

Royal
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Antenna



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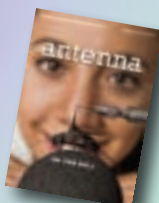


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Index and online copies



Index

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Cover Picture: Mating Stag Beetles, *Lucanus cervus*, photographed by Barbie Lindsay for the 2012 photography competition (see page 110).

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Editorial

Are you feeling adventurous? You might be after reading this issue.

2025 marks 40 years since Project Wallace, our Society's ambitious expedition to Sulawesi, Indonesia. Expedition member, John Tennent, recalls the trials and trails. Not to be outdone, Peter Cranston recounts his adventures at the Trus Madi 'Bug Camp' in Sabah, Borneo, Malaysia, and thinks that you would be wowed by the experience.

The reasons for insect declines remain hotly debated. In his Research Spotlight, Stuart Reynolds asks whether fungicides, herbicides and other chemicals might act synergistically with sub-lethal concentrations of insecticides to hasten the demise of insects. The herbicide, glyphosate, especially, comes under Stuart's spotlight. 'Insects in the News' picks out articles in the popular press expressing concern over the impact on insects of the prophylactic use of parasiticides on pets. We asked Tilly Collins for an expert opinion.

EnTeam visits Keele University and revisits RHS Wisley to see their fabulous new labs. The previous issue's EnTeam interviewed entomologists at Ant Lab in the North Carolina Museum of Natural Sciences. In this issue, Claire Price follows that up, talking to the Ant Lab Head, Adrian Smith, about his online videos which spread the word on entomological (and other) topics.

Our Featured Insect is a Mexican firefly, *Photinus anisodrilus*. Discover the unusual feature leading to its specific name.

Librarian and Archivist, Rose Pearson, shows off some beautiful illustrations from the book *Plantae et Papiliones Rariores* by Georg Dionysius Ehret, and we bring news on new article types for *Agricultural and Forest Entomology* and key questions that *Physiological Entomology* will address in the future.

We have a report of the ever-popular and ever-growing Student Forum and we showcase the winners of the Student Science Communication Awards.

We hope that many people are visiting the RES garden at Stratford and that youngsters have been enthused by the new 'Lloyd of the Flies Wetland Bug Hunt' at Wildfowl and Wetland Trust centres, where they will have met Aardman's specially created character, a dragonfly called 'Dart'. Read all about it.

To our Northern Hemispheric members, we wish you a wonderful entomological summer. To our Southern Hemispheric members, we hope you are catching up with writing papers for the RES journals. *Antenna's* copy bank is lower than it has been for a while, so now would be a very good time to submit articles, no matter which hemisphere you call home.

Many thanks to all contributors.

Richard Harrington and Dafydd Lewis

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

Antenna

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Letter from the President

There's nothing quite like the long, sunny days of summer. The buzz of bees and hoverflies flitting through fields and gardens, the warmth of the sun, a cool drink in hand – it's an idyllic scene. For many, this is a time to slow down and soak it all in. But for me as an entomologist, summer has always meant something a little different. A sunny day? That's a field day! This has always been the season of exploration, of discovery – the busiest time of year for field-based insect scientists. It's when we get outside, get our boots muddy, and rekindle that sense of wonder that first brought us to insects.

Though I now find myself more desk-based than net-in-hand, that excitement hasn't faded. These days, my work isn't so much dictated by the turning of seasons or the academic calendar. Every month brings something new, and this year has been particularly dynamic for the Royal Entomological Society.

We've had a busy start to the year, not least because of the relocation of our headquarters. The sale of our current property is well underway, and the RES team and trustees have been busy scouring London and surrounding counties for a new home. I'm thrilled to say we've identified some fantastic options. Our priority is to secure a space that's modern, accessible, and fit for the future: a place for connection, collaboration, and support for all our members. With updated facilities including meeting rooms, event spaces, and a relocated library, our new HQ will be a welcoming hub for RES members and other insect enthusiasts. And thanks to the latest digital infrastructure, we're making sure that even if you can't join us in person, you'll always be able to connect with us virtually.

Beyond bricks and mortar, the RES team has been advancing its

work on insect-relevant policy. Insects are essential to biodiversity, food security, public health and the resilience of our ecosystems. Yet, they are often overlooked in nature policies, where focus typically falls on larger, more charismatic wildlife or on habitats, and in agricultural policies that focus on yield, trade, innovation and food safety. While Integrated Pest Management has long been part of official agricultural policy, it's not always applied in practice. Encouragingly, regenerative agriculture, which promotes the ecological roles of insects and other natural processes, is gaining recognition across Europe. Several countries are exploring supportive policies for soil health and sustainable farming. Health policy, too, is beginning to embrace "One Health" and systems-thinking approaches – concepts that recognise the deep interconnection between human and ecological wellbeing.

At the RES, we believe insect science has an important role to play in shaping these conversations. As a first step, we

are planning to connect more closely with policymakers to understand their priorities, and to explore how our expertise can support effective, evidence-based decision-making.

And of course, no summer update would be complete without a nod to one of our favourite annual celebrations—**Insect Week!** This joyous event, supported by partners across the UK and Europe, is a chance to share our passion far and wide. Whether you're hosting or attending a walk, a talk, a demonstration, a competition, it's a wonderful opportunity to 'stand tall for the small'.

Wishing you a summer full of sunshine, discovery, and six-legged encounters.



Jane Stout

President
Royal Entomological Society



RESEARCH SPOTLIGHT



The Chemical Cocktail Hour: A roundup of environmental pollutants and insect declines

There is evidence that certain kinds of fungicides interact synergistically with insecticides to disrupt honey bee foraging behaviour

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Sublethal effects and declining insects

Insect scientists have recently become much more interested in the sublethal effects of pesticides and the interactions between them. Why? In the last decade, we have become uncomfortably aware that populations of insects in many different ecosystems are declining all over the world (Van der Sluijs, 2020; Wagner, 2020). I have written about this before in *Antenna* (Reynolds, 2019a; 2019b; 2023). Not all insects are affected, and populations can go up as well as down, but it's clear that there's a real problem. The environmental factors driving these declines are undoubtedly complex and include changing land use and climate change (Rumohr *et al.*, 2023; Grevé *et al.*, 2024; Müller *et al.*, 2024). However, there is also good evidence that in at least some cases, exposure to the residues of diverse agrochemicals in the environment is an important cause of a general loss of fitness among insects (Martelli *et al.*, 2025; Wan *et al.*, 2025).

The effects of insecticides on insects are not all-or-nothing; exposure to a sublethal level of a

toxic agent may allow the insect to survive, but its fitness may be compromised by long-term disruption of physiology or behaviour. Research on honey bees has been prominent in work that supports this conclusion, but what is bad for bees may be bad for other insects too, and there is evidence of adverse sublethal effects in other insect taxa. Social Hymenoptera have been of particular interest in research of this kind, perhaps mostly because these insects provide a valuable ecosystem service by pollinating our crops, but also because it's easy to see how poor motor coordination or direction-finding on the part of workers might compromise the wellbeing of the whole colony. This subject has been extensively reviewed, specifically for bees (Alkassab *et al.*, 2017; Chmiel *et al.*, 2020; Di Noi *et al.*, 2021; Tosi *et al.*, 2022) and for other insects (de França *et al.*, 2017; Bantz *et al.*, 2018; Müller, 2018; Bartling *et al.*, 2024; Ullah *et al.*, 2024). A large number of physiological, neural and behavioural systems may be negatively affected; it is particularly interesting that these may include the immune system,



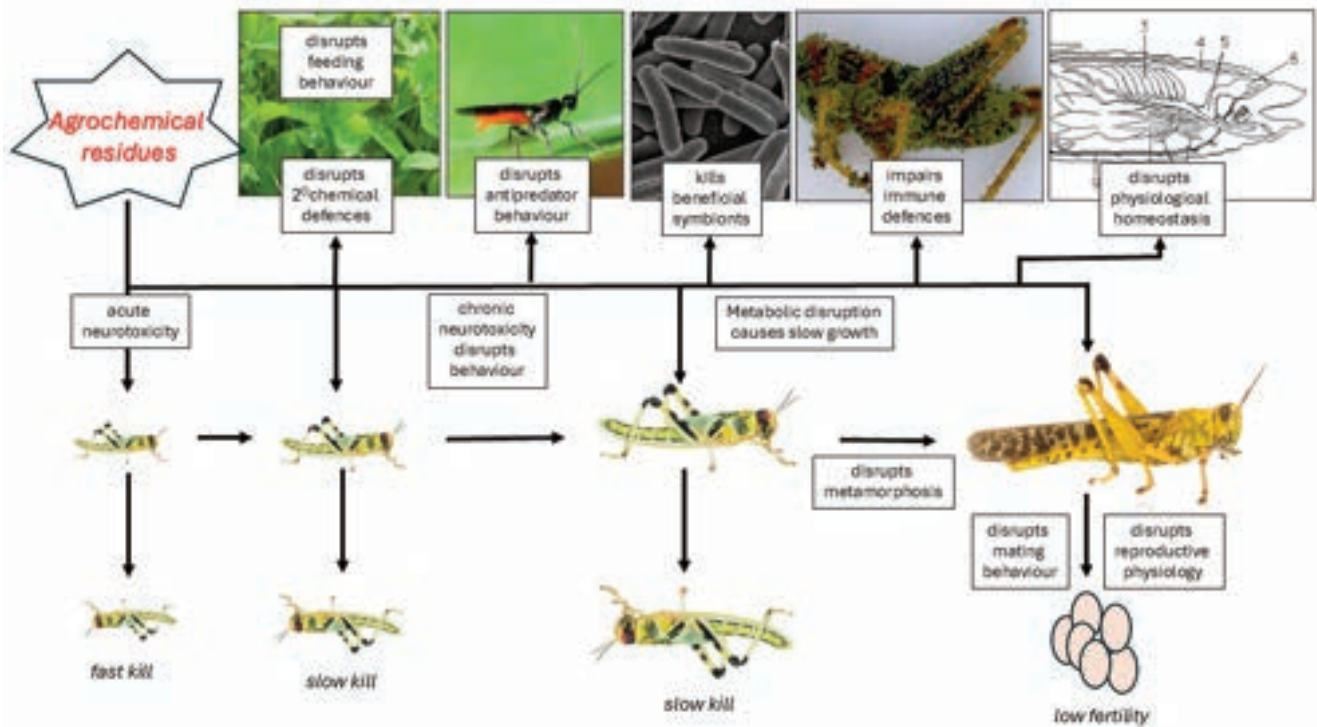


Fig. 1. Hypothetical ways in which sublethal exposure to environmental agrochemical residues might cause harm to insects.

This illustrative scheme shows possible sublethal effects on a locust, but it is not meant to imply that any or all of the listed routes of possible harm have been shown to operate in this insect. See text for details.

and sublethal toxic effects of pesticides may lead to loss of beneficial microbial symbioses as well as increased susceptibility to disease (Fig. 1).

Here's an illustrative example: it was long ago shown that honey bees exposed to the herbicide, 2,4-dichlorophenoxyacetic acid (2,4-D) are not killed, but their colony fitness is reduced because egg hatching is prevented by high levels (1,000 ppm) of the chemical, while at low doses (e.g., 100 ppm), treated colonies show reduced brood development (Morton *et al.*, 1972). More recent work shows that exposure of bees to sublethal doses of 2,4-D disrupts the behaviour of both nurses and foragers. In the former case there is a significant reduction in hypopharyngeal gland volume, and decreased expression of the genes linked to nursing behaviour, while in foragers sensitivity to gustatory stimuli is reduced, associated with decreased expression of genes encoding taste receptors and neuromodulator receptors essential for associative learning processes (Kim *et al.*, 2025). What's going on here? Are these changes in gene expression simply the consequence of an altered pattern of behaviour, or does the behaviour alter because

the transcriptome has been affected by the insecticide? From the point of view of the colony's fitness, the point is that the characteristic behaviours of both nurses and foragers contribute to the colony's success in rearing offspring, and that this measure of fitness is decreased in declining populations of bees (Whitehorn *et al.*, 2012; Goulson *et al.*, 2015).

Neonicotinoids

Readers of *Antenna* will be aware that one particular chemical category of insecticides, the neonicotinoids, is regularly accused of being one of the causes of global insect declines (a recent example is Tetlie *et al.*, 2024). The evidence appears particularly persuasive for pollinator die-offs (Blacqui re *et al.*, 2012; Goulson, 2013; Paoli *et al.*, 2024) and declines of freshwater aquatic insects (Barmantlo *et al.*, 2021; Mandal *et al.*, 2025). This is worrying because these chemicals are now the most frequently used group of insecticides, representing more than a quarter of insecticides applied worldwide (Hladik *et al.*, 2019).

It is mainly because of their effects on social insects that neonicotinoids have now been completely banned from most agricultural uses in Europe and in

the UK (UK Government, 2025). These effects may be due to direct disruption of neuronal signalling pathways within the brain when neonicotinoids bind to acetylcholine receptors. Given that neuronal membrane receptors for acetylcholine (Matsuda *et al.*, 2009), the principal sensory neurotransmitter of insects, are the main target of neonicotinoids, it doesn't seem at all surprising that the rather sophisticated behaviour of honey bees (flower recognition, navigation, learnt associations between food sources and sensory signals, communication within the hive, etc.) should all be susceptible to disruption. But an alternative explanation for the longer-term effects of neonicotinoids is that they also affect the redox status of the brain, which shows increased levels of reactive oxygen species (ROS) like hydrogen peroxide, in turn suggesting the possibility of inappropriate lipid peroxidation and membrane damage (Macke *et al.*, 2024).

The question of whether neonicotinoids are a significant contributor to insect declines remains controversial (Cressey, 2017) and a lot of effort goes into trying to resolve it; by my

reckoning the cumulative total of scientific papers specifically on the subject of the environmental effects of neonicotinoids has now reached 646! However, it needs to be remembered that many other agrochemicals are not intended to be insecticides but nevertheless may have the potential to harm insects (see below). What if the problem is not really about any single chemical pollutant, but about the potentially synergistic interactions between them? In that case, which chemical in the toxic mixture would we blame?

Synergism among pesticide chemicals

There is evidence that certain kinds of fungicides interact synergistically with insecticides to disrupt honey bee foraging behaviour. Reviewing such studies, Schumann *et al.* (2022) concluded that inhibition of sterol synthesis is a key requirement for

this synergistic effect. When Schumann *et al.* (2025) exposed honey bees to a mixture of the sterol-biosynthesis-inhibiting fungicide difenoconazole and the cyano-substituted neonicotinoid insecticide acetamiprid, the frequency of foraging trips was reduced, but this did not happen when a mixture of the same insecticide with a non-sterol-biosynthesis inhibiting fungicide was used. When solitary bees *Osmia cornuta* were exposed to a mixture of acetamiprid and the fungicide tebuconazole, another sterol biosynthesis inhibitor, their reproductive success and population growth rate were reduced (Siviter *et al.*, 2024). Neither chemical had such an effect on its own. While this particular synergistic relationship thus appears quite specific, I have no doubt that further research will lead to the discovery of the existence of other interactive pairings of agrochemicals.

Agrochemicals in the environment

Of course, the agricultural environment is contaminated by many agrochemical residues, not just neonicotinoids. A study by Kruse-Platz *et al.* (2021) in which air was sampled by a network of 69 suction traps located across Germany indicated the scale of the problem. No fewer than 109 different agrochemicals were recovered in the traps between 2014 and 2017; the quantitatively most important of these ($n=18$) are named in Fig. 2. Most of them were fungicides or herbicides rather than insecticides, but because only those that are sufficiently volatile to be distributed in the air can be detected in this way, the list of those agrochemicals that were trapped probably does not reflect the full range of those present in soil, water and associated biota. The prevalence of chemicals other than insecticides certainly

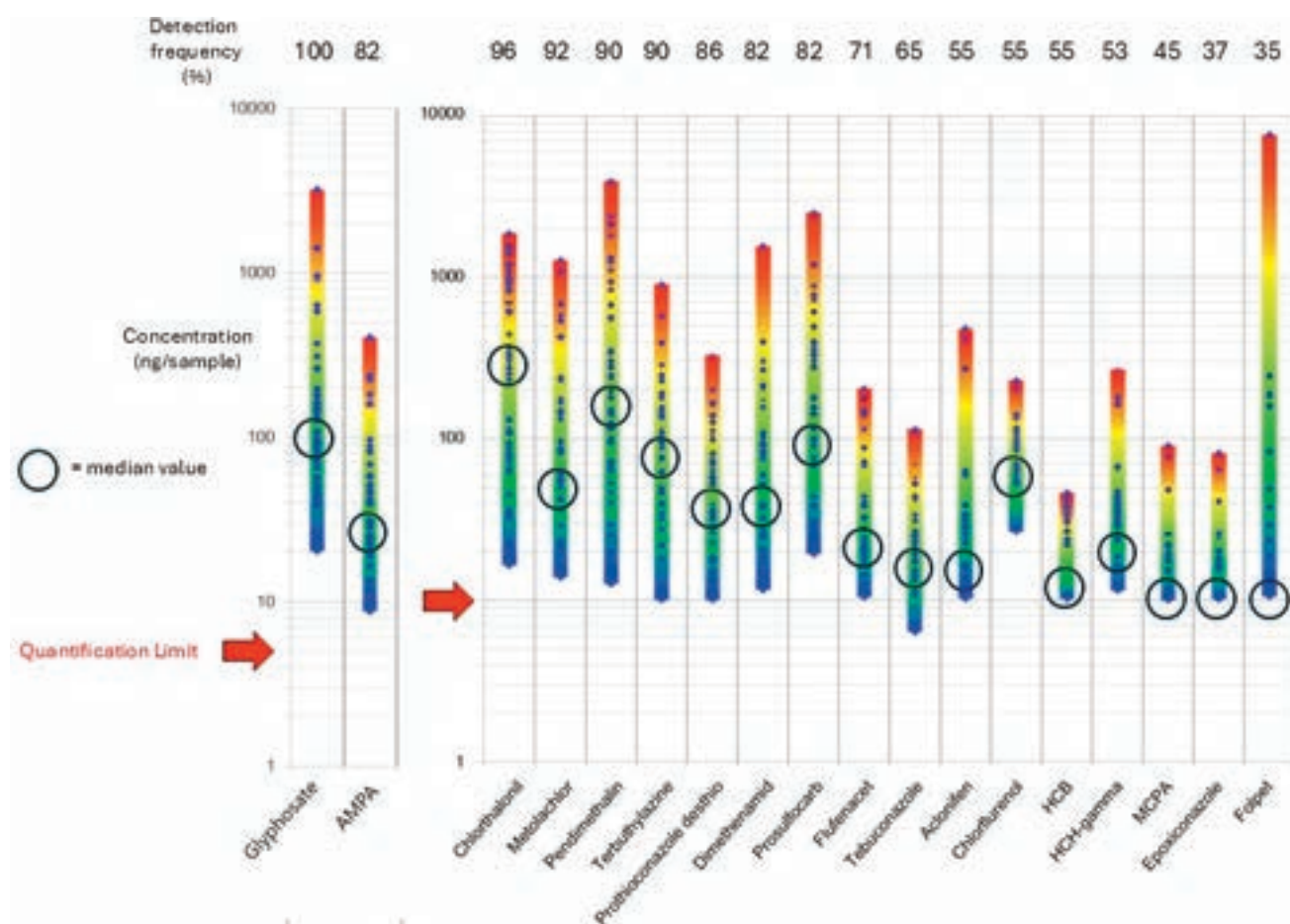


Fig. 2. Agrochemical contamination of the environment in Germany, 2014–2017.

The figure shows the 18 agrochemical residues most commonly detected in passive air traps and ventilation filter mats at a large number of sites of diverse ecological characteristics. Detection frequency (% of traps that detected each chemical) is shown by the line of figures at the top (note that glyphosate was detected in every trap). The chart shows the range of agrochemical mass detected in positive samples from all the trap sites as a multicoloured bar for each chemical. The range of mass detected in positive samples (typically ~ 10 – 1000 ng/sample) is similar for all the chemicals. Note that the median mass of each chemical that was trapped in all samples (shown as an open circle) is strongly influenced by the proportion of traps in which the chemical was detected. The graph is reproduced from Kruse-Platz *et al.* (2021) under Creative Commons Attribution 4.0 International License.

raises the question of whether they might nevertheless have harmful effects on insects, whether in their own right or by synergising the sublethal effects of insecticides. With possibly hundreds of environmental agrochemical residues across the globe, the potential for toxicological complexity is challenging.

Of course, one has to start somewhere! With this in mind, please note particularly that the herbicide glyphosate was found to be present in every single one of the sampling sites, and that its principal metabolite aminomethylphosphonic acid (AMPA) also occurs at relatively high levels. Note also that the fungicide chlorthalonil was the chemical found at the highest concentrations. Later in this article I will discuss in more detail the potential of these compounds to be sublethally toxic in their own right, and also to act as synergists of other chemicals.

Exposure maps

There is every reason to suppose that the situation in Germany is much the same as is found elsewhere in countries in which intensive agriculture is widely practiced. The problem is obviously related to increasing agrochemical application rates; global pesticide use increased worldwide by 63% over the 20-year period up to 2021 (Elumalai *et al.*, 2025).

Maggi *et al.* (2019) used pesticide application figures reported to the Food and Agriculture Organization (FAO) and other international bodies by United Nations member countries to build a global database of the 20 most heavily used pesticide active ingredients. They used these data to estimate pesticide use on a crop-by-crop basis and mapped the data onto a global grid. Fig. 3A shows a global map for the use of one particular pesticide, the herbicide glyphosate, on global maize (corn) crops for 2015. The data show that the highest rates of glyphosate application on this crop were in the USA and western Europe, with China and South America not far behind. The amounts of chemical applied were high; the most heavily treated fields received 0.4–4.0 kg ha⁻¹ yr⁻¹.

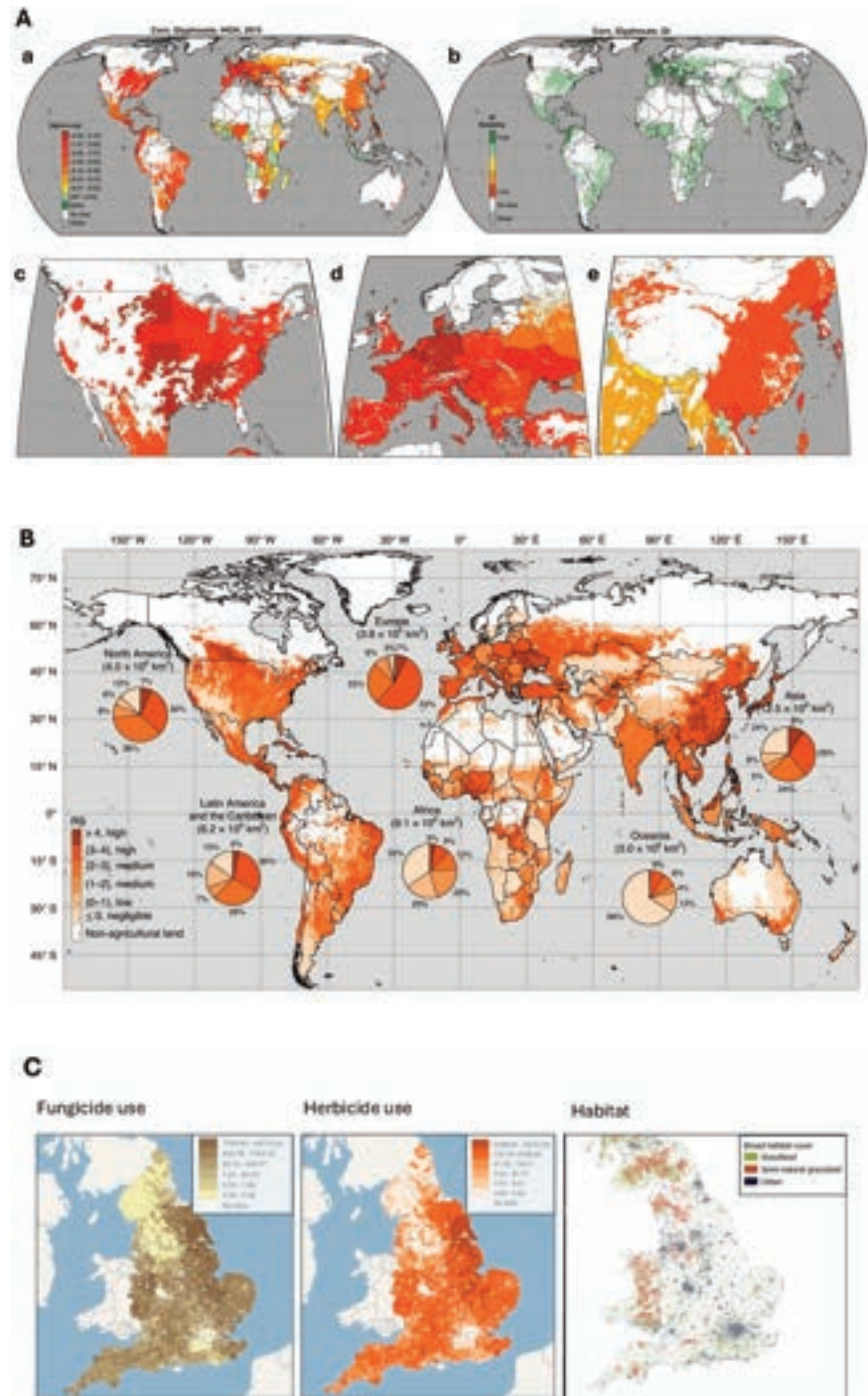


Figure 3. A. B. C. Exposure maps of environmental harm.

Global gridded application rate and quality index maps. **A:** Upper panels show estimated local annual application rates on maize in 2015 of the herbicide glyphosate mapped onto a global grid, and (b) the corresponding quality index QI map, which indicates the reliability of the data. Lower panels show regional application rates of glyphosate in (c) North America, (d) Europe and (e) East Asia. Reproduced from Maggi *et al.* (2019). Creative Commons Attribution 4.0 International License.

B: Global map of estimated pesticide Risk Score (RS, 0–3). The map has a spatial resolution of 5 arcmin (~10 km × 10 km at the Equator). Pie charts represent the fraction of agricultural land classed under different RS in each region, and the values in parentheses above the pie charts denote the total agricultural land in that region. Reproduced with permission from Tang *et al.* (2021).

C: The two maps on the left show census-ward level estimates of the usage of herbicides and fungicides (kg per census ward) for England for the year 2000, based on data from the Pesticides Usage Survey (PUS). The habitat map on the right shows woodland, urban and semi-natural grassland cover for Great Britain in 2019. The pesticide maps are from the Environment and Health Atlas for England and Wales, reproduction licensed under a Creative Commons Attribution-No Derivatives 4.0 International License. See: <https://www.envhealthatlas.co.uk/homepage/>. The habitat map is based upon the Land Cover Map (LCM) 2019 produced by the UK Centre for Ecology and Hydrology (UKCEH), and was obtained from: <https://www.ons.gov.uk/economy/environmentalaccounts/bulletins/habitatextentandconditionnaturalcapitaluk/2022>

This approach was extended to compute the total pesticide risk for all cropland in all countries. Tang *et al.* (2021) used data of the same kind to estimate total pesticide inputs and combined this with known rates of pesticide movements through different environmental compartments (groundwater, surface water, soil and the atmosphere) in order to model the environmental fates for 92 pesticide active ingredients in 168 countries. This allowed the determination of a 'pesticide risk factor' that noted where modelled pesticide levels exceeded currently designated 'no effect' concentrations. As we'll see later, this is a very conservative assumption, because the environmental hazards associated with many widely used pesticides are almost certainly seriously underestimated. It was concluded that almost two-thirds (64%) of global agricultural land (about 24.5×10^6 km²) is at risk of pesticide pollution by more than one active ingredient, and 31% of this is at high risk of environmental damage (meaning that residues exceed 'no effect' levels by a factor of >100) (Fig. 3B). The risk in regions with a lot of intensive agriculture is even greater; no less than 61.7% of European cropland was considered to be at high risk of environmental damage in this way.

Many attempts to identify the anthropogenic causes of environmental harms such as insect declines use a correlative methodology that is derived from epidemiological studies seeking to show a link between exposure to a particular chemical and human health. The requirement in such cases is to demonstrate a statistically significant correlation between proven past exposure to the chemical and demonstrable harm that occurred as a direct consequence. However, it is much easier to prove a chemical's link to adverse human health outcomes than it is to prove a link to environmental harm. This is because in most cases we can't be sure of the actual level of environmental exposure to pesticides, and also because pesticides are designed (indeed required by regulatory

agencies) to be active at very low concentrations.

Global maps of pesticide use are helpful in showing the scale of the problem, but the models of Tang *et al.* (2021) make many assumptions about the dynamics and fate of applied pesticides. Moreover, Figs. 3A and 3B are mapped on a relatively coarse scale, and to predict future environmental harm we will need much more geographically localised data on pesticide applications and how this translates into residues. Ideally, this information would be available in real time, since the environmental effects of pesticides may be considerably delayed beyond the time at which the chemical enters the environment, and we would like to have as much warning as possible of future insect declines. For the moment, maps of this type may be more useful in showing the scale of the problem rather than making detailed predictions.

There have been attempts in the UK to map pesticide use on a much more local scale, as shown in Fig. 3C. It remains a problem, however, that flying insects move around a lot, and may thus be exposed to sublethal levels of pesticide residues over a wide area. Soil insects and Collembola don't move around like this, and comparing the welfare of these highly localised hexapods with maps of pesticide use may turn out to be useful in suggesting particular epidemiological hypotheses. However, as the third map of Fig. 3C shows, there is a further problem, which is that agrochemical use co-varies with different kinds of land use. Grassland, for example, is less likely to be treated with agrochemicals than cropland, and different crops will be treated with different chemicals at different times of year. This is likely to prove a problem in interpreting any hypothetical relationship between particular agrochemicals and insect welfare.

Glyphosate

The most intensively investigated case relating an agrochemical to human and environmental health is that of the herbicide glyphosate [N-(phosphonomethyl) glycine], introduced in 1974 by Monsanto

as 'Roundup'. Thanks to the introduction of glyphosate-resistant genetically modified ('Roundup Ready') crops, designed to make it easier (and less expensive) for farmers to control weeds, glyphosate is now the world's most widely used herbicide (Giesy *et al.*, 2000), with about 700,000 tonnes being applied globally each year (Maggi *et al.*, 2019). Residues of both glyphosate and AMPA are now found almost universally in the environment (Battaglin *et al.*, 2014; Muñoz *et al.*, 2023).

The question of whether glyphosate has damaged either humans or the environment remains controversial (Van Bruggen *et al.*, 2018). Glyphosate interferes with the shikimate pathway for the synthesis of aromatic amino acids (tryptophan, phenylalanine and tyrosine), a biochemical mechanism that is present in plants and many microbes but not in animals. The argument that this is glyphosate's specific site of action played an important part in the original argument that glyphosate is safe for humans and other animals (including insects). It is not, however, a valid argument since the chemical could easily have other toxic actions. We now know that glyphosate also causes the inappropriate formation of damaging ROS in the tissues of a number of animals, plants and microbes, and this can act independently of the shikimate pathway (Bailey *et al.*, 2018). Moreover, it has become evident that normal functioning of almost all animals is dependent on their associated microbiota, and at least some of these microorganisms will be sensitive to glyphosate.

Even though an astonishing 60–80% of people in the USA have detectable glyphosate and AMPA residues in their bodies (Galli *et al.*, 2024), the long-term human health risk of this agrochemical remains unknown. Glyphosate is alleged by many activist groups to be a human carcinogen, but this is controversial. The International Agency for Research on Cancer (IARC) has judged that glyphosate is indeed carcinogenic, but the American Environmental Protection Agency (EPA) came to the opposite



conclusion and declared glyphosate to be safe (Benbrook, 2019). In 2022 the EFSA (European Food Safety Authority) concluded that there was insufficient evidence to prove the alleged mutagenic/carcinogenic effects of glyphosate and reapproved its agricultural use until 2033 (European Union, 2023). There have been multiple legal claims in the USA against Bayer (the company that now owns the Roundup brand) alleging human health damage caused by glyphosate, and in June 2020 the company agreed to settle over 100,000 Roundup lawsuits, agreeing to pay up to a staggering US\$ 9.6 billion to settle those claims, and setting aside a further US\$ 1.5 billion for future claims. The company did not admit liability. Neither the American lawsuits nor the EU ruling say anything about the environmental pros and cons of glyphosate.

Environmental effects of glyphosate on insects

There is no doubt that glyphosate can be toxic to insects in the laboratory. Although glyphosate is relatively safe to honey bees in short-term testing regimes, it does have both measurable acute (Zhu *et al.*, 2017), and longer-term toxicity, significantly shortening adult lifespan (Motta *et al.*, 2020a; Castelli *et al.*, 2021). The mechanism of glyphosate's insecticidal effect is not known, although the inappropriate production of ROS is considered a likely candidate (Traxler *et al.*, 2023). Studies of glyphosate's potential for harm to insects in the field are few. In a recent example, the application of glyphosate to a tropical agroecosystem (banana farms in Martinique) significantly reduced soil macrofauna species richness but not total biomass (El Jaouhari *et al.*, 2023). The fact that glyphosate is so universally present in the environment makes it reasonable to ask whether glyphosate residues could contribute to insect declines. The

best understood case is for honey bees; a large number of physiological, biochemical and behavioural parameters are known to be affected by sublethal exposure to glyphosate, including altered motor activity, reduced sensitivity to taste stimuli, impaired associative learning and disruption of the normal sleep-wake rhythm (Vazquez *et al.*, 2020; 2024).

One particularly well-investigated way in which exposure to sublethal levels of glyphosate act to reduce honey bee survival is interference with the insects' immune function (Smith *et al.*, 2021; Kahn *et al.*, 2025). The endogenous adult gut microbiota of honey bees is disturbed when young workers are exposed to the chemical, an effect that occurs both in the laboratory (Dai *et al.*, 2018; Motta *et al.*, 2018; Castelli *et al.*, 2021) and under field conditions (Motta *et al.*, 2020b). Bacteria that possess shikimate pathway enzymes (especially the major beneficial honey bee symbionts *Snodgrassella alvi* and *Lactobacillus apisi*), are selectively suppressed through interference with microbial growth and biofilm formation in the gut (Motta *et al.*, 2024). Presumably as a consequence of the altered gut microbiota, the pattern of expression of immune genes is significantly changed (Smith *et al.*, 2021; Motta *et al.*, 2022), adversely affecting both multiple immune effectors and the survival of affected bees when challenged with pathogenic bacteria (Motta *et al.*, 2018). Resilience to Deformed Wing Virus (DWV) but not the microsporidian fungus, *Nosema ceranae* is affected by glyphosate (Castelli *et al.*, 2021).

The ability of sublethal levels of glyphosate to interfere with the gut bacteria of honey bees is particularly ominous. Almost every insect has a gut microbiome that contributes to normal levels of fitness, and many insects also enjoy mutually beneficial metabolic relationships

with specialist bacterial endosymbionts. Symbionts play key roles in dietary specialisation (Ge *et al.*, 2024), behavioural interactions (Liberti *et al.*, 2024) and detoxification of phytotoxins and environmental pollutants (Kline *et al.*, 2024).

Is it possible to say whether glyphosate residues in the environment contribute to insect declines? Although the gun is already smoking, it may prove to be hard to acquire epidemiological evidence of environmental harm in the field, because it will be hard to find any land that is not already contaminated. I'll return to the glyphosate question at the end of this article.

Neonicotinoids and insect declines

Once evidence for insect declines began to accumulate, it was natural to suppose that if they are caused by one or more polluting chemicals, the offending environmental residues would probably be environmental insecticides or their metabolites. Since neonicotinoids are now the world's most widely used class of insecticides, they have been the main suspects. Although there's plenty of evidence that neonicotinoid residues are at least capable of damaging insect populations (Frank *et al.*, 2020), and most recently that they are particularly damaging to hemipterans (Sedmeier *et al.*, 2025), there have been relatively few instances where the environmental case against neonicotinoids has been sustained by classic epidemiological evidence from the field. An important paper is the one by Rundlöf *et al.* (2015), in which it was shown that when a proprietary insecticide containing a combination of clothianidin (a neonicotinoid) and β -cyfluthrin (a non-systemic pyrethroid) was applied to oilseed rape seeds in Sweden, it reduced the population density of all wild bees, harming solitary bee nesting as well as

The ability of sublethal levels of glyphosate to interfere with the gut bacteria of honey bees is particularly ominous



bumblebee colony growth and reproduction. There is thus the possibility of a synergistic effect between the two insecticides. The nature of the evidence means that it isn't certain that the seed treatment damaged insect populations through a systemic action in the treated plants; one or both of the seed treatment insecticides could have leached into the soil, for example. In contrast to effects on wild bees, the treatment did not diminish honey bee numbers, indicating that neonicotinoids are not universally damaging. That this important result depended on the use of an insecticide mixture suggests to me that there may be multiple ecotoxicological factors at work when neonicotinoid insecticides appear to be linked to insect declines. If that proves to be the general case, then unfortunately it will always be difficult to reveal the effect of any one factor without controlling for the others.

Chlorothalonil

We now know that one of these other drivers of insect declines is the fungicide chlorothalonil. This chemical has been up to now widely used on many different crops, including wheat and barley in Europe and the UK. You'll recall from Fig. 2 that chlorothalonil was quantitatively the top contaminant in European air samples. We now know that this agrochemical poses a serious danger to wild bees, facilitating their infection with the gut pathogen *Nosema* (Pettis *et al.*, 2013). Moreover, chlorothalonil levels in the environment predict both pathogen prevalence and range contractions in US bumblebee species (McArt *et al.*, 2017), so that this is one of only two cases where we have strong epidemiological evidence that environmental agrochemical contamination can drive an insect decline.

Chlorothalonil was effectively banned in the EU in 2017 for most agricultural purposes, although the decision (European Food Safety Authority, 2017) was explained as due to 'data gaps' and mentioned the chemical's dangers to 'honey bees and other non-target arthropods' only in passing. In the USA, the EPA in January 2025 issued an interim decision that says: 'EPA could not accurately assess the risks to

pollinator species because of a lack of data'. The agency announced that it would seek additional information "to fully evaluate risks to non-target terrestrial invertebrates, especially invertebrate pollinators". Thus, it's not really clear whether this chemical is seen by either the EFSA or the EPA as an environmental risk despite the rather strong epidemiological data. The case of chlorothalonil and wild bee declines tells us that chemical residues in the environment really can drive insect declines, but the evidence doesn't rule out the possibility that chlorothalonil is synergised in this action by one or more other chemical residues.

Predicting environmental harm

All the agrochemicals now in use were originally subjected to stringent testing before they were approved by the regulators. Obviously, if we now find that some of them are damaging to the environment, then those tests cannot have been sufficient to detect their potential for ecological harm. How many other environmental chemicals are already present in the environment that have not yet been revealed by post-hoc epidemiological analysis to be a risk to nature? And what about possible synergism between the new chemical and others already present in the environment?

It seems that if we are serious about preventing harm to insect populations, we need a better system of testing new chemicals to predict their environmental toxicity, whether alone or in combination with other widely used agents. Like the existing system, this will need to operate at multiple levels, screening for potential harm at an early stage, and testing for efficacy and possible environmental damage when deployed in the field, but it needs to be more effective.

Reviewing this unhappy situation, Weisser *et al.* (2023) called for greater emphasis to be placed on experimental studies that predict the potential of newly introduced agrochemicals to cause ecological damage. Ideally, such work would be done at an early stage, thus avoiding the withdrawal of candidates on which a lot of money had already

been spent. Although the data that result from laboratory experiments can be analysed inexpensively, extrapolating from lab-scale findings to the field is risky, and there is a real risk that a valuable product will be rejected by mistake. On the other hand, discovery and development of a new agrochemical product is notoriously expensive – currently estimated at US\$ 300 million (AgBioInvestor, 2024) – so there's plenty of opportunity to reduce costs by avoiding late-stage field trial failures on environmental grounds. Moreover, there is a serious operational difficulty, which is that we don't have good ecotoxicology data for most of the chemicals that we already know to be present in the environment, and which may be just as dangerous as the new ones.

Thus, there is a strong case for setting up laboratory-scale, high-throughput testing systems to predict the possibility of adverse environmental effects at the earliest possible stage. Where such trials can be done using existing laboratory robotic systems, there is considerable potential to provide useful information at low cost. Moreover, such methods also offer the opportunity to examine interactions between chemical pollutants. Although it must be admitted that the number of chemical combinations to be tested is potentially infinite, there are some obvious combinations with existing widely-used chemicals that ought to be tested. The most commonly encountered

If we are serious about preventing harm to insect populations, we need a better system of testing new chemicals to predict their environmental toxicity, whether alone or in combination with other widely used agents



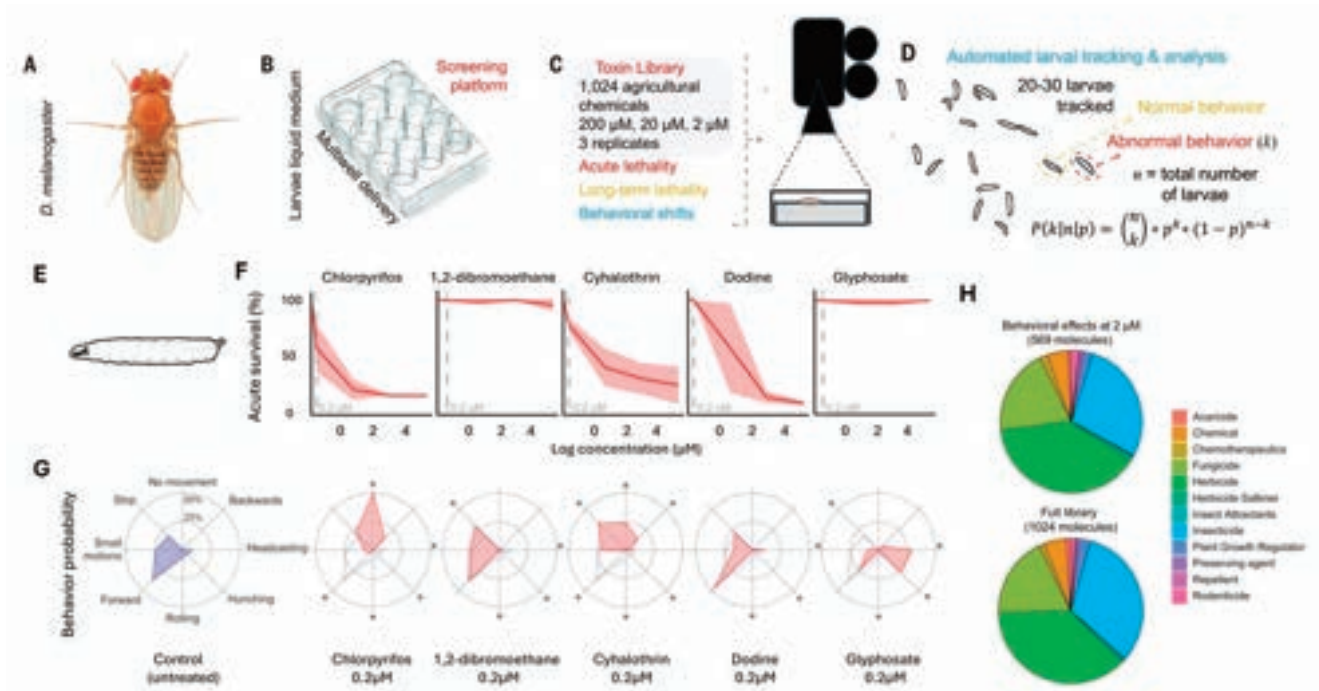


Figure 4. A high-throughput screen for sublethal actions of environmental chemicals on *Drosophila* behaviour. **A.** Adult *Drosophila melanogaster*. **B.** multiwell plate for delivery of test chemicals in liquid nutrient media to a group of ~ 20 fly larvae. **C.** The library of test chemicals. **D.** Automated larval tracking and analysis. **E.** *Drosophila* larva. **F.** Adult survival when challenged with varying doses of 5 representative test chemicals. Note that at a low dose of 0.2 µM, only chlorpyrifos has any acute insecticidal activity at all. **G.** Radar plots compare the behaviour of the treated larvae (pink) with an untreated control (blue). All five chemicals cause significant disruption of normal behaviour; **H.** Shows the functional classification of all 569 chemicals (56%) that disrupted larval behaviour. Insecticides, herbicides and fungicides were all represented. Figure is (modified) reproduced from with permission from Gandara *et al.* (2024).

residual agrochemicals, like glyphosate and AMPA, seem like the right place to start.

The *Drosophila* growth and behaviour screen

Following a similar line of reasoning, Gandara *et al.* (2024) have recently described just such a testing platform that can be used to assess the toxicological effects of test chemicals on the growth, behaviour and survival of the fruit fly *Drosophila melanogaster* (Fig. 4). This was used to test a library of 1,024 chemicals, deliberately chosen to reflect diverse uses as well as differing chemical properties. Most were agrochemicals; insecticides, herbicides, fungicides, and plant growth inhibitors were all tested, but some known neuroactive chemicals (like caffeine) were also tested as reference points.

The remarkable result of this study was that more than half (57%) of the chemicals altered normal patterns of larval mobility, even at sublethal concentrations. Many that affected behaviour in this way are not usually considered to be insecticidal and come from a remarkably varied

range of chemical categories, but the fact that they do affect behaviour implies that all the active chemicals have the potential to cause ecological harm. Surprisingly, the proportion of chemicals with behaviour-modifying activity from each functional class was much the same as in the chemical library as a whole (Fig. 4H). This implies that it is not justified to consider known insecticides as being potentially more harmful than other agrochemicals.

A further interesting point is that sublethal effects on larval behaviour were temperature sensitive, with the incidence of most of the observed chemically induced aberrant behaviours increasing at higher ambient temperatures. This suggests that sublethal chemical effects on behaviour may be synergised by elevated temperatures. Since it is already known that climate change may contribute to insect declines (Halsch, *et al.*, 2021), this connection may prove important as fossil-fuel-induced climate change continues in the coming years.

Gandara *et al.* (2024) went on to investigate the possible

mechanism whereby sublethal levels of agrochemicals were able to interfere with larval behaviour by examining the proteomes and phosphoproteomes of larvae exposed to a low concentration (0.2 µM) of five particular chemicals: chlorpyrifos, cyhalothrin, dodine, glyphosate and 1,2-dibromoethane. Only the most toxic insecticide (chlorpyrifos) affected the proteome, but all the compounds except the fire-retardant (1,2-dibromoethane) caused marked changes in both larval behaviour and the pattern of protein phosphorylation. This probably reflects their interference with the regulation of neuronal or muscle function; unlike changes in protein synthesis, the addition or subtraction of phosphate residues from cellular proteins can take place very quickly. It's revealing, of course, that only five compounds were investigated in this way; this kind of work is much more laborious than the multi-well plate larval behaviour screen. Another way of looking at this is to say that the high-throughput screen was successful in predicting that it would be worthwhile to examine the actions

of these five chemical compounds in more detail.

Finally, anticipating that industrial use of a toxicology platform of this type might require the test organism to be an insect other than *Drosophila*, Gandara *et al.* (2024) went on to show that the basic screening methodology could be modified to accommodate other insects by using mosquito larvae (*Anopheles stephensi*) and Painted Lady butterfly larvae (*Vanessa cardui*). The analysis was not so comprehensive as with fruit flies, but nevertheless it showed that both these insect species react to sublethal levels of a wide range of environmental agrochemical residues with aberrant behaviour in much the same way as *Drosophila*.

The idea of using a high-throughput insect behaviour screen to detect bioactive chemicals of interest is not totally new. Grieco *et al.* (2005) described a high-throughput system to assess the motor responses of adult mosquitoes to repellants. A superficially similar approach to the same end was described by Bedrossiantz *et al.* (2020) using swimming larvae of the freshwater copepod *Daphnia magna*, although in this case only a limited range of chemicals was tested and behavioural analysis was much less detailed. Buckingham *et al.* (2021) also described a multi-well plate motility assay to screen chemical compounds for mosquito larvicidal activity, but their study concentrated on lethal rather than sublethal effects.

Mixtures and synergy

Then there is the question of what happens when insects are exposed to a cocktail of diverse agrochemical residues, present either in the soil, the interstitial water within the soil, as well as in or on the food they eat (plants or perhaps other invertebrates). As Hernandez *et al.* (2013) have wisely observed, “pesticides almost always occur in mixtures with other ones”. Interactions between toxicants have always attracted a good deal of attention from toxicologists in general (Bloch *et al.*, 2023), and methods for distinguishing additive, synergistic or even antagonistic interactions are well-developed

(Tallarida, 2001). Although it has sometimes been supposed that mixture components that shared the same mechanism of action would simply be additive, while examples of synergy would usually concern mixtures of active constituents with different molecular targets (Borgert *et al.*, 2004), this is not always the case, presumably because toxicodynamics and metabolic fates may not always be similar when comparing chemicals with the same mode of action. Both insecticide toxicologists and applied entomologists interested in the field performance of insecticides have long known that synergistic interactions can occur between insecticides (Sun *et al.*, 1960), but it has also become apparent that synergistic interactions commonly occur between insecticides and environmental chemicals with other functional roles (Cedergreen *et al.*, 2014; 2023), both fungicides (Biddinger, 2013; Raimets *et al.*, 2018; Bloom *et al.*, 2021; Albacete *et al.*, 2024) and herbicides (Pape-Lindstrom *et al.*, 2009; Lichtenstein *et al.*, 2013). A meta-analysis of 356 interactions from 90 studies in which bees were exposed to combinations of agrochemicals, nutritional stressors and/or parasites found that while interactions between chemical and nutritional/biological stressors were generally additive, there was strong evidence for synergy between chemicals (Siviter *et al.*, 2021).

Glyphosate again

Finally, in case you hadn't guessed that it was coming, I will point out that one of the chemicals that was shown in Gandara *et al.* (2024)'s high-throughput screen to cause behavioural changes in fly larvae at sublethal levels is none other than the ubiquitously occurring herbicide glyphosate. While a 16 h exposure at concentrations up to 4 µM had no significant effect on short-term survival, larval behaviour was significantly distorted by the herbicide even at only 0.2 µM. This is clear evidence that glyphosate exerts its own sublethal effects on the behaviour of fruit fly larvae. Moreover, although glyphosate has frequently been asserted to be without lethal effects on insects

(which may well be true when tested under laboratory conditions), it is now known that glyphosate has ecotoxicological effects of its own on a variety of invertebrates including insects (Evalen *et al.*, 2024). While these actions may well be the consequence of increased levels in the affected insects of ROS in the tissues of the afflicted animals, there is a possibility that the resulting lethality is actually due to synergistic interactions (perhaps mediated by ROS) with other toxicants. It is known that the ecotoxic effects of glyphosate are increased in severity through the herbicide's interaction with a variety of co-formulated synergist chemicals (whose identity is often not disclosed by the manufacturer) that are additionally present in glyphosate-based herbicides (GBH) (Klátyk *et al.*, 2023; 2024). Given the ubiquity of glyphosate residues, maybe it is now time to enquire into the possible role of glyphosate and especially GBH in insect declines.

High-throughput, automated behavioural assays of the general type introduced by Gandara *et al.* (2024) have tremendous potential to identify environmentally damaging pollutants, either alone or in combination. Doubtless even better variants, or others modified for particular purposes will be devised. As Gandara *et al.* (2025) have pointed out, the adoption of screening systems of this kind will enable artificial intelligence systems (AI) to be used not only to speed up screening procedures but also to improve accuracy.

All this will enable us to discover new information about the occurrence and prevalence of sublethal effects on insect behaviour, which may (or may not) explain some aspects of the declines in insect populations that are now so evident. Whether this will enable remedial action to be taken is another matter. A big part of the problem is that a great deal of chemical pollution of the environment has already occurred, and it may take time to reverse it, even if we stop adding new pollutants to those that are already there. Moreover, global intensive agriculture has become so dependent on glyphosate, that it won't be at all easy to stop using it.



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'Entomology Camp', Trus Madi, Borneo Jungle Girl Camp



Fig. 1. A. Poster of the Moths of Borneo, Gunung Trus Madi; B. Malaysian Moon Moth, female, *Actias maenas* (Saturniidae); C. Keat Soon's Stick Insect, *Orthonectrosia keatsooni* (Lonchodidae); D. Boxer Mantis, *Astillasula* sp. (Hymenopodidae); E. Dead-leaf Grasshopper, *Chorotypus* sp. (Chorotypidae); F. Malaysian Treehopper, *Pyrgauchenia tristaniopsis* (Membracidae); G. Mannam's Leaf Insect, *Pulchriphyllium mannani* (Phyllidae); H. stag beetle, *Odontolabis imperialis* (Lucaniidae); I. Guest with camera, outside guest house; J. Nicky Bay at a highly attractive light sheet. K. Night 'hornet', *Provespa* sp. (Vespidae).

Photographs by Nicky Bay with permission. For many more of his excellent photographs see <https://www.nickybay.com/moths-of-borneo-gunung-trusmadi/> and checkout his Flickr page.

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(Taiwan, Denmark)
and **Kelvin Ng**
(Trus Madi, Sarawak)

In Sabah, North Borneo, at slightly over 4,000 metres above sea level, Gunung (Mount) Kinabalu is the highest mountain between the Himalaya and New Guinea. The ascent is straightforward and aided by an obligatory porter carrying one's backpack. Visitors ascend from overnight accommodation at Panar Laban, 700 metres in elevation below the summit, starting in early morning darkness to view sunrise from the peak. The first time I ascended, some 50 years ago, my permit

allowed me to remain for several days to collect aquatic insects. I could roam freely, unaccompanied, initially around the camp surroundings of interesting vegetation including orchids, pitcher plants, rhododendrons, bamboos, 'Australian' Myrtaceae and weird austral gymnosperms. By sunrise viewers had started to descend and the granite summit area was mine for the remainder of the day, and the next. It took hours for the surrounding cloud layer to clear and for another, lower, summit to emerge to the south. From the lower slopes of Kinabalu National Park an expanse of good-looking native forest (not palm plantations) stretched southward to the isolated peak.

It was not until the 1990s, when Penny Gullan and I took a break from interminable rain and endless mud at Kuala Belalong (Brunei) to climb Kinabalu that I recalled the spectral peak. Our obligatory porter, who carried both backpacks, stopping frequently for a smoke, identified the mountain as Trus Madi. He said access was only by 4x4 truck for 50 kilometres of muddy, often impassable, old logging trails. Furthermore, permits were not given, so back it went into a 'to-do' list. Subsequent visits to Borneo (Sarawak, Brunei and Sabah) led me to understand that the adjacent hills of the Crocker range might provide the only (very difficult) access and our Kinabalu porter-guide had told the truth. So, still on the 'to-do' list. As Covid travel restrictions eased in 2022, joining a birdwatching trip to Sabah, including Kinabalu and Danum, was very tempting. Even more so, there was an option of a week-long pre-trip extension that included two nights at 'Trus Madi'. What a surprise to find that alternative names for this place were 'Jungle Girl Camp', 'Bug Camp' or 'Entomology Camp'. Despite excellent birding at hides close to the camp, entomologists had priority in booking. Thus, in August 2023, I was bracing in a

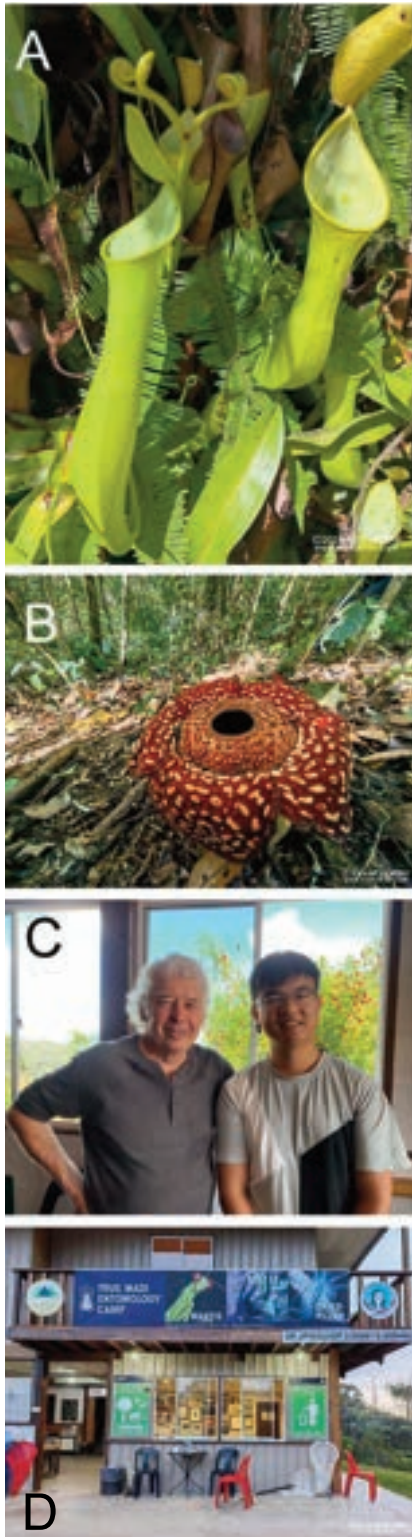


Fig. 2. A. Pitcher plant, *Nepenthes reinwardtiana* (Nepenthaceae); B. *Rafflesia pricei* (Rafflesiaceae); C. The author with Fang-Shuo Hu in the guesthouse; D. The guesthouse.

Toyota 4x4, one of a convoy of three vehicles heading along the upgraded but still rutted old logging trail in a shuttle service provided from the asphalt trailhead to the Jungle Camp. Only half a century late arriving!

Our driver, Peter, provided much information. He ran a major tourism enterprise in Sabah, from reef boats to rainforest tours, until Covid killed off tourism after March 2020, including his business. He now volunteers at Trus Madi for the duration of the less-wet season when it is open to visitors. The camp closes in the really wet season starting from October/November when access is impossible. Peter and a second volunteer, Rudolph, with a Ford Ranger, apply their off-road driving skills ferrying birders to hides, entomologists to the light sheets, and visitors and supplies to and from the distant asphalt. So obviously, visitors don't arrive on-spec – no walk-ins and a strict booking system is in place, not least because any visit requires prior entry permits for visitors and vehicles. The guesthouse is full board and catering supplies is a major enterprise in the remote location on the slopes of Trus Madi which, at 2,642 metres, is the second highest mountain in Borneo (lower only than Kinabalu). The mountain and the camp lie within the highest category of forest reserve (Class I fully protected) covering 74,736 hectares (747 km²). Selective logging ceased long ago, and the current-day, well-recovered forest quality and the elevational range (guesthouse is at 1,400 m) produces extravagant biodiversity. The fauna and flora include rare pheasants, partridges and pittas, binturongs, tarsiers, many squirrels and tree-shrews and a huge diversity of insects, exemplified by the moths selected for the poster in Fig. 1A, familiar to some from Jeremy Holloway's studies half a century ago. Some insects challenge the *Guinness Book of Records* in size or weight. One of the longest insects in the world, Chan's Megastick (*Phobaeticus chani*) clocks in at more than 50 cm and is often seen close to the accommodation. The Malaysian Moon Moth, *Actias maenas* (female, Fig. 1B), comes to one or more of the dozen light sheets that are run every night. Many common but elusive insects show crypsis as in tropical 'bugs' (Fig. 1 D, E, G) and some 'true bugs' show parental care (Fig. 1F). Other heavyweights are valued in illegal trade (Fig. 1H). Within the reserve

are several *Nepenthes* pitcher plant species (Fig. 2A), with a thriving larval dipterous infauna, and several species of the famous giant flowering rafflesias (Fig. 2B), carrion flowers, whose pollinators are calliphorid flies lured by the colour and odour of dead meat.

It was this profuse diversity that encouraged Philip and Jimmy Chew and partner Clare ('Jungle Girl') to propose a reserve for ecotourism, conservation and education in entomology. Sabah Forestry Department took more than 20 years to grant permission, and subsequent development on the old logging camp site proceeded slowly as funding was entirely self-generated (including by the sale of their houses). Over the last 20 years the accommodation has grown from a few tents through several iterations of guest houses, with the current one the largest and most recently completed after neglect and tropical jungle-invasion during the lengthy period of closure due to Covid.

So, one might ask "just how much interest is there in such a facility?", especially as no permission is given to collect specimens, even of those that come to, and die at, the many light sheets, usually in astonishing abundance. On my first visit, after dawn in a bird hide, I returned for a late breakfast to see on the big table alongside pooters, nets, lenses and other entomological and photographic paraphernalia was a familiar entomology textbook. This had arrived with a mixed-age group of Taiwanese entomophiles, accompanied by Fang-Shuo Hu (Fig. 2C, with the author) who was heading to Europe to a PhD programme at the University of Copenhagen. Fang-Shuo now studies phylogenomics and functional morphology of the predatory behaviour of the tribe Staphylinina (rove beetles). Subsequently, Fang-Shuo has told me that in two years more than 250 Taiwanese individuals have visited this Entomology Camp. A main guide is Shih-Chieh Huang, a well-known television presenter and popular science book author, who has a contract with the camp to lead Taiwanese groups. These ecotourism enthusiasts, comprising 20 to 30 people of various ages, all love nature and

want to experience tropical forests. In addition to the tourists, Shih-Chieh has collaborated with the Taiwanese Society of Insect Natural History, bringing along entomologists to guide and educate the visitors. These entomologists not only share their knowledge with the participants but also have the opportunity to conduct field studies. The journey includes both outdoor observations and indoor courses, with both activities emphasising the connection between nature and environmental ethics. The team members hope that every participant enjoys the natural area and gains a deeper respect for it. This surely assists the promotion of

sustainable use of insects and forests and supports the conservation ethos of Trus Madi.

To understand how typical these visitors are, I asked Kelvin Ng, who manages the guesthouse and is also an avid birder. He told me that more than 400 guests come each year, mostly in groups but with independent travellers permitted. Visitors include macro-photographers who assume an expanding significance and include Nicky Bay, who provided illustrations for Plate 1, shown with camera gear (Fig. 1I) and surrounded by insects at a light (Fig. 1J). Visitors largely come from China, Taiwan and Japan, some like Nicky Bay from Singapore, yet

only a few from Malaysia. I have to admit that one insect appeals less to me, as a recipient now of two very painful stings from night hornets (*Provespa* wasps) (Fig. 1K) that turn out at dusk and attend the light sheets (and traps).

The reliable presence of the beautiful Bulwer's and Argus Pheasants at hides means that Trus Madi now is a must-visit location on Bornean birding tours with both international and local-guided agents. It certainly also should be on the radar of insect enthusiasts from a much wider area than regional Asia. Europeans and North Americans would be wowed by the tropical experience!



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Abstract Submission deadline: Friday 18th July

**Submit an
abstract**



Thursday 9th October
Elm Grove Conference Centre, University of Roehampton, London





Still from a video of a Cecropia Moth (*Hyalophora cecropia*) filmed in slow motion © Adrian Smith

AntLab: Using online videos to disseminate entomological science

Claire Price interviews Dr Adrian Smith (@AntLab on YouTube)

Claire Price

What made you want to make videos on YouTube?

Adrian Smith

When I started out making public facing videos, I was a postdoc, and I was frustrated that I couldn't get my university to write press releases to promote my research. So, I decided that I was going to do my own version of that and make a video. The first videos were summaries of research articles that I or my colleagues had published. I hoped that these would be tied to an institutional press release with a YouTube link within it. If you look back at the

older videos on AntLab, that's what most of them will be. Some of them have nothing to do with insects; for example, I made a video (Smith, 2017) of the work of a team of astrophysicists, where they describe the shape of a new galaxy they observed. So that's an AntLab video! It doesn't make sense that it's on the channel, but that's where it came from. I started my career working on ants and used to exclusively work on them, and that's why my channel is called AntLab. I don't only focus on ants anymore, but it's a good six-letter name, so I just kept it. The videos I make now are very

different from the ones I started out making, as eventually I broadened why and what I make videos for, and it has grown from there.

Claire Price

Is filming and post-production a skill that you've taught yourself, or have you been on a course?

Adrian Smith

Capturing video has always been part of my research. It's integral to behavioural biology, as I'll often record something and then take data from the footage. So, I was already filming things while doing science and then it was just



learning how to edit. When I was a graduate student, I secretly enrolled in a film school at Scottsdale Community College in Arizona that taught night classes, and I dropped out after a semester. I took one class to learn how to do nonlinear editing and that was enough to teach me how to edit film together. From there, it was learning by doing. I'm not sure if I make videos the right way, I'm certainly not the best editor. I don't know much about animation effects or anything like that, but I work within what I know and try to do something slightly new or learn new skills every time I make a video. It's one of those things that you just do and get better at, and you learn your strengths and where you need to improve.

Claire Price

Do you see comments from people changing their mind about how they see insects after they watch your videos, going from hating them to finding them interesting?

Adrian Smith

I see those comments sometimes, but I also see comments like 'Insects are gross. This is disgusting'. I don't make things to change people's minds, though. I make videos because I think they

make interesting stories. I only have two rules: first, it has to be a story that hasn't been told before, or an insect filmed in a new way; second, there has to be a reason in the video narrative as to why I made that video. That usually means expressing some sort of subjective feeling or insight or appreciation from my own self, about why I went to the bother of making a YouTube video. Changing people's minds is never a goal. If it happens, great. If it doesn't, that's out of my control.

Claire Price

I've seen that you've done a few side projects, for example the collaborative art project for National Geographic (Roth, 2024; Smith, 2024). How did that come about, as it's a bit different from what you usually do?

Adrian Smith

I make content for Instagram too (@dradriansmith), and an artist, Xavi Bou (@xavibou), saw my work on this platform. He usually works on birds and landscapes, using video footage to collate frames into a single image, and he was looking to work on insects and tried to film them before. He was struggling, but then saw my work so he contacted me. From there, I would film things, send them to



Still from a video of an American Cockroach (*Periplaneta americana*) jumping between two platforms, filmed in slow motion.
© Adrian Smith



Sapho Longwing butterfly (*Heliconius sapho*) © Xavi Bou

him to put them through his process and then we'd see what we get. We did that for years and then pitched a project to National Geographic to debut it there, which it did earlier this year. I don't think that there's much of a difference between why some artists do art, and why some scientists do science. I think at the core of it, there's a hugely overlapping motivation and reason for doing both things. I found that true with Xavi's approach and with my approach. He comes at it from the art perspective, I come at it from the science perspective, but at the end of the day, we're both trying to visualise the natural world in a new and surprising way that inspires us so much that we want to use it to engage people with nature.

I think that's my core motivation for doing science and his core motivation for doing art, so these collaborative projects across disciplines make sense once you

realise that purpose. So, I don't consider this stuff as side projects, I consider it more as different avenues of me being the type of scientist that I am. It might not be peer reviewed science with a capital S, but for me it's from the same motivational place, and it's ultimately for the same purpose.

Some people think of National Geographic as a magazine where you must re-dig up King Tut or film a Great White Shark doing something incredible to be featured in it, but the insects that were in this six-page spread were all from my porch, from my backyard (with one exception, a tropical butterfly from our museum, but otherwise totally ordinary). You can't get any more ordinary than those insects that I worked on, but when we look at them this way, you get to see them in an extraordinary new light, and I think that's the power of doing either science or art.

Claire Price

Were the flipbooks (Flipboku) going off the same idea?

Adrian Smith

Exactly, they saw my work and thought it would be interesting to make flipbooks out of insects. It's the same idea of visualising biodiversity in a way that gives people a new story to tell about nature all around, and a new way for them to appreciate or have a conservation ethic towards things that might have been overlooked or seen as ordinary or not spectacular in any way. These flipbooks showcasing species that can be found here in North Carolina can be bought in our museum gift store and visitors can take them home and say "Hey, did you know that moths can be as colourful or more colourful than butterflies?"

Claire Price

Do you have any advice on how to make successful videos that are both informative but also entertaining on YouTube or any other platform?

Adrian Smith

Yes, I have lots of advice. I teach a three-credit hour class called 'Creative media production for scientists', so a whole semester's worth of advice! I think the most important thing, when you're starting, is to make things for yourself and disregard whether anybody would watch it or not. Just make the thing that you wish existed and go from there. Making something, publishing it, telling a story that wasn't out there or didn't exist, is an accomplishment in and of itself. Whether it gets 100 views or 100 million views is inconsequential. All that really matters is that you took the time to do something that not very many people do. That's where everybody should start, and I think that's where I started. I wanted to tell the story of my science, and I wanted to have some sort of creative summary of what I was working on or publishing as a scientist. I couldn't get the institution to help me, so I just did it myself. I think that people often immediately want to skip to 'how do I get a million followers and a million clicks and ad money and sponsors' but that is later, if you're lucky, maybe.

If the goal of making something is 'I want something to exist that



Two-lined Spittlebug (*Prosapia bicincta*) © Xavi Bou

doesn't exist' and you make the thing that is the successful creation, that's a successful piece of media, you checked off your main goal. If you start out seeing it that way, you'll discover things, you'll refine your interests and your reasons for making things as you go on, and you'll find your voice as you make more and more things. You'll find what platforms work for you or what type of media works for you as you make things.

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Fig. 1. Base Camp (photo: Barney Page).

*Do you know the pile-built village where the sago-dealers trade –
Do you know the reek of fish and wet bamboo?
Do you know the steaming stillness of the orchid-scented glade
Where the blazoned, bird-winged butterflies flap through?
It is there that I am going with my camphor, net, and boxes,
To a gentle, yellow pirate that I know –
To my little wailing lemurs, to my palms and flying-foxes,
For the Red Gods call me out and I must go!*

Rudyard Kipling
The Feet of the Young Men

Planning and the early days

This year marks the 40th anniversary of the legendary Project Wallace (PW). Well, perhaps not legendary, but an event that lingers in the memories of everyone who took part. It was said to be the biggest entomological scientific expedition ever. Perhaps – I don't know – but it was certainly adventurous. Planned by the Royal Entomological Society to celebrate the 150th anniversary of the Society's formation and the centenary of receiving the Royal Charter, the expedition took place

in collaboration with the Indonesian Institute of Sciences (LIPI) and with support of the Joint Services. By any standard it was an ambitious undertaking, with more than 100 scientists from 17 countries and ca 60 widely diverse Service personnel thrust together on a remote island for a year, divided into three 4-month phases. Combined, we were a truly motley crew, affectionately and proudly referring to ourselves as 'Wallies' ... but what a time we had.

First proposed in December 1978, several locations for the expedition were considered, with Sulawesi selected because of its rich and unique endemic fauna and in recognition of Alfred Russel Wallace, who visited the island 1856–1859. Wallace served as President of the RES from 1870–

1871 and is credited – together with Charles Darwin – with significant ideas on evolution and biogeography. The imaginary 'Wallace's Line' drawn between Bali and Lombok and between Borneo and Sulawesi bears his name. But before anyone set foot on the island, a site had to be identified, political agreement reached, funding found, and a camp built. That would all take time: years surely, although documents in the RES archive suggest that building the camp was still being discussed with WWF Indonesia in March 1984 and that a ship carrying 30 tons of Base Camp equipment valued at £90,000 left the UK on 12th October 1984, arriving in Singapore in mid-December. By this time, scientific and Service schedules were more-or-less finalised, with

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individual project programmes and dates agreed. Thankfully, the Governor's Office in Manado arranged for PW to use buildings used by contractors for the recently completed Toraut Irrigation Scheme, which became a rather up-market camp for the whole period. Base Camp (Fig. 1) comprised a brick building, with sleeping rooms, open dining / meeting area, a kitchen and an open veranda. A second building served as a laboratory and we also had use of four wooden huts on stilts (Fig. 2), 100 m from the main buildings. Considering this was a major field expedition, accommodation was remarkably comfortable. Freight, including three white Land Rovers – supplied by the MoD and finally left to the local community rather more dented than when they appeared – arrived at Bitung on 20th January 1985. Local Customs authorities quite reasonably opened everything but were bewildered by, for example, a large box containing nothing but old newspapers which they removed and shook to see if anything lurked inside (paper was fundamental in packing botanical specimens). The illustrated account that follows is largely a personal view of Phase 2, with input where available (almost exclusively from scientific participants) from the other teams – 40 years was a long time ago, and memories fade. Data from Phases 1 and 3 participants were understandably patchy, with some notable exceptions (see acknowledgements). I have consciously avoided duplicating previously published PW accounts as far as possible and this account aims to give a sense of our adventure rather than an account of the scientific achievements and species found.

Joint Services support

The Services: Royal Navy; Army; Royal Air Force, have a unique system of what is affectionately referred to as 'Adventurous Training' whereby individuals can organise or join Service or non-Service expeditions away from their usual working environment. Such activities are considered 'character-building' and are often introduced by way of Defence Council Instructions (DCIs). Normally, I would never have seen



Fig. 2. The Stilts accommodation (photo: Barney Page).



Fig. 3. A storm washed away the first bridge – George Rahman and Pete Woods on the bridge.

a DCI, but happened to be working in the Ministry of Defence at the time PW was being planned. I can picture the Chief Clerk coming into my office and throwing the PW DCI on my desk, with a smirk and the words "This might be just up your street. Haha". He was right. Tongue in cheek I asked my immediate boss if I might apply. Surprisingly, permission was given, clearly on the understanding that it was a waste of time. A hurdle was that PW was looking for either specialists (surveyors, signallers, cooks) or 'handymen', able to turn their hand to almost anything. Sadly, and frankly rather pathetically, my DIY skills hover just below zero. The only job I thought I could do was the 2IC (Second In Command: probably a bit above my pay grade) but what I neglected to tell anyone in

my own very small military organisation, was that I had been elected a Fellow of the RES the year before. When I was accepted for Project Wallace, the grief and recriminations from above for allowing me to apply were quite noisy but happily conducted mostly out of my earshot. And so, it came to pass. I was lucky to be assigned to Phase 2. Phase 1 had to set everything up, settle in and build sub-camps; without doubt this was the most 'difficult' time. Early local difficulties included major confusion over what type of visa was required and issued. This resulted in Geordie Maddison (Services) being incarcerated for two weeks in Manado for appearing with what police regarded as 'incorrect documentation'. Phase 3 had the task of closing down the Base Camp at the end of the year,



Fig. 4. The deluxe Phase 2 bridge (photo: John Tennent).

including ensuring that some of the equipment (e.g., military radios) was returned to the UK. Phase 2 ensured the smooth running of the camp with the added advantage of having a small contingent of women participants (always useful in soothing the occasional over-exuberant male ego).

Camp life

The expedition was based in the Dumoga-Bone National Park, a large area of mainly virgin forest north-west of the Park Headquarters and the Kossingolan Irrigation Scheme. Base Camp was five minutes' walk from the east bank of the Toraut River, which was joined by the smaller River Tumpah further downstream. Most of the subsequent trails, *en route* to or at high points, necessitated crossing the Toraut and then walking up the west bank of the Tumpah. Since beginning what might be a 4–10-day trip wet from the waist down was an uncomfortable event, a bridge was built over the Toraut River by Phase 1 in only five days. With stone towers confined by wire mesh, bridged with timber, a structurally solid bridge was

built (although it required a sense of balance to negotiate); it lasted well, until a storm washed away the timber (Fig. 3). Lessons were learnt. The next bridge was slightly higher, with a handrail until it too was washed away. The engineers and handymen took this as a personal affront and conspired to build a bigger and better bridge (Fig. 4), which only suffered some minor damage by floods. But the final bridge of Phase 2 was still there when I returned briefly at the end of the year; the camp was eerily empty.

Named sub-camps were erected on cut routes. Page Camp was the nearest to Base Camp, followed by Hog's Back, home to The George Else Memorial Hammock (hymenopterist George was famed for never having ventured further!); then Edward's Camp, with a spectacular view over a forested valley to the east: a perfect place to run a mercury vapour trap (Fig. 5). This long route finished at 'Camp 1440' (Fig. 6), named because this was the elevation stated on the map. Our surveyors subsequently found that almost all elevations marked on the maps were optimistically high and that the actual elevation



Fig. 5. View across the valley and hills from the back of the Edward's Camp shelter (photo: John Tennent).

of '1440' was nearer 1,100m. But the name stuck; it was in frequent use, often for lengthy periods and the camp became quite a sophisticated structure. The hanging sign on the right in Fig. 6 reads *"Welcome / Salamat datang to Club "14-40". Enjoy your stay in self-catering luxury"*. Gunung Mogogonipa, to the south of Park HQ was a shorter steep climb and a sub-camp was also erected on the summit of Gunung Muajat, east of the settlement of Kotamobagu. South-west of Base Camp, another long trail was cut to the summit of Gunung Poniki (1,817m), with supporting sub-camp lower down, Ice Station Zebra (Fig.7).

Scientists with diverse disciplines had different needs; anything that could be collected with a net was relatively easy – the scientist concerned required little more than transport to and from selected locations. Malaise traps were everywhere: by the river, in the forest (Fig. 8), in the mountains and high in the canopy. Light trappers required a generator and serious quantities of fuel to run them all night to collect moths and other insects everywhere, including Camp 1440,



Fig. 6. Barney Page carrying out maintenance at Camp 1440



Fig 7. The camp at Ice Station Zebra: thoroughly miserable in wet weather (photo: Barney Page)



Fig. 8. Malaise trap in the forest.

where moth folk often stayed longer than a week. They also needed food and water, medical supplies and communications equipment. All of this was organised on a daily basis with scientists declaring what they needed and where they wanted it for the next day (longer trips and use of a vehicle required more notice) and the Service contingent making efforts to ensure no one was disappointed. We were all physically fit before we started but soon became ultra-fit with constantly carrying very heavy loads up steep hills. We cut and maintained long, sometimes complex, tracks through the forest, which we marked by tying white plastic tape to saplings – made more difficult than expected when we found the tape was attractive to nocturnal squirrels which in some areas chewed the tape almost as quickly as we could replace it. Another issue was leeches, omnipresent from Edward's Camp and upwards – some participants suffered more than others.

BBC filming visit

A highlight of Phase 2 was the visit of a BBC film crew, bent on filming *Wildlife on One – Sulawesi*. We pouted a little when we found that David Attenborough had been obliged to abandon his planned participation due to the award of his knighthood that year. The filming process was an eye-opener; I guess we'd thought they would film what they happened to come across in their allotted time and then write a script around it. But the reverse was the case. The team, in the form of Director Keith Scholey and cameraman Martin Saunders (famed for the Attenborough Rwanda gorilla sequence) already had a script for what they expected to film ... and my duties included helping them to get what they wanted.

An assemblage of butterflies imbibing mineral salts on the side of a river was on the BBC list and Martin asked me where he would find such a thing. I explained the best method of attracting butterflies and we both left Base Camp before breakfast the next morning to walk the half mile to a suitable patch of sand and stones by the Tumpah. Once there, we both peed by the river and went back for breakfast. About an hour



Fig. 9. Martin Saunders filming butterflies puddling on the riverbank (photo: John Tennent).



Fig. 10. Waiting patiently for the Maleo to emerge under its own steam; John Tennent, Martin Saunders, local assistant, Keith Scholey (photo: René Decker).



Fig. 11. The Eureka! moment (photo: John Tennent).

later we returned to find dozens of butterflies on our damp patch, with probosces extended, waiting to be filmed (Fig 9). There was a pair of hornbills nesting in a lone tree far distant from the path back to Base Camp: too far away to see them in any detail. Martin stopped to film them briefly and I said naively that they were surely far too far away to see. When the film appeared, they were full-frame in perfect focus. Astonishing!

The RES actively sought non-entomological projects for Project Wallace: financially, it probably wouldn't have worked at all if it was confined to insects. One unexpected (and unplannable) scene the BBC witnessed was the hatching of a Maleo bird. The weird-looking megapode, *Macrocephalon maleo*, is endemic to Sulawesi and, like all megapodes, buries its eggs in mounds. On hatching, the young megapode is entirely independent, being perfectly able to look after itself. The bird was the subject of a study by René Decker, a Dutch Scientist based near Dumoga with Charlotte

Vermeulen (studying cattle egrets). René took us out to a nesting site with the intent of being filmed listening to an egg with a stethoscope. This duly took place, but an excited René exclaimed that the egg was about to hatch. He hurriedly re-buried it in the nest mound and we waited patiently. Amazingly, after half an hour or so, a head appeared above ground and a Maleo chick struggled out. During this protracted process its eyes were viciously attacked by ants and I'm afraid we interfered with nature by brushing them away and making a wide ring with military-strength insect repellent out of camera range, which ants chose not to cross. I've often wondered what the little bird, seeing daylight for the first time and being stared at by huge human faces and a whacking great television camera thought of his (or her) birth, but after being weighed by René, it made a break for the forest, fending for itself from the first moment; I like to think it ate a lot of ants (Figs 10, 11).

The only other 'outside' visitors we had were the British

Ambassador and his wife (Fig. 12) and the Governor of Sulawesi Utara Province, with his cavalcade of 30 vehicles!

Staying safe

Everyone who came to Base Camp was briefed as to the dangers of getting lost in the forest. Once inside the forest there are no prominent features. There were no broad paths through the forest, but narrow tracks cut through a vicious spiny understorey mainly by Phase 1 and added to and maintained by Phase 2. Stepping just a few metres off a marked path and turning round unable to see the path was disorientating and there was a real possibility of not finding the path again. Fortunately, our routes close to Base Camp and most of those further afield lay in an area between two rivers and many streams. Instructions on what to do if lost were simple: always walk down; compass direction was not that important, but on reaching a stream, walk down it and if it joined another, walk down that one. Eventually, it would come out



Fig. 12. The visit of the British Ambassador and his wife; the overall Leader of the expedition, Hugh Rose, is second from the right and the Deputy Leader, Sean Brown, is furthest on the right (photo: Jon Martin).

close to Base Camp or a village. The rule was that everyone must report in detail where they planned to go before setting out in the morning.

Research visits by Indonesian scientists were frequent and on one occasion, following the usual briefing, we found two of them had set off together one morning without leaving any indication of where they were going. This wasn't a reason for immediate concern, but they were not back by late afternoon and the situation suddenly became more serious. All routine work stopped and the following morning teams of 3–4 people went out, armed with radios, to cover the area as best they could. The scientists appeared not to have taken any food and as the day wore on it was decided that the authorities should be informed. Several policemen turned up some time later, dressed in tight yellow t-shirts and tighter green trousers, without a map. By this time the male scientist had been found and later in the day, Jeremy Holloway and team found a footprint in the sand by the side of a stream that eventually led to Anita, the lady scientist. All was well that ended well.

Fogging

The only thing the military *really* didn't like was the fogging (Figs 13–15). This required suspending large, inverted cones just above the ground; each cone had a plastic container of alcohol at the

base, the idea being that when a thick 'insecticide' smoke was powered very noisily into the canopy, the stunned invertebrate wildlife there would fall down into a cone and slide down into the container at the bottom. This was a great way of sampling what was living up there, but unfortunately it had to be done at dawn, when the air was still – and it required all-hands-on-deck. Dawn fogging was not something to look forward to. At the end of Project Wallace, the result of fogging included a large number of containers with a very mixed bag of contents. Some insect orders were retrieved by specialists, but one suspects many remained unexamined. A codicil to the fogging was a blanket e-mail around 10 years ago from a non-entomological department of the NHM along the lines of *We're in the process of taking over a new room and have found a large number of boxes labelled 'fogging' full of containers containing what looks like sludge. If anyone knows what they are or wants them, please take them in the next week, after which they'll be destroyed*". Don't ask. I don't know the answer.

A memorable day came with the arrival of Andy Austin from the Waite Agricultural Research Institute in Adelaide. With no previous experience of British military ways, Andy made the mistake of confessing to carrying a bottle of duty-free Johnnie Walker Black Label whisky – which

he would be willing to share 'on special occasions'. It probably took the best part of an hour for him to agree that if one of us stood on his head, naked, in the river, in mixed company, he'd part with the bottle then and there, because obviously no-one would be either brave enough or stupid enough to do that. Twenty minutes later the bottle changed hands – and was empty by morning. It made a very pleasant change to the local bottles of 'screech', which came in a limited variety of flavours – whisky, brandy etc. It tasted pretty awful, and intake was temporarily curbed when a scientist with some medical knowledge arrived; he declined the offer of screech and spent a long time scrutinising the list of ingredients listed on the bottle label before calmly and very seriously declaring that by rights, we should all be dead.

Postscript

An interim report and account of the early days covering Phase 1 and their subsequent handover to Phase 2 were presented early (Holloway, 1985; Knight, 1985). Several other accounts were published subsequently and the situation 10 years (Kirk-Spriggs, 1995) and 30 years on (Noyes, 2016) was discussed. John Noyes included some interesting photographs of the Services teams at different times, which are and will remain of great historical interest. Ashley Kirk-Spriggs returned to Toraut – possibly the only Wally to have



Fig. 13. Nigel Stork and the fogger (photo: Grace O'Donovan).



Fig. 14. Insects dropped from the canopy and were captured in inverted cones.



Fig. 15. Fogging in the canopy.

done so post-expedition – in 1995, to find the small airport at Manado now handling international flights and air-conditioned coaches on the smooth, once pothole-ridden roads. The local pub (The Dog and Duck) and the laboratory are now extended residential buildings, and the main Base Camp building is now *The Wallace Centre*. Access to the forest is controlled – a paid guide is mandatory, even to walk the ‘novice trails’, whilst the Project Wallace trails are overgrown and unusable. There is an impressive suspension footbridge over the River Tumpah and a 6-day trip to Gunung Poniki is possible mostly along a river route, not through the forest following our long-overgrown forest track. The Dumoga-Bone National Park has now received attention from illegal gold miners and, as is sadly so often the case in ‘tourist’ destinations worldwide, attracted litter and witless graffiti.

We saw the Dumoga-Bone at its best. Across the board, everyone learned something daily and mutual respect was the order of the day: scientists were quite taken with the fact that although Service folk might routinely complain about everything, they

were completely reliable and carried enormous heavy loads on request with good humour and apparent ease. Conversely, the work of scientists, mysterious at first, was fully embraced. The fact that scientists were able and willing to carry their own gear and to spend long periods under very difficult conditions for the sake of their research, without complaint, was impressive. Equally impressive is the long list of publications resulting from international Project Wallace research: a largely undated list was included by Bill Knight (Knight, 1988) but I don’t know if anyone has maintained such a publication list. I suspect not. Despite the occasional hiccup, Project Wallace 1985 was a resounding success. It changed many people’s lives and formed firm and lasting friendships.

A truly remarkable feature of Phase 2 is that we have organised irregular get-togethers, often for a whole weekend; admittedly, largely due to the interest, industry and organising skills of Del and Jane – Royal Engineer and military nurse, now Mr and Mrs Drake. With apparently little in common, we made friendships that have lasted 40 years within

the worlds of both Science and Service – in fact we’ll be meeting for the 15th time in October this year, in Southampton. *Vive la Wallies!*

*All this was a long time ago,
I remember,
And I would do it again*

T. S. Eliot
Journey of the Magi

Acknowledgements

Thanks to a number of Wallies who related stories and freely offered their PW photographs on request; in particular Nicky Bateman (Phase 2: Services), Jane & Del Drake (Phase 2: Services), Hannelore Hoch (Phase 3: scientist), Ashley Kirk-Spriggs (Phases 2,3: scientist) Grace O’Donovan, (Phases 2,3: scientist) and Barney Page (Phases 1-3: Services).

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Pet Parasitocides: A modern dilemma

This is Henry. Henry is not an insect. He is a dog, and as such, he is the potential host of several arthropod ectoparasites. As a much-loved member of our household, we want him to live his 'best life' and not cover the sofa in fleas.



Henry is a Patterdale Terrier dog (*Canis lupus familiaris*).



Tilly Collins

Centre for Environmental Policy,
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When we inherited Henry in 2020, we were encouraged by the vet to use a 'spot-on' product year-round at monthly intervals to protect him from common ectoparasites – mostly fleas (Siphonaptera) and ticks (Ixodidae). Initially we followed this advice, but after reading the list of active ingredients on the label and chatting with a friend who is a sustainability-focussed veterinarian, we decided to move to a 'responsive mode' rather than prophylactic application. If Henry gets fleas, we will treat; if he gets a tick, I will remove it carefully.

But the problem is not just Henry. There are around 13 million dogs in the UK (McMillan *et al.*,



A cat flea (*Ctenocephalides felis*). Most fleas on both dogs and cats are of this species (Image: Andrei Savitsky. CC BY 4.0).

2024), not to mention 12.5 million cats (CATS Report, 2024). Flea treatments designed for domestic pets contain insecticides such as imidacloprid and fipronil that are known to pose environmental risks (Chagnon *et al.*, 2015). Prophylactic treatment of so many pets would represent a massive use of these chemicals. What happens to the active ingredients once they have been applied? Could it be that a general uptake of anti-flea prophylaxis is actually a threat to biodiversity and ecosystem functioning?

Intrigued by these questions, together with colleagues we have formed an affiliation of academics whose skills combine effectively to explore the topic; it is called PREPP – Producing Rational Evidence for Parasiticide Prescription (<https://www.imperial.ac.uk/grantham/research/parasiticides-pollution/>).

Beyond the domestic sphere, my own first academic foray into the flea treatment problem (with an excellent MSc student, Clodagh Wells) explored the

potential risk to the environment of these pet parasiticides, and led to the sobering conclusion (Wells *et al.*, 2022) that there is indeed a problem, and PREPP was duly commissioned by the Grantham Institute to write a briefing paper on pet parasiticide pollution (Preston-Allen *et al.*, 2023). The highlights are as follows:

- Substances that are banned for routine agricultural purposes are still being sold and used for pet parasiticide treatments in the UK.
- Current legislation only requires a very limited environmental risk assessment for pet parasiticide products before they are authorised for domestic use. These assume that as individual doses are small, the environmental risk is also small.
- These chemicals do, however, enter the natural environment, principally through domestic wastewater, and are toxic to many freshwater species; even at environmental concentrations as low as 0.013

micrograms per litre for imidacloprid.

- The active ingredients in parasiticides are frequently detected at concerning high concentrations in UK waterways, predominantly in urban areas (e.g., imidacloprid detected above 1 microgram per litre) (Egli *et al.*, 2023). Such concentrations negatively affect aquatic life in controlled laboratory trials and field studies.
- Exposure to parasiticides may affect vulnerable (*i.e.*, sensitive) species within our rivers, lakes, and ponds, disrupting communities and ecosystem processes. The extent of the environmental impact on aquatic ecosystems is yet to be quantified.

Now, further work from the University of Sussex has elucidated some of the ‘down the drain’ pathways of these chemicals. It was shown that handwashing and pet bed washing contribute to the environmental burden, and

parasiticides can still be detected in dog-washing water a month after application (Perkins *et al.*, 2024). Another investigation in the ponds of London's Hampstead Heath shows dog swimming can be an important source of chemical contamination (Yoder *et al.*, 2024). Now, a recent study has found flea treatment insecticides in 100% of sampled birds' nests and shown that nestling mortality rises with their concentration (Tassin de Montaigu *et al.*, 2025).

We believe that there is now sufficient evidence of environmental contamination and risk from this domestic use of anti-flea insecticides to ask for a legislative review in which over-the-counter sales could be halted, as has recently happened in Switzerland (March 2025), in favour of a genuinely risk-based prescription system. These are chemicals designed with the primary role of killing insects, at which they are very effective, and their over-use threatens to damage the environment and also raises the spectre of developing resistance. This has already happened with fipronil which is increasingly considered ineffective against fleas in some UK regions (Cooper *et al.*, 2020). Thus, if they are to retain their efficacy, their application needs to be moderated.

One of the biggest data gaps in the case for frequent prophylactic application of pet parasiticides is that we don't know the extent of the risk imposed by the parasites on pets or people. Beyond the incredible inconvenience of a pet carrying fleas and infesting a home, what are the real risks of these parasites vectoring zoonotic disease? What then are the knock-on consequences for human health? This is an important research avenue and while initial explorations suggest that risks are very low, access to reliable data is a challenge. Advertising has taken advantage of this uncertainty, and product promotions play to our fears by emphasising the risk. One recent billboard advert quoted a figure of almost 3,000 cases of canine lungworm identified in the UK – rarely, lungworm infection can blind and even kill dogs. Alarming, yes, but when you

consider that this is the number of cases noted in >10M dogs over a time frame of 16 years, the risk perspective is quite different.

As well as environmental contamination, we are now looking at the human exposure risk within the home. Immunological studies are rising in number and indicate that prenatal and childhood exposure to pesticides can affect long-term health in a number of ways (Tassin de Montaigu *et al.*, 2025). Last summer Henry, along with pets of other colleagues, was dosed with over-the-counter Advantage and (with another fantastic MSc student, Xindan Liang) we collected and tested the floor dust, furniture covers and mop water for residual imidacloprid presence every few days for the following two weeks. Again, the results were sobering, with one 'cat home' averaging 66 µg/L of imidacloprid in mop water 7 days after the treatment was applied, and 45 µg/L 14 days later. Across Europe the predicted no-effect concentration (PNEC) for imidacloprid in freshwater is 13 ng/L [note the units!].

To complement this finding, this year we plan to collect dust from 50 homes and assess for more general levels of contamination. The chronic exposure levels of adults in close pet contact professions also need to be explored. Pet groomers, kennel workers, vet nurses and vets themselves are likely to be particularly at risk of exposure, and hair analyses have been proposed to study this.

The human story is also critical. Over the past few decades attitudes to domestic pets have changed, with many more people viewing themselves as pet 'parents' rather than owners, and with this there has been a greater uptake of 'premium products' and 'pet wearables'. In Europe, the annual value of pet-related products and services rose from 10 billion euros in 2010 to 25 billion euros in 2023 (<https://www.statista.com/statistics/515412/pet-products-pet-services-value-europe/>) and in the UK the number of insured pets rose by about 2M over this time. This shift in perception and the rise in insurance plans, which often come with advice to use

parasiticides in a preventative manner, have contributed to a dramatic rise in domestic pesticide use.

Pet owners need accurate information to be empowered to make informed decisions about how to manage the parasite and pesticide risks of their domestic animals. The playing field has been uneven and emerging research findings will help level this. It would perhaps be unwise simply to ban the use of effective chemicals, which would possibly increase the chances of regrettable substitutions, but we should consider the use of pet parasiticides more holistically and include the externalities of environmental and human health through a 'one health' approach.

As I said at the start, I want to do what is best for Henry but must also consider the welfare of the environment and my kids in my decisions. I'm now investigating alternative approaches (peppermint-scented pooch?) – and am improving my tick removal skills.

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Insects in the News

January to March
2025

Richard Harrington
with help of material from
Dafydd Lewis, Peter Smithers,
Stuart Reynolds, Hugh Loxdale,
Linda Essex and Jes Bartlett



Most of this issue's stories come from *The Guardian* and, unless stated otherwise, that was their source. It is asking readers to nominate species for its second annual Invertebrate of the Year competition, and one well-known entomologist has suggested hoverflies, pointing out that they are greatly underappreciated as both pollinators and predators. Below you can read about bumblebees flying in winter. In the UK we also have Winter Moth, November Moth and December Moth to keep us amused, but the *Guardian's* Country Diary draws attention to our ten species of winter gnat (*Trichocera* spp.), also known as winter cranefly. Males gather in large ghostly swarms to perform dances to attract prospecting females. They don't bite humans but are attracted to our warm bodies, hence desperate swatting may be observed on occasions, increasing body temperature and attracting more gnats.

In the last issue we reported on a couple who bought a £36 million Victorian mansion in Notting Hill only to find it infested with moths, which were apparently eating the wool insulation as the main course, clothes for dessert, followed by a glass of wine. The couple sued the vendor for failing to disclose a problem with 'vermin'. Now we can report that they won. £30 million was paid back, including £15,000 for ruined clothes. The story had all the elements necessary to ensure wide

circulation. The vendor was a former GB rower, now 'up the creek without a paddle'. The purchaser's father was a Georgian businessman who fell out with Vladimir Putin and moved to the UK before dying of heart failure (oh yeah?!). *The Daily Telegraph* reported that an 'insect specialist' (if it was you, please get in touch) described "an infestation of extreme proportions amounting to millions of moths". All this raises many questions relevant to our profession. What species was it? Is this a common problem? Can moths be classified as 'vermin'? Would it ever be possible to say with certainty that a property was free of moths? I feel an *Antenna* article coming on.

I was listening to the BBC News whilst cooking a delicious Valentine's meal for my better half, and learnt that Messingham Zoo, near Scunthorpe, is selling a service whereby jilted lovers can name a cockroach after their ex and be sent a film of it being torn apart by a meerkat. Apparently, the zoo has been "crawling with requests". I have informed our Insect Welfare and Ethics Committee. On which note, *The Guardian* has taken up the cause, asking: "Do worms feel pain and are ants happy? Why the science of invertebrate feelings is evolving". *The New Yorker* published a long article on insect sentience, largely based on work on bees in Lars Chittka's lab at Queen Mary University, London.

That leads us neatly to the inevitable pollinator paragraph.

The Bumblebee Conservation Trust says that UK bumblebee numbers fell to their lowest on record in 2024, probably due to the cold and wet conditions in spring. From the present to some ancient history – *The Jerusalem Post* reported that the oldest bee fossil ever found has turned up almost perfectly preserved in volcanic mudstone in New Zealand. It has been named *Leioproctus barrydonovani* after the distinguished NZ apidologist and is 14.6 million years old. The UK's targets to stop destruction of the natural world could be met even if all the country's bees, wasps, ants and moths were to go extinct, because Natural England's 'Red List' and the government's biodiversity indicators do not cover enough species. The government admitted that there are gaps in its species risk indicators but blamed a lack of data. More funding, more data – simple as that. The government is blanket banning the use of neonicotinoid seed treatments in sugar beet and will no longer pay attention to science-based forecasts of aphid-borne virus

Marmalade Hoverfly *Episyrphus balteatus*.
(Credit: Adam Lawson).



incidence. Sugar beet is a largely non-flowering crop in its first year of growth, when the roots are harvested to produce sugar, and I'm not convinced that anybody will notice an increase in the number of bees in Eastern England as a result. Fertilisers, too, are under fire. Rothamsted's Park Grass experiment, which started in 1856, has shown that increasing amounts of N, P and K 'doused' on agricultural grassland, reduced flower numbers fivefold and halved the number of pollinators, especially bees. This is, of course, because fertilisers create conditions suitable for fast-growing grasses to outcompete the great diversity of plants requiring insect pollinators. Bumblebees were active in Scotland over our unseasonably mild Christmas according to Buglife, as reported by the BBC. This puts nests at high risk of failure because of a shortage of energy-providing flowers and the risk of return to low temperatures. Bumblebees normally hibernate, but at least two of the UK's 25 species have been nest building early. On the plus side, *The Daily*

Telegraph reported on an RNA pesticide that targets specific genes in the parasitic Varroa mite, rendering it harmless. But do we need bees at all? MIT scientists are designing robotic insects that could one day swarm out of mechanical hives and perform pollination at a rapid pace and, according to *Science Live*, "increase crop yields dramatically without harming the environment". It's very clever stuff involving collaboration between entomologists and roboticists, but does it have to come to this?

As inevitable as a pollinator paragraph is a rare/new species discovery paragraph. Two for you this time – poles apart, but both with wonderful names. *STV News* reported that a new population of the Arctic Wave Dancer (*Wiedemannia simplex*) has been found in high altitude lochs in the Cairngorms, Scotland. The next nearest populations of this tiny fly are in the arctic regions of Finland, Norway and Russia. *The Miami Herald* reported that a farmer in New Zealand discovered a new population of the critically endangered Canterbury Knobbled

Weevil (*Hadramphus tuberculatus*). "I was like a stunned mullet when I learned these were so rare", said the farmer.

When I was a kid, my parents used to pay me for killing *Pieris brassicae* caterpillars on our cabbage plants. I can't remember the going rate – perhaps one old penny per ten. Now, in the Philippines, villagers are being paid for capturing mosquitoes in a bid to combat an outbreak of dengue – one peso (0.14 pence) per five. There is concern, though, that people might be rearing them up to reap the rewards. I didn't think of that in my innocent childhood!

My wife and I foster cats for an excellent charity called The Blue Cross. Before the cats come to us and before they go to their 'forever home', their worm and flea treatments must be up to date. This has often puzzled me. We don't treat our children for headlice just in case they pick them up at school; we wait until they've got them. So why do we prophylactically treat pets with chemicals that will wash off into gardens and streams, threatening insects and the food chain? This issue has been picked up in the media following work by Dave Goulson (University of Sussex), who has found that songbirds are inadvertently killing their young by building nests with contaminated cat fur. He accuses vets of profiteering. The British Veterinary Association is sympathetic, recommending that parasiticide use reflects the risk of an animal's exposure to parasites. We keep our foster cats indoors, by the way, by order of The Blue Cross. We invited Tilly Collins to follow up on this – see article on page 83.

Mention of headlice has got me itching. "Ditch the itch: what's the best way to soothe mosquito bites?", read a headline following an Australian study. People have apparently had success with honey, basil, vinegar, onion, aloe vera, garlic, lemon balm, chamomile tea, avocado and toothpaste. There is evidence that drinking alcohol increases the risk of being bitten, and Cameron Webb (University of Sydney) has a theory to explain this. The more alcohol you drink, the more likely you are to forget to apply mosquito repellent.

Cheers!



Featured Insect

Photinus anisodrilus, a tiny Mexican firefly that likes it dry



Cisteil Pérez

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Photinus anisodrilus is a small species of firefly endemic to western Mexico. It was discovered and described in 2007 by the Mexican specialist Santiago Zaragoza (Zaragoza-Caballero, 2007), based on material collected in 1995 from the seasonal dry forests of Jalisco. This species, which is only around 7 mm in length, exhibits behaviour and ecology that contrast with those of other fireflies and, at the same time, is very similar in morphology to species distributed much further away in the western United States.

The adults of many tropical firefly species can be seen flying during the rainy season and/or are associated with areas with high soil or environmental

humidity. However, *P. anisodrilus* prefers very different habitats. Its adults are usually more abundant during the driest and hottest time of the year in various ecosystems including croplands. They are also active during the wettest months, but in smaller numbers. In humid and cold habitats, adults tend to disappear during the rainy months. These habitat preferences and tolerance of low humidity levels could explain why they are associated with urbanised areas and grasslands from Morelia, Michoacán, Mexico, which are typically warmer and have lower humidity levels.

Photinus anisodrilus has another aspect related to its internal anatomy that could be useful in exploring evolutionary hypotheses about species origin and differentiation. Insect genitalia have traditionally been used to distinguish between species, as they tend to be highly consistent in shape among individuals of the same species. The lock-and-key

hypothesis suggests that male genitalia (the 'key') and female genitalia (the 'lock') fit together perfectly, preventing individuals from 'choosing the wrong mate' and avoiding hybridisation – a concept linked to natural selection and interactions between species that share the same space and time (Silveira *et al.*, 2022). However, *P. anisodrilus* exhibited over 120 distinct forms of male genitalia in a sample of 150, but Zaragoza's analysis indicated that they all belonged to the same species.

There is another approach, the sexual selection hypothesis, which involves positive and negative interactions between males and females of the same species, which may lead to sperm competition, female preference (maybe for more stimulating anatomical traits), and sexual conflict. These dynamics could drive variations in genital anatomy within the same species, promoting healthier offspring, and usually resulting from high levels of promiscuity. Is there more than one species in the *P. anisodrilus* of Zaragoza's original sample? Or is this variation derived from sexual selection? There is another mystery to be solved: he noted that *P. anisodrilus* genitalia (and their variations) closely resemble those of four other species found rather far away, in the western United States. Are these species closely related?

The high variability in male genitalia inspired its scientific name, derived from the Greek *anisos* (meaning 'different') and *drilus* (meaning 'penis') and is being studied by Mexican researchers to discover more on this tiny species. Nevertheless, while the exact mechanisms behind these traits remain unknown, the species' habitats are rapidly and increasingly threatened by human activities, and conservation strategies are needed to preserve this and other insect species.

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EnTeam

Centre for Applied Entomology and Parasitology, School of Life Sciences, Keele University

Claire Price

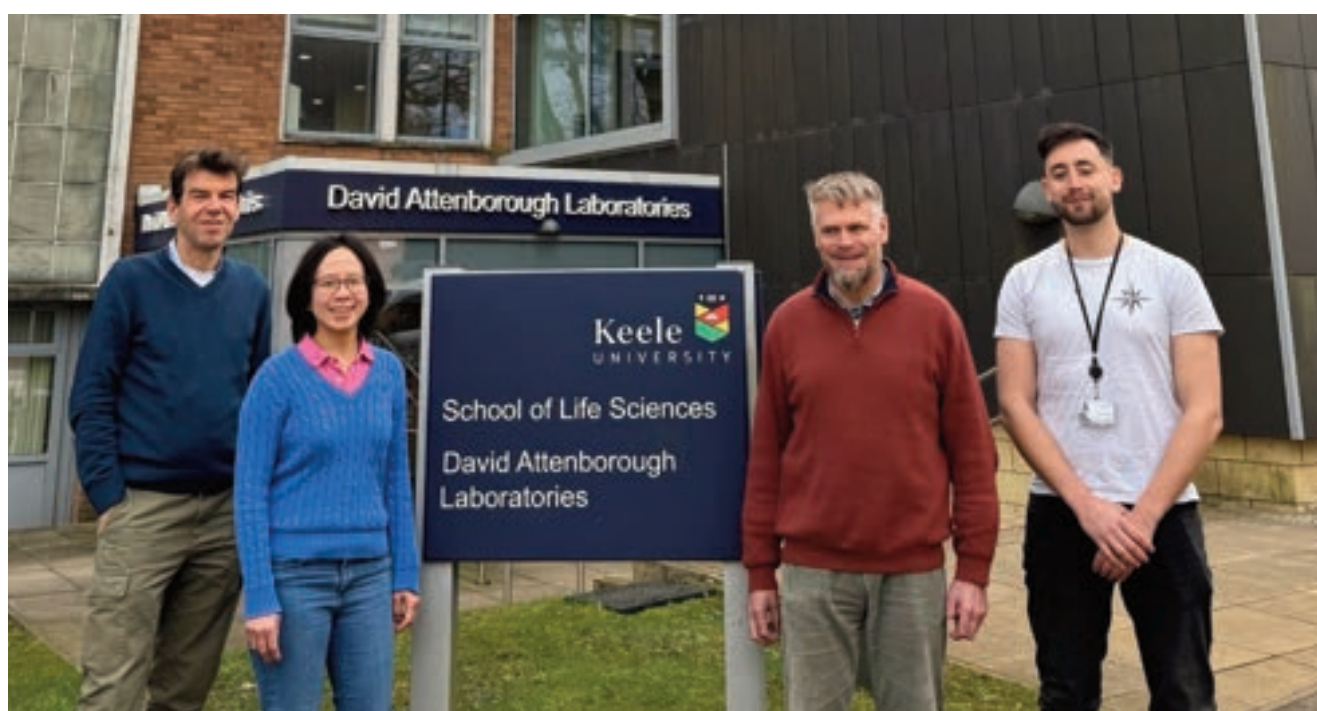
Harper Adams University

The second iteration of the EnTeam series revival took place in person at Keele University, near Stoke-on-Trent. I made my way there on a very rainy February afternoon to meet a few of the entomologists of the Centre for Applied Entomology, Parasites and Pathogens, led by Professor Toby Bruce, which studies medical, veterinary and agricultural insect pests.

My first visit was to Professor James Bell, a quantitative ecologist and entomologist who joined Keele University last year. James was the head of the Rothamsted Insect Survey, where he was working on both insect conservation and vector biology, studying insect declines and aphids vectoring plant pathogens respectively. He continues to do

so at Keele, but in agriculture, he is now limiting his research to the sugar beet-insect-virus-proteobacteria-phytoplasma system, using aphid and plant hopper vectors as model groups. The proteobacteria-phytoplasma component is a new area of research, in part funded by the UKRI E-Prep project. James is interested in farmer behaviour in terms of when to sow the crop relative to the prevailing weather conditions and the virus threat, but as an entomologist he is fascinated by aphid biology, and this combined knowledge helps inform his 4-year StatBeet project funded by the British Beet Research Organisation (BBRO) and in collaboration with Rothamsted Research. His insect conservation research is

supported by a half-million-pound project called DRUID (Drivers and Repercussions of UK Insect Declines), funded by the Natural Environment Research Council (NERC) and in collaboration with Leeds and Reading Universities, Rothamsted and the UK Centre for Ecology and Hydrology (UKCEH). The plan for DRUID is to use monitoring data to assess the trends in insect declines in various taxa, from the well-studied Lepidoptera to the less investigated Coleoptera, Orthoptera, Diptera, Odonata and Hymenoptera, and how they are affected by the various pressures insects face such as climate change, land use, pollution, etc. A summary of the DRUID research activities so far is captured in a recent animation posted on



The aphid team, from left to right: James Bell, Trisna Tungadi, Toby Bruce and Tom Foster (© Trisna Tungadi).

YouTube (Rothamsted Research, 2025). James also has a burning interest in insect flight and was able to record videos of aphids in flight, measuring speed and duration to calculate how far they could potentially travel before getting exhausted, which would help understand virus transmission and spread, thus underpinning the StatBeet activities. He is in the process of setting up a flight lab at Keele once the new insectary is ready, which was my next destination of the day.

James and I then met with Kieran Latham, Architect and Project Manager at Keele, who took us on a tour of the insectary, then a work in progress but set to be completed by late February/early March. With a project value of £1.5 million partly funded by the Wolfson Foundation, it contains seven separate environmental control walk-in chambers, operating individually with their own temperature, light and humidity settings. Most importantly, each unit is isolated and designed to prevent escapes, as there will be human disease vector projects housed there. Just behind the insectary, the construction of a glasshouse was also underway, and the building will include two offices. The brand-new insectary will house projects tackling vector-borne diseases, from mosquitoes and midges to hoppers and aphids.

The new insectary will be managed by Dr Tim Harvey-Samuel, lecturer in Arthropod Genetics. His duties will include managing users and space, as well as ensuring that everything in the insectary runs smoothly. Tim is also an active researcher, who focuses on developing new, more powerful and sustainable genetic biocontrol tools against pest insects. This involves genetically modifying the pest through the sterile insect technique and CRISPR/Cas9 technology, targeting agricultural pests such as the Diamondback Moth (*Plutella xylostella*) and other pest lepidopterans, as well as animal and human disease vectors such as mosquitoes within the *Aedes* and *Culex* genera. A large part of his work is looking to better understand the fundamental science of gene regulation and



The completed insectary, with numerous work benches and state of the art walk-in chambers (© Kieran Latham).

sex determination in target species, which will be helped by an Academy of Medical Sciences-funded project which will generate high-quality, cell-level transcriptome maps of mosquito gonad-tissues. These transcriptomic maps will provide him with the fundamental information needed to design the next generation of generic biocontrol tools, as researchers in this field currently don't have a good idea of how to engineer precise gene expression in gonad tissues.

I then met with Dr Trisna Tungadi, who joined Keele University as a lecturer in Plant Health two years ago, bringing expertise in plant viruses and aphids as virus vectors. Trisna utilises aphids as a tool to better understand how plant viruses change plant biochemistry and its

impact on virus transmission. Since her arrival at Keele, Trisna has successfully set up her lab to enable her to grow plants in controlled conditions via purchasing several reach-in environmentally controlled plant growth chambers. Before coming to Keele, Trisna worked at NIAB, Kent, as a post-doctoral researcher. She investigated how egg-laying behaviour of *Drosophila suzukii*, a major insect pest in soft fruit crops, is influenced by interspecific competition with other species of *Drosophila*. Trisna started working with the Peach-Potato Aphid (*Myzus persicae*) during her PhD and two post-doctoral projects at the University of Cambridge with Professor John Carr's research group. During her time in Cambridge, her main project focused on cucumber mosaic



virus (CMV), one of the plant viruses with the broadest host range, able to infect economically important crops worldwide. She worked extensively on determining how CMV infection on two model plants, *Arabidopsis* and tobacco, affects *M. persicae* feeding behaviour and fitness and how this facilitates virus transmission. She was also involved in a postdoc project working with bean growers in Kenya. At Keele, Trisna has two ongoing research projects. In the first project, she is a primary supervisor for a PhD student, Tom Foster, co-supervised by Professor Tom Pope and Dr Joe Roberts from Harper Adams University. Tom is trying to understand what makes the Bird Cherry-Oat aphid, *Rhopalosiphum padi*, an efficient vector of barley yellow dwarf virus (BYDV). BYDV damages cereal

crops and is transmitted by aphids in a persistent way – the virus will circulate inside the aphid's body long term. The project focuses on bacterial endosymbionts present in the aphid, and whether harbouring certain species of bacterial endosymbiont will affect the aphid's ability to vector BYDV. Using *R. padi* colonies collected from several fields, Tom is genotyping and screening the bacterial endosymbionts that are present in each population. He will then perform virus transmission experiments using aphid colonies carrying different bacterial endosymbionts. Trisna's second project is funded by a Royal Society Research Grant, which involves studying Black Grass (*Alopecurus myosuroides*) as a potential reservoir for BYDV. Black Grass is a problematic weed in cereal crops that has become resistant to herbicides. The project investigates whether Black Grass can be infected by BYDV and whether it can be a good host for aphids, to assess the risk that Black Grass poses as a host for aphids and BYDV, hence potential infection to the crop. Trisna collaborates with Rothamsted Research scientists on this project, a weed molecular biologist, Dr Dana MacGregor and a plant virologist, Dr Lawrence Bramham. Trisna's long-term aim is to widen her research theme to better understand how plant viruses contribute to shape the landscape ecology of both crops and non-crop plants, and vector distribution. When she is not doing research, Trisna teaches modules on Biology undergraduate and Master's courses, covering modules in Plant Science and Sustainability, Ecology and Plant Biology. Trisna also contributes actively to the UK scientific community; she is a Board Member of British Society for Plant Pathology (BSPP), and a member of the Virology Steering Group of the Association of Applied Biologists (AAB).

Trisna then led to me Toby Bruce, Professor of Insect Chemical Ecology, whom I had met several times at the AAB Conference on Biocontrol and Integrated Pest Management but had never had a chance to talk to at length. Toby joined Keele in 2017 and set up a chemical ecology

lab, where he investigates the potential of using molecular compounds, singular or in blends, that insects can detect using their antennae, to influence their behaviour. He is particularly interested in finding ways to apply these techniques in agricultural pest control to improve food security around the world. Past projects using chemical ecology that Toby was involved in include the use of pheromone traps to control the Orange Wheat Blossom Midge (OWBM) (*Sitodiplosis mosellana*) that only feeds on wheat and very closely related grasses. Surprisingly, even though OWBM is a highly specialised insect, it responded to a blend of very common compounds, such as (Z)-3-hexenal, the smell of cut grass, which led Toby to think that this 'blend recognition' response could also be applicable to other insect species, and that insects will respond differently to blends of odours compared to individual compounds. He cited as another example, the work of a former PhD student, Ben Webster, who worked on Black Bean Aphid (*Aphis fabae*), showing that the insects were repelled when exposed to individual compounds emitted by their host plants but became attracted when exposed to blends. This makes sense, as in nature insects are never exposed to compounds individually, but rather mixtures of them, Toby explained. He also showed that chemical compounds can be used to change the behaviour of natural enemies of pests, which was investigated in a past project on the control of Fall Armyworm (*Spodoptera frugiperda*) using a push-pull strategy with companion plants to repel the pest from the crop and attract it to companion crops and also attract natural enemies such as parasitoid wasps. Taking me on a tour of his lab, Toby showed me the various pieces of equipment that can be used to do chemical ecology bioassays, starting with a small arena in which an insect is placed, that is connected to an olfactometer introducing a natural sample, to then observe the insect's walking behavioural response (attraction or repulsion); if the behavioural response is significant, Toby explained that he would use the GC-MS (gas



The Galizi team, from left to right: Trevor Thompson (Post Doc), Emily Chesters (PhD Student), Lara Ravenscroft (Senior Research Technician), Jak Kerr (Senior Research Technician), Boubacar Tembely (PhD Student), Roberto Galizi (PI), Jake Hasenauer (Post Doc), Cameron Scully (MPhil Student) (© Emily Chesters).

chromatography-mass spectrometry) machine to identify and measure the concentration of the compounds making up the sample; these identified chemicals can then be used to do electroantennogram recording, which can show how the insect's brain responds when the antennae detect a specific compound, and this leads to the identification of biologically meaningful compounds. There isn't any chemical ecology project taking place at Keele now, but Toby mentioned that he is in the process of applying for funding to run a collaborative project with Harper Adams University, ADAS and Rothamsted Research to investigate the potential of a push-pull system to control the Cabbage Stem Flea Beetle (*Psylliodes chrysocephala*), a pest of Oilseed Rape.

My final visit of the day was with Emily Chesters, a third-year PhD student working in Dr Roberto Galizi's lab. Roberto is a Reader in Infectious Diseases at Keele, whose laboratory aims to generate new solutions for the control of vector-borne diseases.

The lab uses molecular and synthetic biology, transcriptomics, functional genetics, and genetic engineering to investigate insect reproduction, and works to improve current genetic control strategies. Emily welcomed me in the laboratory where she keeps her insects, *Anopheles gambiae*, a mosquito species responsible for transmitting malaria. She works on one of the projects involving transcriptomics and synthetic biology for the development of genetic control strategies, specifically looking at improving our understanding of gene regulation within the male and female reproductive organs, and how this could be leveraged to improve current genetic control strategies. To create transgenic lines, she uses microinjection, which involves injecting DNA directly into a mosquito egg using a very fine needle. After microinjections, she can use the transgenic lines to see how changes in DNA sequences within the mosquitoes alter gene expression within the male and female reproductive organs. Another side of the project is

looking at targeting genes of interest using the CRISPR/Cas9 technology, looked after by two other PhD students, Lakamy Sylla and Boubacar Tembely, who share their time between Keele and the University of Science, Technique and Technologies of Bamako (USTTB), in Mali. Indeed, the Galizi lab is also involved in establishing the African Centre for Excellence in Molecular Engineering (ACEME) in Bamako, as malaria is a significant health problem in Mali.

I would like to thank again James, Trisna, Toby, Emily and Tim for taking the time to talk to me about their research, as well as Kieran for showing me the new insectary.

Reference

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EnTeam Extra

RHS looking for sightings of ‘mystery buddleja aphid’

Richard Harrington



Wisley's new science labs (photo: Richard Harrington).

Much has happened at the Royal Horticultural Society (RHS) at Wisley since I visited back in those heady pre-Covid days to discuss their work for an EnTeam article (*Antenna* 43(3), 118–120, 2019). There is a brand-new road in, a splendid new entrance area, shop and cafeteria, Andy Salisbury has become head of the Plant Health Team, RES Trustee Hayley Jones

has taken over from Andy as head of the Entomology Team, and they have a truly magnificent new laboratory complex. In the EnTeam article, there is even a picture of Hayley standing by a model of the new science block. I just had to go back for a look at the real thing!

I happened to show up when Hayley was catching up with

volunteer Sherry who identifies the moth samples from the Rothamsted Insect Survey's (RIS) light-trap at Wisley, something of a coincidence as I used to lead the RIS, although my work mainly involved the suction-traps and aphids. And there's another coincidence. Hayley has recently been consulting the RIS about reports of crinkled and yellowed buddleja leaves in the southeast of England, which began appearing in 2023. Samples sent for virus testing came up negative, and eventually aphids were found on the undersides of very new leaves and pinpointed as the main cause of the symptoms. In 2024 the phenomenon was even more widespread in southern England. Working with the RIS, a sample of aphids was identified as *Aphis gossypii*, a polyphagous species usually associated with glasshouses.

The RHS is asking for photos of symptoms and samples of aphids on buddleja, to help confirm the identity of the aphid involved and discover the extent of the issue.



Hayley Jones (left) with volunteer Sherry (photo: Richard Harrington).



Buddleja damaged by *Aphis gossypii* (photo: Hayley Jones).

External Meetings



The Morphology Meeting 2025

20th–22nd February 2025

Zoological Museum, Kiel, Germany

Supported by *Physiological Entomology*

Report by Thies Büscher

Co-Editor-in-Chief, *Physiological Entomology*

The annual meeting of the Morphology subject group of the German Zoological Society is a conference for researchers working on all aspects of morphology across the animal kingdom. As such, the meeting offered excellent networking opportunities for researchers from all career levels. The meeting was free and attracted 100 delegates.

The four invited keynote speakers presented different perspectives on morphology: Prof. Stanislav Gorb (Kiel University), insect functional morphology and biomimetics; Prof. Christine Böhmer (Kiel University), functional morphology of vertebrates; Dr David Labonte (Imperial College London),

functional morphology of the musculoskeletal system; and Dr Vanessa Schendel (University of Queensland), venom modulation in centipedes. The meeting featured a keynote competition, whereby students and early-career scientists submitted applications for a fifth keynote slot. The winner was Max Stüwe (PhD student, University of Rostock) who presented his work on Riedl's burden in the cranial anatomy of fish.

The majority of delegates were working on insects and other arthropods. In total 35 talks and 11 posters were presented across morphological disciplines including descriptive and comparative morphology,

theoretical and experimental biomechanics, and ecological and evolutionary aspects of morphological structures. For details see the program at <https://www.zoologisches-museum.uni-kiel.de/de/tagung/programm-downloads>.

There was a productive exchange of ideas and fruitful discussions about methods and approaches. The ice breaker, poster sessions and social events in the museum's galleries enabled participants to connect to each other and continue the discussions in a very zoological atmosphere.

What is Nature? How we think about the environment in the Anthropocene Age

Bath Royal Literary and Scientific Institution

14th April 2025

Stuart Reynolds

Department of Life Sciences and Milner Centre for Evolution, University of Bath

Report by Richard Harrington



Fall foliage at Walden Pond, Massachusetts USA. (Credit: The Walden Woods Project).

Our past president and esteemed author of our Research Spotlights has been associated with the University of Bath for 48 years. He is also a leading light and regular contributor to the Bath Royal Literary and Scientific Institution (BRLSI), which holds frequent events, including evening meetings which can be attended in-person or online by anybody for a very reasonable fee.

Stuart gave a brief history of ideas about Nature, followed by an account of how it has been affected during the Anthropocene Age, then presented his thoughts on why and how it can be protected. Unsurprisingly, insects featured a lot, but there's much more to Stuart than just insects.

Whilst much of the talk covered territory that will be very familiar to many *Antenna* readers, I confess to not having heard of some of Stuart's pioneers of Nature, natural history and conservation thought and action. This account thus majors on these people, each of whom warrants further attention. Stuart's opening picture was of Walden Pond in

Massachusetts, where Henry Thoreau (1817–1862), American essayist and poet, set himself the goal of simple living and self-sufficiency. His book 'Walden, a reflection upon simple living in natural surroundings' was perhaps the first to encourage a respect for Nature for what it is.

So, the history of ideas. Animism is the belief in a supernatural power that organises and animates the material universe. Genesis, and other creation myths, say that before creation, all was chaos and disorder. When Adam and Eve were expelled from the Garden of Eden, they entered the disorder of the world and were tasked with recreating the order of the lost Eden. Cultivated nature was good, wild nature had to be subdued.

How did we get from there to where we are now? There was a long period during which Nature was feared. Then came Carl Linnaeus (1707–1778) and Joseph Banks (1743–1820), who classified wild nature, and J.W. von Goethe (1749–1832) and Alexander von Humboldt (1769–1859) who

recognised that there is continuous change in Nature and that everything is connected in a dynamic equilibrium. William Wordsworth recognised that humanity was inspired by Nature, and he, in turn, inspired the study of natural history. Arguments were not going theology's way and at the end of the Georgian era, it fought back. William Paley (1743–1805) compared the design of the universe to finding a watch. He argued that if you found a watch lying on the grass and saw how complicated it was you would have to assume someone made it. Darwin at first adhered to this view but, of course, eventually championed the counterargument. Thomas Robert Malthus (1766–1834) recognised that Nature is vulnerable to human interaction and that there are hence limits to the extent to which humans should exploit Nature and a limit to human population size (the carrying capacity). Donella Meadows (1941–2001) with her husband Dennis and a think tank they founded in the 1960s called the 'Club of Rome' wrote the



Replica of Thoreau's cabin near Walden Pond and his statue (CC BY-SA 3).

bestselling book 'The Limits to Growth'. This recognised Nature as a system with many components that all have to share a limited pool of energy.

The concept of the Anthropocene Age was coined by Dutch chemist Paul Crutzen (1933–2021). The idea is that this is the age in which humans have a predominant effect on Nature. This is mostly because of an exponentially increasing population (the human population rose from 2.5 billion in 1950 to 8 billion in 2025 and is predicted to rise to 11 billion by 2100 but to stabilise at this level), but also due to more disposable income and advances in technology. The rate of increase in population has recently begun to fall for the first time. 45% of the Earth's habitable land surface is used for agriculture (in the UK, 70%), leading to a loss of 'Nature'. Some examples of this were considered. One of particular interest to readers of *Antenna* was the falling populations of UK farmland birds, many of which are insectivorous. This in turn is almost certainly due to declining numbers of flying insects. But what is the reason for that? We don't know! It is a worrying state of affairs. Stuart suggested that humans as a species are simply appropriating too much of the Earth system's

productivity, inevitably leaving less for Nature. Thus, we need to find ways to conserve Nature.

John Evelyn (1620–1706) was amongst the first conservationists. He was interested in conserving oak trees, fearing that too many were being cut down to build ships. Soame Jenyns (1704–1787) believed that deforestation in Trinidad and Tobago led to failure of the rains and hence failure of sugar cane crops. His motives for conserving forests thus had an economic basis. George Marsh (1801–1882) understood that Nature is not inexhaustible and that humans have damaged the environment. John Muir (1838–1914) came up with the concept of National Parks and was leader of the Victorian Conservation Movement which mostly got going in North America. "God never made an ugly landscape", he said. Gretchen Daily (b. 1964) of Stanford University, introduced the concept of ecosystem services, and of valuing nature. Edward O. Wilson (1929–2021) was opposed to the 'natural capital' concept, coining the term 'biophilia' to express the innate human bond with other species, resulting from hunter-gatherers living in close quarters with Nature and needing to understand it. Many studies have shown that

humans experience enhanced well-being in natural environments. In his best-selling book 'Half Earth – Our Planet's Fight for Life', Wilson says that we should conserve half our landmass for Nature. The fact that 45% is already used for agriculture alone, presents a conundrum to be discussed at a future BRLSI meeting.

A Q&I session discussed the validity of the term 'Anthropocene' and the differing views of stratigraphical geologists and Earth scientists interested in energy flows. The human carrying capacity of the Earth was discussed further, with Stuart saying that it depends on how we live, for example the amount of meat in our diets. He thought top-down regulation to be 'pie in the sky' and that the answer will have to emerge as a consensus from us all. He was asked whether increase in the CO₂ concentration has a positive effect on energetics, responding that this may be so in cooler parts of the world but in the tropics, where productivity is greatest, increases in temperature will be detrimental, even to the point that people will be unable to survive, leading to migration and strife. Will we be able to avert this or are we heading for the buffers?



Planthopper nymph with the 'fibre optic' tail (Photo: Weixiang Lee).

News from Council

Council Meeting

Council met online on 26th February 2025.

CEO's Report

The Society is now at the end of its first three-year strategic period, during which progress has been significant. RES publishing is in a stronger position, membership has grown, income has diversified, and we have organised some of our biggest outreach events ever. We have continued to build our capacity on policy and public affairs. We have signed an agreement with the Field Studies Council to run an entomological education programme at the RES garden in Stratford Cross. We have continued to explore opportunities for income, including a collaboration with WWT and Aardman, involving Lloyd of the Flies trails at some WWT reserves. The book *Insects* has had great feedback and is being translated in China. There is hope that there will be deals for editions in France, French Canada, Italy, Central Europe, Japan and Taiwan. 6,000 copies of *Insectarium* have been printed, and a 2,000-copy reprint is due soon. An associated activity book is due out on 3rd July. The first of the new Children's book series,

How to be a Ladybird, is due out on 5th June and *How to be a Dragonfly* will be published on 2nd October. The journals had a record year in 2024, with 1,798 submissions and 501 articles published, 50.9% of which were open access. Dates, venue, convenors and plenary speakers for Ento25 have been agreed and registration is open. We have been developing our bid to host ICE 2033. The Conservation Science team has been successful in attracting funding for new projects in both the UK and Europe. Good progress is being made with the sale of The Mansion House and the search for a new head office.

Matters for Discussion

Council discussed a consultation paper on the future structure of the European Congress of Entomology. The ECE Praesidium is keen to understand how it can best work with European entomological societies.

Council discussed a proposal from the EDI Committee that overarching EDI targets be developed and adopted by all committees.

Matters for Decision

The new Strategy, Strategic Implementation Plan and

2025/2026 budget were approved.

A proposal that the Society supports the BASF Rawcliffe Award for Sustainable Farming was approved.

The first stages of the RES Investment Policy and Business Continuity Plan were approved.

Council approved a change of Director of RES Trading, Jane Stout taking over from Jane Hill.

Matters for Information

Council was informed of the procedure and timescale for electing the next President Elect.

A report from the Education and Training Committee was tabled.

A report from Barclays on the RES investment portfolio was tabled.



Library and Publications

Plantae et Papiliones Rariores (1748–1759) by Georg Dionysius Ehret

Rose Pearson

RES Librarian and Archivist

At 55 cm by 38 cm, but only a few pages long, *Plantae et Papiliones Rariores* or *Rare Plants and Butterflies* by Georg Ehret is one of the tallest and widest but slimmest volumes in the RES Library. However, its fifteen plates feature some of the most detailed and beautifully crafted natural history illustrations of the 18th century, which expertly straddle the line between science and art.

Ehret was born in Heidelberg, Germany in 1708, and the gardening and drawing skills taught by his father provided a solid foundation for his later career. His first professional illustrations for the botanical work *Hortus Cliffortianus* (1737) were made in collaboration with Carl Linnaeus. Following a disagreement over payment from a patron, the botanist Johann Wilhelm Weinmann, he moved to London. There he enjoyed huge professional success, with high demand for his work from many well-known figures of the day. Hans Sloane, the founder of the British Museum, was a key supporter, and Ehret taught drawing to the richest woman in England, Margaret Cavendish, the Duchess of Portland.

Plantae et Papiliones Rariores was financed by subscriptions and produced in parts between 1748 and 1759. Ehret carried out all aspects of the production of the book himself, creating the initial paintings then transferring the images to metal plates for etching. The whole plate, including the handwritten text, would have been etched in reverse, so that the final printed image appeared the correct way round. Ehret also hand coloured



Picture 1. Plate 1 of *Plantae et Papiliones Rariores*.





Picture 2. Plate 5 *Plantae et Papiliones Rariores*.

the finished prints himself. This process, along with the large size of the work, allowed for an exceptional amount of detail but was time consuming and expensive.

Ehret's gardening experience had given him a good understanding of plant structure, and his artistic training is also clear. Rather than isolated depictions of plant and insect specimens, butterflies and their host plants are shown in dynamic, integrated compositions, as seen in Plates 1 and 5. The plates also include short texts, mostly in Latin, describing the plants and insects

portrayed. Plates 4 and 8 consist of innovative tables, where parts of the plants featured in the preceding plates are described and illustrated within the table itself. Particularly notable are the pages of notes depicted within the table on Plate 8 in a *tromp l'oeil* style, complete with curling edges. Later pages include this information incorporated into the individual plates.

Ehret worked closely with Phillip Miller, the chief gardener at the Chelsea Physic Garden, which specialised in medicinal plants, and his work features a number of plants from the garden. A



Picture 3. Plate 8 of *Plantae et Papiliones Rariores*, featuring an innovative table.

porcelain factory was based close to the garden, and illustrations from this book were printed on Chelsea porcelain. Ehret continued to have a successful career; he died in 1770. The genus *Ehretia*, a plant in the Borage family, was named after him.

This copy of the book was donated to the Library by Lepidopterist and sometime RES Librarian Henry Jerome Turner, in 1932. If you would like to view this work, or other items in the RES Library and Archive, please contact library@royensoc.co.uk or 01727 899387.

New article types launched for *Agricultural and Forest Entomology*

Jordan Cuff

Editor-in-Chief Agricultural and Forest Entomology

Jayne Whiffin

Managing Editor, RES.



The RES is delighted to announce that *Agricultural and Forest Entomology* (AFE) is launching several new article types, creating a space for different types of research and some innovative new formats in the journal.

As well as research articles, reviews, viewpoints and short communications, the journal is now inviting methods and applications articles, which present novel research methods, novel applications of methods from other disciplines or new data analysis programmes or packages. The recent AFE special issue *Advances in insect biomonitoring for agriculture and forestry* (Vol 27, Issue 1), includes articles that demonstrate and propose advances that can contribute towards meeting many of the challenges facing biomonitoring, and the Editors-in-Chief anticipate that publishing more methods and applications articles will continue the trend of highlighting advances in methodologies used across the field.

Excitingly, the Editors-in-Chief of AFE also now invite 'policy insights' articles. These short articles should present a novel perspective on recent or upcoming agricultural and/or

forest policy that stands to impact insects positively or negatively. The focus should be on the impacts of that policy on insect populations, and ideally how those impacts can be mitigated or encouraged. It is hoped that through these policy insights, there will be real-world applications and effects driven by the research published in the journal.

This has also involved a redesign of the review-style articles, now renamed 'synthesis' articles to broaden the scope for systematic reviews and meta-analyses, and to focus on advancing the frontiers of the science through synthesis, as opposed to simply summarising a topic. The existing 'viewpoint' articles, essentially short perspective articles, also have a revised description to encourage new directions, ideas and perspectives for the field.

These are important first steps in a wider expansion of the content

that AFE publishes, with more new formats currently in development that will represent an exciting new chapter for the journal.

"These new article types unlock a world of opportunities to publish exciting new research and ideas, and I can't wait to see the kind of research AFE will publish in the months and years ahead. Strengthening the link between AFE and policy, whilst separately encouraging innovation in research methods, feels like an incredibly natural evolution, and one that promises to influence not only what we study, but also how and why we do it". Jordan Cuff, Editor-in-Chief, *Agricultural and Forest Entomology*.

Read in detail about all the article types the journal accepts at <https://resjournals.onlinelibrary.wiley.com/hub/journal/14619563/homepage/forauthors.html> and consider submitting some exciting and innovative new articles.



A Common Yellowjacket wasp, *Vespa vulgaris*, laden with pollen, serving as both pollinator and predator (photo: Jordan Cuff).

Looking to the future of key questions in *Physiological Entomology*

Thies Büscher

Co-Editor-in-Chief, *Physiological Entomology*

Physiological Entomology is one of the oldest Royal Entomological Society journals. For over 100 years, the journal and its predecessors have published research on how insects work and adapt to their environments. This broad scope spans all biological levels and disciplines, including molecular genetics, morphology and ecology. We are particularly interested in mechanisms, hence our journal tagline 'How Insects Work: From Genotype to Phenotype'.

Now, *Physiological Entomology* is looking to the future. In their latest editorial, 'Key questions in *Physiological Entomology*' (Vol. 50, Issue 1), the journal editorial board has carried out a horizon scan to put forward what it sees as the key research questions for now and the future. In simple terms, *Physiological Entomology* considers 'How insects work' and the questions all relate to how we can understand insect function

better. Five major themes were identified from the questions put forward, and we are excited to see these shape the future of research published in the journal:

- Nutrition
- Reproduction
- Environmental adaptation
- Interactions with other organisms
- Phenotypic plasticity

The editorial presents an overview of all the key questions identified and puts them into context within the above themes. Whilst these questions don't cover the whole scope of the journal, we see them as key areas for future research, and hope that they will provide inspiration for grant proposals as well as journal submissions.

If you have an idea for a review or research article based on these questions and would like to

discuss it with the editors, please contact the journal at phen@royensoc.co.uk.

"I welcome this editorial with key questions. Research questions form the, sometimes underappreciated, creative part of science during which future novel research is planned. Having appropriate research questions is essential for development of new research proposals and we hope that considering these questions will not only help our community improve publications but also become more competitive in winning research funding". Toby J.A. Bruce, Co-Editor-in-Chief *Physiological Entomology*.

Read the editorial at [Key questions for future research in Physiological Entomology - Büscher - 2025 - Physiological Entomology - Wiley Online Library and submit to the journal at https://resjournals.onlinelibrary.wiley.com/journal/13653032](https://resjournals.onlinelibrary.wiley.com/journal/13653032).

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Meetings

Verrall Lecture

From Democratic Consensus to Cannibalistic Hordes: The remarkable world of insect swarms

(Recording available: <https://www.royensoc.co.uk/event/verrall-lecture-2025/>)

5th March 2025

Imperial College London

Prof. Iain Couzin, Max Planck Institute of Animal Behaviour

Report by Gaia Mortier, University of Reading

An annual entomological highlight, the Verrall Lecture celebrates advances in insect science and serves as a prelude to the Verrall Supper, organised by the Entomological Club. Our speaker was Prof. Iain Couzin, renowned director of the Max Planck Institute of Animal Behaviour.

The audience was introduced to the concept of 'collective behaviour' and 'social contagion' – observations of certain behaviours spreading through groups of human and non-human animals alike. An especially compelling example of this can be found within colonies of army ants. These insects not only show optimised traffic flow that would make any rush-hour commuter jealous, but they are also capable of creating living architecture; building structures out of their own bodies to support their nomadic lifestyle, such as bridges and scaffolding.

The talk moved on to one of the biblical plagues that is anything but outdated: locusts. Desert Locusts (*Schistocerca gregaria*) continue to pose a significant threat to livelihoods and food security across farming regions of Africa and South Asia, with control measures remaining in dire need of improvement. Locusts provide an excellent example of swarm adaptations, as solitary locusts differ in both morphology and behaviour from gregarious conspecifics. This phenotypic plasticity allows locusts to thrive in variable conditions, such as during monsoons or droughts. In contrast to adult Desert Locusts, which form flying swarms, nymphal locusts are flightless, forming groups known as 'marching bands' in

which they traverse vast amounts of land. Movement strategies of the supposedly vegetarian Desert Locust nymphs were found to include motivational 'cannibal nibbles', where slower moving individuals risked losing a limb if they lagged behind. Although Prof. Couzin and his team aimed to study this behaviour in-situ, an unsuccessful trip to Africa – involving a grumpy camel and a sandstorm visible from space – threw a spanner in the works. Instead, Mormon Crickets (*Anabrus simplex*) were used as a model species until the team was able to visit Africa following the 2019 locust outbreak.

As is the case with many swarming animals, you cannot study an individual and expect to understand the broader thinking of the colony. Instead, Prof. Couzin and his team are using novel techniques – some of which would have undoubtedly been deemed sci-fi not too long ago – to trigger

swarm behaviour in individual animals. Virtual reality screens were altered to trick the animals into thinking they were marching alongside a 3D representation of their swarm. This allows for field-scale results in a lab setting, with several exciting applications in the field of neuroscience, and allows for the real-time analysis of decision making in swarming insects. With such advanced technology and creative approaches, there is no doubt that much more is yet to be discovered.

Prof. Couzin combined several key ingredients such as humour, a visually impressive slideshow, and well-presented data into a captivating and insightful talk. After answering several thought-provoking questions, he was presented with the President's Medal. As the lecture came to an end, the swarming audience collectively moved on to supper at the Rembrandt Hotel.



Prof. Iain Couzin receiving the President's Medal from Vice President Seirian Sumner.

Young Verrall Lecture

Defend, Deal or Depend? Plants and Insects in Partnership

1st March 2025

Staffordshire Invertebrate Science Fair

Dr Ben Clunie, Harper Adams University

Report by Francisca Sconce

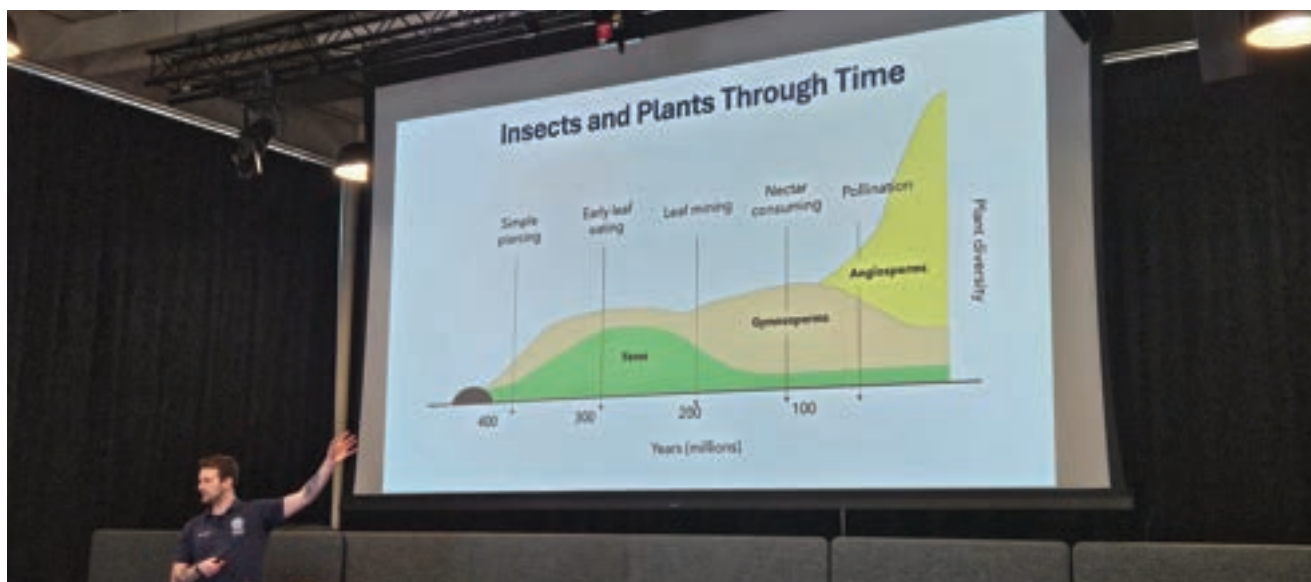
The Staffordshire Invertebrate Science Fair took place at the Stoke-on-Trent campus of the University of Staffordshire. The RES contributed an interactive stand, supported by volunteer Wilson Wall. Over 700 visitors attended. On our stand they could hear about RES activities, meet some live insects and see an advance copy of *How to be a Ladybird*, the new book for 5- to 7-year-olds.

In the afternoon, the RES hosted the Young Verrall Lecture with the

Amateur Entomologists' Society, as part of the Fair's talk programme. Dr Ben Clunie from Harper Adams University stepped in for Prof. Iain Couzin, who was unable to attend. Ben's talk 'Defend, Deal or Depend? Plants and Insects in Partnership' was aimed at 7- to 11-year-olds and focused on what an insect is, the evolution of insects and plants, and their strategies for survival. An impactful moment was a picture of a garden and the sound

of insects and other animals slowly fading away, before Ben shared ideas to help conserve insects and wildlife. Seventy visitors attended the talk, and at the end there were lots of questions from the young audience.

The talk was recorded and can be viewed on the YouTube channel of the Amateur Entomologists' Society: <http://www.youtube.com/@ametsoc>.



Ben Clunie gives the Young Verrall Lecture 2025.



The RES table.

Student Forum 2025

31st March – 1st April 2025

University of Reading

Report by Idris Adams, Vera Kaunath, Ben Hawthorne



Delegates inspecting a carabid during the campus and museum tour (photo: Fran Fleming, RES).

It is one of the most important dates in any student entomologist's diary: the RES Student Forum; two days of networking and sharing entomological research, this year hosted by the University of Reading. At registration on day one, it was great to welcome all our in-person delegates, catching up with familiar faces from previous RES events, as well as meeting many first-timers. Poster boards started to fill with some great visual entomology – the anticipation for the event was palpable.

From the get-go, we had excellent talks from students, presenting on topics including invertebrate responses to anthropogenic impacts, the electrostatic interactions between insects and their environments, and the acoustics of invertebrates beneath the soil. We were treated to a range of excellent posters, on subjects as diverse as utilising wasps in integrated pest management and using metabolomics on blow flies to

determine the postmortem interval in forensics.

Two workshops took place during the event, one of which allowed students at the university to give a tour of the green campus grounds (aided by some sunshine!) and the museum, with an introduction to the collections given by curator Amanda Callaghan. The second of the workshops gave attendees an opportunity to get hands-on and show off their skills in preparing entomological specimens, pinning and carding a range of beetle species, led by Chris Foster and the RES's Fran Sconce. Online attendees were also able to take part in a networking session, resulting in some interesting discussions about termites as sustainable hydrogen producers for combating climate change, and advice for taking the step from Master's to PhD when translocating one's life isn't necessarily an option.

In addition to student attendees presenting their fascinating research, our three invited

speakers: Chris Foster, Franziska Kohlt and Dave Goulson, gave valuable insights into their academic journeys through their research and experiences. Despite all pursuing academic careers, each brought their own unique perspectives to the event, be it the participation of citizen scientists in assisting monitoring schemes, understanding our cultural relationships with insects through literature and the arts, or communicating science to the public via charities and outreach. The three speakers also took part in a panel discussion answering questions submitted by attendees, again providing vital information and practical advice on how best to pursue a career in entomology, how we can engage non-scientists in research, and detailing some of the challenges they had faced in their own careers.

The Ento Pub Quiz made a much-anticipated return to the event, including the infamous Frankenbugs round and a range of entomology-themed questions



Best talk winner Madeleine Price
(photo: Fran Sconce, RES).



Best talk runner up Ayman Asiri
(photo: Fran Sconce, RES).



Student delegates viewing exhibits at the Cole Museum of Zoology
(photo: Fran Sconce, RES).

in popular culture and science. Team names were again a highlight of the quiz, with the first prize going to 'The Brocopteras and the Mutillibabes'! The EntoFashion competition, another essential feature of the Student Forum, was judged on the second day and was made a huge success by the range of colourful insect clothing on display. Congratulations to the winners, Abra Ash and Stephanie Glendinning.

Amongst all the fantastic talks and posters, there were those that particularly stood out and were voted on by attendees as being worthy of special recognition. Congratulations go to Madeleine Price and Ayman Asiri, winning first and second place prizes for best talk, and Genevieve Kiero Watson and Vikki Rose, winning first and second place prizes for best poster.

The Student Forum marked the last event organised by Vera

Kaunath as RES Student Representative, and with such a successful event, we would definitely call it *going out with a bang!* Thank you, Vera, for everything you've done as a rep over the last three years – you have had such a positive impact on the direction of the RES, including the future of the Student Forum. We wish you the best of luck with the rest of your PhD. Vera hands the baton over to Rosy Christopher, who we would like to welcome to the Student Rep team.

Thank you to everyone who participated, online and in-person. A conference is like a living, breathing organism – we can plan the event, but it is truly you who shape the atmosphere. Thank you to our invited speakers for delivering memorable and impactful talks. We couldn't have done this without the help of Chris Foster, our local correspondent, and the RES staff, Fran Fleming, Fran Sconce, Luke Tilley and Bianca Saccone – huge thanks to all of you.

We hope to see you all at Ento25 hosted by the University of Strathclyde, Glasgow. But for now, our attention turns to planning the Student Forum 2026. Will you be joining us there?



Poster winner Genevieve Kiero Watson
(photo: Fran Sconce, RES).

The Lloyd of the Flies Wetland Bug Hunt

Anne Weinhold, RES Business Development and Fundraising Manager

We were delighted to continue our partnership with Aardman and RES Ambassador and well-known Housefly comedy character Lloyd, when WWT, the charity for wetlands and wildlife, ran 'The Lloyd of the Flies Wetland Bug Hunt' at its wetland centres this spring.

The hunt offered families an opportunity to dive into the remarkable world of insects, with our team and WWT colleagues advising Aardman on creating an exclusive new character, a dragonfly called 'Dart'.

Following the trail across each WWT site, families were also able to 'shrink down' to fly size and see the world through an insect's eyes, using Aardman's augmented reality app. The trail and app have

also been showcased at the RES Insect Science Garden at Stratford Cross, London, with visitors able to explore our garden at the same time.

RES staff were able to visit several of the WWT sites to experience the trail for themselves. It was wonderful to see so many people engage with Lloyd and his friends as they discovered the variety of amazing habitats while also learning about the species that live there, with fun facts provided by our team and WWT.

At the launch of the WWT Lloyd of the Flies Wetland Bug Hunt, our CEO Simon Ward said: "We are delighted to build on our partnership with Aardman with this wetland adventure and WWT



at their sites. We are passionate about inspiring the next generation of insect scientists. Lloyd and his new friend Dart are ideally placed to help us encourage children and their families to see the world through the eyes of an insect and appreciate their vital role in the health of humans and the planet."



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RES Student Science Communication Award 2024

Fran Sconce

The results of the 2024 Student Science Communication Award were announced in April. Twenty-three entries were submitted from students in the UK, US, Argentina, Sweden and India. Members of RES Outreach Committee judged the entries: Dr Victoria Burton, Postdoctoral Researcher at the Natural History Museum, London, and Dr Chantelle Jay, Engagement Officer at the Forestry Commission.

Victoria said: "After four years, this will be my last year judging the award. It has been a pleasure, as always, to read such a wide variety of topics and styles of writing on insects. The future of insect science communication looks bright!"

Chantelle said "This was my first time as a judge for this competition, and what an honour! The standard of entries was just superb, with varied approaches and writing styles. I'm so pleased that the judging process provided

the opportunity to discuss and showcase the pieces. All entrants should be extremely proud of their work".

The winner of the RES Student Science Communication Award 2024, receiving a prize of £400, is Agustina Porrino, doctorate student at Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Argentina, for the essay *The fly's flight through a behavioural ecologist's eyes*.

Agustina said: "I am deeply grateful to the Royal Entomological Society for this incredible recognition. Taking part in this competition has been a truly enriching experience. As someone who strongly believes in the importance of making science accessible and engaging, winning first place reinforces my commitment to sharing my passion for insect behaviour with the world and encourages me to keep pushing forward with even more determination."

The runner up, receiving a prize of £300 is Leona Breen, master's student at Harper Adams University, UK, for the essay *Beetle Mania*.

Leona said "I was absolutely over the moon to hear that my silly little wrestling article is making it into *Antenna*. Stag beetles are my all-time favourite animals, and I love any opportunity to chat and write about them. I really hope my piece gives an insight into just how exciting the world of male competition is for these little critters. I've accomplished something that I'm incredibly proud of by coming in second place!"

Editor: These pieces are in the format specified by the competition and not the format specified by the *Antenna* author guidelines.



Winner of the RES Student Science Communication Award 2024. Agustina Porrino, doctorate student at Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Argentina, for the essay *The fly's flight through a behavioural ecologist's eyes*.



Runner up of the RES Student Science Communication Award 2024. Leona Breen, master's student at Harper Adams University, UK, for the essay *Beetle Mania*.

The fly's flight through a behavioural ecologist's eyes



Agustina Porrino

How do you describe someone who gets easily distracted? In many Latin American countries, there is a popular saying — often used by mothers and teachers — that goes ‘*Se distrae con el vuelo de una mosca*’. It means that even a flying fly is enough to draw someone’s attention and pull them away from whatever they were doing. To be honest, I have heard it more times than I can count, since I have always been the kind of person whose attention was focused on the intricate leg movement of a walking beetle, or on how bees flew from flower to flower. Little did I imagine that this so-called *distraction* would lead me to become a behavioural ecology student.

Getting distracted by a flying fly or observing animal behaviour sparks a whole host of questions: **Why** does the fly fly the way it does? **Where** is the beetle heading and why? **How** do bees decide which flowers to visit? **How** do they orient themselves to return to their hives? These questions are at the heart of behavioural ecology, a field that combines the study of animal behaviour, the ecological scenario where animals play their behavioural strategies, and how certain behaviours evolve over time¹. Personally, I believe that this curiosity ties back to one of the oldest human inquiries: **why** animals do what they do and — remembering Tinbergen's four questions — how does that favour their survival?

Beyond observing animals and trying to delve into their motivations, we have recognised their exceptional performance under certain circumstances and sought inspiration from them to tackle a wide variety of modern challenges. If no one had ever been *distracted* by the way flying insects fold their wings, perhaps we might never have found the inspiration for designing a specialised disaster exploration robot capable of adapting to complex environments. This hybrid ground-air searching robot can fold its wings like a bee when navigating through narrow spaces, like buildings ruins after an earthquake, which is of vital importance to rescue and save people’s lives². Without studying how insects adapt their movement to complex environments, such innovations might not exist.

In fact, behavioural ecologists have been so *distracted* by insect flight to the point of sparking entire fields of research. The ability of insects to achieve such complex manoeuvres has encouraged the study of the aerodynamic forces that maintain them airborne and stabilised by continuously adjusting their wing movement. This understanding has led to the development of newfangled biomechanics, such as the micro air vehicles (MAVs) like RoboBee³, which mimic the complex biological systems of flying insects. Insect-sized flying robots can operate autonomously in multiple environments⁴ and have potential uses ranging from crop pollination, search-and-rescue missions, surveillance, minimally invasive robot-assisted surgeries, to high-resolution weather, climate, and environmental monitoring.





Going even further, the study of the collective organisation and communication mechanisms of social insects like ants, bees and wasps have also inspired amazing breakthroughs in algorithm design, such as swarm intelligence algorithms. For instance, the study of pheromone-based communication in ant colonies led to the development of algorithms like Ant Colony Optimisation (ACO), which replicates how ants use pheromone trails to find efficient paths and is being used to optimise internet data routing and managing traffic⁵. Similarly, systems like ColCOS Φ ⁶ use virtual pheromones to replicate insect chemical signaling to enable robots to work collectively. These algorithms showcase how deeply the observation of insect behaviour can influence technology, offering solutions for disaster response, healthcare, and environmental monitoring. Contrariwise, they also represent a huge opportunity to facilitate social insect research, since there still are too many unresolved questions about social insects' collaborative behaviour.

Innovations that stem from observing animal behaviour — particularly from insects — are key examples of biomimetics. Biomimicry involves emulating natural processes, structures, and systems to solve every-day human problems. The remarkably efficient communication of social insects, their resource allocation, navigation strategies and overall adaptive abilities have inspired great technological advancements. By studying these small yet complex organisms, researchers unlock sustainable and adaptive solutions that are applicable to diverse fields. Observing insect behaviour not only enhances our understanding of ecosystems but also fuels breakthroughs that improve technology and quality of life.

So, from now on, if you hear someone say '*Se distrae con el vuelo de una mosca*', take a moment to reconsider that observing the fly's flight might not represent just a trivial distraction. What some see as aimless attention might actually be the kind of curiosity that leads to breakthroughs, both in understanding nature and developing innovative technology. For me, that phrase does not represent a critique anymore but a reminder that sometimes, the smallest details — like the flight of a fly — can spark the most amazing discoveries.

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Tuesday,
November 5th
2024

Beetle Mania

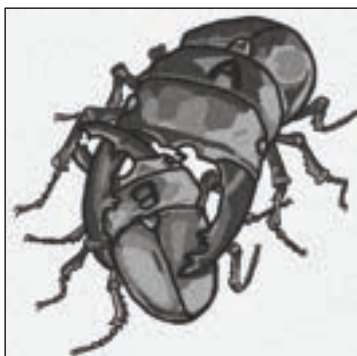
All your beetle battle news

Issue
#10

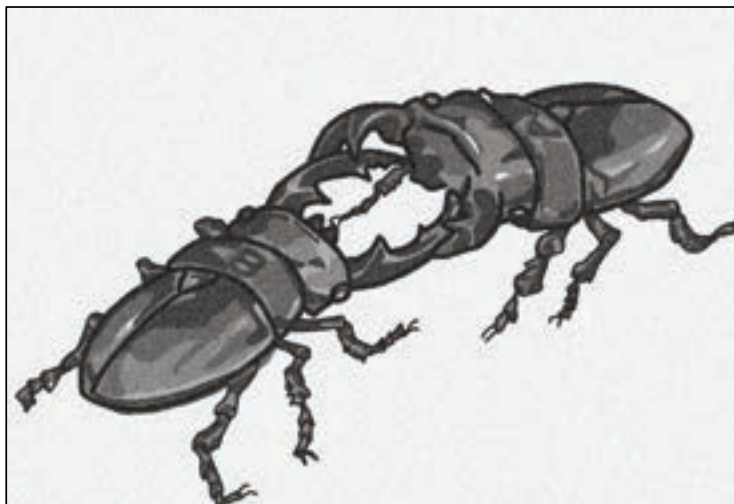
Shocking Ash Tree Showdown

The latest updates

Last night on the fallen ash tree, the Beetle-Mania match delivered not just brute force but a shocking twist that left spectators gasping in disbelief. What began as a classic showdown between two recently emerged golden titans, ended in a cunning move that no one could predict.



The Alpha in an attempt to dislodge his smaller opponent, the Beta¹¹



Alpha and Beta grapple in the ring¹¹

Leona Breen

Golden Stags Take the Ring

The latest updates to get you through the day

The main event featured two insects from southeast Asia, an 89mm powerhouse Alpha, a young man known for escalating directly into aggressive tactics, as well as his slightly smaller, yet almost equally ferocious rival, a 65mm Beta¹. Both of these males went head-to-head sporting a classic broad orange margin on the outer edge of their elytra, complemented by their elaborate elongated mandibles². Like any male *Odontolabis cuvera*, these boys only had three things on their mind: territory, sap sites and most importantly, females³. From the ring of the bell, the two giants locked horns, trading thunderous slams in a battle for dominance and the admiration of the beloved female.

The two warriors battled ferociously for nearly half an hour as they exhausted their immense strength.

The predicted outcome showed that the Alpha had an 85% chance of winning⁴, as this colossus was ready to employ his signature move. Using his tarsal claw to cling to the log, the Alpha was struggling to dislodge his slightly smaller opponent. The Alpha was seen using the distal zone of his elongated mandible in an attempt to dislodge his opponent's leg, even though this tactic transferred less bite force⁵, it is seen as a classic and almost flawless move in the world of lucanid wrestling.

The crowd were on the edge of their seats, eagerly waiting for one of the boys to dislodge their opponent and drop him off the tree, but as the action began to peak, a third unexpected male made his move.

Alpha Male



Contestant one⁶

Beta Male



Contestant two⁶

Gamma Male



Contestant three⁶

Leona Breen

Golden Stags Take the Ring Continued

The latest updates to get you through the day

A Gamma male entered the venue, an elusive man known more for his cunning and speed than his size — at a mere 43mm¹, and almost indistinguishable from the small mandibles of the female. The crowd watched eagerly, knowing that at his size he wouldn't stand a chance against the two beasts in front of him. Yet, as the Alpha and Beta males in the ring threw around their weight, oblivious to anything outside of the stump, the Gamma slid past the ring. The audience erupted in shock as the Gamma male approached the female, and charmed her with his fitness⁶. With his short mandibles, and weighing much less, the Gamma had much greater mobility⁷. Without a single grappling move, the diminutive trickster dashed from the log with his prize before the two brutes had noticed the absence of the female.

This strategy is so rare we have only ever seen it once before, in a contest between the Little Stag Beetles, *Dorcus rectus* back in 2013⁸. Professionals have named this 'trimorphism', the occurrence of sexually competing males having three distinct morphs, as opposed to the usual two⁹. Last night was a huge day in beetle battle history, and coleopterists around the world will never forget the first sighting of our second ever Gamma male. By the time the Alpha and Beta released their grapple and realised what had happened, it was too late. A stunned silence fell over the fallen tree, quickly replaced by a roar of disbelief from the crowd. The two behemoths, still locked in a stalemate, could only watch in

frustration as the spotlight shifted to the puny Gamma male. Fans are left wondering: was this a pre-planned stunt, or has the Gamma genuinely outsmarted the lucanid wrestling world?

One thing is certain, last night's event will go down in stag beetle battle history as the match where the smallest male walked away with the biggest prize.



The female that last night's contestants went head-to-head for.¹⁰

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

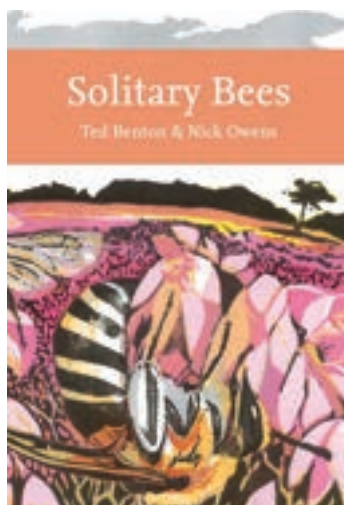
The following reviews have been added to the *Antenna* website:
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[Courtship and Mate-finding in Insects: A Comparative Approach](#)

Raymond J.C. Cannon
Published by CABI. 2023.
ISBN: 9781789248609

Reviewed by Tom Pope



[Solitary bees – The New Naturalist Library volume 146](#)

Ted Benton and Nick Owens
Published by William Collins. 2023.
ISBN: 9780008304553

Reviewed by Richard Jones



[Conservation of Dragonflies: Sentinels of Freshwater Conservation](#)

Michael J. Samways
Published by CABI. 2024.
ISBN: 978-1-78924-837-1

Reviewed by Eleanor Colver, Conservation Officer at the British Dragonfly Society



EVENTS

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

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

June 2025

Mon 23 23–29 June
[Insect Week 2025](#)

September 2025

Tue 9 9–11 September
[Ento25](#)

Tue 9 9–12 September
Control of Vectors, Pests and Parasites (external event)
www.vectorspestsparasites.com

October 2025

Thu 9 9 October
[Insects as Food and Feed \(SIG\) 2025](#)

Mon 13 13–17 October
[XII International Symposium on Aphids](#) (external event)

November 2025

Wed 5 5 November
[Orthoptera Special Interest Group \(SIG\) 2025](#)

February 2026

Tue 10 10 February
[Behaviour Special Interest Group \(SIG\) 2026](#)

June 2026

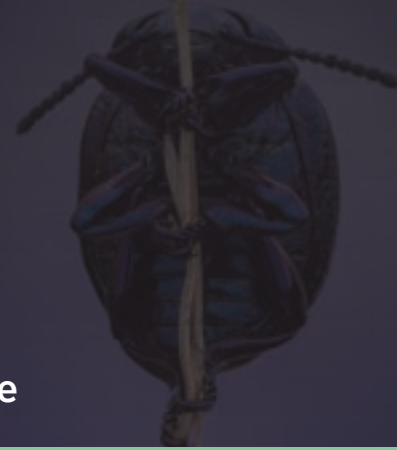
Mon 29 29 June–3 July
[XIII European Congress of Entomology](#) (external event)

For full details on all RES meetings please visit

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