Bulletin of the Royal Entomological Society Volume 43 (1) 2019

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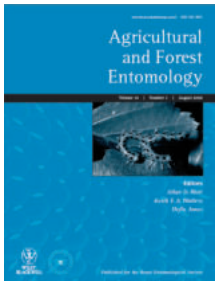

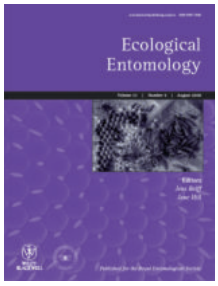

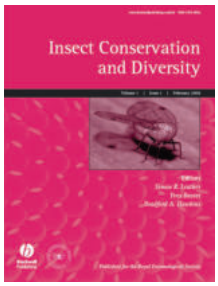

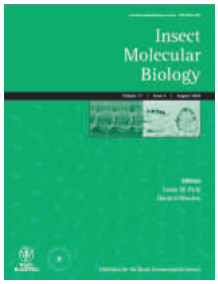

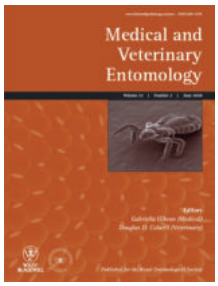

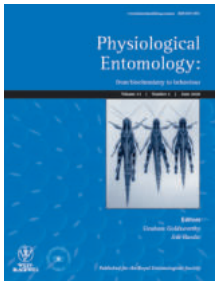

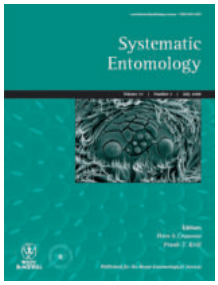

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2019 print or online prices: UK £935, Euroland €1,191, USA $1,729, Rest of World $2,013
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2019 print and online prices: UK £1,938, Euroland €2,468, USA $3,592, Rest of World $4,187

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2019 print or online prices: UK £1,455, Euroland €1,851, USA $2,690, Rest of World $3,139
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Antenna (Bulletin of the Society). Free to Members/Fellows. Published quarterly at an annual subscription rate of £60 (Europe), £65 (outside Europe). This journal contains entomological news, comments, reports, reviews and notice of forthcoming meetings and other events. While emphasising the Society's affairs, *Antenna* aims at providing entomologists in general with a forum for their views and news of what is going on in entomology. Subscriptions and advertising enquiries should be sent to the Business Manager at The Mansion House, Chiswell Green Lane, Chiswell Green, St. Albans, Hertfordshire AL2 3NS and any other enquiries to the Editors (antenna@royensoc.co.uk).

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

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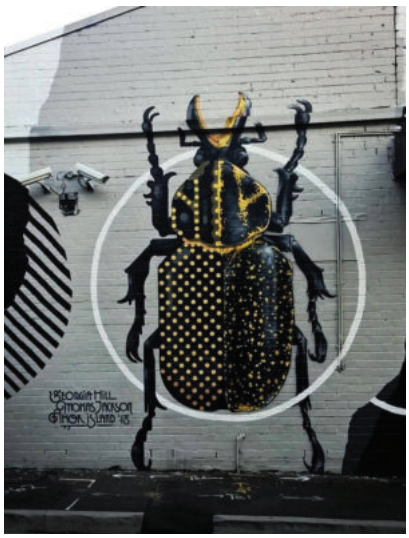

COVER PICTURE

Beetle mural in Australia by artists "Amok Island" (www.amokisland.com) and Thomas Jackson (www.thomasjackson.com.au) (see article page 12).

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EDITORIAL

It's very pleasing to have so much choice material, but very difficult to choose! Let me start by pointing out a few new features. Former President Stuart Reynolds has kindly agreed to write a "research spotlight" for each edition. These articles will discuss some of the big entomological issues of the day, and may be a touch controversial in the hope that they will generate discussion in these pages. Do write in to agree or disagree with Stuart's views, this time on insect declines, a topic chosen by Stuart but one close to my own interests. It seems to me that we see many scientific papers and popular press articles highlighting declines in insects we love (pretty ones, rare ones and beneficial ones) and increases in ones we care for less (crop pests, disease vectors). I have a hypothesis to explain this. Insects which are pests tend to be highly fecund and highly mobile (those are two important traits that make them pestilential). These traits also predispose them to cope with environmental changes. If they are abundant and highly migratory, they can blast their way through an ever increasingly fragmented environment. They can afford losses, but the few that find a new home will establish rapidly because of their high fecundity. Insects of conservation concern tend to be less fecund, less migratory and hence less able to adapt to change. There are many exceptions, of course, but I advocate this as a reason for generally getting more of what we don't want and less of what we do want. Feel free to write in about that, too!

I pinched the next idea from *American Entomologist*, the *Antenna* equivalent of the Entomological Society of America. Excellent entomology depends on excellent entomological teams. In each issue I hope to profile one such team, and I have started with NIAB-EMR (East Malling Research). If you'd like to be next, let me know. Also new to this issue is a journals section, in which key papers from a particular RES journal will be highlighted. In the current issue, the Editors of *Agricultural and Forest Entomology* review recent papers discussing the growing problem of invasive pests.

National Insect Week is the Society's biggest outreach event and Chief Executive Luke Tilley has provided a fulsome report of last summer's highlights. There has been a plethora of Society meetings, too, and several of these are recorded. My role of Special Interest Group Coordinator sits nicely alongside that of *Antenna* Editor, and I did nab a couple of people at the Ento Outreach SIG meeting to produce articles. I was particularly taken by the concept of Members of the Scottish Parliament being Species Champions (see Craig Macadam's article) and by the entomological street art described by Apithanny Bourne.

On the following page, our President, Chris Thomas, introduces himself and outlines his priorities for his presidency. Chris will be chairing the judges of the competition to convert the Mansion House garden into a haven for insects. Do get involved in this important development. Also profiled herein are two of our wonderful student representatives and this year's RES Scholars. Grant reports, book reviews and an obituary for a great contributor to entomology and to the Society complete this issue. Very many thanks to all contributors, and apologies to those whose offerings have been held over for the time being.

Many will be pleased to learn that there is now an on-line index for *Antenna* – see Val McAtear's article. We are also moving towards making older *Antenna* articles available on-line to anybody, and recent ones to members. More later.

Richard Harrington

Guidelines for submitting photographs

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

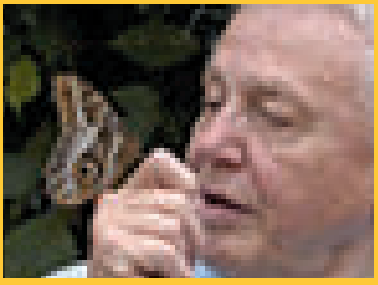
Electronic images can be embedded in the Word document but we will also require separate electronic images. These should be the full size image (.jpg or .tiff) from the camera even after the author has edited the file.

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

If an image is intended for the front cover then the photograph should be in ***portrait format*** and again should be the full size image from the camera even after the author has edited the file.

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

300dpi



72dpi

From the President

Chris Thomas

Sometime soon, we humans will formally declare ourselves to be in the Anthropocene, the human epoch. We represent a force changing the world to such an extent that the entanglement of humanity and the rest of nature is evident wherever we look. This presents us with great challenges.

Understanding the processes that enable the huge variety of insect life to adjust to human alteration of the world is fascinating. Some insects have declined while others have thrived in response to farming, climate, nitrogen deposition, biological invasions, and so on, and these adjustments have been taking place for thousands of years. Many of the insect species which are threatened in Britain are dying out because the medieval management of ecosystems is no-longer economically or socially viable. The species associated with low nutrient meadows and coppiced woodlands are disappearing because these management practices are things of the past, except when we pay landowners to carry on doing it. This leaves us with a conundrum. Should we keep manicuring the Earth's vegetation indefinitely to maintain the species that benefitted from past land management by humans, or 'let go' and accept that the denizens of historical landscapes are being replaced by colonists of modern ecosystems, such as suburban gardens. There are no easy answers.

Chris Thomas in his garden

This is one challenge of many. The human population is still growing. Per capita consumption of food is still rising, at least in parts of the world where this is desirable (where people are still under-nourished), and so we need to produce more food and prevent waste. We need to be able to stop insects eating our crops and spoiling food. Paradoxically, the most effective way for us to save insect species – globally – may well be to produce our food in intensive, entomologically-depauperate cropping systems, generating as much food as possible from the minimum area of cultivated land and leaving other, wilder areas to maintain biodiversity. We also need to be able to control insect vectors of crop, livestock and human diseases. The trick is to do all these things with the minimum of collateral damage; avoiding poisoning non-target insects that are either benign or positively beneficial. So many challenges.

To this end, we are in the process of launching the Royal Entomological Society's Grand Challenges project, which aims to identify the most important issues in entomology, contributing to wider international efforts. Many of these will ultimately relate to the human condition, but others will simply be curiosity-driven fundamental science challenges. Long-standing as well as new questions about insect diversity, morphology, physiology and behaviour may well be up there. We will start asking the Fellows and Members of this Society for their suggestions, the details of which will be announced separately. The Royal Entomological Society is particularly well positioned to identify the most important challenges because of who we are. Our membership's interests, career stages and nationalities, and variety of journals, provide a broad perspective that covers the full gamut of entomological pursuits, from killing insects to saving them, and from pure science through to its applications. Once we have identified these challenges, we will get together with other societies in an international context, so that we can bring them to the attention of policy-makers and those who fund research. Ultimately, the aim is to make the world a better place: a 'good' Anthropocene for people in general, and a world of endless joy for entomologists. We can try.

This engagement with the membership is one part of an overall emphasis in the coming years, enabling more people to participate in Society activities, building on the excellent work of the past. We also hope to increase the number of Fellows and Members. To this end, we will ask *you* for suggestions about the Grand Challenges, we are asking *you* to redesign the Mansion House grounds to the benefit of entomology (see page 18), and we will look to increase transparency, so that *you* can influence how the Society develops. We will fill as many positions as possible using a 'bottom-up' approach and make it easier for members to become involved. The more open and representative the Society can be, the better.

It is a huge honour to have become President of the Royal Entomological Society, a wonderful Society with a great past. But we should never rest on our laurels. If you have any suggestions as to how we could improve things in the future, please tell us.

CORRESPONDENCE

Antenna plastic wrapper

Dear *Antenna*,

I'm disappointed that my copy of *Antenna* arrives in a plastic bag!

I think that the RES should be doing better than this.

It is now clear that plastics are major contributors to environmental degradation. Microplastic pollution is now ubiquitous in the oceans (Jambeck et al., 2015, *Science* 347:768-771), in fresh waters (Florian et al., 2015, *Environmental Chemistry* 12:582-591), and in the soil (Machado et al., 2017, *Global Change Biology* 24:1405-1416). Insects are among those organisms that have been shown to accumulate plastic resides (Dalu et al., 2018, *Science of the Total Environment* 612:950-956). We still need to know more about the ecological damage that microplastics cause, but I think that we don't need to wait to do something about the problem.

Although plastic may now be so ubiquitous that it's impractical to make a complete and overnight switch to less damaging materials, there are many uses of plastic that could easily and swiftly be discontinued. There is widespread public concern about this issue and it's pretty clear that responsibility for action should not rest only on end-users, but also on those who package goods in disposable plastic in the first place.

It seems to me that a serious international entomological society should be trying extremely hard to avoid using plastic in this way. Distributing the Royal Entomological Society's journals in plastic looks, well, thoughtless.

I hope that there are plans to put *Antenna* and the Society's other journals into some other kind of mailer.

Yours sincerely,

Stuart Reynolds FRES
University of Bath

Editor: The subject of postal wraps was raised at the meeting of *Antenna* Editors and Associate Editors in October. All agreed, of course, that the Society must do what is best for the environment in this regard. Initial research, including consultation with other environmental organisations, has revealed this to be far from straightforward, as paper wraps and compostable wraps have certain environmental problems of their own. Our current wrap is fully recyclable (but not compostable), and has been for some time. So, for now, we will make it clear on the address sheet that it is recyclable, and do more research to determine the best long-term solution for all our journals.

Richard

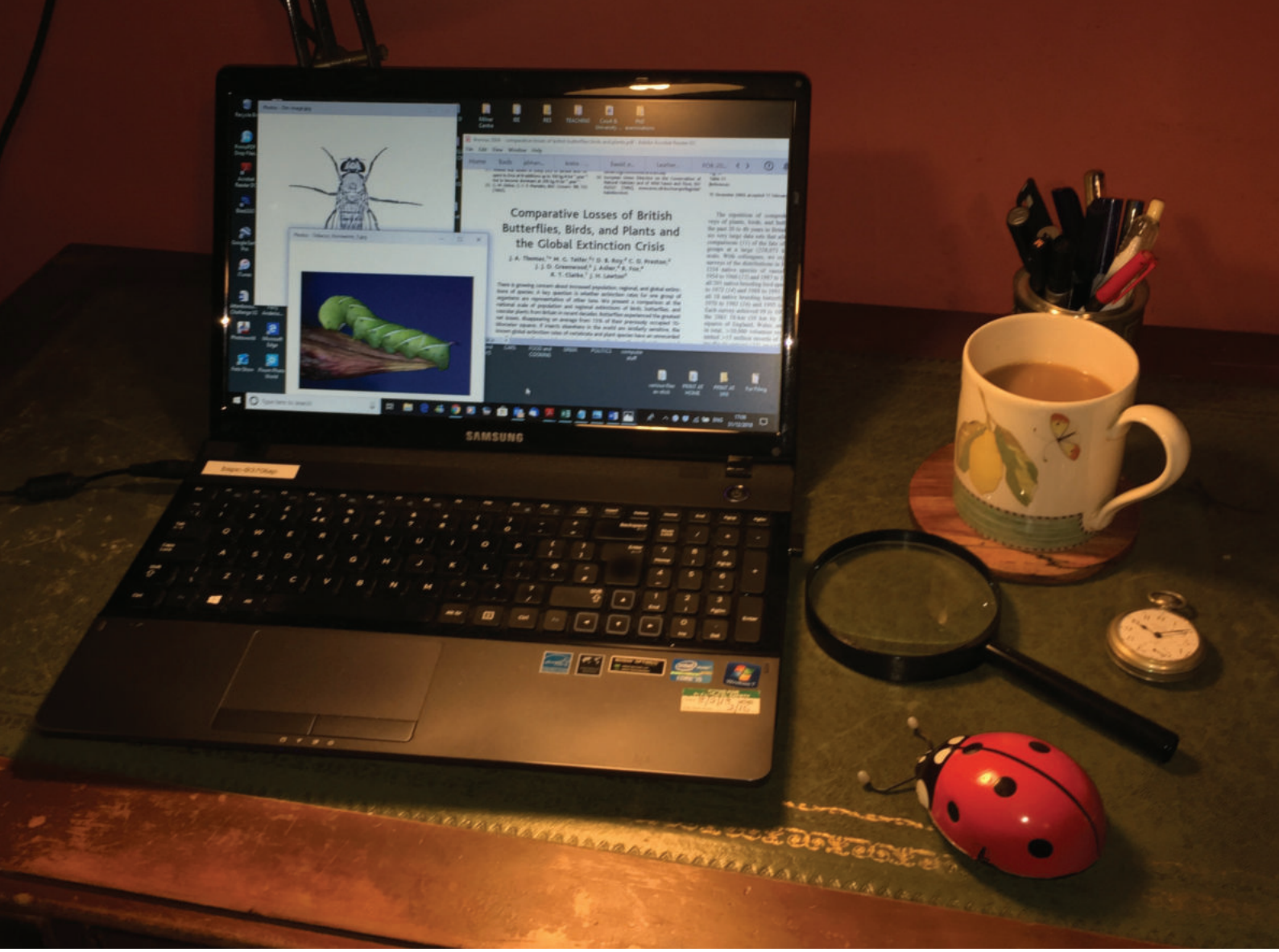
Verspoor, R. and Powell, K. Termites: Global pest and a tasty treat.

42 (3) 2018 p103

Dear Editor,

In the above article the authors referred to termites as a tasty treat but not everybody finds them so. When I was carrying out research into termites as pests of crops in Malawi, a local farmer was collecting the alates and soldiers of *Macrotermes michaelseni* (Sjostedt) to eat. He dropped them in boiling water then dried them in the sun. I ate them and I liked them. The farmer gave me some to take back to the UK where I offered them to work colleagues. Quite a number of them liked the taste but several found them disgusting. We discovered that the taste of termite lingers in the mouth for a long time – well over an hour – and during that time those who disliked the taste could be seen pulling faces and rinsing out their mouths with water or coffee. Neither seemed to work and they just had to put up with it until it eventually cleared of its own accord.

Regards
Jim Logan
(Retired from the Natural Resources Institute (NRI))



Bugpocalypse? The Krefeld paper and large-scale declines in insect populations

RESEARCH SPOTLIGHT

Stuart Reynolds

Department of Biology and Biochemistry, University of Bath

To entomologists, the German city of Krefeld (located on the Rhine, not far from the Dutch border) has now become famous as the home of the Krefeld Entomological Society, an impressive local organisation of non-professional insect scientists, which in October 2017 tossed an ecological bombshell into the entomological literature. A paper by Hallmann *et al.* (2017a), hereafter called "the Krefeld paper", reported that the biomass of flying insects at protected sites in Germany had declined by more than 75% during the 27-year period 1989-2016. This dismaying figure was based on population data gathered by members of the Krefeld Society, and analysed in conjunction with scientists at the Radboud University in the Netherlands, and the University of Sussex, UK. The implication of the paper was clear: if insect numbers even in protected sites show such massive declines, then this must surely be a general phenomenon, begging the question: are such declines happening everywhere? If it is indeed true that insect declines like this are widespread, then insects must really be in trouble. And if so, what are the implications for ecosystems in general?

The Krefeld paper quickly became what is often called a "hot paper". In

just over one year it has been cited in the scientific literature more than 100 times, and the publisher reports that the PDF has now (January 2019) been downloaded more than half a million times. In fact, this is one of those extraordinary papers that made an impact even before its publication, being the subject of a substantial "Features" article in the important weekly journal *Science* almost a full 5 months before the paper itself was published (Vogel, 2017).

Subsequently, the Krefeld study has been extensively reported in the world's press, for example in the UK by the *Guardian*, the *Independent*, even the *Daily Express*. In the USA there were long pieces in the *New York Times* and *Washington Post*, and doubtless there were stories in many other eminent and serious newspapers in other countries too, not to mention the internet. The media frenzy provoked by the paper was the subject of an editorial in the *Annals of Applied Biology* (Leather, 2018).

The irony of all this is that the Krefeld study was not originally designed to investigate a long-term insect decline at all. The original idea, as made plain by the authors' published commentary (Hallmann *et al.*, 2017b), was simply to compare the populations of flying insects at different nature conservation sites representing different types of ecosystem. This was slow work; only after years of trapping did it become evident that the study was revealing evidence of a massive long-term decline in insect numbers at almost every one of the sampled sites.

The study was a big one. To measure the sizes of insect populations, the Krefeld entomologists collected samples using Malaise traps (large tent-like structures designed to trap flying insects), operated day and night through the spring, summer and autumn of a single year in each location. Numerous trapping sites (n=63) were widely distributed in Germany. Each trap was operated for around six months, being emptied slightly more often than once a fortnight. Literally millions of insects were collected representing a wide range of taxonomic categories. Because it would have been prohibitively time-consuming to identify them all; they were simply dehydrated in ethanol and weighed for total biomass: 53.54 kg of dried insects were taken in all.

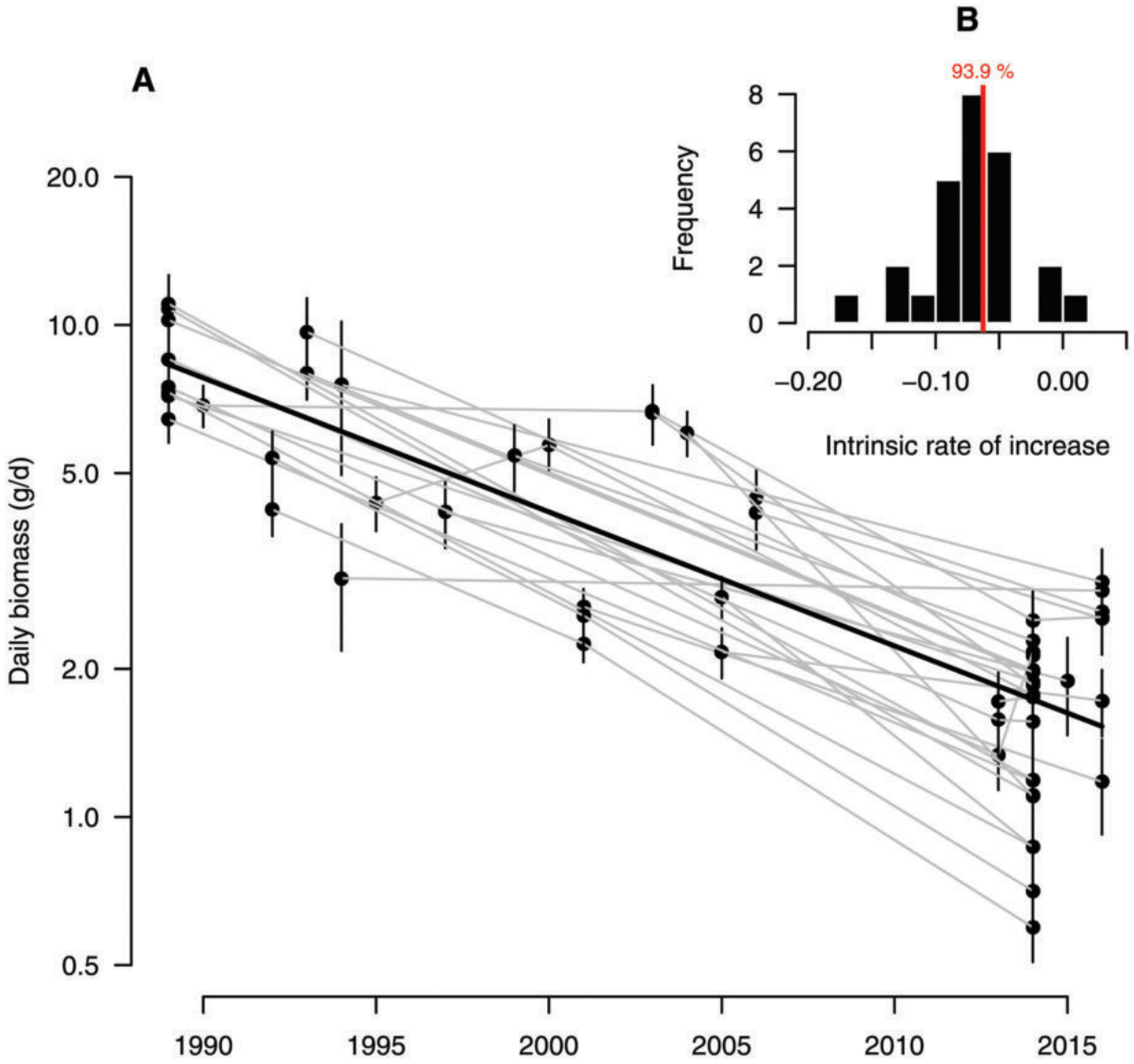


Fig 1. Insect biomass from Malaise traps operated at selected locations in Germany by the Krefeld Entomological Society. (A) Daily biomass (mean ±1 se) across 26 locations sampled in multiple years. Grey lines connect values from the same site. The bold black line shows the mean estimated trend in daily biomass vs time. (B) Distribution of mean annual rate of decline. Reproduced under Creative Commons license from Hallmann *et al.*, 2017a.

So far so good; most people would reckon that biomass is a good proxy for population size. Indeed, if we are thinking about the trophic interactions that exist between flying insects and other creatures (see below) then it is possibly the best measure. With so many sites studied, there was a good opportunity to compare catches according to the ecology of the trapping site, which was one of the study's initial aims. The large number of samples and long trapping periods meant that day-to-day variation and other variables (like the weather) would probably cancel out, and in any case, account could be taken of these other factors in a *post hoc* statistical model.

But what about the possibility of a general long-term change in insect populations? The Krefeld study hadn't been designed to detect such a change. As it became increasingly apparent that trap catches were declining markedly over time regardless of location, the Krefeld entomologists decided to modify their original design to include repeat visits to about 40% of sites. They must have been shocked to see the results, which indicated dramatic losses in insect populations at almost every revisited site. Because some sites had been visited only once, statistical modelling was used to disentangle the role of time from location, ecological category and surrounding land use, weather conditions etc. The end-result of the analysis was that the whole dataset contained statistically significant evidence of a strong negative trend in the biomass of trapped insects over time.

Because this is an important paper, you should read and evaluate it for yourself, but just to whet your appetite, Figure 1 here encapsulates the Krefeld paper's key finding. It shows the daily biomass of trapped insects plotted against year at those sites (n=26) that were sampled in more than one year. The bold line shows the mean trend for these sites, representing an average yearly decline of 5.2%. This represents a seasonal decline of 76% over the 27 years of the study (the midsummer decline was a slightly greater 82%). Such a reduction in insect biomass can only be described as drastic. The media called it "apocalyptic". Where had all those insects gone? And why?

The Krefeld study raises questions. The first is, "are the findings really true?" The answer, despite the limitations of the experimental design noted above, is "yes". That a statistically significant and marked decline in sampled flying insect biomass took place at numerous sites over the years of the study is unequivocal. This conclusion does not depend on choosing particular data points, nor on the choice of the starting and ending years of the analysis, but instead reflects a trend present throughout the whole dataset.

To what extent can we generalise from this? The Krefeld study doesn't show that large declines in flying insects are occurring everywhere, but we are obviously being given a powerful wake-up call! Insects are the most numerous (Sabrosky, 1952) and most speciose (Hamilton *et al.*, 2010) of all animals and are key components of trophic networks in terrestrial habitats (Schoenly *et al.*, 1991). Widespread declines on this scale in the biomass of insects would have sinister implications for the composition and functioning of most terrestrial ecosystems.

The Krefeld study is not a local peculiarity. The large number of sites sampled in the study were from diverse ecological categories and were distributed over almost 20% of the total area of Germany, a country in which land management and agricultural practices are similar to those in most of Northern Europe. The trapping sites were all in protected areas and were unlikely to have suffered directly from agricultural interventions. The insects found to be undergoing declines were not selected, charismatic species but were representative of flying insects in general. Remember too that flying insects (i.e. winged adults) spend most of their lives as larvae, a condition in which they sample all sorts of different niches, both below and above ground (Wardle *et al.*, 2004).

A massive general decline in the number of adult insects thus implies that things are not as they should be in many different environments. In fact, we might well consider the sampled sites and their insects to be indicators – "canaries in the coal mine" – for what is going on in the landscapes around them. In other words, the Krefeld paper strongly implies that something is seriously wrong in the natural environment of Northern Europe. As entomologists, we would all have to agree that this message is indeed newsworthy.

We can also ask why the Krefeld paper made such a large impact (which is likely to be continued as citations tend to be self-reinforcing) when it was not the first to detect a long-term decline. I suggest that this is an example of the overthrow of a previous way of thinking about things ("paradigm"), and its replacement with a new model. As in the case of other scientific revolutions (Kuhn, 1962), the new view took time to be generally accepted. In this case, the old paradigm overturned by the Krefeld paper was the rather widely held opinion of the 1980s and 1990s that the environmental situation had improved a lot since the DDT-related "Silent Spring" problems of the 1950s and 60s. At that time, widespread agricultural use of organochlorine insecticides had resulted in the accumulation of these chemicals in both terrestrial and aquatic food chains, with consequent drastic effects on top predators such as avian raptors, and widespread declines in songbirds (Carson, 1962). The establishment in 1970 of the US Environmental Protection Agency (EPA), and the prompt implementation of bans in many countries on the agricultural use of DDT, aldrin etc. did indeed rescue much damage to wildlife, although the benefits were slow in coming (Bourgeon *et al.*, 2013). This narrative of successful regulation explains how what I call the "getting better" paradigm was established.

But actually, things were not getting better. Even after the banning of organochlorine insecticides, in the 1970s, the pace of agricultural intensification had continued. New chemicals and formulations were introduced; both chemical use and yields per hectare continued to rise. With increasing mechanisation, "tidy" farming became the norm in economically and technologically developed countries, with crops increasingly weed-free and hedgerows and headlands no longer providing "wild" space for insects, despite the efforts of environmental regulators to promote wildlife-friendly farming (Butler *et al.*, 2007).

In the late 1990s concerns about a "second Silent Spring" began to emerge, initially in relation to the decline in farmland birds (Krebs *et al.*, 1999). Perhaps this ought to have rung entomological alarm bells sooner, because many of the declining birds were insectivorous. By the early 2000s,

losses of diversity in particular insect groups were being reported. The reports did not however collectively present a picture of a widespread and massive decline in insect biomass. Instead, they mostly represented the idea that increased conservation efforts were needed to stem local losses of particular species.

Much attention has been devoted to declines in populations of wild insect pollinators (Biesmeijer *et al.*, 2006; Potts *et al.*, 2010) but in general actual population sizes have not been directly measured (this is very difficult); instead the declining local diversity of pollinator populations was reported. The two papers mentioned above discussing pollinator declines have each been cited >1000 times and public interest in pollinators is indeed very great. But pollinators are widely seen as "special" and the scale of interest in them did not lead to widespread concern about the fate of other insects.

With hindsight, what was needed when concerns about insect declines first surfaced around the year 2000 was a straightforward attempt to quantify the abundance of insects in general. It's not surprising that not many studies of this kind were initiated. This kind of work requires significant resources and enthusiasm; funding is problematic because large-scale ecological surveys must be conducted and continued over significant periods of time. It is in fact (let's be honest) *expensive*. And scientific careers are often not well adjusted to long-term goals.

As it happens, however, relevant long-term survey work was already being done for other reasons. The Rothamsted Insect Survey (RIS) was originally established to monitor populations of insect pests of crops, especially aphids. Since 1964 this outstanding programme has used an extensive UK national network of aerial suction traps to collect annual data on the abundance of flying insects in order to provide advice to farmers. Interestingly, aphid numbers have shown no evidence of long-term decline during the 50 years of RIS collections (Bell *et al.*, 2015). But the traps collect other insects too. In one study, data from 4 selected RIS sites were used to monitor long-term trends in all the trapped insect species (Shortall *et al.*, 2009). Only one of the four sites (at Hereford) showed a net decline in trapped insect biomass over the period 1973-2004, most of which was due to a massive reduction in Spring swarms of bibionid flies (by far the largest single component of the trapped biomass at this site), but since other large flying insects declined more or less in parallel, bibionids may not be special. At the other sites, there were no significant overall trends. Thus far, therefore, the RIS suction traps have not confirmed the "extensive long-term decline" scenario of the Krefeld study. Perhaps this is because suction traps sample a different set of flying insects to the Krefeld Society's Malaise traps? Or is it something to do with the locations of the particular chosen traps?

But there are other ways of sampling insect populations. The RIS also operates a network of almost 100 light traps located all over Great Britain. This has yielded strong evidence of a marked decline in population sizes in one particular insect group – macro-moths. Conrad *et al.* (2006) analysed data for 337 relatively common and widespread species trapped in this way from 1968 to 2002. Over the whole of the UK, there was a highly significant (31%) decline in the number of them caught during the 35-year period. But not all species were equally affected. Indeed, some species actually increased in abundance against the overall trend. What is going on here? We don't know.

Again, we have to puzzle over why this important paper did not hit the headlines. The Conrad *et al.* paper has been singled out plenty of times by other ecologists and entomologists (at the time of writing it has accumulated >170 citations) but it didn't trigger the same kind of media interest as the Krefeld paper. This comparative neglect was not because the authors failed to spell out the implications of their work. In the paper's Abstract Conrad *et al.* wrote: "*These results have important and worrying implications for species such as insectivorous birds and bats and suggest as-yet undetected declines may be widespread among temperate-zone insects*". I can only agree.

Similar though less extensive studies have revealed other apparent long-term declines in populations of other particular kinds of insect, such as aphids, butterflies and various kinds of pollinator. I don't have space to discuss all of them here, but most of these papers are mentioned in the Introduction to the excellent paper by Fox (2013).

Because the causes of these variously documented insect population declines are not immediately obvious, the papers that reported them have tended to assert that the reasons for the declines are "complex" (e.g. Conrad *et al.*, 2006). While almost certainly true, this assertion unfortunately doesn't provide a testable hypothesis about causation that can be incorporated into a new paradigm to replace the old model of "things are getting better". If things are really getting worse, then it is as well to propose an idea of why this is so. New paradigms are more readily accepted when there is a candidate mechanism.

Thus, we can say that by the time the Krefeld paper was published in October 2017, there was already a limited but solid body of published evidence indicating that some insects (but not others) were experiencing long-term population declines. The Krefeld paper was innovative only in the sense that its body of evidence was wider and deeper than anything that had gone before, and by looking only at biomass, it avoided the (possibly confusing) necessity of saying which insects had declined and which had prospered. In discussing the data, it also concentrated clearly on a single message, that insect populations were declining.

Even when evidence of a general decline in insect populations is actually present in the data that are collected, it may require an appropriate research paradigm to "see" it. A paper by Ewald *et al.* (2015) is a good example of this: the authors analysed suction trap (D-vac) samples of arthropods taken from >100 individual wheat fields in Sussex, UK, over the period 1970-2011. The paper gave figures for the net changes in populations of various invertebrate (mostly insect) groups over the 42-year period of sampling but didn't comment on any overall pattern. Instead, the paper pointed out that some groups increased in numbers, while others declined. This emphasis on short-term change is understandable, because year-to-year weather-related variation was here far more visible than the long-term trend. For these authors, this is what their paper was about. After publication of the Krefeld paper Holland and Ewald (2017) took the opportunity to comment further. They pointed out that an approximate 35% reduction in total arthropod numbers had occurred during the 42 years of the Sussex wheat field project, which hadn't been mentioned in the original paper.

Now that our collective entomological paradigm has been shifted, it's obvious to ask whether long-term declines in insect abundance are taking place everywhere or only in Europe. A recent paper by Lister and Garcia (2018) provided new evidence on this question by comparing historic and newly acquired sampling data from protected sites in Puerto Rico. It was found that a marked decline in sweep net catches of insects had occurred between 1976-77 and 2011-2013, reducing the size of the catch by a factor of 4-8 times. Declines also occurred in catches at sticky traps located at ground-level (470-473 mg per day down to 8-13 mg per day, a more than 40-fold reduction) and at canopy-level (21-37 mg per day down approximately 4.5-fold to 5-8 mg per day). Similar results were seen when comparing old and new sampling data from a reserve in Western Mexico. It must be said that this Central American study is less securely based than the European research mentioned above, because the actual sampling periods were much shorter, and therefore more susceptible to interference by the weather. Nevertheless, it may well be that a picture of a global pattern of long-term insect declines is now beginning to be assembled.

There are plenty of questions that arise from the studies that I have discussed above. Here I'll list just a few:

What toxicological, ecological or environmental factors are directly or indirectly responsible for insect declines? What are the knock-on effects of long-term insect declines on trophic networks in which insects play an important role? Are we looking at a single environmental phenomenon, or a combination of changes that are unfriendly to insects? Can we (and indeed should we) attempt to reverse insect decline(s)? How should entomologists monitor insect populations so that declines can be detected more quickly (certainly in less than a quarter of century!). How can this work be funded? Do "amateur" organisations like the Krefeld Society have a special role to play in such long-term monitoring studies?

Perhaps an important question to ask in this article for *Antenna* is this one: "What should be the response of the Royal Entomological Society to growing evidence of declining insect populations?"

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Scottish Champions: MSPs adopt threatened species

When we talk about public engagement with entomology, we tend to think about children all agog, huddled around an entomologist showing them some fascinating insect. We might think about a pond-dipping session with participants eagerly sweeping through the depths for entomological treasure. Perhaps we'll think of a glossy magazine showing off some equally glossy butterflies or dragonflies. Or even television programmes like *Springwatch* or *Life in the Undergrowth* showing us entomological wonders from the UK and farther afield. Few people would think of the Scottish Parliament as a place for entomological outreach though, but that's where Scottish Environment Link members are spreading the word about invertebrates and their conservation.

Scottish Environment Link (SEL) is an umbrella organisation for environmental organisations in Scotland. With over 35 member organisations, including Buglife, Butterfly Conservation Scotland and the Bumblebee Conservation Trust, SEL aims to ensure that the environment is fully recognised in the development of policy and legislation affecting

Patrick Harvie MSP with a Red mason bee. © Scott Shanks

Craig Macadam
Buglife

Scotland. So where does entomological outreach fit in?

In 2013 Scottish Environment Link launched a new initiative called Species Champions. This initiative asks Members of the Scottish Parliament (MSPs) to lend political support to the protection of Scotland's threatened wildlife by becoming 'Species Champions'. With almost one in ten species in Scotland at risk of extinction, political support for protecting our natural environment has never been more critical.

Since its launch in 2013, the Species Champions initiative has gone from strength to strength. Today, halfway through the current session, there are 102 MSP champions, across all political parties, representing 79 per cent of the chamber - a clear majority for wildlife! Invertebrates are well represented, with 25 species ranging from the Forester moth (*Adscita statices*) and Spiny lobster (*Palinurus elephas*) to the Narrow-headed ant (*Formica exsecta*) and Pond mud snail (*Omphiscola glabra*).

Since its inception in 2013 the initiative has successfully raised awareness of wildlife issues in the Scottish Parliament, with no fewer than 36 motions tabled, 51 parliamentary questions asked, and 6 debates. These included the first ever debates on invertebrates in the Scottish Parliament: on the Freshwater pearl mussel (*Margaritifera margaritifera*) and on pollinators. The latter debate led to a commitment to develop and implement a Scottish Pollinator Strategy.

Former MSP Mary Scanlon asked an impressive 34 parliamentary questions during her term as Species Champion for the Freshwater pearl mussel. In addition to these written questions, she also regularly asked what impact decisions of the Parliament might have on pearl mussels.

During the summer recess of 2018, Scottish Environment Link challenged MSP Species Champions to 'meet their species'. The MSPs met this challenge with great enthusiasm! Alexander Burnett MSP went paddling in the River Dee and got the chance to see pearl mussels that are around 80 years old. Tom Mason MSP went pond dipping at Castle Fraser, near Inverurie, where he got to see his species, the Northern damselfly (*Coenagrion hastulatum*). Angus Macdonald MSP visited Wester Moss near Stirling where he tried his hand at bug-vaccing and found the Bog sun-jumper spider (*Heliophanus dampfi*), while Scottish Green Party co-convenor Patrick Harvie MSP took part in a UK Pollinator Monitoring Scheme FIT count and found his species, the Red mason bee (*Osmia bicornis*).

Alexander Burnett MSP with a Pearl mussel. © Craig Macadam

The Species Champions initiative has successfully brought invertebrates into the Scottish Parliament and taken MSPs out to see their species in their local patch. By engaging them with species in this way it is hoped that they will continue to advocate for their species, and other wildlife while going about their parliamentary business.

Can street art help save our insects?

Apithanny Bourne

** The #WallsforWildlife campaign is kicking off by mapping all existing nature-themed street art in the UK. If you have spotted a great piece, let us know where and we'll add it to our interactive online map.*

Mantis mural by "Amok Island" in Sydney (www.amokisland.com)

When it comes to communicating the plight of our environment to the public, the visual arts are a powerful, yet underused tool. Often acting as a gateway to other subjects, art can connect on an emotional level where statistics and reports so often fail to create impact. As one of the most accessible art forms around, street art has huge potential to engage city dwellers with insects. Most people live in urban settings, where detachment from wider environmental issues is an increasing problem; but street art can be enjoyed for free and provide a hard-to-ignore reminder of the issues we all face. Meaningful pieces can not only enhance built-up environments aesthetically, but provoke thought and challenge the viewer. Encompassing everything from stickers to posters to murals; street art is wonderfully versatile and there are already some incredible insect-inspired pieces across the world.

The potential of street art in inspiring and translating *ecological* problems to the masses is exciting. We are lucky to have so many wonderful charities championing our invertebrates and collectively organising hundreds of engagement events across the UK each year. Nevertheless, they often attract similar groups of people - usually those with an existing interest in the environment, who already have a good grasp of the issues facing pollinators, for example. These events are undoubtedly extremely important, and should always form the bulk of our outreach but, by only having such events, we risk excluding a large sector of society.

We must endeavour to reach beyond our regular audiences, to a population which is composed predominantly of visual learners. This inevitably means trying new things and actively seeking out opportunities, instead of waiting for them to come to us. Far from recruiting readers to begin vandalizing their local communities, this is a call for increased collaboration between science and the arts. There are successful street art festivals all over the world – why not a purely biodiversity themed one here in the UK? A #WallsforWildlife campaign could see scientists and conservation charities teaming up with artists to create inspirational, species-focused murals. And why not have undergraduate biology and art students collaborating on pieces of work? The most exciting and interesting things occur at the crossover between different disciplines.

So, can street art can help save our insects? Not exactly, but science alone can't either. Safeguarding our environment is going to demand collaborations between people of all different talents. Whether we welcome new people into entomology through scientific papers or through awe-inspiring pieces of artwork, it does not matter. By its very definition, art is whatever you want it to be – the engagement opportunities are significant if we are willing to take them.

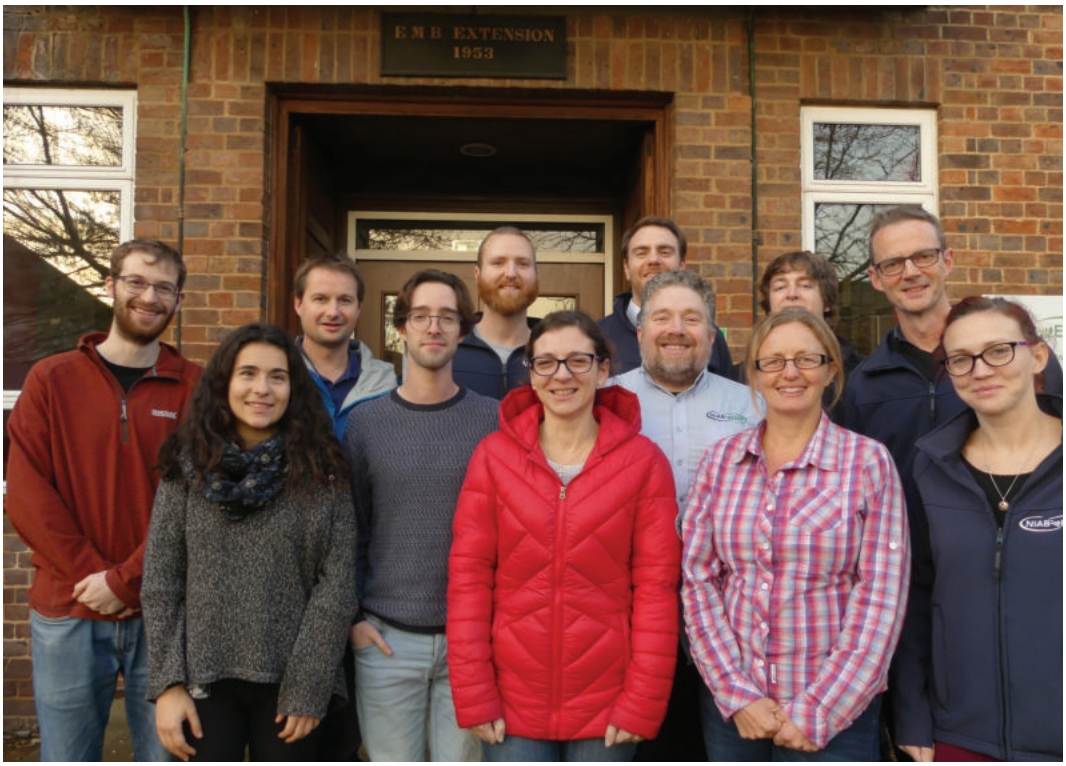
3D wasp art in Lisbon by street artist "Odeith" (www.odeith.com)

Stag beetle mural in Sisak (Croatia) by street artist Lonac (www.lonac.blogspot.com)

ENTEAM

Richard Harrington

I'll come clean – I have stolen this idea from our colleagues across the pond. When I was employed, and used to read it cover to cover, *The American Entomologist* included profiles of entomological laboratories. Whether it still does, I haven't checked, but I enjoyed the articles and have taken it upon myself to start something similar to spotlight those who are at the forefront of entomology over here. If feedback is good, I'll continue. If you would like your institute/department/group to be profiled, please let me know. The Society is, of course, international, so these profiles should not be exclusively from the UK. It may be, though, that non-UK groups will have to be interviewed remotely. I can always ask!



The NIAB EMR entomologists.

NIAB EMR, East Malling, UK

There were two main reasons for starting at NIAB EMR (formerly East Malling Research). The first was that I was speaking to Glen Powell shortly after I had the idea. The second was my shame that, during my career in aphid biology, I never once visited East Malling, which has a history stretching back more than a hundred years (Gregory *et al.*, 2013). In 1913 fruit growers clubbed together and purchased the first 9 hectares of land on which to do research to assist their profitability, along the lines of the well-established set-up for arable crops at Rothamsted. The first director, Captain Robert Wellington, defined its mission as "the study of problems met with in the actual culture of fruit trees and bushes". That remains the case, and the current Operations Director (and ultra-keen butterfly and moth recorder), Ross Newham, explained that NIAB EMR aims to act as a vital bridge between fundamental research and industry practice.

As regards entomology, Ross explained that, against a background of the loss of active ingredients due to legislation and resistance, and the need for residue-free produce, research within the extensive entomology-based team is centred on alternatives to insecticides in the first instance, with better integration and targeting of insecticides where needed. Alternatives include means of pest control such as trapping or interfering with insect behaviour using semiochemicals, and encouraging natural enemies. Improved pollination is also a vital area of research as is understanding, predicting and controlling non-native species. Concept orchards aim to bring together all areas of research at NIAB EMR, putting science into practice to maximise crop value, hopefully convincing growers to adopt new and environmentally-sound techniques. Key for the future food security agenda is sustainable intensification – reducing inputs and reducing waste, through novel pest control regimes, is vital.

And so off to the labs, my first stop being with second-year PhD student Rory Jones (co-supervised by Matthew Goddard at the University of Lincoln),

Rory Jones and his T-maze olfactometer.

one of a strong and keen student community and one of many people working on the non-native model species, Spotted-wing Drosophila (SWD) (*Drosophila suzukii*), which first appeared in the UK in 2012 and has a broad host-range. Rory is using T-maze olfactometers to find out which yeast species are most attractive to SWD. The idea is that feeding baits, not in contact with fruit produce, comprising the best yeasts will be incorporated with plant protection products and draw SWD away from crops to their death; the potential crop protection thus not even being placed in the crop!

My host, Glen Powell, described the potential threat posed by another invasive, the Brown Marmorated Stink Bug (*Halyomorpha halys*), and work being done to prepare in case it arrives in the UK. Like SWD, it originated in Asia but has spread around the world rapidly during the last 20 years for reasons unknown. It is now in many European countries, feeding on over a hundred plant species and causing damage to widely grown crops as diverse as sweetcorn, legumes, brassicas, tomatoes, top fruit and nuts. In preparation for monitoring in the UK, Glen visited Basel, where it can easily be found. It has a taste for exotic tree species such as Indian Bean Tree (*Catalpa bignonioides*), builds up urban populations thereon and then moves into nearby apartments to overwinter, often in large clusters. Although living up to its name, Glen describes its stink as "peppery coriander – not too unpleasant". Residents of infested apartments may beg to differ. Because it is well armoured, it is not easily killed with insecticides; fine-mesh exclusion is becoming a favoured method of control in crops where that is feasible. The potential of egg parasitoids for biocontrol is being investigated. Sticky traps with a USA-produced synthetic aggregation pheromone lure were used at ten trapping sites in the UK from June until October 2018, and a grower-awareness campaign launched. Vigilance and prompt action will be key to eradication of any vanguard populations.

After a very wet morning the sun came out, facilitating a fascinating visit to a cherry orchard, where Francesco Rogai was optimising field lures for SWD. These involved Cha-Landolt bait rather than Rory's yeasts. I'd never heard of that. It comprises a mix of methianol, acetoin, acetic acid and ethanol, all chemicals from fermenting fruit, put into dry-lure sachets in a range of ratios (8 treatments x 8 replicates). My visit was in early December, just when large numbers of SWD are moving into woodland to overwinter. It is a good time to test the lures because they are not in competition with fruit. Francesco is also doing a survey for native parasitoids. He is looking especially for *Trichopria drosophilae*, which is commercially available for release in Europe, but so far has not found it. Last year, four native parasitoid species were identified with help from the Natural History Museum (David Notton), including a high proportion of *Pachycrepoideus vindemmiae* and *Spalangia erythromera*.

Bethan Shaw is looking at SWD from a very different angle, in a PhD project with the University of Southampton. She is studying its circadian rhythms for locomotion and oviposition in the hope of achieving better timing of control measures. Previous work by others on locomotion of *Drosophila* species has used virgin males but Beth has found that mixed-sex populations behave very differently. Under hot conditions (> 30°C) oviposition switches from the middle of the day to morning and evening peaks. Beth is also looking for any circadian impact on susceptibility to insecticides. She has not found this, but has found sublethal effects on egg-laying.

To protect raspberry crops from this relatively recent arrival, growers need to spray. Adam Walker wants to extend

Francesco Rogai and his SWD traps in a cherry orchard.

any spray interval as much as possible. He has trialled fortnightly sprays of SWD-effective products, to protect fruit in combination with exclusion netting, and found good control of SWD. Results will soon be analysed, then growers informed so they can make decisions based on scientific evidence.

I ended my visit with Michelle Fountain, Deputy Head of Pest and Pathogen Ecology. She is a fruit pollination specialist and is especially interested in increasing solitary bee numbers in apple orchards. Pollination is currently suboptimal in modern varieties such as Gala and Braeburn, and Michelle is looking to improve nesting habitats for important andrenid pollinators in collaboration with the University of Reading and CEH. In other fruit crops Michelle has demonstrated the hugely important role that solitary bees have in pollination. As hard-working natives evolved for the UK climate, their work rate is so good that their role should be encouraged in cropping situations.

With Sarah Arnold at Greenwich University, Michelle is also looking at the potential of caffeine in enhancing bumblebee flower visits to strawberries. Caffeine increases learning ability and stops bees getting distracted and leaving the area. Conservation biocontrol is also a large part of Michelle's focus. Following previous work at NIAB EMR on hedgerow management in pear orchards to encourage anthocorids, which are important predators of Pear Psyllid (*Cacopsylla pyri*), Michelle is focusing on the conservation of earwigs as important natural enemies in tree fruits.

Another long-standing area of work at NIAB EMR has been the collaboration with David Hall and his colleagues at NRI (Greenwich University). Here the use of semiochemicals in a push–pull system aimed at reducing damage by the European Tarnished Plant Bug (*Lygus rugulipennis*) has been successful. Hexyl butyrate acts as an alarm pheromone pushing the mirid out of the crop, whilst traps around the crop use plant volatiles and sex pheromone to capture the pest. The groups have also, more recently, identified the sex pheromone of blackberry and gooseberry sawflies to enable detection and appropriate control strategies for bushfruit growers. In related projects, though some sex pheromones of mirid pests have previously been identified by other teams globally, the group at NIAB EMR has been successful in working out the correct ratios of the various attractants as many are also alarm signals at a different level.

It was this last part of the visit that highlighted what is key to teams working with crops – the industry has moved on a million miles from broad-spectrum chemicals and all the problems associated with them. Today, studying the ecology of the pests – behaviour, interactions, dispersal, semiochemistry – is key to ensuring we can tip the balance of favour in crops away from pests.

My grateful thanks to this fine team who, even on this brief pre-Christmas visit, can be seen putting in a diverse range of fascinating scientific skills to address each of the economically important pest species in fruit crops in truly exciting ways. I returned home, secure in the knowledge that our five a day are in good hands.

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Society News

Council Matters

Council met on Wednesday 3rd October 2018 with the new President, Prof. Chris Thomas, in the Chair. The President welcomed the new Trustees, Mrs Julie North and Dr Rebecca Farley-Brown. He also thanked Drs Allan Watt and Jenni Stockan for accepting the posts of Vice President.

Dr Tilley, Chief Executive, gave a brief summary of the National Insect Week (NIW) activities in 2018. The number of events during NIW was greater than ever before. The launch event was discussed by Council and the need to attract suitable publicity. Dr Tilley felt that the association of authors and artists has given an extra dimension to NIW. Mrs North, herself an artist, agreed to explore more links in this direction. Ms Whiteford, Registrar, gave a report on Ento'18 which was held at Edge Hill University in Ormskirk, with *c.* 100 delegates attending per day. Those of Council who attended commented favourably on the conference organisation and content. The President felt that the venue was very suitable and had good facilities. Dr Tilley reported that the workshops had run smoothly but having them at the end of the conference had impacted on attendance as delegates were travelling home. Ms Whiteford reported that the conference finances were well within budget. Ms Whiteford further reported that Ento'19 will be held 20-22 August 2019 at the London School of Hygiene and Tropical Medicine with Profs Mary Cameron and James Logan as convenors. Council also discussed a query from Dr Murchie as to whether the RES would act as the host for the Praesidium of the European Congress of Entomology (ECE). This would involve a page or so on the website and holding ECE monies. Council expressed some caution, particularly about any direct financial involvement, and deferred the matter to the Finance Committee for their consideration.

Council discussed the various requirements and some changes associated with the Wigglesworth and Westwood awards. Dr Shaun Winterton, Editor of *Systematic Entomology*, chairs a new judging panel for the Westwood Medal and Marsh Prize for excellence in insect taxonomy. The balance between traditional and molecular taxonomy is a recurrent theme with this award and, as the science moves forward, it was agreed to reconsider the scope and criteria for the award to reflect current best practice.

The President gave a brief update on the RES gardens. He outlined the provisional timetable for a membership competition to design an entomological garden, with the end of June 2019 as a potential deadline. Dr Farley-Brown asked about the recurrent costs of maintaining the garden. The President considered that they would be comparable and hopefully lower than those that were previously allocated to maintaining the National Gardens of the Rose, during the recent upheaval.

Prof. Field, Honorary Editorial Officer, circulated a financial report that showed that the Society journals were doing well. The previous Registrar / CE, Mr Blakemore, had negotiated a new advantageous 10 year contract with Wiley prior to his retirement and there is a proactive Wiley's team that is keen to promote the Society's journals. Prof. Pickett enquired about the impact of open access on the journals. Prof. Field commented that, whilst more articles are published open access, this has not, to date, affected subscriptions. Prof. Field said that one Handbook in the *Identification of British Insects* series is due to go to press and another three are in progress.

Dr Tilley provided a review and update on the '*Grand Challenges in Entomology*' initiative. He reported that he had been in contact with the Entomological Society of America and they were supportive of the Society's approach, which in the first instance is to ask the Membership for their 'top 100 questions in entomology'. These will be framed within the Grand Challenges topics of sustainable agriculture, invasive species and vector-borne diseases, but also including more positive aspects of entomology such as insect-ecosystem services, conservation and biodiversity. It is intended that this process will entail a membership questionnaire and be facilitated by contracting a post-doc to process the responses and organise a workshop. The first result will be a publication in one of our journals.

The President and Dr Tilley introduced two brief discussion papers. The first by Prof. Thomas, outlined a number of questions and possible approaches directed towards maximising membership engagement with the Society. This included, for example, the types of meetings, the location and timing of the AGM, how to attract entomologists that are not members and whether we should be setting hard targets for activities and growth. Dr Tilley's paper focussed on the Society's strategic aims and the functioning of the sub-committees. This in the main looked at considering the demographics of the sub-committees and the skillsets that may be required in the future.

Following the due rotation of Trustees in accordance with Chapter 5 of the Society's Bye-Laws, there will be two vacancies on the RES Council following the AGM. Anyone interested in volunteering for the Society should in the first instance contact the Registrar, who will provide guidance and the nomination forms. Nominees for Council require a proposer who is a Fellow of the Society and a supporter who is either a Fellow or Member.

Photo: © Andrew Smith

Competition: Design an Insect Garden

The Royal Entomological Society invites entries to transform its grounds to be a haven for insects, inspiring for education and exciting for entomologists.

£1,000 first prize

Up to four runners-up prizes of £250 each

The competition is open to all Fellows and Members of the Royal Entomological Society, closing date 23:59, 30th June 2019.

Are you a frustrated entomologist or garden designer, longing to flex your muscles and design an imaginitive and inspiring insect garden? Here is your chance. The Royal Entomological Society owns grounds of approximately two and a half hectares just waiting to be transformed. And when we say 'garden', this can be interpreted loosely. Any kind of environment that you can't fit, or are not allowed to have, in your own garden could be incorporated within the design.

The RES headquarters and grounds are at The Mansion House, Chiswell Green Lane, St Albans, AL2 3NS (location: 51.727425, -0.372552) in southern England. We took over management of the gardens in 2018, most of which used to be a rose garden (see map). We intend to develop the grounds for the benefit of entomology. This could incorporate any combination (but not necessarily all) of the following goals: conserving insects, providing an educational resource for anyone from school children to garden designers, enthusing entomologists and establishing a location where research could be carried out. Any other societal or entomological benefits could be included.

A few details

The whole or part of the area can be included in the scheme. A set of photos of the garden, in its current state, can be viewed at: https://www.royensoc.co.uk/news (scale and boundary in links therein are approximate only).

You can suggest replacing as much or as little of the existing planting and garden structure as you like, within the constraint that establishment costs are as modest as possible and that, once established, maintenance costs should be low, compared to typical grounds/gardens management. Winning entries could be designs for the entire garden, or an overview of the whole combined with specific details of particular elements.

Currently, there are hard surfaces/paths, three ponds (two circular, one square), two small buildings, grassy paths and other areas, and herbacous beds and shrubberies between the paths. There are also some trees, mainly around the perimeter. In terms of structure, the hard surfaces (see map) are in pretty good condition, the ponds may leak a bit and there is vehicular access to the garden – more can be added if needed for the establishment work. The planting is primarily of garden cultivars. The rose cultivars that were valuable in their own right have already been removed by rose enthusiasts, although many of the original roses remain.

The process

In addition to the web pages, we will hold an OPEN DAY for interested parties wishing to view the garden on 22nd May 2019, but we welcome entries from those who are unable to attend in person. The closing date for the competition itself is 30th June 2019. An assessment panel will then identify the winning entries, with the intention of announcing the winners on 31st August 2019.

Once we have identified the winning entries, we will invite those who have been successful to work with us to develop a 'final plan'. It is possible that the RES will decide to go with a single winning design for the grounds, although the garden refurbishment may well include elements from more than one of the competition designs, with additional input from others (see the rules). The aim is to start any works on the garden over the winter to spring of 2019-2020.

Good luck!

Rules

Designs may be from individuals or from groups.

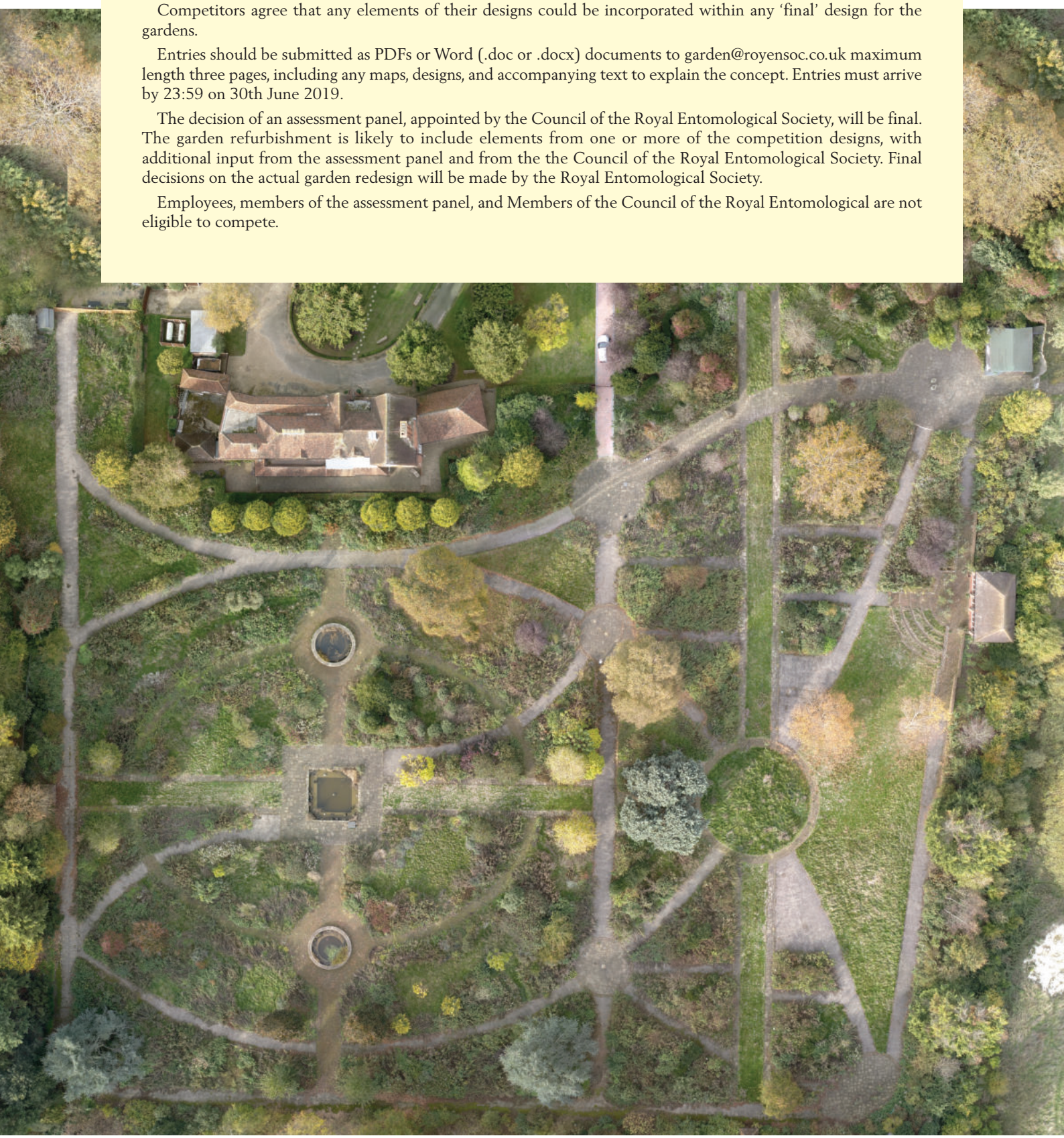
The winner and runners-up agree to their designs being made available on the web, and published in *Antenna* magazine so as to inspire others to develop insect gardens.

Competitors agree that any elements of their designs could be incorporated within any 'final' design for the gardens.

Entries should be submitted as PDFs or Word (.doc or .docx) documents to garden@royensoc.co.uk maximum length three pages, including any maps, designs, and accompanying text to explain the concept. Entries must arrive by 23:59 on 30th June 2019.

The decision of an assessment panel, appointed by the Council of the Royal Entomological Society, will be final. The garden refurbishment is likely to include elements from one or more of the competition designs, with additional input from the assessment panel and from the the Council of the Royal Entomological Society. Final decisions on the actual garden redesign will be made by the Royal Entomological Society.

Employees, members of the assessment panel, and Members of the Council of the Royal Entomological are not eligible to compete.



Thousands of children took part in insect hunts during NIW © Ben Sharpe

Little things, big campaign; National Insect Week 2018

Luke Tilley, Chief Executive

National Insect Week (NIW) is a biennial initiative that aims to promote awareness of the importance of insects, entomology and entomologists. It is one of the major outreach activities of the RES and helps towards the Society's role to disseminate information about insects and insect science. The RES coordinates partners and event organisers to bring together a nationwide programme of events for the public, all celebrating insects and those who work with them.

NIW 2018 was the eighth campaign, now supported by 74 official partners with events in every region of the UK. The strapline "little things that run the world" was once again used as a rallying call for the initiative, and was inspired by E.O. Wilson's seminal 1987 paper on the conservation of invertebrates.

NIW is now such a large initiative that it is difficult to summarise all aspects or to acknowledge the hundreds of people that contributed to its success. The RES is very grateful to all the event organisers, partner organisations, journalists and members of the public that made 2018 the biggest NIW to date.

The RES coordinates and funds the core activities of NIW, including media enquiries, liaising with organisers, competitions, distributing support packs, and managing the social media and website content (@insectweek; www.nationalinsectweek.co.uk). Each organisation contributed to the success of the campaign by holding events or providing activities and information for the public.

As in previous years, the official partners were the main drivers of the NIW initiative. The number of organisations taking part was larger than in previous years which increased the number of events registered, the variety of activities offered, the amount of online activity and the overall public impact. Partners and event organisers funded their own events and activities but received merchandise and support from the RES.

Events relating to the sub-theme of 'Insects in Literature' were funded by the RES. This included events and resources from The Story Museum Oxford, the British Society of Literature and Science and bestselling author of the Beetle Boy Trilogy, M.G. Leonard.

Prizes for competitions were kindly provided by the Association of Science Education (ASE) and miniguides by the Field Studies Council. Videos by Metabugs were funded by an RES Goodman Award and can be found on the RES YouTube account.

The Launch

The launch event was held in the Glasshouse Gallery at the Royal Horticultural Society's Garden at Wisley in Surrey on Monday 18th June. The RHS has been a committed NIW partner since the beginning of the initiative and always provides engaging events during the week. Approximately 45 guests attended from partner and sponsor organisations. The event also

Artist Carim Nahaboo talks to the launch guests about the inspiration behind Insect Isles.

Aquatic insects on show.

Insect handling with Janice Smith © Etaterina Shatalova.

hosted fifty schoolchildren learning about insects and the plants they need. The children also took part in an insect trail around the Wisley site and this was available to all visitors over the summer months.

The 2018 campaign was officially launched with speeches from Dr Hayley Jones (Entomologist, RHS), Sir Nicholas Bacon (President, RHS), Prof Lin Field (Editorial Officer / former President, RES), M.G. Leonard, and Dr Luke Tilley.

After the introductory speeches and lunch, there was an opportunity to browse a number of exhibits:

Entocast – the popular insect podcast hosted by PhD students Nick Howe and Liam Crowley from the University of Birmingham.

Entomology at the RHS – Dr Andrew Salisbury, Dr Hayley Jones and Dr Stephanie Bird demonstrating the important entomological projects of the RHS.

NIW 2016 Photography Competition – an exhibition of the winning photographs from the 2016 competition to commemorate the launch of the 2018 competition (www.nationalinsectweek.co.uk/photography).

Eatbugs – insect snacks provided by Roberto Padovani, Eleanor Drinkwater and Megan Hasoon from the University of York.

Insect Isles – an inspiring artwork by artist and illustrator Carim Nahaboo representing the 24,000+ species of insects in the UK. The art work featured illustrations of insects from around the UK, showcased on an attractive map of the British Isles.

NIW goodies – an exhibit showing the posters, pencils, pens, rulers, crayons, seed mixes, ID guides, booklets, key rings, stickers, t-shirts and wrist bands on offer to supporters and organisers of NIW events.

Events

1,067 events were uploaded onto the NIW website, the largest number to date (278 in 2010; 306 in 2012; 403 in

Guests enjoying the exhibits at the launch event.

2014; 541 in 2016). These took place across the UK, including ID workshops, moth trapping, public talks, insect walks, exhibitions, bioblitzes, craft activities, museum collection events and much more. Organisers were provided with information and merchandise once their event was registered on the NIW database. An interactive map allowed people to explore the events on the database during the months before NIW and plan their week. A conservatively estimated 100,000 people attended NIW events.

Competitions

Two main competitions, organised by the NIW team, ran during NIW and beyond:

Photography competition

Building on its success in previous years, the RES continues to hold the popular NIW photography competition. 1,487 entries were received. The winners will be announced in early 2019, ready to be exhibited at events around the country during the year.

The Great Bug Hunt

The Great Bug Hunt returned during 2018 in conjunction with the ASE. 4,012 entries were received. This competition helped to secure in the classroom an awareness of insects.

The winning schools were as follows:

Overall/Y3&4: Little Melton Primary School, Norwich (School visit by Graham and Janice Smith from Metabugs)

Reception: Westerhope Primary School, Newcastle-upon-Tyne (ASE prizes)

Y1&2: Chandlings Oxford (ASE prizes)

Y5&6: The Willows School, Rotherham (ASE prizes).

Online

NIW has a notable presence on Twitter and Facebook now. Francisca Sconce managed the digital campaign on behalf of the RES and she continues to provide social media content between the 2018 and 2020 campaigns.

The NIW Facebook page (www.facebook.com/nationalinsectweek) attracted 2,755 "likes" and over 4,000 posts of pictures, news and comment. The Twitter account (@insectweek) was used to highlight events, interesting entomological news and to link up with the official partners. The account had 11,300 followers by the end of NIW 2018. The maximum reach of a NIW tweet was 2.2m individual accounts on 18th June (launch day). #NIW2018 was used to group NIW comments before, during and after the campaign. An additional hashtag (#likeinsects) was introduced to encourage people to comment on why they like insects.

Media coverage

As ever, there was considerable media interest in NIW. 774 items were collected, which is an increase from 581 during NIW 2016. The largest numbers of items were found in regional printed press, featuring articles and announcements about events local to their readership. National coverage included BBC Springwatch, BBC Countryfile, BBC Radio 2, BBC Radio 4, LBC, TalkRadio, CBBC Newsround, The Daily Express and The Daily Telegraph.

Feedback from the public has been excellent and has highlighted the role NIW plays bringing scientists and the general public together to celebrate the wonder and science of insects.

The RES would like to sincerely thank all Members and Fellows involved in NIW 2018, who directed their enthusiasm and efforts towards increasing public interest in insects, particularly in young people.

If you would like to be involved in NIW 2020 then please email the RES team (niw@royensoc.co.uk).

Meet our Student Reps

Age, experience, youth and enthusiasm are vital components of any society. There may have been times when ours was heavy on the former pair and light on the latter - not any more. We have been blessed with a succession of excellent student representatives who have brought freshness to our methods, meetings and magazines, and done much to ensure our future as a vibrant, relevant organisation. It is a symbiosis, as the Society offers many opportunities for students of entomology to learn, gain experience and make useful contacts. Here are profiles of two of our three current reps.

Adam Bakewell

Growing up in Stoke-on-Trent, with a ten square-foot concrete patch as a garden, I didn't really interact with insects. In fact, my most prominent childhood memory of an insect is when a crane fly flew into my mouth when I was talking one time. Evolution has always captivated me though, and I am fascinated by how ecology has shaped the incredible diversity in physiology, morphology and behaviour that living organisms exhibit. In 2016 I started work on my PhD at the University of York; an ambitious project to create a taxonomically broad life history database for insects and utilise it with modern phylogenetic comparative methods to answer fundamental questions about the co-variation of these traits and the evolution of insect life histories. Practically, this has involved reading thousands of papers about insect biology and behaviour and two and a half years later I can say that I've definitely fallen in love with the group! I massively enjoy being a part of the Royal Ent Soc's community of entomologists, and am excited about the upcoming postgraduate forum that I have been organising together with my fellow PG reps. Outside of my PhD, I also co-host a science news podcast, *Generic Drift* (Twitter: @GenericDrift), where we regularly talk about insects.

Roberto Padovani

I'm a PhD student at the University of York, investigating how insects associate with non-native plants in Great Britain. The advent of air travel, and an ever more interconnected world, has ensured that non-native plants are an increasingly important part of the British landscape, and so it is vital to understand how insects interact with them. I've always been fascinated by insects, and so have relished the opportunity to discover more about how they might be affected by our changing 21st century ecological landscape. In addition to my PhD I'm very active in science outreach work. As well as being involved with the *York Pint of Science Festival* for the last three years, I run an entomophagy outreach group with two of my friends and colleagues, Megan Hasoon and Eleanor Drinkwater. As *Eat Bugs Outreach* (Twitter @EatBugsOutreach), we have attended numerous events both within York and across the country, and it's always a pleasure to challenge members of the public to overcome their preconceptions about edible insects. I'm very happy to be one of the RES Postgraduate Reps, and I'm looking forward to what should be a very stimulating RES Postgraduate Forum in March 2019.

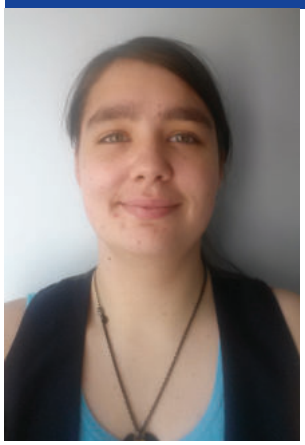
The Royal Entomological Society MSc Scholars 2018

Simon Leather

Professor of Entomology, Harper Adams University

The Royal Entomological Society has for many years provided scholarships to aid aspiring entomologists wishing to study the MSc in Entomology, first at Silwood Park and since 2012 at Harper Adams University. Thanks to the Society's generosity, the number of students applying to the course and taking up a place on the course, has been increasing year on year. We are incredibly grateful to the Royal Entomological Society for their support and it is an indisputable fact that the availability of these scholarships has helped swell the numbers of entomologists graduating in the UK. It becomes harder and harder to arrive at our decision, the quality and number of aspiring entomologists increases with every year that passes. We had an incredibly tough time deciding who to award the scholarships to and after much soul searching picked the following from a very competitive field.

Samantha Blackburn-Turner



Whilst working towards my degree in Applied Bioscience and Zoology, I studied modules in *Introduction to Entomology* and *Integrated Pest Management*. The more I learnt about insects the more they fascinated me. The intricacies and evolution of their behaviours, particularly in the Hymenoptera, but also the Myrmeleontidae (Neuroptera), is where I'd like to focus my attention. As there are millions of insects still left to be described but faced with potential extinction due to climate change coupled with over-zealous pesticide usage, it's possible that certain beneficial insects may disappear before we even know what they are. They need to be protected as well as researched further and faster to prevent negative public perceptions of what are considered to be "pests", leading to the eradication of potential keystone species.

I want to expand my knowledge further by exploring entomological behaviour in more depth, so I can continue to study and inspire others to be as captivated by these wonderful insects, as I am. I have already made a start in educating the public by setting up a small project in my local area to increase awareness of pollinator decline and improve their populations. I created detailed leaflets highlighting the best flowers to have in your garden for pollinators and handed out 214 free flowering plants at a local event which inspired local conservation.

The modules of principal interest to me from the MSc Entomology course at Harper Adams University are *Insect Physiology and Behaviour* and *Ecological Entomology*. The former will give me a broader understanding of insects, their structure and behaviours, thereby allowing me to share my knowledge effectively with the public. The latter has a focus on insect conservation which will aid me in any further conservation projects I hope to lead whilst highlighting areas of concern that need more attention.

The receipt of this scholarship will allow me to get started right away in furthering my career. I'll be able to focus fully on my studies and hopefully get some volunteering experience in the field. Thus, I'll be able to put my newly learned knowledge to practical use and get to know my fellow entomologists already involved in conservation projects across the UK. I aim to build on my basic knowledge, develop my skills and to specialise in insect behaviour so that I will be better equipped, both theoretically and practically, to enter the workplace within my desired field after graduation.

Abigail Enston

I have always been fascinated by the vast array of insect life and how it has evolved. I find the sheer number of species and the variation between them, in physiology, life history traits and life cycles extraordinary.

A few years ago, I attended a Verrall lecture, which I found inspiring, and whilst I was there, I met a Harper Adams student who spoke with enthusiasm about entomology and the master's course. While at the London Natural History Museum I read about the work being done in relation to mosquitoes to fight malaria, and this made me realise how valuable a career in entomology could be.

With the predicted global food shortages and potential redistribution of species due to climate change, I believe an in depth understanding of insects will be of increasing value in the future. During my degree I took an ecology and conservation route through the biology modules, and was originally signed up for an integrated master's. I withdrew from this in order to specialise in entomology.

In truth I'm excited about all the available modules, but *Insect Physiology and Behaviour* and *Diversity and Evolution of Insects* are of particular interest to me. During my time volunteering as a laboratory assistant in the University of York 'Ant Lab', I looked at colony level behaviour in *Myrmica rubra* and developed a particular interest in the steps involved

in the evolution of behaviours, where they start as something completely different and have evolved to the behaviours we witness today. I therefore look forward to learning about other species, and how their unique behaviours evolved. After my work in the 'Ant Lab' I decided to pursue my interest in social insects by looking at the life history traits in the order Hymenoptera for my dissertation, in particular the so-called fast-slow continuum. My study focused on evolution in the order Hymenoptera and I am looking forward to learning about other orders in *Diversity and Evolution of Insects*.

As I suffer with dyslexia and dyspraxia this scholarship will be hugely beneficial to me. My learning difficulties mean that I find some aspects of study particularly challenging. The scholarship will help massively by reducing the amount of paid work I will need to do to support myself during the master's course, and give me the essential time I need for study and to get the most out of the course.

I would like to take this opportunity to thank the Royal Entomological Society for awarding me the bursary; it is going to greatly impact my master's year and I am immensely grateful.

Neive Percival

Entomology has been a keen interest of mine since a very young age. At one time, I was lucky to live near Thetford Forest and spent countless hours rooting around the undergrowth for worthy specimens. From bug hotels to butterfly tents, my family endured them all. Often now, I can be seen educating younger relations and family friends on where to find the best critters. This fascination with insects only grew during my years as a zoology undergraduate at Queen Mary University London, with a particular interest in Coleoptera. I had hoped to complete a dissertation project looking at mandible size in Lucanidae but due to factors out of my control, I was unable to and instead worked with signal crayfish (*Pacifastacus leniusculus)*. However, preliminary research featured background reading into condition dependence in the beetle *Onthophagus taurus*, which I found especially absorbing. I also completed a module titled *Species and Their Relationships*, which focussed on taxonomy and phylogeny, which I enjoyed immensely.

The Entomology course at Harper Adams appealed to me for a number of reasons, the first being the wide range of module topics, each sounding more interesting than the last and all linking closely together. The other reason why I wished to study at Harper Adams was the opportunity to study under Professor Simon Leather, who is greatly respected in the field of entomology and I feel working with him would be extremely advantageous to my future career in the field. From the modules offered on the course, I am looking forward most to the *Biology and Taxonomy of Insects* and *Diversity and Evolution of Insects* which will build on my current knowledge of the field of taxonomy, going into greater detail for the specialist field of entomology and linking classification with the evolution of family group traits. *Insect Physiology and Behaviour* also draws my attention as I feel it is essential to know and understand the physiological mechanisms of an organism in order to manipulate it, whether this be for beneficial purposes or biological control. Insects also make good model organisms as they are prolific, easy to maintain and carry few experimental regulations. This I feel intrinsically links this module to *Commercial and Practical Biological Control*, which I also feel provides extremely important knowledge regarding crop protection.

Receiving a scholarship from the Royal Entomological Society has been enormously helpful for me and I am incredibly grateful. Having taken loans out for my undergraduate course, I am already in debt. This scholarship allows me to fund my year at the university without having to enquire into taking out an additional loan on top of my postgraduate loan which will pay for my fees. It has also enabled me to afford rent at the university rather than having to travel an hour by car every day. Again, I am more than thankful that the Royal Entomological Society has given me this opportunity; I look forward to my year ahead and my future years in entomology.

James Rowland

As a young boy I fondly remember my grandfather excitingly pointing out White Admiral butterflies present in woods close to where we lived; his passion sparked my enthusiasm and I could soon name most of the common butterflies. My interest in entomology led me to study Zoology as my BSc subject, during which I developed a more rigorous taxonomic understanding of the sheer diversity of insects present, even within a species-poor area such as the UK. With an obsession for entomology well established, I undertook my dissertation on the differing Carabid assemblages on a lowland heath site. I was able to map different Carabid assemblages present within four isolated valley bog systems at the site and returned a year later to conduct further trapping.

While at University I discovered the British Entomological and Natural History Society (BENHS) and attended various workshops run by the society. During an *Introduction to Diptera* course I was amazed at how little we know about certain species in terms of life history and abundance, especially in less accessible orders such as Diptera. By studying entomology at Harper Adams, I hope to focus solely on my passion and, after completing the course, to assist in improving our understanding of individual species ecology and identification.

The *Commercial and Practical Biological Control* module is of particular interest to me since paying a visit to Wye Bugs and meeting Dr Mike Copland and Sue Stickels. I was fascinated by the use of natural parasitoids to control populations of pest species such as the Citrus Mealy Bug (*Planococcus citri*), instead of relying on broad spectrum

pesticides. After talking with Mike and Sue I am keen to learn more on the potential of developing novel applications of biological control on commercial systems such as the use of parasitoids on controlling muscid flies on poultry farms.

The *Biodiversity and Ecosystem Services* module intrigues me. I am interested in merging the ideas of biodiversity conservation with ecosystem service provision. I would like to use these ideas in my research project to examine how habitat recreation for rare bumblebee species in the Romney Marsh area has impacted on the larger pollinator assemblage. This would allow a determination of any possible benefits for the diversity of pollinator species present and an assessment of their ecosystem service to the agricultural systems that dominate the area.

In the past year I have been volunteering with my local wildlife trust and working at an ecological consultancy to earn sufficient funds to pay the tuition fees for the MSc. I am extremely grateful for the receipt of the Royal Entomological Society bursary. The receipt of the scholarship has enabled me to completely self-fund the master's and hence minimise any debt that I have already accrued from completing my BSc. I will now be able to enhance my entomological skills in the future by attending identification courses and field meetings such as those run by the Natural History Museum. Attending these extra-curricular activities will assist me further in developing a career in entomology.

Hayden Yates-Walmsley

I have selected to study entomology as the natural world has always captivated me throughout my life, and insects have always been a huge part of that journey. During my bachelor's degree, I chose to write my first entomological literature review on the unique polyphenism of *Nemoria arizonaria*, which is still yet to be fully understood. This sparked a huge passion within me as it combined my interest in the natural world, problem solving and doing something to positively impact global issues. I then realised that what once was a childhood fascination, could be a professional and enticing career, where I could contribute to existing research and hopefully be a part of implementing entomological measures and solutions to issues on a global scale. Since my first year of undergraduate study I have aspired to attend Harper Adams University to become an entomologist. Being awarded the chance to study entomology at Harper Adams University is an incredible opportunity, and one I intend to seize wholeheartedly. I have consistently proven throughout my previous studies and work experience, that when presented with an opportunity I strive to achieve as highly as I can.

Biodiversity and Ecosystem Services is a course module I am particularly interested in, as I am eager to expand my current knowledge on insects' response to climate change, from an agricultural perspective. The IPCC reported several gaps within the research on climate change and ecosystem goods and services, such as phenological monitoring across crop–pest–natural enemy food chains. My undergraduate dissertation followed a similar topic and I hope to build upon my current knowledge, using this module, to focus on integrating biodiversity conservation within agriculture for my thesis. I am excited to begin my postgraduate thesis, as well as to enhance my research skills. I believe that the *Research Project* module will be very advantageous to me, as I can acquire essential research career skills and work with the knowledgeable professors and staff members at Harper Adams University.

This scholarship represents an opportunity to focus my attention on laying the foundation of my future career. As I am not coming from a biological science undergraduate degree, I feel I may need to work harder to ensure I fully comprehend the more scientific aspects of the course. Whilst completing my master's degree I would relish the opportunity to network and secure relevant work experience within the field, possibly through unpaid internships and networking events. With the financial aid provided by this scholarship I am thereby able to cover additional fees and travel costs. Furthermore, I may prioritise opportunities such as extra-curricular activities alongside my course, which will increase my employability. I am deeply grateful to have been awarded one of the RES MSc Scholarships.

JOURNALS AND LIBRARY

Invasive insect pests: a growing problem? Recent research published in Agricultural and Forest Entomology

Allan Watt, Barbara Ekbom and Hefin Jones
Editors of Agricultural and Forest Entomology

Invasive insects, including a wide range of agricultural and forest pests, feature strongly in recent papers published in *Agricultural and Forest Entomology*.

The phenomenon of invasive species is far from new. The greenhouse whitefly (*Trialeurodes vaporariorum*), for example, was introduced to the UK about 160 years ago (Kareem *et al.*, 2019). Many major pests have spread far from their original range. The woodwasp species *Sirex noctilio* is native to Europe, Asia and North Africa, where it is a minor pine pest. It has spread to become a major pest in Australia, New Zealand, South Africa, South America, north-eastern North America and north-eastern China (Hajek *et al.*, 2018). Such pests may originate from almost any part of the world. The red gum lerp psyllid (*Glycaspis brimblecombei*), for example, is native to Australia, where it feeds on *Eucalyptus*. It was first recorded in the USA in 1998, then Mexico, Chile, Brazil, Argentina, Ecuador, Venezuela and Peru (Cuello *et al.*, 2018).

Many new pests have been added to the number of long-established pests, including the western conifer seed bug (*Leptoglossus occidentalis*) native to North America but now introduced to most of Europe, parts of Asia and North Africa (Farinha *et al.*, 2018). Another example is the brown marmorated stink bug *Halyomorpha halys*. Originating from Asia, it was introduced to the USA in the mid-1990s where it has become a serious agricultural and nuisance pest across the country, as well as in Canada and many European countries (Morrison *et al.*, 2018). Although *H. halys* is known to feed on over 100 host plants, it is also a serious nuisance pest in buildings. Natural overwintering sites include the underside of the bark of standing dead trees, but it is better known for its habit of infesting buildings during autumn. Huge numbers of insects may settle on and inside homes and other buildings in rural landscapes. *Halyomorpha halys* prefers darker coloured homes built with natural materials despite these buildings being less common in the landscape (Hancock *et al.*, 2019).

Sirex noctilio, a wood-boring pest of pine trees, native to Europe, Asia and North Africa and an invasive pest in many other parts of the world. (Photograph from Ann Hajek, Department of Entomology, Cornell University, Ithaca, New York, U.S.A.)

Infestation of the brown marmorated stink bug *Halyomorpha halys* on a building in the mid-Atlantic region of the USA during a citizen science survey of 18 States in 2013-14 (Photograph: Tracy C. Leskey, Appalachian Fruit Research Station, Kearneysville, West Virginia, USA); Right: Adult *Halyomorpha halys* (Hemiptera: Pentatomidae) hiding among the leaves of tree of heaven, *Ailanthus altissima*, one of its preferred hosts in the USA (Photograph: Rob Morrison, USDA-ARS Center for Grain and Animal Health Research, Manhattan, Kansas, USA).

Perhaps most focus on invasive pests has been on those introduced from their original range to other parts of the world. In addition, entomologists have studied native insects that are expanding their range. A current example is mountain pine beetle (*Dendroctonus ponderosae*), which has recently expanded its range eastwards across North America (Shegelski *et al.*, 2019).

Although insects naturally spread across the globe, human activities are well-known to have greatly increased their dispersal and the chances of them becoming pests in new parts of the world. The oak processionary moth (*Thaumetopoea processionea*), for example, was first recorded in the UK in 2006 after being accidentally introduced through the importation of infested oak trees (Williams & Jonusas, 2019).

The close relationship between temperature and insect development means that the spread of insect pests is constrained by climate and, therefore, likely to be affected by climate change. The two spotted oak buprestid (*Agrilus biguttatus*) is an important secondary pest of oak, strongly linked to Acute Oak Decline in the UK. Research on its life history and thermal requirements has shown it to be thermally limited in the UK and indicated that its distribution, and potentially that of Acute Oak Decline, will be affected by climate change (Reed *et al.*, 2018). Similarly, the polyphagous shot hole borer (*Euwallacea* nr. *fornicates*), an ambrosia beetle native to South-east Asia that has invaded southern California (as well as other parts of the world), is likely to spread into areas warm enough to allow them to complete a generation but with winter temperatures not cold enough to kill them (Umeda & Paine, 2019). In contrast, the abundance of the highly polyphagous spotted wing drosophila (*Drosophila suzukii*), native to East Asia and first recorded in both the USA and Southern Europe in 2008, is limited by high temperatures and dry conditions (Eben *et al.*, 2018).

Current research on invasive pests includes work on invasion history, which has benefited from the use of molecular techniques (Kareem *et al.*, 2019), dispersal (Shegelski *et al.*, 2019) and the microbes introduced along with insects (Hajek *et al.*, 2018). The relationships between invasive pests and their host plants has been the topic of several recent papers, including research on how the larval performance of the emerald ash borer (*Agrilus planipennis*) is enhanced on stressed trees (Rigsby *et al.*, 2019), phenological synchrony between European pine sawfly (*Neodiprion sertifer*) and its new hosts in North America (Chorbadjian *et al.*, 2019) and the host plant stimuli affecting foraging by *H. halys* (Morrison *et al.*, 2018).

Experimental girdling of a Manchurian ash tree as part of a study to determine how larval performance of emerald ash borer *Agrilus planipennis* is enhanced on stressed trees (Chad Rigsby, Department of Biological Sciences and Environmental Sciences, Wright State University, Dayton, Ohio, U.S.A.)

The pine sawyer beetle *Monochamus galloprovincialis*, vector of pinewood nematode *Bursaphelenchus xylophilus* in Europe.
(Photograph: Inge van Halder, INRA, University of Bordeaux, France)

The role of natural enemies is also a topic of recent research on invasive pests. Native predators have been shown to have the potential to have a significant impact on introduced species. White-footed mice (*Peromyscus leucopus*), for example, reduce populations of the gypsy moth (*Lymantria dispar*) in North America, an impact enhanced by oak forest thinning (Larsen *et al.*, 2018). Native parasitoids may also play a role in natural control of invasive pests. The weevil *Pissodes* sp. was introduced to South Africa in the 1940s but it was only recently discovered that a native wasp *Pycnetron pix* attacks it, leading to the possibility of using this parasitoid for augmentative biological control (Wondafrash *et al.*, 2018).

Management of invasive species is the major theme of recent research. Monitoring the spread of these pests is clearly a priority. Pheromone trapping programmes have been designed for many species, including the oak processionary moth in England (Williams & Jonusas, 2019) and pine sawyer beetle (*Monochamus galloprovincialis*), the vector of pine wood nematode (*Bursaphelenchus xylophilus*), in France (Jactel *et al.*, 2019). Citizen science is an additional option for monitoring invasive pests and was used to study the overwintering site preferences of the brown marmorated stink bug discussed above (Hancock *et al.*, 2019).

Recent research on pest management also includes cultural control of the European grapevine moth (*Lobesia botrana*) (Moosavi *et al.*, 2018) and sterile insect management of the false codling moth (*Thaumatotibia leucotreta*) (Boersma *et al.*, 2018). The potential of using plant resistance against invasive pests has also been explored. Although the red gum lerp is a worldwide pest of *Eucalyptus*, not all species are equally susceptible to this psyllid, which has a higher mortality on *E. dunnii* than *E. camaldulensis* (Cuello *et al.*, 2018). Understanding the mechanisms of resistance in hosts in the native range of insects may facilitate breeding for resistance in their introduced range. To this end, research on resistance to the emerald ash borer was investigated on its native host, Manchurian ash (Showalter *et al.*, 2018). The higher resistance of the native host is conferred by phloem traits that affect larval performance, and lower oviposition, opening the way to breeding resistance traits into trees in its introduced range.

The problems caused by invasive pests show no sign of slowing down. Many existing pests are likely to cause further problems when, as seems likely, they become introduced to other suitable parts of the world. The spruce bark beetle (*Ips typographus*), for example, is already a serious forest pest in its native Europe and recent research suggests it would pose a similar threat to spruce forests in North America if introduced there (Flø *et al.*, 2018). Many more unexpected pest problems will, no doubt, occur as insects continue to spread and become established across the world. In Great Britain, for example, between 1 and 13 new invertebrate pests were reported each year between 1970 and 2013 (Smith *et al.*, 2018).

We can confidently predict that the pages of *Agricultural and Forest Entomology* will continue to report the science of invasive insects for many years to come.

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Library News

Val McAtear

Recently, well relatively recently, the editors of *Antenna* decided that it would be useful to produce an index to *Antenna*. There is a printed index for 1977-2001, but nothing covering the later issues.

After discussion, I suggested that the most useful way to achieve this would be to add *Antenna* articles to the Library database under the media type "Antenna". It would then be accessible to everyone as long as they have a PIN number for the database. I have therefore enjoyed the last few months browsing through the issues of *Antenna* from 2002 and entering all the papers into the database. It has brought back many happy memories of people and events.

If you would like to look through the index the first step is to email me (lib@royensoc.co.uk) a request for a PIN number for the library database. Then you can go to http://heritage.royensoc.co.uk/ enter your Fellowship/Membership number followed by the PIN and you have entered the database. The next step is to do a guided search with the media type "Antenna" and that will only show the papers in the *Antenna* index. However, the whole database is a wonderful window on the RES library and well worth exploring. We are always adding new books, donated books and papers, and old papers held in our reprint collection. As yet the archives are not included in the database - that is a future project.

I would like to thank the following for donating books to the Library:

Densey Clyne:
My encounters with minibeasts

Henry Disney:
Regaining life's winding trail

Robin Edwards & Nicholas Donnithorne:
Ash, E.C. *Ants, bees and wasps: their lives, comedies and tragedies*; Réaumur, M. de. *Histoire des guêpes*

Paul Green:
World crop pests: Soft scale insects parts A and B

Alan Henderson:
Minibeasts: True rulers of our world and the key to our survival

Declan Murray, Jim O'Connor & Patrick Ashe:
Chironomidae (Diptera) of Ireland; A review, checklist and their distribution in Europe

Wallace Peters:
A collection of volumes including a special copy of his book *Ethiopian butterflies*

David Pinniger:
Pests of houses great and small

Isabel Thomas & Daniel Egneus:
Moth: An evolutionary story

Thomas Turner & Vaughan Turland:
Discovering Jamaican butterflies and their relationships around the Caribbean

Graham White:
Runs of the *Journal of Medical Entomology* & *Mosquito News* along with several books

We are always grateful to those who consider donating to the Library, but as there is only a finite amount of shelf space we do have to be a little picky and only accept items in good condition that do not duplicate our holdings and that are not accessible on the web. In general because of these conditions we do not accept collections of reprints.

SOCIETY MEETINGS

ENTO'18, the Royal Entomological Society Annual Meeting: a Forest Entomologist's Perspective

Anne Oxbrough
Edge Hill University, UK

Edge Hill University hosted the Royal Entomological Society's annual major science conference between 28th and 31st August 2018. The theme of the conference was '*The good, the bad and the ugly'* although it's hard for entomologists to label any insect as ugly. The conference was a great success with 110 delegates from the UK, Ireland, mainland Europe, USA, Pakistan, South Africa and Nigeria. The presenters represented universities, NGOs and Small and Medium Enterprises (SMEs).

Conference sessions were themed around the Society's journals and Forest Insects and their allies were well represented, with a session dedicated to *Agricultural and Forest Entomology* chaired by David Williams of Forest Research.

In this session presentations covered diverse topics including climate change issues *(Investigating short term effects of elevated carbon dioxide on forest insects: One year of data from BIFoR FACE* by Liam Crowley, University of Birmingham) and pest species (*Entomopathogenic fungi on* Dichomeris eridantis *(Lepidoptera: Gelechiidae) larvae, an important insect pest of Indian rosewood* (Dalbergia sissoo), by Gunjan Srivastava of Forest Research Institute, Dehradun (Uttarakhand, India)).

Further forest-related talks were given in the *Insect Diversity and Conservation* session chaired by Simon Leather of Harper Adams University, and the *Insects and Society* session chaired by Peter Smithers of the RES and Plymouth University. Presentations included *Edge effects and relic populations among* Corticolous *collembola in Richmond Park, Surrey* by Peter Shaw of Roehampton University and *Recording insect species with citizen science in Italy: scientific outputs on saproxylic beetles* by Alessandro Campanaro from Council for Agricultural Research and Economics, Italy.

Insect Genomics Special Interest Group Meeting

University of Leicester

14th September 2018

Richard Harrington

Leicester has a strong team working on the genetics of sociality in insects, which was reflected in many of the presentations, including that of keynote speaker Yannick Wurm (Queen Mary University of London). Fire Ants (*Solenopsis invicta*) were introduced to Alabama in the 1930s. They are highly invasive and aggressive and one in every four people in the south-eastern USA gets stung in a given year. The ants have two social forms under balancing selection: one form with single queens and one form with multiple queens. Single-queen colonies have a large queen which can migrate long distances, whereas multiple-queen colonies have dozens of smaller queens which tend to stay local and lead to larger colonies. Whether a colony has the single- or the multiple-queen form is controlled by a supergene complex of more than 400 protein-coding genes, which occupies about two thirds of a chromosome, the "social chromosome", or 4% of the total genome. The supergene complex has two variants, SB and Sb. If a colony includes only SB/SB workers, they will accept a single queen, and she must be SB/SB. However, if half of the workers in the colony carry the Sb variant of the supergene (i.e., if they are SB/Sb), the colony will accept multiple queens, all of which must also be SB/Sb. Recombination between SB and Sb is suppressed throughout the supergene region. This suppression results from there being large inversions between SB and Sb (the DNA is flipped around). Furthermore, Sb/Sb individuals do not reproduce, thus Sb lacks recombination opportunities. As a result, Sb has many more long terminal repeat transposons,

Left to right: Craig Wilding and Liz Duncan (presentation judges); Katherine Beadle and Hollie Marshall (organisers); Lyam Baudry (presentation winner); Charlie Durant (poster winner); Yannick Wurm (invited speaker and poster judge); Richard Gill (poster judge).

microsatellites and centromeric satellites than SB. As a result, Sb is about 80% longer than SB, a process called degenerative expansion, whereby mildly deleterious mutations are gradually accumulated, followed by a slow degradation of functional elements, and compensatory mutations elsewhere in the genome. The work suggests that the advantages of having several queens outweigh the costs of the unfavourable mutations in the supergene region. The topic was explored further by Yannick's colleague Carlos Martínez-Ruiz, who provided evidence for the evolution of the social chromosome system being shaped by social antagonism between the two social forms, which have diverged only in the last half million years.

Rob Hammond (University of Leicester) presented evidence that a large and contiguous genomic region is involved in the social polymorphism of another ant, *Leptothorax acervorum*, even though the social organisation of this species differs from that of *S. invicta* in that social phenotypes are restricted to particular populations. In monogynous (but not polygynous) populations, workers disable all the queens except one, and will kill them if they try to reproduce. The genomic region involved in this behaviour does not have shared synteny with that of *S. invicta*, indicating independent evolution, and divergence is low, indicating recent origin (tens of thousands of years).

In other work, Yannick found that chronic exposure to neonicotinoids affects gene expression in bumblebee heads, the effect being stronger for clothianidin than imidacloprid and stronger in workers than in queens. Many questions remain to be answered but Yannick hopes that the work will lead a tool enabling the detection of hitherto undetected impacts of neonicotinoids, which could be used by regulatory agencies to quantify toxicity.

One of the meeting organisers, Katherine Beadle (University of Exeter), is also studying differential impacts of neonicotinoids on bees. The Red Mason Bee (*Osmia bicornis*) has low sensitivity to certain neonicotinoids but not others, the difference relating to the complement of cytochrome P450 enzymes present. It is hoped that this work will lead to the design of novel bee-safe insecticides and screening tools for new insecticides.

Honey Bees (*Apis mellifera*) store pollen, mixed with some nectar and saliva, as "bee bread" in a ring around the brood nest. Nutrition is gradually released from the pollen to sustain the brood. Phil Donkersley (Lancaster University) is using metagenomics approaches to identify the microbial community associated with this bee bread, and its functional roles. Working with the British Beekeepers Association in parts of northwest England, 472 bee bread samples from 30 hives were collected, and their associated microorganisms identified. Microbial alpha diversity appeared to be positively correlated with plant diversity, and probably affects hive function.

Phenotypic plasticity goes to extremes in social insects. Eamonn Mallon (University of Leicester) looked at differences in gene expression, linked to methylation, between queenless reproductive workers and queenless non-reproductive workers of the Buff-tailed

Bumblebee (*Bombus terrestris*). Two hundred and three genes showed differential methylation and, if treated with a cancer drug that wipes out methylation, non-reproductive workers became reproductive workers. The functional role of methylation/demethylation is not yet known. Eamonn plans to change this by using CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) to methylate/demethylate individual genes rather than the whole genome, which has not been possible until recently.

In the absence of queen mandibular pheromone (QMP) and brood pheromone, worker bees can lay unfertilised eggs. Liz Duncan (University of Leeds) is investigating the genome-wide response to QMP in Honey Bee ovaries and has found that differentially expressed genes (about a third of the Honey Bee genome) are organised in clusters, which have an evolutionary history pre-dating the lineage leading to Honey Bees. Furthermore, the complexes are marked differently in repressed worker ovaries by common chromatin modifications, suggesting that these regions are preconfigured to respond to the loss of QMP. Such mechanisms imply that QMP responsiveness has shaped the evolution of the Honey Bee genome.

Colony collapse disorder (CCD) in Honey Bees is still poorly understood. This has led to considerable effort in sequencing candidate contributory pathogens such as deformed wing virus (DWV). Other arthropods, such as ants, coexisting with Honey Bees, succumb to viruses that are less well studied and it is possible that some of them may infect bees. Viruses of *Varroa* mites, which parasitize bees, may also infect the bees themselves. Katherine Brown (University of Cambridge) has developed a computational pipeline to identify transcripts of +ve sense RNA viruses of the family Iflaviridae in publicly available RNA-seq databases. Eight candidates for major contributors to CCD have so far been detected, all closely related to DWV.

The haplodiploid wasp *Nasonia vitripennis*, a parasitoid of blow flies, is a model organism for the study of sex selection. Cues for sex allocation include the number of foundresses in a patch and the number of previously parasitized hosts. Alun Jones (University of Leicester) used two published RNA-seq datasets to investigate the role of alternative splicing (whereby a single gene can encode for multiple proteins) in sex allocation. Foundress number had no effect on alternative splicing. Comparisons between parasitized and non-parasitized hosts have yet to be done.

Significant strides in reducing the prevalence of malaria have been made in the last ten years as a result of insecticides, but insecticide resistance in *Anopheles gambiae* is a major threat. Selective pressure leaves a genetic footprint, and Nick Harding (University of Oxford) performed a genome-wide search for signals of selection in populations of *A. gambiae* from eight African countries. Loci under selection include many known to be associated with insecticide-resistance mechanisms, but Nick found seven novel loci. Four of these had a plausible role in insecticide resistance.

Much of the work described in the above talks depends on assembling complete chromosomes of large genomes, which constitutes a massive technical challenge. Lyam Baudry (Institut Pasteur) presented instaGRAAL, a fast, open-source program to scaffold contigs based on the collision frequency between DNA sequences and the nucleus. The assembly software and associated polishing pipeline results in high quality chromosome-level assemblies.

An excellent raft of posters was available during the breaks and for a dedicated session after the talks.

Amy Withers (University of Lancaster) used transcriptomic approaches to study how infection with *Spodoptera frugiperda* nucleo-polyhedrovirus influences migratory flight ability in male and female Fall Armyworms (*Spodoptera frugiperda*), previous flight-mill experiments having shown that infection compromises the migratory ability of males but not females. Transcriptomic variation in the response of each sex to virus infection and flight were highlighted.

Melanie Brien (University of Sheffield) combined genetic and phenotypic data to compare the genetic basis of the iridescent structural colour in two mimetic *Heliconius* butterflies, *H. erato* and *H. melpomene*. Although both species occur across Central and South America, only subspecies found in Ecuador and Colombia sport the bright, highly reflective blue colour. Crosses of iridescent and non-iridescent subspecies were made and F1 and F2 offspring used in the analyses. Five loci controlling variation in iridescent colour in *H. erato* were found, one of them on the male sex (Z) chromosome. Females with an iridescent father were brighter blue than those with a non-iridescent father. Males were always bright blue. Results from the phenotypic analyses suggested that this is similar in *H. melpomene*, although the sex linkage is less clear.

Meeting co-organiser, Hollie Marshall (University of Leicester) is looking at bumblebees for evidence of "genomic imprinting" whereby only one allele of a gene is expressed in a diploid organism (often through methylation/demethylation), expression depending on the sex of the parent from which it came. Four reciprocal crosses of *B. terrestris audax* and *B. terrestris dalmatinus* have been made and whole genome sequencing of the parents done to allow parental alleles in the offspring to be determined. RNA-seq of head and abdomen tissue from reproductive and non-reproductive workers were then analysed to identify imprinted genes. Alongside this, parent-of-origin methylation in four more reciprocal crosses was identified. The data are being paired to identify possible imprinted genes, shedding light on Haig's Kinship theory as a possible explanation for genomic imprinting.

David Pritchard (University of Leicester) ran experiments to study pre- and post-transcriptional processes that effect the switch to reproduction in Buff-tailed Bumblebee (*Bombus terretris*) workers. Queenless colonies were fed 10HDA (10-hydroxy-2-decenoic acid) and HDACi (histone deacetylase inhibitor) components of Honey Bee royal jelly, which are known to influence caste fate. Neither had any effect, demonstrating that the stimuli causing reproduction in *B. terrestris* workers are likely to be different from those influencing caste fate in *A. mellifera*.

In similar vein, Sandra Moreno (University of Bristol) looked at transcriptional gene expression patterns associated with the reprogramming of paper wasp *Polistes lanio* workers to queens as a result of the death of an existing queen. During the queenless transitioning period some workers fight to gain monopoly of egg-laying. Five

hundred genes were found to be differentially expressed between queens and transitioning wasps and more than 5,000 between workers and transitioning wasps. Wasps in transition are a distinct phenotype, suggesting that transitional wasps must reprogram their behaviour and physiology.

Using a range of bioinformatics tools, Lauren Mee (University of Liverpool) sought interactions between sociality and immunity by identifying signatures of site-specific positive selection across the whole transcriptomes of 11 bee species, focussing on where these signatures occur in immunity-associated genes and then comparing these patterns across different social lifestyles.

In spite of their existence as close-knit colonies and their use of antibiotics to combat infection, ants, it seems, do not suffer from antimicrobial resistance. Charlie Durant (University of Leicester), best poster winner, is studying the bacteriophages of ants through metagenomic analysis of phage in the midgut. It is hoped that the study will lead to the discovery of new ways in which microorganisms are controlled, and that this may have relevance to control of human diseases.

I couldn't stay for the wine reception, but doubtless conversation continued and, perhaps, became even livelier and more broad ranging.

At the previous meeting of this group, Hollie Marshall (University of Leicester) and Katherine Beadle (University of Exeter) kindly offered to organise this Leicester meeting. What a fantastic job they did! Both are PhD students and both said that organising the meeting was a great experience. They set a trend; at the Leicester meeting Amy Withers and Phil Donkersley offered to organise the next one at Lancaster University, and we even have a potential offer from the University of Oxford for 2020. Many thanks to them all – the meetings will, I'm sure, be equally good.

Ento Outreach Special Interest Group Meeting

National Museum of Scotland, Edinburgh
29th November 2018

Richard Harrington

Introduction

A meeting that started off as the Public Understanding of Entomology SIG ended, by popular demand, as the Ento Outreach SIG – good decision. And a wonderful, eclectic set of outreach projects was represented by their proponents. There were three main themes, that overlapped to a considerable extent: public engagement, enthusing children and fusing science with art.

Public engagement

Keynote speaker was Helen Roy (Centre for Ecology and Hydrology), on the very day that her new book (with Peter Brown, and amazing illustrations by Richard Lewington) *Field Guide to the Ladybirds of Great Britain and Ireland* (Bloomsbury Wildlife Guides) was published. Helen is in demand worldwide, for her knowledge of ladybirds, and the UK Ladybird Survey, which she leads, is the epitome of citizen science projects. Helen described the technological advances that have encouraged ever more people to become involved in wildlife recording, and the research opportunities such data present, but stressed the importance of retaining the "old-fashioned" engagement methods preferred by some. It's not always straightforward. A call for sightings of Asian Hornet (*Vespa velutina*) led to an inundation of sightings of European Hornet (*Vespa crabro*), every record requiring verification. There have been fewer than ten UK reports of *V. velutina*, every one leading to eradication as a result of an efficient Defra rapid-response force. Helen stressed the joy of recording wildlife and the ever-present opportunity for new discoveries on one's doorstep. She was recently responsible herself for the first Oxfordshire record of the ladybird *Scymnus interruptus*.

Nick Howe and Liam Crowley (both University of Birmingham) also highlighted the role of new media in two-way science communication, but warned of the challenges facing such platforms in the light of recent data protection breaches and "fake news" issues. They focussed on podcasting (see also their article in *Antenna* 42(3) 136–137), disposing of the myth that people's concentration spans are becoming ever shorter by showing that people will listen to lengthy podcasts if the content is good.

In order to improve understanding of the potential vectors in Europe of *Xylella fastidiosa*, a bacterial pathogen causing diseases such as olive quick decline, SASA ran a citizen science survey to collect cuckoo spit samples containing the insect nymphs together with host-plant material. Katherine Lester's poster showed *Philaenus spumarius* to be the most abundant vector species in Scotland, feeding on a surprisingly wide variety of plants, including trees.

Gabrielle Flinn (RSPB) outlined the "Rare Invertebrates in the Cairngorms" project, which has engaged landowners, governmental bodies, local communities, funders and the on-line community, again using many different media. The biggest survey is for Kentish Glory (*Endromis versicolora*), now found in the UK only in the central highlands of Scotland. Gabrielle emphasised the importance of enthusiasm, humour, emotion and marketing in science communication.

Staying in Scotland, Craig Macadam (Buglife Scotland) explained how a

The bites of the round table.

The Outreachers.

quarter of MSPs have become Species Champions for invertebrates, vertebrates and plants. This had led to a much higher profile for conservation in parliamentary debates and to valuable practical actions. Whilst similar schemes exist in Westminster and the Welsh Assembly, they have not become so firmly embedded as in Scotland. For more details see page 10.

As elsewhere, Ireland's pollinator species are in decline. A poster from Katherine Burns (University College Dublin) explored public knowledge and views on pollinators. She found that there are negative perceptions of some pollinators which need dispelling, and critical knowledge gaps that need filling, if there is to be effective promotion of work to protect Ireland's pollinators.

It is fair to say that the majority of public engagement involves species of conservation concern, or at least species that are beneficial. Gary Needham (Syngenta), redressed the balance to some extent by including the need for pest control in public discussion. Jealott's Hill welcomes around 150 visits a year from overseas colleagues, school and higher education groups, youth clubs, political figures and the media.

A major role of museums is, of course, public engagement. Zoë Simmons (Collections Manager at Oxford University's Hope Museum) explained how this is achieved at her Museum, which hosts the second largest entomology department in the UK. She described the "HOPE for the future" programme which aims to transform accessibility of the Museum's resources, involving rehousing all 1.1 million British insects in the collection. Ashleigh Whiffin (National Museums Scotland) showed how social media has revolutionised the way museums and collections around the world communicate with the public, and described the SCOPE framework (Strategy, Content, On-line, Platforms, Evaluation) aimed at making collections more accessible in this way. The framework was produced in collaboration with researchers at CSIRO, Australia (full paper freely accessible on-line via the *Annals of Entomological Society of America*).

Open spaces also have a vital role in enthusing the public about insects, of course. Alice Laughton (The Royal Parks) presented "Mission Invertebrate" aimed at discovering, celebrating and protecting the invertebrates inhabiting the 5,000 acres of London's Royal Parks, which attract 77 million visitors a year. Displays, self-led activities, hands-on experiences, story-telling, dressing up and take-home exercises engaged 6,000 people in the first year of the project.

Enthusing children

Sally-Ann Spence (Minibeast Mayhem) is dedicated to enthusing children, especially of primary school age, about insects. Keen to work with adults too, she hosts workshops at her research centre on her family farm near Swindon. Working in schools, she takes entomology into the classroom using hands-on learning techniques with live invertebrates. She explained the challenges in designing educational material, and in overcoming children's (and teachers') phobias.

In the North Pennines Area of Outstanding Natural Beauty, *Coldblooded and Spineless* is an ambitious partnership project which aims to record and celebrate invertebrates in the uplands. Samantha Tranter (North Pennines AONB Partnership) showed how curriculum-linked activities in arts and science have created four art trails to highlight the value of invertebrates.

A new generation of children is being introduced to one particular insect order, the Coleoptera, through Maya Leonard's astonishingly successful *Beetle Boy* books (see reviews in past *Antenna* issues), aimed at 8–13-year-olds. The books have been translated

Drawing favourite insects.

Apithanny Bourne and the drawings.

into 40 languages. Their success is the more extraordinary bearing in mind that Maya is not an entomologist and only started learning about beetles two or three years ago with the help of experts well-known to most *Antenna* readers. She has gone to great lengths to ensure that the beetle facts are correct albeit, of course, that the stories are fictional. She believes that she has already reached 6 million people and is now writing the screenplay for ten one-hour programmes, hopefully destined for internet streaming.

Fusion of science and art

Insects feature in many art forms. Maya's stories (above) are an example. Anthony McCluskey (Butterfly Conservation Scotland) gave examples of stories he tells to help engage the public with the world of butterflies. The mass migrations of Painted Lady (*Vanessa cardui*), the bizarre relationship between Large Blue (*Maculinea arion*) and ants (*Myrmica sabuleti*), and the changing fortunes of the Northern Brown Argus (*Aricia artaxerxes*) are examples lending themselves to such narrative. Anthony cleverly compared the heroes and plots of these stories to those of well-known films, *Gone with the Wind* in the case of the Painted Lady – you get the idea.

The stories of the Painted Lady migrations and the Large Blue association with ants, feature in poems by "yours truly" from a new book, *The Butterfly Collection*, which is the first to celebrate each of our 58 UK butterfly species in verse. After outlining how my butterfly hobby began at the age of 8 and emphasising the potential for sparking an interest in primary-school aged children in particular, I invited delegates to choose butterfly species, poems about which I then read. Unsurprisingly, bearing in mind our location, Scotland's specialists were to the fore. These poems, though, are aimed more at adults than children.

Artist Apithanny Bourne showed some incredible examples of insects in street art, aimed at drawing attention to important ecological issues. There is no doubt that these spectacular works are a powerful and underused communication tool capable, in Apithanny's words, of inspiring awe and connecting with people on an emotional level. Each delegate was given the wherewithal to draw their favourite insect and say why it holds that position. For more details see page 12.

Ways forward

Chris Jeffs (British Ecological Society) emphasised the importance of supporting emerging communicators in developing their skills. Learned societies and organisations involved in public engagement can help the career development of students and the delivering of research impact. Conversely, students and researchers are essential in fulfilling the strategic aims of those organisations. Chris hoped that the BES and RES could work together in promoting public engagement.

Luke Tilley (RES Chief Executive) concurred, and led a discussion on next steps. Many excellent suggestions were put forward and these will be added to those made at the inaugural meeting of this SIG at *Ento'17* to form an on-line resource in due course.

Thanks

The National Museum of Scotland was a marvellous venue for the meeting, and huge thanks are due to Ashleigh Whiffin and her colleagues for making this an exceptionally enjoyable and productive event. Ashleigh, who has recently been invited onto the RES Outreach & Development Committee, also led a tour of the Museum's invertebrate collections the following day, at the National Museums Collection Centre. The Museum hosted the Insect Pollination SIG in October 2017. Hopefully we'll be back again.

Climate Change Special Interest Group Meeting

University of Birmingham
14th December 2018

Richard Harrington

Introduction

Those who trust their fellow scientists already know it. Those who listen to our Honorary Fellow Sir David Attenborough already know it. Climate change is a major threat to the future of humanity. At the opening ceremony of the United Nations-sponsored climate talks in Katowice, Poland, Sir David said, "If we don't take action, the collapse of our civilisations and the extinction of much of the natural world is on the horizon. The world's people have spoken. Their message is clear. Time is running out. They want you, the decision-makers, to act now."

As vital components of nearly all ecosystems, and with their particular sensitivity to temperature, the fate of insects in the face of climate change is critical to the fate of many other organisms. Thus, as entomologists, we have a role to inform and advise policymakers. Our SIG can play a part in this, and people came from as far away as Iraq, Sweden and Germany to do just that. We also welcomed several final year students from the University of Birmingham, who registered for the meeting as preparation for their 2019 module "Adaptation to Changing Environments".

The deep south

Veteran of Climate Change SIGs and of Antarctic research, Pete Convey (British Antarctic Survey) was our first keynote speaker. He began by pointing out that there are several biogeographic regions within the Antarctic. Only 0.2% of it (25,000 km^2) is ice-free, giving opportunity for life on land, but every bit of exposed land has life. In continental Antarctica there are many lichens and a few mosses, supporting a few tardigrades, rotifers and bacteria. Maritime Antarctica supports much more life, including two flowering plant species. Macroscopic algae cover a large area and these support abundant Collembola, "Antarctica's gazelles". A midge, 0.5cm long, is the largest land animal in Antarctica (Penguins and Elephant Seals are considered to be marine life!).

The Sub-Antarctic includes mountain ranges reaching 2,900m high. Above 300-400m these are ice-free. Tussock grass grows up to 2m tall and there are 60 or so flowering plants and several insect species. In 2005, a hoverfly invaded, which could be a pollinator should plants requiring pollination arrive, thus threatening existing ecosystems.

The Antarctic broke off from America 30 million years ago, and there is compelling evidence that some organisms, including insects, have been around for far longer than that. The level of endemism is incompatible with the theory that colonisation of terrestrial habitats has only occurred since the Last Glacial Maximum (LGM), about 12,000 years ago. Indeed, the only insect endemic to the Antarctic continent, the flightless midge, *Belgica antarctica*, is separated by more than 30 million years from its next closest relative in the Maritime Antarctic. Thus, Gondwanaland relics are present and molecular technologies support this notion.

Over the next century, there is likely to be a 50 to 100% increase in the area of ice-free land and procedures must be in place to protect it from alien introductions. Specially Protected Areas have been designated and agreements are enacted in the national laws of the signatory countries. The current protection network, however, underrepresents the range of biogeographic zones, and some parts of the Antarctic are not protected at all, leading to great concerns for many ecosystems as human activity increases and the climate changes.

The threat posed to the Antarctic by invasive species was picked up by Jes Bartlett (University of Birmingham). Wind and water currents provide natural barriers but can't stop the risk posed by 50,000 tourists and 5,000 scientists a year. Seeds and microbial life are brought in on shoes, clothing and food, and 1,376 invertebrates from 17 orders and 98 families have been intercepted in cargo and packaging over 13 years. Climate change is allowing ever more of these invaders to colonise.

Jes presented a case study for terrestrial invertebrate invasions. *Eretmoptera murphyi* is a parthenogenetic, non-biting, non-flying chironomid midge. It was endemic to South Georgia but was moved to Signy Island in an unfortunate transplant experiment in the 1960s. 85,000m^2 of Signy now harbour the midge and, in the sites where it occurs, it is by far the most abundant terrestrial organism. It has spread along footpaths and up to 410,000 larvae per m^2 have been found. By altering soil structure and nitrogen content, it knocks out a range of organisms including springtails, mites, tardigrades, rotifers and nematodes.

Diapause and pollination

Diapause is critical to the life-cycle of many insect species, as it enhances stress tolerance and coordinates growth, development and reproduction with annual cycles of favourable environmental conditions and food availability. Scott Hayward (University of Birmingham) explained how climate change may potentially disrupt diapause. It is usually induced in receptive stages of an insect's life-cycle by a set numbers of days with a photoperiod less than a critical value, the critical daylength (CDL). At higher temperatures insects may pass through the receptive stage before sufficient days below the CDL have occurred. If temperatures rise above a certain level after induction, insects may be tipped out of the diapause pathway. In some species, diapause may be shortened at abnormally high temperatures. Others

Fran Sconce and Nick Howe on registration.

may fail to terminate diapause through lack of a chill cue. Scott is modelling these phenomena to predict the impacts of climate change on, for example, pollination, and pest and disease outbreaks. He is also developing mitigation strategies.

Katrina Carter (University of Birmingham) is looking at the impacts of climate change on diapause in the bumblebee *Bombus terrestris audax*. Warmer autumns are preventing queens from entering diapause, resulting in colonies remaining active over winter, exposing them to combined stressors of low-temperature and pesticides. Katrina looked at whether sublethal doses of the neonicotinoid imidacloprid have any impact on their supercooling point (SCP). None was found, but SCP may not be good indicator of cold hardiness. Next, she will test whether there is any impact of imidacloprid on the bee's ability to undergo rapid cold-hardening.

The solitary bee *Osmia bicornis* is a particularly good pollinator of orchards. It has an obligatory diapause, as opposed to the facultative diapause explored by Scott and Katrina. Nick Howe (University of Birmingham) is interested in the impacts of climate change on this form of diapause which cannot be switched off by warming conditions. Instead, he found that higher winter temperatures increase the rate of lipid usage, such that the bees may run out of energy reserves before they terminate diapause and so cannot be replenished by feeding. Even a small delay to the start of winter leads to zero survival, probably for the same reason.

Our second invited keynote speaker was Deepa Senapathi (University of Reading) who is examining and modelling the spatial and temporal impacts of climate change on pollination by bees. Many bee species have shifted to higher latitudes. Models show that the Red-tailed bumblebee (*Bombus lapidarius*), for example, is expected to remain reasonably stable across Europe until the middle of the century but decline markedly thereafter, with concomitant risks to pollination. In response, apple orchards are likely to move north unless commercial pollinators are brought in. Climate change is advancing the phenology of bees, often faster than the plants they pollinate, leading to phenological mismatch. Social bees are advancing faster than solitary bees, and generalists faster than specialists. Deepa pointed out that there is a dearth of knowledge on how climate change will impact pollination by bees in the tropics.

It is clear from the above that there is much concern over the impact of climate change on pollination. Penelope Whitehorn (Karlsruhe Institute of Technology) plans to tie several strands together in an integrated assessment of the impacts of changes in climate and agricultural intensification on European bumblebee populations. Data on species distributions, land use and climate will be used to find factors associated with bumblebee distribution, and simulations will be run under change scenarios. Agent-based modelling of agricultural decision-making will identify which populations are most at risk in order to inform policymakers on appropriate interventions to maintain adequate pollination levels.

Forest ecosystems

An important recent development in climate change studies at Birmingham comes from the BiFOR FACE (Free Atmosphere Carbon Enrichment) facility (see *Antenna* 41 (3) pp 128-132). The hazel and oak woodland has nine FACE rings. Three of these produce the CO_2 concentration expected by 2050, 150ppm above current ambient. Three rings produce current ambient levels and three are controls blowing fresh air. There are also three "no-infrastructure" control plots. BiFOR Director, Rob MacKenzie, outlined the range of projects using the facility and said that the University has guaranteed funding it until at least 2026. Liam Crowley (University of Birmingham), who is flying the flag for entomology at BiFOR, explained that insect responses to elevated CO_2 concentrations could potentially change forest performance, although he has so far found no significant difference in the area of insect leaf mines in treatment and control plots.

Fire, logging and drought may not be possible in BiFOR, but Aradhana Roberts (Lund University) is looking at the increase in frequency of these disturbances around the world as a result of climate change, and impacts on insects. Case studies using litter traps in India (fire), Borneo (logging) and Peru (drought) show an increase in forest litter and herbivory following fire and logging, suggesting that herbivory could make a major contribution to nutrient cycling and influence ecosystem change in disturbed forests. In the case of fire, the increase in herbivory is due to new growth and fewer defences and in the case of logging it is due to increased light. Under drought conditions, herbivory

Lunch time discussions.

decreases because of increased leaf turgor and fewer insects. Understanding the effects of these disturbances in forest ecosystems could help to develop sustainable forest management practices.

Asian tigers in the UK?

The Asian tiger mosquito, *Aedes albopictus*, is a vector of more than 20 viruses of humans and animals. It first arrived in Europe in Albania in 1990 and spread to Genoa and along the Mediterranean coast. It has now reached as far as The Netherlands and Northern France, and Sören Metelmann (University of Liverpool) is concerned that it will arrive in the UK. Indeed, eggs were found in 2016 and 2017. The European strain does not seem to be more cold-adapted than Asian tropical strains, suggesting that data from Asia can be used to parameterise models relevant to Europe. Sören has developed a life-cycle model including human population, temperature, rainfall and photoperiod as variables, temperature being the most influential variable. London and south-eastern England are already suitable for colonisation and most of England and parts of Wales are expected to become so over the next 50 years.

From the Mesopotamian marshlands...

The Mesopotamian marshlands of southern Iraq are a World Heritage Site and comprise one of the biggest and oldest wetlands in the Middle East. They have faced dam construction, petroleum extraction, drainage programmes and wars in recent years. Climate change and water control in Iraq and upstream countries have led to water scarcity. Half the Marshland area is under serious threat of biodiversity loss as a result. So far, no studies have been done in the Marshlands to evaluate the impacts of climate change on insects. Ali Kareem (Kerbala University) aims to rectify that. Baseline data on genetic diversity will also be gathered.

... to the European highlands

Genetic diversity throughout Europe of the UK's one true alpine butterfly species, the Mountain ringlet (*Erebia epiphron*) reveals an interesting story, narrated by Melissa Minter (University of York). The presence of 29 mitochondrial DNA haplotypes that split before the LGM shows that the species has survived in long-term refugia throughout glacial and interglacial periods. This genetic diversity is at risk under expected climate change scenarios due to loss of suitable habitat. For example, the Lake District population is genetically unique. The butterflies are being forced to ever higher altitudes as the climate warms and in due course may have nowhere left to go. Future work will look at differences in the ecology, morphology, physiology and behaviour between English and Scottish populations, the hope being that the findings will inform conservation strategies.

And finally...

Many thanks to Scott Hayward and his colleagues at the University of Birmingham for organising and hosting an excellent meeting. Hopefully, we can find ways of getting the messages across to those with power and influence. Our hosts are at the forefront of relevant research and there was also strong contingent of their undergraduates, some at their first conference. These are the researchers of the future, and it is clear they gained a great deal from the meeting, having already posted comments back to Scott about how they hadn't realised the diversity of insect climate change research and how the meeting helped them to realise the uses of current research in tackling the challenges posed by climate change.

Honorary Fellow Interviews

Dick Vane-Wright

by Peter Smithers

Oxford was bustling on an unusually hot April day as I walked to the University Museum of Natural History to meet Dick Vane-Wright. He was at the museum to examine specimens and records of butterflies of the genus *Acraea*, from Kilimanjaro. This was part of a study with former student Steven Liseki, supported by the Leverhulme Trust, looking at altitudinal variation in butterfly communities on this iconic mountain. I meet Dick in the foyer of the museum, and as we walk to the quiet room that has been organised for us Dick describes the project with great enthusiasm, "I am still turned on by butterflies, even now I open a box and think wow, isn't that fantastic?". We arrive and settle down to discuss Dick's life in entomology.

What triggered your interest in insects?

"My aunt Margaret gave me a book on natural history for my seventh birthday. She wasn't a naturalist herself; it was just one of those things aunts gave their nephews back then. The book contained a series of monthly nature walks, each one accompanied by a colour plate that illustrated the plants and animals mentioned in the text. As my birthday was at the end of July, I turned to that month and found it was a hunt for butterflies. The plate was of butterflies feeding on a buddleia bush, so I took the book into the garden and found a buddleia. I looked at the book and then at the bush and back at the book. Every butterfly in the illustration was present on the tree and every butterfly on the tree was in the book. Looking back I wonder if that was true but at the time it was unmistakable for me. This switched me on to butterflies and to books, so thereafter I was a regular at the local library, hunting for books on butterflies."

"Shortly after this I was on my way to school when I spotted an unusual looking white butterfly. I did not have any collecting gear with me so I threw my school books at it and caught it. I looked it up and identified it as a Black-veined White – but the book said it was extinct in Britain so was I correct? I then persuaded someone to take me to the Natural History Museum and compared my butterfly, now pressed like a flower between the pages of a book, with the specimens in the public gallery. It transpired that I was right but I was then puzzled as to how I had caught a locally extinct species. I found out some years later that L. Hugh Newman (the person the BBC always consulted then if insects needed to be discussed) had been breeding them at nearby Lullingstone Castle. Most likely one had got away and ended up between the pages of my book."

"By the time I was ten, I was into beetles, moths, crane flies and a whole diversity of insects but strangely I was terrified of spiders. I would read about

them and found them fascinating but they really freaked me out. By the time I was twelve I was also interested in a wide range of sciences, such as astronomy, chemistry and engineering, and of course model airplanes. But then at thirteen, music struck and within a short time I was consumed by jazz. I took up the trumpet and practiced relentlessly, much to the horror of the people next door. By eighteen I had joined a local rehearsal band and it was there that I met Mike Osborne, an alto sax player who went on to gain an international reputation. At this point I realised that I did not have it; I was never going to make it as a jazz musician. Mike had that quality we call talent – but I did not. Over the years my interest in music has rather faded and I have become more and more interested in entomology, in fact I am more interested today than I ever have been."

How did you obtain your first job at the Natural History Museum?

"I had got into jazz via my older sister who was at art school; she brought jazz into the house but also lots of her girl friends, all of whom were very attractive. At that point I began to develop an interest in more than just jazz and entomology! One of her friends, Joanna, had acquired a brief job as an illustrator for a new botany gallery at the NHM. I was talking to her one day and said, "I'm not sure what to do now my music career is not going to happen".

"So what do you want to do?" she asked.

"I'm interested in insects."

"I work at the Natural History Museum" she said, "Lots of people work on insects there."

"Really?"

"If you like I can arrange to introduce you to my boss", and she did."

"An appointment was made for me to meet John Cannon, then a senior scientist in the Botany Department. The day came and I was taken to the old botany herbarium where John had his office. The room stretched into the distance, lined with row upon row of mahogany cabinets full of pressed plants. I was amazed. I had no idea what any of it was but I knew I wanted to work there. John Cannon talked for some time about the museum and his department and then he asked me what I was interested in. "Insects" I replied. "Oh!" There was a pause. "I see", he said, "In that case I will introduce you to Mr Doncaster in Entomology". I was whisked off to the Entomology Department where I was introduced to John Doncaster. We had a quick chat and then he said they would be advertising for an assistant in the near future, so make sure to look out for the advert in the paper. I waited and waited but no advertisement appeared, then after eight months I enquired at the NHM about the ad and was told there had been a delay but it would be out in a couple of weeks. It was. I then applied and I got the job."

What were your early years like at the NHM?

"This was 1961. I began in the setting room where all assistants started life in the museum. I sat opposite Peter Jerrard, who had had a keen interest in spiders and kept live ones on his desk. This was testing for me but realising my problem he assured me that the treatment for phobias was to start small and work up. So, I took a holiday by myself to Romney Marsh and started collecting spiders, starting with the tiny linyphiids and working up to larger species. By the end of the week I was cured. However, years later, while collecting Lycaenid butterflies in the Philippines I backed into a *Nephila* web, and I realised as the six inch long female walked down my arm that larger spiders still freaked me out."

"By the end of 1961 I was assigned to the Diptera section where I worked for Paul Freeman, Peter Mattingly, Harold Oldroyd and Ken Smith. It was in those initial years that Paul Freeman encouraged me to develop an interest in craneflies, as he was not keen on them himself; they lost their legs far too easily. Craneflies are an interest I still have today. Under a microscope they may look like aliens from outer space but they are fascinating creatures with intricate and complex structures. However, I very soon realised that without a degree I would not progress very far in science, so I applied to University College London to read biochemistry. This was a bad choice as I hated it, and so in the second year I transferred to a zoology degree. I graduated with a first and then, tipped off by friend and museum dipterist Brian Cogan that there was a vacancy, I reapplied and was appointed to work on the phylogenetics and biogeography of butterflies, starting on tropical members of the Satyrinae."

A chance meeting with Professor Dietrich Schneider (one of the pioneers in the discovery of bombykol), led Dick to visit his lab in Bavaria where Dick met Michael Boppré. They quickly became friends and began a lifelong collaboration, working on colour patterns and pheromone communication systems in butterflies. The visit also resulted in Dick switching his focus from the Satyrinae to the Danainae. This switch led Dick and museum colleague Phillip Ackery to begin work on a book about the taxonomy and biology of milkweed butterflies. While they were familiar with the taxonomy of the group, they realised they had less of a grasp on the biology, or in fact of butterfly biology in general. So, they decided to organise a butterfly biology workshop where invited experts would discuss their work and thus save them days wading through the literature. The first was held in April 1977 at the RES HQ at Queen's Gate. This prompted a second in December and a third in 1978. At this third meeting the delegates formed the Butterfly Research Association and started to plan the first international symposium on butterfly biology that eventually took place 1981. These meetings have proved extremely successful and now run every four years. Dick has so far attended every one of the meetings except the most recent, which took place in Bangalore during June 2018.

Mobile lab expedition to SW Africa

Dick had been involved in a number of museum expeditions but the expedition to South-West Africa in 1972 was one that I was particularly keen to hear about. The collections in the museum for South-West Africa were patchy, but hinted that the region possessed an extremely diverse fauna. The entomologist R.E. Turner had collected widely in the area but there was only so much that one individual could do. So, the museum decided to send an expedition to the region in order to add material and fill the gaps.

The plan was to conduct standardised collecting at 150 sites across the region. The five team members were selected in order to cover as many insect groups as possible. Mick Day dealt with the Hymenoptera, as well as being chief mechanic and driver, Brian Cogan collected Diptera

and acted as expedition leader, Peter Hammond was coleopterist and archivist, Dave Hollis took care of Hemiptera and Orthoptera and was also a driver and photographer, and Dick collected Lepidoptera, acted as a photographer and was chief coach builder.

As a ready-made vehicle was not available within the expedition budget, their mobile laboratory was built from scratch. The museum purchased the chassis and a new engine of an ex-army Bedford 4x4 Howitzer tractor, to cope with the rugged terrain. The cab was taken from an ex-army Green Goddess fire engine, as it could easily seat five people. With support from the rest of the team the main body of the truck was largely built by Dick and, as Richard Fortey comments in his book, '*Dry Store Room No. 1*', "Dick Vane-Wright proved to be as good a carpenter as he was a lepidopterist and fitted out the laboratory in fine style". It was a complex project as the vehicle had to provide working space, storage for gear and personal items and allow the five team members to cook and sleep inside the vehicle. It took a year to complete and was shipped to Cape Town strapped to the deck of a Union Castle ship, where the team collected it.

The journey covered about 12,800 km through some of the most breathtaking and desolate landscapes in Africa. The habitats studied varied from sand deserts to tropical rain forests and from dry river-beds to swampland. The expedition collected millions of specimens, many of which are still being sorted today, or are yet to be examined, a significant number being species and genera new to science.

In 1976, Dick founded '*Antenna*' along with Peter Hammond and Valerie Brown; this was a new kind of journal that would carry news of the Society's events and activities, but would also publish short articles in order to communicate with a wider readership.

How did you become involved in conservation?

"In 1980, we had gone to the Philippines because we knew their forests were under threat; I was there for six weeks but it was very depressing as all the habitats were wrecked and by the time I left, I was ill. I then flew to Papua New Guinea and walked into tracts of pristine rain forest and I was instantly better. My experience of the environmental degradation in the Philippines upset me and that's when I developed an interest in conservation."

"Historically, conservation reserves were set up without any criteria other than someone knew they were good, which meant that there were many areas that were ignored. So, I worked with Chris Humphries and fellow entomologist Paul Williams to create the NHM's *Biogeography & Conservation Laboratory* in order to analyse the distribution of plants and animals with a view to determining new conservation areas. We soon

realised that people in Australia and South Africa were also interested and we spent a year working together in Berlin in an attempt to bring all of the current information together in a book. Many papers were published but the envisioned collective book never materialised.

This collaboration indirectly led to the inception of GloBIS' (Global Butterfly Information System), which is dedicated to making comprehensive information about all the known 20,000 species of butterflies available on the Internet, and to promoting butterfly systematics." As a result of these activities Dick became attached to the Durrell Institute of Conservation and Ecology, University of Kent, where he still teaches occasionally.

"By then the more rigorous process of selecting conservation sites had been widely adopted and an entire industry had evolved around it, generating an ever-increasing complexity of criteria. The problem then was: once a site is designated how do you stop it going to hell? And, if it does, what should one do? Many organisations hang on to reserves long after they have been severely degraded. Conservationists need to learn to let go once a fight has been lost and concentrate resources where they can be most effective. At this point I drew a line under my involvement and moved on."

"One of my worst experiences was in the Philippines, when I was sending some live butterflies back to the UK and was feeding them on honey. I had travelled to the other side of Masbate to acquire some local honey and was returning to base on Cebu. I hitched a ride in a Jeepney, and just as we were about to depart a pig was thrown in the back with me. It was not happy as it was on its way to a major feast (feasts always end badly for pigs). Its rear end was facing me so by the time we arrived, the pig had urinated and defecated on me several times and, just as I thought it could not get any worse, I realised that my jar of honey had turned upside down in my bag and leaked onto my trousers, so on arrival I was covered in a fine cocktail of honey and pig excrement. The local flies loved me."

"Back then there was a school of thought that suggested that, as most of Earth's habitats are being wrecked, we should collect as many species as possible before they are all gone. From my perspective, once species are extinct the dynamic has gone; I don't want to be a palaeoentomologist. I want to study animals while they are still with us. Life is extraordinarily remarkable and all living things are inherently beautiful. The tiger is one of my favourite animals but I don't need to see one, I just need to know they are out there – somewhere!"

Consilience

It was while Dick was 'Keeper of Entomology' at the NHM that the Belgian artist Jan Fabre (great grandson of the famous French entomologist Henri Fabre) became artist in residence for three years from the year 2000. "He was looking for volunteers to work with him so I offered my services. The end product was to be a video installation that featured museum staff dressed and behaving as the insects they studied. This appealed to the performer in me. I was dressed as a butterfly and tried to show how various groups of butterflies flew." Snatches of the film '*A Consilience*' are still available on the internet.

The Philosopher

The educational psychologist David Kolb described two approaches to learning and life: convergers and divergers. Convergers are focused and are looking for an answer, while divergers are interested in the fractal nature of things and are not bothered if they don't get an answer. "I am a diverger; every question generates new questions which means I am forever thinking of new projects." The combination of this intense curiosity and Dick's boundless energy have carved a career that is as diverse as the butterflies that he studies. His experiences in the field of conservation have made a philosopher of him, causing him to question the relationship between science and the natural world.

"One of the things I dislike is that some scientists believe that their view of the world is the only view. We need to take a wide range of perspectives into account, in order to understand the world around us." In 2009 Dick contributed a chapter to the book, '*Theology, Evolution and the Mind*'. In it he states, "My aspiration is to encourage all people, consistent with their own beliefs, to reconcile their identity with the rest of nature and make conservation of other living things an imperative rather than a reluctant afterthought"; a sentiment that will resonate with us all. "To understand life you need to look at all levels, from the molecular to Gaia. I think I am a really frustrated ecologist. I am fascinated by how organisms see their environment. What do they pay attention to and what do they ignore?" The anti-reductionist C.H. Waddington has had a great influence on Dick. Waddington believed that an organism's behaviour is a key factor in the process of adaptation. Dick is also dissatisfied with the current reductionist approach to biology that focuses only on the role that genes play. "Genes are important but what the whole organism does is also important. Its interaction with its environment cannot be described only in terms of its genes. I have started scribbling notes on this but probably won't live long enough to write them up."

Time had run out and our trains were calling us, so we continued talking as we walked to the station. There was still so much to ask about from such a diverse career. Had he been aiming for the job of head of Entomology at the NHM? "Definitely not. Miriam Rothschild once accused me of being very ambitious. I protested profusely at the idea; I have not an ambitious bone in my body. My career has been a random walk across academia, every destination unintentional."

This random walk is still taking Dick on new journeys to new insights and discoveries, journeys that will illuminate our understanding of the natural world and help us all to gain a better appreciation of its beauty and complexity. We hope that Dick will have many more years in which to write up those notes and continue to share his unique perspective on the natural world.

GRANT REPORTS

RES Conference Participation Fund Reports

XVIII IUSSI Congress

Report by Elizabeth Evesham

Kings Education

The XVIII Congress of the International Union for the Study of Social Insects (IUSSI) was held in Brazil, in August 2018. Topics covered included gene expression and the creation of genetic tools to study neural networks, evolution, behaviour and ecology of social insects, and their plasticity such that they can switch their role within the organisation of a colony because of changes to their environment. Computer simulations, algorithms and mathematical models remain areas of interest for many research labs.

The symposium which I co-chaired with my colleague David Nash (University of Copenhagen) was well attended and contained high-quality talks on what I perceive to be a valuable area of today's research: the conservation of social insect populations in the light of pesticide usage, urbanisation and other changes in land use, which are impacting our social insect populations worldwide.

The venue for the meeting was the Casa Grande Hotel Resort and Spa, designed in an authentic Brazilian colonial style. It is situated on the island of Guarujá, on the coast of São Paulo, one of the chicest addresses on the Brazilian coast. The symposia took place in rooms that housed grand chandeliers and interesting paintings. Coffee and tea breaks buzzed with conversations on topics such as brain evolution in social insects and the genomics of stingless bees. No one went without food during the breaks since there were always little snacks filled with banana, guava or cheese on offer with a selection of pastries in the afternoon.

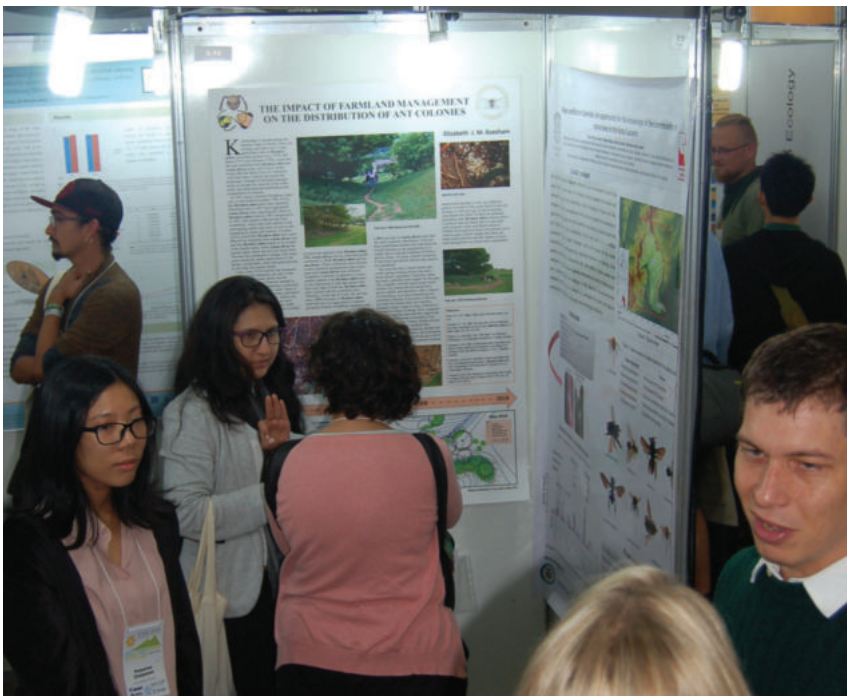
This was a most stimulating Congress and I have many ideas I wish to pursue in my research field, just when I thought I had retired! I also have many examples to use in my teaching of genetics, ecology, behaviour and phylogeny.

I would like to thank the Royal Entomological Society for their support. This trip would not have been possible without their help.

Abstracts can be found at https://www.iussi2018.com/home.

Report by Isobel Ronai

I recently completed my PhD investigating the genetic and mechanistic basis of worker sterility in the social insects, in particular the honey bee. In 2018 I travelled to Guarujá, Brazil, for the *18th Congress of the International Union for the Study of Social*



Insects (IUSSI2018) – the quadrennial international social insect conference.

This conference is always the largest social insect gathering and was attended by over 700 biologists from 38 countries (with a large contingent of local Brazilian researchers). The conference presentations covered the breadth of social insect taxa (bees, wasps, ants and termites) and topics from cellular biology to evolutionary theory. My favourite Symposium was 'Genome editing in social insects' because it was a great opportunity to learn from leading researchers about current advances in genetic techniques (i.e. CRISPR-Cas) for social insects.

The organisers of the 'Evolutionary co-option and "Ground Plan" revisited by current physiology and genomics' Symposium invited me to speak on the review I published as part of my PhD thesis: *The mechanistic, genetic and evolutionary basis of worker sterility in the social Hymenoptera* (http://dx.doi.org/10.1016/bs.asb.2016.03.002). I am very grateful that I had the opportunity to promote my findings to the international social insect community, for whom I wrote this review. Further, my PhD supervisor gave the opening plenary address of the conference during which he presented the main empirical findings of my PhD.

I should mention that throughout the conference there were many jokes made about conference attendees crawling around on the ground, peering into bushes and pointing up at branches in order to hunt for (social) insects – while the staff of the conference venue looked on perplexed.

Overall, this major international conference provided me with significant professional opportunities (fostering international collaborations) and also allowed me to explore a new country. I wish sincerely to thank the Royal Entomological Society for its support to attend the conference.

International Whitefly Symposium 2018

Rebecca Corkill

PhD student at the John Innes Centre, Norwich, sponsered by Oxitec and BBSRC

In September 2018, I had the privilege to travel to Perth, Australia, to attend the three-day International Whitefly Symposium 2018. I am a PhD student and, as such, I have limited funds. Fortunately, the Royal Entomological Society helped me by awarding a travel grant.

Whiteflies, especially *Bemisia tabaci*, are a huge humanitarian and economic pest. The theme of the meeting, *Putting Farmers First*, highlights how urgently high impact research is needed in this field.

Meeting people whom I have only read about was a privilege. I was selected for an oral presentation, entitled "Early embryogenesis of *Bemisia tabaci*". As a result, I was able to get suggestions for solutions to the problems I was having. I have already applied these solutions to my work and I am instantly seeing results. For example, I spoke to Peter Atkinson (University of California Riverside), who was developing a CRISPR-Cas9 system for *Bemisia tabaci*. CRISPR-Cas9 is a genome editing tool that is faster, cheaper and more accurate than previous techniques of editing DNA. His work relates closely to mine, and it was a relief to hear that some of my negative results were paralleled in his.

The symposium dinner was a poolside BBQ. For an English gal, the Australian spring evening temperature of 18°C was very welcome. Throughout the social, the wine flowed and the conversation even better. I was able to catch up on old friends, make new ones and enquire about future jobs (nicely combining the past, present and future in one night).

I have never been to Australia before, and I thoroughly embraced the Australian way of living; from eating BBQ most nights to holding baby kangaroos. It was an experience that I will never forget. Without the funding that I received from the RES it would have been incredibly difficult to go to this career-enhancing conference. So with that I thank you!

RES Outreach Fund Award Report

Further work on the Auchenorrhyncha of Kibale forest, Uganda

Alvin Helden

School of Life Sciences,
Anglia Ruskin University, Cambridge CB1 1PT

In 2017 the Royal Entomological Society helped to support my first year of insect collection for my project, *Auchenorrhyncha (leafhoppers and relatives) of Kibale: initial species list, host plant associations and mouthpart morphology*. I was very grateful to receive a further award to continue my work. This year the money was used to cover the costs of an additional four days in Uganda, prior to the start of the Anglia Ruskin University field course, which I run there each year. Specifically it covered the cost of the monthly research fee, accommodation and food, and of hiring a field assistant.

As in the previous year, I used the moth trap (sheet) (Figure 1) running during the field course to collect specimens. However, the additional days before the 2018 field course enabled me to focus on collecting specimens from trees and other plants (Figure 2) which, in time, will give valuable insect-plant species records. This would have been completely impossible without the encyclopaedic knowledge of the local flora possessed by the field assistant, Katusabe Swaibu. He guided me through the forest to 22 species of trees, bushes and some herbaceous plants, from which I collected 116 specimens. I brought these back to the Makerere University Biological Field Station (MUBFS), where I was staying, to photograph the live specimens. I would have collected even more but my plan to spend four days in the forest was cut to three due to an unplanned, additional day in Entebbe, waiting for my delayed luggage to catch me up.

From the moth sheet and other, unidentified plant species, I collected a further 292 individuals and am now continuing to work through mounting specimens, and making and photographing genitalia preparations.

Figure 1. Photographing Auchenorrhyncha attracted to a moth sheet at MUBFS.
(Photo: Peter Brown)

Figure 2.
Investigating the Auchenorrhyncha swept from an *Erythrococca* bush at MUBFS.
(Photo: Sophie Mowles)

My plan for the future is to continue to collect specimens during and prior to the 2019 field trip, then to process all male specimens in order to produce an initial species list for Kibale by 2022, together with an accompanying series of photographs. Although I have not started to try to put names to the specimens, except for one or two more obvious ones, comparison of genitalia morphology has shown 142 species so far.

I would like to thank the Royal Entomological Society for supporting my work with an Outreach Fund Award during 2018.

SCHEDULE OF NEW FELLOWS AND MEMBERS

as at 5th December 2018

New Honorary Fellows
None

New Fellows (1st Announcement)
Professor Petros Ligoxygakis

Upgrade to Fellowship (1st Announcement)
None

New Fellows (2nd Announcement and Election)
Mr Krzysztof Miler (as at 3.10.18)
Dr Richard Merrill (as at 3.10.18)
Dr Thiruvengadam Venkatesan (as at 3.10.18)
Dr Marcio Roberto Pie

Upgrade to Fellowship (2nd Announcement and Election)
None

New Members Admitted
Mr Adam Mantell (as at 3.10.18)
Dr Rosemary Susan Lees (as at 3.10.18)
Mrs Zohreh Ofshahraki (as at 3.10.18)
Dr Gail Jackson
Miss Clementine St John Webster

New Student Members Admitted
Miss Bethany Roberts (as at 3.10.18)
Miss Jennefer Sarah Livesey (as at 3.10.18)
Mr Douglas Harry Boyes (as at 3.10.18)
Ms Manuela Quilla Carnaghi
Ms Emilie Ellis
Mr Gary Hartley
Ms Amelia Hood
Mrs Sanaa Nagem Abed
Miss Jessica Beth Jennings
Ms Samantha Blackburn-Turner
Mr Ben Howarth
Mr William Rennison
Miss Lucy Pocock

Re-Instatements to Fellowship
None

Re-Instatements to Membership
None

Re-Instatements to Student Membership
Ms Gillian Weyman

Book Reviews

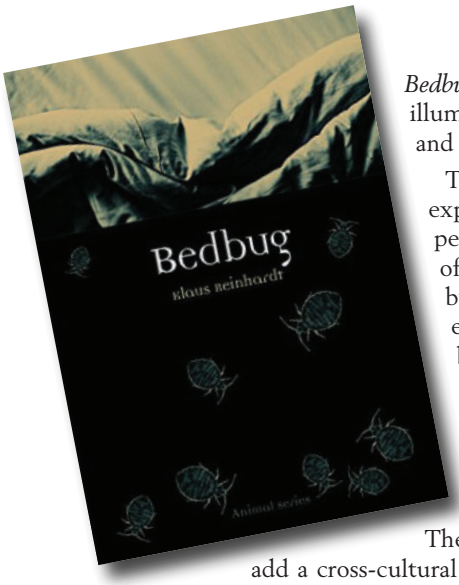
Bedbug

Klaus Reinhardt

Reaktion Books (as part of the *Animal* series)

ISBN 978-1-78023-973-6

£12.95



Bedbug is another excellent addition to Reaktion's highly acclaimed *Animal* series. Klaus Reinhardt illuminates the biology of this old enemy and explores our attitudes to it across western history and culture.

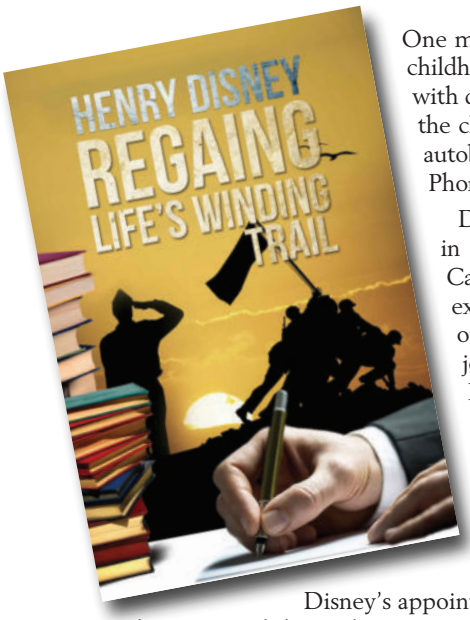
The book begins by looking at the 'bedbug' in the context of the rest of the Hemiptera and explores the diversity of bedbugs themselves. It then examines bedbug behaviour and our perception of their feeding habits. The next chapter looks at bedbug sex, examining the biology of traumatic insemination, its evolution and the way that this behaviour has been assimilated by writers of the horror novel. The bedbug mouth parts are the subject of the next chapter exploring their morphology and the human reaction to their bite. Chapter 6 focuses on how bedbugs are reared by scientists in the lab and explores the link between scientists feeding bedbugs on themselves and masculinity. It also examines the way western society views bedbug bites. The book then reviews the history and processes of bedbug eradication. The final chapter looks at the way that political ideologies have used the bedbug to label sections of society that they consider undesirable as unhealthy and unwanted outsiders. *Bedbug* then goes on to explore and dispel the concept that bedbugs are linked to poverty.

The book is richly illustrated with photographs, cartoons, posters and book covers, all of which add a cross-cultural perspective to the informative text. Klaus Reinhardt has produced a thought-provoking book that explores a twenty-first century entomological taboo, dispelling many of the myths that surround this insect and revealing a fascinating, if not entirely welcome, invertebrate. Perhaps we should, as Klaus hints, learn to live with our bedbugs.

Peter Smithers

Regaining Life's Winding Trail

Henry Disney
Austin Macauley Publishers
ISBN 978-1786127976
£16.99 (hardcover)



One might expect the life-story of a systematic entomologist to be a relatively tranquil narrative: childhood obsession with natural history, an encounter with a stimulating teacher, a few early battles with disputatious editors and colleagues, before eventual emergence as the acknowledged expert of the chosen group, master of all that is therein surveyed. But for Henry Disney, as this fascinating autobiography reveals, the path to becoming the world expert on the biology and systematics of the Phoridae, the most speciose of all the dipteran families, was over steep and obstacle-strewn terrain.

Disney did not start out as a systematist. His earliest jobs were as a medical entomologist, first in Belize (British Honduras), working on the ecology of Dermal Leishmaniasis, and then in Cameroon, studying the vectors of River Blindness (Onchocerciasis). This was demanding and exacting work. In Belize this involved catching, dissecting and sampling blood from a wide range of mammals, including vampire bats and climbing rats. At one point, Disney found himself in a jolting Land Rover clasping on his lap a leaking jar containing the brain of a rabid dog in saline. In both jobs, he was frequently required to improvise, with rather limited resources: this included designing the widely used "Disney Trap" for catching sandflies and other biting flies, which involved a suspended cage, containing a mammal on a metal tray covered in castor oil. Disney's wife, Audrey, gave birth to their third child in Cameroon, an event probably accelerated by Audrey discovering her husband blocking the door to their bathroom, having collapsed on the floor in a coma induced by cerebral malaria. But despite all this excitement, the vectors of Leishmaniasis were nailed and the biology of River Blindness put on a firmer footing.

Disney's appointment to these overseas posts followed, somewhat indirectly, from an extraordinary mishap that occurred during his National Service: this would have blown a less resilient personality completely off course. His file was mistakenly transposed with that of the unit troublemaker, and instead of being considered for Officer training, Henry was sent on a punishment posting to Cyprus, where at the age of 18 he found himself on active service in the middle of a full-scale anti-terrorist campaign. It was on the basis of this stressful military experience that he obtained the posting to Belize, since it was thought it would enable him to cope better than other candidates with the challenging conditions there.

Disney's emergence as a systematic entomologist did not occur until he settled down as Warden of Malham Tarn Field Study Centre in 1971. In his spare moments when not running the field centre, teaching on its courses, and managing the large local nature reserve, he began to research the ecology of certain dipteran families, most importantly the Phoridae (scuttle flies). His success in transforming our understanding of this important family relied initially on two factors: slide-mounting, rather than pinning, the specimens, a habit he had begun whilst studying the insect disease vectors in the tropics; and the purchase of a high-quality compound microscope, made possible not by a conventional research grant but from a legacy from his redoubtable Aunt Sheila.

Phorid taxonomy found an unexpected ally in the form of the Chairman of the Field Studies Council Executive Committee, who dismissed Disney from his post at Malham, with no prior explanation. Disney fought back and was offered an FSC-funded research post, and so he was eventually able to retire from Malham to spend more time with his flies. Since 1984, he has been in the Zoology Department at the University of Cambridge, ruthlessly focussed on the Phoridae, producing over 500 papers on this family alone: these cover everything from fascinating novel discoveries of natural history to a complete redrawing of the map of Phorid systematics. His collection, housed in the University Museum of Zoology at Cambridge, has the greatest concentration of primary types of any collection held there.

The reader should note that the narrative text is interspersed with over 250 poems reprinted from the ten published volumes of Disney's poetry. Try not to be put off by this: the narrative is entirely covered by the prose. The poems act as reflections or meditations on the text, a bit like the arias in Bach's *St Matthew Passion*: this can occur when the meaning is too personal to be borne by prose, as is the case of my favourite poem here, written at the time of his Mother's death.

Two themes, the most important elements in the author's life, run throughout the book - his Christian faith, and the deep love for his wife and family. But there is a third theme, which is more accessible to the general reader: Disney's magnificent antipathy to all forms of established authority. It doesn't really matter what form this takes but the list is long: the Ministry of Defence, Christian fundamentalists, dead phorid taxonomists, authors of textbooks, fraudulent forensic entomologists, most lawyers, Police Commissioners, T.S. Eliot, Bertrand Russell, and Richard Dawkins. This is just a small selection. In the various battles described here, the reader might sometimes feel a grain of sympathy for the authority figure, worn down by Disney's implacable honesty and granite integrity. After victory, the final coup de grâce is often delivered in the form of a poem.

I warmly commend this book to anyone interested in the practice of insect ecology, and especially to the legion of co-authors, from over fifty countries, who have benefitted enormously from Henry's unflinching generosity in helping them identify and understand the flies they are studying. As he enters his ninth decade, three-quarters blind, a bit deaf and not especially mobile, the publications on phorids keep on coming. And readers may wish fully to endorse his hope, expressed in one of his later poems, that "I'd rather go/On crest of wave to reach for sky".

William A. Foster, Department of Zoology, University of Cambridge

Natural Enemies

Ann Hajek and Jørgen Eilenberg

Cambridge University Press

ISBN 9781107668249

£34.99

The first edition of '*Natural Enemies – An Introduction to Biological Control*' by Ann Hajek was published in 2004. In this second edition Ann is joined by Jørgen Eilenberg and together they have delivered a successful update, whilst keeping much of what made the first edition so popular with students, professionals and, indeed, anyone looking to learn more about biological control. This revised edition reflects developments in the field of biological control over the last 14 years, such as the increased interest once again in classical (importation) biological control in response to ever-increasing introductions of invasive species, coupled with development of methods to minimise the environmental risks of this approach. This edition also reflects the increased use of augmentation biological control, where permanent establishment of the biological control is not sought. Here, the growth in diversity of both arthropod predators and parasitoids, as well as invertebrate pathogens, is reflected. Those familiar with this book will, however, be pleased to see that all of these additions have been included whilst maintaining the same authoritative but easy to read style and retaining the wonderful graphs, illustrations and topic boxes that characterized the first edition.

The book has 20 chapters, which are grouped into six parts. In the first two parts, the reader is introduced to the role of natural enemies and the different strategies for their use as biological control agents. An historical perspective is used to introduce the reasons why biological control is increasingly important as a crop protection strategy. The familiar issues of pesticide resistance and concerns about pesticides and human, as well as environmental, health are discussed. These arguments for increased adoption of biological control strategies are discussed alongside more recent issues around the declining numbers of synthetic pesticides for agriculture, as well as the threats posed by invasive species, often as a result of increasing global trade. There are then useful chapters that introduce biological control and the diversity of approaches that may be taken. This leads into three chapters that introduce classical (importation), augmentation (both inundative and inoculative) and conservation forms of biological control.

The main section of this book is divided into three parts that cover the biological control of invertebrate and vertebrate pests, weeds and plant pathogens, and plant parasitic nematodes. As may be expected, the largest of these is the part covering the biological control of invertebrate pests, in which there are separate chapters on use of predators, parasitoids, nematodes, bacterial pathogens, viral pathogens and fungal pathogens. Usefully, however, the first chapter in this part considers the ecological basis for use of predators, parasitoids and pathogens to control pests. Here, both the attributes of the pests and the natural enemies are considered in relation to biological control. The coverage of the biological control of weeds has a broadly similar format, introducing firstly the ecological concepts that underpin this form of biological control before describing specific strategies and case studies. Although the focus here is again on the use of invertebrate biological control agents, it is good to see that vertebrates are considered, as are both terrestrial and aquatic systems. In the final part, the biological control of plant pathogens and plant parasitic nematodes is covered. The types of pathogens and nematodes, their antagonists and the strategies for using these antagonists are effectively introduced.

Much of the final part of this book is new to this second edition. In the first chapter in this part there is a thorough review of the concerns around the safety of biological control and specifically non-target effects. Much of this chapter focuses on host specificity and our ability to predict and prevent non-target effects from occurring. The chapter on the use of biological control as part of an Integrated Pest Management (IPM) programme is good to see and reflects the fact that biological control is often used alongside other controls, including selective use of conventional synthetic pesticides. The final chapter considers the challenges facing use of biological control in a changing world. Challenges identified include the threats posed by invasive species and climate change as well as the urgent need to improve the sustainability of crop production systems.

With its clear and logical layout, excellent use of topic boxes and illustrations throughout, I recommend this book as a very readable yet comprehensive introduction to biological control.

Tom Pope, Harper Adams University

OBITUARY

Henry L.G. Stroyan

(1921-2018)

By Sebastiano Barbagallo

Henry and Kay Stroyan.

Eminent aphid taxonomist, Vice President (1966-67) and Secretary (1968-74) of the Royal Entomological Society and author of two of its Handbooks, Henry Stroyan, passed away on 5th October 2018.

Henry Lindsay Gray Stroyan was born in Derby on 9th January 1921, and grew up there. He graduated from the University of Cambridge in 1942 with a BSc (Hons) in Natural Sciences and was awarded the Frank Smart prize for Zoology. Soon afterwards, he enlisted in the army and was posted to India where he served during World War II in the capacity of Entomologist Officer, charged with the protection of stored food from insect pests. In these years, Henry had the opportunity to continue his studies for an MSc in Entomology, which he obtained in 1946, also from Cambridge, when he returned from India.

In 1947 Henry was awarded a research grant by the UK Agricultural Research Council (ARC) to study aphid taxonomy and biology at Cambridge. Soon he met Dick Hille Ris Lambers, with whom he had a life-long friendship and professional relationship. In 1952, Henry transferred to the Ministry of Agriculture Fisheries and Food (MAFF), working at the Plant Pathology Laboratory in Harpenden. In 1966, he conducted taxonomic studies of aphids in the United States in collaboration with Clyde F. Smith, North Carolina State University, with funding from a Kellogg Fellowship. The production of many excellent entomological publications earned Henry a Doctor of Philosophy degree in Entomology from the University of Cambridge in 1973.

Henry retired from his post at MAFF in 1982 but received permission to work there for a further year to complete his second RES aphid handbook, on Pterocommatinae and Aphidini, published in 1984. The first, on Chaitophorinae and Callaphidinae, was published in 1977. He was a prolific writer, with more than 100 publications from 1946 to 1999. He contributed hugely to the knowledge of world aphid fauna and particularly that of Britain, describing 51 new taxa. He is perhaps best known among aphidologists for his taxonomic and biological investigations on the Macrosiphini genus *Dysaphis*.

Soon after his retirement, Henry offered his large aphid collection to the Natural History Museum (London). He also provided the writer of this tribute with his bibliographical collection on aphids, which is now kept at the University of Catania as a valuable source of aphid literature which is otherwise difficult to find.

Henry was a perfect gentleman, very likeable and generous, and extremely devoted to his family. The writer met Henry for the first time in May 1975 during a period spent under his supervision at MAFF, studying the bio-systematics of aphids. This led to a personal friendship and a long-lasting scientific collaboration on the aphid fauna of Sicily. Since then, a never broken series of mail correspondence and family visits to Harpenden was established. These social visits included Henry's wife Kay, before she passed away a few years before him, and the writer's wife Dora. During the last of these visits in September 2018, Henry was in excellent health for his age. Complications from a hip fracture occurred in October 2018, causing his unexpected demise.

Henry's death is a true loss for all aphidologists. He was a master of science and life. He is survived by his sons Alasdair and Rory, daughter Sarah, and grandchildren Angus and Gemma.

Acknowledgement

Sincere thanks are expressed to Mrs Sarah Carmichael for the biographical information provided.

A longer version of this obituary is available from Richard Harrington (richard@royensoc.co.uk).

Diary

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 so that refreshments can be organised. Day meetings typically begin with registration and refreshments at 10 am for a 10.30 am start and finish by 5 pm. Every meeting can differ though, so please refer to the details below and also check the website, which is updated regularly.

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

MEETINGS OF THE ROYAL ENTOMOLOGICAL SOCIETY

Verrall Lecture
Wednesday, 6 March, 2019
Venue: The Flett Theatre, Natural History Museum, London, SW7 5BD

2019 PG Forum
Thursday, 21 March, 2019 to Friday, 22 March, 2019
Venue: Biology Department, University of York, York, YO10 5DD

Insects as Food & Feed Special Interest Group
Tuesday, 2 April, 2019 to Wednesday, 3 April, 2019
Venue: Royal Agricultural University, Stroud Road, Cirencester, GL7 6JS

Aphid Special Interest Group
Wednesday, 3 April, 2019 to Friday, 5 April, 2019
Venue: Rothamsted Research, Harpenden, AL5 2JQ

Insect Parasitoid Special Interest Group
Tuesday, 9 April, 2019
Venue: Newcastle University

Forest Insects and their Allies Special Interest Group
Thursday, 11 April, 2019
Venue: University of Birmingham, BIFoR FACE facilty, Staffordshire

Arthropod Cuticle Special Interest Group
Tuesday, 16 April, 2019
Venue: Flett Lecture Theatre, Natural History Museum, London

Insect Endosymbiont Special Interest Group
Thursday, 25 April, 2019
Venue: University of Nottingham

Infection & Immunity Special Interest Group
Friday, 26 April, 2019
Venue: University of Nottingham

Annual General Meeting
Wednesday, 5 June, 2019
The Royal Entomological Society Annual General Meeting, open to Members & Fellows ONLY.
Venue: The Mansion House, Chiswell Green Lane, St Albans, AL2 3NS

Insect Festival 2019
Sunday, 7 July, 2019
Venue: York

Ento '19
Tuesday, 20 August, 2019 to Thursday, 22 August, 2019
London School of Hygiene & Tropical Medicine, Keppel Street, London, WC1E 7HT

National Insect Week 2020
Monday, 22 June, 2020 to Sunday, 28 June, 2020

NON-SOCIETY MEETINGS

German Society for Applied and General Entomology (GDaaE), Halle, Germany, 1-14 March, 2019

The French Academy of Sciences organizes its first major conference on 12-14 March, 2019

"New avenues for the behavioral manipulation of disease vectors", organized by Le Studium Loire Valley Institute for Advanced Studies from 21-23 May, 2019 in Tours

Insect Hormones Meeting, Kolymbari, Crete, Greece, 30 June-6 July, 2019

Eighth International Symposium on Molecular Insect Science, Sitges, near Barcelona, Spain, 7-10 July, 2019

XXVI International Congress of Entomology, Helsinki, Finland, 19-24 July, 2020

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

Alfred Russel Wallace Award 2019

For post-graduates awarded an outstanding PhD in Entomology!

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

Requirement

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

Who Can Enter?

All post-graduates who have been awarded a PhD degree, on the basis of a thesis written in the English language, within the period 1 October 2018 - 31 December 2019.

Prizes

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

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

Entries

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

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

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

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

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

The Judges

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

Closing Date

The closing date for entry is 31st December 2019. Winners will be announced in the Spring 2020 edition of *Antenna* and on the RES website **www.royensoc.co.uk**

RES STUDENT AWARD 2019

Write an entomological article and WIN!

www.royensoc.co.uk

REQUIREMENT

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

WHO CAN ENTER?

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

PRIZES

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

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

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

ENTRIES

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

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

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

For further information telephone: 01727 899387

Please include:

- Your name and address (including postcode)
- Your e-mail address
- The name and address (including postcode) of your academic institution
- Evidence of your student status e.g. student I.D. card

THE JUDGES

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

CLOSING DATE

The closing date for entries is 31 December 2019. The winner will be announced in the Spring 2020 edition of *Antenna* and on our website.

PLEASE CUT AND RETURN THIS PORTION WITH YOUR ENTRY

Article title: _____

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Student name: _____

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Address: _____

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Telephone: _____

E-mail: _____

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Name of academic institution:

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