Bulletin of the Royal Entomological Society Volume 43 (2) 2019

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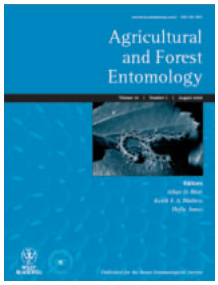

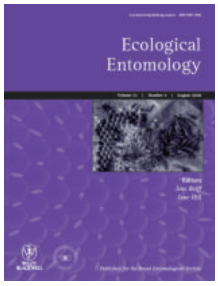

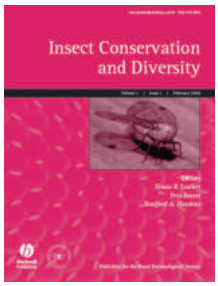

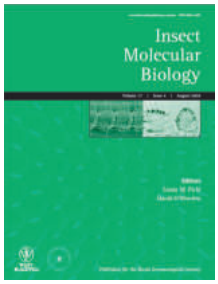

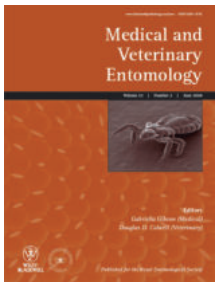

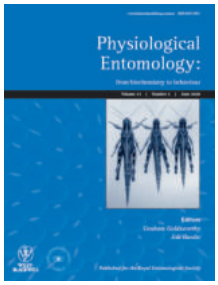

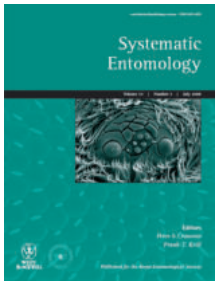

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Oil beetle at Daneway Banks. Photo by Amanda Cox (see article page 81).

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

Editors:
Dr David R. George
(Stockbridge Technology Centre)
Dr Richard Harrington
(Rothamsted Research)

Editoral Assistant:
Dr Jennifer Banfield-Zanin

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

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EDITORIAL

Hello and welcome to the summer issue of *Antenna*. At the time of writing in early spring, insect activity here in Yorkshire was just beginning to gather pace, though by the time 43-2 reaches you the UK will hopefully be 'buzzing' with entomological activity. It's already looking like it will be a good year for ladybirds, and a stroll through my village this afternoon, on a sunny 6th April, was rewarded with an abundance of tawny mining bees (*Andrena fulva*). Whilst populations of many bees are in decline, there do seem to be some species that are bucking this trend; Stuart Reynolds digs deeper into this topic in his 'Research Spotlight', positing that patterns of pollinator 'ups and downs' may be linked to modern agricultural systems. Much of my own work has focused on ways to promote pollinators and other insects in farmed landscapes, from flowering field margins to polycultural production practices using bee-friendly 'living mulches'. Field margins also feature in one of this issue's articles – several of them being subjected to 'hypogean pitfall trapping', with fascinating results, as revealed in Ian Sims *et al.*'s contribution. Sampling is also the subject of another two articles in 43-2; one focusing on a recent 2018 student field trip led by the author (Elizabeth Evesham), and the other reporting on two significant lepidopteran samples from the Malay Peninsula, taken somewhat less recently in 1971 by the article's (co)author, S. Swift. Lepidoptera also feature in our first (and final) article of this issue, with Richard Lamb of the Stratford-upon-Avon Butterfly Farm providing an entomologically engaging overview of 'Butterfly House Management'.

Whilst field margins and polyculture are often targeted to butterflies and bees, they can do much for other insect groups as well, including the focal group of 2019 – the Diptera. With this being the 'Year of the Fly' it's fitting that this group also gets its share of page space, both in Society News (e.g. see Peter Cranston's account of 'Flying in Africa – 9th International Congress of Dipterology') and in Erica McAlister's appraisal of the recently published 'Review of the Manual of Afrotropical Diptera, Vols 1 & 2'. Flies were also front and centre for this year's Wallace Award finalists, with all three theses considering this group, and two concentrating exclusively on Diptera. You can find out which dipteran doctorate took first place in Society News, where we also feature a report on the 'Insects as Food and Feed' SIG (containing yet more flies). A report from the European Congress of Entomology also features here, as well as an update from RES journal *Ecological Entomology* on the recent implementation of their Apprenticeship Editorial Board. This section is topped-off with Jeremy Thomas *et al.* providing 'News from Daneway Banks SSSI', where the main headline of 2017-2018 was the discovery of the exceedingly rare rugged oil beetle, *Meloe rugosus* (see front cover). Given the astounding diversity of this site it should come as no surprise that bees, butterflies and flies all get a mention here too.

This issue also includes our usual Letters, our usual Book Reviews, and our usual Diary of Meetings. In a break from the 'usual' we've also included a Web Review, as well as a stand-alone painting of the swallowtail *Papilio natewa* on *Stachytarpheta mutabilis* by 14 year-old Rory Barraud from Wellington College, New Zealand. Rory produced this work whilst taking part in Operation Wallacea in Fiji in 2018 (https://www.opwall.com/about-opwall/), and the *Antenna* team thought that it was so good that you might like to see it!

Dave George

Guidelines for submitting photographs

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

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

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

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

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

300dpi

72dpi

CORRESPONDENCE

Research outside employment – a conundrum for many aspiring entomologists

Vicki Hird's letter in *Antenna* 42(2) highlights the problem of aspiring researchers finding opportunities. How many graduates actually achieve a research career? Remarkably few, I suspect. Many like Vicki go on to alternative careers and at least some of these lament their lack of fortune to achieve their ambition. Jobs are scarce and, with large numbers trained each year, there can only ever be a low success rate. My own experience will not be unfamiliar: I graduated during a downturn in Government spending (1980s) at a time when traditional employers in biological sciences were shedding jobs at a frightening pace. It took 14 years of effort to secure a permanent job in an environmental discipline! I suspect that something similar still happens today. Even in good times, the numbers of applicants for jobs can be alarmingly high: I recall doing 'paper boards' in the 1990s when applicants ran into the multiple hundreds and on one occasion one of my team applied for a job where there were almost a thousand applicants!

So, how do you make yourself employable or even get noticed? On an alternative track: how do you find a way of employing your research talents if paid work is not forthcoming?

There is an answer, at least, for the aspiring entomologist: personal study and self-improvement. In his letter to *Antenna* 42(2), Clive Betts indirectly highlights a critical issue: that there can be no end of initiatives to help people acquire skills but, in the end, it comes down to personal drive to acquire the necessary skills and profile. Occasionally, we see new young faces emerging through their own dogged determination. When advising aspiring entomologists I have often remarked that if you cannot find the right avenue then there is an option for you to make your own opportunities. Those that use some initiative and drive are often the ones who are successful in getting their feet on the employment ladder. It might not strictly be in academia, but it may be jolly interesting nevertheless. It is unlikely to be the most financially rewarding approach, but if you are prepared to swap wealth for intellectual and moral satisfaction there are opportunities.

So, what can you do to make your mark?

Not all BSc and MSc theses will end up in the mainstream peer-reviewed literature, but at least some of them ought to. I can think of at least two projects that could, and should, have been published. The fact that they have not, means that there is an opportunity for somebody else to repeat them but the opportunity to make the next leap has been lost. There will be plenty more. They might not be accepted by a flagship journal but could well find a home in other journals, especially those that publish studies of the ecology of individual organisms. Obvious front-runners include *The British Journal of Entomology & Natural History*, *The London Naturalist*, *Dipterists Digest*, *The Yorkshire Naturalist* and *The Lincolnshire Naturalist*. Clearly the paper must be relevant to the journal's readership, but there are often editors who need new manuscripts. Solid ecological studies stand a good chance of publication if written well and if they follow normal publication conventions. If your research project was novel and generated a new insight, then it does no harm to write it up and submit it. Simply engaging with the peer-review process is an important part of career development, even if your offer gets turned down.

Amongst natural scientists, entomologists are exceptionally lucky. There are lots of low-hanging fruits still to be picked. For example, we know precious little about the larval ecology of vast numbers of Diptera. If you want a catchy description then it is the larval ecology of 'pollinators'. You don't need a lot of expensive equipment, but you do need the critical skills of a researcher: patience, dedication to recording the minutiae, and imaginative thinking based on a sound knowledge of your subject area. Those skills don't come from jobs, they come from personal discipline and can be developed at home. And, even if you never produce a ground-breaking paper, short notes on observations in suitable journals and newsletters will help to grow your profile and CV.

Meanwhile, we hear a lot from the academic world about the benefits (to academia) of 'citizen scientists'. Some of those 'amateurs' are actually world leaders in their subject. They have got to that point by dogged determination and an infinite curiosity about some aspect of the natural world. Taxonomy and invertebrate ecology are now largely populated by such specialists (certainly in Dipterology). You could be one of them if you put your mind to it. So, even if you end up doing something far-removed from your degree, there remains the possibility of an active life in research.

So, what do you need as a starting point?

I often look on in amazement as the gaggle of twitchers of all ages put vastly expensive optics to their eyes. Then come the expensive cameras – a reasonable-quality DSLR runs into the high hundreds or even thousands of pounds and seems to populate the persona of young and old alike (as do expensive mobile phones). Yet, suggest the purchase of a microscope and the answer would be: 'I cannot afford such a luxury'. In reality, there are several manufacturers of perfectly acceptable entry-level dissecting microscopes in the £300-400 bracket. Expensive optics are actually less important than making sure you get good lighting (and even that need not be expensive using modern LEDs). Similarly, the bookshelves of the birder are often filled with expensive tomes; even so, people throw their hands up in horror at the thought of a book on flies costing maybe £30. That book and a basic microscope could be the gateway to a career, or at least to an absorbing hobby, that will satisfy the most curious mind for a lifetime.

I use the example of Diptera because that is my own area of interest, but there are many other possibilities – from bees to beetles to bugs. The invertebrate world is your oyster (and yes there are also plenty of marine invertebrates whose ecology remains to be unravelled). Finding an untapped research area is no different to the professional world – somebody has to recognise the niche through an intimate knowledge of their subject.

So for the aspiring entomologist I urge engagement with a wide spectrum of entomological and natural history societies as part of the process of acquiring the skills and profile that you will need to get work in many aspects of the natural sciences. Join the societies, develop some taxonomic expertise and a personal research interest; and above all else get involved. Many such societies are crying out for younger members and people to take on responsible positions. Granted, these societies don't have the kudos of the RES, but showing initiative and drive will help to advance your career into the realm of entomological research.

Roger Morris

Das Verschwinden der Schmetterlinge (Butterflies)

Dear readers of *Antenna*,

Please allow me first to introduce myself as the Translations Manager at Polity.

I am writing in order to ask whether there might be any lepidoterologists out there fluent in German who would be interested in potentially assisting us in translating Josef H. Reichholf's *Das Verschwinden der Schmetterlinge* (Butterflies), the English translation of which will be published by Polity. The author was a Fellow of the RES for many years and will be reviewing the translation.

Should this opportunity be of interest to anyone reading this letter, please contact me using the email address below.

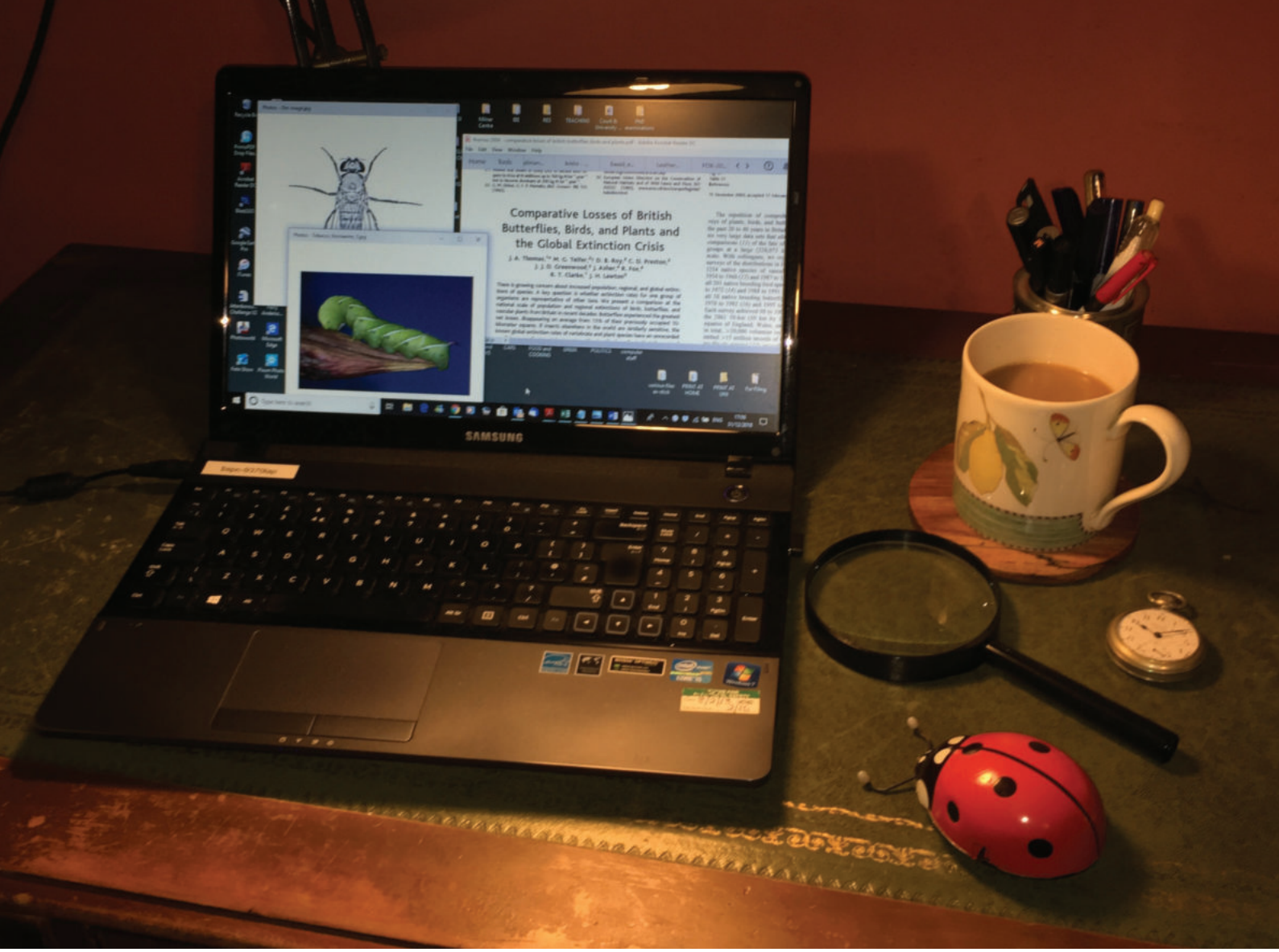
With thanks and best wishes,

Elise Heslinga
elise.heslinga@politybooks.com

Society E-Newsletter

In January 2019 the Society launched a monthly e-newsletter for Members and Fellows, which summarises news, upcoming events, opportunities and recent publications. If you did not receive this in your email inbox and would like to, please email info@royensoc.co.uk and your details will be updated.

Francisca Sconce
Outreach & Engagement



Pollinator Ups and Downs

RESEARCH SPOTLIGHT

Stuart Reynolds

Department of Biology and Biochemistry, University of Bath

In my last *Research Spotlight* article (*Antenna* **43** (1), 5-9) I discussed the evidence for widespread insect declines. I originally thought that in this second article I would write about a completely different topic, but the publication of a new paper about pollinators in trouble changed my mind. Goulson & Nicholls (2016) have likened wild pollinators to "canaries in the coalmine" and I agree that we need to be concerned about their welfare.

The new paper is by Gary Powney and his colleagues at the Centre for Ecology and Hydrology (CEH) near Oxford, along with entomologists from the Bees, Wasps and Ants Recording Society (BWARS) and the Hoverfly Recording Scheme (HRS). They analyse almost 750,000 observations of insects, using records of 353 wild bees and hoverflies over large areas of Great Britain to show that around one third of these pollinating species declined between 1980 and 2013. Most of the losses were from species that were already relatively uncommon. Some big losers were *Bombus ruderarius* (Red-shanked Carder Bee, Fig 1a), *Lasioglossum parvulum* (Smooth-gastered Furrow Bee), and *Panurgus banksianus* (Large Shaggy Bee), each of which vanished from around half of their previous locations. For both bees and hoverflies, there is an uneven but progressive and statistically significant overall declining trend (see Fig. 2).

But an important caveat is that not all British pollinators are declining. Just over half of the species monitored were neither increasing nor decreasing. And the ranges of some species of bee and hoverfly, about 10% of the total, were found to have increased markedly between 1980 and 2013. Most of these winners were bumblebees and solitary

Fig. 1 a. Red-shanked carder bee (*Bombus ruderarius*), a species which has declined significantly since 1980. Image: Rasbak/Wikipedia, CC BY-SA. *b.* Ashy mining bee (*Andrena cineraria)*, a species which has increased significantly since 1980. Image: Aiwok/Wikipedia, CC BY-SA 4.0. *c.* Ivy bee (*Colletes hederae*), an invasive species that colonised the UK in 2001 and has since greatly expanded in population size and geographic range. Image: Hechtonicus/Wikipedia, CC BY-SA 3.0.

bees. For example, *Andrena cineraria*, the Ashy Mining Bee (Fig. 1b), and *Lasioglossum pauxillum*, the Lobe-spurred Furrow Bee, each increased their range five-fold during that period. Another species, the Ivy Bee, *Colletes hederae* (Fig. 1c), only colonised mainland Britain in 2001 and the range over which it can be found has since been expanding by 16% per year (more about this below). Overall, however, the ups and the downs don't cancel out. The overall diversity of pollinators at any one place has fallen steadily.

Before I begin trying to explore just what all this means, it's important to note the paper by Powney *et al.* (2019) doesn't document actual numbers of insects. Instead it reports the number of 1 km^2 grid cells in which these insects were recorded during each year of the study period. Thus, a decline in the number of occupied squares is very likely to underestimate the true decrease in total population size. Nevertheless, the results are consistent with the already alarming downward trends in general insect abundance seen in the other studies in the UK (Conrad *et al.*, 2006), Germany (Hallmann *et*

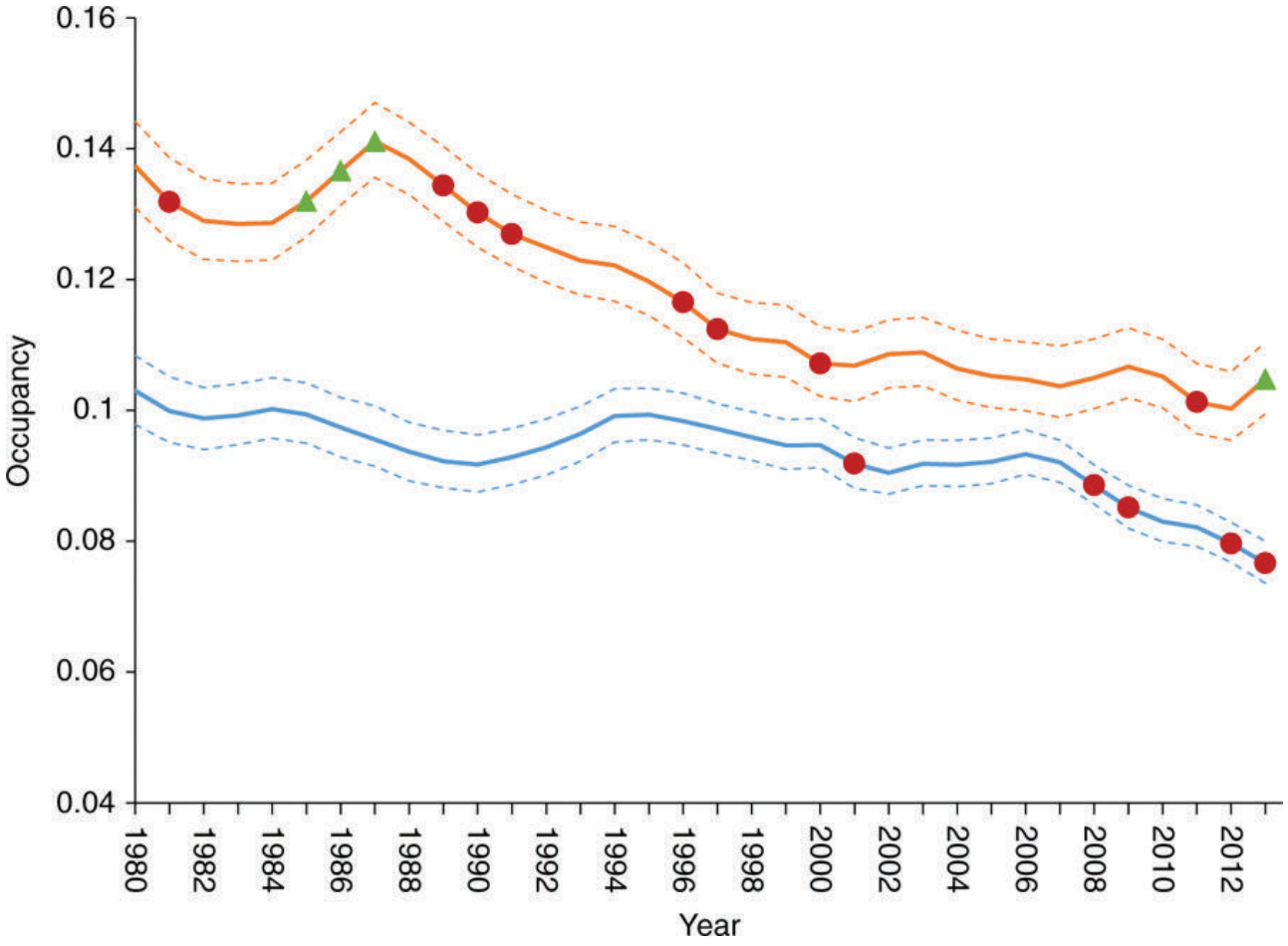


Fig 2. Contrasting patterns of change among major groups of pollinating insects. Trend lines show average occupancy of 1 km^2 grid cells in Britain across all modelled bee ($n = 139$, blue) and hoverfly ($n = 214$, orange) species. Uncertainty is represented by the 95% credible intervals (delimited by dashed lines). Red circles and green triangles highlight years with notable decreases or increases, respectively. Notable years were defined as those where the upper (decreasing) or lower (increasing) 95% credible interval for the first derivative of occupancy did not span zero. Figure and legend reproduced from Powney *et al.*, (2019); CC BY 4.0.

al., 2017), and Central America (Lister & Garcia, 2018) that were the subject of my previous article.

Incidentally, another very recent "insect decline" paper is a meta-analysis by Sánchez-Bayo & Wyckhuys (2019), which provoked a media frenzy by suggesting that current rates of decline might lead to "the extinction of 40% of the world's insect species over the next few decades". There are some problems with the methodology of that paper and it's not only me that thinks its conclusions are unduly alarmist. This doesn't mean that the paper is without value; at the least it assembles a dismal catalogue of insect declines that have been studied in one way or another. But the fact that the paper's attention is selectively focused only on those papers that are about declines makes it difficult to use it as a measure of how serious the problem actually is. But since the paper has already been subject to a strongly worded published critique (Komonen *et al.*, 2019), I'll refrain from going into more detail here.

The finding by Powney *et al.* (2019) that UK native wild pollinators are in trouble is in some ways unsurprising. There have been numerous previous reports of declining pollinator diversity and visitation rates over the past decade, both in the UK and in Europe and North America; reasonably up to date summaries of the evidence are to be found in Goulson *et al.* (2015a) and Ollerton (2017). The situation has led to a great deal of public interest, even alarm, and much speculation about causes and possible remedies. Not everyone, however, is convinced that the situation is dire. It's difficult and expensive to monitor pollinator diversity and population size (Lebuhn *et al.*, 2013), and there has been criticism that the evidence base for global pollinator declines is flimsy and geographically biased (Ghazoul, 2015; answered by Goulson *et al.*, 2015b). If only for this reason, the new paper by Powney *et al.* (2019) is a welcome contribution to the literature. In fact, because a large number of species have been individually monitored, the study offers a remarkably detailed picture of what has been happening in the UK insect pollinator guild over a period of more than 30 years. The new data allows us to ask a number of questions about pollinator declines.

One of these questions is whether all insects, or only some, are suffering? If most pollinators are affected, then we might suspect a causal factor that directly affects a wide variety of insects, irrespective of their way of life. Widespread pesticide pollution would be an obvious candidate; but if it should turn out that some insects are doing well while others are not, then some ecological niches must somehow be favoured while others are adversely affected, suggesting that niche-specific factors are the most likely candidates.

The study by Powney *et al.* (2019) provides a rather clear answer to this, which is that at least among British pollinators there are both "losers" and "winners". As I mentioned previously, around 33% of pollinators were found to be declining. But the occupancy of map squares of about 10% of bees and hoverflies increased markedly between 1980 and 2013. Most of these winners were bumblebees and solitary bees (but that doesn't mean that you're OK if you're a bee).

What has changed to cause some insects to prosper while the rest declined? Powney *et al.* point out that many of the bees increasing in geographic coverage are well-known as pollinators of agricultural crops; the supplementary materials of the paper show that during the period 1990-2006, while 22 species of dominant crop-pollinating bees actually increased in occupancy of sampled squares, 117 other bee species declined steadily. As noted above, two of the biggest winners among crop-pollinating bees were *A. cinerea* and *L. pauxillum*, both pollinators of oilseed rape, *Brassica napus*. The success of these bees shouldn't be a surprise; the area devoted to this crop in the UK has increased hugely in recent times, growing more than 160-fold from just 4,006 ha in 1970, to 641,562 ha in 2010 (FAOStat, 2019). From the point of view of pollinators that are able to use this crop, oilseed rape looks like an open goal waiting to be scored.

Another big winner among pollinators was *Colletes hederae*, the Ivy Bee (Fig. 1c), an invasive species (Dellicour *et al.*, 2014) that has recently spread across western Europe, only reaching mainland Britain in 2001 (Cross, 2002). Today this insect is common at a wide range of sites across southern England (BWARS, 2018). It isn't just widely distributed, but is also seen in large numbers where it occurs (BWARS, 2019). The reasons for the sudden rise to prominence of this insect in western Europe are still uncertain, but the facts that its host plant *Hedera helix* is common almost everywhere and that its flowering period overlaps to only a limited extent with other plants, may explain why the ivy-pollination niche is attractive. Its considerable success in newly invaded areas may be the result of escape from parasites encountered elsewhere. It isn't clear whether *C. hederae* would compete with and therefore depress native bees, but its highly specialist habits suggest this is unlikely.

What are the likely environmental and economic consequences of these pollinator ups and downs? Massive, overall losses of pollinators would be serious for two reasons. First, readers of *Antenna* hardly need to be reminded that wild bees and hoverflies are important in allowing many flowering plants to set seed by transferring pollen between them (Grass, 2018). Without them, seed production in many (but not all) wild flowers is reduced and their populations fall. In a vicious circle, this would cause pollinator numbers to decline even further (Lundgren *et al.*, 2015). Second, not only wild plants are affected, but also agricultural crops. Strawberries (Klatt *et al.*, 2014), apples (Cross *et al.*, 2015) and oilseed rape (Bommarco *et al.*, 2012) are just three of the many crops that benefit from pollination by bees and other insects. Even in vegetables where yield is not directly reduced by lack of pollination, production of seed for planting next year is dependent on insects (Fijen *et al.*, 2018). Without insect-provided "pollination services", some of these crops could no longer be grown and human economic activity would be diminished. The annual value of insect pollinators for the UK alone has been estimated at £ 603 million (Vanbergen, 2014); globally, pollination adds US$ 153 billion to the economy each year (Potts *et al.*, 2010).

Why have some pollinator species declined? Popular suggestions for possible causes of insect declines include loss of natural habitats (e.g. hedges, field margins and headlands), loss of wildflower sources of pollen and nectar, pollution by agricultural chemicals, artificial light at night, climate change, and invasions by exotic species. The literature is so vast that I am not going to attempt to cite references on this point. Many of these possible causes apply equally to pollinators and other insects. Powney *et*

al. (2019) take care not to blame any particular factor. This seems wise to me, not least because so many people get very hot under the collar about this subject.

But if I had to name my top suspect for pollinator declines, the success of farmers in growing highly productive monocultures must certainly be it. Not only does a monoculture reduce the diversity of available pollen types (Hass *et al.*, 2019), but it also crowds out plants that flower outside the relatively short flowering season of the crop plants themselves.

Of course, pesticides are a popular target for environmental activists and there is indeed mounting evidence that some of them are very bad for pollinators (see Goulson *et al.* 2015). There has been much concern about neonicotinoids in particular; although these compounds were thought to be environmentally safe when they were introduced, evidence against them has continued to accumulate (Ihara & Matsuda, 2018). A particularly interesting paper is that of Budge *et al.* (2015) who used large scale data to show that in 9 regions across England and Wales during the period 2000-2010, losses of honeybees, *Apis mellifera*, were significantly correlated with neonicotinoid usage on oilseed rape. Honeybees are domesticated rather than wild pollinators, but this finding is almost indisputably relevant to both.

The damaging effects of certain pesticides on pollinators may be subtle; for example, they can adversely affect foraging behaviour through effects on motivation and or sensory impairment (Muth & Leonard, 2019). On the other hand, Ratnieks *et al.* (2018) are quite right to point out that there are pitfalls in extrapolating from laboratory to field, with much research on this topic being lab-based. However, as it happens, the EU has recently embarked on a very large-scale experiment by banning most agricultural uses of neonicotinoids. It is as yet too soon to determine whether the EU ban, first imposed in 2013 and recently extended (EFSA, 2018), will lead to a resurgence of wild insect pollinator populations, but we will soon see.

Although insecticides are obvious candidates as causes for pollinator declines, it is the fungicide chlorothalonil that has most recently emerged as a serious suspect; this agent, extensively applied in the UK to cereals, has been shown to facilitate damaging infections of a well-known microsporidian parasite of bumblebees, *Nosema bombi* (McArt, 2017). The EU has been engaged on a review of this chemical for more than two years (EFSA, 2019) and at the time of writing (late March 2019), it is reported that use of chlorothalonil will soon be restricted in the EU (Guardian, 2019), although the reasons for this ban include toxicological issues that don't have anything to do with bees. Again, this will be an opportunity to find out whether it really does cause pollinators to decline.

What about the increases in some pollinator species found by Powney *et al.* (2019)? It's possible that these species have increased simply because measures were taken to encourage them (Marja, 2018). These include the EU's set-aside scheme, which operated from 1988 to 2008 (Firbank *et al.*, 2003). It's notable that Fig. 2 shows that bee populations appear to have stayed relatively steady during the set-aside era, but then declined sharply thereafter (on the other hand this didn't appear to help hoverflies). Powney *et al.*'s supplementary materials show that the 22 species of dominant crop-pollinating bees mentioned before appear to have crashed since 2006. Perhaps then these bees had been supported by nectar sources within set-aside land? It seems though that they don't much like the CAP Pillar 2 agri-environment schemes that succeeded set-aside. Of course, there are plenty of conservation ecologists trying out schemes for encouraging pollinators (see for example Buhk *et al.*, 2018) and one can only hope that in a post-Brexit UK, meaningful approaches will be found to implement such schemes.

Some of the pollinator species that have increased are associated with widely grown agricultural crops. Is this an example of unconscious artificial selection? Superficially, the enhanced populations of crop-pollinating bees (e.g. *A. cinerea* and *L. pauxillum*) seem like an encouraging finding, at least from the point of view of the ecosystem service they provide to agriculture, although perhaps not from the point of view of rural biodiversity. But even this may not be good news for farmers: it's known that loss of pollinator diversity decreases crop yields, and this may be more important than simple insect numbers (Hoehn *et al.*, 2018). Further, the declines are mostly among solitary bees and hoverflies, while many of the increases are among social bumblebees. Relying on fewer species of pollinators may leave these insects open to viral diseases that spread readily among social insects. This is already known to be a big problem in honey bees and bumblebees (Grozinger & Flenniken, 2019).

Is there an overarching simple explanation for all of this? A unifying view that makes a lot of sense to me is that loss of farmland biodiversity is the inevitable consequence of the inexorable increase in the intensity of agriculture. In the UK, even our towns and cities are surrounded by an overwhelmingly agricultural countryside. As farming grows more and more efficient, less and less space and resources are left for anything other than human food crops. As agricultural landscapes become more and more simplified, we can expect the wild biodiversity associated with them to decline.

Regardless of the actual proximate cause, it is my view that intensive agriculture *per se* causes the problem. The fact that the CEH study shows that crop specialist pollinators have actually increased underlines this. If we want to conserve farmland biodiversity, then we have to make some choices. There's a trade-off between wild nature and farming efficiency and we have to decide how much wild nature we want.

This article started its life as an Opinion Piece previously published in *The Conversation:*
https://theconversation.com/insects-species-that-prefer-crops-prosper-while-majority-decline-114206
It has been radically rewritten but keen readers may just see signs of its provenance.

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Butterfly House Management

The Stratford-upon-Avon Butterfly Farm is a wildlife display, owned by Clive Farrell, that currently attracts over 150,000 visitors each year. The business is solely funded by the gate receipts, shop takings and the pupae business. In this article I will briefly explain a little of the science behind the diverse systems that go to make up a successful Butterfly House.

The first things to get right in a Butterfly House are the physical conditions. We aim to get a daytime temperature of 26°C with 80% relative humidity, while we let the temperature fall naturally to 15°C at night. These conditions are greatly affected by sunlight, so we find that we are adding heat at 27°C in the winter and venting off at 24°C in the summer. This complicated micro-management of heating and vent control systems has developed into a fine art. The butterflies will tell us if conditions are right; if they are flying, feeding, courting and ovipositing then all is well, and we should feel slightly sticky in shirt sleeves. The humidity is created by watering the flowerbeds and the paths daily, and up to three times each day during very hot weather. We also have ponds, streams and waterfalls that help to create the humid environment. The white noise of the main waterfall also helps to give our visitors a sense of isolation even in a relatively crowded small space. Butterflies being creatures of the sunshine, it is imperative that we clean the netting and the glass inside and out on an annual basis to allow maximum light transmission. As a result, we have become quite adept at roof work along with the many other maintenance jobs that we have to undertake during the winter; tour guides and pupae packers become cleaners, repairers and painters.

The next most significant thing to get right is the planting. We use structural plants to make the place look like a jungle, even though it is very 'gardened'. Screening plants are used to turn the visitors away from the centre at each turn, thus making the area seem much bigger than it really is. We plant bays in a north-south direction to create sunny glades where the butterflies congregate. In these brightly lit areas we plant banks and banks of nectar rich flowers to feed the 3,000 butterflies that can be on the wing at maximum peak times. Most butterflies feed from nectar, but a few only take cut fruit. Our fruit table makes a magnificent display when it's covered with Caligos, Morphos, Charaxes and

Richard Lamb
Stratford-upon-Avon Butterfly Farm




Top left: The re-opening ceremony in 2015; Top right: Clive Farrell; Bottom left: the entrance to the Butterfly House; Bottom right: the colossal Olmec head.

other Nymphalids. In the winter there is never enough nectar in the flowers, so we supplement the butterflies diet with 10% sugar solution offered in drinkers coloured blue and yellow. These are filled up every day of the year, but we often fill them up six times a day in the depths of the winter.

Adult butterflies are only a small part the insects' life cycle. They are caterpillars for much longer, and caterpillars are arguably the more important part of the local ecology. It is important to breed as many species as possible as this reduces the overall cost of the display, and some caterpillars have such stunning colours and shapes that they make a good display all by themselves. My favourite species are those that don't destroy their food-plant, such as the Heliconids on passion flower, the Glasswings on *Cestrum* and the many Pansys, Eggflys, Siproetas and others on *Blechnum*, *Hygrophila* and *Asystasia* etc. There are species that eat too much, and as a result their access to food-plants must be managed; the Swallowtails on Citrus, Caligos on Banana and Monarchs on Milkweed are prime examples, as if left to their own devices they would eat all available food-plants leaving nothing for future generations. The silkmoths and some hawk moths that we display as caterpillars either go on small potted trees or else on cut stems, which adds another daily chore to our schedule, keeping them supplied with plenty of fresh leaves.

It is essential that none of the plants that we use have any trace of insecticide, for obvious reasons. We source the plants from pesticide-free suppliers and, even then, we sometimes have to re-pot and wait a few months before they are usable. We tend to grow most of what we need ourselves. This inevitably leads to plant pests, so we use a range of biocontrols; *Encarsia* for whitefly and *Cryptolaemus* for mealybug are the main ones. Fortunately, ambient conditions are too humid for red spider mite to be an issue.

We source our pupae from all round the tropics. We have suppliers in the Philippines, Malaysia, Thailand, Kenya, Tanzania, Ecuador, Suriname, Costa Rica, El Salvador and our own farm in Belize. As each shipment requires a Common Veterinary Entry Document to enter the EU, we arrange for all our shipments to arrive at Heathrow every Monday, where they are cleared and made available for us to pick up. This is expensive, so to spread the cost we import at least 1,000 pupae from each supplier. These are not all for Stratford. We supply many of the other UK and European Butterfly Houses with pupae, and even send them as far away as the US, Canada, South Africa and New Zealand. Moving time-sensitive pupae around the world with all the correct documentation is a whole other skillset we have had to develop. Most of my time is currently spent attending Brexit briefings and pondering on a way forward should trading entomological livestock with the EU prove difficult going forward. During our slow period in the winter we move around 14,000 pupae a week, rising to over 20,000 during the height of the summer.

The excess of the pupae business goes into our own display. I aim to put 1,000 into the garden each week giving an

Preparing the pupae.

absolute minimum of 1,500 adult butterflies on the wing at any one time, though I'm much happier with at least 2,000. I try to get a pyramid of sizes with many smaller species, fewer middle-sized ones and fewer still larger ones. Then I try to have every colour combination possible with no single colour over-dominating; this is where the science gets a little arty. All the pupae go into an emergence cage, which is kept at a constant 26°C day and night with a constant 80% humidity to provide ideal hatching conditions for the butterflies. The emergence cage is also where we quarantine the pupae, as there are many pests and diseases that can come to us from the tropics. I check every single one daily and remove any pupae showing any sign of illness. The pupae can be affected by fungal, viral and bacterial diseases, as well as parasitic flies and wasps. If any of these get into the caterpillar areas all breeding could be interrupted for a season.

We are not just a butterfly farm as we have many other creatures in residence; there are free flying birds, all seed eaters of course, fish in the ponds and free ranging iguanas. In our Minibeast Metropolis we house tropical grasshoppers, praying mantids, stick insects, beetles and an amazing colony of leafcutter ants. We also have hermit crabs, giant millipedes, giant centipedes and African land snails. In a darkened room we display tarantulas, scorpions and sometimes a black widow spider. We also have axolotls, frogs, lizards and snakes. With a lot of livestock their food becomes attractive to rats and mice, which we keep at bay with regular baiting. If robins, wrens or tits get into the house they are chased out as soon as possible, as they can eat their body weight in butterflies each day. Spiders are an ever-present problem; my biggest loss of adult butterflies is probably due to spider bites. We remove cobwebs every day and as the birds are continually flying around this also helps to keep the airways free of webs. In the early years we also had hummingbirds and sunbirds, but they are now not easily available. They eat spiders and make their nests with cobwebs, a very elegant method of biocontrol.

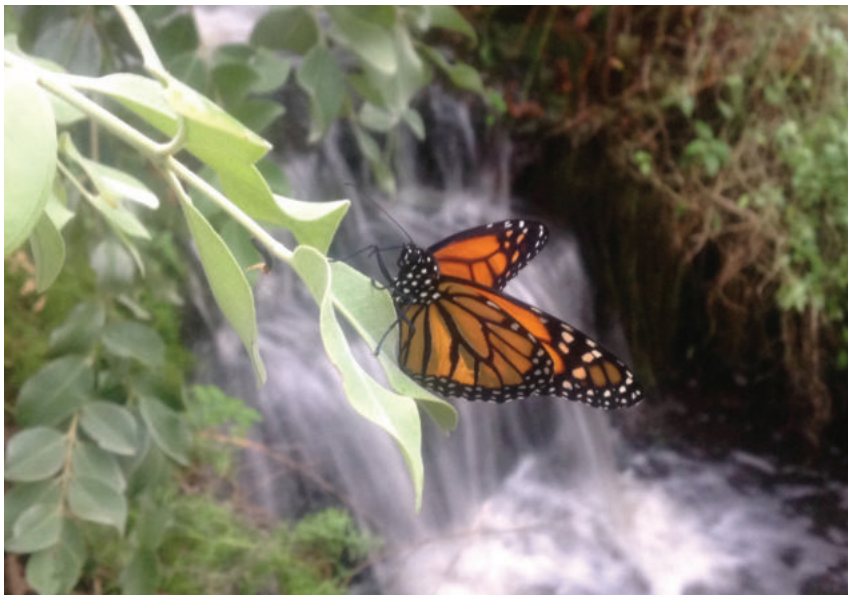
The Animal Team like to use cockroaches and crickets as displays and live food, which can cause problems, as even the most benign species, of which we have a couple, can escape and become a problem. Any insectivorous species that escapes into the house can devastate the butterfly display.

Back in 2015 we had a makeover; the farm was then 30 years old and needed a facelift. We gave the place a Maya theme as our farm in Belize is right next to some Maya ruins at Lubaantun, which translates as 'Fallen Stones' and is the name of our Belizian establishment. So as visitors wander around the jungle, they come across various statues depicting many Mayan characters and even a colossal Olmec head, which was an ancient structure when the Maya were at their peak, 1,500 years ago.

To run this show 365 days a year takes a dedicated team of people, and I'm ably helped by Sarka Bohac, whose main responsibility is to run the pupae business. When the van gets back from the airport on a Monday afternoon there are seven of us all unpacking, quality controlling and counting pupae. All day Tuesday the same team packs up the pupae for shipping to our customers. At our busiest time we can sort and move 22,000 pupae in a day. The farm side is run by James Ship, with Cat Gibbons and Chris White working on the horticulture, and Mark Nelson and John Withers working on the animal husbandry. The front of house and marketing is managed by Jane Kendrick with her team of full-time, part-time and seasonal shop staff.

We are classed as a zoo and therefore must fulfil various obligations to retain our zoo licence, which we have to re-apply for every three years. Apart from being part of the leisure and tourism industry, we also aim to educate our visitors subliminally on the importance of rainforests and butterflies. We also take groups of school children on organised tours, giving them a more formal understanding of insect anatomy, life cycles, habitats, colour and camouflage, and now even the Maya civilisation. Each winter I set aside an hour per week for staff training, during which time my front of house staff have learned the basics of how we operate, and my educational team have received a much more in-depth grounding in entomology and the Lepidoptera in particular. I also take staff from other butterfly houses and train them in the running of a butterfly display.

We are also required to undertake research in our establishment. We have links to Warwick and Birmingham Universities, along with Moreton Morrell and Pershore Agricultural and Horticultural Colleges. All have sent students here to undertake research



Monarch butterfly over the waterfall.

Glasswing.

One of the free-roaming iguanas.

projects. We do quite a lot of in-house research ourselves, all designed to improve the husbandry of our butterflies. We send material to Cambridge, Lund and Berkeley Universities where it is used at the cutting edge of science.

The last big thing that we get involved with is conservation. We only source our stock from ethical and sustainable operations, these being either conservation projects or community initiatives. Our charity funding is split between the Kipepeo Project of the Arabuko Sokoke Forest in Kenya and, more locally, the Warwickshire branch of Butterfly Conservation. We have also helped the Homerus Project, run by our umbrella organisation the International Association of Butterfly Breeders and Exhibitors (IABES), and sent disaster relief to Sri Lanka and the Philippines. We work very closely with Butterfly Conservation; I'm on the committee of the Warwickshire Branch. Both myself and other members of staff have run transects, a wider countryside square, square bashed for the Millennium Atlas and its five yearly updates, and most of us take part in the Big Butterfly Count. Our front garden is laid out with various ponds for dragonflies and amphibians and a wild flower meadow surrounding planters containing the ten most important butterfly nectar sources in the UK; *Buddleja*, *Sedum*, scabious, red valerian, *Phuopsis*, *Hebe*, hemp-agrimony, oregano, *Aster* and *Verbena*. It also has several butterfly foodplants; oak for the purple hairstreak, disease-resistant elm for the white-letter hairstreak, blackthorn for the brown hairstreak, buckthorn for the brimstone, a holly and ivy hedge for the holly blue, garlic mustard for the orange tip, bird's-foot trefoil for the common blue and various long and short grasses for many browns and skippers. We have plans for a green roof to be planted up as an elevated nettle bed for the Vanessids. For the last few years we have held minibeast handling sessions as part of National Insect Week using material kindly supplied to us by the RES.

Butterflies are my vocation, and I admit that after a hard week in the tropical butterfly house I like nothing better than to go into the local countryside and record British butterflies and other wildlife. I get as much pleasure in finding a dingy skipper colony as I do from getting a new exotic butterfly into production.

Jasons Bay, Johore State, Malay Peninsula.

Rarities of the Malay Peninsula:

A note and update of significant historical information relating to the recording of *Elymnias penanga f. johnsoni* and *Hidari bhawani* in 1971

S. Swift
Gosport, Hants, UK

J. W. Phillips
Hayling Island, Hants, UK

Introduction

From an early age I (S. Swift) have been interested in the Lepidoptera, especially butterflies, and as a naval officer I had the opportunity of visiting various parts of the world rich in these insects. With thanks in no small part to the input and encouragement of my co-author (J.W. Phillips), this article recounts one of my most memorable periods collecting and studying these most majestic of insects, with specific reference to two of my most significant catches.

Between 1969 and 1972 I was stationed at the Naval Base on Singapore Island, and during this period was able not only to explore Singapore Island itself, which at that time was partly jungle with numerous collecting opportunities, but also to visit the mainland Malay Peninsula. The latter provided even better localities for a lepidopterist, with many diverse habitats.

The main collecting site on the island of Singapore was in the Mandi Sambwa forest; further afield on the mainland, visits were frequently made to Pehang – Frazers Hill and Kuantan, Malacca, Mount Ophir and Jahore State, especially Kota Tingi, Mersing and specifically the Sedili – and the Jasons Bay area, which consisted of extensive beaches bordered by secondary jungle. It was here that I captured and recorded the two rarities that are the subject of this article; namely *Elymnias penanga f. johnsoni* and *Hidari bhawani*.

During my excursions, my collecting companion and fellow lepidopterist was Norman Parker, an expatriate who

was working for a company in Singapore and was acquainted with Lt Col. J. N. Eliot, a prominent entomologist and leading author on the Lepidoptera of the region. During this time Lt Col. Eliot was undertaking a revision for the Third Edition of *Butterflies of the Malay Peninsula* by Corbet & Pendlebury, published in 1978. Some years later a Fourth Edition was produced, published in 1992 and including full colour plates by B. d'Abrera.

Over the period 1969–1972 I amassed a comprehensive collection of Malaysian Butterflies of approximately 1,000 set specimens, all of which were donated to the Hope Entomological Collections, Oxford University Museum of Natural History, in June 2015. However, prior to parting with my collection, and appreciating the potential significance of my records of *Elymnias penanga f. johnsoni* and *Hidari bhawani*, specimens of these species were donated to The Natural History Museum, South Kensington, London, for incorporation into the National Collection.

The recording of these two specimens on the Malay Peninsula in 1971 is considered to be of some significance. When the importance of the two records was realised, photographs were forwarded to J. N. Eliot, who himself acknowledged their extreme rarity in his correspondence, reprinted here, and also in his two revisions of Corbet & Pendlebury. The object of this short article is to register, somewhat belatedly, a record of that event, whilst also providing some detail on the butterflies themselves.

Elymnias penanga f. johnsoni Talbot 1929

Lepidoptera, Nymphalidae, Satyrinae

Shown in Plate I, this specimen was captured at Jasons Bay, Jahore State, Malay Peninsula on 21st November 1971, my having spotted it flying just above head height in secondary jungle.

The genus is distributed from Sri Lanka to New Guinea and the Bismarck Archipelago and the Papuan area, and as Eliot states: "In the genus *Elymnias* the adults are very characteristic in appearance, they are not sharply separated from the rest of the Satyrinae and of rather large size and delicate, usually of rather sombre coloration and many are extremely rare; and are mostly forest dwellers, preferring shade to the sunshine and are inclined to be crepuscular in habit and are of great biological interest on account of their mimetic associations."

Eliot does not devote a separate subheading for *E. penanga* Westwood 1851, but states that it differs from other Malayan species of the genus in having the forewing apex rather pointed and the hindwing termen entire. The female is polymorphic and has a number of forms throughout the range, which extends from Assam to Sumatra and Borneo. Various forms of *E. penanga* are figured in the plates by d'Abrera, namely *f. penanga*, *hislopi* Eliot 1967 and *abrisa* Distant 1886, but these do not include the very rare female form of *johnsoni* Talbot, which has a broad whitish longitudinal stripe astride the cubitus with the basal two thirds of vein 2 on the forewing, and the hindwing, sullied white with rather narrow dark margins.

Jasons Bay, Johore State, Malay Peninsula.

Plate I. Photo: Natural History Museum, London.

Plate II. Photo: Natural History Museum, London.

Dear Swift

Thank you very much for your letter of 2nd March in which you kindly say I may keep the slides. This I should like to do as they will be most useful to me for ready reference in writing Corbet & Pendlebury's book Edn 3.

The E. penanga f. johnsoni Talbot 1929. This seems to be only the second known example. The original came from Penang.

H. bhawani seems to be one of the world's greatest rarities. A specimen was caught in S. Vietnam about 8 years ago. Otherwise it seems to be known only from a very few examples from S. Burma & Langkawi. Is. I have not heard of any examples being taken before in Malaya proper.

Parker sent me an interesting Lebadea martha male from Singapore a day or two ago. It turned out to resemble very closely a male I took before. This was on Great Kariman Island. So I have very little doubt that the establishment of a colony of odd L. martha is the result of immigration from the Rhio Archipelogo.

A similar case occurred a few years ago back when Hislop started finding a curious form of Euthalia godartii on Blakang Mati.

In this case it was not possible to pin down the founder of the colony as being from Rhio. Since nobody yet knows what godartii looks like in those islands.

Parker also told me of 2 P. memnon female agenor which he had taken on P Tiomon – most interesting.

Yours Sincerely
John Eliot

J. N. Eliot – Correspondence, 3rd March 1972.

Surprisingly Eliot makes no reference to the recording of the specimen in Plate I in either his Third or Fourth Editions, despite being aware of its existence. His check list of distribution details of all known species in both editions also omits reference to *Elymnias penanga f. johnsoni*, though some years on it can be considered that the plates presented here fill this gap.

***Hidari bhawani* de Niceville 1889**

Lepidoptera, Hesperiidae

See Plate II

This specimen, shown in Plate II, was also captured at Jasons Bay, Johore State, Malay Peninsula, in the same locality as the *E. penanga*. I recollect observing this skipper fly into a clump of dead palms where it settled on a withered leaf. To this day I can still recall being immediately struck by how well the underside of the butterfly exactly matched the palm leaf. When shown to Norman Parker, a leading authority on Lepidoptera in the area, his immediate reaction was one of total amazement; to be expected given that this species was not known to occur in this region.

In the genus *Hidari* the adults are rather large and the elongated wings are dark brown above (more reddish in the female) with separate pale-yellow hyaline spots on the forewing and a semi-hyaline spot in space. The female is appreciably larger than the male, and the genus is distributed from North India to Sundaland. The very rare *H. bhawani* is easily recognised by the striated underside and by the erescentric spot in space 2 on the forewing.

Again, Eliot does not allocate a separate sub-heading for *H. bhawani* in his text(s) and makes no reference to the record of the specimen in Plate II. His letter of 3rd March 1972 states that, at that time, he was unaware of any examples being taken in Malay proper, and only notes examples from S. Burma and the Langkawi Islands. His checklist featuring particulars of distribution, however, contradicts this statement, where the distribution for *H. bhawani* includes Malay proper.

Conclusions

In summary, *E. penanga f. johnsoni* and *H. bhawani* can be considered rarities in the Malay Peninsula, at least during the 1970s when the specimens pictured here were collected. It would be interesting to know whether these species still occur in the region nearly 50 years on from my observing them there. Publishing 20 years on from my own collecting trips in the area, Corbet & Pendlebury (Fourth Edition, 1992) note their rarity, though without specific reference to their capture. Nevertheless, as elsewhere, much is likely to have changed in the region since then.

It would also be interesting to know whether further historic specimens of *E. penanga f. johnsoni* and *H. bhawani*, captured in the Malay Peninsula, are secreted in either other museum or private collections. Dr Huertas of the Natural History Museum, London, advises that she cannot find further evidence of any specimens other than the two under consideration when searching the main U.K. National Collection, although concedes that specimens may lie un-labelled in the accession collections as yet uncatalogued.

Acknowledgements

Sincere thanks are firstly due to the Natural History Museum, South Kensington, to whom the specimens were initially donated and where they currently reside as part of the National Collection and in particular Dr Blanca Huertas, Senior Curator of Lepidoptera, Life Sciences Department, who expended considerable time in tracking down the specimens and also providing the reference photographs.

Thanks are also given to the Malaysian Nature Society (MNS), Kuala Lumpur. As the original publishers of Corbet & Pendlebury, the MNS were contacted in order to obtain a local and current perspective on the butterfly fauna of the region, which was freely given by Intan Zurani Abd Razak, Sally Lee and in particular Henry S. Barlow, an acknowledged authority on the fauna of the Malay Peninsula.

Thanks are also due to the Hope Entomological Collections, Oxford University Museum of Natural History, specifically Dr James Hogan and Darren Mann, for their interest and input and for the acceptance by the Department of the bulk of the 'Swift Collection of Malaysian Lepidoptera' for incorporation in the main collections. Without them it is more than likely that the collection would have been lost to posterity.

Finally, we would also to thank Dr Jeremy Holloway for his interest and support.

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The Joys of the Biology Field Trip

Dr E.J.M. Evesham

How do you get a bunch of teenagers interested in creepy crawlies? Answer: take them on a field trip away from any other distractions, apart from each other and their mobile phones of course! Little do the students know that my well-organised programme of daily activities gives little time for social gatherings or texting. The evenings likewise will be full-on, filled with such delights as the processing of data and writing-up of practical reports, leaving what's left of a long day to fall into bed for a much-needed sleep.

Whilst taking part in a field trip and getting cold, windswept and possibly wet may not be top of every teenager's wish-list, I think my own passion for entomology and the outdoors eventually rubs-off. Even the evenings spent crunching numbers and typing have their benefits, leaving the students with the knowledge to better answer examination questions on ecological techniques, such as mark-recapture, and an improved understanding of statistical tests.

So, what does one of my Biology Field Trips actually entail in terms of entomological and other content? To answer, here's a taster from one of my most recent outings to Leeson House Field Studies Centre, Swanage in Dorset. This particular fieldtrip was attended by thirteen International students studying their Biology A-level and Biology Advanced Level Foundation courses at Kings Education, Bournemouth.

Day 1

A brand-new minibus picked us all up, together with enough baggage to last a month! What do students need for two days?

The weather was kind; dry, cool and with sunny intervals. Having been split into four small groups, the students worked on collecting data from Studland, assessing soil samples, wind speed, soil pH, aspect and numbers of different plants along a transect line. I couldn't help pointing out the beautiful dragonflies with their intricate wings flying over the "Little sea" as we made our way inland. Dune beetles were also in abundance.

Having navigated through the rough undergrowth and around a few dog walkers, we headed back to Leeson House to carry out statistical analyses on the day's data and plot kite diagrams. It was great to see the students smiling throughout, laughing with each other and getting the work done. Lots of hot chocolate and food helped to maintain energy levels, though everyone should sleep well tonight, myself included!

Day 2

Contrary to expectations, I didn't get much sleep, and I wasn't alone! Lots of giggling and thumping came from the girls' room, but at least they were happy!

The day started by visiting the River Piddle in Wareham. It was great to see the girls all going into the water with their nets to get samples, with some in waders to access the deeper parts of the river. They were fascinated to see the many different invertebrates found, as well as several species of fish.

The students observed the correlation between the speed of water flow (between the near, shallow side of the river and the deeper, far side) and the species of invertebrates sampled. It was quite refreshing to see that there were species here which one would expect to see in oxygen-rich waters, and the students made use of identification charts to name the invertebrates sampled. Catches included species such as the lesser and greater water boatman, water beetles and beetle larvae, cased caddisfly larvae, dragonfly nymphs, freshwater shrimps, stoneflies and mayflies.

A quick lunch was then taken before venturing on to the windswept hillsides of Kimmeridge. Here I introduced the students to some resident ant colonies of *Myrmica rubra*, taking the opportunity to teach them a technique of marking individuals so that they could carry out a mark-release-recapture exercise to estimate population size.

This activity, whilst engaging, was undertaken amidst much squealing and with many an ant ending up covered in more than a little sticky paint! Of course, one of the biological assumptions made with this method is that the paint has no effect on the insects themselves, nor other members of the colony. Perhaps not so when students are at the other end of the paintbrush! At least my formicid friends could now be left in peace – if only for the next 24 hours.

We then walked, carefully, along the Jurassic rocks of Kimmeridge Bay to our next sampling site – the tidal shore. Here the students were introduced to the many types of seaweed present, with one student enquiring whether this was the same seaweed that was good for your hair! Personal grooming products have certainly changed since I was a teenager! Here data were

gathered on limpet lengths, with the many brightly coloured snails present also under close investigation, though more for their aesthetic appeal than anything else.

On the way back to Leeson House, the fresh air and life outdoors was beginning to have a 'positive' effect on the students, most of whom were now subdued and quiet. Before the evening's work commenced, a light trap was placed outside the classroom to see what varieties of moth we might capture by morning. Another long evening of statistical analyses and some writing-up of the day's work might just be enough to ensure a peaceful night and a restful, well-needed sleep!

Day 3

Having had a couple of fair weather days, we woke to wet and windy weather outside the window. However, we took advantage of a sunny interval to collect ants back at Kimmeridge, from the same location as we'd marked them the day before. It would seem that the ants had outwitted the students and hidden themselves away, though enough unlucky individuals took the bait to make our mark-release-recapture experiment a success.

Then it was back to Leeson House to view what was inside the moth trap; a convolvulus hawk moth and yellow and red underwings to name but a few, with most of the catch prompting a repeat of the previous day's 'squealy moments'. Such reactions to the natural world emphasise the need for students, whatever they are studying, to get outside and appreciate the living components within the habitats around them, whilst interacting with the environment. 'Learning by doing' can be especially effective in education, and particularly for engaging young people with entomology, ecology and the environment. We should perhaps all look to get ourselves and our students outside the classroom more often.

The rest of the morning gave the students an opportunity to consolidate the past days' work and catch up on any of the other subjects, ahead of hopping back on the coach for the return trip to Bournemouth.

Figure 1. Hypogean pitfall trap dismantled.

Hypogean Pitfall Trapping: A Window into Another World

Ian Sims
Syngenta International Research Station, Jealott's Hill, Bracknell, Berkshire RG42 6EY
email: ian.sims@syngenta.com

Jon Cole
c/o British Entomological and Natural History Society, Pelham-Clinton Building, Dinton Pastures Country Park, Davis Street, Hurst, Reading, Berkshire, RG10 0TK

Mark G. Telfer
Independent entomological consultant, 10 Northall Road, Eaton Bray, Dunstable, LU6 2DQ

With growing concerns around food security, we are striving to increase agricultural productivity in response to a fast-growing world population (EC, 2010: Godfray *et al.*, 2010). Consequently, soil fertility and productivity are becoming important issues (EC, 2010), so much so that they featured in Theresa May's 25 year plan for the environment (GOV-UK, 2018).

Currently, around 70% of the United Kingdom's land area is under some form of agricultural regime (GOV-UK, 2012). Threats to soil fertility and biodiversity, including stressors such as soil compaction, erosion and loss of organic carbon, arise mostly from intensive agriculture (EC, 2010). Key to soil fertility is a diverse invertebrate fauna, i.e. good biodiversity, comprised largely of decomposers, detritivores and shredders. So the assessment, preservation and enhancement of soil biodiversity is becoming of increasing importance (EC, 2010). In 2006 the EU started a procedure to provide a legal framework for the protection and monitoring of soil biodiversity, culminating in the Soil Thematic Strategy (EC, 2012). This identified sampling techniques as a major concern of monitoring programmes.

Traditional methods for sampling soil biodiversity include pitfall trapping from the soil surface and heat-extraction of collected soil samples using devices such as Tullgren funnels. The former does not sample true hypogean (subterranean, or soil-dwelling) organisms and suffers from quantified biases (Greenslade, 1964; Luff, 1975; Lin Y-C *et al.*, 2005), while the latter requires destructive sampling of the soil, making replication and repeat sampling over prolonged periods both difficult and unreliable (Macfadyen, 1960). Underground (hypogean) pitfall traps overcome these problems. Such traps have been used in the UK mostly by coleopterists investigating saproxylic Coleoptera in the soil around dead tree stumps. Unfortunately, the non-coleopteran catch has usually been discarded. Some workers have used them in the tropics and elsewhere, in caves and on scree

Figure 2 (inset). Sample collection bottle; Figure 3. East Jubilee Field margin on 25th November 2014 (used for case study 1). Note white marker flags indicating positions of the two hypogean pitfall traps.

slopes (Lòpez & Oromí, 2010; Mammola *et al.*, 2016; Nitzu *et al.*, 2010). Their first use in the UK on arable field margins was in 2014, when they were used to monitor and assess soil biodiversity (Sims *et al.*, 2016).

The hypogean pitfall trap (Fig. 1) used for the following four case studies was a modification by MGT of a design originally described by John Owen (Owen, 1995). The body consisted of a length of PVC drain-pipe (50 cm long, 11 cm external diameter) with three vertical equidistantly spaced windows, or collection ports, (8 cm wide and 20 cm long) cut in the wall. The collection ports were covered with galvanised wire (1 cm^2 mesh size) to minimise the ingress of soil yet enable the passage of invertebrates from the soil into the trap. A sample collection bottle modified with an outer sleeve so that it was a tight sliding fit within the trap body (Fig. 2) was positioned below the collection ports. To enable invertebrates entering the trap to be collected in the sample bottle, three equidistantly spaced windows were cut around the bottle's shoulder. A tight-fitting lid prevented direct ingress of rainwater and surface-dwelling (epigean) invertebrates to the trap. The whole was buried vertically in the soil, either by excavating a hole and back-filling, or with the use of a post-hole digger. The latter caused less disturbance of the soil and resulted in a more natural soil profile surrounding the trap.

As the traps were to be left *in-situ* for an appreciable amount of time (one to two weeks) between sample collections, a preservation fluid was used to prevent the escape of trapped invertebrates, their predation by large carabids and staphylinids, or the decomposition of soft-bodied and/or delicate taxa. Several sorts of preservatives have been used in pitfall traps (Hall, 1991; Woodcock, 2005), but monopropylene glycol was preferred as it is non-toxic, colourless and offers short-term preservation of DNA (Moreau *et al.*, 2013).

Case study 1: Annual trial on a field margin at Jealott's Hill, Berkshire

An annual trial was commenced on 31 October 2013 (Sims *et al.*, 2016). Two hypogean traps were deployed five metres apart on a grassy margin of East Jubilee Field (Fig. 3) at Syngenta's Jealott's Hill Farm, Berkshire (OS map ref. SU876738). The traps were placed in excavated holes, which were then backfilled. After a two month settling-in period to allow the backfilled earth to consolidate, the first trap sample was collected on 20 December 2013. Samples were collected at approximately weekly intervals throughout 2014, until 9 January 2015 when the last sample was collected. As the two pitfall traps were located close to one-another their contents were pooled on each sampling occasion to produce a more representative bulk sample of that location on the field margin. Samples were filtered through bolting silk (mesh size approximately 250 µm), and the organisms collected by hand picking before preservation in 70% aqueous ethanol. Identification of the invertebrates was conducted to species level where possible, to Order, Cohort, Sub-cohort, Super-family or Family in the case of Acari and to Family for some coleopterous and dipterous larvae.

To assess the suitability of the data generated for estimating hypogean biodiversity, Species Richness (SR), the Shannon-Wiener Diversity Index (S-WDI) and Inverse Simpson's Diversity Index (ISDI) were used (Feest, 2006). Species dominance was assessed using the Inverse Berger-Parker Dominance Index (IB-PDI) (Leinster & Cobbold, 2012).

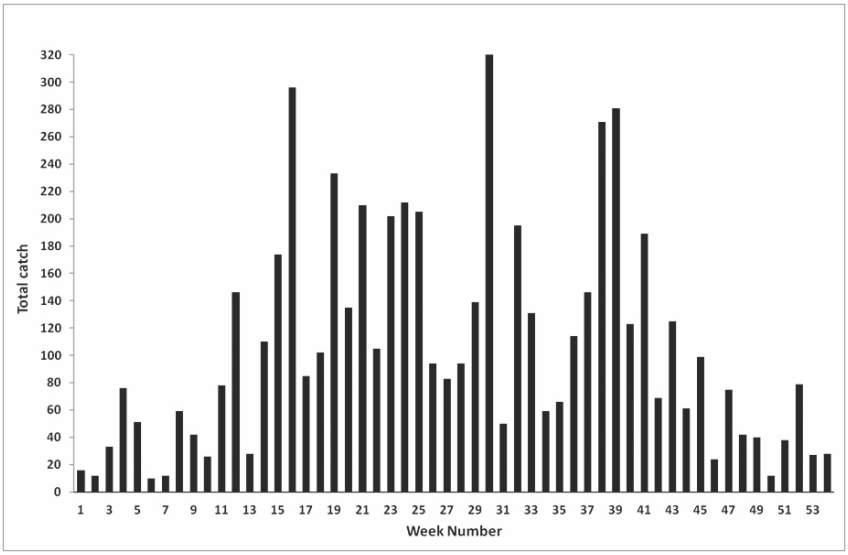

Figure 4. Total number of specimens recorded over the duration of case study 1.

Diversity

A total of 6,197 individual specimens were collected (Fig. 4), 91% being identified to the various taxonomic levels outlined above. This represented 263 "taxa" and included representatives of the Annelida, Arachnida (Acari and Araneae), Coleoptera, Collembola, Diplura, Diptera, Gastropoda, Hymenoptera (Formicidae and parasitic wasps), Myriapoda (Chilopoda, Diplopoda), Isopoda and 10 "numerically smaller groups", i.e. those for which few specimens were recorded.

Unusual records

During this study 22 examples of the parasitic wasp *Baeus seminulum* Haliday and eight examples of the beetle *Choleva agilis* (Illiger) were recorded. These are the first Berkshire (Watsonian vice-county [VC] 22) records, and in the case of *B. seminulum*, double the number of known UK records. In addition, the Nationally Scarce staphylinid beetle *Ilyobates propinquus* (Aubé) was trapped. Two examples of the staphylinid *Ischnosoma splendidum* (Gravenhorst), formerly *Mycetoporus splendidus* (Gravenhorst), were also trapped. This is a scarce species in Berkshire; these are believed to represent only the eighth or ninth examples so far recorded from VC 22. The hemipteran *Sehirus luctuosus* Mulsant & Rey (forget-me-not shield bug) has not been reported from pitfall traps of any type (Tristan Bantock, pers. comm.), and was thus an unexpected catch in the current work. Another unexpected catch was the great-crested newt, *Triturus cristatus* (Laurenti), a European Protected Species. This was removed alive from one trap on 25 April, during a very wet period that coincided with newt migration to water bodies to breed. This species has not been recorded from this 10 km square before (Matthew Smith, pers. comm.). Taken together, these records indicate that scarce and uncommon invertebrates, as well as vertebrates, can be found on field margins under environmental stewardship schemes.

Case study 2: Two MSc projects, Peartrees Field, Jealott's Hill, Berkshire

During 2014 and 2015 two MSc research projects (James Keeble and Michael Smith) used hypogean pitfall traps to examine soil biodiversity on four floristically different margins (one un-amended, one sown with tussocky grass, one sown with 80% grass : 20% wildflower and one sown with 90% grass : 10% wild flower, Figures 5 to 8) of Peartrees Field, adjacent to East Jubilee Field, at Jealott's Hill. Each project ran for two months, from early May to late June, with a total of eight samples collected at approximately weekly intervals. Two traps were deployed per margin and diversity indices calculated as for case study 1.

Diversity

Although the actual diversity index scores differed from year to year, the two data sets were almost identical in terms of which margins scored highest and lowest with the various indices (Table 1). The only difference was that in 2014 the margin with the lowest species richness was the 80 : 20 grass : wildflower margin, while in 2015 this was the un-amended margin, when the 80 : 20 margin scored the second lowest for species richness.

Many of the same species of hypogean invertebrates were recorded during both projects. However, a surprising feature common to both was the general lack of earthworms in the samples. This was unexpected, as intuitively it was anticpated that hypogean pitfall traps would collect good numbers of annelids. This was not the case, with only a few of the smaller species of worm, like *Allolobophora chlorotica* (Savigny) and *Aporrectodea rosea* (Savigny), being recorded. It is possible that larger worms, such as *Aporrectodea longa* (Ude) and *Lumbricus castaneus* (Savigny), detect the void within the trap body and mistake this for a subterranean void such as a mole run. Their instinctive reaction would likely be to reverse direction before they fall into the void, thus avoiding one of their main predators, the common mole, *Talpa europaea* Linn.

Table 1. Species diversity index scores from four field margins during 2014 and 2015. TG = tussocky grass, 90:10 = 90% grass:10% flowers and 80:20 = 80% grass:20% flowers.

Margin type	2014				2015			
	SR	IS	S-W	IB-P	SR	IS	S-W	IB-P
Un-amended	32	1.9	3.2	1.9	27	4.1	1.9	2.3
TG	33	2.6	7.5	3.2	47	11	2.9	5.1
90 : 10	30	2.5	8.5	5.4	44	11	3.0	6.2
80 : 20	29	3.0	5.5	3.0	41	13	2.8	5.6

Green = most diverse; Orange = least diverse. SR = species richness, IS = inverse Simpsons diversity index, S-W = Shannon-Weiner diversity index, IB-P = inverse Berger-Parker diversity index.

Figure 5. Peartrees unamended field margin (U-A) on 30 June 2015 (used for case studies 2 and 3).

Figure 6. Peartrees tussocky grass field margin (TG) on 30 June 2015 (used for case studies 2 and 3).

Figure 7. Peartrees 80 % grass, 20% wildflower seeded field margin (80 : 20) on 30 June 2015 (used for case studies 2 and 3).

Figure 8. Peartrees 90% grass, 10% wild flower seeded field margin (90 : 10) on 30 June 2015 (used for case studies 2 and 3).

Case study 3:

Comparison of hypogean and epigean pitfall trap catches

During 2017 an MSc student (Jonathan Griffiths) used two of the field margins described in case study 2 (tussocky grass and 90 : 10) to compare the catches from epigean and hypogean pitfall traps. The former were plastic drinking cups (7 cm diameter) inserted into plastic sleeves in the ground, such that their rims were level with or slightly below the surface of the soil. During this two month project (early May to late June) three of each trap type were deployed on each study margin, and eight samples of invertebrates were collected from each trap at roughly weekly intervals. The same indices were used to assess biodiversity as previously.

Diversity

Epigean invertebrate biodiversity was higher than hypogean biodiversity on both margins, while the tussocky grass margin had the highest epigean and hypogean biodiversity overall (Table 2).

The species composition of the epigean samples was different from that of the hypogean samples. The numbers of species of carabid and staphylinid beetles from the epigean traps were 13 and 9 respectively, while the hypogean traps caught only two species from both groups. Many larger species of carabid and staphylinid were present in the epigean samples. The average length of the carabid species recorded from the epigean traps was 8.4 mm (Fig. 9), but from hypogean traps this was 6.2 mm (Fig. 10). Epigean staphylinids (Fig. 11) averaged 6.7 mm long, against 3.8 mm for the hypogean staphylinids (Fig. 12).

Both Collembola and Acari, good indicators of soil health (Sims *et al.*, 2016), were present in high numbers in

Table 2. Species diversity index scores from epigean and hypogean pitfall traps on two field margins during 2017. TG = tussocky grass, 90:10 = 90% grass:10% flowers.

Margin type	Epigean				Hypogean			
	SR	IS	S-W	IB-P	SR	IS	S-W	IB-P
TG	92	17	3.4	5.6	57	12	3.1	4.6
90 : 10	95	6.8	2.8	2.9	53	1.3	0.7	1.2

Green = most diverse; Orange = least diverse. SR = species richness, IS = inverse Simpsons diversity index, S-W = Shannon-Weiner diversity index, IB-P = inverse Berger-Parker diversity index.

Figure 9. Violet ground beetle *Carabus violaceus* Linnaeus, a carabid found in epigean samples (length 20 - 30 mm)

Figure 10. *Amara bifrons* (Gyllenhal), a carabid found in hypogean samples (length 5.3 – 7.4 mm)

the epigean and hypogean samples. However, the epigean Collembola species composition included more taxa adapted to a surface existence (pigmented, and with well-developed appendages including the furcula or springing organ, e.g. Fig. 13) than the hypogean trapped Collembola (Fig. 14).

Case study 4: Hypogean pitfall traps deployed for saproxylic Coleoptera

John Owen's (1995) interest in hypogean pitfall trapping was prompted by the discovery of the weevil *Ferreria marqueti* (Aubé) in hypogean habitats in Britain. This beetle is very seldom seen, other than by hypogean pitfall trapping, usually at the roots of exotic conifers. Owen (1997) ran hypogean pitfall traps in 18 Surrey gardens and found *F. marqueti* in 14 of them, showing quite clearly that this weevil is not rare and that hypogean pitfall trapping can open up new frontiers in our knowledge of British invertebrates.

The use of hypogean pitfall trapping by coleopterists in semi-natural habitats has been equally ground-breaking. John Owen installed hypogean pitfall traps at the roots of old oaks (*Quercus* spp.) and beeches (*Fagus sylvaticus*) at Ashtead Common, and a range of other ancient parkland and wood-pasture sites in south-east England (Owen, 1999; Owen, 2000). This trapping programme yielded several species of beetle including *Rhizophagus oblongicollis* Blatch & Horner and *Oxylaemus variolosus* (Dufour) which had previously been regarded as rarities but have come to be more familiar to coleopterists deploying hypogean traps. Hypogean pitfall trapping at the roots of oaks at Ebernoe Common in West Sussex (a Sussex Wildlife Trust reserve), and at the roots of a standing dead exotic broadleaf tree at the National Trust's Petworth Park (also West Sussex) led to the rediscovery of *Oxylaemus cylindricus* (Creutzer in Panzer) in Britain after a gap of more than 100 years since the previous record (Telfer, 2011a). The Petworth Park survey in 2010 also found 27 examples of the rove beetle *Medon dilutus* (Erichson) from a single hypogean pitfall trap (Telfer, 2011b). Until the advent of hypogean pitfall trapping, only two

Figure 11. Devil's coach horse *Ocypus olens* (O. F. Müller), a staphylinid found in epigean samples (length 23 - 32 mm)

Figure 12. *Paederus littoralis* Gravenhorst, a staphylinid found in hypogean samples (length 8.0 – 10 mm)

Figure 13. *Pogonognathellus longicornis* (Müller), a mostly epigean springtail (length 6 mm, excluding antennae)

Figure 14. *Folsomia candida* (Willem), a mostly hypogean springtail (length 2.0 mm including antennae)

individuals of this species had ever been found in Britain.

Conclusions

The similarity in the rankings of maximum and minimum biodiversity index scores derived for the various margins during 2014 and 2015 show that hypogean pitfall traps provide a repeatable assessment of soil biodiversity. All three studies reached similar conclusions in that they identified the tussocky grass margin as having the highest soil biodiversity.

The work conducted in 2017 shows the two types of trap sample different species. Hypogean pitfall traps only sample organisms that are active within the soil profile. Hibernating and/or aestivating species will not be sampled until they resume activity. The occurrence of juveniles in the catches, as was the case with the millipedes, centipedes and woodlice, is indicative of the reproductive phases of an organism's lifecycle. So hypogean pitfall traps can provide data on when activity, growth and/or reproduction are occurring. Furthermore, they have the potential to assess biodiversity at different depths throughout the soil, and to provide data on migration through the soil profile.

The use of hypogean pitfall traps by coleopterists clearly has great potential for biological recording, survey work and conservation where saproxylic species are concerned (Telfer 2011a, 2011b). Flight interception traps may also be used, but will only sample those organisms that are actively flying. Hence their efficiency is greatly affected by adverse weather conditions such as wind, rain and temperature. The only adverse weather to affect hypogean pitfall traps has been found to be excessive rainfall, when flooding can occur, this posing a similar problem for epigean pitfall traps.

When it comes to assessing or monitoring soil biodiversity, the use of hypogean pitfall traps avoids some of the biases associated with epigean pitfall traps that have been identified by various workers. Once installed, they can be operated for prolonged periods with minimal maintenance, producing extensive data sets from precisely located sites. Consequently, they would be useful for the Field Studies Council's Soil Mesofauna Project (Burkmar & Bell, 2015), as once deployed they require little effort to sample and can be run for extensive periods (years) with minimal maintenance. They also avoid the problems associated with destructive repeat sampling when using Tullgren funnel extractions of field-collected soil samples.

It appears that the best time to use hypogean traps for assessing soil biodiversity in the UK is from early April to the end of September, and that Collembola, Coleoptera and Acari are good indicators of soil biodiversity due to their persistently high biodiversity

index scores, regardless of season. They have been shown to be effective at sampling the macrofauna (myriapods, isopods, ants, etc.) and mesofauna (Collembola and mites), but are less effective for the microfauna (nematodes, copepods, etc.) (Sims, 2018).

The use of baited traps has not been explored, but this raises the interesting possibility of selectively recording hypogean scavengers such as Formicidae (Schmidt & Solar, 2010), carabids, staphylinids and gastropods. In such situations traps may need to be emptied more frequently, perhaps daily, to prevent predation, but in doing so it would be possible to return the catch to the study site alive after non-lethal identification.

These case studies demonstrate both the importance of hypogean pitfall trapping for assessing soil biodiversity and the potential richness of soil-dwelling invertebrates under arable field margins. This is important as field margins, be they grassy or floristically enhanced, are one of the key strategies of Entry Level and Higher Level environmental stewardship schemes. It is to be hoped that such schemes, or something like them, would continue if Britain were to leave the European Union.

With 2015 being the International Year of Soils (UN, 2013), it was truly astonishing that more than 6,000 animals had been collected from a couple of small "holes in the ground" over the course of the previous year. Of course, two thirds of these were springtails!

Acknowledgements

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Society News

Fig. 1. Grazing on Daneway Banks: (left) Cotswold, Norfolk and Wiltshire Horn sheep in winter (© Alan Sumnall). (right) Welsh Mountain ponies, 8th May 2018, shortly before grazing ceased for the summer. Note the abundant *Lasius flavus* mounds and numerous cowslips (© Jeremy Thomas). The scuffed track in the right foreground provides excellent breeding habitat for the Downland Villa beefly, *Villa cingulata*.

News from Daneway Banks SSSI: 2017-18

Major population of Rugged Oil beetle breeding across our new nature reserve

Jeremy Thomas, David Simcox, Sarah Meredith, Anna Pugh, Mark Greaves, Alan Sumnall

Much has happened at Daneway Banks since the RES announced the purchase in 2016 of our first nature reserve, in co-ownership with the Gloucestershire Wildlife Trust (GWT) who manage the site to our mutual aims (Thomas 2017). During 2017-18, these 40 acres of prime Cotswold grassland were again grazed to perfection for its distinctive limestone species, with much of the land close-cropped between autumn and spring to create a short sward that is then left fallow during May to September, allowing flowers to bloom and seed and insects to breed (Fig. 1). Amongst this, a mosaic of smaller sub-areas are being rotated or maintained as mid-successional to taller swards to encourage – among much else – the thriving colony of Liquorice Piercer moth and the hoped for return of the Duke of Burgundy butterfly. That this has been possible is in no small part due to the installation of new high-quality fencing generously funded by grants from Grundon Waste Disposal, and to an additional water supply at the lower edge of the reserve donated by our neighbour Nick Spencer of Daneway House. In addition, GWT land manager Alan Sumnall has made a great start on coppicing a 2 acre strip of hazel and blackthorn scrub, with the aim of enticing Dormice and Pearl-bordered fritillaries to cross from neighbouring Siccaridge Wood to breed here. Selected highlights from the past two seasons are described below.

Plants

The flora was again diverse and stunning in 2018, despite die-back from drought in July and August. Before that, cowslips bloomed in greater abundance than ever and there was the usual fine display of orchids, including a stand of flowering Greater butterfly orchid that had lain dormant before the coppicing. Tens of Frog orchid and a few hundred Green-winged orchids bloomed on the upper stretch beyond the dew-pond, and nearer the gate was the usual show of Cut-leaved Self-Heal, one of our two extreme national rarities among plants. The other, known from just six UK sites, is the Cut-leaved Germander. For many years this biennial labiate of disturbed skeletal soils persisted as one

Fig. 2. Green-winged orchids on the upper strip of Daneway, May 2018 (© Jeremy Thomas)

or two plants in the far eastern compartment before disappearing for a decade. It re-appeared in fair numbers on spoils after the dew-pond was excavated in 2010 before again dying back in 2016-17. Happily, more than two hundred new small plants were found in autumn 2018 as the flora grew back from the parched sward once rains had broken the summer's drought: we expect a fine display of flowers in the summers of 2019-20.

Insects

Highlights since the previous report include large emergences in 2018 of the rare Downland Villa bee fly and of Dark Green fritillary, White-letter hairstreak, Small blue and Large blue butterflies, the last increasing by 80% and emigrating to lay eggs on three neighbouring sites. However, due to the summer drought and over-crowding of its caterpillars in *Myrmica sabuleti* ant nests, we expect Large blue numbers to fall back to 2016-17 levels or lower in 2019. Many visitors enjoyed seeing Large blues in 2018, including HRH The Prince of Wales on a successful return visit, having failed to see it (due to a late date and overcast weather) during his official opening of Daneway two years earlier. Many appreciative tweets were posted on the ukbutterflies.co.uk and other websites, including a wry comment by Mark Tutton: "*a fabulous trip to Daneway this year and saw good numbers* [of Large blue] *but experienced a beautiful female taken in the act of egg laying by the equally rare - if not more so - Downland Robberfly* Machimus rusticus *which is listed as Vulnerable. The robberfly is quite large 25mm but dropped its prey as I tried to photograph it and left me with a very sad corpse - hopefully she had done her work. There were certainly plenty of other specimens at this fabulous site*."

Extrapolating from the diversity of plants and Lepidoptera, we previously estimated that the number of insect species inhabiting Daneway could be in the low thousands, with the majority yet to be discovered (Thomas 2017): the Downland robber fly is a welcome new record. A start towards a fuller inventory was made by Dr Nigel Spring's EuCan volunteers, who trapped 196 species of moth on 30th June – 2nd July 2017, of which four are Nationally Scarce and a further 31 locally distributed. In mid July, Dr Alan Stewart briefly surveyed the Auchenorryncha, Heteroptera and Orthoptera, discovering 47 species in two hours, a "*list of hoppers [that] is remarkably long*", including *Batracomorphus irroratus* and *Ribautodelphax pungens*, two very local species of Auchenorryncha.

The Rugged Oil beetle *Meloe rugosus*

The stand-out find of 2017-18 has been the discovery of a large colony of Rugged Oil beetle, *Meloe rugosus* breeding in numerous spots across the upper half of Daneway Banks. The first record was of its louse-like first instar larvae (triungulins) on May 2nd 2017, made by co-authors Anna Pugh and Mark Greaves, on whose observations this account is based. The adult stage is also elusive, being nocturnal and out in late autumn to early spring, but was found by Alan Sumnall and GWT volunteers Amanda Cox and Nick Rohrerin during the last two autumns, with an exceptionally high number (for this species) of 11 sightings in one evening near the dew pond in 2018.

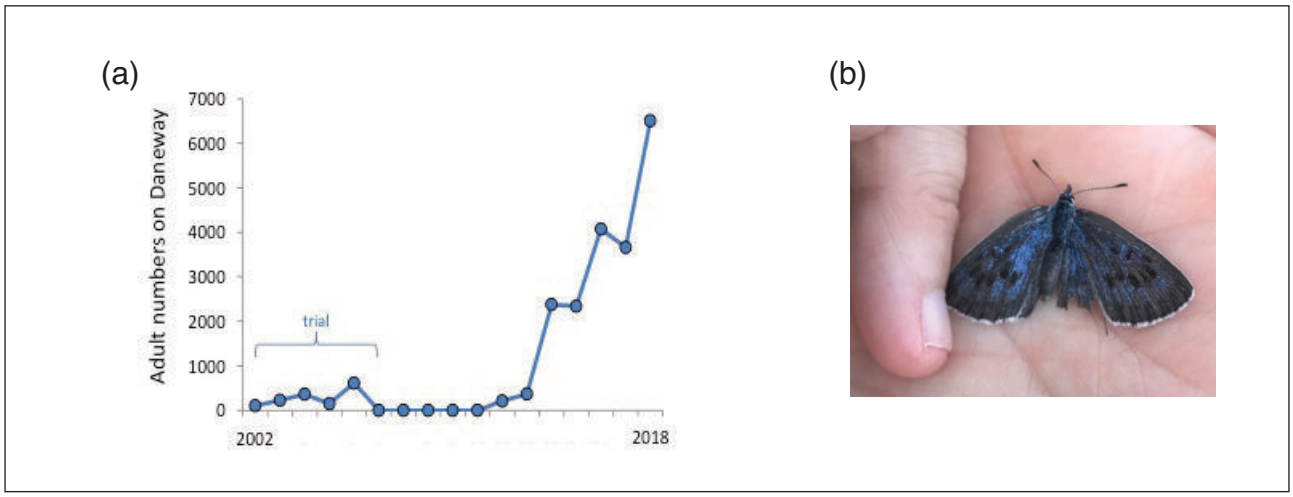

Fig. 3(a) Growth in the population of the Large blue butterfly *Maculinea arion* since its re-introduction from Somerset to Daneway Banks. (b) Prey to the Downland robber fly (© Mark Tutton).

Fig. 4. Rugged Oil beetles (©Amanda Cox) on Daneway Banks, autumn 2018. The individual with extended abdomen, bottom left, is a gravid female ready to lay eggs in loose soil within her limited walking distance.

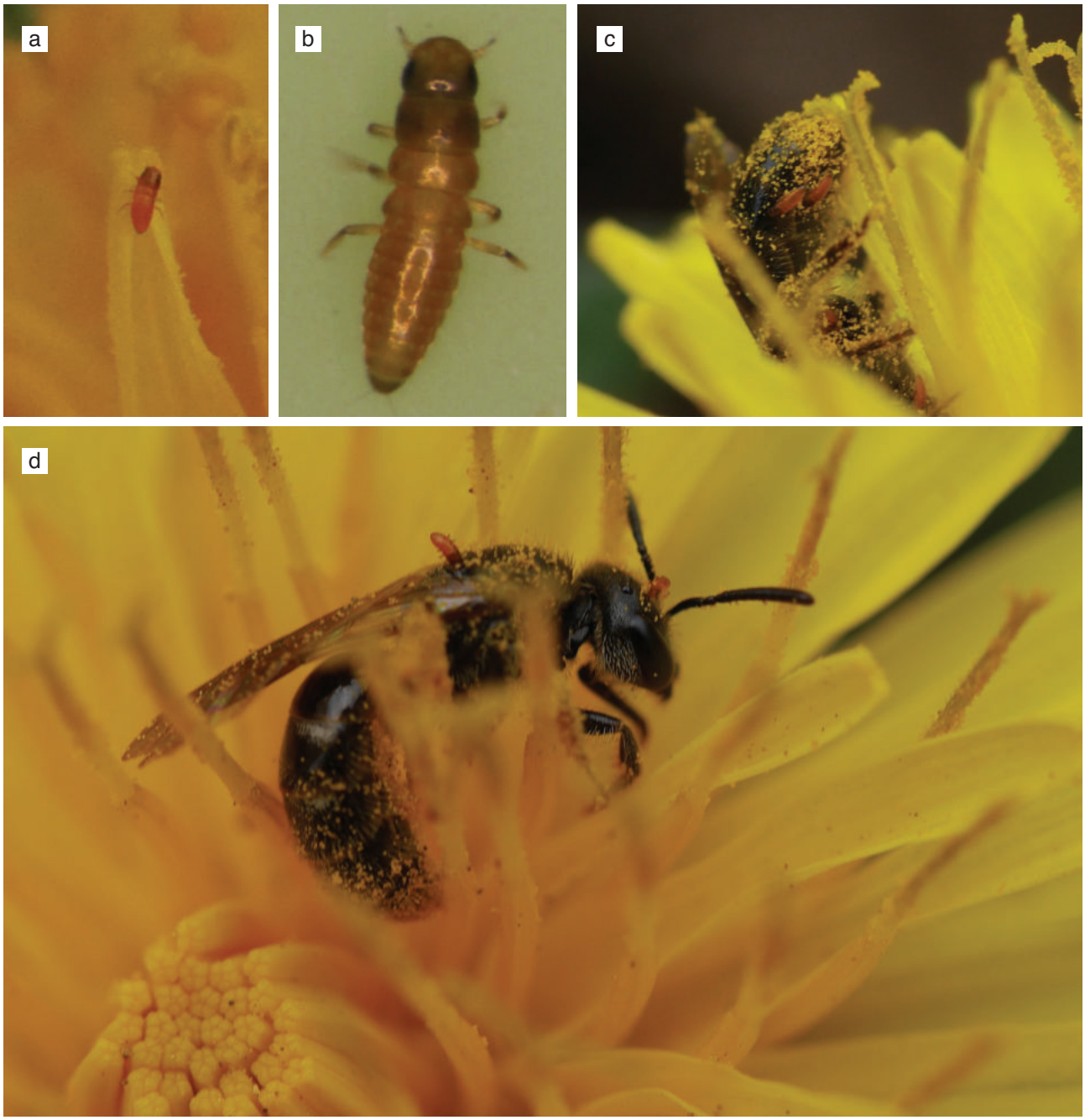

Fig. 5. Rugged Oil beetle triungulins (first larval instars) on Daneway, 2017(©Anna Pugh and Mark Greaves). (a) Exposed triungulin waiting to hitch a ride on a solitary bee. (b) Close-up: the triungulins of each UK species are distinctive; those of the Rugged Oil beetle are tiny (~0.5 mm) with an orange body, dark brown head and dark tip to the abdomen. (c, d) Two *Lasioglossum calceatum*, an abundant sweat-bee, that have acquired four (c) and two (d) triungulins attached to them while foraging for pollen and nectar on Dandelions.

Meloe rugosus is one of five species of Oil beetle currently known in the UK, although three additional species were recorded in the 19th century. Violet and Black Oil beetles are comparatively widespread, but distinctly local; the others, including the Rugged Oil beetle, are exceedingly rare. All, so far as is known, are kleptoparasites whose larvae feed mainly on pollen stored in the breeding chambers of solitary or primitively eusocial mining bees. Both sexes of adult are flightless and distinguishable from similar-looking beetles by their "*limp wing-cases yawning over their backs like the tails of a fat man's coat that is far too tight for its wearer*" (Fabre 1919). Excellent illustrated accounts of the generic life-cycle, identification (including Fabre's descriptions) and status of UK Oil beetles are provided by Ramsey (2002) and by UK expert John Walters on https://www.buglife.org.uk/activities-for-you/wildlife-surveys/oil-beetle-hunt.

Like other Oil beetles, female *Meloe rugosus* (Fig. 4) lay eggs in loose soil in short open turf containing disturbed ground with local poaching from livestock. These hatch over a short period in early to mid-May, emerging as triungulins which climb into open flowers, mainly Dandelions (95% of individuals found), Buttercups, and Mouse-ear hawkweed on Daneway.

In dull weather, the triungulins lie hidden deep within their flower, but in sunshine or at the slightest vibration, they climb to the tips of the flower (Fig. 5(a)) to await a solitary bee collecting nectar and pollen. It soon

also collects triungulins, which we found - in this species of Oil beetle - attached to their host not by the three-pronged tarsal claws that give the instar its name, but by their jaws (Fig 5d). It is assumed that they then behave like other species of Oil beetle, and detach themselves on reaching the subterranean chambers that the bee is filling with pollen for its own progeny, before eating the bee's eggs and living underground as a kleptoparasite for six months, feeding on the resources provided by their host.

Very little is known about the ecology of the Rugged Oil beetle, least of all which species of bee it exploits. On Daneway and nearby Sheepscombe, Anna Pugh and Mark Greaves found triungulins attached to two species of solitary bee: *Lasioglossum calceatum* on three occasions, and *Halictus tumulorum* once at Sheepscombe. Both are in the family Halictidae known as sweat bees. Both are primitively eusocial, with each burrow containing several radiating cells filled with pollen, each housing a separate batch of eggs that probably form the triungulin's first meal. *Lasioglossum calceatum* is especially abundant on Daneway, and appears to benefit from the regime of winter grazing and scuffing by ponies and sheep (Fig. 1) introduced to create 'Large blue habitat'. These observations do not prove that *L. calceatum* and/or *H. tumulorum* are the only, or even actual, hosts of the Rugged Oil beetle – after all, Large blue butterfly larvae are adopted by any species of *Myrmica* ant but survive only with *M. sabuleti* – but they are an intriguing pointer inasmuch as, to our knowledge, these are the first records for this beetle as to which host(s) may be involved.

Anna Pugh and Mark Greaves also made a survey of triungulins across the whole of Daneway on the 12th-13th May 2018, examining 346 plants. In all, they found 51 triungulins on 35 plants, most across the top section between the western gate and Adder Bank at the east end, where 37 triungulins were counted on 23 flowers (108 plants sampled). These densities are similar to those in the best areas of nearby Sheepscombe where they found 42 triungulins on 26 out of 147 plants sampled in May 2017. On Daneway, the triungulins were well distributed across the whole top section, whereas on Sheepscombe they are confined to three local areas. Since adult females are flightless and comparatively sedentary, we infer that a major population of Rugged Oil beetle breeds on Daneway, the more so since Sheepscombe supports one of its largest known populations in the UK (Hackman 2017, 2018). In total, 29 sites in eight southern UK landscapes have confirmed records of this beetle (nbnatlas website), with the Stroud-Cirencester-Gloucester triangle of limestone grasslands providing nine of them [thanks to surveys in 2015-17 by Anna and Mark (new records for Daneway, Sheepscombe, Bulls Cross, Juniper Hill) and Jo Hackman's team at Natural England (Edge Common, Cranham Common, Painswick Beacon) adding to the historical Cotswold localities of Swifts Hill and Strawberry Banks]. With more surveys in progress by BugLife's Back-from-the-Brink team, we may hope that additional colonies of this fascinating insect will be found in this region on other sites that are also being restored to early-seral herb-rich grassland following decades of abandonment and dominance by tall swards of *Brachypodium pinnatum*. Meanwhile, together with the Gloucestershire Wildlife Trust (which owns three other Cotswold Rugged Oil beetle sites), the RES will seek to learn more of the ecology of this strangely beautiful insect, to enable us to maintain the nationally important population breeding at Daneway Banks.

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The Congress venue, the Stazione Marittima Centre, with the cruise ship '*Symphony of the Seas*'.

The European Congress of Entomology in Naples

Archie Murchie

Writing this on a dreich, dark November day in Belfast, it is a pleasure to look back on the glorious summer and the European Congress of Entomology held over 5 days, 2nd – 6th July 2018, in Naples. The Congress was the largest ever with almost 1,000 delegates from 65 countries presenting 460 talks and 560 posters. It was held in the highly impressive, but somewhat unusual, setting of the Stazione Marittima Congress Centre, which shares the venue with the cruise ship terminal. It was a curious experience to exit the Congress and be completely overshadowed by a giant ship, including on one day the *Symphony of the Seas*, the largest cruise ship in the world.

The Stazione Marittima proved itself to be an excellent venue with a large central hall for plenaries with five smaller halls for parallel sessions immediately opposite. In the corridor between was space for exhibitors, including the RES stand. There was therefore good footfall and constant interest in the Society's journals and activities. We were fortunate as well that our publishers, Wiley, were allocated an adjacent stand. Posters were displayed in a large, airy central hall, which also served as the location for the buffet lunches and coffee.

The Congress followed the format of typically starting with a plenary lecture and then dividing up into six parallel sessions. Within each session, speakers were allocated 15 minutes, or 30 minutes for a keynote presentation. As expected for such a Congress, the range of topics was considerable with a total of 54 sessions covering all aspects of entomology. The Congress used the 'Whova' mobile phone app, which soon proved an invaluable tool for navigating the Congress sessions and also provided a good means for delegates and the convenors to communicate.

The RES was well represented at the Congress and acknowledged as Congress sponsors. I had the privilege of speaking on behalf of the Congress Praesidium during the opening ceremony, whilst three former Presidents, our current Vice-President and many Fellows/Members presented or chaired sessions. The Society was given the opportunity by the Congress convenors to jointly present, with Andrew Polaszek of the Natural History Museum, the Westwood Medals to Frank Hennemann, Oskar Conle, Paul Brock and Francis Seow-Choen, who gave gracious and amusing acceptance speeches outlining their reasons for working on the taxonomy of Phasmatodea*.

As we know, a successful conference is judged not only on its scientific content but also its food. Naples did not disappoint. The Congress dinner was held on the seafront of Naples at the Bagno Elena Beach Resort, which provided a beautiful setting looking over the bay. A few brave souls even took the opportunity of a night-time dip in the sea, whilst the proximity of the Congress centre to central Naples allowed all delegates to visit the many restaurants close to the venue and off the main thoroughfare of the Via Toledo.

After the Congress was finished my family came over for a week's holiday. We stayed in the Centro Storico, which is Naples' Historic Old Town and a UNESCO World Heritage Site. It is jam-packed full of architectural history, Baroque churches and Roman-Greco

* Westwood Medals awarded for this monograph: Revision of the Oriental subfamily Heteropteryginae Kirby, 1896, with a re-arrangement of the family Heteropterygidae and the descriptions of five new species of Haaniella Kirby, 1904. (Phasmatodea: Areolatae: Heteropterygidae). *Zootaxa* **4159**: 1-219.

The Society's information stand at the ECE manned by Luke, Kirsty and Fran.

Presentation of the Westwood Medals for excellence in taxonomy to Francis Seow-Choen, Frank Hennemann, Paul Brock and Oskar Conle by Andrew Polaszek, Natural History Museum (far left), and Archie Murchie, RES / AFBI (far right).

The Congress dinner was held on the Naples beach front.

The Oriental hornet, *Vespa orientalis*, having a drink at a water fountain in Pompeii.

The city of Naples with Mount Vesuvius in the background.

The commonest mode of transport in downtown Naples – the scooter.

Other photos of the Congress are available at www.ece2018.com/photogallery/

Plenary speakers**		
Francesca Barbero	University of Turin	Eavesdropping on communication among ants, butterflies, and plants
Rolf Georg Beutel	FSU Jena	The phylogeny of Hexapoda and the evolution of megadiversity
Andrea Crisanti	Imperial College London	Editing population genetics for vector control
Marcel Dicke	Wageningen University	Multitrophic plant-insect-microbe interactions
Angela Douglas	Cornell University	How insects manage their microbes
Teja Tscharntke	University of Göttingen	Integrating biodiversity services in agriculture

** most presentations available on www.ece2018.com

Main topics covered during the Congress	
Agricultural and Forest Entomology	Behaviour
Biological Control and Integrated Pest Management	Chemical Ecology and Multitrophic Interactions
Ecology and Toxicology of Insecticides	Ecology, Biodiversity and Conservation
Genetics and Evolutionary Biology	Insect Control Biotechnology
Insects and Global Food Production	Medical and Veterinary Entomology
Morphology, Systematics and Phylogeny	Parasitology, Pathology and Immunity
Physiology and Biochemistry	Social Insects and Apidology
Urban Entomology and Stored Product Protection	Symbiosis and Insect Vector Biology

ruins, some of which are buried under the present city and can be visited through subterranean tours. We also took the opportunity to climb Mount Vesuvius, take a trip out into the Bay of Naples to visit the island of Ischia and have a day-trip to the ancient ruins of Pompeii. At one drinking fountain in Pompeii, I noticed some additional visitors – the impressive Oriental hornet *Vespa orientalis*. Although not to be confused with *Vespa velutina* (the 'Asian' hornet), which is presently invading France and western Europe (with sporadic incursions into England), *V. orientalis* is nevertheless a predator of honeybees. Although indigenous (or at least long-established) in southern Italy, its appearance in the Campania region seems to have occurred within the last 10-15 years.

'Vespa' is also a name synonymous with the common mode of transport in Naples: the scooter. One of my most abiding memories was of trying to cross the road to get to the Congress. Mostly, I waited for a local who seemed to obliviously step out into the traffic, mobile phone in hand, and wade through a sea of scooters. Having an interest in motorbikes, I was amazed to see the diversity of scooter rider, from a family of four on a single scooter, an old man carrying shopping bags wrapped round the handlebars, to an immaculately-dressed Sophia Loren lookalike poised and the picture of Italian chic.

Naples and her Universities and Institutes have a long and rich entomological history. In her plenary lecture, Angela Douglas spoke about the connections between Naples and Paul Buchner, sometimes referred to as 'the founder of systematic symbiosis research', who was inspired initially by lectures by Prof. Umberto Pierantoni at the University of Naples Federico II, who lived for many years on Ischia. I was reminded as well of our late President Dame Miriam Rothschild's Desert Island Discs interview on BBC Radio 4 when she reminisced about her time at the Stazione Zoologica (Naples Zoological Station) in the 1950s and spoke of the romance of Naples and the surrounding countryside. I like to think that the 2018 European Congress of Entomology continued and enhanced that Neapolitan entomological tradition. For that, we are grateful to the organisers and hosts. In particular, we should thank the chairs, Profs Francesco Pennacchio and Romano Dallai, of the Società Entomologica Italiana and the Accademia Nazionale Italiana di Entomologia, as well as the conference manager, Ms Marina Morra, of Event Planet.

The 12th European Congress of Entomology will be in Crete 2022, hosted by the Hellenic Entomological Society and convened by Emmanouil Roditakis and Stefanos Andreadis.

Flying in Africa – 9th International Congress of Dipterology, Namibia

Peter S. Cranston
Honorary Professor, Australian National University, Canberra

1. Ashley Kirk-Spriggs at the ICD reception; 2. Official launch of the *Manual of Afrotropical Diptera*; 3. *Litoria barringtonensis* frog with feeding *Sycorax* flies. Photo Narelle Power.

Introduction

In late November 2018, 300 aficionados of flies (order Diptera) assembled in Windhoek, the capital of Namibia, for the 9th meeting of the International Congresses of Dipterology (ICD), held for the first time in Africa.

So why Namibia? Our host, Ashley Kirk-Spriggs (Fig. 1), originally from Wales, had been employed in Namibia although was now based in the National Museum, Bloemfontein, in South Africa. Ash continues to expose truly unexpected elements in the fly fauna of this arid country. Fellow dipterists were enthusiastic to visit and participate in the meeting and to investigate the local biodiversity: many came early and / or stayed on later to explore.

The conference included the book launch of the *Manual of Afrotropical Diptera* (Fig. 2), a multi-authored total overview of the order, a decade-long in preparation but now with the first two volumes completed and free to download (or available at a modest price for hardback editions). Editors Ashley Kirk-Spriggs and Bradley Sinclair (Canadian Food Inspection Agency, Ottawa) obtained substantial sponsorship for the project, enabling appropriate inexpensive dissemination (see www.afrotropicalmanual.org for further details). Recall the high diversity of medically-significant flies in Africa and for this reason alone the widest community will welcome this authoritative work.

A second conference event bringing all delegates together was a public lecture introducing 'the year of the fly', that is, 2019. This was due to be presented by Steve Marshall, author of the magnificent and definitive '*Flies: The Natural History and Diversity of Diptera*' (2012, Firefly Books). However, Steve was unable to attend, and at very short notice his Canadian colleague Jeff Skevington (Canadian National Insect Collection, Ottawa) took over the presentation accompanied by Steve's beautiful photographs.

4. Student oral presentation prize winner Jessica Gillung at the podium; 5. Runner-up poster presentation Xuankun Li beside his poster.

6-8. Photographic prize winners, see text for details.

The scientific sessions

With four concurrent sessions it was not possible to attend all the presentations that I would have wished, so I'll start with acknowledging some I missed. First, a session on forensic entomology - thanks to CSI, we all know that fly larvae play an important role in decomposition. Molecular techniques and new analytical tools are making rapid advances in this field, as reviewed by plenary speaker Martin Hall (Natural History Museum, U.K.). I regretted also missing Adrian Pont's (Oxford University Museum of Natural History, U.K.) tribute to the life of the late Roger Crosskey, an honorary member of the ICD (see obituaries in *Antenna* 42: 87–93 and *Zootaxa* 4455: 35–67).

Dipterists are at the forefront of entomological phylogenomic studies and several sessions and posters were concerned with both 'new' results and methodological issues. A trite summary of these many presentations is that well-established evolutionary relationships, including those established on morphological data from all life stages, can be robust and appear also from mega-molecular datasets. Addition of the remarkable amount of novel data from genomics can lead to better support for traditional relationships, new insights, and yet can fail to provide guidance in areas of contention. Thus, more data are not necessarily better and we need insights into which subset of genes 'works best' and why conflicts remain and how to deal with them. The student prize-winner (see below) addressed some of these methodological issues.

By no means were systematists the dominant contributors. A fascinating half-day session concerned the biology and diversity of the frog-feeding flies (*Corethrella*, family Corethrellidae, and *Sycorax*, family Psychodidae). The females of these flies are mandibulate and feed on the blood of amphibians, with *Corethrella* locating their hosts by 'voice recognition'. The session was co-organised by Ximena Bernal (Purdue, USA) who in summary addressed the critical question of how the flies actually 'hear' their hosts calling. All other known insect 'hearing' morphologies can be eliminated, not least by the very small size of the flies with respect to the wavelength of the sounds that they respond to. An international, especially Brazilian, assembly of researchers assured the

audience that there is much unexplored diversity and studies must continue, including those by herpetologists. Coincidentally, during the meeting I was sent an image from an Australian herpetologist showing a hylid frog covered with *Sycorax* flies (Fig. 3). There remains much to be discovered in this world-wide special association.

Several interesting fly–plant interactions are well studied in southern Africa, including both pollination syndromes and phytophagy. An excellent plenary talk by Netta Dorchin (Tel Aviv University, Israel) on the potentially enormous taxonomic and ecological diversity of the Cecidomyiidae (gall midges) prepared us for presentations that included galling of the hyper-radiation of southern African succulents belonging to the family Aizoaceae. Genomic studies suggest that the astonishing species-richness of gall midges may be true of many other groups, some unexpected based on their morphological uniformity. Under the term 'open-ended' taxa, presentations on such megadiverse groups, and how to study them, were provided by several speakers.

A fascinating session convened by Kurt Jordaens (Royal Museum for Central Africa, Tervuren, Belgium) concerned long-proboscis flies and nectar-producing native flowers with long tubes or spurs. These 'long-tongued' flies belong to the families Nemestrinidae and a part of the austral radiation of the Tabanidae (horseflies). These 'coevolutionary systems' have been studied especially in southern Africa in seasonal rainfall areas of both western (summer dry) and eastern (summer wet) vegetation. However, an iconoclastic study in Cameroon presented by Ximo Mengual (Alexander König Museum, Bonn, Germany) showed that pollinator dynamics may be more 'fluid' than expected by 'coevolution': long-spurred plants may have sequential visitors. An *Impatiens* (balsam) species is visited early in the day by a short-proboscis syrphid when the spur is replete with nectar, but later in the morning an *Apis* (honeybee) drinks from the now half-empty spur. After noon, the depleted spur provides nectar that is accessible only to the long-tongued hoverfly *Rhingia mecyana* – yet all three visitors can pollinate. The generality of this requires further study but undermines the Darwinian view of an evolutionary 'arms race' between the plant and ever more specialised pollinators.

Another presentation, fortunately without associated olfactory delights, reviewed the diversity of flowers that produce luring smells of faeces, carrion, roadkill and the like. This is well known in the 'stapeliads', a group of stem succulents popular amongst cactus and succulent horticulturalists. They will know of the odour (giving rise to the name 'carrion flowers') and the range of blowflies and relatives lured to them. In the genus *Ceropegia*, the trap flowers are solely pollinated by flies, using a lock-and-key system that lures, traps and then releases the pollen-laden flies. The system involves only chemical mimicry with no reward provided.

Staying locally, one of the major tourist attractions in the karoo vegetation of western South Africa (Namaqualand) is a mass spring flowering of multi-coloured daisies. Pollination is largely by flies, notably *Megapalpus capensis*, a bombylid, with no bees involved. But what pollinates the invasive Namaqua daisy (*Arctotheca calendula*, 'capeweed') on Australian roadsides verges and grasslands, in the absence of the specific beefly? There is an honours project awaiting.

The prize-winners

The winning student talk from amongst many high-quality presentations was by Jessica Gillung (University of California, Davis) (Fig. 4) for "Phylogenetic relationships of spider flies (Acroceridae) and the perils of phylogenomics". Runner-up was her fellow Brazilian Diego A. Fachin (Universidad de São Paulo), with "A phylogeny of Sarginae (Stratiomyidae) – monophyly, new characters, species-rich genera and the problem of the Chrysochlorininae/ Hermetiinae".

From a large field, the poster competition was won by Isabel C. Kilian Salas (Alexander König Museum, Bonn, Germany) with "Barcoding Dipteran pollinator networks in agroecosystems", and the runner-up was Xuankun Li (Australian National Insect Collection, Canberra, Australia) with "Towards a revision of the Bombyliinae of Australia" (Fig. 5).

In the photography contest, Ana Gonçalves (Centre for Ecology, Evolution and Environmental Changes, Lisbon, Portugal) won with "*Anahydrophus cinereus* (Dolichopodidae) feeding on an amphipod" (Fig. 6), Steven Gaimari (California Department of Food and Agriculture, Sacramento) was awarded 2nd place for "Male of *Nothybus longicollis* (Nothybidae) from Sabah, Malaysia" (Fig. 7) and Nathan Butterworth (University of Wollongong, Australia) was 3rd for "*Acridophagus paganicus* (Mythicomyiidae) from Hobart, Australia" (Fig. 8). This latter fly was of particular interest in that it was re-encountered for the first time in 100 years to the day!

In conclusion, this fascinating meeting attracted geographically and scientifically diverse participants, notably from Brazil (well represented among the prize-winners) and from throughout sub-Saharan Africa. Fly research was showcased across the continent, worthy publicity was provided for the new regional *Manual*, and the 'year of the fly' was introduced. The scientific content was exceptional, due to a cadre of organisers for the many sessions. Congratulations especially to Ashley Kirk-Spriggs for all aspects of his bold and successful decision to stage such a meeting in Namibia. We look forward to the next meeting, to be hosted in California (or just over the border in Nevada) during a cooler month in 2022.

Acknowledgements

I thank the Royal Entomological Society, particularly Lin Field (Publications Officer), for supporting my registration associated with the promotion of two 'virtual' issues for the meeting. One issue showcased Diptera papers in *Systematic Entomology*, the other included two papers each from the remaining RES entomological journals. These promoted the full range of our journals to the wide Dipterological community, with all papers free to view and download from www.bit.ly/diptera. Many people willingly provided images, particularly the three winners of the photographic competition. Adrian Pont kindly assisted with information and reviewed a draft.

The original building at the RAU

Third Meeting of the Insects as Food and Feed SIG Insect Production

Royal Agricultural University, Cirencester
4th April 2018

Peter Smithers

Following the success of the previous two meetings the Insects as Food and Feed (IAFF) SIG was looking for a venue away from the South-East, so when the opportunity arose to hold the meeting at the Royal Agricultural University in Cirencester it was enthusiastically seized. The RAU has a long and distinguished history. It was established in 1845 when it was the first college of agriculture in the English-speaking world, a heritage that is only too obvious as one walks around the original buildings that now form the hub of this modern university. We had been fortunate indeed to be invited to hold our meeting on their campus. The day was chaired by Dr Mark Ramsden, following welcomes from the author on behalf of the RES and Prof David Hopkins from the RAU, with presentations summarised below.

The future for insect bioconversion products in poultry feed

Aidan Leek

Aiden discussed the impact that insects will make to the animal feed market. Insect-based feeds for fish have been approved and it is expected that their use for poultry and pig feed will follow shortly. Pet food will also be an important, but niche, player in the industry. Meal worm and black soldier fly are the likely candidates as animal feed supplements, but kelp fly is also being explored in Scotland. The choice of substrate that the insects feed on is vital as it will determine the fatty acid and amino acid content of the final product. Recent research has shown that the use of insect products can result in a reduction in the use of antibiotics. Insect products are high in lauric acid, which has been shown to inhibit fungal pathogens, and chitin has been shown to possess probiotic properties. Anti-microbial polypeptides (AMP's) are also potentially extremely useful, with 150 AMPs found in insects to date. The main challenges are the production cost, consistency and quality of supply, plus identifying appropriate sources of material to act as insect feed.

Pest risk analysis of black soldier fly (BSF): overcoming hurdles to its use for livestock feed

Archie Murchie

Many introduced insects have become a problem, so careful consideration is given to any new insect, including this one. With black soldier fly the larvae feed on dung, carrion and other decaying organic materials while the

IAFF SIG in session.

adults only feed on nectar. Therefore, if it escaped into the wild the larvae would most likely establish in dung and compost heaps which are currently not of conservational concern. It is native to south-eastern USA and became established in Europe in Malta in the 1930's, but is now a cosmopolitan species that is distributed across southern and central Europe. As the larvae can only tolerate a few days at 0°C, develop at 15°C and require 346 degree days to complete development, the current climate change models predict that it will remain a southern European species in the near future. The only real risk would be as a competitor with native flies in dung and compost systems. There is no evidence of disease transmission, it has few parasitoids, is not attracted to human habitation, and could also be an important pollinator.

Northern Ireland produces large volumes of animal waste (12 million tons of animal excreta) and 450,000 tons of organic household waste, so this offers great potential as BSF feed. There are concerns about consumer perceptions of insect-fed poultry, but if insect protein is compared with fish meal it is more sustainable and environmentally-friendly. The use of poultry litter as a feed is also being explored, using BSF to process it initially, followed by sending the remaining product for aerobic digestion. Heat generated by the digester can then be fed back into insect production.

A possible model for Ireland would be a satellite system, with a central breeding house producing eggs that are sent out to satellite units which use larvae to process various materials.

Grubby politics: lobby strategies to put insects on the table and in the trough

Vicki Hird

This talk outlined how to promote IAFF to people who might influence whether we can carry on doing it. Lobbying depends on research and evidence, political leverage and a certain amount of luck. Political allies are important, but it must be remembered that they are easily lost as politics is an inconstant arena; politicians can switch allegiance or be removed from power.

Work is ongoing towards a new legislative framework for IAFF and therefore policy support is needed. To do this we need Ministers visiting IAFF facilities and Westminster debates on IAFF. MPs can often be attracted to meetings with celebrity advocates, plus food and wine.

We need to be aware of the alternatives, and be able to compare them with IAFF. The Committee on Climate Change is now looking at agriculture, so it is important to talk to them. Making the case for IAFF is not just a matter of presenting evidence – it is knowing what you want or need to say and presenting it as a conversation, not a broadcast.

Insects as food is likely to remain a niche market, but feed is a growing arena. At the moment, it does not feel as if IAFF will be a big political issue. Young people are far more concerned about what they eat so are likely to exert a greater influence on the decision makers, so target them.

The industry should be prepared for good and bad press moments and have a rapid response strategy if things go wrong. We should get to know who in Westminster to approach for support, and we should all talk to our local MPs.

Legislation regarding insects as food and feed

Rachel O'Connor & Freya Lemon

Food

The legislation regarding insects as food was piecemeal until January 2018, when the new novel food regulations from the EU came into being. These now include whole insects and their parts as novel foods. 'Novel foods' are any food not used for human consumption in Europe before 1997.

The European Union has a list of approved insect food species. To gain approval, the applicant must demonstrate that there is no risk to human health. If it is replacing an existing food the new food must possess the same nutritional properties. All of these applications are in the public domain. Insects already on the market have a grace period until 2020 in which to gain approval.

Local authorities and the Food Standards Agency now have the power to inspect novel food producers and close them down if they are not conforming to the regulations.

Delegates enjoy lunch.

Feed

Feed legislation is lagging behind the legislation for insects as food. New sustainable ways to feed livestock are needed, and insects are seen as a viable alternative to soya meal, the current preferred source of protein for this sector.

Current legislation is a result of the 2001 BSE crisis. It prohibits the use of processed animal protein, meat and bone meal in animal feed. Insects have been caught by these regulations which were never intended to cover them.

In 2013 the EU introduced an exception for non-ruminant animal protein in aquaculture. However, this legislation did not take insects into account. In July 2017 the EU passed legislation which permitted the use of 7 species of insect in aquaculture and the slaughter house provision (this decreed that any farmed insect should be taken to a certified slaughter house to be killed) has been removed. Even so, there are many restrictions regarding what insects can be fed on if they are to be used as feed for animals destined for human consumption.

The EU is looking to approve insects as feed for poultry and pigs. The European Food Standards Agency has been mandated to conduct a risk assessment of insects as poultry feed and the EU may initiate another for pig feed in the near future. Regarding Brexit, it is vital that the UK harmonises its feed law with EU law before Brexit, as UK law currently does not allow insects as feed.

Innovation

Ali Hadavizadeh
(Program Manager at Farm 491)

Farm 491 offers start-ups help to develop their ideas and build a business case around them.

It has four hundred and ninety-one hectares of farmland to act as experimental plots, plus office space, meeting rooms and business support. Farm 491 also runs boot camps where a small number of start-ups are corralled with a range of expertise to produce viable business plans. Their website is https://farm491.com.

Woven

Nick Rousseau

Woven is a network for the 'insects as food and feed' industry and seeks to act as a hub for advice and discussion. It is looking for new members, as the larger the membership the greater the diversity of expertise the network can offer. Their website is https://woven-network.co.uk.

Following the above talks, and lunch, the meeting split into two groups to discuss insects as food and insects as feed. These were open discussions with many of the participants outlining their strategies and exchanging ideas and information. This then dissolved into more informal discussion groups before adjourning to the bar in preparation for dinner.

The dinner, which was kindly sponsored by Michelmores, was held in the main dining room in the original building, which added a grand atmosphere to the event. There were lively discussions in the bar prior to and during the meal.

Unfortunately, Sarah Beynon had been taken ill the day before and so was unable to deliver the after-dinner talk, but the author offered a talk he had delivered at the ECE in York on 'Insects in Advertising'. This outlined the way that insects are used to brand a range of products and explored the various responses that the adverts invoked. It explored the idea that insects are used in a positive sense by the advertising industry and that we might tap into this to market insects as food and feed.

The company then disbanded, with some retiring to bed after a hectic day while a determined group of delegates were ushered to the student bar to continue their discussions.

The day had been a great success and as a result it was agreed that the 2019 meeting (April 2nd & 3rd) would be a two-day event, with a day each on insects as food and insects as feed.

We would like to thank The Royal Agricultural University for offering us their excellent facilities and making us all very welcome, and Michelmores for generously sponsoring the meal. A vote of thanks also to the rest of the organising team, Mark Ramsden (ADAS/RES), Rachel O'Connor (Michelmores), James Wright (Multibox) and Kirsty Whiteford (RES).

Alfred Russel Wallace Award 2018

The RES's Wallace Award was created to recognise "post-graduates who have been awarded a PhD, and whose work is considered by their supervisory team to be outstanding". As in previous years all 2018 applications ably met these criteria, with three finalists submitting their theses in full and being invited to present their work to a panel of judges who gathered at Mansion House in early March. Dr Andrew Lucas and Dr Ellen Moss presented their theses in person, with Dr Patrick Rohner delivering an overview of his work via Skype. All finalists greatly impressed the judges, though after some deliberation a clear winner emerged in Dr Patrick Rohner, for his thesis 'Sex, size and growth determination: Why are female insects more strongly affected by malnutrition?' Our congratulations go to Patrick, as well as to our two runners-up. Summaries of all three finalists' work are provided below.

Dave George (on behalf of the 2018 judging panel)

Finalist and overall winner:

Dr Patrick Rohner

Awarding institution: University of Zurich, Switzerland

Sex, size and growth determination: Why are female insects more strongly affected by malnutrition?

Body size is a highly variable trait that most closely relates to an insect's performance. Large individuals generally have more offspring, live longer, and are better at acquiring resources. However, growing large typically also imposes costs in terms of increased predation risk and a higher resource demand. Hence, depending on the environmental conditions, insects are expected to adjust their growth to maximize their adult performance. Nevertheless, our understanding of how size and growth react to environmental quality remains limited. This is because body size is a particularly complex trait influenced by many genes and a multitude of molecular pathways. Body size is also fundamentally entwined with many other critical traits such as development, reproduction and survival. It is therefore difficult to link the evolutionary drivers of body size variation to their underlying mechanisms.

In six chapters, this dissertation sought to integrate different biological sub-disciplines, ranging from physiology to macroecology, to acquire a more complete understanding of how body size evolves and why it varies so strongly among insects. Particular attention was given to the interplay between selection, sex roles and growth strategies in mediating the large variation in insect size.

For instance, previous research has shown that female body size reacts more strongly to malnutrition than male size. However, because females are also the larger sex in most of the insect species examined, it is impossible to tell whether the stronger dependence of female size on food is the result of being female or simply of being larger compared to males. Taking advantage of those rare cases where males evolved to become larger than females enabled investigation of whether females really respond more strongly to food shortage or whether this is mostly due to size itself. Detailed within-species analyses in several fly species, and between-species comparisons across a broad range of other insects, revealed that the larger sex generally reacts more strongly to food shortage. That is, whichever sex is larger is also more susceptible to environmental perturbance and that this reaction is not dependent on belonging to the female sex. In other words, the larger sex is under more intense selection to maximize adult body size due to greater fitness consequence and reacts accordingly. A laboratory study on the yellow dung fly further revealed that "critical weight", one of the major mechanisms in size determination, plays a major role in shaping body size differences between sexes and the sex-specific response to resource limitation. This reveals the complex interplay between selection acting on adult individuals and sex-specific larval physiology and size determination systems.

As a whole, these studies suggest that size differences between the sexes are mostly driven by differences in the way males and females react to environmental conditions, placing novel emphasis on size determination systems and their dependence on the environment. Because body size has major impact on an individual's performance, these findings are useful in predicting the fate of insects facing environmental change.

Finalist:

Dr Andrew Lucas

Awarding Institution: Swansea University, Wales

Hoverfly communities in semi-natural grasslands, and their role in pollination

A third of crop production depends on animals – and that's mostly insects – for pollination. Yet because of habitat loss, pesticides and diseases, pollinators are in trouble. There just aren't enough insects to go around…

Hoverflies are flies just like the familiar bluebottle, but many look

remarkably like bees or wasps to frighten predators. And just like bees, they feed almost exclusively on nectar and pollen, collected from flowers. This makes hoverflies potential pollinators of a range of crops and wild plants.

I studied hoverflies in rhôs pastures, an iconic Welsh habitat. These wet grasslands support a variety of plants which provide food for hoverflies, that can in turn also pollinate plants and crops in the wider countryside. My work found that rhôs pastures supported a distinctive community of hoverflies but, to increase the abundance and number of species of hoverflies, careful management by light grazing is required to maximise the number of flowers. Weather was also important, with hoverflies preferring conditions that are not too hot or too cold, and not too wet or too dry. This has implications for hoverflies as climate change progresses.

Because they are significant pollinators, monitoring hoverflies is vital, yet many species can be difficult to identify. To advance molecular identification methods for this important group I sequenced a standard section of DNA from over 200 hoverflies of 85 British species. These were added to other hoverfly sequences that had already been published, with the resulting sequence set used to determine how effectively this molecular methodology could tell species apart. Almost all species could be discriminated, suggesting that DNA is a practical tool to identify hoverflies without the need for time-consuming work by expert taxonomists.

But what plants are hoverflies visiting? Thanks to pioneering work at its National Botanic Garden, Wales was the first country to have a DNA database of all its plants. I extracted DNA from pollen carried by hoverflies and compared it to this database. This provided new insights into how hoverflies transport pollen. The results revealed that hoverflies visit a wide variety of plants, but individuals seem to specialise, so a hoverfly that has visited a bramble flower is more likely to immediately go to another bramble flower than any other plant species. When comparing the pollen loads of 11 different species, I found that, although they visited similar flowers, pollen loads were subtly different between species. This suggests that it is important to have the full range of hoverfly species present to ensure effective pollination.

These results add to our current knowledge on hoverfly pollination networks, yet many questions remain. Does all this pollen transport result in effective pollination? What happens to these networks when species are lost? How will climate change affect hoverflies? There is so much more to learn about these fascinating, but underappreciated insects.

Finalist:

Dr Ellen Dorothea Moss

Awarding Institution:
Newcastle University, UK

Impacts of simulated warming on plant-pollinator interactions and ecosystem services in agro-ecosystems

Insect pollinators are a diverse group of animals that includes many thousands of species of flies, bees, moths, butterflies and wasps. These insects are exceptionally important as they pollinate the vast majority of the world's flowering plants, including around 46 different flowering crops, and both these plants and their pollinators are culturally significant. Recent declines in pollinators and wildflowers are therefore worrisome. Climate change is an emerging threat that has already affected many species. So far, most of the published research has focussed on small numbers of pollinator and wildflower species, but these organisms form large and complex communities, so it is important to investigate the climate change effects at a wider, community scale.

Investigating the impacts of climate change on communities is challenging; many researchers use indirect methods (e.g. historical data comparisons). I simulated climate warming in an outdoor field experiment by suspending infra-red heaters above plots of wildflowers, which represents the first time this experimental design has been used to investigate plant-pollinator communities. The findings demonstrated that a 2°C increase in temperature caused a range of negative impacts that started with the plants and cascaded onwards throughout the community: floral abundance was reduced by nearly 40% and nectar volumes decreased by over 60% for two species; this reduction in pollinator food caused the frequency of flower-visits to increase, which in turn caused the community relationships to become more complex and diverse. Additionally, several wildflowers produced fewer and/or smaller seeds, including two already rare species, which suggests the community is likely to change over time.

The compositions of pollinator and wildflower communities are not static through time; as any gardener can tell you, different species are active at different times of year. Despite this, most pollinator research does not account for these temporal community transitions and there are currently no published investigations that have looked at how climate change can affect them. The data collected from the field experiment allowed me to conduct a pioneering investigation on this topic, which revealed that the temporal patterns were disrupted by the simulated warming, and that different types of pollinator and plant responded differently. These findings suggest that climate change impacts on pollinator communities may not only be inconsistent between different communities in different locations, but could also be inconsistent across time for a given community in the same location.

Because pollinators and wildflowers are important to agriculture and to people's enjoyment of nature, we need to understand the broader implications of climate change affecting these organisms. I collected information from across different academic subjects and collated this within a framework, which I used to explore the range of impacts on both nature and people. This revealed many negative effects on the physical and living aspects of our environment, which will in turn lead to negative impacts on humans and society, including: reduced food security, and reductions in the well-being benefits of interacting with nature. This investigation also highlighted several unanswered questions, which should be high priorities for future research.

JOURNALS AND LIBRARY

Bridging the Referee Gap by Creating an Apprenticeship Editorial Board

Rebeca B. Rosengaus [1], Francis Gilbert [2], Bernard Roitberg [3]

[1] Department of Marine and Environmental Sciences, Northeastern University, Boston, MA, USA. r.rosengaus@northeastern.edu

[2] University Park, University of Nottingham, Nottingham NG7 2RD, UK. Francis.Gilbert@nottingham.ac.uk

[3] Professor Emeritus, FRES, Simon Fraser University, Canada. roitberg@sfu.ca

As senior editors of *Ecological Entomology*, we have come to realize that a younger generation of scientists needs to be recruited to assess whether manuscripts submitted for publication are scientifically sound. Since 2010, a worrying trend has become obvious: an excess demand for peer-reviewers has resulted in an untenable burden for everyone, but particularly for the ~20% of the researchers who consistently performed between 69% and 94% of the reviews (Kovanis et al., 2016). Such statistics should prompt our respective scientific communities to address this imbalance, which clearly looms as a significant impediment in the "quality control" of scientific inquiry.

To tackle this referee gap, the Editors-in-Chief for *Ecological Entomology* developed and are now implementing a new pedagogical approach whereby, through the creation of an *"Editorial Apprenticeship Program"*, graduate students and postdoctoral fellows can familiarize themselves with the multiple aspects inherent in any peer-review process. This program hopes to help prepare and ultimately expand the *ad-hoc* referee pool. Although a similar call to include the participation of early career researchers exists (Casado 2018), the reality is that unless we, as established scientists, take on the mantle for targeting, educating and preparing our graduate student and/or postdoc populations on the significance of, and steps involved in, any review process, the referee gap issue will continue to worsen. A reduced pool of young scientists serving as *ad-hoc* referees has significant negative trickle-down consequences. First, a lack of future referees will surely affect the efficiency and speed with which journals publish manuscripts. Second, experienced referees help safeguard the quality and robustness of scientific inquiry and thus, the recruitment of young scientists plays an important role in our respective scientific communities. Unfortunately, young scientists receive little to no exposure to this important process during their professional development (Walker 2018). This apprentice program invites, involves, trains, supervises and recognizes the participation of graduate students and postdocs as *ad-hoc* referees. This program, in our mind, is a worthwhile endeavor, representing a "win-win-win" situation for journals, young scientists and the future of science.

As a proof of concept, the Editors-in-Chief for *Ecological Entomology* received approval from the Royal Entomological Society (RES) and Wiley to run this apprenticeship as a pilot program. This "*Apprenticeship Editorial Board*" is comprised of graduate students and postdocs working under the supervision of our current Associate Editors. This approach required "buy-in" from our Associate Editors who committed themselves to oversee the review of their student(s), ensuring high quality reviews that provide constructive criticisms to the authors. We anticipate the "in-training" participants will benefit tremendously from experiencing and understanding the review process while engaging in it from "behind the scenes"; enhancing their critical reading skills and ultimately, becoming better authors themselves, potentially becoming future Associate Editors. Moreover, these new "ad-hoc referees in training" are current in their fields, they are well informed about recent literature and are shrewd when it comes to the latest analytical/statistical techniques. Hence, we foresee their reviews to be excellent contributions to the review process.

Expected outcomes

The development and implementation of the "*Apprenticeship Editorial Board*" has the potential for expanding the education and promotion opportunities of graduate students and postdocs into academic positions. Although the latter are not easily measurable outcomes, it is vital that

From an Editorial Apprentice

Erin Cole, Ph.D. Candidate
cole.eri@husky.neu.edu
Ecology, Evolution and Marine Biology
Marine and Environmental Sciences Department
Northeastern University
Boston, MA

"I am finding the experience as an apprentice to be invaluable as both a reviewer and submitting author. In addition to gaining confidence in my critical reading skills, I feel more confident that my feedback has value. This experience has also given me insight into the process that my own submissions will go through in the future. I believe it has helped refine my ability to identify and remedy weaknesses in my own writing and experimental methodology."

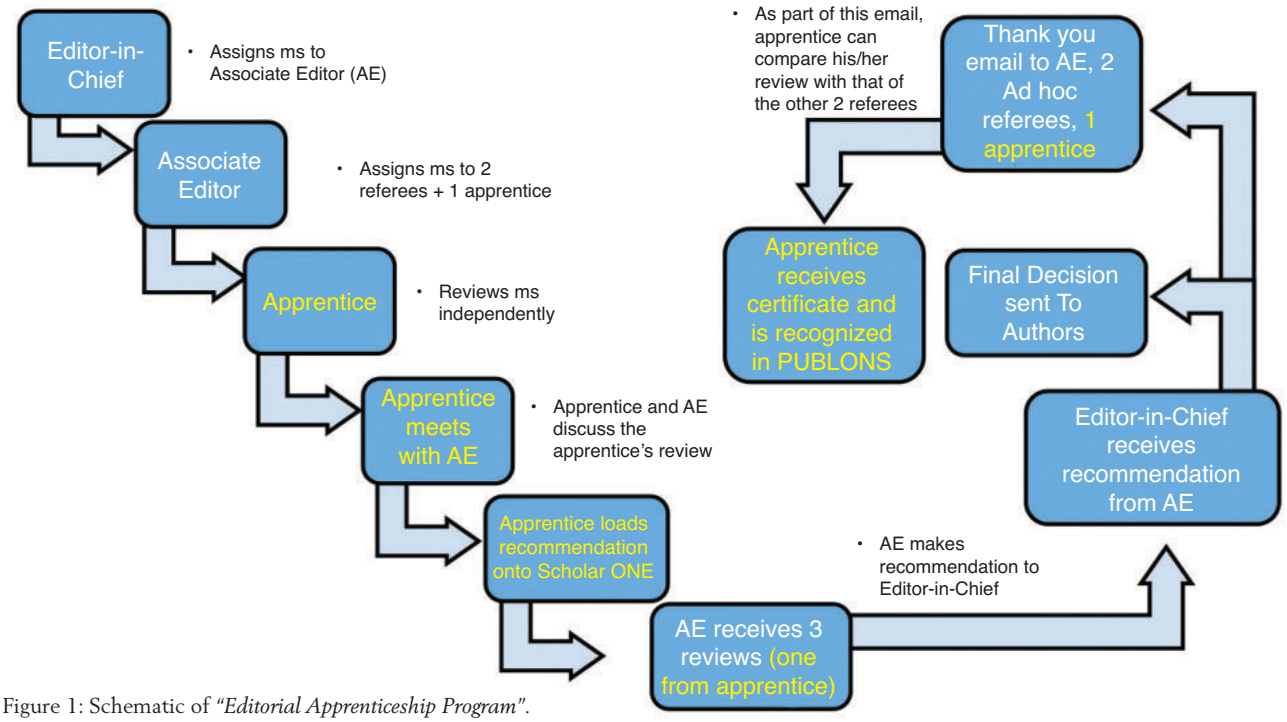


Figure 1: Schematic of *"Editorial Apprenticeship Program"*.

we, as researchers and educators, search for novel strategies to enlist a new generation of scientists into our ranks. As part of the implementation of the pilot program, a pre-assessment survey was conducted in which participants were asked to rate the following statements:

- I feel comfortable providing a review
- I have served as an official referee in the past
- In the past, I have reviewed manuscripts in concert with my supervisor
- How confident are you in your ability to contribute stylistic improvements to authors of submitted manuscripts?
- How confident are you in your ability to contribute and/or suggest scientific improvements to authors?
- How confident are you in your ability to provide statistical advice/suggestions to authors?
- How knowledgeable are you about the various steps /levels involved in the review process?
- How many articles have you co-authored as a first author?
- How many articles have you co-authored in which you were not the first author?

Apprentices will be asked to respond to a second survey one year into the program to quantify the effectiveness of this scheme (Figure 1).

Guidelines

Students on this apprenticeship board are expected to serve as third anonymous referees. Hence, at the end of the review process, every manuscript would receive three recommendations: two from our experts in the field (as is currently being done) and one from yet another expert, our grad student/postdoctoral apprentice.

The recruitment of our first apprentice cohort followed a multi-pronged process. First, we alerted the *Ecological Entomology* Associate Editors of the possibility for their students' participation. Of the 20 Associate Editors, 11 responded in the affirmative and nominated 13 apprentices. The participants were then enrolled into Scholar ONE, the platform that handles the submission and reviewing process for RES journals. From here, once the Editors-in-Chief assign a manuscript to an Associate Editor, the latter decides if the apprentice under their supervision can act as referee based on the apprentice's area of expertise. The invited apprentice receives the same email and same time-frame to turn in a recommendation as that provided to our regular invited *ad-hoc* referees. In this way, we are not impacting the duration of our normal review process. We strongly believe that this personalized and "official" request to serve as an anonymous referee will go a long way in making our apprentices feel they are part of the

From an Editorial Apprentice

Emilie Ellis
PhD Researcher // Grantham Scholar
Grantham Centre for Sustainable Futures &
Department of Animal and Plant Science,
The University of Sheffield

"A lot of the time, when you are an early career scientist, your skills tend to be over-looked and subsequently not used to their full potential due to perceived inexperience. Being a part of this programme is refreshing as its core is about giving less experienced scientists training and an opportunity to prove themselves as competent researchers too."

Emilie with a white-witch moth while in Costa Rica

"review team". The expectation is that, initially, the Associate Editor will commit to supervise the review and recommendation of their apprentice until we ensure high quality reviews from our new participants. Once the students have "proven" themselves, we intend to emancipate them, decoupling them from their supervisor. From then on, *Ecological Entomology* will consider the apprentice's feedback as a stand-alone recommendation.

Ecological Entomology recognizes that the apprentices are under significant time constraints and that their priority is to focus on their PhD or postdoc responsibilities. Hence, to avoid overloading participants, we are restricting the number of assigned manuscripts to no more than one concurrent manuscript and no more than three manuscripts in a year.

The implementation of this program required modifications to the Scholar ONE platform. Both the Royal Entomological Society and Wiley have been, and continue to be, strong supporters of this endeavour and have helped to ensure this novel scheme becomes automated as much as possible. In particular, we appreciate the help received from Ms. Sarah Laseke, our Editorial Assistant, in helping resolve some of the logistical issues prior to the programme's inception.

This *"Apprenticeship Editorial Program"* represents a novel educational as well as a recruitment tool that involves our young scientists to join the ranks of our reviewers. The combined efforts from the Editors-in-Chief and Associate Editors of *Ecological Entomology*, together with the support of the Royal Entomological Society and Wiley, can bring about important benefits to everyone involved. We anticipate this scheme to be successful and hope it is expanded to other Royal Entomological Society journals.

From an Editorial Apprentice

Zoe Getman-Pickering, PhD
Candidate Department of Entomology
Cornell University
Ithaca, NY 14853-260
Email: zg94@cornell.edu

"I think this program is wonderful, and I hope other journals start following your lead."

From an Editorial Apprentice

Dr. Patrícia Nunes-Silva
PNPD - PPG em Biologia
UNISINOS

"The material I've received has already helped me, by improving the way I conduct a review and also in my writing process. I'm looking forward to the next steps"

References Cited

Casado M. 2018. Junior reviewers jump into the pool. *Nature,* 560 (7718):307

Kovanis M, Porcher R, Ravaud P, Trinquart L. 2016. The Global Burden of Journal Peer Review in the Biomedical Literature: Strong Imbalance in the Collective Enterprise. *PLoS ONE* 11(11): e0166387.doi:10.1371/journal. pone.0166387

Walker T R. 2018. Teach PhD students to peer-review. *Nature*, 561: 177

SCHEDULE OF NEW FELLOWS AND MEMBERS

as at 6th March 2019

New Honorary Fellows
None

New Fellows (1st Announcement)
Professor Bruce E. Tabashnik
Dr Barbara Jane Tigar
Dr Arkadiusz Urbański
Professor Paul Alexander Opler
Professor Mark Rowland

Upgrade to Fellowship (1st Announcement)
None

New Fellows (2nd Announcement and Election)
Professor Petros Ligoxygakis
Dr Agiesh Kumar Balakrishna Pillai (as at 5.12.18)

Upgrade to Fellowship (2nd Announcement and Election)
None

New Members Admitted
Ms Zoe Adams (as at 5.12.18)
Mr David Neil Milburn (as at 5.12.18)
Revd Roger A.M.T. Quick (as at 5.12.18)
Mr Rob Deady (as at 5.12.18)
Miss Clementine St John Webster (as at 5.12.18)
Mr Simon Loughran (as at 5.12.18)
Mr Gabriele Gloder (as at 5.12.18)
Ms Olga Hionis
Mrs Sarah Adamson
Dr Louise Mc Namara
Mr Christopher George Horley
Dr Islam Sobhy
Mrs Maureen Odendaal
Miss Stephanie Pearl Mary Rogers
Miss Katy Potts
Mrs Tara Sedgwick

New Student Members Admitted
Mr Hayden Yates-Walmsley (as at 5.12.18)
Mr James Raymond George Neate (as at 5.12.18)
Mrs Sienna Al-Zurfi (as at 5.12.18)
Mr Konstantinos Tsiolis (as at 5.12.18)
Miss Nicola Dawn Cowley
Miss Simona Principato
Mr Finlay Bryson Richardson
Mr Richard Lloyd Mills
Miss Beth Moore
Mr Abadi Mashlawi
Mr Luca Manelli
Miss Amy Louise Fowles
Miss Harriet Hall

Re-Instatements to Fellowship
Dr David Corke (as at 5.12.18)

Re-Instatements to Membership
None

Re-Instatements to Student Membership
None

Deaths
None

Book Reviews

Insect Behaviour: From Mechanisms to Ecological and Evolutionary Consequences

Edited by Alex Córdoba-Aguilar, Daniel González-Tokman, and Isaac González-Santoyo

Oxford University Press

ISBN 9780198797500

£37.99

Insect Behaviour is a comprehensive collection of reviews written by world-leading scientists, covering the many aspects of insect behaviour, from the genetic level to global migration strategies. The editors have done a great job in pulling together expert reviews to give a detailed picture of this expanding multi-disciplinary field. Specialist readers can gain a good understanding of the current state of the field covered by each topic, as well as of what pending scientific questions remain to be answered. The logical transition between chapters makes it easy to follow the trail of thought from genes through physiology and ecology to evolution.

The book reflects well the ever-changing focus of insect behavioural research. Topics that were generally not discussed in many earlier publications are now included as they are regarded more and more relevant, such as the responses of insects to a changing world, food security and pest control, or conservation issues. The Glossary and Index are indispensable parts of the book that make navigation within and between chapters much easier. The authors provide a comprehensive reference list at the end of each chapter for those who may find some parts less detailed or want to get a better picture of the actual topic.

This book is a refreshing new approach to introducing insect behaviour and can also be recommended to anyone with an interest in the ecological and evolutionary aspects of the field.

Jozsef Vuts & Jason Lim

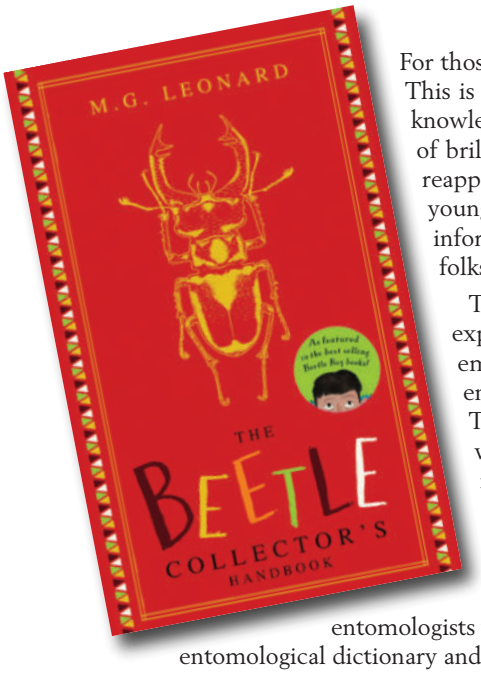
The Beetle Collector's Handbook

M G Leonard, Illustrated by Carim Nahaboo

Scholastic

ISBN 978-1-407185-66-8

£10.99



For those who have read any of the *Beetle Boy* trilogy, the title of this book will be very familiar. This is the book that Darkus acquires from his father and becomes the source of most of his knowledge about beetles. The transformation of this fictional text into a factual reality is a stroke of brilliance. It is a book that has acquired a legendary status amongst *Beetle Boy* fans, so its reappearance will be greatly anticipated. It is designed to excite, entertain, inform and inspire young people. It is packed with information about the most charismatic beetles on the planet, information that is presented in a style that will be accessible to both young people and older folks who are looking for an uncomplicated introduction to these amazing insects.

The book is offered as a Victorian handbook, written by the eminent entomologist and explorer Monty G. Leonard. In his introduction he talks a little about himself and other eminent entomologists of the day before extolling the virtues of studying beetles and encouraging both boys and girls to go into the countryside and see what they can find. There are also brief sections on beetle morphology, taxonomy and preparation for field work, plus information on building bug hotels and how to record your observations. The next 110 pages are dedicated to a myriad of fascinating facts and figures about beetles from around the globe, some of which are found in the UK but many of which are tropical species. It is a good balance of beetles that can be easily located in the UK with those species that have a big wow factor. The book ends with a note from M.G. Leonard on how she became fascinated with beetles, followed by short articles from the two entomologists who were consultants on this project, Dr Sarah Beynon and Max Barclay. There is also an entomological dictionary and suggested further reading.

The pages of the book are foxed so that the book looks old and the text is littered with pencilled notes from Darkus, many of which relate to the *Beetle Boy* books. There is even a reference to the R.E.S. where Darkus asks, "How old do you have to be to become a member and is there a test?". The illustrations by Carim Nahaboo are superb. Some are black and white drawings but most are brightly coloured paintings, both of which bring the beetles to life, enhancing the information on offer and stimulating the reader's curiosity.

The combination of intriguing information and cool illustrations presented as an antiquarian book that is embedded in the *Beetle Boy* novels is one that is sure to send children of all ages racing to the nearest book store. *The Beetle Collector's Handbook* enhances the legacy of excitement and curiosity generated by the *Beetle Boy* novels, adding hard facts to the sense of adventure and exploration found in the novels.

Peter Smithers

Review of the Manual of Afrotropical Diptera Vol 1 & 2

Both volumes are published by SANBI Publishing
and both are by Kirk-Spriggs, A.H. & Sinclair, B.J. (Eds)

Vol 1: ISBN is 9781928224112 and price is £39.00

Vol 2: ISBN is 9781928224129 and price is £49.00

Both volumes are also available for free pdf download from
http://afrotropicalmanual.org/

It was with a heavy thud that these two tomes were deposited on my desk. These long-awaited manuals (with more to come) were highly anticipated and, thankfully, they do not disappoint. They are packed full of information; the production is of high quality and full of high-resolution images throughout. Most of the chapters have a different author(s) but I did not find that this hindered the flow of the book.

The first volume is packed with information that is not only relevant to Afrotropical species and those studying them, but will also appeal to Dipterists across the globe (including the UK); it is overflowing with the fundamentals of dipterology, including their evolution, natural history and impact in ecosystems, including their impact on us humans, I found myself scribbling down notes, or stopping and searching the internet to learn more about the facts that I was being immersed in. There is also a chapter on collecting and preservation techniques that covers not only methods, but also provides some excellent images to aid the reader in their endeavour. Where the focus was purely afrotropical, especially on Dipterologists and collections of material, I was entertained and enlightened. I thought that I knew a fair amount about collections containing flies across the globe, but I realise now that this is not the case.

But the real gem in Volume 1 is the key to Diptera families. This in production was sent to all of the authors of the family chapters and so benefits from a wealth of informed opinion. And each couplet comes with clear, detailed images highlighting the diagnostic features necessary for identification. The photographic images are an integral part of the key and, along with the diagrams, really do make using the family key very easy.

Volume 2 contains 42 Family level chapters, starting with Limoniidae and Tipulidae and ending with Dolichopodidae. Each one has been written by a leading taxonomic specialist of those families and as well as containing a detailed genus level key, they also provide a wealth of further information. Each chapter differs in content depending upon both the author and the ecology/importance of the family. Some chapters are packed full of images (e.g. the Mycetophilidae chapter featuring the wings of many of the genera) but all provide a substantial reference list to help the user delve further into the groups if they wish too.

The only sad point about this book is what is not in there. Too many of the genus descriptions end with 'nothing known about their biology or larvae'. Hopefully, manuals such as this one will encourage everyone, irrespective of where they are in the world, to go out and discover more about flies and their many varied ways.

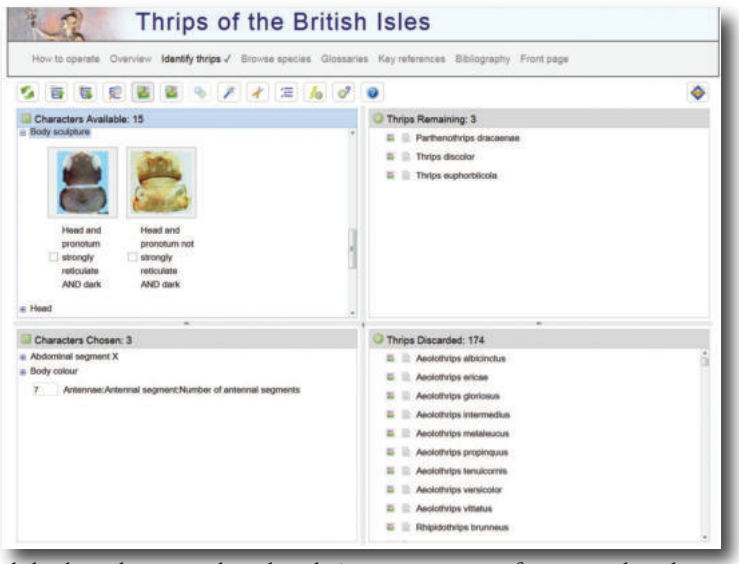
Erica McAlister,
NHM London

Webpage Review

Thysanoptera Britannica et Hibernica - Thrips of the British Isles

Laurence A. Mound, Dom W. Collins & Anne Hastings
Lucidcentral.org, Identic Pty Ltd, Queensland, Australia

Web site: https://keys.lucidcentral.org/keys/v3/british_thrips/ – Access is free



This free web site is devoted to the thrips (Thysanoptera) of the British Isles. It includes an identification key to adults, a data sheet for each species and a series of short articles on associated topics. Previously, the Royal Entomological Society's handbook on Thysanoptera, published in 1976, was the key to use for British thrips. It is no longer in print, although a free pdf can be downloaded from *www.royensoc.co.uk/out-print-handbooks*. However, after 43 years it is seriously out of date because of the new species that have arrived during that time. The old key included 158 species, whereas the new key covers all 177 species taken alive at least once in the British Isles up to 2018. Importantly, the new key includes the invasive pest species that have arrived since 1976, such as the western flower thrips (*Frankliniella occidentalis*) and the recently arrived Japanese flower thrips (*Thrips setosus*).

The new key is more than an updated replacement though. The web-based format is much easier to use than a paper key. Behind the scenes it uses Lucid knowledge management software, which is being increasingly used for new identification keys. There are simple instructions for those unfamiliar with Lucid keys, and it should only take a couple of minutes to master its use. One useful feature is that users no longer have to follow a fixed sequence of couplets. The user clicks on a button to select a 'Best' feature to use, but if that feature is difficult to see, one can usually click again to find a next best feature to use instead. Beginners are unlikely to have much difficulty with the identification features because of the many superb illustrations that appear throughout. The photos of specimens on microscope slides have been produced with Auto-Montage software so that the specimen is in focus throughout. Line drawings from the 1976 key are also included. For each identification feature in the key there are usually expandable thumbnail illustrations next to each choice. There is no more need to hunt for a figure, as is often necessary with paper-based keys! Another valuable feature is that as one progresses through the key one can see a list of the species that are remaining (top right) or discarded (bottom right) and a record of the choices that have been made (bottom left). This gives a real feel for how the key works and the consequences of choices.

There is a useful data sheet for each species with a detailed description, photographs, a list of synonyms and an introduction to its biology. These can be printed or downloaded as pdf files. Brief articles cover topics such as 'Host plants', 'Distributions', 'Future distributions and climate change' and 'Thrips as pests in Great Britain and Ireland'.

The key is web-based, so it needs to run in a web browser on an internet-connected desktop computer, laptop or tablet. I also ran it successfully in the Chrome browser on my mobile phone (Samsung Galaxy S8) and I could easily access and read the data sheets for each species. The identification key worked on the phone, but needed quite a bit of zooming in and out to be legible. Using an online key instead of a paper key can present some initial inconveniences, such as the need to move a computer next to a microscope, but these aspects need to be balanced against the enormous benefit of providing free access to anyone almost anywhere in the world. Online keys can also be updated as new species arrive, although they depend on ongoing support as web technology changes. I suspect that the web address may change over time, so if the one above stops working, visit the parent site (*www.lucidcentral.com*) and search for thrips.

This web site will be a great asset to beginners and experts alike, and not least because it's free! A reliable and easy to use key is the gateway to the study of an insect group. This new key is certainly reliable and easy to use and should encourage an increase in the study of thrips.

William D. J. Kirk

Diary

Details of the Meetings programme can be viewed on the Society website (www.royensoc.co.uk/events) and include a registration form, which usually must be completed in advance so that refreshments can be organised. Day meetings typically begin with registration and refreshments at 10 am for a 10.30 am start and finish by 5 pm. Every meeting can differ though, so please refer to the details below and also check the website, which is updated regularly.

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

MEETINGS OF THE ROYAL ENTOMOLOGICAL SOCIETY

Insect Festival 2019
Sunday, 7 July, 2019
York Museum Gardens

Insect Festival Bristol 2019
Saturday, 17 August, 2019
Bristol Museum and Art Gallery

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

Aquatic Insects Special Interest Group
Tuesday, 1 October 2019
Venue: CEH, Lancaster

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

NON-SOCIETY MEETINGS

CNRS Jacques Monod International Conference "Integrated Insect Immunology: Controlling Infections", 24-28 June 2019, Station Biologique de Roscoff, Roscoff, France

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

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

X X VI International Congress of Entomology, Helsinki, Finland, July 19-24, 2020.
'Entomology for our planet'

EMBO Workshop "Molecular and Population Biology of Mosquitoes and Other Disease Vectors", 22-26 July 2019, Kolymbari, Chania, Crete, Greece

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

Painting of the swallowtail *Papilio natewa* on *Stachytarpheta mutabilis* by 14 year-old Rory Barraud from Wellington College, New Zealand, whilst taking part in Operation Wallacea in Fiji in 2018 - see *https://www.opwall.com/about-opwall/*

RES STUDENT AWARD 2019

Write an entomological article and WIN!

www.royensoc.co.uk

REQUIREMENT

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

WHO CAN ENTER?

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

PRIZES

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

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

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

ENTRIES

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

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

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

For further information telephone: 01727 899387

Please include:

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

THE JUDGES

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

CLOSING DATE

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

PLEASE CUT AND RETURN THIS PORTION WITH YOUR ENTRY

Article title: _____

_____

_____

Student name: _____

_____

Address: _____

_____

_____

_____

_____

Telephone: _____

E-mail: _____

_____

Name of academic institution:

_____

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