasion of her 90th Birthday, in 2016. Around 10,000 guests, including several representatives from the RES, attended the street party in the Mall, St James's Park. These included Hugh Loxdale MBE, Hon. FRES, who reported on the event for *Antenna*. Organisers supplied guests with ponchos when heavy rain threatened to put a damper on proceedings, but fortunately the weather cleared up in time for guests to enjoy a 'classic British street party lunch' served from wicker hampers. The Queen and Prince Philip waved to guests as they drove by in an open-top car, and other members of the Royal Family, including Princes William and Harry, also drove past. The Queen later gave a speech to attendees via video link.

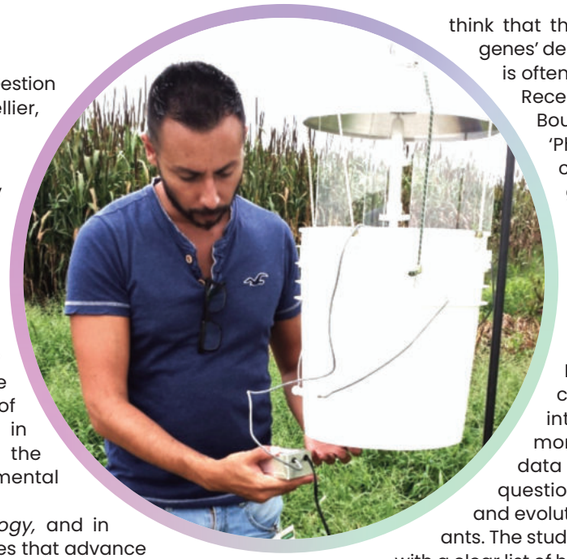
On 8th September 2022, at the age of 96, the Queen passed away at Balmoral Castle. The cause of death was recorded as 'old age'. In a message from then President, Prof. Helen Roy MBE, Hon. FRES, the RES sent its condolences to the Royal Family and expressed our thanks for 'her unwavering support for the charities of which she was patron.'

HM The Queen and the RES Archives

The RES library and archives include several items that highlight the long relationship between the Society and Her Majesty the Queen. These are available for members to view at the Society's St Albans Headquarters. Please contact the Librarian and Archivist, Rose Pearson (rose@royensoc.co.uk) to arrange an appointment.

Meet the Editors

Ecological Entomology, Insect Conservation and Diversity and *Systematic Entomology* have recently welcomed new Editors-in-Chief to their teams. Here Rob Wilson, Manu Saunders and Gael Kergoat tell us a bit about themselves and highlight some of the latest research from their journals.



Gael J. Kergoat
Systematic Entomology
Centre de Biologie pour la Gestion des Populations, Montpellier, France
(Photo credit: Nicolas Nègre)

I am an evolutionary biologist and entomologist, working at the French National Research Institute for Agriculture, Food and the Environment (INRAE). I have a particular interest in integrative taxonomy and the study of the diversification dynamics of insect groups, especially in relation to host-use and the impact of past environmental changes.

For *Systematic Entomology,* and in general, I really value studies that advance our understanding of insect group systematics and address questions of broad importance in ecology and evolution. Depending on the questions you ask, I also think that the old 'more taxa or more genes' debate matters, and sampling is often the key here.

Recent journal highlight:
Boudinot B.E. *et al.* (2022) 'Phylogeny, evolution, and classification of the ant genus *Lasius*, the tribe Lasiini and the subfamily Formicinae (Hymenoptera: Formicidae)'. *Systematic Entomology* **47**, 113-151. https://doi.org/10.1111/syen.12522

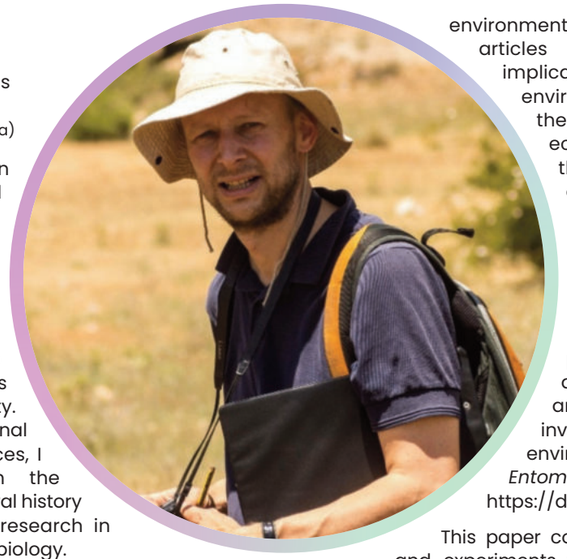
I really like this comprehensive study that integrates molecular, morphological and life history data to address multiple questions about the systematics and evolutionary history of a group of ants. The study design is well thought out, with a clear list of hypotheses to be tested with appropriate tools and data.

Manu E. Saunders
Insect Conservation and Diversity
University of New England, Australia
(Photo credit: Deborah Bower)

I am a community ecologist based at the University of New England, Australia. My research focuses on how insect communities are affected by land use and disturbances, and how community-level interactions contribute to ecosystem function and services.
In general, I'd like to see more studies published in *Insect Conservation and Diversity* from understudied regions and insect groups. I'm particularly keen to see more research on community-level interactions and networks, including empirical studies exploring relationships between insect communities and ecosystem function and services other than crop pollination.

Recent journal highlight:
Hadrava, J. *et al.* (2022) 'A comparison of wild bee communities in sown flower strips and semi-natural habitats: A pollination network approach.' *Insect Conservation and Diversity* **15**, 312-324. https://doi.org/10.1111/icad.12565

Understanding how insect community structure is affected by different conservation interventions is essential to inform land management that sustains biodiversity. This paper explores this very nicely with a network analysis approach.



Robert J. Wilson
Ecological Entomology
Museo Nacional de Ciencias Naturales, Madrid, Spain
(Photo credit: Juan Pablo Cancela)

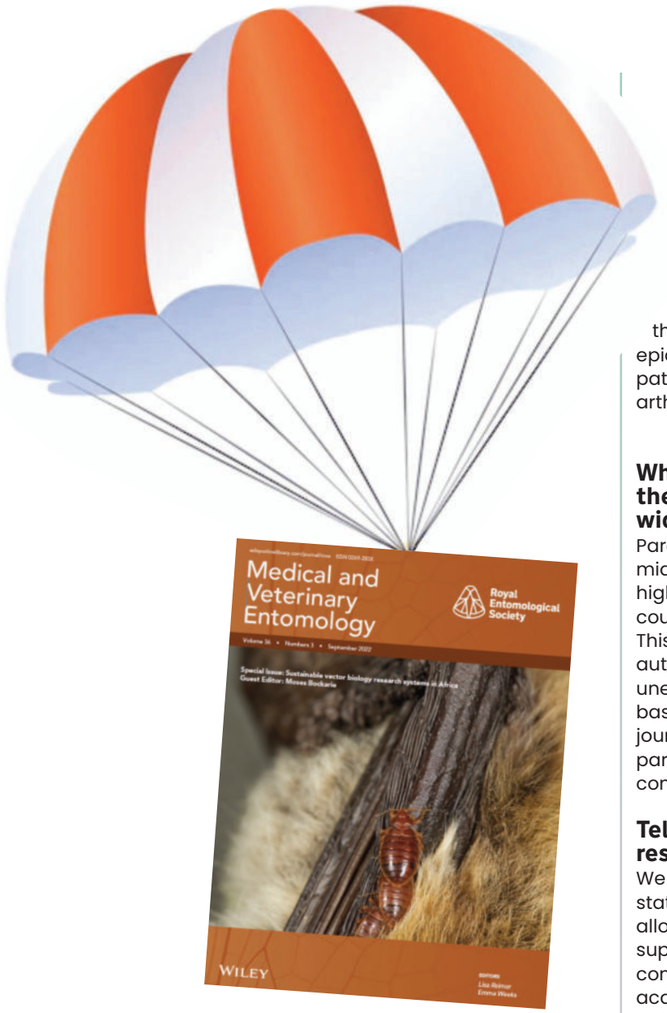
My work focuses on butterflies in fragmented and mountain landscapes to understand ecological responses to global change. I consider how effects of microclimate and habitat on insect populations scale up to determine species distribution and diversity. Now based at Spain's National Museum of Natural Sciences, I am also interested in the untapped potential of natural history collections as a tool for research in ecology and conservation biology.

As the leading journal in hypothesis-driven insect ecology, *Ecological Entomology* provides a vital forum for research on insect populations and communities. Papers in the journal demonstrate how, and indicate why, insects respond to changes in their environment. Importantly, whilst the articles often have applied implications for conservation or environmental management, they also advance the ecological and evolutionary theory and evidence to develop future research into insects and biodiversity more widely.

Recent journal highlight:
Jardeleza M-K.G. *et al.* (2022) 'The roles of phenotypic plasticity and adaptation in morphology and performance of an invasive species in a novel environment'. *Ecological Entomology* **47**, 25-37. https://doi.org/10.1111/een.13087

This paper combines field observations and experiments to test why the size and abundance of an invasive fruit fly change over an elevation gradient, demonstrating the roles of both plasticity and local adaptation, and the resulting complexity in understanding and managing insect populations.

Confronting parachute research in *Medical and Veterinary Entomology*



Medical and Veterinary Entomology recently published an editorial introducing a new policy to address parachute research in their journal ('Introducing a new initiative to prevent exploitative research partnerships in *Medical and Veterinary Entomology*', Lisa J. Reimer, Maureen Laroche, Emma N. I. Weeks, https://resjournals.onlinelibrary.wiley.com/doi/10.1111/mve.12599). This is an important new initiative that the Society will be monitoring closely.

In this article the team that created the policy, Editors-in-Chief Lisa Reimer and Emma Weeks, and Associate Editor Maureen Laroche, explain the new policy and its importance.

What kinds of articles does *Medical and Veterinary Entomology* publish?

Medical and Veterinary Entomology publishes novel research papers covering the biology and control of insects, ticks, mites, and other arthropods of medical, veterinary and forensic importance. The main strengths of the journal lie in the fields of arthropod behaviour and ecology, epidemiology and transmission of vector-borne pathogens, and novel, field-evaluated approaches to arthropod control.

What is 'parachute research', and what are the implications of it for the journal and the wider research community?

Parachute research is research conducted in low- and middle-income countries (LMIC) by individuals from high-income countries, without inclusion of host-country researchers or benefits to the host institution. This practice has led to underrepresentation in authorship, imbalances in research funding and unequal career advancement opportunities for LMIC-based researchers. There are also implications for our journal: research that arose out of inequitable partnership can cause significant harm to the communities that hosted the research.

Tell us about MVE's new policy on parachute research

We are inviting authors to fill out a structured reflexivity statement to accompany their submission, which will allow them to explain how international partners were supported and included in six key areas: study conceptualisation, research management, data acquisition and analysis, data interpretation, writing and authorship. Statements will be required for research conducted in (or using samples from) low- and middle-income countries when funding is attributed to researchers and institutes based in high-income countries. We will evaluate the statements to ensure that the research team has constructively engaged with the statement, and that LMIC partners have been involved in the development and dissemination of the research.

What do you hope to achieve with this policy?

We hope that this is just the first step of an iterative process for our journal which will allow us to ensure that the work we publish has relevance to disease-endemic, low- and middle-income countries. I hope this will allow authors to reflect on the quality of their international partnerships, celebrate best practice and identify areas where improvements can be made.

Joint meeting of the Royal Entomological Society and the Royal Aeronautical Society

5th July 2022 online

Convenors: Richard Harrington (RES) and Sohail Chughtai (RAeS)

Report by Richard Harrington

Figure 1. Phantom FGR2.

Figure 2. Pitot tube blocked by a bee.

Insects and aircraft have much in common. Most obviously, they fly, and are hence concerned with aerodynamics, manoeuvrability and fuel efficiency. They may be camouflaged. They may have defence and attack systems. They may carry passengers. It is thus not surprising that Geoffrey de Havilland, aircraft pioneer and keen entomologist, named some of his planes after insects: Tiger Moth, Gipsy Moth, Puss Moth, Mosquito, for example. Realising the commonalities, the Royal Aeronautical Society (RAeS) contacted the Royal Entomological Society (RES) to discuss the possibility of a joint meeting. It was agreed that it would take place on an evening (UK time), comprise an introduction from the organisers to the RAeS and RES, a talk from a Fellow of each Society, and a discussion on the potential for future collaboration.

With 25,000 members and 67 branches worldwide, the RAeS is much larger than the RES. It has a fabulous HQ in London, which includes a lecture theatre and world-class library. It has 21 Special Interest Groups, very like the RES. It has three priority themes: Tomorrow's Aerospace Professional; The Future of Flight; and Climate Change and Sustainability. Like the RES, it organises conferences and events, and publishes journals and a colourful members' bulletin.

I have to say that, in my entomological career, I didn't expect to introduce somebody with the credentials of Dai Whittingham, although he does have a degree in zoology. Dai joined the RAF in 1974 and flew Phantoms for seven years. He became Air Component Commander for all UK flying operations in Iraq and Afghanistan and later chaired the Military Aviation Regulatory Group. His last military appointment was as Deputy Commander for the NATO Early Warning Control Force, from which he retired in 2010. In 2012 he was appointed Chief Executive of the UK Flight Safety Committee and remains in that post today.

Dai is a member of the RAeS Flight Operations Group and spoke on how insects can interfere with flight operations. His first and most serious example involved a Phantom FRG2 from 41 Squadron (Figure 1), which crashed at Mawbray, Cumbria, killing its two occupants, on 17th December 1975. The cause was a blocked pitot tube (Figure 2), the culprit being a bee. Pitot tubes open to the outside of the aircraft and measure airspeed, altitude and altitude trend as part of a pitot-static system which feeds

Figure 3. Wall Mason Wasp (*Ancistrocerus parietum*).

Figure 4. Larvae of Wall Mason Wasp in a pitot tube.

into flight control and navigation systems. Any blockage can result in false readings, causing pilots to react wrongly. The probes are heated so that they can remain ice-free in the -60°C conditions of high altitude, and the charred remains of insects can be challenging to identify. Samples are sent to the Natural History Museum via the Air Accident Investigation Branch.

A Wall Mason Wasp (*Ancistrocerus parietum*) (Figure 3) was identified by the Natural History Museum, using DNA tests, as the cause of a problem with an Airbus A319 at Heathrow on 19th July 2021 (Figure 4) and a Boeing 777 at Heathrow of 15th June 2021. A Hairy-toothed Small Leafcutter Bee (*Megachile pilidens*) (Figure 5) which had nested in a pitot tube of a Boeing 777 which had been on the ground for six days caused the aircraft to abort take-off. Pitot tubes form waterproof 'insect hotels' and the mitigation is a cover, which is placed over the aperture if an aircraft is on the ground for any length of time, as happened a lot during the Covid pandemic. These covers are a nuisance to put in place and remove, because of their positions (Figure 6). They have also been known to be inadvertently left on. Insects can also get into micro-switches and cause short-circuits.

Surface contamination is another problem caused by insects, and an example was shown of a windscreen plastered in locusts in South Africa (Figures 7 and 8), which the wipers could barely clear. Such contamination also reduces aerodynamics and fuel efficiency, as increased drag can only be overcome by increased thrust. NASA has developed coatings that allow insect residue to flow off aircraft wings and rockets, but these are expensive and easily damaged.

Drone operation can also be affected by insects. Because drones fly lower and slower than manned aircraft, they are less prone to drag from insect detritus, but they can have similar issues as regards interference with sensors.

Insects present in cockpits can cause dangerous distractions. There has even been an example of a fly activating very sensitive touch-screen instrumentation. Dai, himself, was once distracted by a Bluebottle (*Calliphora vomitoria*) and almost (but not quite!) inadvertently opened his cockpit canopy to remove the offender. He was travelling at 460 knots, about eight times the open canopy's tolerance!

Wildlife management in the vicinity of airports (a 13 km radius is recommended) is important in reducing risks to aircraft. Clearing grass reduces insect populations which, in turn, reduces potentially hazardous bird and bat populations.

Insects in the cabin of commercial airliners can be a risk to human health and can lead to spread of pests and diseases to non-native areas. Where the risk is high, insecticidal sprays are used, although these must be safe to humans and cause no damage to aircraft structures. Insects, though, are perfectly capable of travelling long distances under their own power, and that is where the second talk came in.

Figure 5. Hairy-toothed Small Leafcutter Bee (*Megachile pilidens*).

Figure 6. Pitot tubes on an Airbus A350.

Jason Chapman (College of Life and Environmental Sciences, University of Exeter Cornwall Campus) is a pioneer of studies on the evolution of animal migration and the impacts of long-distance movement on populations. He uses insects or birds in most of his investigations, with novel technologies such as biological radars, weather radars, meteorological simulations, tethered flight, and genomics approaches. Most insects are too small to carry satellite tags, although the largest insects can now carry the smallest tags, which leads to the ability to track individuals for the first time. They can migrate at high altitude and often at night. They are hence difficult to study. Insects over 10 mg in weight can be detected using radar, but most cannot be identified to species level directly from their radar echo. Speed and direction, body alignment, mass and shape of insects flying as high as 1,200 m can be deduced using Jason's vertical-looking radars.

The aerial 'bioflow' of insects is extraordinary. It has been calculated that 3.2 trillion insects, weighing roughly 3,200 tonnes, migrate at high altitude over 70,000 km^2 of central southern England each year. Maximum migratory distances of Painted Lady butterflies (*Vanessa cardui*) and the aptly-named Globe Skimmer dragonflies (*Pantala flavescens*) are 3,500–4,000 km for a single generation and 12,000–60,000 km for the annual round trip. When scaled to body length, these are the world's longest migrations.

Figure 7. A locust-spattered aircraft.

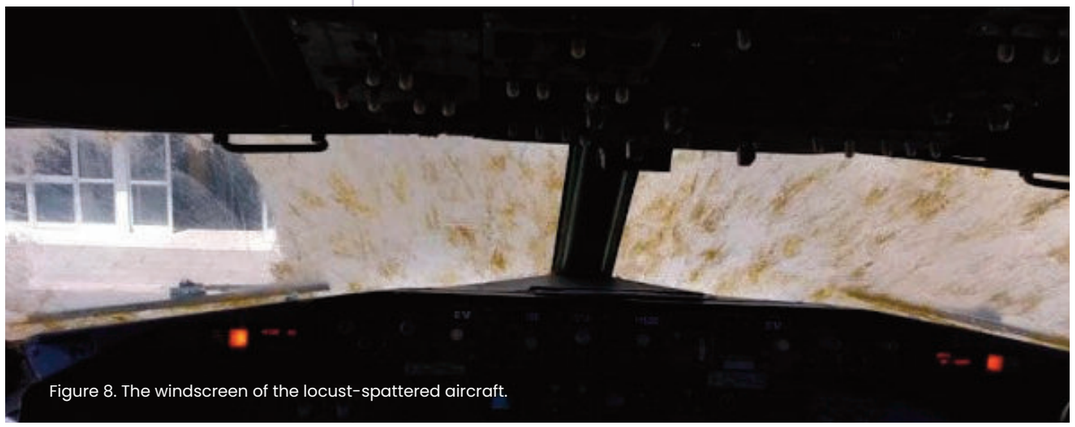


Figure 8. The windscreen of the locust-spattered aircraft.

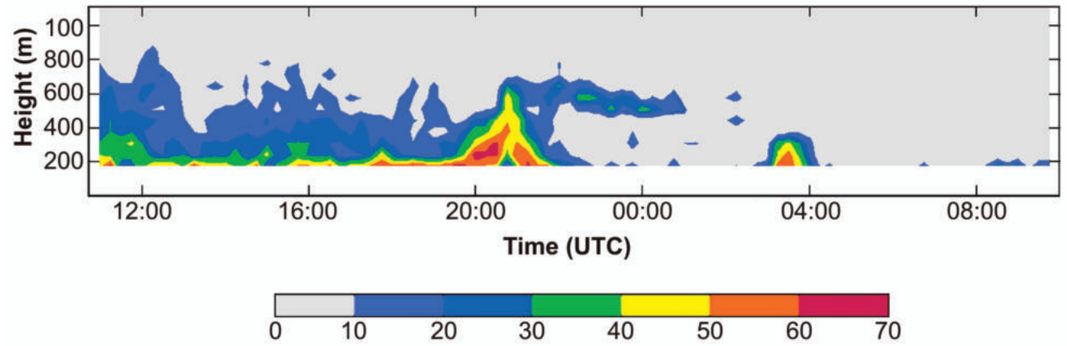


Figure 9. Insect abundance (Number / 5 minutes / height band). From Reynolds, D.R. *et al.* (2008) *Bulletin of Entomological Research* **98**, 35–52. With permission.

Jason outlined the radar technologies used to monitor these movements, which include small, purpose-built radars as well as existing networks of radars set up for other purposes, such as weather monitoring and forecasting. Existing networks of insect traps and aerial trapping from tethered blimps carrying a net at a height of 200–300 m help to suggest which insects are responsible for the radar echoes. The work has shown that there are intense take-offs at dawn and dusk with lower activity in between (Figure 9), and that insects tend to rise to the warmest and fastest layers of air, the low-level jets, which contribute to the speed and direction of movement. These tend to be 300 m to 800 m above ground level, with speeds of around 50 km/h. At night, the low-level jets are often warmer than air near ground level, maximising the potential duration of insect flight. The vast majority of insects flying at high altitude are very small and show little selection of direction. Larger insects, though, can select winds that take them north in spring and south in autumn, with summer flights being in a random direction. This is akin to pilots deliberately selecting high-level jets in order to give them a strong tailwind. In this way, night-flying insects generally attain speeds of up to 60 km/h. They often fly for 4 h, meaning that in a single night they can readily travel 200 km.

On average, the total biomass of migrating insects over southern England includes 100 tonnes of nitrogen, 10 tonnes of phosphorus, and 9 trillion joules of energy – enough to feed 40,000 people for a month. There are massive ecological consequences of these migrations. Apart from nutrients and energy, toxins, disease propagules, parasites and pathogens are being transported. The trophic balance of ecosystems is being affected, with herbivores, predators and prey moving around. For example, 500 million hoverflies (Figure 10) are estimated to arrive in the UK during the spring immigration and 2 billion depart in autumn. Each migrant, on average, carries ten viable pollen grains from up to three species. Thus 5 billion pollen grains are brought into the country each year and 20 billion taken out. These hoverflies easily outnumber Honey Bees and a vital pollination service is thus being 'helicoptered in'. It has been estimated that each year, the larvae of immigrant hoverflies and their subsequent generations eat 4 to 10 trillion aphids, possibly 20% of the population. They thus provide a very important pest control service to supplement that provided by residents. Furthermore, they form food for higher trophic levels such as songbirds and insectivorous mammals. It is thus clear that insect migration is a hugely important phenomenon, which is becoming far better understood as a result of these studies using radar. Jason is collaborating with scientists around the world to extend these studies to a larger geographic scale. It is expected that climate change is affecting the number of species and individuals migrating, the distance they move and the routes they take, but predicting the nature of these changes is difficult due mainly to uncertainty about how wind patterns will change.

Figure 10. *Episyrphus balteatus*. © Will Hawkes

From a poll conducted during the meeting and from a feedback questionnaire, it appears that there is a strong appetite for future collaboration between the RES and the RAeS. Many thanks to Sohail and the RAeS team for initiating this collaboration, and to the RES staff team for handling the logistics. Thanks also, of course, to Dai and Jason for their fascinating and complementary presentations. Dai expressed amazement that insects can locate and use low-level jets, but Jason pointed out that they have had 400 million years to fine-tune their behaviour. Just as amazing to entomologists is that humankind has achieved such extraordinary aeronautical feats in an evolutionary blink of an eye. We have much to learn from each other as our respective technologies continue to advance apace.

Insects as Food and Feed SIG, 2022, at the NHM, April 26th & 27th

Peter Smithers & Mark Ramsden

The in-person audience at the NHM.

This year's conference was a hybrid event held in the Flett lecture theatre at the Natural History Museum, London. It ran over the 26th & 27th of April and attracted 104 registrants, 60 in person and 55 online. We were fortunate in securing Professor Arnold van Huis, the editor of the WHO Report on Edible Insects, to give the keynote lecture. Unfortunately, he was not able to join us in London, but he delivered his talk online.

Keynote lecture

Arnold van Huis, Emeritus professor, Laboratory of Entomology, Wageningen, The Netherlands.

Edible insects: progress and prospects

During the last five years the number of articles dealing with edible insects increased exponentially. As feed for animals, the Black Soldier Fly is often targeted, mainly because the larvae can transform many different organic side streams of low economic value into high value proteins and fats. Microbial communities in substrates and the insect gut may help in the conversion of low-quality organic side streams.

The nutritional value of insect products compares well to those of the common meat products. Health benefits of insects relate to the high content of polyunsaturated fatty acids, the high iron and zinc content, the antioxidant capacity, and the positive effects on the gut microbiota. Chitin strengthens the immune system in humans and in animals, improves plant growth and activates plant defences. The fat of insects can be technologically applied as biolubricants, biodiesel, cosmetics, and butter replacements in bakery products. Proteins can be employed as a base for bioplastics used for agricultural purposes.

The environmental impact of producing insects is lower than that of common production animals, and legislation is gradually becoming more conducive to it. A major challenge is to process insects and disguise them in familiar products and make them safe and appetising. Several strategies are proposed to convince consumers to go from an occasional snack to mainstream food.

Professor Van Huis's talk is available to watch on the RES website at https://www.royensoc.co.uk/membership-and-community/special-interest-groups/food-feed/

Kieran Whitaker, Entocycle.

Industrial-scaled production of insects in the UK, challenges and solutions

Kieran introduced Entofarm 1, the first UK industrial insect factory that will initially produce 2,000 tonnes of insect protein per year. This is situated on the outskirts of London. The challenges at the moment are producing a constant product whilst scaling up production to meet the projected demand, although at the moment demand outstrips supply. The company comprises 20 engineers of which only four are biologists, but the team has expertise from across the value chain. They plan to finish construction and begin production in 2023.

Desmond Cave, Beta Bugs

Enabling the UK Black Soldier Fly (BSF) industry to take flight

Desmond gave an introduction to BSF and outlined why they are the future of animal feed. He also outlined the production procedures and how they differed. Using trays in a shipping container they could produce 312 tonnes of larvae/year but if rotary barrels were employed production rose to 648 tonnes/year. Desmond then discussed genetic improvements to increase the

A Better Origin container insect farm on-site at a poultry farm.

quality of the larvae and egg production. The larvae can be fed on a wide range of waste foods and a range of animal manures, but consistency of the food source is vital. At the moment legislation aimed at mammals is limiting the range of resources that can be fed to BSF.

Helen Hesketh
Insect Doctors: training insect pathologists to prevent and manage infectious diseases in insect mass rearing
Helen gave an update on the progress of the INSECT DOCTORS initiative, which is a European Joint Doctoral Programme that is educating 15 PhD students to develop the skills needed to diagnose and manage disease problems in commercial insect production systems. She then introduced three of the students on the programme who gave an outline of their studies.

Anna Slowik, UK Centre for Ecology & Hydrology
Nutritional ecology of entomopathogenic fungi: you are who you eat
Anna discussed how, in host-parasite relationships, multiple factors determine disease outcomes. Nutrition is an important aspect which mediates interactions between the host and pathogen, especially considering the host organism is the essential diet for its pathogenic symbionts. This relationship was examined using a framework to understand and predict infectious diseases in mass-reared insects and to optimise growing conditions.

Pascal Herren, UK Centre for Ecology & Hydrology
How environmental conditions affect host-pathogen interactions in *Tenebrio molitor*
Pascal explained how environmental conditions can affect host responses to pathogens by altering development, behaviour, and immune responses of insects. In this study, he looked at the impact of the environment on host-pathogen interactions in *Tenebrio molitor*, a commonly mass-reared insect species.

Carlotta Savio, Wageningen University, The Netherlands
The role of probiotics in health maintenance in mass reared insects
Carlotta discussed how probiotics can enhance insect health and pathogen resistance. Her project focused on the effects of probiotic microorganisms and diet composition on mealworm fitness parameters, such as microbial composition and the immune system, when the insects are reared in mass-rearing environmental conditions.

We then had a series of rolling introductions where members of the audience had thirty seconds of microphone time to say who they are and what they do. This has always been very successful and creates many networking opportunities over lunch.

Rob Lilywhite, University of Warwick
Frass as fertiliser: advantages and disadvantages – insights from the 'Insectrial Revolution project'
By 2030 Europe could produce one million tonnes of insect protein a year, but for every kilogram of protein produced three kilograms of frass are generated. Will this be a disposal problem, or an opportunity to make this part of a circular economy?

Because of its volume and possible value, the market for it could be as substantial as the market for the protein. Frass is a mix of uneaten food substrate, insect fecal pellets and shed exoskeletons. The nutrient content of frass (N, P & K) is modified by the nature of the feedstock given to the larvae. One of the problems is the presence of ammonia, which can be toxic to plants. Drying removes much of the ammonia, but it also reduces the nutrient content.

Composting the frass is another approach that is being explored to reduce the ammonia levels. They are also hopeful that the chitin content will stimulate plant defences.

Miha Pippen, Better Origin
Status of insects as feed in the UK post-Brexit
It has been around a decade since the start of insect farming for the animal feed sector in the UK, and what was once an idea has now begun to materialise tangibly. From aquafeed to poultry, insect uses as animal feed are growing in scale and impact, and Miha reviewed the current status of British insects in the feeds landscape in the first post-Brexit years.

Better Origin will bring the production of insect protein to the farmer. The X1's are mobile insect farms in a converted shipping container that source local waste as a feedstock. They produce live larvae that are fed directly to poultry. Live insects are nutrient rich but also offer behavioural benefits and an increase in animal welfare. The units are automated and run by AI systems to ensure continuity of the product.

Day 2
Rachel O'Connor, Michelmores
UK Legislation: where are we now?
Rachel provided an update on the UK legislative position for insects as food and feed. There have been significant EU legislative changes since Brexit (developments in poultry, swine feed and frass) and Rachel discussed what this means for the UK and the current UK position on insects as food. She went on to speculate on what might be in the pipeline regarding legislation relating to insect sentience and GM.

Dr Nick Rousseau, Woven Network
Progress towards edible insects being fully legal in the UK market, post-Brexit (online talk)
The Woven Network is now operating as a trade association for the UK edible insect sector, and is making significant progress towards being the voice for 25 or more companies to secure Novel Food approval, and to press for a transition arrangement to support trading in the interim. Nick discussed progress to date and the current situation. Happily, due to the efforts of the Woven Network, the Food Standards Agency has reversed its earlier ruling and UK companies can now sell insects while the legislation is developed.

Serge Corneillie, Cor Aqua Consulting, Tokyo
The use of insect meal from a feed manufacturer perspective (online talk)
The feed industry is seriously interested in using new and sustainable raw materials such as insect meal. However, there are major constraints in using these materials, related to supply, quality and price. The feed industry needs to produce feeds that give consistently good performance at a competitive price. Every change in raw materials is risky, as it can change the effectiveness of the feed and/or reduce the performance of the animals consuming it. This is often related to the volume of feed uptake. Moreover, the raw materials used should be consistent in terms of nutritional quality, as feed companies cannot afford to check the nutritional specification of each new batch (composition). Lastly, the profit margins in the feed industry vary widely, from high volumes with minimal profits in poultry feed to low volumes but high profits in pet food. Understanding these factors will speed up the integration of insect meal into the feed industry.

Jennifer Ferreira & Pattanapong Tiwasing, Coventry University
The Thai edible insect industry: poised for export growth?
Thailand is the world's largest producer of edible insects, with more than 20,000 insect-producing enterprises generating an average annual output of 7,500 tonnes, which mainly supplies domestic and regional markets. Over the past two decades the industry has grown, contributing to greater income generation and employment opportunities. In Thailand, edible insect products are primarily and commercially produced for human consumption, with over 200 species consumed. However, only a few insect species are widely acceptable among many consumers, and fewer species are sold regularly in markets, such as House Crickets (*Acheta domesticus*), Bamboo Caterpillars (*Omphisa fuscidentalis*), grasshoppers, and Giant Water Bugs (*Lethocerus indicus*). Of these, House Crickets are very popular with consumers and are relatively easy to farm.

The global market for edible insects is expanding rapidly, and there is potential for the significant growth of the Thai edible insect industry to increase exports to overseas markets, particularly the EU and UK. Thus, the Thai Government officially released the first Good Agricultural Practices (GAP) for cricket farming in November 2017, which is the first GAP standard for cricket farms in the world to help farmers to improve cricket farming systems and quality of cricket products to meet the standard and requirements for export. Yet, key challenges remain for the Thai edible insect industry in terms of knowledge gaps, standards gaps, and a changing regulatory landscape. The Thai edible insect industry needs to engage in research to demonstrate the safety of its products, and the capabilities for doing so, as well as the capacity to ensure compatibility with international standards and certifications.

Richard Small InsPro
Nutrient circularity enabled by Black Soldier Fly (BSF) larvae: recycling food waste
Food waste is an inevitable result of urbanisation, but if valorised correctly this becomes an asset. Bioconversion of food waste using insects to produce animal feed, in place of soya, brings food waste by-products back into the human supply chain. Nutrient circularity prevents nutrients that are heavily invested with time, transport, water, GHGs from being lost.

InsPro has developed a dispersed business plan that comprises an insect bioconversion unit that can be taken to the waste stream or the farm, where the animals can be fed on BSF, which minimises waste of resources and feed miles. These units are housed in small trailers and use BSF to convert food waste into insect protein. They need no services, so they can operate on

INSPRO mobile insect production unit.

Brambell's Five Freedoms.

very remote sites. The converters are offered as a service so the farmer has no involvement in running the unit, as the trailers are loaded and emptied manually by InsPro staff. Waste food is milled and then placed in the unit, and a week later larvae and frass are ready for harvesting. The larvae feed the poultry and the frass can be used as a soil conditioner. It is hoped that this system can be used to to generate carbon-neutral eggs.

Emilie Filou, Journalist, Buzzing podcast
Creating a buzz about insects as food and feed
The concept of using insects as food and feed is starting to gain traction. Coverage in the media is slowly moving away from sensationalist headlines and starting to deal with the emergence of the insect protein industry, but how can that transition be accelerated? Emilie discussed what the insect industry could do to raise its profile, from finding allies in partner sectors to changing the language and captivating the public through social media. The language used needs to be clear: 'insects as food' or 'edible insects', not 'entotarian' or 'insectivore', terms that just confuse the public. The industry should target millennials and generation Z, as they are health-aware, environmentally-conscious, open-minded and big on snacks and convenience foods. Celebrity endorsement would also pave the way for more general acceptance of insects as food and feed.
Emilie writes the monthly blog/newsletter 'Buzzing', which updates readers on recent events and developments in the industry. To subscribe, visit: https://www.emiliefilou.com/buzzing/

Meghan Barrett, Rethink Priorities, Los Angeles, USA (online talk)
Identifying major welfare concerns facing Black Soldier Flies reared and killed at scale, and potential areas of future concern for the industry
Meghan discussed current and future welfare concerns identified for Black Soldier Flies (BSF). The numbers of insects that will be killed as the industry develops will be vast, so it is important to develop humane killing and rearing methods. These should enshrine Brambell's Five Freedoms: Freedom from hunger; discomfort; pain, injury and disease; freedom to express normal behaviours; and finally freedom from fear and distress. Assessing insect welfare is still in its infancy and it is currently difficult to evaluate. Genetic modification is currently being explored as a means of increasing the value of the final product, so we need to be very aware of any impacts that may have on BSF behaviour and welfare.

The talks finished each day in the early afternoon, which gave plenty of time for two vibrant panel discussions allowing a frank exchange of views and clarification of many issues that had been raised by the talks. The two days had been a great success, and delegates were already discussing next year as they left.

When I first became involved with this SIG I was focused on the idea that insect protein could play a vital role in feeding an ever-growing human population. But as these meetings have evolved it is clear that this industry offers far more than potential food. Many of the byproducts of insect farming are turning out to be potentially valuable in their own right and offer greener alternatives to plastics, fertilisers and pesticides. The potential of insect bioconversion is also enormous, and is set to valorise many waste streams that are currently a problem.

The problems faced by the insect farming industry are diverse, but so are the approaches that have been developed. Insect farms can be very large and static, or they can be small and local, hi-tech or manual. I am always amazed by the range of approaches that can be found across the industry. Insect farming is evolving rapidly and is continually becoming more complex, both in the way that it operates and in terms of the products and services that it offers.

Fera Science opens new insect bioconversion unit in York, UK

Luke Tilley

Fera Science Ltd opened a new £1m specialist insect laboratory at its York Biotech Campus in August this year. Guests were invited to the launch of the new facility, which brings together a multidisciplinary team and their skills to research the benefits and challenges of producing insects as part of the circular economy, converting food waste into Black Soldier Fly larvae, *Hermetia illucens* (Stratiomyidae).

Insect bioconversion involves feeding insects biomass from waste to create useful products, such as proteins and oils, packaging materials, and even soil nutrients from frass.

At the opening of the facility, a former storage unit converted into a purpose-built entomological laboratory, guests were treated to several presentations from the Fera Science team detailing the global status of insect bioconversion, how useful it will be to address the global protein deficit, and the contribution that the new research unit will make to advance research and development in the UK. The unit will nurture new scientific skills and innovative approaches to collaboration.

The facility was officially opened by Tamara Finkelstein, Permanent Secretary at the Department for Environment, Food and Rural Affairs, who praised the investment into the insect bioconversion unit at a critical time for innovation in biotechnology within the UK. She also highlighted the importance of the unit for providing research into the reduction of the environmental impact of waste and the production of animal feed.

The research facility provides a strong base for the development and retention of entomological skills dedicated to improving what we know about insect bioconversion and its role within a circular economy. The factory production approach at the unit will help evaluate how processes can be scaled up in this fast-growing area of research and development.


Permanent Secretary at the Department for Environment, Food and Rural Affairs, Tamara Finkelstein officially opens the facility.


Black Soldier Flies processing food waste.


Hermetia illucens - adult flies.

Dr Maureen Wakefield explains the use and value of Black Soldier Fly frass.

Shaping the Future for Pollinators: Innovations in Farmed Landscapes

Dr Michael Garratt
University of Reading

Convenor, Pollination SIG

A great informal venue which really encouraged questions and discussion. Photo: Michael Garratt.

It finally happened! After two false starts due to the pandemic, the 'Shaping the Future for Pollinators: Innovations in Farmed Landscapes' meeting at last took off. This was a collaborative event between the Association of Applied Biologists, British Ecological Society and Royal Entomological Society, and with so much happening in the world of pollinators and pollination there was much to discuss. With an all-star cast of invited speakers and an exciting array of submitted abstracts, the meeting was well attended in person and online at the venue in Slough, UK.

Pollinators play a vital role in maintaining both natural and agricultural ecosystems, and healthy populations bolster food security, livelihoods and social wellbeing. In the face of increasing pressures of climate and land-use change, pollinators including bees, flies and butterflies continue to draw focus as a well-studied group in the context of the wider public awareness of the status of global invertebrate populations. As a result, the research covered over the three-day meeting was wide ranging in scale, from molecules to landscapes; in scope, from threats to solutions; and in approaches, from field ecology to predictive modelling. It was a great showcase of the latest research, generating debate and challenging questions. Even the BBC's Farming Today programme joined on the final day, highlighting wider societal interest in this field.

The meeting kicked off with a session on 'Landscape-scale management of pollination' and talks from Lucas Garibaldi (National University of Río Negro) and David Kleijn (Wageningen University). Video-linked in from Argentina, Lucas gave a great overview talk which included examples of successes and failures to manage pollinators and pollination at large scales, highlighting cascading implications of this all the way to employment and human health. David presented a great case study from the Netherlands, emphasising the number and diversity of actors needed to make landscape-scale conservation action a success. But with his project seeing the return of the Shrill Carder Bee (*Bombus sylvarum*) to a region where it had been lost, it was great to start the meeting with a good news story. The session concluded with talks from Jo Staley (UK CEH) and Bastian Häfner (Thünen Institute of Biodiversity, Braunschweig) continuing the theme of co-designed landscapes and the effects of landscape scale agri-environment schemes. It was during this session that the eventual running theme 'to pan trap or not to pan trap' when surveying pollinators was first raised.

Intense negotiations around the posters. Photo: Michael Garratt.

The second session included seven talks under the 'pollinator habitat management' theme. Alex Klein (University of Freiburg) opened with an impressive talk covering multiple collaborative EU-funded projects exploring the potential of hedgerow and flower margin habitats, the impacts of pesticides, and the role of semi-natural habitats. This was followed by two talks which departed from more conventional ecological research, with Morgan McKraken (UK CEH) exploring the extent to which the public respond to habitat restoration, and Lotta Kristiansen (Swedish University of Agricultural Sciences) on Knowledge and Innovation System (KIS) approaches, highlighting that 'place-based leaders', and maybe not scientists, are best able to drive changes in landscapes; certainly something for us to reflect on. The second part of this session included

Insights on where bees are really nesting from Konstantinos Tsiolis. Photo: Michael Garratt.

two talks showcasing novel tools to support habitat management and restoration for pollinators. Saola Kavanagh (Waterford Institute of Technology) presented their 'score card' for measuring the success of habitat establishment on farms, and Elizabeth Cook of PlantLife demonstrated their MyMeadows app to help land managers maximise their species-rich grasslands, a key habitat for flower-visiting insects. These are great examples of research translated into action. It is encouraging to see research delivering impact, something that was common to all the work presented at the meeting.

After an evening soirée to admire the excellent set of posters with a glass of wine in hand, day two began with a series of talks on crop pollination. The scene was set by Chris Hartfield of the NFU. By revisiting key findings and evidence from recent years concerning threats and pollinator declines, the talk culminated with Chris posing a series of important 'unknowns', prompting the scientific community to target these with further research. Such appraisals of where we stand as a research community are valuable flag posts to help refocus efforts. The remainder of the session showcased excellent progress in our understanding of the pollination of key entomophilous crops, including soybean, oilseeds, beans and apples, as well as a demonstration of the merits of temperate agroforestry systems from Alexa Varah, based on her PhD work at the University of Reading. This session finished with PhD candidate Konstantinos Tsiolis (University of Reading), presenting his painstaking work exploring the nesting ecology of andrenid bees. These are important pollinators in many cropping systems. He showed that, perhaps contrary to conventional wisdom, many species nest in well-vegetated areas, foraging further into crops than originally thought.

After another lively lunch of buzzing conversation, the afternoon was made up of two sessions, the first exploring the capacity of pollinators to meet their nutritional needs in the wider landscape. Phil Stevenson (Royal Botanic Gardens, Kew) presented some very interesting work on the antimicrobial properties of pollen and nectar. Phil reminded us that he hails from the second most bee-diverse place in the UK, Kew (107 different species recorded); clearly, bees are getting a balanced diet if they are lucky enough to have a season pass to the gardens! The second session of the afternoon covered 'Monitoring and modelling' and we were privileged that Claire Carvell (UK CEH) was able to show us preliminary results from the world's first national systematic pollinator monitoring scheme (which is in the UK), now into its fifth year.

The final day started with a sobering reminder of the challenge of climate change from Nacho Bartomeus (EBD-CSIC, Sevilla), but he moved swiftly on to a more positive outlook, reminding us not to forget the potential of theoretical ecology to help us understand and, importantly, predict ecological responses to our changing environment. We then heard two great talks from Emily Carlson (Oregon State University) and Dara Stanley (University College Dublin), presenting progress made in our understanding of the risk pesticides pose to pollinators. The last session of the meeting covered 'Innovative strategies in pollination biology'. This included Jamie Robins of BugLife giving us an insight into the stakeholder engagement and mapping activities needed to inform the national-scale habitat restoration initiative B-Lines.

I would like to thank AAB, BES, RES and Syngenta for their support of this meeting, and particularly Geraint Parry and his team (AAB) for logistical support. I would also like to thank my fellow scientific committee members Rob Carlton, Barbara Smith, Naomi Jones, Lorna Cole, Helen Thompson and Simon Potts, with whom it was a pleasure to work closely bringing the agenda together. It's great to see such progress being made in pollination ecology, the establishment of UK PoMS (National Pollinator Monitoring Scheme) being one example, and our capacity now to model pollination services at a national scale. The research showcased at the meeting was challenge-focused; it engaged multiple stakeholders beyond scientists, and strove to deliver positive impacts for pollinators and society integrated throughout the research process. We were often reminded of the many challenges we face, and there is much we still do not know in this research field, but the outlook is a positive one.

The Society at the XXVI International Congress of Entomology

Helsinki, Finland, 17th – 22nd July 2022

The RES takes a stand: report by Emilie Aimé (Head of Publishing)

Among the 800 or so delegates at the XXVI International Congress of Entomology were the RES President, members of the staff, trustees and journal editors. This was the first time we had been to an international conference since our rebrand and the launch of our new strategic plan. Armed with our vision to 'enrich the world with insect science' we set out to show the entomological community what we've been up to, and our plans for the future.

Our stand was one of the most eye-catching in the exhibition (in our humble opinion), and we generated plenty of buzz throughout the conference. We were keen to recruit new Members and Fellows and were offering discounted rates for delegates. We signed up around 40, including one or two who came back to us after several years away. If you're reading this after having joined us at ICE, a very warm welcome! It was lovely having the opportunity to chat to delegates and exhibitors in person again, including catching up with colleagues from the Entomological Society of America.

We had around 20 journal editorial board members at the conference, which meant a fantastic presence for our publications. During one of the poster sessions we held a 'pitch-your-paper' gathering at the RES stand which generated a lot of enthusiasm and some great conversations. Editors provided advice to researchers on publishing their work and were able to let people know that submitting to our journals supports all the Society's work. Being together in person also gave us a chance to thank the editors for all their hard work on the journals, with dinner at a local restaurant.

In the scientific programme, as well as several talks by trustees and journal editors, Francisca Sconce, our Senior Outreach and Learning Officer, chaired a session on science communication, including talks on sci-comics and pre-publication peer review, as well as a talk on the RES's own outreach work.

The RES team at our stand at ICE L-R Simon Ward, Gulam Hussain, Luke Tilley, Emilie Aimé, Francisca Sconce © Royal Entomological Society.

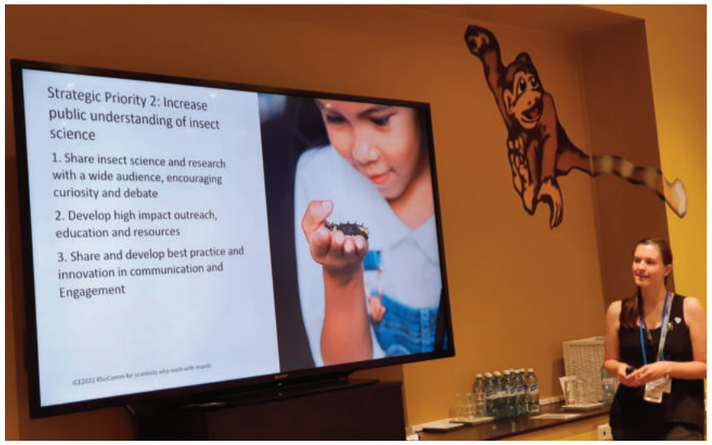
All in all, our return to in-person conferencing was a great success. Don't worry if you missed us at this meeting. At the time of writing, we're preparing for the ESA meeting in November and the BES meeting in December and considering our conference attendance for next year.

The Wigglesworth Lecture presented by Professor Janet Hemingway CBE FRS FMedSci FRCP Hon.FRES: report by Helen Roy (Past President)

Words are insufficient to convey the joy of listening to Professor Janet Hemingway giving the Wigglesworth Lecture. Her talk was utterly incredible and having the opportunity to meet her even more so. The research that Janet has led is fascinating. Her determination to advance understanding of vectors of tropical disease to contribute to managing some of the deadliest human diseases is beyond inspiring. The ways in which she applies her research to deliver practical solutions have been critical to reducing mortality in many parts of the world.

Former director of the Liverpool School of Tropical Medicine, much of her research has focused on malaria-transmitting mosquitoes, although she has an extensive list of publications on many other vectors of diseases. It was impressive to hear the ways in which she has unravelled complex biochemical processes to gain mechanistic molecular understanding of insecticide resistance to inform the development of novel strategies for managing resistance in insect disease vectors. Janet has highlighted issues of pyrethroid insecticide resistance in the African *Anopheles* malaria vectors as well as concerns over the lack of urgency in addressing the problem (Hemingway *et al.*, 2016). She pragmatically calls for improving the evidence for the use of different interventions within Integrated Vector Management (IVM) and highlights the urgent need for advocacy based on economic evaluation (Hemingway, 2018).

Janet has had a leading role in the Innovative Vector Control Consortium, embracing approaches to IVM. She described the interdisciplinary nature of her work and the importance of collaborations with diverse partners. Her research has underpinned approaches to vector control endorsed by the World Health Organisation. The story behind the latest mosquito nets being deployed in Africa took her from the offices of the Bill and Melinda Gates Foundation to working with industry to test the bioefficacy of long-lasting insecticidal nets treated with piperonyl butoxide by gathering evidence through operational use in Uganda (Mechan *et al.*, 2022). It was fascinating to hear of her scientific role in the process but also her ability to recognise opportunities to meet the needs of local communities.



RES Senior Outreach and Learning Officer Francisca Sconce, talking about the RES outreach work © Royal Entomological Society.

More recently, Janet has been working on lymphatic filariasis, a vector-borne, neglected tropical disease caused by *Wuchereria bancrofti, Brugia malayi* and *Brugia timori*, which affects 51 million people worldwide and leads to severe physical and mental disabilities. The nematodes that cause the disease are host to the bacterium *Wolbachia* and by targeting this endosymbiont there has been substantial progress in reducing infection (Quek *et al.*, 2022).

Much to the delight of many delegates, Janet joined us at the Royal Entomological Society stand within the exhibition area of the conference to continue discussions. It was wonderful to hear her joy and laughter as she chatted with entomologists at all career stages. When asked about advice for early-career researchers, Janet thoughtfully explained that it was important to seize opportunities and take others with you. Janet has seized many, many opportunities and taken many others with her. The impact of her research is phenomenal, and she is simply a lovely person to spend time with. I feel immensely privileged to have had the honour of presenting Janet with the Wigglesworth Award – indeed, I was so captivated that I forgot to present the medal! Janet took this in very good humour, and I am delighted that we all had the opportunity to share a small part of her amazing entomological story.

RES Past President Helen Roy, showing the RES team a ladybird pupa. © Royal Entomological Society.

References

Hemingway, J. *et al.* (2016) *The Lancet* **387**, 1785–1788.

Hemingway, J. (2018) *Pesticide Biochemistry and Physiology* **151**, 73–75.

Mechan, F. *et al.* (2022) *Current Research in Parasitology and Vector-Borne Diseases* **2**, 100092.

Quek, S. et al. (2022) *Proceedings of the National Academy of Sciences* **119**, e2120003119.

Phasmatodea and Related Insects Symposium: report by Thies H. Büscher (Kiel University; Associate Editor, *Physiological Entomology*)

Being one of the largest conferences on insects, the International Congress for Entomology in Helsinki provided a home for a series of symposia on specific groups of invertebrates which usually get mixed into miscellaneous sessions at smaller conferences. One of these symposia was on stick and leaf insects (Phasmatodea), organised by Matan Shelomi (National Taiwan University) and myself, which gathered a series of contributions spanning a range of aspects of the biology of phasmids and their closest relatives.

It was pure enjoyment to be part of a symposium filled with talks from various perspectives on stick insects, including phylogeny, evolution, locomotion, ecology, nervous systems, taxonomy and immunology. Although one presenter did not show up, it did not affect the atmosphere of the session, as Braxton Jones, a PhD student and energetic phasmid enthusiast from Australia, spontaneously jumped in and presented a talk he was not expecting to give at this conference; and he did well. The whole session was filled with a great audience, which established a convivial atmosphere and fruitful discussions about the fascinating group of stick and leaf insects.

ENTO22

14th – 16th September 2022, University of Lincoln

Convenors: Sheena Cotter, Graziella Iossa and Paul Eady

Report by Richard Harrington

What do you call a migration that converges on a different area each year? ENTO. And how nice it was to be back together again, this time in the fine city of Lincoln, in the impressive Isaac Newton Building of the university's attractive campus. The cathedral towers over the city and, on this occasion, was open free to all who wished to pay respects to Her late Majesty, our Patron. The climb up the very steep hill was well worth it.

With 55 excellent talks, sometimes in parallel sessions, and 32 top-quality posters, it is not possible here to delve deeply into the science, abstracts of which can be viewed at https://www.royensoc.co.uk/event/ento22/#Programme. Instead, I will give an overview of the topics covered, an outline of the plenaries, and try to convey the happy atmosphere generated by the presentations and a varied range of associated events.

First the science. Oral sessions were dominated by climate change, insect decline and their impact on ecosystem services, with a smattering of pest and vector control, a smidgen of societal engagement, a soupçon of molecular taxonomy and a sprinkling of other topics. Posters possibly covered a more diverse range of topics. Three plenary speakers were well-chosen. Sylvain Pincebourde (Director of Research, CNRS, France) demonstrated the role of microclimate in driving climate change impacts on invertebrates. His take-home messages were that: i) centimetre scale matters – we need macroecologists, meteorologists and climatologists to down-/up-scale processes; ii) we need to understand the amplitude of microclimatic change to quantify the response of the microcosm; and iii) microclimatic effects are subtle – detailed thermal analyses at fine-scale are urgently needed. Jessica Ware (American Museum of Natural History) and President of the ESA, spoke passionately on diversity in entomology and the dangers that some entomologists face in certain countries, asking 'Who has access to entomology spaces?", an issue that she has contended with whilst carrying out her field work on Odonata and Dictyoptera. By combining DNA data from recent, to 100-year-old odonatan specimens she showed that damselflies and dragonflies diverged 225 million years ago. The locations of collected specimens give valuable information about historic distributions, allowing species distribution modelling. Using new collections of the long-distance migrant, *Pantala*, she showed high levels of gene flow worldwide and by using hydrogen isotopes in the wings to determine the origin of collected specimens, she showed that most *Pantala* were migrants. She concluded by highlighting the work being done by the ESA to increase representation in the entomological community and pointed out that we need entomologists from all backgrounds and regions to work on the pressing issue of insect declines. Nalini Puniamoorthy (National University of Singapore) reported her impressive studies on sexual selection and biological diversification in: sepsids (mechanisms that mediate population diversification); scarabaeids (reproductive trait divergence in cryptic species complexes); culicids (how barriers to reproduction can play a role in disease transmission); and stratiomyids (optimising reproduction to improve food-waste bioconversion in urban systems). She concluded that: i) barriers to gene flow can arise through environmental and reproductive mechanisms; ii) integrating behavioural, morphological and molecular data can be a powerful approach; and iii) it is important to nurture student-led research.

Jane Hill hands Helen Roy the President's Medal (and a ladybird picture).

I don't think I've ever before been to a conference talk featuring a standing ovation. This was earned by Michael Pocock (UK Centre for Ecology and Hydrology) who gave a truly moving lecture on the work of the late Douglas Boyes, who died tragically young and did so much to uncover the impacts of light pollution on moth abundance. This work earned Douglas and his co-authors this year's prize for the best paper in our journal *Insect Conservation and Diversity*. The award was presented at the conference dinner to Douglas's mother, Clare, and husband, Jacob. Another talk that moved me was that of the three winners of the student essay competition (see *Antenna* 46/3, 152–155), from now on to be renamed the student science communication award. The lecture was expertly presented online, each student outlining their essay whilst commenting on the positive experience of participating in the competition and the Society more generally.

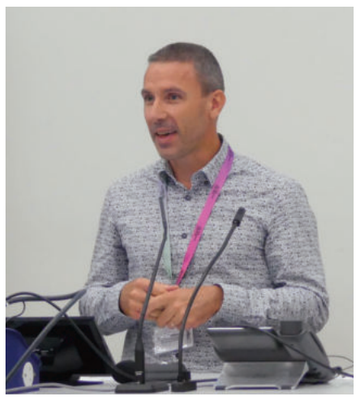
Doddington, Ava Seales (University of Lincoln) shows off her carrion beetles.

A visit to nearby Doddington Manor to hear first-hand from Isobel Wright about the impressive plans to 'rewild' its 770 hectares was a real bonus. A baseline survey by Graham Lyons has revealed 778 insect species, of which 20 have a conservation status. A small beetle, *Cryptocephalus frontalis*, was the first record of the species in the vice-county since 1901. One hundred and twenty seven species of spider were found, two of them new to Lincolnshire. Two master's students from Lincoln, Ava Searles and Chloe Francis, introduced us to their carrion beetle and dung beetle projects, respectively.

The student ENTOlympics were organised again by Liam Crowley (University of Oxford). After six cleverly-devised rounds featuring some devilish questions, team 'Nameless Wasps', featuring Clare Boyes (Manchester Metropolitan University), Jacob Jaffe (London School of Economics), Amma Simon (Keele University) and Ben Hawthorne (Harper Adams University) emerged victorious.

The President's wine reception featured clarinettist Karen Wimhurst, who performed her own impressive compositions co-starring various orthopterans, cicadas, toads and frogs. Other events included a pre-conference mixer, a women in entomology breakfast, a workshop on how to get published, the conference dinner, a mentorship breakfast, a GLiTRS workshop on what's driving insect decline and, of course, the Society's AGM, at which the presidential reins were handed over from Helen Roy to Jane Hill. The Society's Obligations Book made an appearance, and was signed by six Fellows, including our new President.

Many thanks to Sheena and her team, presenters and co-authors, participants, associated event organisers, RES staff and all others involved in a truly memorable meeting of the highest quality.



Plenary speaker, Sylvain Pincebourde.

Plenary speaker, Jessica Ware.

Plenary speaker, Nalini Puniamoorthy.

Karen Wimhurst plays her clarinet.

ENTOlympics winning team, Nameless Wasps, Ben Hawthorne, Amma Simon, Clare Boyes and Jacob Jaff, with quizmaster Liam.

HONORARY FELLOW INTERVIEW

Gordon at his desk.

Gordon Port

A life with slugs and other invertebrates

Bristol to Newcastle is a five-hour train journey, giving me plenty of time to ponder the impending interview with Gordon. I had first met him at the sixth annual Ento meeting at Reading in 2003, where we'd had a long conversation about outreach and this common interest has kept us in contact over the intervening years. Gordon had long been on my list of interviewees and the time had now come for this southern lad to head north, so armed with Seirian Sumner's *Endless Forms*, which entertained, amazed and informed me on the long ride, I journeyed to Newcastle. On arrival I made a classic southerner's blunder by asking staff at Newcastle which platform I needed for a train to Prudhoe, only to receive a puzzled frown, followed by "Ah, you mean Pruda". Gordon collected me from Pruda station and we settled into his conservatory with a generous supply of cake from his recent birthday, and with tea supplied in mugs adorned with images of slugs. Then, Gordon began answering my questions.

Early Years

"Whilst entomology was not a huge part of my childhood, my father did encourage me to take an interest in these animals as he was a frustrated zoologist. At school he had the same biology teacher as Dick Southwood, but my father was Head Boy when Southwood was a junior. I was always slightly concerned that my father might have mistreated Southwood at school, and that this would have repercussions on my career prospects. My father went to Liverpool to study zoology, but as we were at war he left university to join up. He had a great enthusiasm for entomology and had a few classic books on insects, including Joy's *Handbook of British Beetles* which now sits proudly in my library.

Our family lived in a rambling house in West Sussex with a large garden, so we were always outside. I would rear caterpillars, keep stick insects and I caught beetles in pitfall traps. Natural history was always a part of our life, but it was just one of the many things that we took an interest in.

At grammar school we were able to undertake a project for A Level Biology so a group of us decided to study ecology, probably because we could work outside the classroom. We investigated floral succession on the South Downs, and meadow recovery from rabbit grazing. We even managed to call in to a pub on our way home."

University

"When I studied at Lancaster University I was unsure of which branch of biology to pursue, but I had some sort of environmental science in mind. I originally wanted to become a biochemist but did not engage with the way it was taught, and I became more interested in ecology and entomology, inspired by John Whittaker's lectures and practical classes. During my second summer, John was approached by the Nature Conservancy Council to find a student to conduct an entomological survey of some forest sites on the Scottish borders, and he asked me if I wanted to take it on. I really enjoyed this project although I did not manage to

Gordon collecting mosquitoes from experimental huts with a motorised sampler in The Gambia, 1979.

identify many insects to species, but it gave me an interesting and useful experience of a field study and a grounding in insect taxonomy. I liked the idea of a career in academia, and I was then fortunate to be offered a PhD at Leicester on insect–plant interactions. However, John got wind of a PhD at Imperial College's Silwood Park Field Station with Nadia Waloff, working on leafhoppers. I had to choose and quickly realised that Imperial College might be a better choice, as Silwood Park offered the great opportunity of becoming immersed in a community of entomologists who were working on a wide range of topics. Silwood was also close to London, enabling easy attendance at RES monthly meetings.

Dick Southwood was director of the field station at that time, and I was a little alarmed when he singled me out at the welcome evening for new PhD students, asking if I was related to another 'tall Port' he had been at school with.

Nadia Waloff was kind and amiable as a supervisor, but also 'hands off' leaving me to get on independently, not something that would be so usual these days with requirements for regular student-supervisor meetings and reports to funding bodies, as I have learnt over my years of supervising 37 PhD students. At my interview, Nadia asked me in her heavy Russian accent whether I had used Lakane skis. I had no idea what these were but imagined some entomological sampling equipment, so I said no, but I had heard of them. It was sometime later that I realised she had said Le Quesne's keys, the RES Handbook keys to leafhoppers written by Walter Le Quesne.

My PhD was a comparative study of feeding behaviour in leafhoppers and planthoppers. When these insects feed they leave a tube of saliva in the plant tissue, making it possible to section the plant and see which tissues the insects had been feeding from. The planthoppers produce branched saliva tubes which rarely reached the plant vascular tissue, whereas the leafhoppers probe directly into the vascular tissue. The sub-family Typhlocybinae are an exception, feeding mainly on the parenchyma of the leaf. Always on the lookout for new approaches I used an early version of the Electrical Penetration Graph (EPG) now regularly used to study feeding behaviour of plant-sucking insects. A technique had also been developed to stun and kill an insect instantly with a high-voltage electric shock; using this, I could watch a leafhopper feeding and stop it in mid feed to see exactly where the stylets were. Unfortunately, the shock tended to blast the insect off the plant, and on at least one occasion I managed to shock myself.

During my time at Silwood a couple of friends and I became involved in a natural history society based in Bracknell, at South Hill Park. One of these friends, Jim Thompson, was investigating factors affecting roadside vegetation, particularly salt. He had observed that plants on the central reservations of motorways were heavily attacked by various species of caterpillars, and we investigated why this might happen. We were able to rule out a shortage of natural enemies (enemy free space) and showed that nitrogen pollution from the traffic (NO_x) was fertilising the plants and making them a much better food source for caterpillars of the Buff-tip moth (*Phalera bucephala*) and other herbivores."

Africa

"In my final PhD year I met (my now wife) Celia, who was one of the MSc Entomology students at Silwood. After we finished our studies Celia started her career at the ADAS consultancy's Reading office, not too far from Silwood where I was lucky enough to get a post-doc position working on mosquito feeding behaviour with Peter Boreham. Peter ran the WHO blood meal testing laboratory, assessing mosquito and other arthropod blood meals to determine which host animals they had come from. My post had the advantage of being local for both of us, although it did also involve two lengthy

Gordon briefing Newcastle University students about insect collecting techniques at a field course in Crete, 2017.

periods of field work in The Gambia during the rainy seasons, a great adventure for someone who had not travelled outside of Europe. It was the late seventies and travel was not as easy as it is today. My first flight to Africa stopped at Casablanca then Las Palmas then on to The Gambia. However, my sense of adventure was quickly deflated when I was greeted by a couple of friends from Silwood at Las Palmas airport who were returning from a holiday.

I was based at the MRC Laboratories at Fajara on the Atlantic coast. The aim of the project was to investigate the high rate of malaria in children to see if it was linked to mosquito feeding behaviour. Peter Boreham had developed a technique to assay the serum protein haptoglobin, by electrophoresis, so we could extract blood from mosquitoes and check the haptoglobin type of the human host, enabling us to identify the individual fed on. Together with the resident MRC entomologist, Joan Bryan, we identified a local village where we knew all the residents and their blood types as a suitable place for the study. We looked for people with different haptoglobin types who shared a bed and collected blood-fed mosquitoes from inside their bed net each morning to determine which person had been fed on. Although we know that mosquitoes show preferences for certain individuals, at close range, inside the net, the mosquitoes feed on the largest surface area of exposed flesh. So larger people were bitten more than smaller people, and babies were bitten less than the adults they shared a bed with. The high rate of malaria infection in the babies was due to a lack of immunity and nothing to do with mosquito feeding behavior.

In my second field season I tested the effectiveness of bed nets, commonly used but most of which had holes. I used two experimental huts that would trap a proportion of the mosquitoes leaving the hut, for later assay. Volunteers slept in the huts with bed nets that ranged from having no holes to many. We could then assess how many mosquitoes had fed on the volunteer and how many had failed. This showed that even bed nets with holes were of some benefit, and this contributed to the subsequent approach of treating nets with insecticides to increase their efficiency.

Towards the end of my first trip to The Gambia I became interested in a serious unidentified disease that was killing people 'up country'. I was loaned a Land Rover and driver and travelled upriver to investigate whether the disease might involve an insect vector. Fellow entomologists Mick Gillies and Tony Wilkes, from the University of Sussex, were also interested and already based at a remote field camp not far from the outbreak. Working as a team, we traced the victims from the few hospitals to their villages to try to identify the cause. We thought the disease might be Yellow Fever and therefore looked for *Aedes*

Slug ecology and behaviour eventually became a theme that has continued throughout my career, and I am regularly referred to as a slug specialist

aegypti, the 'usual' vector. The best, though not risk-free, way to sample mosquitoes is to use human bait, so we rolled up our trouser legs and collected alighting mosquitoes, but never found *A. aegypti*. We did capture a few specimens of *A. furcifer / taylori* which had not previously been recorded as a Yellow Fever vector. Yellow Fever was later confirmed at Porton Down, once I had returned to the UK with tissue from infected patients (the vacuum containers with dry ice and tissue samples were kept with me on the flight). We suggested *A. furcifer / taylori* as the probable Yellow Fever vector and this was confirmed by the WHO the following year."

Newcastle upon Tyne

"As I finished my post-doc position and Celia had transferred to ADAS, Newcastle, I made contact with entomologists at Newcastle University, especially Martin Luff, and applied for a research fellowship to investigate a range of blood-feeding flies that were affecting livestock in the northeast. Fortuitously, a vacancy for an applied zoology lecturer also became available at Newcastle University and I was successful in both interviews, opting for the lectureship. Looking back, it was a wonderful time for teaching as we had class sizes of only twenty-five

Gordon leading a ladybird hunt with young entomologists at the Hancock Museum, 2016.

students and got to know them all individually; nowadays, classes can be ten times that size and you know hardly any of the undergraduates.

I worked on blood-feeding flies with Stuart Ball and Martin Luff, and I also obtained funding to continue my work on roadside invertebrates. Then Celia came home one day talking about the economic problems farmers had managing slugs. I realised that predicting slug activity was key to timing molluscicide treatments, and I started looking at slug behaviour in detail. Using time-lapse video, we showed that slugs are not attracted to molluscicide pellets. With newly available data loggers we demonstrated the key importance of soil surface moisture in controlling slug activity and developed methods to forecast slug activity and predict population changes. Slug ecology and behaviour eventually became a theme that has continued throughout my career, and I am regularly referred to as a slug specialist.

Another colleague, Alan Davison, was studying the fluoride levels in the environment around an aluminium smelter just north of Newcastle, and together we monitored the fluoride levels in a range of insects collected around the smelter. It had been assumed by others that any fluoride was passed up the food chain and accumulated in predatory invertebrates, but we demonstrated that it was a surface accumulation effect. Insects with smooth cuticles, such as aphids, had low fluoride loads whilst hairy invertebrates, like spiders, had much higher loads due to the retention of fluoride-containing particulates in the dust. Another investigation, into the effect of ozone on plants and insect herbivores, showed that ozone altered the suitability of the plant for the insect in a complex way. Whilst there may have been a diverse array of projects across my career, the unifying theme has tended to be invertebrate feeding behaviour, as demonstrated by the diversity of the many PhD projects I have supervised over the years, ranging from slugs to beetles, bugs, butterflies and biological control.

When Celia and I arrived in the northeast we were keen to find out about local natural history and joined the Wildlife Trust, but even closer to the university was the Natural History Society of Northumbria (NHSN), a learned society that predates the RES. It had been founded by gentlemen naturalists in 1829 and they later founded the Hancock Museum in Newcastle, which the Society owns and leases to Newcastle University. Over the years I have helped to organise events for the entomological section of the NHSN. I have always been interested in public engagement and when I became the RES regional Secretary for the North I would often promote local events as joint RES/NHSN. Over the years I became more involved with the Society, and finding the membership somewhat skewed to an older demographic I have especially encouraged university biology students to participate. We now have many more young people who give talks, attend field meetings and volunteer at the NHSN nature reserve north of the city. The reserve has its own outdoor classroom and is regularly visited by local primary school groups, thus encouraging children to engage with nature perhaps for the first time in their lives. I am now the chair of the Board of Trustees of the NHSN, a post that keeps me busy."

RES

"While doing my PhD we were encouraged to join the RES and I became a Fellow in 1977 in the traditional way, by shaking the hand of the President, J.D. Gillett. At that time only the monthly meetings were the norm, and I suggested that we organise a one-day workshop on plant-sucking insects. Van Emden kindly agreed to chair the day and we invited speakers from around the UK and Europe. It was my first exciting venture into the joys of organising scientific meetings.

When I moved to Newcastle it became more difficult to attend meetings in London so I was initially less involved. I distinctly remember a phone call from Richard Harrington asking if I would be the newly-created Regional Secretary for the North of England. This was a post I really enjoyed, meeting fellow entomologists from around the region and further afield and also facilitating meetings hosted by a range of institutes, on a wide variety of topics. A particular highlight for Celia and me was attending the soirée at the Zoological Society of London in 1985 to celebrate the centenary of the granting of the Society's Royal Charter, which was attended by our patron, Her Majesty Queen Elizabeth II. After a while I was invited to join Council, and I later chaired the Membership Committee for five years.

Back in 1996 Richard Harrington called to say that the RES wanted to hold the annual meeting 'outside' London, and would I therefore organise it at Newcastle University (Ento'97). There was little guidance,

Gordon at the AES/RES exhibition in York in 2006. Bumblebee by Catriona Port, photo Archie Murchie.

Julie North and Gordon at the York Insect Festival, 2013.

and I had a fairly free hand. I remember the Registrar, Greg Bentley, bringing the Obligations Book to Newcastle and entrusting me with its safe keeping, which made me slightly nervous. The meeting was a great success and the following year it moved to Exeter, and the rest is history. Twenty years later it was my turn once again to organise Ento'17 in Newcastle, together with Darren Evans and James Gilbert.

The Amateur Entomologists' Society has always held an annual exhibition in London, and in 2006 they ran a similar event at York Racecourse in conjunction with the RES. As Regional Secretary I helped organise our participation. After this joint venture the RES decided to run the Insect Festival in York Museum Gardens and Julie North, Luke Tilley and I were asked to organise this. It has been a hugely popular event with the public and has run every two years since 2009, also engaging local schools via an insect art competition, with awards presented to winners at the festival. The first National Insect Week occurred while I was on Council, and ever since I have also aimed to organise Insect Week events in the northeast."

We had to call a halt to our conversation as dinner, booked at a local pub, was calling. On arrival at the pub, Gordon pointed out the graveyard next door as one of 118 sites that had been surveyed earlier this year for overwintering ladybirds by a team of twenty-three NHSN volunteers under his guidance. Inside we were joined by his daughter and her husband, Catriona and Callum, both veteran volunteers of the York Insect Festival.

Gordon is an entomologist who has been quietly embedded in the organisation and modernisation of the RES. He is an unassuming pioneer who has been at the forefront of all of the Society's new initiatives, a constant champion who has broadened the Society's engagement with the wider world of entomology and natural history. He was one of the first regional secretaries and organised the first of the annual meetings to be held outside of London. He was one of the drivers behind the York Insect Festival. Working with local natural history societies, he has blended local and RES meetings to capture as wide an audience as possible, merging professional and amateur interests to celebrate the invertebrate world.

In the corner of Gordon's conservatory was a series of entomological cabinets, containing a collection of insects from Moorhouse National Nature Reserve in the North Pennines, having been donated by John Whittaker from Lancaster University and destined for The Hancock Museum, a testament to Gordon's continued involvement with local natural history. His interest in invertebrates has also filtered into the life of at least one of his daughters, Catriona, who was often surprised when opening the fridge to grab the butter only to find a container of slugs. "I used to encourage her to take invertebrates she had collected in the garden into school to show the rest of the class, and when she worked as a nursery assistant she invited me to visit the nursery and talk to the children about minibeasts". Over dinner that night Catriona demonstrated her enthusiasm for invertebrates with fond memories of insect hunting with her father, and now, as a practising psychotherapist, Catriona launched into a discussion of insect phobias, such as delusory parasitosis. Invertebrates are clearly deeply embedded into the Ports' family life.

Gordon's quiet energy has pervaded so many aspects of both the RES and Northumbrian natural history, and continues to do so after his retirement from university duties. This commitment to both our understanding of invertebrate feeding behaviour and his encouragement of a better appreciation of invertebrates by the wider public is a legacy that will run into future generations.

When I asked Gordon to sum up his time as an entomologist he simply said "It's always been and continues to be great fun" - a sentiment that we can all appreciate, so we hope that Gordon will continue to have fun for many years to come.

Peter Smithers

International Union for the Study of Social Insects (IUSSI) Congress 2022

3rd-7th July, San Diego, CA

Elizabeth Evesham
(elizabethevesham@gmail.com)

Apis mellifera liguistica inside a propolised free hive (by Simone Finstrom).

It was so refreshing to have an in-person conference in such a wonderful city. San Diego is on the Pacific coast of California and is a naturalist's paradise with its varied terrain from desert and mountains to sea and lush, exotic vegetation.

The venue for the XIX Congress, IUSSI, was the Marriott Marquis Hotel, set along the bayside with views of luxurious yachts as well as ancient ships converted into restaurants and a Naval aircraft carrier, the USS Midway, now a museum.

The reception took place on the terrace of the hotel with good views of the harbour and was marked by fireworks, celebrating the 4th of July, Independence Day. The event is also known as the 'Big Bay Boom'- which was very apt.

The following four days of the conference each started with a plenary session, followed by symposia comprising talks on social immunity in eusocial insects; protecting our pollinators and food supply; invasive species; genetical, ecological and behavioural studies; evolutionary pathways and cognitive abilities in social insect colonies, and my own, *The benefits of human activity on social insect populations.* My symposium brought together colleagues from Brazil, Africa, Cameroon and Europe, each faced with finding solutions to managing ecosystems to try to protect the habitats of social insect populations and their geographical dispersal routes. Genetic and morphological studies have enabled us to understand how ants have evolved to tolerate extreme temperatures and humidity. In Nigeria, research has led to rural areas, having suffered severe crop losses through climate change, changing to apiculture that has given a boost to the local economy. However, there is much work still to be done to get government backing and to reduce pesticide levels. Ghana has a problem with 'honey hunting' and the Forestry Commission has encouraged the harvesting of propolis (a substance produced by honeybees from tree and plant resins combined with wax, which has health benefits to the colony) and bee venom, which provide an attractive investment and motivation to preserve tree-hives and prevent the destruction of bee populations.

Propolis was the 'hot topic' of other talks since it is removed in commercial hives. However, its antimicrobial properties mean that if honeybees include it in their nest architecture, their productivity and health are enhanced.

I was particularly interested in the symposium entitled *Spatial structure and organisation within social insect colonies*. Deborah Gordon (Stanford University) spoke about *Cephalotes goniodontus* (Arboreal Turtle Ant) and how it solves problems of connecting nests by using different tree branches. Claire Detrain (University of Brussels) looked at how *Myrmica rubra* (European Fire Ant) can adapt to biotic and abiotic environments. Large colonies benefitted from their ability to explore over a wider area for resources by increasing the number of nest entrances. Peter Marting (University of Auburn, Alabama) looked at the impact of colony performance and survival on organisation of honeybee nests in three dimensions. To do this, he installed colonies within boxes that had empty wooden frames to see how bees build their combs unguided. For some of the colonies, the orientation and order of the frames within the boxes was changed each week for a six-week period. He found little difference in colony-level performance, such as worker population, nest area and hive height, between disturbed and undisturbed groups. However, the development of the combs over time did differ. While control colonies built combs evenly on all leading edges, the disturbed colonies focused their efforts on new comb growth in areas that offered the largest, adjoining nest fragment. Therefore, honeybee colonies can shift their pattern of nest construction at no extra cost to colony-level performance. I think this is an important find given the impact of human activity on the habitats of pollinators. Insects truly are resilient. I asked Peter whether honeybees remembered the shape of their nest. I had found this to be the case in *M. rubra*. In honeybees, it would seem that there is an

Camponotus rufipes which has distinct dispersal routes in the cerrado areas of Brazil (by Gustavo M. Mori).

element of remembering nest shape in this study, but it would be an interesting project to pursue.

In another symposium about the impacts of introduced honeybees on native pollinators in non-managed ecosystems, Maureen Page (University of California, Davis) found that honeybees indirectly reduced pollination of an ecologically-important wildflower, *Camassia quamash*, by preventing native and more-effective bees from visiting it. So instead of this mutualism having a beneficial effect on pollination, it reduced nectar and pollen availability for native species. Therefore, this has a negative impact on plant pollination, and the placement of hives needs careful consideration. There is also ongoing research on the impact of forest fires on floral resources and honeybee and *Bombus* populations.

Besides the vast array of high-quality posters and talks, with some online, there was plenty of chance to socialise and meet colleagues.

The closing ceremony was marked by Professor Bert Holldobler receiving the Hamilton Award. This was established in 2006, in memory of W.D Hamilton, and recognises lifetime achievement in the biology of social insects. I have met Bert on many occasions at social insect meetings, along with the eminent E.O Wilson, who was a myrmecologist and a great mentor.

In four years' time, the IUSSI Congress will be in Freiburg, Germany and I would encourage entomologists to go if they get the chance.

I would like to thank the Royal Entomological Society for supporting me on such an adventure and for giving me the opportunity to gain inspiration to pursue my research studies further, and to be able to provide novel examples of the impacts of climate change on insect populations worldwide in my teaching on food security and ecology within the secondary school curriculum.

Native bee *Bombus mixtus* visiting *Camassia quamash* (by M. Page and N. Williams).

Report on an L.J. Goodman Award for Insect Physiology and Behaviour

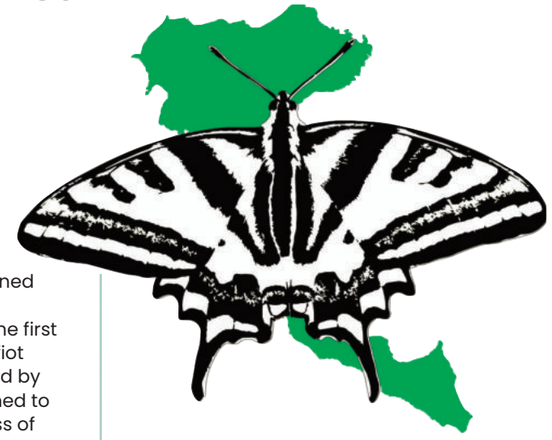
Corfu Butterfly Conservation: initiating a conservation project in a foreign territory

Dr Dan Danahar
Executive Chair of Corfu Butterfly Conservation
dan@corfubutterflyconservation.org

British entomologists rarely make new discoveries daily but one way to rectify this is to work in a foreign territory. Today, most people know about the Ionian Island of Corfu because of the work of the late author Gerald Durrell. The account of his childhood as depicted in the idyll *My Family and Other Animals* (Durrell, 1956) had a considerable impact on the British public at the time of its publication. Ironically, for decades since, the study of Corfu's natural heritage has remained Durrell's neglected realm.

Sutton (2012) published the first literature review of the Corfiot butterflies. This was followed by Ghinis *et al.* (2013) who aimed to raise the public's awareness of Corfiot biodiversity through the publication of a photographic booklet containing colour images of most of Corfu's butterfly species. The most recent literature review by Ghavalas & Coutsis (2018) included examinations of genitalia for some critical butterfly species, confirming their presence on the island.

Distribution of locations with butterfly records (n = 3228) – a measure of the most recent recorder effort (all records received between 1 January 2021 and 20 July 2022).



The logo of *Corfu Butterfly Conservation* (CBC).

Interest in the conservation status of Corfu's butterfly assemblages has its origins in a Facebook discussion page (Danahar, 2014), which led to the creation of *Corfu Butterfly Conservation* (CBC) – registered as a UK Community Interest Company (No. 13813164) in 2021 (Danahar 2020; 2022a). CBC has now become a non-profit organisation working in partnership with both governmental and non-governmental partners in Greece, the UK and Europe. Its six core aims are:

1. to encourage the continued growth of a responsible community of Corfu butterfly enthusiasts;
2. to survey the butterflies of Corfu and determine the number of species present on the island, their distribution and their flight periods;
3. to find out if the butterfly communities of Corfu could be used as indicators of habitat quality and, if so, help with the conservation of other Corfiot wildlife;

GRANT REPORT

4. to identify potential losses of species and habitats and inform the Greek authorities about which need protecting;
5. to publish the butterfly survey results and the conclusions drawn from these data in the first comprehensive Corfu Butterfly Atlas; and
6. to encourage eco-tourism outside the main tourist season, bringing extra revenue to Corfu.

The CBC Facebook Group currently has a membership of over 900 individuals. Through this platform, members support each other to enhance their identification skills as well as their understanding of the ecology and behaviour of the different Corfiot butterfly species. Furthermore, it is this dialogue that has definitively confirmed the existence of 76 butterfly species on the island.

CBC launched its *Corfu Butterfly* (citizens science) *Survey* (CBS) on 7th January 2020 (which would have been Gerald Durrell's 95th birthday). It aims to encourage the public (both residents and visitors) to collect data on the distribution of Corfu's various butterfly species. These data will be used to produce the first comprehensive Corfu Butterfly Atlas. However, we came to view 2020 as a 'null' year for data collection because the Covid-19 pandemic made it difficult for residents to go out to survey butterflies and also led to a significant reduction in the number of overseas visitors to the island (Danahar, 2021).

CBC provided 8,000 dual-language butterfly posters, one for every child, in each of Corfu's 54 primary schools. These posters are designed to aid the identification of the 76 known butterfly species observed on Corfu.

Obviously, Facebook is not designed to store sizable amounts of biological records, let alone retrieve every photographic sighting that is recorded on it. *Ergo*, we used the 2020 recording season to upgrade our independent website, to make this recording possible. Thankfully, CBC received a generous contribution of £3,000 from the *Goodman Award* (managed by the Royal Entomological Society) which supported our efforts towards this goal.

Our new website was designed and developed by Steven Cheshire, who had built the website for the Warwickshire branch of *Butterfly Conservation* – amongst many other sites. Our mapping code was written by Bob Foreman, the biodiversity data lead at the *Sussex Biodiversity Record Centre*. Subsequently, the CBC website (corfubutterflyconservation.org) and the CBS were both relaunched on 1st January 2021.

Whilst our website is conventional in many ways, once sightings have been verified, they join a database from which a range of operations are performed, and the outcomes displayed. These include: 1) showing the latest records; 2) displaying first and last sightings; 3) revealing the species we expect to see monthly, based on data reported in previous years, and 4) generating graphs to show each butterfly species' monthly abundances, plotted over the course of the year.

The website generates distribution maps but these have yet to be made public, although examples of the first year's results have been published (Danahar, 2022b). The website continuously grows in functionality but there are still areas for improvement. At the time of writing the CBS has been running for just over 18 months and, although this is a relatively short period of time, the data we have collected have already made it possible to speculate about the impact that changes in land management may be having on the Corfiot butterfly communities (Danahar, 2022c).

Thanks to the *Goodman Award* and the Royal Entomological Society, the CBC website increases our understanding daily of Corfiot butterfly assemblages.

References

Danahar, D. (2014) Corfu Butterfly Conservation, a *Facebook* discussion group, https://www.facebook.com/groups/634400976634167.

Danahar, D. (2020) *European Butterflies* **3**, 6–7.

Danahar, D. (2022a) *Butterfly* **140**, 22–23.

Danahar, D. (2021) *European Butterflies* **4**, 10–11.

Danahar, D. (2022b) *European Butterflies* **5**, 18–21.

Danahar, D. (2022c) *Butterfly Conservation European Butterfly Group eNewsletter* **31**, 22–27.

Durrell, G.M. (1956) *My family and other animals*. Rupert Hart-Davis.

Ghavalas, N. & Coutsis, J.G. (2018) *Phegea* **46**, 10–20.

Ghinis, S. *et al.* (2013) *Butterflies of Corfu*. Natural History Museum of Salento, Corfu Press.

Sutton, P.G. (2012) *Bulletin of the Amateur Entomologists' Society* **71**, 63–77.

Green Hairstreak (*Callophrys rubi*) nectaring on Branched Asphodel (*Asphodelus ramosus*).

Hungarian Skipper (*Spialia orbifer*) basking to thermoregulate its body temperature.

EntoSci 2022: a new online experience

Francisca Sconce
Royal Entomological Society, UK (fran@royensoc.co.uk)

The entomology conference for young people returned online in 2022. With the support of Harper Adams University and partners of the Royal Entomological Society, the event about entomology careers and study pathways took place on 25 April 2022. There were live interactive sessions and on-demand videos and resources, and over 200 teenagers joined us live on the day.

We kicked off with welcomes from Adam Hart as chair of the RES Outreach Committee, Helen Roy as President, and the Harper Adams entomology team including RES trustee Joe Roberts. Seirian Sumner from UCL gave the first keynote talk on 'Ten Reasons to Love Wasps', summarising her career, highlighting the diversity of this group, their beauty, their ecosystem services, their fascinating behaviour, and their value as a food and medicine. Kanchon Dasmahapatra from the University of York gave a keynote talk on 'From Jungles to Genomes: the evolution of butterfly wing patterns', talking about his career journey, and work on *Heliconius spp* butterfly colour pattern mimicry, variation and evolution.

Stefan Gates then presented a session on 'Amazing Insects', drawing on his experience as a television presenter and writer, including his times travelling and eating insects. Amoret Whitaker and Luca Manelli recorded an interactive workshop on forensic entomology, talking about their careers and research, and providing online resources to identify Calliphoridae larvae and calculate post-mortem interval from a simulated crime scene. Graham and Janice Smith filmed many of their different insects and arthropods, and talked about their Metabugs consulting business, working on natural history TV, films and documentaries. Heather Campbell from Harper Adams University ended the day talking on 'How to Study Insects and Travel the World', including her career and work on ant ecology and baboon spiders.

Early-career entomologists recorded short talks about their careers so far and their projects. Claire Hoarau, a PhD student at Harper Adams, talked about

Luca Manelli collects evidence in the forensic entomology session at EntoSci 2022.

Kanchon Dasmahapatra talks about *Heliconius spp* butterflies in the second keynote at EntoSci 2022.

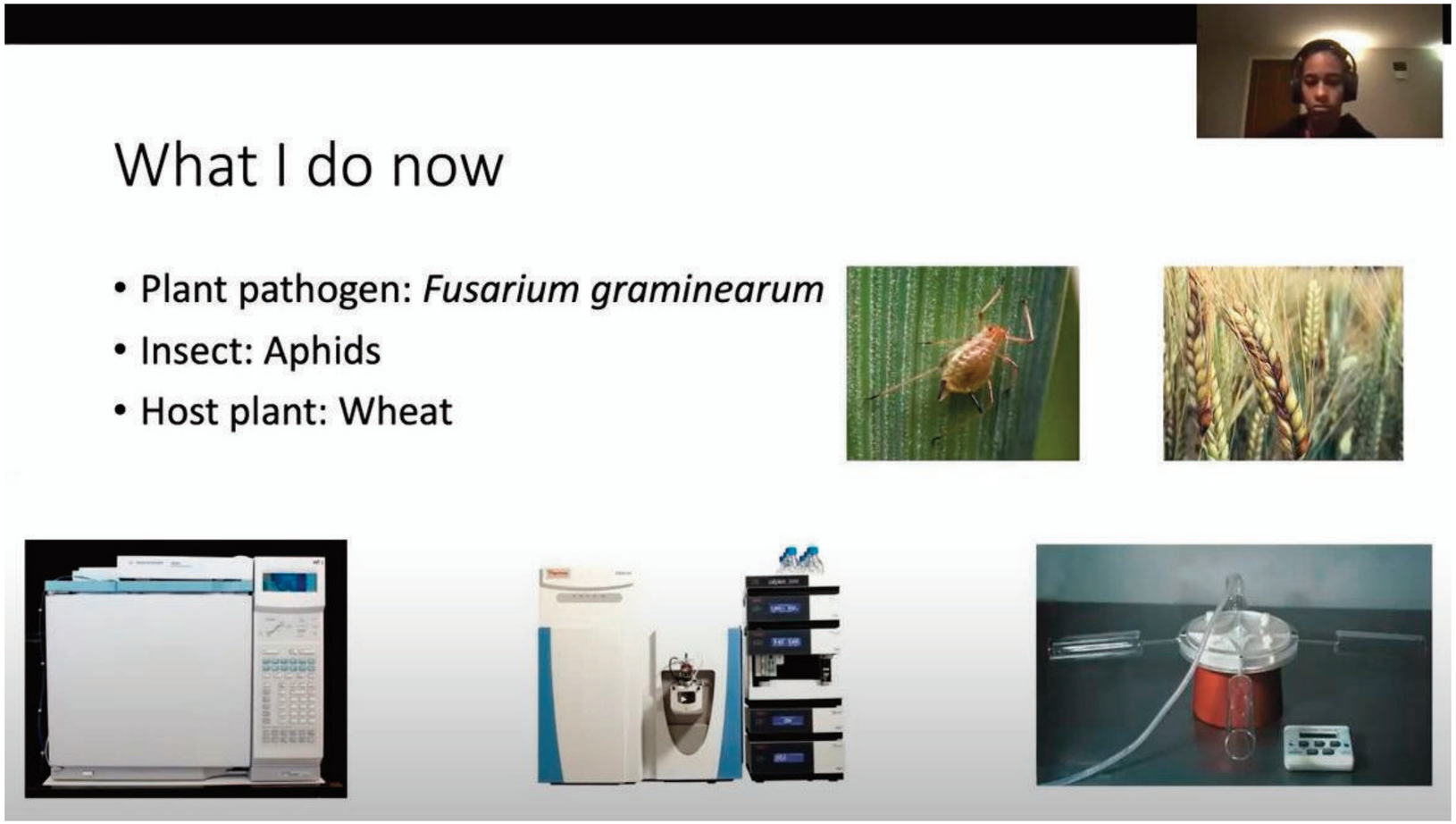
biopesticides to control Cabbage Stem Flea Beetle. Leanna Dixon, Assistant Entomologist on the Tanyptera Project at World Museum, Liverpool, talked about pollinator identification, biological recording schemes and community science projects. Jen Jones, Assistant Ecologist at JBA Consulting, talked about a Master's project on Bilberry Bumblebees on the Long Mynd. Amma Simon, postdoctoral research associate at Nottingham and Keele Universities, talked about the plant pathogen *Fusarium graminearum* on wheat. Graham Smith, Skipper Ranger at Butterfly Conservation, talked about the reintroduction of Chequered Skipper into Rockingham Forest. Will Hawkes, PhD student at the University of Exeter, talked about researching insect migration with on-location videos from Cornwall and Cyprus.

Exhibitors providing on-demand content included the British Dragonfly Society, Bumblebee Conservation Trust, Field Studies Council, British Ecological Society, Royal Horticultural Society, Darwin Tree of Life project, Buglife, Fera, Association for the Study of Animal Behaviour, Slug Disco and the Tanyptera Trust.

We are indebted to Sally-Ann Spence, who created the event, and Simon Leather who developed the partnership with the Royal Entomological Society. Many thanks to Rachel Brookes and James Armstrong at Harper Adams University for providing all the event infrastructure, and to all contributors who provided content.

Watch back EntoSci 2022 content at http://harper.ac.uk/joinentosci and on the Careers in Entomology pages on the RES website. If you are interested in taking part in future events please contact Fran Sconce at fran@royensoc.co.uk.

Janice Smith of Metabugs with a katydid at EntoSci 2022.



Amma Simon presenting her early career entomologist talk at EntoSci 2022.

Andy Benson in the Bumblebee Conservation Trust's exhibitor video at EntoSci 2022.

Westwood Medal Report

Dr Shaun Winterton
Chair of Publications Committee

In recognition of the importance of taxonomy to our basic understanding of global biodiversity, the Royal Entomological Society offers an award recognising excellence in insect taxonomy, the J. O. Westwood Medal. The award is named in honour of the leading 19th century British entomologist, John Obadiah Westwood (1805–1893). Westwood was the inaugural holder of the Hope Chair of Entomology at the University of Oxford, when the Reverend F.W. Hope established it in 1863. Westwood was one of the original founding members of the then Entomological Society of London, in 1833, and served as President for three separate periods, 1851–52, 1872–73 and 1876–77. In 1883 he was elected to the unique position of Honorary Life President of the Society. He was a prolific author and published on most groups of insects and illustrated his own works, and those of many others, with his exquisite drawings and paintings.

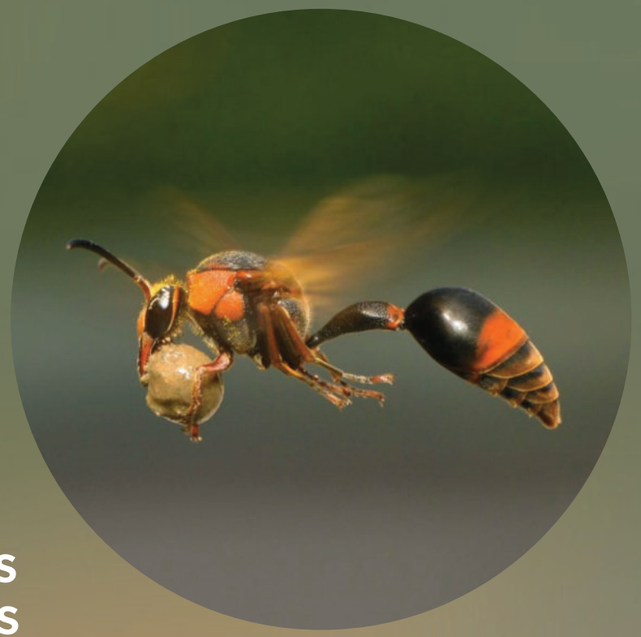
The J.O. Westwood Medal is awarded annually to the best comprehensive taxonomic work on a group of insects or related arthropods (including terrestrial and freshwater hexapods, myriapods, arachnids and their relatives) in the spirit of the life works of J.O. Westwood. Typically, this will be a substantial taxonomic revision or monograph. Nominations are judged by a panel of senior Fellows of the RES with expertise in descriptive taxonomy.

We are pleased to announce that the 2021 winner of the J.O. Westwood Medal is Clarke D.J. *et al.* (2019) 'The weevil fauna preserved in Burmese amber - snapshot of a unique, extinct lineage (Coleoptera: Curculionidae)'. *Diversity* **11** (1), 219 pp. This outstanding taxonomic publication concerning fossil weevils in Cretaceous Burmese amber is a landmark publication in our knowledge of weevil evolution and classification. With a total of 52 new species in 26 new genera, it is one of the largest and most significant contributions ever made to the field. The authors address the technical challenges of working with Burmese fossil material, including altered and obscured taxonomic characters, preservation artifacts, and with light microscopy and µCT imaging. This provides some interesting background to the issues faced by workers studying amber fossils, both methodological and ethical. Their examination of a vast amount of exceptionally well-preserved material, garnered widely, is meticulous and expertly documented with exceptional images. David Clarke recently presented their results at the ENTO 22 conference at the University of Lincoln.

The J.O. Westwood Medal remains open to nominations. Details regarding eligibility and the nomination process can be found on the RES website and next page.

Bowangius cyclops. Image courtesy of Duane McKenna.

An acorn weevil (Curculionidae: *Curculio* sp.) stands on a sunflower (*Helianthus* sp.). Image courtesy of Duane McKenna.



Free online access to all RES journals for all Members and Fellows from January 2023

From January 2023, all Members and Fellows will be able to access RES journals online for free, as a new benefit of their membership. Print copies of journals at a discounted rate will no longer be offered as the Society continues to reduce the environmental impact of its publications.

Do not forget to take full advantage of the benefits of being part of the RES:

- Fellowship is a well-regarded qualification, with postnominal letters FRES
- Membership includes postnominal letters Mem.RES
- Access to our globally important library and its services
- Exclusive access to grants and awards
- Free or discounted meeting and conference registrations
- Over 20 Special Interest Groups
- 30% discount on Identification Handbooks

The RES team is always looking for ways to develop what it means to be a member of the Royal Entomological Society. Please let us know what works best for you.

EVENTS

Details of the meetings programme can be viewed on the Society website (www.royensoc.co.uk/events) and include a registration form, which usually must be completed in advance.

Offers to convene meetings on an entomological topic are very welcome and can be discussed with the Chair of the Meetings Committee (richard@royensoc.co.uk).

February 2023

Wed 1 — 1 February — **Online talk – May Berenbaum (virtual event)**

March 2023

Wed 1 — 1 March — **Verrall Lecture**

Sat 4 — 4 March — **Young Verrall Lecture**

Sat 4 — 4 March — **Staffordshire Invertebrate Science Fair (external event)**

Mon 13 — 13 March – 15 March — **Global Soil Biodiversity Conference 2023 (external event)**

Thu 30 — 30 March – 31 March — **Student Forum 2023 (hybrid event)**

April 2023

Wed 5 — 5 April — **Online talk – Arnold van Huis (virtual event)**

Wed 26 — 26 April — **Behaviour Special Interest Group (virtual event)**

May 2023

Wed 3 — 3 May — **Online talk – Angharad Gatehouse (virtual event)**

June 2023

Wed 7 — 7 June — **Online talk – Robert Pyle (virtual event)**

Mon 19 — 19 June – 25 June — **Insect Week 2023**

July 2023

Wed 5 — 5 July — **Online talk – Lin Field (virtual event)**

September 2023

Tue 5 — 5 September – 7 September — **Ento23**

October 2023

Wed 4 — 4 October — **Online talk – Martin Kaltenpoth (virtual event)**

For full details on all RES meetings please visit www.royensoc.co.uk/events

Royal Entomological Society

Library and Archives

Access our online Library catalogue: http://heritage.royensoc.co.uk.

The Library and Archives are based at our Mansion House site in St Albans. Members and Fellows of the Society may visit the library, by appointment, Tuesday-Thursday 9.30am-4.30pm.

Visitors can consult the Main Collection, Rare Books Collection, our Journals Collection, Archive material and may borrow items from the Main Collection. Please contact the Librarian, Rose Pearson, on library@royensoc.co.uk or 01727 899387 to arrange an appointment.