Royal Entomological Society

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Antenna

CONTENTS

Volume 48(1) | 2024

Bed bugs: Don't panic!

The thrips of the Maltese Islands

Climate change and insects: We don't know enough

Those jazzy striped butterfly antennae: Why do some species have them and others don't?

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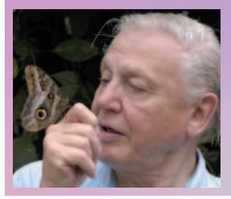

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Submissions are made by email to antenna@royensoc.co.uk and reviewed by *Antenna*'s editorial team. There are no page charges for publication in *Antenna*, where we encourage use of full colour figures and photographs to accompany text. Standard articles 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: Female dance fly (probably *Empis livida*) photographed by Colin Lamb in Oxfordshire, England.
Back cover: Female Meadow Grasshopper (*Pseudochorthippus parallelus*) photographed by Jeni Fulton Price near Exeter, England. Both photographs were submitted to the Society's Insect Identification Service, see article on pages 49–53.

Editorial

Since we last met, bed bugs have hit the headlines in Europe, especially in France. Will Hentley presents the rational angle of the seasoned entomologist, whilst I report on the often distinctly less rational angle of the UK press, along with other insect stories that have made the news.

It is a particular delight to have two articles from overseas contributors, inspired by the respective Society Representatives in their countries. Godwin Degabriele tells us about the thrips of Malta, an insect group and country that have rarely featured in *Antenna*. Featured more often are the impacts of climate change, but Femi Benny presents this from an Indian perspective, highlighting the need for more research on this topic from tropical regions. Another theme rarely featured in *Antenna* is antennae. Hugh Loxdale asks why they are striped in some butterflies but not others.

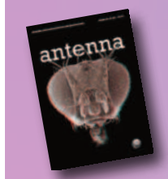
This issue's 'featured insect' comes from Dave Goulson. So, it's a bee, of course. Wrong! Turn to page 22 to discover Dave's choice. Many other insects feature in Jim Hardie's annual round-up on the Society's Insect Identification Service. I remain astonished by the number of specimens (mostly photographs) sent in by the public, impressed by Jim and members of the Society who identify them speedily, and delighted by the comments of the enquirers.

As usual, there is much Society news to report: Special Interest Groups, online meetings, outreach events and sponsored art. The Society has also been making an impact at major events around the world.

You may notice that there is no 'Research Spotlight' from Stuart Reynolds in this issue. Instead, Stuart is the subject of the Honorary Fellow Interview. How does he manage to write so thought-provokingly on such a wide range of topics? There are plenty of clues in the interview.

With many thanks to all contributors and the whole editorial team.

Richard Harrington



Antenna

Index and online copies

Index

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Antenna

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Letter from the President

How many butterflies are there on Earth?

RES/BSBI visit to Daneway Banks (jointly owned by the RES and the Gloucestershire Wildlife Trust) in June 2023. A pair of Large Blue butterflies busy producing the next generation behind the backs of visitors.

I was posed this question by a journalist working on the BBC Radio 4 programme 'More or Less', who was trying to answer a young listener's query, and the subsequent conversation led down many interesting 'rabbit holes'. Yet again it was clear how little we know about insects, even comparatively well studied ones such as butterflies. The question was about the number of individuals, rather than how many species there are, but even questions about the number of insect species rapidly turns into a puzzle about how to estimate insect numbers from current information, as well as broader questions such as 'what is a species?' before going onto more philosophical considerations about 'what is an individual?' and what stage of an insect's life cycle should be surveyed (egg, caterpillar, adult?). Questions about how many individuals there are quickly lead into considerations about patterns of relative abundance within insect communities, and why some species are far more common than others. Anyone who runs a moth light-trap has probably wondered why this is – noticing that the majority of the catch is likely made up of just a few species, and that most species are represented by just a few individuals. Trying to answer this question, I probably shouldn't have been surprised to find myself reading a paper by a previous RES President - CB (Carrington Bonsar) Williams (President 1947–48) – from an article published in 1960 (*The American Naturalist* vol 94 number 875) where he explored patterns of relative abundance of species. He discusses the log-series and log-normal distributions of relative abundances, pointing out that for moths caught in light-traps run at Rothamsted Experimental Station (now Rothamsted Research) in Harpenden, England, "the six most abundant species (three per cent of the total) provide 50 per cent of the individuals". Reading the paper made me reflect on how much we still discuss these fundamental ecological concepts over 60 years later (I wonder if CB Williams would be surprised?), why some insects are rare and others common, and why many insects are declining but others increasing. We still don't know how many insect species there are on Earth, even before we get to estimating the number of individual insects. It's good that there is a much greater appreciation of the importance of insects, and concerns about their declines, and much more monitoring data. Plot spoiler - you probably will not be surprised that my answer to the journalist was essentially 'we don't know'. You can have a listen at https://www.bbc.co.uk/sounds/play/w3ct5b6r.

I'm writing this letter as 2023 comes to an end, and 2024 starts, and so I have been reflecting on the RES highlights during 2023 – for me, it was the RHS Chelsea Flower Show in London in May, #Ento23 in Falmouth in September, and a fabulous visit to Daneway Banks Nature Reserve in Gloucestershire in June, jointly organised by the RES and Botanical Society of Britain and Ireland (BSBI). I'm looking forward to a busy RES year in 2024, particularly the 27th International Congress of Entomology meeting in Kyoto, #Ento24 in September, and our search for a new home for the Society. Exciting times! I hope you will continue to enjoy and value being a member of our Society – perhaps by attending a SIG meeting or the Ento conference, listening to an online talk (check the RES web site for events), celebrating Insect Week, or publishing your insect science in one of the RES journals. If your entomology colleagues are not already Members or Fellows, please encourage them to join us. If you are interested in being more involved with the Society, please check the website for volunteering vacancies ('Membership and Community' tab).

Jane Hill OBE
President
Royal Entomological Society

Correspondence

Diversity of ethical positions in *Antenna*

Dear Editors,
I was struck by the diversity of ethical positions addressed in the *Antenna* 47(3) meeting reports. Bob Pyle, the founder of the insect conservation-focused Xerces Society, depicted with his well-worn butterfly net, Marsha, in hand, became a conservationist because of his horror of butterfly habitat destruction in his hometown. The first sentence of the next article, on pest control technologies, reads: "Food productivity must increase by 70% to feed an additional 2.3 billion people by 2050 – a huge challenge for science and society." Aside from the fact that those 2.3 billion people (about a 22% increase from our current 8 billion plus) must be a very hungry bunch to consume a projected 41% of the world's 2050 food production, why is it presented as a given that the world's human population is going to continue to grow at an exponential rate? If that is so, then it is inevitable that all our meadows and fens, let alone rainforests and savannas, are going to be cropland or pasture or solar panel farms, sooner or later.

A few pages later, we come to a report on the Insect Welfare and Ethics Special Interest Group, whose meeting was preoccupied by the neuro-philosophical issue of whether individual insects feel pain. Let's say they do. So what? Are we going to stop driving cars and trucks (which kill billions or trillions of insects every year)? Are we going to stop deploying pesticides and genetically modified plants that are toxic to insects, and stop the rampant destruction of natural habitats to grow food for our billions of extra people? Are we going to stop monitoring insect diversity via the mass slaughter of insects in light traps, malaise traps, *etc*., and preserving their pathetic corpses as 'specimens' in museums? Is Bob, exhorting us to "keep nets in the hands of kids", a heartless monster, promulgating gratuitous juvenile cruelty towards our insect brethren?

It seems to me that the fundamental ethical question – or "challenge for science and society" - is about those 2.3 billion people. Until we find a solution for that problem, all the others are vanities.

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(My opinions expressed here do not necessarily reflect the views or policies of the US government or the USDA, by whom I am employed.)

Lousy mites

I do not normally submit comments about published articles but I feel compelled to point out an error in the paper on scabies by Mark Walker in *Antenna* 47(4), 187–191. The caption to Fig. 3 in this article incorrectly states that the image shows an advertisement for killing mites. However, the ectoparasite shown in the image is an adult female Crab Louse, also known as the Pubic Louse, *Pthirus pubis* (L.), which, of course, is an insect, not a mite. Incidentally, since the advertisement is in French, the name "*le morpion*" is used for a Crab Louse in French. Further, through no fault of the author, the lithograph shown in Fig. 4 incorrectly states, in three instances, that scabies is caused by an insect. It is caused by a sarcoptic mite, of course. Lastly, in Fig, 5 it may have been helpful to state that the scabies mite shown in the image had been cleared (probably in lactophenol) and slide-mounted. An uncleared specimen would look very different.

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Response from Mark Walker

Thanks to Professor Lance Durden for spotting my error and these useful observations. Fig. 3 clearly shows a Pubic Louse and not a Sarcoptic Mite. The figure was labelled in the Wellcome image collection as a mite that causes scabies in humans. This possibly accounts for my mistake; I obviously believed the text and not the evidence in front of my eyes.
The general public is generally unaware that mites and insects are taxonomically different. Fig. 3 may have been mislabelled as a result. As pointed out by Prof. Durden, the same confusion is seen in Fig. 4. However, it could well be that the original marketeers purposely chose a Pubic Louse image to advertise their anti-mite product; these parasites have an undoubtedly unpleasant appearance, which could have been thought to enhance sales.

Bed bugs: Don't panic!

Bed bugs (Cimidae) are amongst the strangest of insects. Almost everyone has heard of them and yet very few people know anything about them. They are universally feared but they can tell us a lot about insect biology, and even about human behaviour. I must admit, until 2014 when I started working for Prof. Mike Siva-Jothy at the University of Sheffield, I had little idea what a bed bug was. All I knew was that Mike liked to feed them on his legs. Fast forward nearly 10 years: Mike is enjoying retirement, and I am feeding the bed bugs on my legs (Fig. 1). During this time, I have been fortunate to study almost all aspects of their biology and behaviour, from their immune system to their distribution across cities around the world. In this article, I'm going to look at the origins of our fear of bed bugs, their 'resurgence' and what we should do about them.

Like all members of the Cimicidae, *Cimex lectularius* (Box 1) feeds exclusively on blood and, although humans are their preferred host, they will feed on other mammals and birds. As with most Hemiptera, development consists of three life stages – egg, nymph and adult (Fig. 2). Each stage requires a blood meal.

Bed bugs spend large amounts of time in refuges and are thus very hard to detect, especially in the early phases of an infestation, and while in their refuge (called a harbourage), they are inaccessible to most chemical control agents and application methods. The most common places to find their harbourages are cracks or crevices in or around beds or sofas; anywhere you spend long periods of time stationary (Fig. 3).

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Figure 1. Feeding bed bugs on my leg. The tube has a mesh top that the insects can fit their mouthparts through.

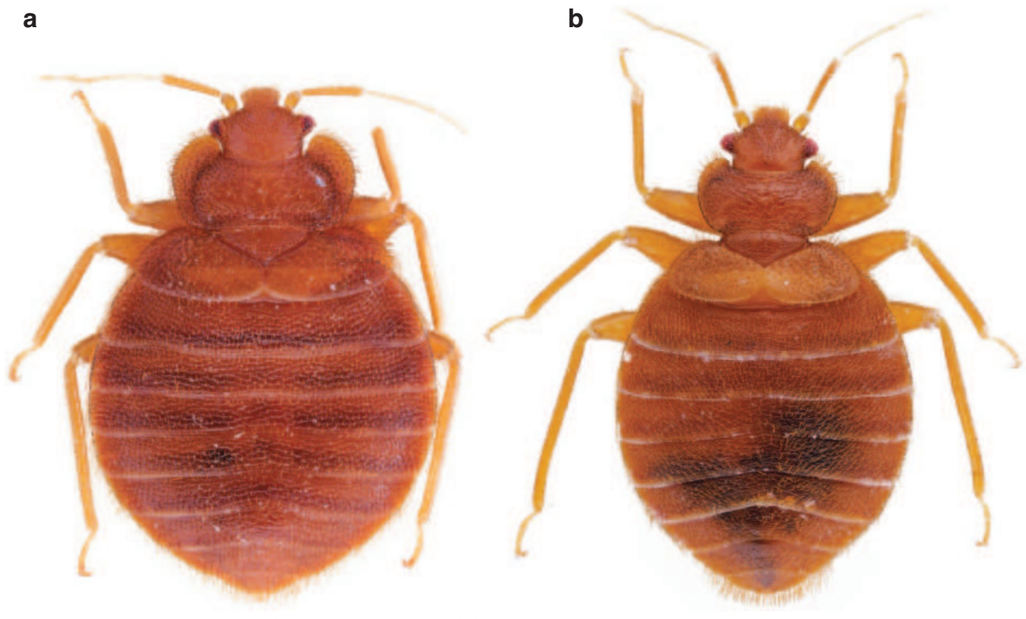
There are very limited empirical data on their natural behaviour in and around harbourages, so most of what is known about leaving and returning to harbourages comes from laboratory studies. They have very few natural predators, most of which are often classed as household pests themselves, such as ants and cockroaches. I was asked by a reporter for *National Geographic* what would happen if bed bugs disappeared overnight. Unlike other haematophagous species such as mosquitos, which have an important role within ecosystems, such as a food source (Fang, 2010), bed bugs do not have such a role. If they were to disappear overnight, nothing would happen to the natural world, but it would have lost one of its most fascinating species.

Fear of bed bugs

Humans seem to have an irrational fear of bed bugs. I am confident in saying that the majority of people in the Western World fear bed bugs more than other blood-sucking insects such as mosquitos. This is surprising given that mosquitos have been termed by the Centres for Disease Control and Prevention as "the world's deadliest animal" (CDC, 2023). Unlike mosquitos, bed

Box 1: What is a bed bug?

Bed bug (often mistakenly 'bedbug' – Box 2) usually refers to either of two species within the family Cimicidae (order – Hemiptera) which feed almost exclusively on humans. The most common in Europe and North America is *Cimex lectularius* (a) and the less common *Cimex hemipterus* (b) which can be found in the tropics. I will focus most of this article on *C. lectularius* which I will refer to as 'bed bugs'; but it is worth noting that *C. hemipterus* is no longer restricted to the tropics and is now established in low-level populations within Europe (Balvin *et al.*, 2021), possibly due to our warming climate.



Adult female *Cimex lectularius* (a) and *C. hemipterus* (b). Adapted from Balvin *et al.*, 2021.

Box 2: Bed bug or bedbug?

I may be preaching to the converted here, but I wanted to mention the two versions of the name 'bed bug'. In most media articles (and some published papers) 'bedbug' is used. Convention has it that where names have two parts and one of them is the systematically correct group name, as is the case here, the group name should be a separate word. If, however, the group name is not systematically correct, it should be combined into a single word – *e.g.*, Citrus Whitefly.

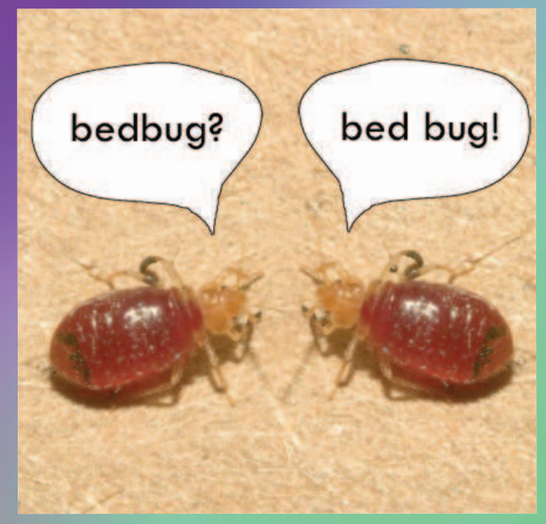


Image credit: Unknown author - https://citybugs.tamu.edu/files/2011/03/bed-bug-cartoon2.jpg

bugs are not known to vector any diseases, and death from a bed bug bite is very unlikely, although some extreme allergic reactions have been reported (Doggett *et al.*, 2012). Bed bugs usually feed on humans when sleeping, very similar to mosquitos, so the idea of something biting while you sleep probably isn't solely driving this fear. Where then does this fear come from?

One possible source of fear may be linked to the long history we share with bed bugs and how they have become embedded in our culture. The phrase "*night night, sleep tight, don't let the bed bugs bite*" has been recited by many parents to their children for centuries. In the 17th Century, bed bugs were not seen as a major concern and being bitten in bed was just a fact of life (Sarasohn, 2013).

This all started to change during the 'Age of Enlightenment' and the start of the industrial revolution with some of the first records of professional bed bug controllers, *Tiffin and Sons,* appearing in 1730 (Usinger, 1966). At this time there was also the emerging 'middle class' who were putting a much greater emphasis on sleep, with many households spending a quarter of their income (Ekirch, 2001) on beds with feather mattresses, heavy curtains, and canopies – perfect homes for bed bugs. Despite attempts to control bed bugs by 'professionals' or even a wide range of home remedies, bed bugs were still very common in people's homes until the 20th Century.

After the first world war the bed bug's days were limited. Chemicals which were used in the war were repurposed for pest control, the most prominent being hydrogen cyanide (Biehler, 2013). This is, unsurprisingly, very dangerous to all living animals, including humans, and could only be used by (very expensive) highly trained professionals. Further, it could only safely treat detached properties due to the risk of accidentally poisoning adjoining properties. Therefore, only the middle and upper classes could afford to rid themselves of bed bugs, whereas the poor, in their high-density accommodation could not. Bed bugs were becoming a symbol of being poor and 'unclean'.

This all changed with the appearance of DDT (dichloro-diphenyl-trichloroethane) in the

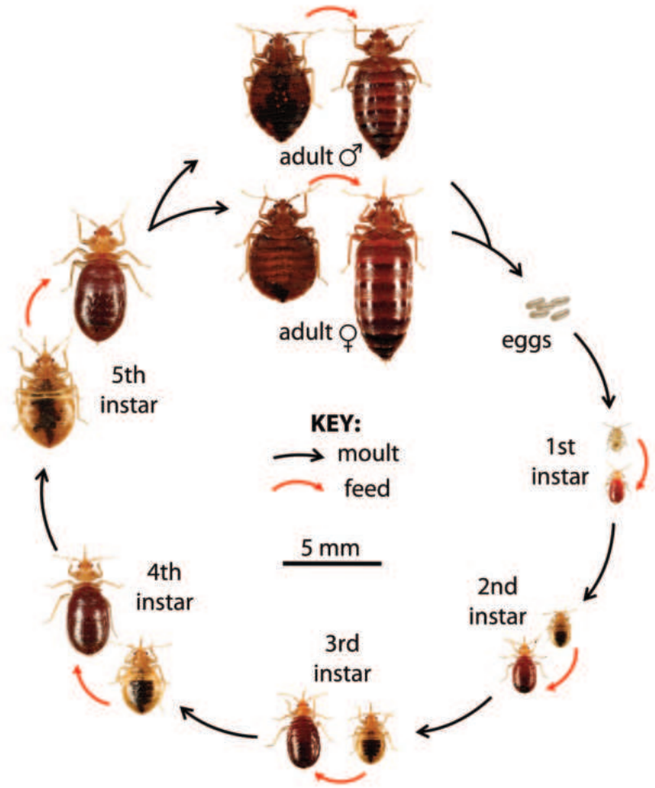


Figure 2. Schematic of bed bug life cycle. Image courtesy of Dr Richard Naylor, The Bed Bug Foundation.

Figure 3. A large bed bug aggregation found under the lining of a box-spring bed. Photo courtesy of Dr Richard Naylor, The Bed Bug Foundation.

1940s. This could be used in high density housing and did not require professionals to apply it (Biehler, 2013). It was so effective that, by the 1950s, bed bugs had been almost entirely eradicated from the Western World (Doggett *et al.*, 2012). Bed bugs became a myth, with the younger generation having never seen one, or knowing what to do if they had an infestation.

Lack of knowledge, therefore, could be a major contributor to the fear associated with bed bug infestations (Goddard and de Shazo, 2012). Fear of the unknown is a fundamental human trait, one which was clearly adaptive for us in our evolutionary past (Brosschot *et al.*, 2016) and remains with us today. One of the side effects of this fear of the unknown is the instinctive need to find the 'truth', even if that 'truth' is not factually correct (Raub, 2021). The urgency to discover the truth can sell stories, so media frenzies often follow.

Media frenzies and misinformation

The media have played a significant role in shaping public perception of bed bugs. Sensationalised headlines and fear-mongering stories can create panic, which leads to irrational responses. Last year's reports on the bed bug 'outbreak' in Paris is one of a long line of such media frenzies. However, the Paris example is slightly different from previous media frenzies because it was fuelled by viral videos on social media. As one of the few scientists studying bed bugs, I received many calls and emails to give my opinion on the outbreak in Paris.

Fortunately, this was not my first rodeo, having experienced a similar

Figure 4. a) AI-generated image of a bed bug (Stefano, Adobe Stock). b) Bed bug feeding (Dr Richard Naylor, The Bed Bug Foundation).

media frenzy when I published a paper about bed bug aggregation behaviour towards dirty laundry (Hentley *et al.*, 2017). The questions that were asked varied greatly depending on the media outlet; for example, BBC Radio 4 and The World Service wanted to know the facts behind bed bug population cycles and what we can do about them, whereas other, less academic, media outlets wanted to know "if we should be hosing down the French with insecticides as they get off the EuroStar". I have found the trick is to stick to the science and avoid jargon. But why do these media frenzies happen and why are they nearly always negative?

Evidence suggests that, over our evolution, seeking out negative information was adaptive. A study by Davis and McLeod (2003) reviewed front-page news stories over the last 300 years and found that very little has changed in the type of news being presented. Many of the themes the authors identified could be linked to adaptive behavioural traits seen in other primates, such as altruism, cheat detection, reputation (or rank), and treatment of offspring. In some ways we are hard-wired to seek out these negative stories and if this kind of story sells, it will proliferate. The stigma associated with bed bugs means that they already have all the traits of a good news story, which may be why we see these periodical media frenzies associated with them.

Public understanding of bed bugs

The theme of our news may not have changed over the last 300 years, but the way we access news has. In 2016, it was found that 60% of adults in the USA were getting their news from social media (Gottfried & Shearer, 2016), increasing to 91% in 2021 (Walker & Matsa, 2021). Social media has increased the efficiency and spread of news transmission, but much of the content has little or no meaningful fact checking or editorial judgement, leading to the rise of 'fake news'. Another study of adults in the USA suggested that people who get their news from social media are less engaged and less knowledgeable than people who use a combination of news sources (Mitchell *et al.*, 2020). This has been seen in the public's understanding of bed bugs, where Seidel & Reinhardt (2013) found that researching bed bugs on the internet, TV or printed media generally resulted in a reduction in recognition rates of bed bugs. The rise of artificial intelligence could exacerbate this. For example, during the Paris bed bug media frenzy, many popular UK media outlets were using images of bed bugs (*e.g.*, Fig. 4) generated by AI. These images are clearly incorrect. I'm not even sure if the example given here looks like a known insect species, more of a mix of several. This misinformation could add to the poor public understanding surrounding bed bugs.

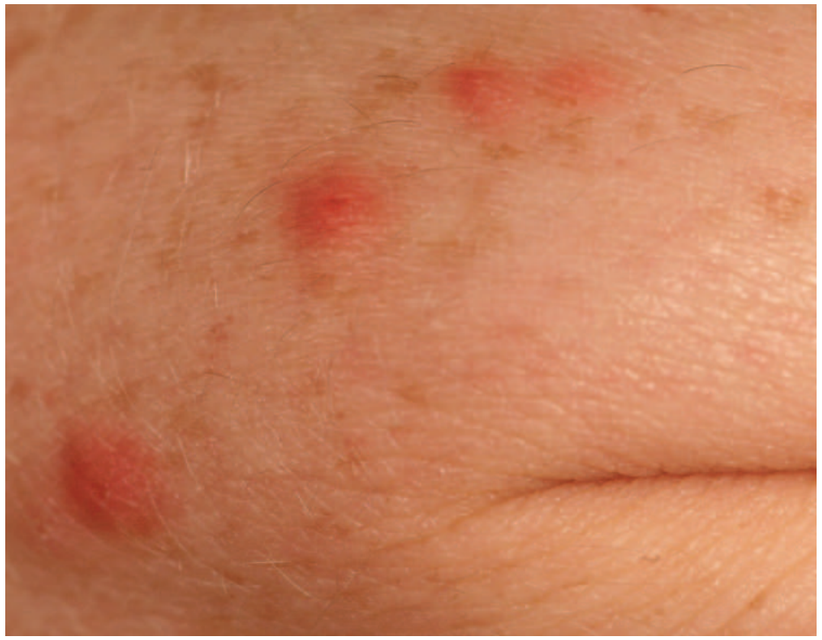


Figure 5. Bed bug bites on human skin. Photo courtesy of Dr Richard Naylor, The Bed Bug Foundation.

If you are interested in learning more about role of AI in entomology, the Data and Electronics & Computing SIGs' theme for their next meeting on 3rd July is AI in Entomology.

Public understanding of bed bugs in Europe is fairly limited. For example, only 13% of residents in four German cities were able to identify a live bed bug (Seidel & Reinhardt, 2013) and only 10% of UK residents could do the same (Reinhardt *et al.*, 2008). In a survey of 600 Indonesian residents, 74% could identify a bed bug (Meisyara *et al.*, 2023), as well as 91% of the residents in an Ethiopian village (Karunamoorthi, 2015), and most from a survey of 900 people in Kenya (Mbuta *et al.*, 2022). Variation in the ability to identify bed bugs could be linked to their prevalence, or to cultural awareness.

With the public clearly having issues identifying bed bugs, their bites are often used as a proxy for an encounter. There are many reports of the public presenting such bites and medical professionals confirming they are bed bug bites (Fig. 5). Even the UK National Health Service provides guidance on identifying bed bug bites. This is surprising given that most scientific papers advise that a bed bug bite is very difficult to distinguish from other insect bites (Doggett *et al.*, 2012; Leung *et al.*, 2024). This is another source of potential false information which could be fuelling the uncertainty and panic around bed bugs.

The Paris outbreak

Nearly every published paper about bed bugs opens with a statement about their increase or resurgence, supported by studies from across the world including China (Wang *et al.*, 2013), USA (Potter, 2011) and Australia (Dogget *et al.*, 2011). One of the key drivers of bed bug dispersal is human travel, therefore it is not surprising that France, as the world's most popular tourist destination (World Tourism Organization, 2019), has seen a resurgence of bed bugs. The Centre National Francais D'Expertise Sur Les Vecteurs (CNEV) in France highlighted that bed bugs were a public health concern. Indeed, they have been reported across the country (Akhoundi *et al.*, 2015; Jourdain *et al.*, 2016), including in Paris (Candy *et al.*, 2018; Chebbah *et al.*, 2021). Finding data about the number of bed bug cases on public transport in Paris for 2023 (or any year) is very difficult. France's regional rail operator, SNCF, reported 37 sightings up to October 2023 and 10 were reported for the same period by the Paris transport operators, RATP (O'Malley & Feighery, 2023). This is a much lower level than social media videos and news reports suggest. Unfortunately, I was unable to find any other data, which is a common problem when trying to understand bed bug population dynamics. There is no central database where occurrence data are reliably recorded. Most of the public would go to the private sector for pest control, but data from this sector are often classed as commercially sensitive and not usually shared, even for scientific research purposes. To understand outbreaks, we need to rethink our research priorities.

Prioritising understanding over eradication

The recent media spotlight on bed bugs has clearly demonstrated that they are a significant problem and, despite our best efforts, are increasing globally. The focus of the scientific and professional community has nearly always been eradication. Like many pest insect species, research into bed bug control has focused mainly on developing new chemical pesticides. In the past, DDT was clearly very effective at almost eradicating them and many have blamed the banning of its use for the current bed bug resurgence; however, this is a misconception. Evidence from as early as the 1950s suggests that bed bugs were already becoming resistant to DDT (Busvine, 1958), which wasn't banned in the UK until 1986, and 1972 in the USA. As we have seen in countless other insect species, pesticide resistance is usually very quick to spread and most bed bugs are, at least partially, resistant to modern pesticides (Lewis *et al.*, 2023).

To address the bed bug problem effectively, we need to shift our focus from eradication to understanding and management. There remain some fundamental questions about their biology and ecology. One of the biggest unknowns is the mechanism by which they disperse. To answer broad ecological questions, we need comprehensive data about their occurrence at fine spatial scales. Unfortunately, these data are hard to come by, not only because the location of confirmed infestations is usually commercially sensitive, but also because data from public bodies are usually incomplete and don't account for the aforementioned private sector. Nonetheless, data from public bodies can give some insight. For example, my own work using data collected from local authorities demonstrated that the number of confirmed infestations follows a clear seasonal cycle that peaks in summer, something supported by studies from Philadelphia (Mabud *et al.*, 2014), New York (Hacker *et al.*, 2022) and China (Wang *et al.*, 2015). The summer peak is unlikely to be linked to temperature because bed bugs live in heated/air-conditioned homes. The peak correlates with the peak in human travel. With humans being the vector for this flightless insect, it would strongly suggest (although never proven!) that our behaviour is the most important driver of the bed bug resurgence.

So, our best hope for controlling bed bugs might be altering our behaviour or, at the very least, educating the public about what bed bugs are, how to avoid getting them and what to do if they are found. Evidence from New York suggests this kind of approach might work. After the widely covered New York bed bug outbreak in 2010 where they were seen in cinemas, the metro and in schools, the city council embarked on a public education campaign, and a disclosure policy where landlords were obligated to notify tenants of infestations. This led to compulsory quarantine, where infested units were taken off the market while the landlord dealt with the problem. They also introduced a priority number to call for information if bed bugs were found. As a result, the number of reported bed bug cases is still declining in the city (Hacker *et al.*, 2022). This is very promising and something that should be trialled in other cities and countries. Another side effect of increasing public understanding of bed bugs might be to reduce the fear associated with them, reducing the chance of media frenzies which can spread false information.

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The thrips of the Maltese Islands

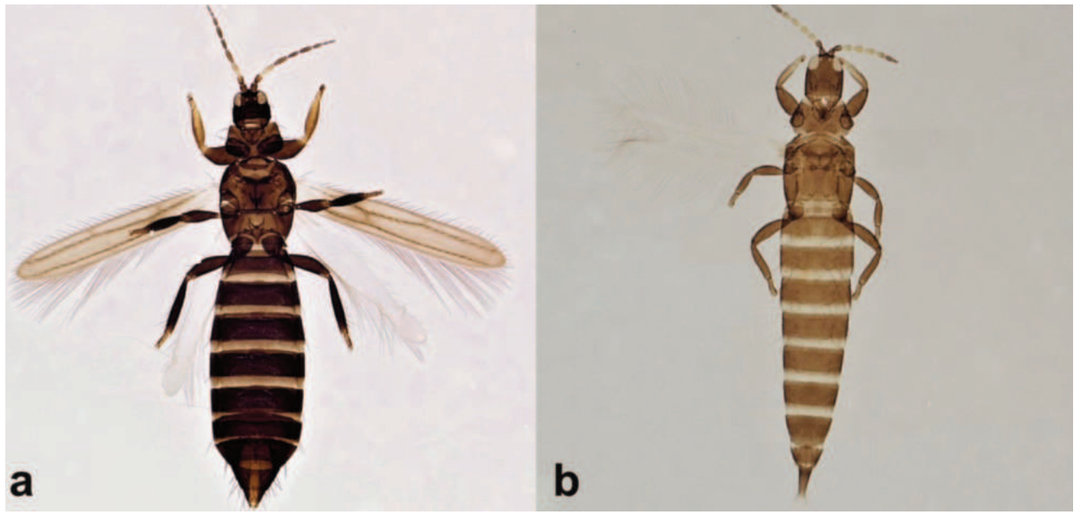

Figure 1. Thrips species a. a terebrantrian (*Melanthrips lybicus*), and b. a tubuliferan (*Haplothrips acanthoscelis*).

For me, the world of insects has always been a fascinating one. From the tender age of three, I leafed through books such as Stokoe's *The Observers Book of Butterflies* and Manning's *Ladybird Book of Butterflies, Moths and other insects* in order to identify the species I encountered in my parents' garden. Growing up, I developed a passion for breeding as many as possible of the butterfly species that occurred in my homeland, the Maltese Islands. Eventually, I received training in butterfly farming at the Stratford-upon-Avon Butterfly Farm, one of the largest of its kind in Europe. But my interest in insects did not stop there. I also studied the diversity and ecology of the dragonflies and damselflies of the Maltese Islands and presented my findings in my undergraduate thesis, which was in time updated and published in a number of places including the *Overview of the Dragonflies and Damselflies of the Maltese Islands*. Following this, the editor of the journal where this work was published, Professor David Mifsud, introduced me to thrips, the diversity of which had never been properly studied in the Maltese Islands and, indeed, relatively little studied across the Mediterranean. This sparked a new interest and curiosity, and I decided to pursue the study of these insects for my doctoral thesis.

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What are thrips?

Thrips are insects of the Thysanoptera (fringe-winged insects), a small order with just over 6,400 described species. Most thrips average between 1 and 3 mm in length. They typically occur on flowers, leaves, stems, leaf litter and dead wood. Around 50% of the known species feed on fungal spores and tissues, while approximately 40% feed on living tissues of dicotyledonous plants or grasses. The remaining 10% exploit mosses, ferns and conifers, or are predatory. Some predatory species feed exclusively on smaller arthropods, while others supplement their diet by consuming pollen. The order Thysanoptera is divided into two suborders, the Terebrantia, where females have a serrated ovipositor and lay eggs within plant tissues, and the Tubulifera, where females lack this ovipositor and deposit eggs in cracks and crevices on or nearby the host plant (Fig. 1).

What challenges does one face when studying such insects?

The size of these insects makes it difficult to study them. Special collecting methods are used, involving beating plants over a white tray to cause the insects to drop onto the tray. These are afterwards collected using a small paintbrush and placed in an Eppendorf tube containing AGA mixture, made up of 10 parts ethanol, 1 part glacial acetic acid and 1 part glycerine, which kills and preserves the specimens until they are properly mounted onto glass slides.

A major challenge in my research involved choosing plants which are likely to yield as many different species as possible. With around 1,200 species of plant occurring on the islands, it was impossible to sample them all. Literature comprising over 200 papers on thrips species found in Europe and the Mediterranean region was consulted and a list of plant species that yielded different thrips species that are typically found on the Maltese islands was compiled. These plants were systematically searched for and sampled across the different indigenous habitats of the Maltese islands but also in cultivated fields, and in public and private gardens. Other plants which were not listed in the literature, but which prevailed in the habitats where fieldwork took place, were also sampled. In all, 75 sites were visited and 398 species of plant were sampled, 252 being indigenous and 146 cultivated.

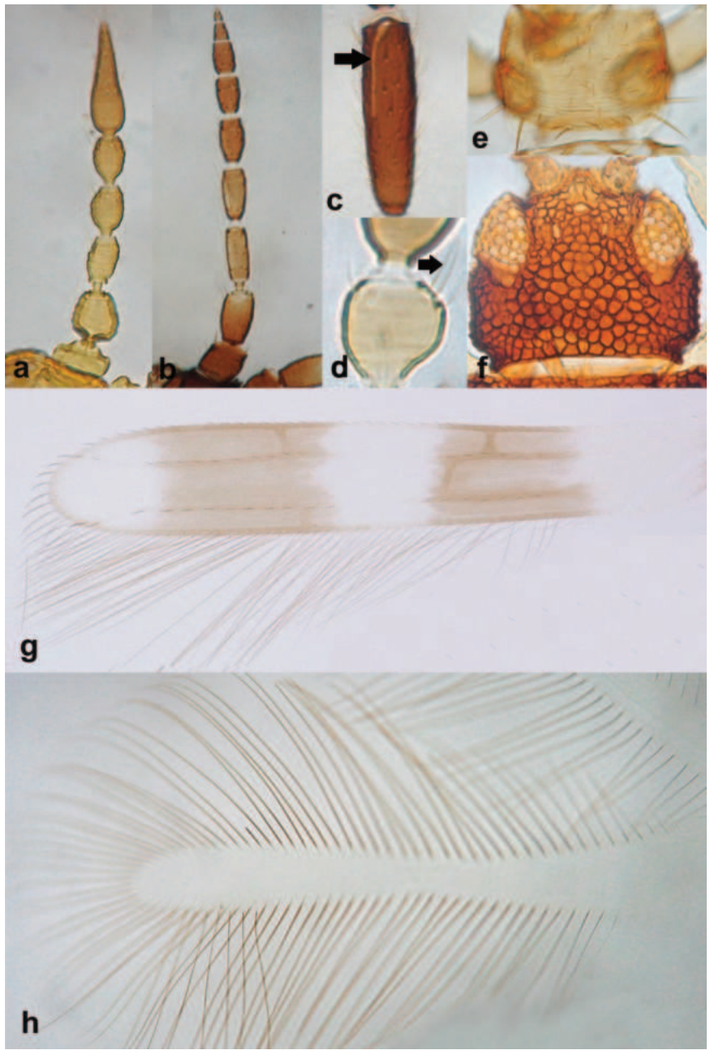

Figure 2. Some diagnostic features: Antennae: a. with six segments; b. with nine segments. Shape of sensoria on antennal segment III; c. groove-like; d. simple trichome (hair-like); e. Chaetotaxy (setal arrangement) on the pronotum (upper section of the prothorax); f. Head with reticulate (net-like) sculpture. Wings: g. with two veins; h. with no veins.

Collected specimens were individually mounted on glass slides for identification. Before this process, however, specimens had to be macerated, that is, their bodies exposed to sodium hydroxide solution to soften food particles within their gut, which could then be flushed out in order to make diagnostic internal structures more clearly visible. Gut contents were expelled from the body by making small holes close to the base of the third leg and massaging the abdomen until the gut looked clear. Following maceration, specimens were dehydrated, since the mountant used to prepare the slides was Canada balsam, which tends to fog up on exposure to moisture. Dehydration involved immersing the specimens in progressively increasing concentrations of ethanol, starting from 75% to absolute alcohol. This process made the specimens brittle, so they were subsequently relaxed by immersion in clove oil.

Mounting of the specimens took place on the cover slip rather than the glass slide in order to be able to adjust the position of the wings, legs and antennae better. These were arranged as required using custom-made tools fashioned from 0.1 mm diameter microneedles attached to kebab sticks and bent to the required shape. Once the specimen was correctly positioned, the glass slide was lowered on top of the specimen. Glass slides prepared in this fashion usually require to be left in an oven for some time to dry the solvent in the mountant. However, due to the warm climate of the Maltese Islands, this step was not necessary as long as the slides were stored flat for a few weeks.

Identification is rather difficult in many thrips species. Some important diagnostic features include the number of antennal segments (usually between six and ten), the shape of the sensoria (chemosensors) on antennal segments III and IV, the chaetotaxy (arrangement of setae) on the body and wings, as well as the number of veins (between zero and two) found on the wings (Fig. 2) amongst others. Due to the degree of variation of the diagnostic features, it was not possible to identify to species level in some cases, particularly if only one specimen was available and if this was collected on a plant which is not typically used as a host (*i.e.*, no larval forms were found accompanying the adults on the said plant).

Collection of specimens took place between October 2015 and October 2022. In all, about 600 specimens were mounted on glass slides.

Specimens were identified by observing the features mentioned above and following dichotomous keys. Photos of specimens and their diagnostic features were also sent to world experts to confirm identification. All species recorded

7 Body bicoloured, with head and thorax yellow with brown areas medially (fig. 4.7a); antennal segment III bicoloured, with the basal half of segment pale yellow, while the apical half dark brown (fig. 4.7c) ..... ***Aeolothrips gloriosus*** Bagnall, 1914

Body uniformly dark brown, though upper abdominal segments can sometimes be lighter coloured (fig. 4.7b); antennal segment III yellow or yellowish brown with the distal fifth brown, paler than segment II (fig. 4.7d) ..... ***Aeolothrips intermedius***, Bagnall, 1934

Figure 4.7: Body (a,b): (a) bicoloured; (b) uniformly brown; antennal segment III (c,d): (c) distal half brown; (d) only distal fifth brown.

Figure 3. Sample of the key to the Thysanoptera of the Maltese Islands.

were clearly distinguishable from each other by just using morphological features, therefore none of the identified species in this study was considered to be cryptic. Because of this, species identification did not involve the use of DNA barcoding techniques. Following identification, an illustrated dichotomous key, designed to be used by the non-specialist to identify the thrips species of the Maltese Islands, was devised (Fig. 3).

What were the findings of the study on the thrips of the Maltese Islands?

This study was the first of its kind to focus specifically on the diversity of Thysanoptera of the Maltese Islands. Nine species had been previously recorded, most of which were listed as agriculturally important. My study revealed the presence of 53 species of thrips in the Maltese Islands, with 43 not previously recorded on the Islands. A further eight species could only be identified to genus level, either because too few specimens were collected on plants which are not typical host plants, because the specimens were poorly mounted, or because the features of the collected specimens did not exactly match others belonging to the same genus but captured in other countries. One species belonging to the genus *Karnyothrips* could be a new species to science, and research will be carried out by comparing the captured specimens with type specimens, to confirm if these match.

The feeding preferences of the recorded species were also studied, both from observations in the field and from records in the literature. Forty-two of the recorded species were found to be exclusively phytophagous, six were phytophagous but also acted as facultative predators, two were obligate predators and three were mycophagous, feeding on fungal tissues and spores. Eighteen of the exclusively phytophagous species were found to be polyphagous. Indeed, these included several agriculturally important species such as *Frankliniella occidentalis* and *Thrips tabaci*.

The distribution of the species found in the Maltese Islands was also researched from the literature. It was found that five species are cosmopolitan, ten species are subcosmopolitan, seven are Palaearctic, while two are Holarctic in distribution.

Gynaikothrips ficorum and *G. uzeli,* gall-inducing tubiluferan thrips found on *Ficus* species, were considered as separate species, despite literature that argues that the boundary between these two species is blurred due to the variability of the distinguishing features. The reason for such a decision was that locally collected specimens showed distinct variations in the diagnostic features and, moreover, during the time between the discovery of *G. ficorum* on *Ficus microcarpa* in 2012 and the subsequent records of *G. uzeli* on *F. benjamina* in 2016, no thrips or galls were found on the latter host plant, which typically hosts *G. uzeli*, despite repeated searches.

Were there species of agricultural importance? Were these species indigenous or of alien origin?

Twenty-seven of the recorded species have been described as having some form of agricultural importance, by being potential vectors of bacteria and fungi. The three most notorious are *F. occidentalis*, *F. schultzei* and *T. tabaci*, which are vectors of Tomato Spotted Wilt Virus (TSWV) that affects several agriculturally important plants. Species like *F. occidentalis* also cause scarring on some fruits such as nectarines.

Of the 27 species mentioned earlier, nine were found to be of alien origin. These species have a cosmopolitan or at least a subcosmopolitan distribution and were accidentally introduced with the import of crops and cultivars. *Heliothrips haemorrhoidalis* and *F. occidentalis* are alien species that had already been locally recorded prior to my studies. Alien records which are new to the Maltese Islands include species like *Echinothrips americanus, F. schultzei*, *Hercinothrips bicinctus* and *Thrips simplex* (Fig. 4). Many of these species originate from tropical world regions and, indeed, in temperate countries can thrive only in greenhouses. However, with the gradual increase in temperature, these species were also recorded on plants in open fields and gardens.

During the study, none of these species was found in large enough numbers to constitute an agricultural problem; however, it was noted that species like *E. americanus* and *H. bicinctus* can, given ideal conditions, breed very fast and cause large infestations which can potentially be harmful to the plants which they are using as hosts. Other species of agricultural importance recorded in the Maltese Islands include *Haplothrips tritici*, *Limothrips cerealium* and *Thrips tabaci* (Fig. 4). The geographical distribution of the first two species does not extend beyond the Palaearctic region, while the third species is cosmopolitan but is believed to originate from the Mediterranean. Because of this, these species are not considered of alien origin.

What is the way forward following this study?

My journey with thrips has reached the first milestone and, like all research, has raised several questions. How possible is it to completely identify any species that were identified only to genus level? Is it possible to confirm whether the *Karnyothrips* species is new to science or just a new record to Europe? Can more species be identified, particularly those that inhabit soil? Can species of agricultural and perhaps quarantine importance find their way to the Maltese Islands via accidental importation with cultivated plants? And finally, will the fact that the climate of the Maltese Islands is becoming progressively hotter and drier affect the species diversity of these insects? These are research questions that make me curious and motivate me to keep on carrying out fieldwork and collecting specimens to provide some answers to these questions. Perhaps roping in specialists and enthusiasts can help resolve these issues – and maybe raise others! After all that is how scientists make progress.

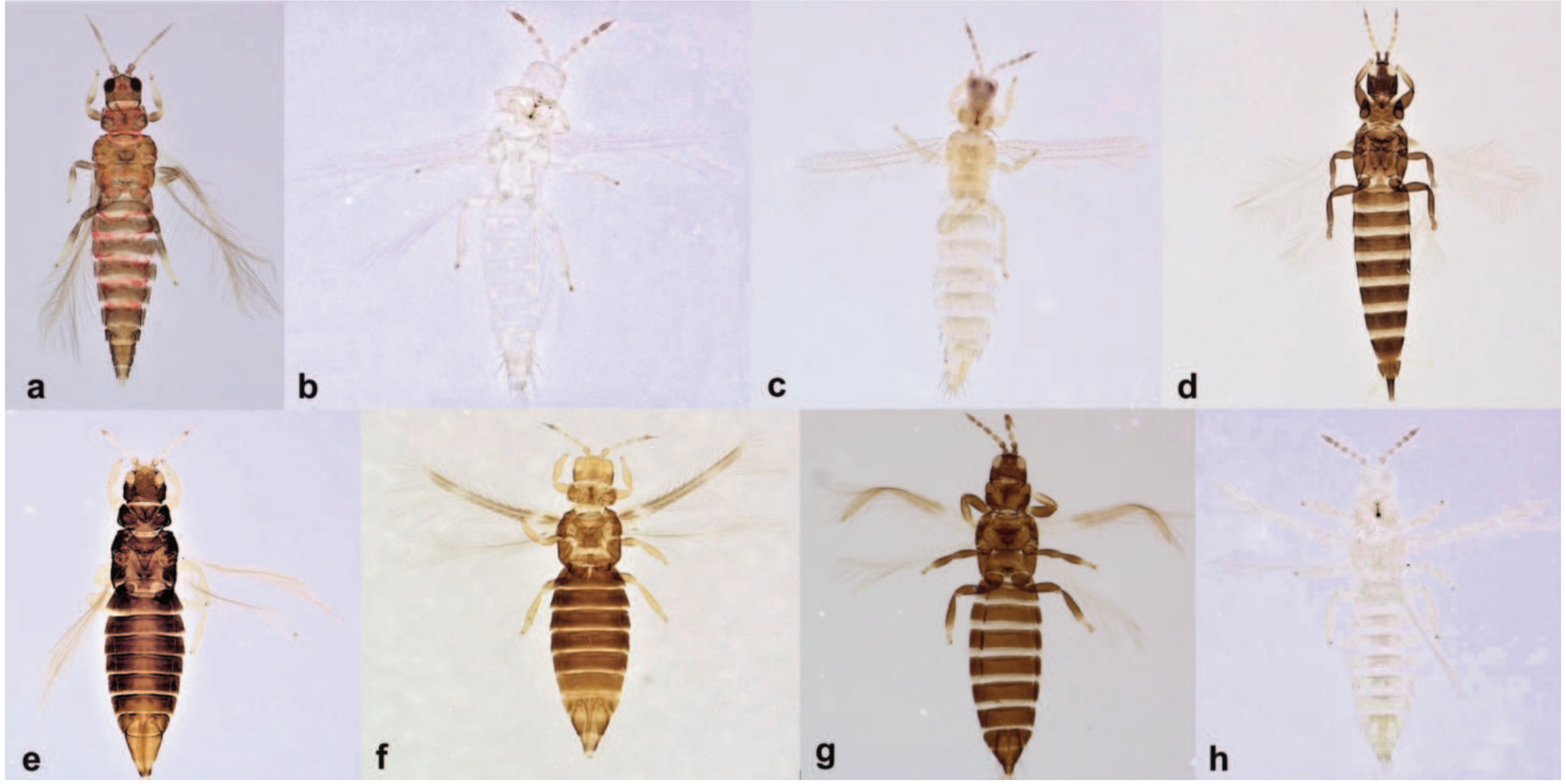

Figure 4. Some agriculturally important thrips species recorded in the Maltese Islands: a. *Echinothrips americanus*; b. *Frankliniella occidentalis*; c. *F. schultzei*; d. *Haplothrips tritici*; e. *Heliothrips haemorrhoidalis*; f. *Hercinothrips bicinctus*; g. *Thrips simplex*; h. *Thrips tabaci*.

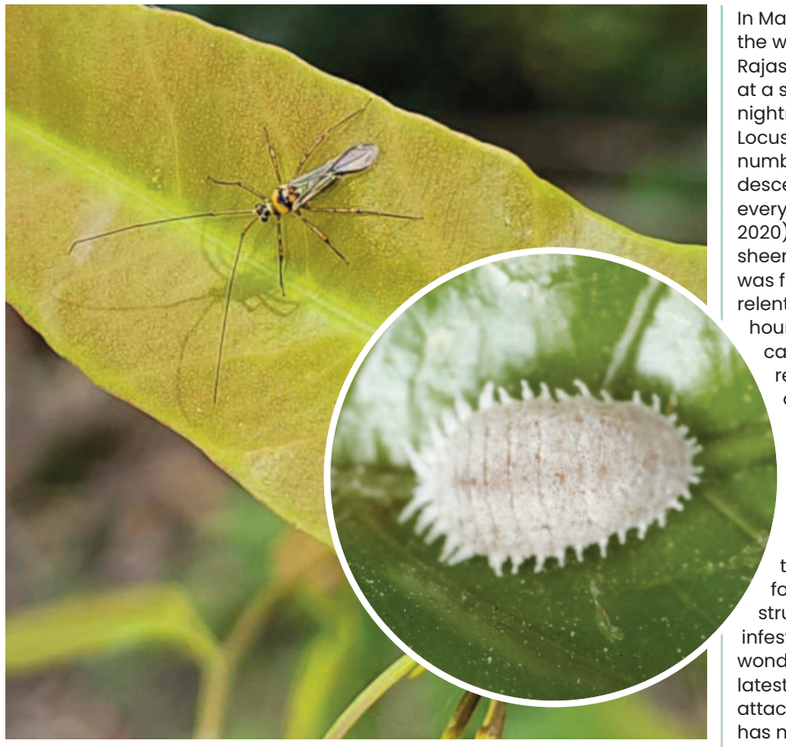

Figure 1. *Helopeltis theivora* (Tea Mosquito Bug). Photo: Dr Srikumar Kotian; Inset: *Planococcus* sp. Photo: Copyright Dr Deepak Deshpande

Climate change and insects: We don't know enough

Much work has been done on the impacts of climate change on insects, particularly in Europe and the USA, and yet the impacts are arguably more immediately catastrophic in other regions. So, it is nice to hear from one of our Indian members on the subject. Encouraged by the RES Rep for India, Sajidha Mohammed, Femi Ezhuthupallickal Benny reports on well-known climate change concerns but from an Indian perspective. We are always delighted to hear from our overseas members. Editors.

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In May 2020, as the sun rose over the western Indian state of Rajasthan, farmers looked in horror at a scene straight out of a nightmare. Swarms of Desert Locusts (*Schistocerca gregaria*), numbering in the millions, descended on their fields, devouring everything in their path (Joshi *et al.*, 2020). The sky was darkened by the sheer number of insects, and the air was filled with the sound of their relentless munching. In a matter of hours, crops that had been carefully tended for months were reduced to stubble. The locusts, driven by a combination of weather conditions and their natural migration patterns, have been wreaking havoc across India and other parts of South Asia in recent years, causing widespread damage to agriculture and threatening food security. As authorities struggle to contain the infestation, farmers are left to wonder how they will survive this latest blow to their livelihoods. An attack of the May 2020 magnitude has not happened for 26 years. What changed in these years and what triggered the attack?

As temperatures rise, weather patterns shift, and habitats are altered, insects are facing a myriad of challenges that threaten their survival. Climate change and its effect on insects are complex and multifaceted, and while we have some understanding of their causes and effects, there is still much that we don't know. Research has shown that climate change can have a significant impact on insect populations (Ladányi and Horváth, 2010). For example, warmer temperatures can affect the timing of insect life cycles, such as hatching and pupation, which can have cascading effects on food availability and reproductive success. There are still many unanswered questions in this context. For instance, it's not entirely clear how different insect species are affected by climate change, or how interactions between species are impacted. Also, the effects of climate change on insect populations may vary depending on the region and ecosystem. Another challenge is that insect populations are notoriously difficult to study and monitor, and many species have not been well documented. This makes it challenging to track changes in populations over time and to identify the underlying causes.

Insects are vital in most ecosystems. They are crucial in determining the species composition of any habitat. Their roles as pollinators, organic matter decomposers, soil nutrient recyclers, and food sources for diverse wildlife make them critical for ecosystem balance and global economies. However, many insect species have been declining at an alarming rate in recent years, whilst several pest species have produced outbreaks. Insects are particularly sensitive to environmental changes, and their instability is an indication of broader ecological imbalances. Scientists are still trying to understand the causes of declines and periodic outbreaks, but climate change is emerging as a leading culprit.

Impact of climate change

Insects are bearing the brunt of the profound consequences brought about by climate change. For example, the untimely birth of immature stages might result in them lacking adaptations to thrive in their novel environment (Sgrò *et al.*, 2016). In areas where winters are normally cold, warm temperatures have detrimental effects on insect diapause, mainly due to the loss of resistance to cold winter conditions.

The existence of insect species in any particular habitat is driven by patterns of temperature, relative humidity, solar radiation and wind. Changes in these abiotic factors impart direct effects on insect populations (Mukhtar *et al.*, 2022). Also, these changes indirectly affect insects by influencing the availability and abundance of food resources, natural enemies, competitors and mutualists, thereby influencing biotic interactions among species. Changes in precipitation patterns can affect the availability of resources for insects, such as nectar and pollen. Extreme weather events, such as droughts or floods, can also disrupt insect populations, alter the availability of food and habitat, and increase the spread of insect-borne diseases. As temperatures warm, insects are moving into new regions, which can disrupt the balance of ecosystems. Also, rising temperatures may allow invasive species to expand their geographic ranges and outcompete native insects for resources. This can have a ripple effect throughout the food chain.

The major and currently understood responses of insects towards climate change are range shift as well as outbreak or breakdown. The implications of these responses are yet to be completely understood.

Phenology

Phenology refers to the timing of recurring biological events in response to seasonal and climatic cues, such as temperature, precipitation and daylength. Insects are highly sensitive to phenological changes and often rely on environmental cues to synchronise their life-cycle events with optimal conditions for growth, development and reproduction. Climate change has altered these cues and disrupted the synchrony between insects and their environment, leading to changes in phenology across many species.

Earlier emergence of overwintering insects in spring is a notable example. Warmer temperatures can accelerate the development of immature stages and reduce the time spent in diapause or dormancy. As a result, many insect species are emerging earlier in the year than they did in the past, sometimes by several weeks or even months. For example, the Tea Mosquito Bug (*Helopeltis theivora*) (Fig. 1), the Citrus Mealybug (*Planococcus citri*) and the Common Fruit Fly (*Drosophila melanogaster*) emerge earlier than usual and thus have the potential for more generations per year, thereby damaging crops even more.

Earlier emergence can have cascading effects on the rest of the life cycle and interactions with other species. If the timing of emergence is not synchronised with the timing of flowering of host plants, it can reduce the availability of food and disrupt pollination services. This can have negative consequences for both the insect and the plants, as well as for the ecosystem as a whole.

In addition to earlier emergence, climate change can affect the timing of other life-cycle events, such as reproduction and migration. For example, warmer temperatures can advance the onset of egg-laying in butterflies, beetles and moths, and lead to more generations per year. This can increase the population density of some species and enhance their ability to adapt to changing conditions. On the other hand, it can also increase the risk of competition, predation and disease transmission, as well as reduce the quality of offspring. Climate change can also alter the timing of migration in some insect species, such as Monarch (*Danaus plexippus*) butterflies and dragonflies. Warmer temperatures can trigger earlier and longer migrations, as well as alter the timing of reproduction and food availability at the migration destination. This can affect the distribution and abundance of insects across different regions and ecosystems, and potentially disrupt interactions with other species.

Range shift

Range shift refers to the movement of a species' geographic distribution towards a new location. Climate change induces shifts in temperature and precipitation patterns, leading to changes in the timing and duration of seasons (Walther *et al.*, 2002). As temperatures and precipitation patterns change, the suitable habitat for a species may shift, forcing it to move in order to remain within its preferred temperature and moisture range as well as to track its food source. Many butterfly species have shifted their ranges towards higher latitudes or altitudes in response to warming temperatures (Chandra *et al.*, 2019). For example, over the last few decades, populations of the Indian Skipper (*Spialia galba*) butterfly (Fig. 2) have shifted by as much as 2,000 meters uphill in the Himalayas. The movement of the butterfly to higher altitudes could disrupt the pollination networks that exist in these habitats, potentially leading to declines in plant populations and reduced biodiversity.

Outbreak or breakdown?

The response of insects to climate change falls within two extremes – outbreaks to breakdowns. The outbreak of Desert Locust in Rajasthan and Gujarat and Asian Citrus Psyllid (*Diaphorina citri*) (Fig. 3) in different parts of India are classic examples. Breakdowns occur when populations crash, resulting in local extinctions. The decline in insect populations has significant implications for ecosystems and human society. The increase in extreme weather

Figure 2. *Spialia galba* (Indian Skipper). Photo: Dr Jafer Palot

events, such as floods, droughts and hurricanes, can destroy habitats and disrupt migration patterns, leading to significant declines in populations.

Warmer winters can enable vulnerable insect stages to survive more readily, leading to more rapid population growth in spring and increased outbreaks in summer. For example, warmer temperatures can accelerate the development of mosquito larvae and increase the number of generations per year, leading to higher population densities and greater risk of disease transmission. However, some insect species may be negatively affected by warmer winters due to faster depletion of resources. Many insects rely on specific plants for food and shelter, but changes in weather patterns are disrupting the timing of plant growth and blooming, leaving insects without the resources they need to survive. Unpredictability of the onset of rains due to climate change affects the periodicity of insect emergence (Ayieko and Ndong'a, 2010). These effects vary from species to species, so generalised conclusions cannot be made.

We don't know enough

While the role of climate change in insect declines and outbreaks is becoming increasingly clear, there is still much we do not know. For example, scientists are still trying to understand the specific mechanisms by which climate change is impacting insect populations. The effect of climate change on insect range, population dynamics and impacts of these changes on communities and ecosystems are yet to be understood in detail. Insect responses to cope with climate change-driven stress are still understudied.

A major issue is the lack of data on insect populations in many parts of the world, including India. Despite being home to several globally significant biodiversity hotspots, such as the Western Ghats and the Eastern Himalayas, the insect biodiversity of India remains largely underexplored and understudied. While there are discussions happening on a global scale on how insects are affected by climate change, we are still at the stage of exploring and describing new species in India. The sheer number of new species being described from these regions serves as a striking example of the vast unknown insect diversity that awaits discovery and further scientific investigation (Ranjith and Priyadarsanan, 2023). The urgency to expand research efforts on the impact of climate change on insects becomes even more apparent in tropical regions. While long-term data and evidence of changes in insect populations predominantly come from Europe and North America, countries with the greatest insect biodiversity and the potential for significant agricultural implications, such as those in the tropics, remain understudied.

Although there have been some studies on insect decline in certain regions, we do not have a comprehensive understanding of the state of insect populations globally. Little is known about other impacts like the reason behind apparently random outbreaks, phenology changes *etc*. This lack of data makes it challenging in relation to fully understanding the scale of the problem and developing effective solutions.

Figure 3. The Asian Citrus Psyllid (*Diaphorina citri*). Nymphs pass through five instars during their development. Photo: copyright Dr Deepak Deshpande

Hence, this article is intended as a compelling call for increased research in tropical countries, highlighting the crucial need to bridge the knowledge gap and gain a comprehensive understanding of what is happening in areas with high insect diversity, where the effects of climate change on insects may be most pronounced. By directing attention and resources toward these regions, we can better comprehend the challenges at hand and develop effective strategies to mitigate the potential impacts on both local ecosystems and global food production. This will likely involve several steps, including reducing greenhouse gas emissions, protecting and restoring habitats, and implementing sustainable farming practices.

Lastly, the 'cute and cuddly' bias is playing out in the attention given to insects and climate change studies. While many people express concern over the plight of charismatic species such as Polar Bears and whales, insects are often overlooked. However, these small creatures are essential to the health of our ecosystems and play a crucial role in pollination, decomposition and pest control. The impact of climate change on insects is therefore a matter of urgent concern. Failure to recognise this could disrupt entire food webs and damage the very foundations of our natural world. It is time for us to broaden our perspectives and take action to protect all non-pest species, regardless of their appearance, from the effects of climate change.

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Those jazzy striped butterfly antennae: Why do some species have them and others don't?

Nothing in biology makes sense except in the light of evolution

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Why do some species of butterfly have visibly striped antennae whilst others don't? More to the point, why are these stripes predominantly confined to certain families such as the Lycaenidae (blues, coppers and hairstreaks) and Hesperiidae (skippers)? Then again, even in the families that generally don't show striped antennae (*e.g.*, whites and yellows; Pieridae), some species still have them! How odd is that.

Quoting the famous adage by the late, great evolutionist Theodosius Dobzhansky (1900–1975): "*Nothing in biology makes sense except in the light of evolution*" (Dobzhansky, 1973), one assumes that these stripes have some functional and hence selective significance or, less likely, once did and have been retained over evolutionary time, for whatever reason/s. Table 1 shows the distribution and relative ranking (= boldness) of the stripes of the 59 resident species of butterfly seen in the British Isles, and 11 vagrant species (Thomas & Lewington, 1991; O'Neill & Montgomery, 2018). This assessment is, of course, somewhat subjective, especially in terms of the weaker-banded antennae, and, anyway, there may be differences in band intensity among natural species populations. As far as we can ascertain from photographs, there appear to be no differences between the sexes in the striped banding observed in the species showing such patterning. Of the 70 species represented in the Table, 64% show striping.

I (HDL) had noted in the back of my mind such striped antennae at some point in my observations of butterflies over many years, both in the UK and abroad. However, this striking morphological trait had never really 'grabbed' my attention – until, that is, Richard started sending me some of the fantastic close-up colour photographs of butterflies taken on his many trips in Britain and in mainland Europe, especially Switzerland, used for his book of butterfly poetry, *The Butterfly Collection* (Harrington, 2018). It was the photo of a male Adonis Blue butterfly, *Polyommatus* (= *Lysandra*) *bellargus* (Fig. 1a), that finally engaged my attention, especially when I enlarged the image with the photographic program Picasa 3 (Figure 1b).

The most obvious explanation for the presence of these stripes is that of disruptive colouration, *i.e.*, 'maximum disruptive contrast', according to the description given in Stevens & Merilaita (2009). Thus, these authors state on page 482, section b:

"[Hugh] Cott's (1940) second sub-principle, maximum disruptive contrast, predicts that in effective disruptive patterns the adjacent elements should contrast strongly (see also Thayer, 1909). Generally, Cott argued that light markings on an otherwise dark object, and dark markings on an otherwise light object, will be most effective in creating a disruptive effect. Overall, the main function of high luminance or colour contrast between pattern elements is to break up the outline or the continuity of the surface."

In the case of butterfly antennae, perhaps the functional reason for these stripes is, as with the false tails and antennae of some lycaenid butterflies, *e.g.*, *Arawacus aetolus* of northern South America (Riley & Loxdale, 1988; Hendrick *et al.,* 2022; Howse, 2022), a form of 'reverse mimicry' (Cannon, 2018). In this way, predation damage, especially by insectivorous birds with their incredible visual acuity, is

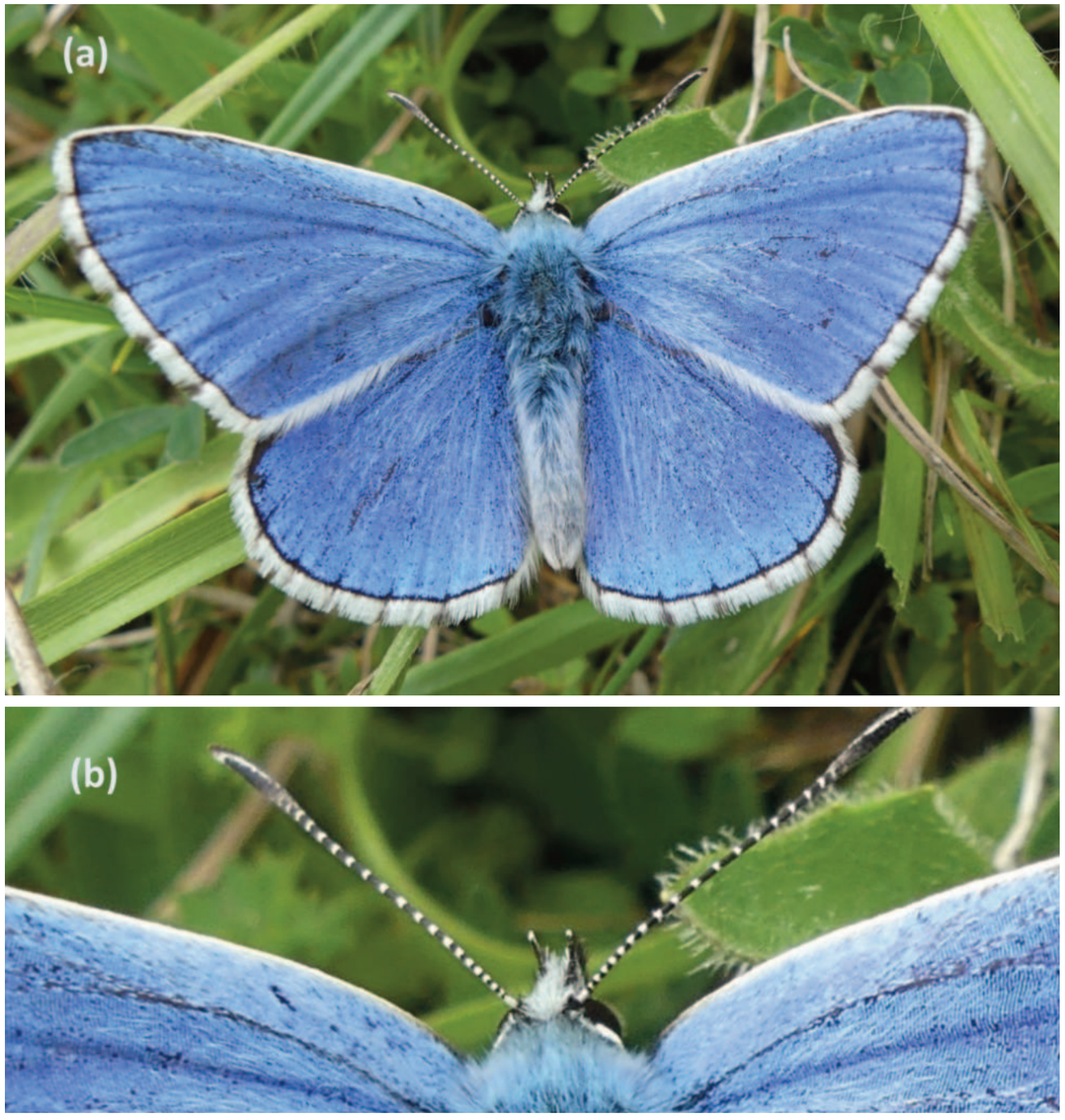

Figure 1. (a) Male Adonis Blue butterfly; (b) enlargement of this photo to show prominence of striping of the antennae. The specimen has 19 antennal flagellar segments (or flagellomeres), including the scape (base), the pedicel (second segment) and the clubbed terminal segment. There is some preliminary evidence that the number of segments differs between species, *e.g.*, Chequered Skipper = 16; Adonis Blue = 19; Green-veined White = 25–26; Small Tortoiseshell = 24–25; Red Admiral = 26–27, perhaps depending on the size of the insect, hence determining the length of the antennae they bear. According to Niehaus & Gewecke (1978) (cited in Cannon, 2020b), "*The antennae are moved by muscles connected to the scape and the pedicel, a bit like a ball-and-socket joint.*" (see Cannon, 2020 a,b for further details about butterfly antennae).

diverted from the antennae. These are vital organs, including for chemical communication used, for example, in host plant detection by females (Baur *et al.,* 1998; Ikeura *et al.,* 2010; Carlsson *et al.,* 2013) and floral detection by both sexes (Andersson, 2003), courting, sometimes involving sex pheromones (Schneider & Seibt, 1969), competition to ward off male rivals (Cannon, 2020a and references therein), thermal detection (Schmitz & Wasserthal, 1993), as well as solar-based navigation in migratory species like the Monarch butterfly, *Danaus plexippus* (Guerra *et al.,* 2012).

A total of six different types of sensilla have been identified on the antennae of four species of skipper. These are likely involved in mechanoreception, olfaction, chemoreception, proprioception, and the detection of temperature and humidity (Xiangqun *et al*., 2014). Similarly, nine sensilla types have been identified in the pyralid moth *Tirathaba rufivena*, with evidence for sexual dimorphism in terms of the length and the abundance of certain types, associated in females with locating host plants and detecting males (Guo *et al*., 2022). Butterfly antennae clearly play a key role in mate location, for example by responding to sex pheromones, and it remains possible that their visual appearance is sometimes the

Table 1. List of the butterflies of the British Isles showing distribution and intensity of antennal striping
https://en.wikipedia.org/wiki/List_of_butterflies_of_Great_Britain

	Antenna obviously striped	Intensity of striping strong ***; intermediate **; weak *
Hesperiidae – skippers		
Subfamily Heteropterinae		
Chequered Skipper, *Carterocephalus palaemon*	Yes	**
Subfamily Hesperiinae		
Small Skipper, *Thymelicus sylvestris*	Yes	*
Essex Skipper, *Thymelicus lineola*	Yes	*
Lulworth Skipper, *Thymelicus acteon*	Yes	*
Silver-spotted Skipper, *Hesperia comma*	No	
Large Skipper, *Ochlodes sylvanus*	Yes	*
Subfamily Pyrginae		
Dingy Skipper, *Erynnis tages*	Yes	**
Grizzled Skipper, *Pyrgus malvae*	Yes	*
Papilionidae – swallowtails		
Subfamily Papilioninae		
Papilio machaon subspecies *Britannicus*	No	
Pieridae – whites and yellows		
Subfamily Dismorphiinae		
Wood White, *Leptidea sinapis*	Yes	*
Cryptic Wood White, *Leptidea juvernica*	Yes	*
Subfamily Coliadinae		
Clouded Yellow, *Colias croceus*	No	
Brimstone, *Gonepteryx rhamni*	No	
Subfamily Pierinae		
Large White, *Pieris brassicae*	Yes	*
Small White, *Pieris rapae*	No	
Green-veined White, *Pieris napi*	Yes	*
Orange-tip, *Anthocharis cardamines*	No	
Lycaenidae – hairstreaks, coppers and blues		
Subfamily Theclinae		
Green Hairstreak, *Callophrys rubi*	Yes	**
Brown Hairstreak, *Thecla betulae*	Yes	*
Purple Hairstreak, *Favonia quercus*	Yes	*
White-letter Hairstreak, *Satyrium w-album*	Yes	**
Black Hairstreak, *Satyrium pruni*	Yes	**
Subfamily Lycaeninae		
Small Copper, *Lycaena phlaeas eleus*	Yes	*
Subfamily Polyommatinae		
Small Blue, *Cupido minimus*	Yes	**
Silver-studded Blue, *Plebejus argus*	Yes	**
Brown Argus, *Aricia agestis*	Yes	**
Northern Brown Argus, *Aricia artaxerxes*	Yes	**
Common Blue, *Polyommatus icarus*	Yes	**
Chalkhill Blue, *Lysandra coridon*	Yes	*
Adonis Blue, *Lysandra bellargus*	Yes	***
Holly Blue, *Celastrina argiolus*	Yes	**
Large Blue, *Phengaris arion*	Yes	*
Riodinidae – metalmarks		
Duke of Burgundy, *Hamearis lucina*	Yes	**
Nymphalidae – fritillaries, nymphalids and browns		
Subfamily Heliconiinae		
Small Pearl-bordered Fritillary, *Boloria selene*	Yes	*
Pearl-bordered Fritillary, *Boloria euphrosyne*	Yes	*
High Brown Fritillary, *Fabriciana adippe*	No	
Dark Green Fritillary, *Speyeria aglaja*	No	
Silver-washed Fritillary, *Argynnis paphia*	No	
Subfamily Limenitidinae		
White Admiral, *Limenitis camilla*	No	
Subfamily Apaturinae		
Purple Emperor, *Apatura iris*	No	
Subfamily Nymphalinae		
Red Admiral, *Vanessa atalanta*	Yes	**
Painted Lady, *Vanessa cardui*	Yes	*
Small Tortoiseshell, *Aglais urticae*	Yes	*
Peacock, *Aglais io*	No	
Comma, *Polygonia c-album*	Yes	*
Marsh Fritillary, *Euphydryas aurinia*	Yes	*
Glanville Fritillary, *Melitaea cinxia*	Yes	*
Heath Fritillary, *Melitaea athalia*	Yes	*
Subfamily Satyrinae		
Speckled Wood, *Pararge aegeria*	Yes	*
Wall, *Lasiommata megera*	Yes	*
Small Mountain Ringlet, *Erebia epiphron*	No	
Scotch Argus, *Erebia aethiops*	No	
Marbled White, *Melanargia galathea*	No	
Grayling, *Hipparchia semele*	No	
Gatekeeper, *Pyronia tithonus*	Yes	*
Meadow Brown, *Maniola jurtina*	No	
Ringlet, *Aphantopus hyperantus*	Yes	*
Large Heath, *Coenonympha tullia*	Yes	*
Small Heath, *Coenonympha pamphilus*	Yes	*
Vagrants		
Scarce Swallowtail, *Iphiclides podalirius*	No	
Pale Clouded Yellow, *Colias hyale*	No	
Berger's Clouded Yellow, *Colias alfacariensis*	No	
Bath White, *Pontia daplidice*	No	
Long-tailed Blue, *Lampides boeticus*	Yes	*
Short-tailed Blue, *Cupido argiades*	Yes	*
Large Tortoiseshell, *Nymphalis polychloros*	No	
Camberwell Beauty, *Nymphalis antiopa*	No	
Map, *Araschnia levana*	Yes	*
Queen of Spain Fritillary, *Issoria lathonia*	No	
Monarch, *Danaus plexippus*	No	

target of sexual selection, as well as natural selection. Antennae may be used in courtship and mating, as in the Wood White butterfly, *Leptidea sinapis* (L.), which possesses sexually dimorphic antennae (Friberg *et al*., 2008). These authors consider it quite feasible that the white antennal patch in wood whites is important during within-species sexual selection. Similarly, Ge *et al.* (2017) speculated that the white spots on the antennae of a Costa Rican skipper, Escalante's Ruby-eye, *Carystoides escalantei*, might be used for sexual signalling. This raises the question as to whether the stripes on antennae are involved in the courtship behaviour of some species.

Another type of 'protective colouration' in which striped or banded antennae could play a part, is that of 'motion dazzle' (Caro & Koneru, 2021). Motion dazzle colouration relies on conspicuous stripes or bands, but also requires movement, "*...which together with the markings makes perception of speed and direction of movement difficult for a viewer to follow*" (Seymoure & Aiello, 2015). It is possible that striped antennae protect the moving butterflies by making predators misjudge their speed or trajectory.

Conclusions

If the view that the black and white stripes on butterfly antennae are for deflecting, or better still, preventing attack on these structures, then butterflies such as the lycaenids, and especially those with false tails, are thereby theoretically afforded double protection [see for example, the colour photographs in my (RJCC's) 2018 blog relating to the Fluffy Tit butterfly, *Hypolycaena amasa amasa* of SE Asia (Perissinotto *et al.,* 2023), and the Common Tit butterfly, *Hypolycaena erylus himavantus* of India and SE Asia (Ghosh *et al.,* 1990)] ....assuming that these false tails really are effective in the role of defence, something which I am not wholly convinced about (but see also López-Palafox & Cordero, 2017 and Novelo Galicia *et al.,* 2019 in relation to this ongoing debate). I also previously noted the presence of striped antennae in the 'false head' butterflies described in this blog and make the comment that the 'false head' tails are not necessarily very good mimics of the true antennae. But then again, they probably only need to be pretty good at deceiving a would-be predator, perhaps momentarily, for the prey to have a chance to escape, in which case they have a protective role and hence are selectively advantageous (Howse, 2022). In this respect, butterflies may be using their tails and false antennae in ways similar to lizards, as decoys or distraction devices, thereby helping them to survive predator strikes (Chotard *et al*., 2022).

We alas cannot give a definitive answer as to why some butterflies show these striped antennae and others don't, even within the same butterfly family, but disruptive colouration, thereby providing some degree of protection from would-be predator attack, seems to be the most likely reason. The phenomenon appears to be widespread in the UK butterfly fauna, as Table 1 reveals, especially amongst the Lycaenidae, and certainly other Asian lycaenids show striped antennal markings (Cannon, 2018), and such striping is indeed widespread amongst some of the butterfly fauna globally (*cf.* Feltwell, 1998). Clearly, further work is required to throw more light on this matter.

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Featured Insect

The European Earwig, *Forficula auricularia* L.

Scientific name: *Forficula auricularia* Linnaeus 1758

Common name: European Earwig

Order: Dermaptera

Family: Forficulidae

Dave Goulson
University of Sussex

The origin of the common name 'earwig' is debated. It may derive from the old wives' tale that earwigs like to crawl into human ears (sometimes embellished by unlikely stories of them laying their eggs inside). A more mundane explanation may be that the hind wings, when unfolded, approximately resemble a human ear, and this is undoubtedly the origin of the specific name *auricularia*.

Sadly, earwigs enjoy limited popularity with the general public, lacking the obvious charm of groups such as butterflies or bumblebees. Their propensity to secrete themselves in nooks and crannies in damp old houses and garden sheds, popping out and scampering about when least expected, is sure to cause alarm in anyone who isn't fond of insects. If you grow your own fruit and veg you will often find them squeezed between the leaves of a lettuce or leek, or hidden within grape bunches, and I have found that few things are more certain to disconcert one's guests at a dinner party than an earwig scuttling out of the salad bowl.

Earwigs are often regarded as pests, nibbling soft fruit and delicate blossoms, and sometimes insecticidal sprays are used to control them. It is not widely appreciated that they are also important predators of small hemipteran pests such as woolly aphids in orchards (*e.g.*, Mueller *et al.*, 1988) and they may well do more good than harm overall. It has also been claimed, anecdotally, that earwigs are nocturnal pollinators, though I struggle to imagine that they are major contributors to crop pollination.

Aside from their economic pros and cons, earwigs display fascinating behaviours, deserving of more attention and research. For example, they exhibit complex courtship, in which the male uses his forceps to wave at a female, stroke her, and encircle her forceps, before, all having gone well, moving on to copulation (Walker & Fell, 2001). Males whose forceps have been experimentally removed enjoy zero mating success, poor things. Males of many earwig species – not including *F. auricularia* – have two penises and have been found to strongly favour using the right one, though both are functional and sometimes one is snapped off if copulation is disturbed (Kamimure, 2006). Pairs of earwigs will share a nest, usually an underground chamber, through the autumn and early winter, but when the female is ready to lay her eggs, she drives the male out. Female earwigs are attentive mothers, guarding and cleaning their eggs in a nest, and regurgitating food for their early instar nymphs, though as their offspring grow and maternal instincts wane the mothers sometimes turn to cannibalism.

If you are interested in taking part in a citizen science project to find out if 'earwig hotels' are effective in a garden setting, visit the website of the Buzz Club www.thebuzzclub.uk/earwigo.

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Insects in the News

October to December 2023

Richard Harrington and Jesamine Bartlett

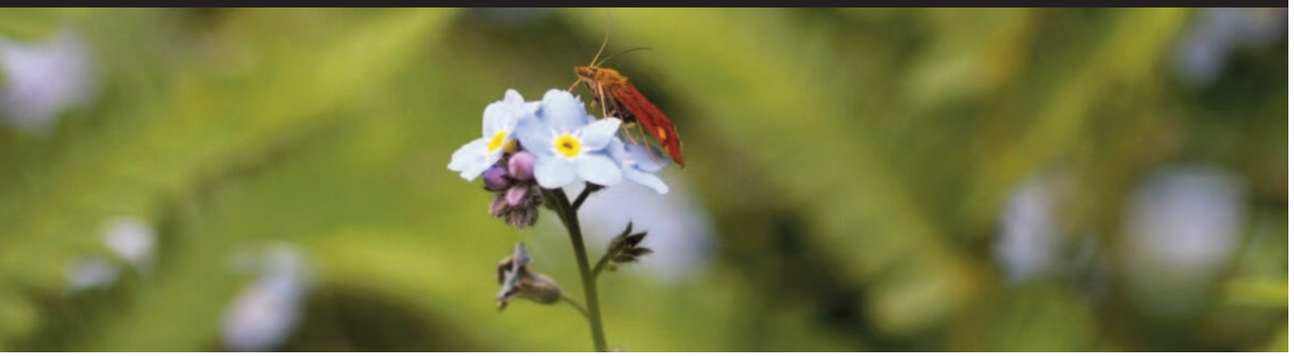
At their last meeting, the editorial team had the idea of a short piece in each issue reporting on insect stories that have made national or international news. This arose because many such stories had been spotted during the summer. Richard's main sources of news are *The Telegraph*, BBC 1 and Radio 4, which probably tells you all you need to know about him, but he was also plied with stories from other sources, especially by Stuart Reynolds. Jes volunteered to roam wider via RSS feeds. Let us know if you'd like us to keep this up.

Autumn and winter may not be the best time for stories on outdoor insects, but the press villains of the fourth quarter were of the indoor variety, bed bugs (especially *Cimex lectularius*). For scientific rigour, see Will Hentley's article in this issue, but here's the press version. On 3rd October, *The Independent* asked: "Is London prepared for the mutant bed bug invasion that has swarmed Paris?", adding "Londoners have begged Suella Braverman to close borders before the French bed bugs can arrive" and "Lovers beware. Paris has been engulfed by an infestation of bed bugs with authorities warning 'no-one is safe'". It reported that horrified TikTok users were standing on the "infested Paris metro" rather than sitting on the fabric seats, and that bed bugs had a penchant for hitching rides on dirty suitcases. The MD of a pest control company was reported as saying "some people who seem to have it all together simply turn into gibbering wrecks". *The Telegraph* cottoned on two days later, leading with "Bed bugs: 'No one's safe, I was bitten in business class'". Paris Fashion Week, the Rugby World Cup and pilgrimages were blamed for the spread. The article reported a similar scare in New York in 2010 and what we might learn from actions taken. Our very own James Logan (London School of Hygiene and Tropical Medicine) turned out to be the source of the "business class" comment. Huh! I never got to travel business class for Rothamsted. He did provide some useful facts and measured comments, though. *The Telegraph*'s Letters Editor got an infestation and paid £1,200 for every room in the house to be heated to 180°C. I hope he took advantage and cooked his meals. The same paper reported that Eurostar trains were to be disinfected while airlines would ground planes if the insects were found. Helpful letters advocated the use of diatomaceous earth to kill bed bugs through dehydration or using metal beds and dousing them with gasoline. By 9th October, sniffer dogs, Thunder and Troy, had been sent from Britain and Ireland, courtesy of the company Doggybug, to help the French control efforts. On 11th, the advice was to put affected clothes and bedding in the freezer for a few hours before washing. After all, we've all got big enough freezers with no food in them, haven't we? Next day, it was reported than many insurers would not pay out over bed bug infestations. A British couple on holiday in Egypt died unexpectedly hours after chemicals had been sprayed in their hotel to control bed bugs. Unsurprisingly, it wasn't long before Russia was being blamed for causing the panic by spreading fake stories, whilst Russia hit back by blaming the spread on Ukrainian refugees. My last sighting of a bed bug article was on 14th December when a library in Northolt was closed because bed bugs were found in returned books.

A few other entomological stories got a brief look in. Oxford University produced the first malaria vaccine capable of being made and applied at scale, with plans to provide 200 million doses per year. Bees apparently used a "stop, drop and roll technique favoured by firefighters" to fend off Asian Giant Hornet (*Vespa mandarinia*) attacks. The oldest insect leaf bites were found on a 312-million-year-old fossil, 70 million years earlier than previously believed. A golf course near Brighton was praised as a haven for 34 butterfly species. Cricket-based snacks were tipped as the next big thing, not news to most readers of *Antenna*. A young conservationist reared and released 1,000 European Glow-worms (*Lampyris noctiluca*) to boost local populations in Hampshire. A UKCEH study has shown the diversity of river insects to have increased 300% over the past 30 years "despite raw sewage dumps". There was an obituary in *The Telegraph* to Colin Smith, a maths teacher who became an expert on Nepalese butterflies. There was a large picture of an art installation on pollination at the Hepworth Wakefield Garden hand crafted from recycled materials by Alison Smith and RES Fellow, Chris Hassall (See *Antenna* 44(2), 80–82). A sighting of an American Painted Lady (*Vanessa virginiensis*) on the Isles of Scilly, the first in Cornwall since 1876, was reported on *The Guardian's* website, alongside a picture of our Painted Lady (*Vanessa cardui*). The error was quickly corrected. As Christmas approached, Tesco recalled packets of its vegetarian stuffing mix after it was potentially contaminated with moths, whilst Deathwatch Beetles (*Xestobium rufovillosum*) and woodworm beetles are devouring the church spire of St Mary's, Long Sutton, Lincolnshire, which was used as a model for Salisbury Cathedral. Finally, birds with 'harmful' names are to be rebranded in the US and Canada, following a similar initiative by the Entomological Society of America. Don't get me (RH) started.

Royal Entomological Society

Society News



Mint Moth (*Pyrausta aurata*). Photo: Fabian Harrison.

News from Council

Council Meeting
Council met online on 22nd November 2023.

Trustees
The President welcomed Professor Walter Leal (Chair of the Membership Committee) and Professor Jane Stout (President Elect) to their first trustees' meeting.

CEO's Report
The CEO reported on Key Performance Indicators, membership numbers, development of a policy and public affairs strategy, the move of The Chelsea Flower Show Garden, conservation work, the Big Give Christmas Challenge, publishing, conferences, business development and the Society's participation in the New Scientist Live event.

Move of Headquarters
The CEO reported on the head office relocation project and it was progressing well. The brief for the relocation is being finalised using feedback from the trustee and staff workshop and the membership survey. A working group has been formed to ensure agility in decision making over the coming months.

Management Accounts and Strategic Risk Register
The Director of Finance gave an insight into the financial performance of the Society for the period ending 30th September 2023 using a new and clearer reporting format. He also presented a review of the Strategic Risk Register, the scoring algorithm for which has been amended to match recommendations of The Charity Commission.

Equity, Diversity and Inclusivity
A new committee to oversee EDI at the Society was discussed. Terms of Reference will be drafted for consideration and a decision made at the next meeting.

Data Protection Policy and Privacy Notices
The CEO presented amendments to the Data Protection Policy and Privacy Notices, produced to ensure that the Society is legally compliant and adopts best practice. These were approved by Council.

Staff Performance Appraisal Policy
The CEO presented updates to the Performance Appraisal Policy and Pay Policy, which ensure clarity and demonstrate best practice. The changes were approved by Council.

Committee Reports
Reports were presented by the chairs of the Publications Committee, the Education & Training Committee, the Science, Policy & Society Committee, the Meetings Committee and the Finance Committee. The CEO gave a health and safety update.

Journals and Library

Library update

Rose Pearson
RES Librarian and Archivist

'Sea Insects' from *The Natural History of Cornwall* (1745) by William Borlase on display at Ento23 in Falmouth. Photo: RES.

2023 has been a busy time for the library, with several exciting projects taking place that aim to make the RES Library and Archive collections more discoverable and accessible to the entomological community.

One major project is the digitisation of the RES Archive in collaboration with Wiley Digital Archives. The digitised archive will form part of their Environmental Science and History Collection, which explores the way human activity is impacting the natural world. As part of this process, much of our Archive material has been taken offsite for digitisation. The digital archive will be available for RES members to consult within the library and available for purchase by universities and other institutions. Some of our material is already available in the collection, with more being added regularly. The platform includes Automated Text Recognition (ATR), which translates handwriting to text, meaning that the contents of documents can be easily searched, increasing the discoverability of the collections. As part of an online event promoting the Digital Archive, I spoke to a group of Academic Librarians about the work of the RES, and its history as a learned society, and highlighted some of the fantastic material we have in our collections, including letters written by Charles Darwin to the naturalist and RES President 1897–98, Roland Trimen.

We have also been working with the British Library UK Research Reserve, to assess our print journal holdings. We compared our collections to other libraries around the UK and discovered that we hold a high percentage of rare and unique titles. However, a number of titles that are little used and widely available elsewhere have been identified for weeding and will be transferred to the British Library for long-term preservation or offered to other relevant libraries and organisations. This will allow us to free up space that is the equivalent of 20 bookcases, which can be used for new acquisitions, or repurposed for additional study space, as well as eliminating the need for external storage.

There have also been a few changes to our online services, including a 'Suggest an Item' form which has been added to the library website. If there is a book, journal or online resource you think that the library should acquire, let us know. Thank you to everyone who has sent in their suggestions already. In related news, a policy for the purchase of new library resources has been approved by the Library Committee and is available to view on the library webpage. Additionally, our library catalogue has an updated interface which should make searching and discovering our collections easier.

Following a recent archive valuation, we received a report picking out some of the highlights of the collection including a photo of Charles Darwin taken by pioneer photographer Julia Margaret Cameron, which was donated to the RES by Darwin's daughter, Henrietta Litchfield. Also highlighted was a portrait of Alfred Russel Wallace by E.O. Hoppé, a renowned photographer who also shot Albert Einstein and King George V.

I have been taking the library out of our St Albans home, attending events including Ento23, The Verrall Lecture and The Orthoptera SIG Meeting. With a stall highlighting some of our rare books, and information promoting our collections and services, it has been a great opportunity to meet members and understand what they need from us and showcase what makes the RES Library and Archive unique.

If you would like to make an appointment to visit the library or archive, have an enquiry, or would like to give feedback please contact the Librarian by email at library@royensoc.co.uk or by phone on +44 (0) 1727 899387.

Grant Report

Metamorphosis

Toby Cotterill and Ian Watkins

METAMORPHOSIS is a collection of solid silver objects depicting the Stag Beetle (*Lucanus cervus*) in the larval, pupal and adult stages. These creations are the product of a collaboration between jeweller silversmith Toby Cotterill, digital sculptor Ian Watkins, and The Royal Entomological Society. The fully hallmarked pieces are available in a range of pendants, pins and keyrings, with a donation from each sale being made to the Society. See https://tobycotterill.co.uk/shop.html#!/jewellery-silver-stag-beetle-insect-metamorphosis for further details.

Antenna spoke with Toby to learn a bit more about what inspired him to work on this collection with the RES.

Toby in the workshop.

When did you first become interested in insects?
"I grew up on a farm in West Wales and spent most of my childhood exploring and playing outdoors with my brothers. One of my earliest memories is turning over a dock leaf and seeing these incredible, iridescent green beetles underneath, like little jewels. I was hooked. I loved my little illustrated wildlife book (which I still have), and learned the names of every plant and animal I saw. Insects, especially beetles, have always been my favourite though; it's like biologist E. O. Wilson said: "I think all kids have a bug period…I never grew out of mine"."

What is it about insects that makes them interesting models?
"I find insects endlessly fascinating, and have visited numerous natural history museums to examine, photograph and sketch entomological specimens. I love them for their fantastic array of form and structure, incredible horns, spines and colours, and the fact that they've adapted to fill in nearly every ecological niche on the planet. They have inspired whole collections of work and continually offer ideas for new pieces. Insects often live secretive lives, untrusted and misunderstood by humans (despite being vital to the success of life on Earth), and I welcome any part I can play to celebrate and promote these amazing creatures."

How do you go about the smithing process when making insect-themed pieces?
"The process for creating the Metamorphosis collection is slightly different from my usual work. The Stag Beetle designs are digitally created, 3D printed, and then cast into recycled silver. I hand-finish the pieces and make them wearable.

Much of my other work is handmade using traditional silversmithing techniques, creating one-of-a-kind pieces inspired by insects and sea creatures. For these pieces I forge sheet silver over steel stakes, and into pitch and wooden formers using hammers and punches. Three-dimensional organic forms are often articulated, fused, and finished with enamels or gold to create little pieces of wearable sculpture."

Meetings

Sustainable Agriculture Special Interest Group meeting

27th September 2023

Jordan P. Cuff (Newcastle University),
Kelly Jowett (Rothamsted Research)
and Jasper Hubert (Koppert)

The RES Special Interest Groups (SIGs) have a long history of supporting engaging meetings, bringing together far-flung entomologists and providing forums for cutting-edge insect science in specific themes. The Sustainable Agriculture Special Interest Group is no different but has been in hiatus since its last meeting in 2017. The Sustainable Agriculture SIG aims to bring together entomologists with an interest in enhancing the sustainability of food production and maintaining agricultural biodiversity, covering everything from land management schemes through monitoring tools to engagement with farmers. With three new convenors, the SIG met for the first time in six years at Rothamsted Research in Harpenden.

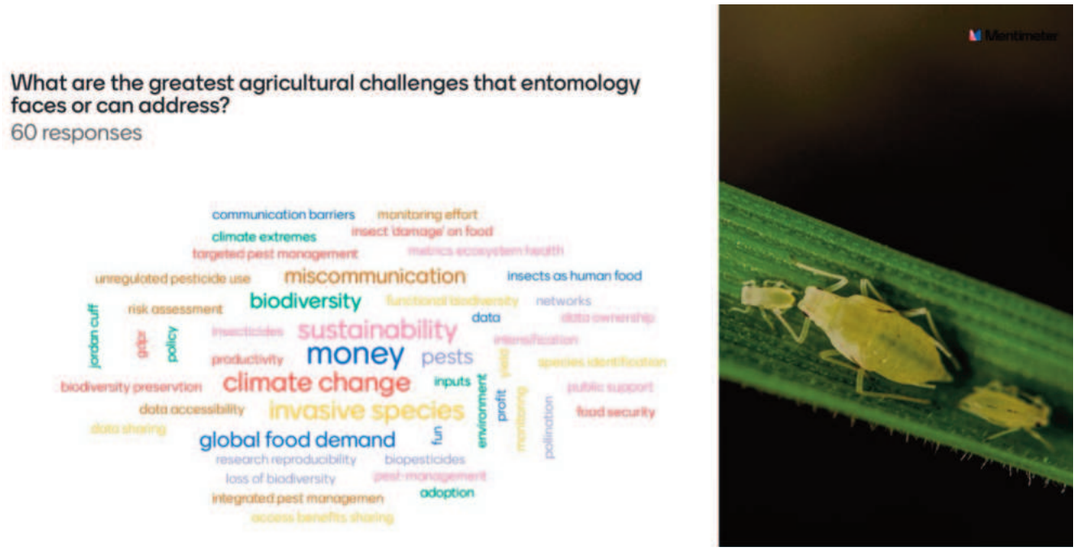
The day promised to cover the full agricultural entomological life cycle, from monitoring for pests and diseases to management of land and resources, and beyond. Sustainable agriculture is faced with a multitude of challenges in the coming decades, from increasing pressure to produce more food on less land for a growing global population, to climate change and the associated range shift of pests. Since insects are central to our food systems as natural enemies of crop pests, as pollinators and as pests, entomological research is optimally placed to monitor and manage these challenges, and this SIG provides an ideal forum within which to exchange best practice and cutting-edge concepts.

The meeting specifically covered three key themes: biomonitoring of pests and beneficials, translation of research into practice, and engagement of practitioners and the public. The day featured invited talks from James Bell (Rothamsted Research), Sarah Beynon (The Bug Farm) and Larissa Collins (Fera Science Ltd) and talks and posters from the delegates arranged into sessions based on the three key themes of the day. Presentations covered everything from virus vector monitoring and integrated pest management data tools, to companion cropping and the economic significance of environmental land management schemes.

The three convenors (left to right: Jasper Hubert, Kelly Jowett, Jordan Cuff) alongside a giant carabid beetle and aphid after an exciting day of sustainable agricultural entomology.

As an afternoon break from talks, delegates were invited on a tour of the Rothamsted Insect Survey suction-traps and labs, and the Rothamsted Research insectary. The Rothamsted Insect Survey has been running nationwide networks of traps since 1964 and the long-term data they produce provide alerts on agricultural pests like aphids and other migrating insects. These data are an incredible resource for national insect science but are also widely used by farmers and policy makers to inform land management. As such, the networks represent the most comprehensive standardised long-term data on insects in the world and have a wide range of fundamental and applied uses. Stepping into the dark, however, the Rothamsted insectary boasted state-of-the-art facilities for the cultivation and rearing of a broad range of insect species, from virus-vector aphids and moths to leafhoppers and beetles. The red-lit corridors and biosecurity protocols were a fascinating insight into the complexity of rearing a diverse range of agriculturally significant insects.

Throughout the day, delegates were encouraged to engage with a live word cloud in the foyer. This asked delegates to identify the greatest agricultural challenges that entomology faces or can address. As the day progressed, this word cloud grew and morphed, informed by the captivating talks and posters. The most commonly



The greatest agricultural challenges faced by entomology, as identified by delegates on the day.

submitted challenges were 'money', 'climate change', 'invasive species' and 'sustainability', with many other challenges fitting into the broad themes of communication, data, pests and biodiversity loss.

This mirrors many of the grand challenges recently identified by RES members in the 'Grand Challenges of Entomology' project but, whilst many of these themes are well-known, others such as research reproducibility, GDPR and metrics for ecosystem health are perhaps newer. This exercise highlighted that the challenges are manifold, ever-changing and varied, but the meeting itself clearly demonstrated significant progress across many of these domains. To finish the day, the plenary speakers were invited to comment on the challenges identified. The speakers highlighted the need for communication across disciplines, and particularly to practitioners, which will be a key aim for the Sustainable Agriculture SIG going forward.

With the day concluded and many happy sustainable agricultural entomologists headed home, attention naturally turns to the future of the SIG. Given the unquestionable importance of sustainable agriculture and the scale of the grand agricultural challenges that entomologists must rise to, the relevance and importance of the SIG has arguably never been greater. Plans are rapidly coming together for a follow-up event and the convenors have every intention of maintaining momentum. We look forward to seeing this SIG grow over the coming years.

Many thanks to all contributors, their co-authors and to Rothamsted Research and RES staff, particularly Amy Everard for all of her help in organising the meeting.

The attendees of the meeting on a tour of Rothamsted's facilities with Dr Chris Shortall.

Aquatic Insects Special Interest Group

World Museum, Liverpool
25th–26th September 2023

Arron Watson
(Arron710@gmail.com)

Our first in-person meeting since 2019 was a joint event with the Tanyptera Trust, a northwest England entomological group. They arrange training and recording days and are based at the World Museum in Liverpool, which kindly hosted the meeting.

At the beginning of 2023 I set out as the new lead for the Aquatic Insects SIG, filling big shoes from my mentor and friend, Craig Macadam. I arranged a survey to better understand what members would like in relation to conference locations, topics and other aspects. I used some of the suggested topics for this meeting and will use others for future meetings. A day of talks followed the next day by a workshop was then developed with the help of some great people including RES Events Manager, Amy Everard.

This year's themes were *Morphology and Identification* followed by *Conservation and Management*. There was an excellent selection of speakers covering a broad range of topics, including Ian Wallace (World Museum) on *How to help Britain's rarest caddis* and Rachel Stubbington (Nottingham Trent University) on *Life in the drying streams of a wet country: the invertebrate biodiversity of UK temporary streams*. There were discussions around drier summers, changing water temperatures and how technology can be used to help solve some of the issues raised. Martin Winter (Environment Agency) had developed an app bringing together documents no longer printed and providing a key for entomologists to supplement the books they use.

Gary Hedges (Tanyptera Trust Manager) offered a tour of the rich entomological history at the museum, with 750,000 invertebrate specimens. The tour was guided by Tony Hunter, curator of the entomological collection, and Ian Wallace, the previous curator. After the tour there were two parallel sessions: *Aquatic insect identification* and *Skill development* with my famous shoe boxes of specimens to work on; Ian's *Caddis agony aunt* for questions about caddis ID; and a deeper look into some of the museum's collections. There is an open invitation to anyone who wants to undertake aquatic insect ID and I will bring lots of specimens to work on for the day (email me if you're keen!).

Day two was a workshop looking at identification of ground-dwelling insects but also branching into some of the amphipods commonly found in bore hole and cave environments. We also covered how to identify the invasive shrimps which are making their way around many of the UK's rivers. The Demon Shrimp (*Dikerogammarus haemobaphes*) and Killer Shrimp (*Dikerogammarus villosus*) are very similar to look at with differences including the rear urosome (back humps) projections. Tim Johns, who led the workshop, is an expert on groundwater fauna and is working on the identification of groundwater invertebrates which are under-recorded due to their habitat. With the smallest species being under a millimetre long and inconspicuous, the workshop was a fantastic opportunity to learn the skills to take up this subject and to encourage further recording.

Another two-day meeting with talks and activities will be arranged for the Autumn of 2024 in a different part of the UK. We hope to see you there.

44th Orthoptera Special Interest Group

Natural History Museum Hybrid Meeting, 8th November 2023

Convenors: Ed Baker, Darron Cullen and Judith Marshall

Report by Richard Harrington and Darron Cullen

The Society's longest running and most regular Special Interest Group met for the 44th time at the Natural History Museum with 29 orthopterists getting together in person and 25 joining online.

After a welcome from the organisers and a plea for data to help validate a Rothamsted Insect Survey model that predicts the distribution of insects, Mark Ritchie (Natural History Museum) presented his lecture on the taxonomy of certain acridoid grasshoppers in eastern Africa. He compared morphological studies of male genitalia with molecular approaches. These led to the conclusion that the genera *Mazaea* and *Ixalidium* (Fig. 1) belong within a single new family, with a sister group in Argentina, not Africa, an intriguing and controversial finding.

Figure 1. *Ixalidium sjostedti* Kevan, Kikafu, Kilimanjaro, Tanzania. Photo: Dr Claudia Hemp

It was a pleasure to welcome a dipterist into the orthopterists' den. Olga Sivell (Natural History Museum) introduced *Stomorhina lunata* (Locust Fly) (Fig. 2), a calliphorid larval predator of the eggs of a range of grasshopper and locust species. Although described as a southern palaearctic species, it has extended its range over the last twenty years to most European countries. It is unclear whether it is resident in much of Europe or whether its presence depends on annual migrations from the south. There is definitive evidence of breeding in The Netherlands, but it is not known what it feeds on there. Olga suspects that it breeds in Britain and gave a list of possible prey species.

More surprising than a dipterist at such a meeting was an engineer. Matthew Morley (London South Bank University) is applying a technique known as dental topographic analysis (DTA) (commonly used in dental anthropology) to the mandibles of grasshoppers. Currently he is using *Valanga nigricornis melanocornis* and *Phymateus saxosus* (Rainbow Milkweed Grasshopper), chosen for their size and knowledge of their diet. Resulting morphometric indices can be correlated with diet and have applications in dietary determination, dietary ecology, identification and classification. Matthew found that all the DTA metrics used have some differentiation power between species and that there is variation in the metrics between sexes. Some metrics vary due to wear, and further investigations are required to resolve this issue.

Figure 2. *Stomorhina lunata* (Locust Fly). Photos: Bob Dawson and Howard Burt

Figure 3. *Satizabalus satizabali*. Photo: Dr Charlie Woodrow

Joining in online from India was Anshuman Pati (Wildlife Institute of India), who explained how conservation efforts aimed at the critically endangered Great Indian Bustard (*Ardeotis nigriceps*) in the grasslands of the Thar Desert play an essential role in grasshopper conservation. Agricultural expansion, overgrazing, lack of landscape planning and the invasive tree *Prosopis juliflora* have led to loss of habitat and there are only about 140 of the bustards left in the world. At key times, grasshoppers form a vital part of the bustard diet, and so by piggybacking on the bird's status as a keystone species, Anshuman hopes to conserve more grasshoppers as well. High populations of grasshoppers are only found in the monsoon season and, even then, not in agricultural, shrub or barren land. Protected grasslands have higher numbers and richness.

Also joining online was David Bennett (Christian Albrechts Universität zü Kiel) who is developing an automatic classifier for the identification of Orthoptera sounds in northern Germany sampled with two commercially available bat detectors. Passive acoustic monitoring provides an efficient alternative to traditional surveying but produces an enormous amount of data. David's system is designed to automatically attribute the signals to species, hence reducing the workload of recorders. The classifier worked well for 17 species, with >80% true positives and <10% false negatives in relation to presence/absence field surveys. David also showed that a cheaper bat recorder was just as accurate as a more expensive one – and the batteries lasted longer!

Although now at Uppsala University, Charlie Woodrow was present in person to talk about auditory tuning to conspecific signals in an Eocene katydid (Tettigonidae). He began by showing an excellent film of tegminal stridulation, whereby sound is produced during closing of the wings. Katydids are masters of this and the size of different parts of the wings determines the sound. Detection is via tympana, which are protected by pinnae, and acoustic tracheae in the front legs. Katydid 'ears' have been found in the fossil record in species including *Eomortoniellus handlirschi*. Through modelling wing biomechanics, acoustic tracheae and resonance of the pinnae, Charlie deduced that a 30 kHz sound was produced.

Figure 4. Home-reared *Stethophyma grossum* (Large Marsh Grasshopper) destined for release in Norfolk. Photo: Stuart Green

Bioacoustics were also the focus of Lewis Holmes (University of Lincoln), but this time in extant katydids from the Central Cordillera cloud forest of Colombia. His aim was to resolve the taxonomic status of *Gnathoclita sodalis*, the only highland species in the genus, which shares more morphological features with the genus *Trichotettix*. Using morphometrics and measuring the resonance of the tegmina, he deduced that *G. solidalis* should be placed in a new sister genus to *Trichotettix*, which was named *Satizabalus* after Lewis's colleague Martin Satizabal. Two other hitherto unclassified species were placed in the same genus (*S. satizabali* (Fig. 3) and S. *huaca*).

No Orthoptera SIG would be complete without an update from Stuart Green (Citizen Zoo) on the reintroduction of *Stethophyma grossum* (Large Marsh Grasshopper) (Fig. 4) to East Anglia. The project has been running for six years. In 2023, a record number of 1,459 releases were made from grasshoppers reared at home by 'citizen keepers'. Field surveys have shown populations to be doing well, with a proliferation at one site in particular, where Stuart thinks that the population is probably self-sustaining. Mating pairs have been seen in the field but, so far, no egg laying has been observed.

Peter Sutton (Orthoptera and Allied Insects Recording Scheme of Britain and Ireland) reflected on distribution changes of a range of species in Britain and Ireland, and the possible influence of climate change. Some species such as *Roeseliana roeselii* (Roesel's Bush-cricket), *Chorthippus albomarginatus* (Lesser Marsh Grasshopper), *Tettigonia viridissima* (Great Green Bush-cricket) (Fig. 5),

Figure 5. *Tettigonia viridissima* (Great Green Bush-cricket). Photo: Peter Sutton

Conocephalus dorsalis (Short-winged Cone-head) and *C. fuscus* (Long-winged Cone-head) are expanding their ranges, but *Omocestus viridulus* (Common Green Grasshopper), which requires damp conditions for its eggs, has been lost from the midlands southwards because humid grassland habitats are gradually drying out. A similar fate has befallen *S. grossum* in Somerset and Ireland and this is related to peat cutting. Remarkably, a large population has become re-established in Somerset in non-typical habitat. Five new species, mostly through natural immigration, have become naturalised in recent years. These include the Mediterranean species *Phaneroptera nana* (Southern Sickle-bearing Bush-cricket) (Fig. 6) along the River Thames in Essex. Peter suspects that there will be more.

Finally, John Paul reflected on half a century's interest in Orthoptera. He met David Ragge at the very first Orthopterists' meeting (which became the Orthoptera SIG) in 1979 and was inspired to help him by obtaining specimens from Europe (Fig. 7). John later became a medical microbiologist. His job took him to Nairobi, providing him with the opportunity to broaden his orthopteroid ambit. Three specimens from those days remain unidentified. He moved to Sussex, where he became County recorder, focussing on monitoring the spread of new arrivals. Currently he lives in Oxford and was surprised not to re-find *O. viridulus* where it used to occur, although its absence was partly made up for by the arrival of *Stenobothrus lineatus* (Stripe-winged Grasshopper). John speculates that whole genome sequencing may have the potential to unravel a number of issues regarding our Orthoptera fauna.

Three excellent posters were presented. Sophia Laskri (University of Lincoln) showed how to determine wing resonance in preserved crickets. Jon Delf (University of Liverpool) presented observations of egg-laying in three species of captive-bred phaneropterine tettigonids, and brought some live specimens along, and Charlie Woodrow elaborated on his lecture on auditory tuning to conspecific acoustic signals in *E. handlirschi*.

Many participants enjoyed further conversation and libations at the traditional post-meeting evening meal.

Many thanks to organisers Darron Cullen (University of Hull), Ed Baker (Natural History Museum) and Judith Marshall (Natural History Museum), all presenters and their co-authors, all participants and the RES team for yet another excellent meeting.

Figure 6. Male *Phaneroptera nana* (Southern Sickle-bearing Bush-cricket). Photo: Peter Sutton

Figure 7. *Barbitistes fischeri*, Alpilles, France. Photo: John Paul

Forest Invertebrate News

A revamped Special Interest Group

Daegan Inward, Brenden Beckett, Talor Whitham, Kirsty Godsman and Abi Enston
(Convenors, Forest Invertebrates Special Interest Group)

New year, new Special Interest Group? We've a new name, new convenors, and a new regular article in *Antenna* (you're reading it)! If you're interested in forests, trees, and their associated invertebrates, we'd love for you to join us, either by contributing a short piece for 'Forest Invertebrate News', as Aoife Crowe has done this time, or by joining us at a new-format Special Interest Group meeting this year.

"FISIG 24" takes place **online** on the **2nd May 2024**, and will look at challenges faced by forest invertebrates and possible solutions. The meeting aims to bring together academics and amateurs, industry and forest practitioners, and entomologists of any 'life stage' or nationality. Join us to consider issues faced by UK and international forest invertebrates, and help guide the conversation on what the next steps could be. We are welcoming abstracts and ideas for either 15-minute presentations or 5-minute informal 'invertebrate updates'. Details are available on the RES events webpage. We look forward to hearing from you!

What? Why? How? Conserving saproxylic beetles

Aoife Crowe
Irish Research Council PhD Candidate, School of Natural Sciences, Applied Ecology Unit, University of Galway, Ireland. aoifejanecrowe@gmail.com

Saproxylic beetles are a functional group found across multiple taxonomic families, with life strategies dependent upon woody substrates. These beetles use such material for shelter, breeding sites, larval development and food; the larvae tunnel through the wood creating feeding 'galleries' (Fig. 1). Saproxylic beetles are ecologically important as they make up a large proportion of the forest insects found in Europe. They bring balance and ecosystem engineering to healthy, woody habitats through the provision of beneficial ecosystem services, including pollination, deadwood decomposition, nutrient cycling and prey provision. Saproxylic beetle populations are steadily declining across Europe, and many species are threatened with extinction due to the changes in, and loss of, their natural woody habitats. Activities such as logging, wood harvesting and replacement of native and broadleaved woodlands with conifer monocultures, are all thought to be negatively impacting the group. Lack of knowledge regarding their ecological requirements and conservation status further threatens their protection. Given their status, mitigating further declines is imperative and measures to help can be taken by those who own or manage woody habitats. The range of important habitats includes woodlands, forests, parklands, hedgerows, gardens and other urban green spaces.

Mitigation Measures

Habitat management – Find suitable alternatives where possible to pesticides and fungicides. Generally, a higher abundance and diversity of beetles are found in less intensively managed habitats, though some species benefit from light management. Overall, non-intervention or less intensive management techniques are advised.

Increased awareness – We should increase research and knowledge and share these findings with more diverse audiences, to determine important habitats, environmental requirements, and management techniques beneficial to saproxylic beetle conservation.

Habitat provision – Conserve and promote native broadleaf woodlands, particularly ancient woodlands and historic estates, which protect diverse woody microhabitats (Fig. 2). This can be helped with generally increased diversity of the flora present. Umbellifers are particularly important for shelter and food resources.

Figure 1. Larval feeding gallery in decaying woody debris. Photo: Aoife Crowe

Light – Many saproxylic species benefit from the provision of open areas within their habitats. These can be provided through mutually beneficial access rides and glades.

Deadwood – Maintaining natural deadwood found within the environment, including the diversity, continuity and connectedness of these resources across the landscape would help these species as well as many others. Different deadwood types (*e.g.*, dead trees, snags, stumps, fallen branches/logs) and conditions (*e.g.*, some pieces under open, light locations versus others in shaded, moist areas) would be a great starting point.

Veteran Trees – Retain veteran trees and their associated old-growth microhabitats, whilst allowing some younger, native trees to age.

Figure 2. *Rhagium bifasciatum* utilise a wide range of broadleaf and coniferous host material. Photo: Aoife Crowe

Monthly Evening Meeting

Insect conservation: From data to action

Úna FitzPatrick
National Biodiversity Data Centre, Ireland

Report by Richard Harrington

Úna FitzPatrick in the field.

For the final lecture of the year in the evening online series, it was a true delight to listen to the joint winner of the Society's 2022 Award for Insect Conservation (see *Antenna* 46(3) 157), Úna FitzPatrick. It quickly became obvious that she was a very worthy recipient of that award. She is passionate about insects, especially bees, and extra-especially Large Carder Bee (*Bombus muscorum*), for which Ireland is a stronghold. Her mission is to assemble data and use them to drive conservation.

Ireland is home to around 31,500 species, 11,422 of which are insects, 101 of which are wild bees. 20% of all plant and animal species are threatened with extinction, and of 117 habitat types, only 15% are in a good state. Against this background, the need for well-informed conservation action is clear and Úna is pioneering a data-based approach involving professionals and citizen scientists. In 2007, Úna helped establish the National Biodiversity Data Centre (NBDC) (www.biodiversityireland.ie), where she is now Senior Ecologist.

An important aspect of data collection is capacity building, and the NBDC offers a range of resources, courses and events, both online and in-person. Records are submitted online and validated before loading. There are now 2,114 records for *B. muscorum* from 220 recorders. In 2012, the NBDC, led by Úna, launched the All-Ireland Bumblebee Monitoring Scheme to collect abundance data to add to the presence/absence data already being gathered. These data suggest that *B. muscorum* is in strong decline, and the Common Carder Bee (*B. pascuorum*) in moderate decline, which came as a surprise. In 2022, the National Pollinator Monitoring Scheme was launched to broaden the range of species studied. So far, 36 sites have been surveyed, the target being 50. Professional surveyors are paid £250 per day.

From all this work, two All-Ireland Pollinator Plans have been produced, one covering 2015–2020, the other 2021–2025. The first was developed without funding and had 81 actions. The second was supported by government and had 186 actions. The objectives were to make farmland, public land and private land pollinator friendly, to produce an all-Ireland Honeybee strategy, to conserve rare pollinators and to ensure strategic coordination of the plan. Schools, businesses, sports clubs, residents' associations, faith communities *etc*., have come on board, recognising that many small actions lead to big impacts. Since 2015, 100% of Councils have become partners, parks have become pollinator-friendly through the Green Flag award, local communities have become pollinator friendly through a special pollinator award, schools have become pollinator friendly, a research project has created an evidence-based pollinator-score for farms, 400 businesses have become supporters, all leading to more and more people engaging with nature.

The ultimate indicator of success is the reversal of losses of wild pollinators. It is too soon to know if this is happening, but signs are good, especially at a local level. For example, Bee Orchids are increasing, and it is hence highly likely that other less conspicuous plants and their associated insects are too.

A lively Q&A session followed Úna's inspiring talk, and covered topics such as international collaboration, climate change, methods for engaging the public, causes of decline, and future funding.

Úna's passion for insects and the translation of data into practical conservation outcomes is infectious, and it is very much hoped that the NBDC will be supported for decades to come, for the longer and larger a dataset, the more useful it becomes.

Many thanks to Úna and to RES staff for a hugely interesting and enjoyable evening.

Bombus muscorum. Photo: Ciaran Taylor

XII European Congress of Entomology (ECE) 2023

Francisca Sconce
RES Senior Outreach & Learning Officer

ECE2023 took place at the Cultural Conference Centre in Heraklion, Crete, Greece from 16th to 20th October 2023, with over 900 delegates attending. The RES was a silver sponsor of the event, with an exhibition stand supported by RES staff promoting our journals and membership options, and the RES logo displayed on delegate lanyards.

We enjoyed meeting entomologists from all over the world, including Members and Fellows supported by the Conference Participation Fund grant such as Prof. Shashikant Udikeri, and RES journal editors who were invited for a dinner with Head of Publishing Emilie Aimé. Luke Tilley and Simon Ward were invited to a meeting of 12 entomological societies from around the world, to compare their approaches and share future priorities.

RES staff also contributed to the conference proceedings. Luke Tilley chaired a session on *Biodiversity and Conservation – Threats and Awareness* and presented a talk *Grand Challenges in Entomology: Priorities and Actions for the Future*. Fran Sconce presented a poster *Bringing Insects to New Audiences* about RES outreach activities and made useful contacts with others working on similar projects around Europe.

Elsewhere in Heraklion town we enjoyed spotting insect-related objects at the Archaeological Museum of Heraklion and insect-inspired street art.

Fran Sconce with ECE 2023 Poster.

Heraklion Cultural Conference Centre street art.

The meeting of 12 entomological societies from around the world.

RES team and Conference Participation Fund grant recipient: Anne Weinhold, Emilie Aimé, Fran Sconce, Prof. Shashikant Udikeri, Luke Tilley and Simon Ward.

The RES at Entomology 2023 – Entomological Society of America (ESA)

Anne Weinhold
RES Business Development Manager

This year's ESA meeting took place at the Gaylord Conference Centre in National Harbor, Maryland, from 5th to 8th November, with 3,600 delegates. We ran an exhibition stand alongside more than thirty other exhibitors, promoting our journals and membership options whilst offering a chance to chat about our research funding offers and other significant contributions the Society makes to global insect science.

We enjoyed meeting entomologists from across the United States and beyond, and had a productive meeting and evening event with the ESA team, exchanging ideas and opportunities to support the entomological community both as separate institutions and in a network of global entomological societies. We enjoyed being present at the handing over of the ESA Presidency from Dr Marianne Alleyne to Jennifer A. Henke. Our CEO, Simon Ward, also joined the inaugural meeting of the new ESA President, meeting some of the funders and partners of the ESA. RES journal editors joined our Head of Publishing, Emilie Aimé, for dinner in National Harbor, where we had the opportunity to offer our thanks to everyone supporting our global publications.

During the conference, Luke Tilley presented at the *Insect Biodiversity Loss: Empowering People and Policymakers to Address the Growing Challenge* Program Symposium session, speaking about *Biodiversity snapshot: Europe and UK Parliament's response*.

This year's ESA participation also proved useful for our Business Development & Fundraising Manager, Anne Weinhold, who forged links with some of the corporate exhibitors whilst making connections with the ESA Events and Sponsorships team. There was consensus that working together more closely in future will benefit both Societies and the entomological community as a whole.

Gaylord Conference Centre in National Harbor, Maryland.

RES exhibition stand.

Maryland.

HONORARY FELLOW INTERVIEW

Stuart Reynolds

The holistic entomologist

The Verrall Supper is always a gloriously chaotic evening where entomologists from across the UK mingle with each other, randomly encountering old friends and new faces. This social melee is a cauldron of nostalgia, new contacts, the exchange of ideas, and future plans. Plus of course much revelry. It was in this heady atmosphere that Stuart and I bumped into each other, as we always do. Not that we don't see each other around Bath, where we are distant neighbours. But there, in the convivial atmosphere of the Verrall, we agreed a plan for this interview later that year.

So, on a glorious June afternoon my wife and I drove through the pastoral landscape of north Somerset to visit Stuart, having received an invitation to lunch with him and his wife Jo. The turning off the road is easily missed, and we did. Back-tracking, we carefully negotiated the narrow lane to the farm on which Stuart lives and pulled up alongside a hedge of roses in full glorious bloom, a blaze of crimson and pink, the long, low house nestled behind it. Jo answered the door and invited us through to the kitchen, where lunch was being prepared. Stuart then ushered us out into the garden where a table was laid in the shade of a large Dawn Redwood tree (*Metasequoia glyptostroboides*), a sun-dappled idyll in a lazy summer meadow. Jo set a feast upon the table and we settled down to an afternoon of fine food and easy conversation.

Early Life

"I was born in 1949 in Bradford in Yorkshire, where my maternal grandfather had a baker's shop in which my mother worked. My father worked at the Electricity Board as a motor mechanic. But with my grandfather's retirement we all moved to Blackpool where my mother opened a small boarding house, and my father went to work at the Gas Board. I enjoyed playing on the wonderful sandy beach which was close to our house; although mostly interested in sandcastle engineering, I was there introduced to a range of interesting invertebrates. My father was a great influence; one of my earliest memories was of him building a TV from scratch, inspired by an electronics magazine. He built it so that our family could watch the coronation of Queen Elizabeth II; of course, all the neighbours came round too! He always wanted to do everything himself and was convinced that there was nothing he could not do. I am afraid that I have inherited both his sometimes inappropriately optimistic self-belief

and his inability to delegate. I don't think that natural history was a big influence on my childhood. I greatly enjoyed family excursions to the Pennines, but it was the landscape that I enjoyed. At that time, fauna and flora mostly failed to register. Later, as a teenager I became interested in gardening; this was perhaps inevitable as my Essex grandfather and great uncle had been keen gardeners, who won all of the prizes at the local flower show (I still have some of their medals and cups)."

School

"I attended the Beach Road Primary School in Cleveleys, where fifty or more children in a class were taught by a single teacher (this was the baby boomer generation). The teachers were very strict and corporal punishment was frequent. This almost Dickensian approach kept order, it's true, but it was more than a bit inhibiting to our creativity and self-belief. At the age of seven we children were divided into those who might later gain entrance to grammar school and those who would certainly not. I was lucky to be in the former group and was intensively schooled in the 11-plus exam. At Beach Road, I was never one of the really clever children as I wasn't good at concentrating on one thing at a time, something that has dogged me all my life. But, I have always thought it is a great merit to be interested in everything all at once. Everything changed quite suddenly when in 1960 I arrived at Baines Grammar School, an all-boys' school in the nearby town of Poulton-le-Fylde. In this excellent school the teachers were kind, interested and offered opportunities. In this environment I discovered to my astonishment that I was brighter than I or my previous teachers had realised. I also learned to concentrate a bit more on the matter in hand. So, did grammar school foster my interest in natural history? Yes, it did. For example, it was at this time that I was first introduced to wildflower identification by my biology teacher. But Baines' also stimulated my interest in a wide range of scholarly topics. At the age of 13 we had to choose between the arts and sciences, and I had no hesitation in choosing the science route. I found both biology and chemistry fascinating. Physics was interesting too, but I was aware from early on

Stuart, *circa* 1953 at the seaside – probably at Fleetwood.

that my maths was not good enough to do it well. When I was 15, to my surprise, I was included among a small group of boys who were thought to show promise; we were removed from normal classes to be coached for a reduced range of O-level examinations, proceeding directly to the sixth form to take our A-level exams a year early. This allowed us to spend a post-A-level year being coached for the Oxford or Cambridge entrance exams. I applied to Selwyn College, Cambridge but my performance in the exams was uneven; despite this, I was given an interview at which I was told that the college would offer me a place because they liked my ability to think laterally. How things have changed! Such a cavalier approach to assessment would be unthinkable today. I had evidently impressed the examiners in the general paper, so perhaps my interest in almost everything had paid off."

University

"At Cambridge, I read for the Natural Sciences Tripos, in the first year choosing to study courses in Physiology, Biology of Cells, and Chemistry. Additionally, I could not escape a special course in mathematics for biologists, which I must admit taught me the importance of statistics and modelling. My very first lecture was on quantum chemistry. It was almost incomprehensible but wonderfully inspiring. The emphasis throughout was on first principles and the evidence that backs up theory. Actual knowledge of 'facts' was less important. In the second year I continued with Physiology and embarked on Biochemistry, but by taking a course in Zoology, I discovered that animals were what really interested me, insects being best of all. This led me to choose to specialise in Zoology in the final year of my degree. At that time the emphasis in the Zoology

Department was on the doctrine of the Danish physiologist August Krogh, who asserted that for every physiological problem there is an animal that is best suited for research. Insects were prominent among such model organisms. Cambridge teaching, then as now, depended heavily on small group tutorials called 'supervisions'. I received personal tuition on a weekly basis in all of my subjects, and worked incredibly hard, doing chemistry and maths problems and writing essays in physiology and cell biology every week. I was exceptionally fortunate that my supervisor for cell biology, and then zoology was Simon Maddrell, a most inspiring teacher. I got on with him well and at the end of the second year he offered me a job as research assistant in his lab over the summer break. I accepted and did pharmacological experiments on the excretory physiology of the blood-feeding hemipteran, *Rhodnius prolixus*. I realised that I could actually do real research; it wasn't something remote but was now within my grasp. I decided this was what I wanted to do and that I would do it with insects. I must have made a reasonable job of it, because Simon offered to take me on as a research student once I had graduated, and of course I accepted."

PhD

"From 1970–1973, I was a research student in the Cambridge Zoology Department, working within the Agricultural Research Council (ARC) Unit of Invertebrate Chemistry and Physiology. Founded by Sir Vincent Wigglesworth, but by then led by John Treherne, this was an exciting place to study insects. My research, which was at least initially supposed to be about insecticide mode of action, was funded in part by Shell Research. At the time, Simon was working on how the chemical insecticides of the day, almost all of which were neurotoxic, kill insects. This wasn't (and still isn't) a trivial question. Disrupting nerve function causes a poisoned insect to be uncoordinated, even paralysed, but there is no obvious reason why that should actually kill it. Unlike vertebrate animals, insects don't need to actively breathe to obtain oxygen. Working with John Casida, an insecticide chemist from Berkeley, California, Simon had shown that insecticide poisoning

Stuart, *circa* 1970.

caused a massive and untimely release of diuretic hormones. The poisoned insects became dehydrated, literally peeing themselves to death. Maddrell and Casida hypothesised that the insecticide disrupts the insect's hormonal environment, all its neurohormones being dumped into the haemolymph together. My job was to test this idea. Simon and I worked together on this in my first year and in 1972 we published a paper in *Nature* demonstrating that insecticide poisoning was indeed accompanied by the simultaneous release of multiple neurohormones. Having achieved this goal, I had to decide what to do with the remaining two years. I tried to make neurophysiological recordings from the insect's brain while it was being poisoned but this proved to be far too ambitious. But my work on insecticide poisoning had exploited the fact that when *Rhodnius* feeds, it softens its abdominal cuticle, allowing the insect to expand to accommodate the blood meal. This is necessary because the bug takes huge blood meals up to ten times its own weight from its host. This process, known as cuticle plasticisation, is regulated by the neurotransmitter serotonin, released from abdominal nerve endings. I now devised a new simple technique to measure the extensibility of loops of abdominal cuticle and used it to speed up my experiments and to characterise the mechanical properties of the softened cuticle (it was lucky that I had studied physics at school!). I wanted to know how the process worked at the molecular level. Using serotonin, I could induce plasticisation under experimental conditions and showed that the integument's epidermal cells pump hydrogen ions into the overlying cuticle, thus loosening the weak secondary bonds that hold its structural proteins together, making it soft and floppy. I went on to show that plasticisation also occurs during moulting. It was at this time that I met Jo, a nurse who had come to Cambridge from London's Middlesex Hospital to study midwifery. Like many nurses, she was (and still is) tough-minded and independent but incredibly generous. She also owned a car! I was very impressed. We met at a Shrove Tuesday pancake party thrown by a friend at Selwyn, and pancakes have never seemed the same (we celebrate with a pancake day feast every year). Jo and I married in 1973, just as I was finishing my PhD. She has been a tremendous support when the scientific going got tough. She and

our three children, together with four grandchildren, continue to be at the centre of my life."

Bristol and Seattle

"I realised that if I wanted to pursue my interest in cuticle, I needed to know more about its structure and chemistry. I had attended a wonderful lecture by Charles Neville at Oxford on cuticle structure, so I thought I should go and work with him. Neville had just moved to Bristol University, so I applied for money to work with him there; I was lucky and was awarded a personal postdoctoral Fellowship from the Science Research Council. I liked Bristol very much, but my research there was not entirely successful. In that pre-genomics age, I knew almost nothing about the proteins of the cuticle, and my hypothesis that plasticisation was due to changes in the strength of intermolecular forces between them was not susceptible to a proper test using the techniques available at that time. I decided that to understand plasticisation, I needed to concentrate on moulting. I travelled from Bristol to Cambridge to hear a talk by the visiting American scientist Jim Truman, who at that time was the brightest rising star of insect physiology, and who had just discovered that the adult ecdysis of moths was controlled by a previously unknown hormone, Eclosion Hormone (EH). I asked Jim if I could work with him at his new laboratory in Seattle, Washington. He said "yes", but I would need to find my own funding. I was fortunate to be awarded a Harkness Fellowship to travel to the US. Once again, I had my own funds, with the advantage that I could act independently. Jim was very good and supported me unstintingly to follow my own ideas. The Harkness Fellowship also came with funds for twelve weeks travel around the US to spread European goodwill. So, Jo and I bought a car (a two-door '66 Dodge Dart, an American classic), and we travelled around the national parks of the western USA, where we camped out; this turned out to be a great way to meet Americans. We travelled by train to go to the East Coast, where I visited the great Carroll Williams at Harvard, and attended the memorable 1976 International Congress of Entomology in Washington DC. My work in the Truman lab went well. I found that

Stuart in Bath from about 1980.

EH not only triggered ecdysis behaviour during the emergence of adult moths, but also controlled plasticisation of the wings during their inflation. I felt that I had made an important contribution to understanding the complex integrative physiology of insect ecdysis and subsequently wrote a review on the topic for *Advances in Insect Physiology* that is still cited today."

Return to the UK and Bath

"It was a condition of my Harkness funding that I returned to the UK at the end of my Fellowship. So, I needed to obtain a university job. This was worrying as the British economy was then in poor shape and University positions were scarce. Halfway through my time in Seattle, Jo and I came back home to attend a family wedding, combining this with job-hunting visits to various universities, but no one seemed to be interested. Providentially, only a few weeks after our final return to the UK I was offered a lectureship in the School of Biological Sciences at the University of Bath, which I of course accepted. Jo and I had friends and family in Bath, and we looked forward to making our permanent home in that beautiful city where I joined the Animal Physiology and Ecology Group.

At Bath my research examined many different insect subjects from feeding through to moulting and metamorphosis. This probably

Stuart and Jo in their garden.

excessively wide spread of topics acquired greater focus as I became intrigued by the idea that the adaptations of insect parasites and pathogens shone a bright light on the insect immune system. This research was always collaborative with Bath colleagues, at first with Keith Charnley, who studied insect pathogenic fungi, and then later with Richard ffrench-Constant. For almost a decade Richard and I worked together on the fascinating luminescent bacterium *Photorhabdus*, which is vectored from insect to insect through its coevolved partner nematode, *Heterorhabditis*. Richard is always full of ideas, and I have enjoyed working with him a lot. He remains my most frequent co-author. But being a University academic involves more than just research. I have always regarded teaching as the job's core responsibility, and I can honestly say that the best thing about my time at Bath has been the wonderful students that I taught there. The shocking truth for *Antenna* readers is that during my 34 years at Bath, I taught very little entomology. When I joined, there were several existing members of staff who already covered this subject, so instead I taught mammalian physiology. I think that gave me a much wider personal view of what is important about insects. Later on, I developed a new course on insect–plant interactions, but even here the emphasis was on ecology and evolution rather than the insects themselves. My interest in everything about insects widened still further when I got involved in scientific publishing as an editor. I was asked to join the Editorial Boards of both the *Journal of Insect Physiology* (*JIP*) and the *Journal of Experimental Biology* and in 1999 I was appointed joint executive editor of *JIP* with David Denlinger. I stopped doing this when I retired but I'm still on the Editorial Board of *Current Opinion in Insect Science*. Later, organisational changes resulted in the formation of a single Biology and Biochemistry Department, of which I acted as Head of Department during 1997-2000; this was quite stressful, but I hope I did a reasonable job."

The Royal Entomological Society

"I joined the Society as a Fellow in 1974 as a young postdoc, just publishing my first scientific papers. Incredibly, that's 50 years ago! I learned much from being a member of Council in 1980–1982 (there were long discussions about the design of the Society tie). The RES was then based at Queen's Gate in South Kensington, with its strikingly ornamented subterranean lecture room and a line of photographic portraits of previous presidents all the way up the staircase. Monthly meetings were preceded by tea and biscuits (and sometimes sherry) in the library. Like many RES Fellows, I liked the old ways, but I think it was right for the Society to move away from London in 2007 and to take on a much wider national and international role.

In 2006, with Glenda Orledge, I organised the ENTO'06 meeting at Bath and after that I became more

and more involved with the Society. I was President from 2010 to 2012, and I have since been a member of both the Meetings and Membership Committees. I suppose that the high point of my involvement with the RES was my role as the main organiser for the RES of the European Congress of Entomology at York in 2014. It was a terrific meeting and I felt proud of what had been achieved. I am a fan of the reorganisation that has taken place in the Society in recent years and feel that it is now a far more representative and responsible organisation than it was, but I think that it's still not as responsive as it could be. I believe that as a body representing both professional and serious amateur entomologists, the RES has a duty to be a leader in policy matters. Right now, we humans are standing on the edge of an environmental precipice. Declines in insect populations are one of the most obvious manifestations of this ecological crisis and monitoring them is a good way to monitor the state of the nation's wildlife. I don't feel that the Society is yet doing enough to push that role. The collaboration with RHS at the Chelsea Flower Show was a great start, but the RES needs to be seen more often in the media, raising the profile of insect declines and their implications. It needs to interact more with decision-makers and opinion-formers as well as the general public. The Society needs a set of agreed policies ready to be applied to incoming enquiries about events in the news, and a register of expertise allowing the right people to engage with the media when enquiries come in."

Stuart with Rex the cat.

Facing the crisis

"I'm deeply concerned about the flawed current relationship between humans and the natural world. Our politicians seem to have no proper conception of human dependence on the Earth system and the rest of the biosphere; I don't think that they understand the terrible predicament that we are in. Without action soon, it won't be possible to avoid catastrophic climate disruption both to human lives and the rest of the biosphere on which we depend. Making a proper contribution to the necessary transition to a zero net carbon economy isn't only about personal lifestyle choices but also ensuring that elected representatives realise the urgency of the situation. As an educator, I'm aware that I have a special responsibility to pass on this message, and my teaching activity in recent years has been devoted to that. The environmental crisis clearly requires interdisciplinary science, yet in most universities in the UK there are relatively few interdisciplinary departments or even research groups, and science degree programmes that truly cross disciplinary boundaries can be counted in single figures. Academia is riddled with intellectual silos and this needs to change."

Coda

Our conversation showed no sign of slowing down, so as space in *Antenna* is limited, we had another glass of wine and meandered around the garden and orchard. Stuart was one of the few RES presidents to write a regular column for *Antenna* while he was in office and continues to write his *Research Spotlight* column today, demonstrating his breadth of interest and depth of knowledge. His address to the Ento12 meeting at Cambridge epitomised his 'everything all at once' approach, where he summarised the development and role of entomology over the reign of Elizabeth II, a talk that he subsequently produced as an article in *Antenna*. Our conversation had ranged far and wide with Jo interjecting on a regular basis to correct Stuart's sense of modesty. His wide range of interests keeps him involved with several of the Society's committees where he continues to offer his unique and often controversial perspective on the way the society is run. Stuart is also an active member of another Royal Society, the Bath Royal Literary and Scientific Institution, which runs an enviable series of public lectures at their base in Queen's Square, Bath. Here Stuart is convenor of the Science team that organises talks from across the entire scientific spectrum, and of a new Sustainability Group. Stuart's inability to concentrate on just one thing has indeed proven to be of great merit. So, we hope that 'everything everywhere all at once' is a mantra that will continue to drive him to deliver yet more holistic interpretations of the natural world through the lens of entomology.

Peter Smithers

Apoderus coryli (Linnaeus 1758). Michael Darby Dec 2011.

The Beetles: On the road again and coming to venue near you

Peter Smithers

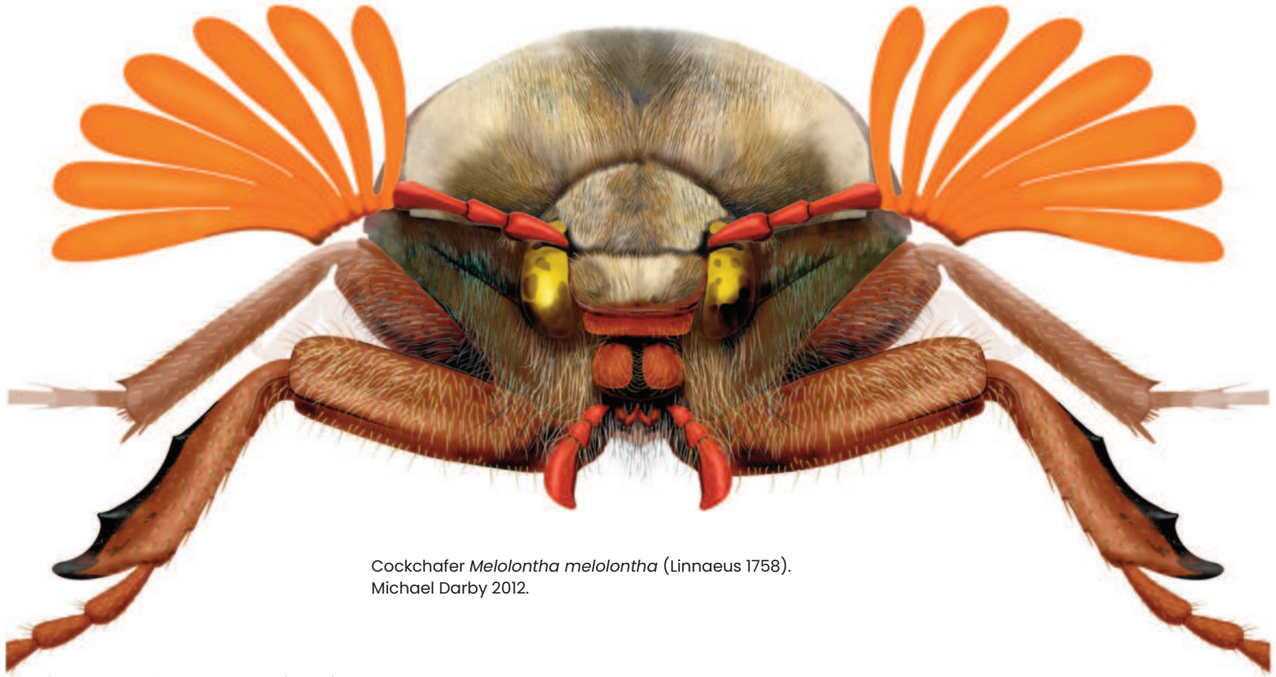
Michael Darby.

Michael Darby's exhibition *Facing up to Beetles* has been delighting audiences across the UK for the past ten years. These vast and vibrant images have fascinated numerous viewers, offering them encounters with a carnival of coleopteran characters. Face to face with some of our most charismatic beetles, the images dwarf the viewer and provide an intimate insight into the complexity and beauty of our beetle fauna. The images are incredibly detailed, and viewers often find it hard to believe that they are actually drawings, but it is this level of detail that makes these portraits so powerful. They are quite literally in your face.

The exhibition has awakened in all ages, a fascination with beetles, insects and the wider natural world, all speaking enthusiastically of their interaction with these portraits. But it is not just faces. Michael has also produced a series of A4 information cards to accompany the images; cards that range over topics such as diversity, size, colour & morphology, habitat indicators and association with plants. The exhibition also features a series of information panels that I rescued from Plymouth City Museum just prior to the rebuilding of their natural history gallery (storage was in short supply and they were destined for a skip). These A0 panels were from an exhibition *BeetleMania* that had run at the museum some years previously (*Antenna* **37**(1), 20–26), and cover beetles in culture, anatomy, literature, natural history books, life cycle, conservation and art. The exhibition is also an opportunity to blend the images with material held by the host venue as the Bath Royal Literary and Scientific Institution did in Bath, using material from their own insect collections and rare-book archive.

Facing up to Beetles came about when Michael entered a single drawing of a Ptiliid beetle in the art section of his local flower show. He was not surprised when he failed to win a prize but was very surprised

The beetles at RBLSI.



Cockchafer *Melolontha melolontha* (Linnaeus 1758).
Michael Darby 2012.

Facing up to Beetles, a brief history

2011–2012
Michael produced the images (see the box for technical details of how).

2012
Facing up to Beetles runs over the summer in Salisbury Library.

2013
I persuaded Michael to offer the images as part of the York Insect Festival where they went on show for a month in Victor J's Art Café. Later that year I interviewed Michael at his Wiltshire home and the article appeared in *Antenna* **38**(1), 39–40.

2014
The Beetles were exhibited in the Sherwell Gallery at Plymouth University where they were resident for two months.

2014–2016
Following discussions with Dave Clark (curator of the insect houses at London Zoo), I arranged for the exhibition to travel to the Zoo, where they were initially on show in the Insect House and then in the Zoo's café. They remained at London Zoo for the next two years.

2016
On their return to Plymouth University, Michael very generously donated the images to the Department of Biological Sciences. The larger images were then installed in meeting rooms around the department while the smaller ones went into storage. Michael sent me the files for all of the images and text panels in case any were damaged and gave permission to use them in any way I could to promote a wider interest in beetles.

Michael had also sent the files to Caroline Chaboo at the University of Nebraska–Lincoln, USA. Caroline then organised for the images to tour state museums and schools across Kansas often with other artworks to promote a better understanding of the natural world. A project that is still running.

2019
I liberated the remaining eight images from storage (with the HOD's consent) in order to show them in Bristol where they spent the summer at Bristol University's Botanic Gardens. They were then moved to the Department of Biological Sciences at Bristol University just as the pandemic hit and remained there until 2023.

2023
Over 2021/22 I had been negotiating with the Bath Royal Literary and Scientific Institution regarding staging the exhibition in their gallery in central Bath, a plan that came together in the autumn of 2022. As there were only eight images available, I applied to the RES Goodman fund for a grant to print the missing images and frame them. This was successful and 18 images were exhibited during March 2023.

I had also been talking to Sarah Beynon at the Bug Farm in St Davids regarding the possibility of showing the exhibition there and Sarah agreed to have the beetles for the summer. To my delight Sarah asked if she could retain the exhibition until Easter 2024.

when the next day the curator of Salisbury Library and Art Gallery phoned him asking if he would like to put on an exhibition of his work in their new gallery. With only one image, he initially turned the offer down, but following a conversation with a friend about the lack of natural history in schools he rethought the idea; maybe images of beetles could inspire young minds to take a greater interest in the natural world. He called the curator to say yes and then had 14 months to produce the images, one every three weeks.

What next
Beyond Easter 2024 the exhibition is up for grabs. If you have a suitable space and would like to host *Facing up to Beetles*, let me know. There are no hire fees, it is just up to the next person who would like the exhibition to collect it from the previous venue. If no venue comes forward it will return to RES HQ. If you would like to explore hosting the exhibition, contact me on peter@royensoc.co.uk.

Acknowledgments
I would like to take this opportunity to express my thanks to Michael for his dedication, tenacity, skill and generosity in generating these portraits and then making them available for this grand tour.

Postscript
Sadly, Michael, who was a former Deputy Director at the Victoria and Albert Museum, died in early January. We offer our sincere sympathy to his wife, Lis, and family. Michael was awarded the BENHS Gold Medal last year.

How the images were produced

Now I know you must be thinking, well how did he do it? Did he draw everything out first? What paints, inks, pencils, pens and so on did he use? It's at this point that I have to come clean and admit that pens, paper and paints never went near any of the pictures, they were all drawn using an ordinary desktop PC and PaintShop Pro software. Professional graphics artists use a drawing pad and, although I acquired one, I always found it easier to use the mouse. So, to use an architectural analogy, I suppose you could call my images CAD beetles. The printing was done for me by a local firm which, by coincidence, had just acquired a printer capable of producing a 2 by 1 metre image on a stiff board. This was convenient not just because of the large size but also because 2 by just under 1 is the largest I could get into my Renault Megane estate. Framing materials and acrylic sheet were all purchased online, and the framing itself done on my kitchen table.

The small drawing shown at the village fete was done using a drawing tube attached to the microscope, but that produced rather wobbly lines which needed careful re-drawing for the show and for publication. It was because of the wobbles and time involved in the re-drawing that I turned to the computer instead, and in particular to PaintShop Pro software. The great joy of PaintShop and of the similar but much more expensive Photoshop is that they allow you to work in different layers on the same image, each layer behaving as a separate image and all layers being capable of being amalgamated or deleted or made more or less transparent. So, starting with a photograph and then creating layers over the top I could use the program's many tools to do the drawing. For example, you can select line thickness and colour with the pen tool, and the mouse does the rest. All you have to do is to click on the beginning and end points of the line you want to draw and use the mouse to achieve the right curvature. Other tools control a huge range of artistic effects and allow colours to be graded, or faded, and to hide or reveal other layers. The initial underlying photograph is then deleted, and you have the final image.

A computer also allows tricks. You can, for example, copy and paste individual features, so you only need to draw half a dozen hairs, or pores, before pasting them in wherever you like. For symmetrical images such as many of my beetle faces, you only need draw half of the image and then copy, flip and paste that to the other half. And another important feature is that you can interact with photographs by simply dropping them in where it helps the image.

It is important to understand that what is produced in this way is a vector image, which is completely different from the bitmap image we started with. Vector graphics don't involve pixels but are produced by mathematical formulae, giving them some distinct advantages, in particular, a very small file size. Another big advantage from my point of view was that they could be blown up to any size without loss of quality.

Michael Darby

RES Outreach activities in 2023

Francisca Sconce
RES Senior Outreach & Learning Officer

For British Science Week (10th–19th March 2023), the RES collaborated with Jess Bill at the STEM Ambassador Hub London on an exciting webinar for Key Stage 2 (7–11-year-olds) school groups. Three members of the Outreach Committee, Amma Simon (University of Nottingham), Hayley Jones (RHS) and Liam Crowley (University of Oxford) gave short talks about creating habitats for insects in our green spaces, how we look at the DNA of insects, and the biology of insect pests on crops. Interesting questions then came from the audience including "Can insects talk to each other?", "How fast can bees fly?" and "What inspired you all to study insects?" Eighty-eight schools from England and Wales joined the webinar, reaching an estimated audience of 5,550 students.

British Science Week webinar participants Hayley Jones, Jess Bill, Liam Crowley and Amma Simon.

Insect Week 2023

Insect Week returned with over 200 events around the country in collaboration with partner organisations. A new website for Insect Week (insectweek.org) launched in early 2023, incorporating engaging design, the new Insect Week branding and improved functionality. The Society collaborated with the British Library for a panel event on the evening of 23rd June, *Insects: Small but Perfectly Formed* to accompany the exhibition *Animals: Art, Science and Sound*. Chaired by broadcaster Martha Kearney, panelists included macrophotographer Levon Biss, entomologist and presenter George McGavin and musician and composer Karen Wimhurst.

A fourth issue of INSTAR magazine, for young entomologists was edited by Outreach Committee member Dominique Vassie. This issue included articles about the bacteria in insect stomachs by Awawing Andongma, rhino beetles in Japan by Kumi Oda, fashion in the insect world by Alicia Hayden, and the value of wasps by Joshua Sammy, Vera Kaunath and Gaia Mortier. The magazine has new design and layout to incorporate the new Insect Week colours and branding. The newest issue and previous issues

can be read on the Insect Week website (insectweek.org/learning-resources/instar).

As a flagship event during Insect Week, the Society was pleased to return with an interactive stand to the Big Bang Fair from 21st–23rd June at the NEC, Birmingham. Activities for the estimated audience of 20,000 10-13-year-olds focused on insects and education and career pathways in entomology, in collaboration with Harper Adams University who funded student ambassadors to attend each day, as well as providing fascinating aphids and parasitoid wasps for inspection under the RES microscopes. Stand volunteers included Liam Crowley, Clare Boyes and Catherine Burton. Live insects for visitors to meet include Nuichua stick insects, and Koppert Biological Systems donated a *Bombus terrestris audax* show hive for display.

Interactive stand at New Scientist Live 2023

The Society returned to New Scientist Live, a large science festival on 7th–9th October 2023 at the ExCel London, with an interactive stand that aimed to promote insects and entomology to families, adults and school groups. Volunteers included Wilson Wall, Awawing Andongma and Chris Jeffs, with students Shathuki Perera, Ilyas Levoy and Ben Biddle. We estimated that we engaged with 15,000 visitors over the three days. Live insects for visitors to meet included leaf insects *Phyllium letiranti*. Damian De Marzo at FERA Science Ltd kindly provided *Myzus persicae* aphids, which were displayed under microscopes to demonstrate insects of economic importance and the incredible biology of aphids and related insects. There was also an art table with materials and visitors were encouraged to enter the RES art competition. Insects from the stand featured in *New Scientist* magazine later in October, and Fran Sconce and Ilyas Levoy appeared in a short video *The science of insects* on *New Scientist*'s Instagram reels.

2024

The Society is planning events in 2024 for British Science Week (8th–17th March) and Insect Week (24th–30th June). Do get in touch with Fran Sconce (fran@royensoc.co.uk) if you would like to take part, and look out for volunteer opportunities advertised on the RES website.

Royal Entomological Society Insect Identification Service 2023

Jim Hardie [1]
Andrew Whittington [2]
and Rowland Furse [3]

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[2] FlyEvidence, UK (awhittington@flyevidence.co.uk)
[3] Reckitt, UK (rowland@royensoc.co.uk)

Despite the increase in identification apps, associated image searching possibilities as well as other websites offering assistance in the identification of biological material, the Society's Insect Identification Service continues to offer an attractive and authoritative means of discovering which insects are touching people's lives.

During 2023 we provided 2,399 responses to enquiries sent via the website enquiry form, via headquarters, or directly to us. This was an increase of 10% over 2022.

Monthly responses to insect identification queries during 2023.

Some fine and unusual insects submitted in 2023

Tettigonia viridissima (Great Green Bush-cricket)

(40–55 mm)

This female Great Green Bush-cricket, *Tettigonia viridissima,* was observed laying eggs into the bare soil by Mark Sargeant on a late July evening above Saunton Sands, Devon**.** Eggs are the overwintering stage of this bush-cricket and may hatch the following spring or remain dormant for a number of years. The species is the largest British bush-cricket and lives in grassland, gardens and waste ground. They are predators of other insects but also feed on plant material. This is a stunning insect which is described as local in the very southern areas of Britain but found throughout Europe, North Africa and temperate Asia.

Tettigonia viridissima female. Photo: Mark Sargeant

Nymphes myrmeleonides (Blue Eyes Lacewing eggs)

(1–2 mm)

Michael Hicks sent in this picture of eggs of the Blue Eyes Lacewing, *Nymphes myrmeleonides,* taken by his wife in January near Sydney, Australia. The eggs are laid in a necklace-like arrangement forming two parallel lines with adjacent eggs alternating in orientation and cross-strand eggs extruding anchoring filaments. The distinctive adults have a wingspan up to 11 cm and white wing tips. The larvae build pit traps, similar to antlion larvae, to ensnare their prey.

Nymphes myrmeleonides eggs**.** Photo: S Hicks

***Chrysoperla carnea* (Green Lacewing)** (15 mm)
David Wilson was impressed by this Green Lacewing during late September in Carlisle, Cumbria. This member of the *Chrysoperla carnea* group is a widespread and common resident in the British Isles and the only species to overwinter in the adult stage. In late September, *C. carnea* begins to look for overwintering locations, typically barns and houses and once an overwintering spot is chosen, they frequently turn from this bright green to a grubby olive brown or yellow.
During summer, adults feed on pollen, nectar, honeydew and other sweet fluids, while the larvae are voracious predators of aphids and other small invertebrates and thus are beneficial in gardens and have become available commercially for the biological control of crop pests.

Chrysoperla carnea. Photo: David Wilson

***Sepidium magnum* (Pompadour Beetle)** (29–35 mm)
Jamie Wills photographed this fine beetle in a small valley in a scrub desert west of Hargeisa in Somaliland. Sometimes called Pompadour or Pompadour Helmet Beetles, they are darkling beetles belonging to the family Tenebrionidae. *Sepidium magnum* is one of the largest and is known to occur in Somalia/Somaliland. Unlike most European tenebrionids, they are diurnal.

Sepidium magnum. Photo: Jamie Wills

***Platyrhinus resinosus* (Cramp-ball Fungus Weevil)** (7–15 mm)

This weevil from the family Anthribidae was spotted by James Crawford in ancient woodland near Norfolk. *Platyrhinus resinosus* is associated with the Cramp-ball Fungus, *Daldinia concentrica*, also known as King Alfred's Cakes, which is also seen in this image, and grows on dead trees, particularly Ash. Female weevils lay eggs in the fungus and the larvae later complete development in the wood beneath. The weevil is described as nationally scarce and very local in distribution, but numbers appear to be increasing.

Platyrhinus resinosus on *Daldinia concentrica.* Photo: James Crawford

***Syrrita pipiens* (Hover fly)** (7–11 mm)
A distinctive and abundant species with large hind femora but the only member of its genus present in Britain. This female *Syritta pipiens* was observed in September and photographed by Richard Heyes in his garden in Blackburn. Adults are seen from March to October. The larvae develop in compost, grass cuttings, hay, manure and silage and may occur in large numbers. This is a beneficial species for gardeners, aiding pollination and decomposition, so is a nice addition to any garden.

Syritta pipiens female. Photo: Richard Heyes

***Dioctria linearis* (Small Yellow-legged Robber Fly)** (8–12 mm)
This is a wonderfully clear image of the robber fly, *Dioctria linearis*, taken in June by Mick Cummings near Bingley, Yorkshire. Like other flies in the Asilidae family, *D. linearis* are predators and stalk other flying insects from perches in low herbage and woodland shrubs, especially where there is light shade and dappled light. Its flight period is May to August and the larvae are soil-dwelling predators feeding on other small invertebrates.

Dioctria linearis. Photo: Mick Cummings

***Lycia zonaria* (Belted Beauty female)** (9 mm)
This wingless female geometrid moth was spotted by 9-year-old Isabella in the sand dunes of North Harris in April and submitted by her mother. While there are reports of this nationally scarce species from the northwest coast of England and north Wales, it is mainly seen on the Hebridean islands off the west coast of Scotland. Larval food plants are wide ranging and include Common Bird's-foot Trefoil and Kidney Vetch but also Burnet Rose and Yellow Iris.

Lycia zonaria female. Photo: Louise Graham

Hemaris tityus. Photo: Abi Vedoy

***Hemaris tityus* (Narrow-bordered Bee Hawk-moth)** (20–24 mm)
Described as nationally scarce in the UK but present throughout Europe, this Narrow-bordered Bee Hawk-moth, *Hemaris tityus,* was photographed by Abi Vedoy in late May near Aselund in Norway. These attractive day-flying moths have a single generation per year and the larvae feed on scabious plants.

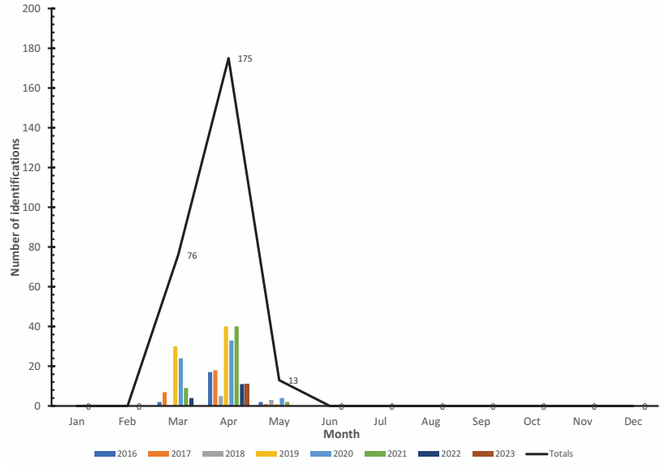
Gasteruption jaculator (10–18 mm plus ovipositor)
There are only five British species in the family Gasteruptiidae. Adult female *Gasteruption jaculator* are elegant, if strange in appearance with an extended neck, long club-shaped abdomen, swollen hind tibiae and a long, white-tipped ovipositor. The adults feed on nectar on flowers, as seen in this image taken in Coventry by Peter Barnes and have a characteristic flight with raised abdomen and ovipositor but dangling legs. The female lays eggs in the nests of solitary bees, particularly yellow-face bees of the genus *Hylaeus*. The wasp larvae feed on stored pollen/nectar provisions and the solitary bee larvae before emerging as adults the following spring. Not surprisingly, females are often reported near bee hotels.

Gasteruption jaculator female. Photo: P.J. Barnes

Bombylius major femlae. Photo: Hannah Khan

The seasonal pattern of queries about *Bombylius major* (Dark-edged Bee-fly) (6–12 mm)
There are nine species of British bee-flies in the family Bombyliidae with five belonging to the genus *Bombylius* and subfamily Bombyliinae. The largest, most widespread, and commonest species in Britain is the Dark-edged Bee-fly, B*ombylius major,* which can be clearly distinguished from its sister species by the wing patterns in the images submitted to the Insect Identification Service. This female *B. major* was photographed by Hannah Khan on her kitchen window in East Suffolk.

Bee-flies resemble bees, particularly bumble bees, in body shape and hairiness as well as in the sound they emit during flight. They can be recognised by the long, rigid proboscis which is always extended in front of the head and used to extract nectar from a variety of flowers whilst hovering, with their tarsi attached to the flower. The



Annual distribution of Dark-edged Bee-fly, *Bombylius major,* identifications per month over 8 years, 2016–2023.

bee-fly life cycle is unusual, and also bee-related, in that the larvae are parasites or predators of bee species. The Dark-edged Bee-fly tends to exploit soil-nesting bees belonging to the genus *Andrena.* Mated females locate host nests, perform a hovering flight and flick eggs towards the entrance. Egg deposition and survival are enhanced by the female coating the eggs with dust/sand, adding both weight and camouflage. When the eggs hatch the bee-fly larvae crawl into the host brood cells where they feed on the stored pollen and the bee larvae.

Bombylius major enquiries over the last eight years occurred over a 3-month period, March through to May, with a peak in April. This phenology closely follows that reported by Dipterists Forum (2023), based on data from iRecord for the years 2018–2021. However, we had no reported sightings in February, with the earliest being March 14th (2020) and March 18th (2019). Our last observations were May 20th (in 2019 and 2020). The 264 individuals reported represented about 1% of submissions to the Insect Identification Service during 2016–2023.

We thank all Members and Fellows who have helped during the year and in particular Liam Crowley, Andy Salisbury, Helmut van Emden, Max Barclay, Judith Marshall, Adam Hart and Tim King.
We continue to receive appreciative comments, increasingly accompanied by donations:

"You are amazing. I spent days trying to find out what it is. Thank you."

"Thank you so much for confirming. I am so relieved. What a great service you offer. Thank you again."

"Thanks very much, my grandson will be fascinated by the answer, as am I. A tremendous service from you."

"Thank you for responding so promptly and for the information. I think you are providing a fantastic service."

"Thanks for the response. Great info to have and very interesting. My children (6 and 3) like insects and will be interested to hear about this. Great to know you offer a source of information for these queries."

"Thanks for your prompt response. Amazed that in this day and age you provide this service free, and I therefore felt the need to make a modest donation to your Society."

"I thank you for your reply and your help. If you can see the amount that is covering the left side of the house you would be astonished. I had sent pictures to pest control companies here on our island and no one could identify them. It was quite distressing. England to the rescue! Thank you." (from Canada)

"Thank you so much for your prompt reply! I was very concerned they were bed bugs. I have made a small donation to the RES as a way of thanks. Keep up the brilliant work!"

Reference

Dipterists Forum (2023) https://dipterists.org.uk/sites/default/files/images/phenology%202022_02_13.PNG (accessed 13/12/2023).

Royal Entomological Society

RES Scholars

The Royal Entomological Society supports three Master's student scholarships every year, following a rigorous application process. This year's winners introduce themselves and explain what the award means to them.

Anne Weinhold (RES), Mia Croft, Fraser Gray, Duran Nanson and Simon Ward (RES).

Duran Nanson

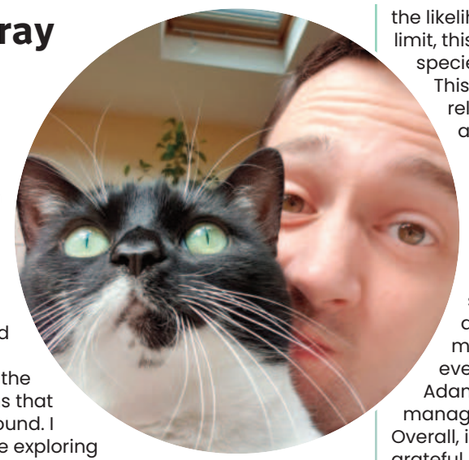
When did your interest in entomology start?
Like many, I had a bit of an affinity for little crawly creatures as a kid, but my interest in entomology didn't really blossom until somewhat later in life. It was actually an animal kingdom/ taxonomy module during my undergraduate degree (in Animal Management) where insects really captured my attention; even though the material only briefly touched upon arthropods, getting that glimpse into how astonishingly vast and diverse the insect world is felt almost magical and otherworldly. It's like that childlike fascination came flooding back and it hasn't left me since!

What aspect of entomology are you most looking forward to learning more about?
I'm really enjoying learning about the diversity and evolution of insects, as I feel like it just builds upon that initial spark of curiosity and fascination that ensnared me in the first place. Delving into the world of behaviour and physiology has been infinitely interesting too; there's really no end to the weird and wonderful habits of insects!

How will the scholarship help you with your studies?
I travel 200 miles each way to attend my modules, as I have commitments tying me down to where I live in the northeast and moving to be closer to the university wasn't really a viable option. The scholarship helps immeasurably with alleviating the costs associated with travel and accommodation, but financial assistance aside, just knowing that the Society supports my peers and I with our studies has really given me a huge boost in morale too. Any time I struggle or feel a little overwhelmed with the workload, that lifts my spirits and gives me the determination to do my best.

What are your future aspirations?
I would absolutely love to be involved in invertebrate conservation, particularly within the UK. We don't necessarily have the flashiest or most striking insects here, so I feel a lot of people tend to overlook them and/or undermine their importance. If I could help even in some small way to shift the public's general perception of insects, then I would really feel like I've made it!

Fraser Gray



When did your interest in entomology start?
My Gran was very interested in the natural world, and she was really engaging when I was young, helping me to find frogs in her pond and showing me the dragonfly nymphs that were whizzing around. I spent a lot of time exploring her garden trying to see what I could find.

I also have a very vivid memory of being 13 years old. It was 2005, winter, I was huddled in a freezing cold conservatory watching *Life in the Undergrowth*. I had never appreciated until that point how diverse our world is. Maybe a cliché but that was when I really fell in love with invertebrates.

What aspect of entomology are you most looking forward to learning more about?
Everything is fascinating and it is difficult to name just one! I recently completed a university project that was focused on Tenebrionidae and dryland habitats. Given the likelihood of us breaching the 1.5°C global warming limit, this family will be an important indicator of how/if species are able to adapt to the changing climate. This is potentially even more interesting given the relatively recent research into some species' ability to consume and process plastics.

How will the scholarship help you with your studies?
I am self-funding the MSc and completing it part-time while working full time. The scholarship has helped to relieve that burden significantly. It has allowed me to take additional time off work when I need to focus on my studies. I have also been able to attend more events, such as visits to the NHM with Harper Adams and to identification workshops. I even managed to save enough for my own microscope! Overall, it has been a huge help and I am incredibly grateful.

What are your future aspirations?
I have another year left of the MSc, so I am mostly focused on doing well with my studies. After that the dream would be a PhD, perhaps in one of the topics I already mentioned. But if nothing else I would really like to contribute to community outreach. I'm sure we have all seen it, but talking with friends and family there is generally (although not always) a feeling of apathy about the state of the world and the species that we share our home with. That is something I find quite difficult so I would like to contribute to helping to bridge the gap between ourselves and nature.

Mia Croft

When did your interest in entomology start?
At five years old I discovered that a buttercup-yellow dress acted as a pan trap for tiny beetles and flies, and this quickly became a favourite garment. I was fascinated by insects at a young age, tracing forest ant networks back to their impressive twig-pile nests in the Oxfordshire woodlands, catching diving beetles in the Thames and observing intricate Mint Moths and plump orb weavers in my mother's herb garden. When my school built a new science block, I designed the enclosed wildlife-friendly courtyard garden at 11 years old, making sure to include lots of foodplants for caterpillars and a pond for freshwater inverts.

What aspect of entomology are you most looking forward to learning more about?
I have been so privileged to learn from world-renowned entomological experts at Harper Adams. I really enjoyed practising taxonomic identification skills with curators from London's Natural History Museum, using high-powered microscopes and dichotomous keys to ID different genera and species of insect from all the major families. I'm looking forward to learning more about how ecosystem functioning is mediated by insects, and how we can maintain these important functions in the face of diversity loss. I also can't wait to learn more about biological control in greenhouses, which I find fascinating.

How will the scholarship help you with your studies?
The scholarship has helped me to attend the Master's full time, allowing me to fully focus on studying insects. I have been able to buy equipment such as a decent hand lens, an insect dissection kit and a lab coat. I'm gradually increasing my ID guide collection, adding valuable guides on hoverflies, spiders and flowering plants, which will be especially useful for my own research project on natural enemies in sown floral field margins. I'm so grateful and honoured to be awarded this scholarship by such a prestigious organisation and the fund has helped me access this course and additional resources to improve my studies.

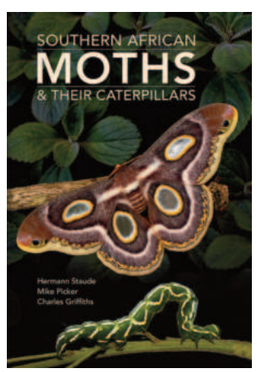
What are your future aspirations?
I would like to continue my studies on insects with a PhD or as a research scientist. I'm keen to reduce agricultural dependence on synthetic pesticides and would like to influence policy to make vital changes to support insects and their habitats. I'm also interested in how insects are impacted by other pressing issues such as light pollution and urbanisation. I want to use new technologies like DNA analysis to investigate how entire insect communities respond to current threats, and how this affects other organisms through trophic networks.

Antenna Reviews

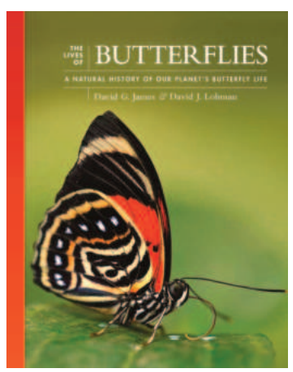
If you wish to recommend a book for review, please contact: antenna@royensoc.co.uk.

The following reviews have been added to the *Antenna* website:
www.royensoc.co.uk/publications/book-reviews/

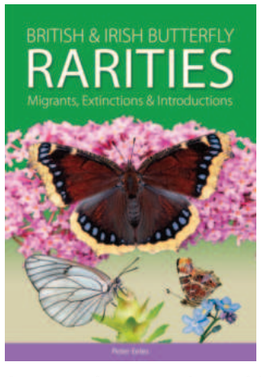
To read review online, please click on the image of the book.



Southern African Moths & Their Caterpillars
Hermann Staude, Mike Picker and Charles Griffiths
Published by Struik Nature/Penguin Random House South Africa; Pelagic Publishing (UK)
ISBN 978177584795 (South Africa); 99781784273477 (UK)
Reviewed by Henk Geertsema



The Lives of Butterflies: a natural history of our planet's butterfly life
David G. James and David L. Lohman
Published by Princeton University Press
ISBN 9780691240565
Reviewed by Richard Harrington



British and Irish Butterfly Rarities
Peter Eeles
Published by Pisces Publications
ISBN 9781913994105
Reviewed by Richard Harrington

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).

April 2024

Thu 25 — 25 April
Climate Change and Medical & Veterinary Special Interest Groups
The impact of extreme events (hybrid event)

May 2024

Thu 2 — 2 May
Forest Invertebrates Special Interest Group
Forest invertebrates: challenges and solutions (virtual event)

June 2024

Mon 24 — 24 June – 30 June
Insect Week 2024

July 2024

Wed 3 — 3 July
Computing & Technology and Data Special Interest Groups
AI in entomology (hybrid event)

Thu 18 — 18 July
Aphids Special Interest Group (online event)

August 2024

Sun 25 — 25 August – 30 August
International Congress of Entomology, Kyoto (external event)

September 2024

Tue 10 — 10 September – 12 September
ENTO24

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