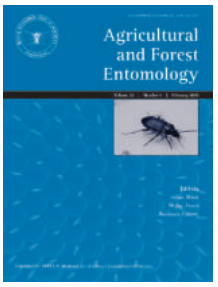
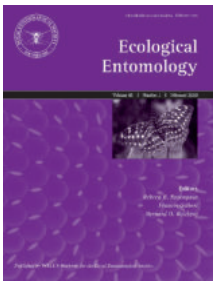
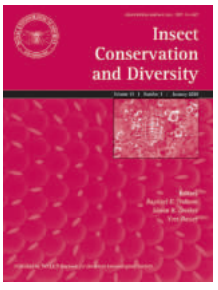
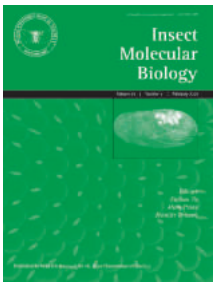
Bulletin of the Royal Entomological Society Volume 44 (2) 2020

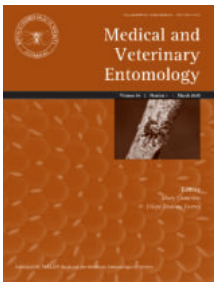
antenna

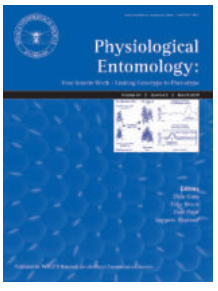


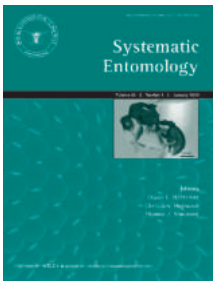












Publications of the Royal Entomological Society

Agricultural and Forest Entomology provides a multi-disciplinary and international forum in which researchers can present their work on all aspects of agricultural and forest entomology to other researchers, policy makers and professionals. RES Members: print £98, online £49
2020 print or online prices: UK £982, Euroland €1,251, USA $1,816, Rest of World $2,114
2020 print and online prices: UK £1,229, Euroland €1,564, USA $2,271, Rest of World $2,643

Ecological Entomology publishes top-quality original research on the ecology of terrestrial and aquatic insects and related invertebrate taxa. Our aim is to publish papers that will be of considerable interest to the wide community of ecologists. RES Members: print £163, online £81
2020 print or online prices: (with Insect Conservation and Diversity) UK £1,628, Euroland € 2,073, USA $3,017, Rest of World $3,518
2020 print and online prices: UK £2,035, Euroland € 2,592, USA $3,772, Rest of World $4,397

Insect Conservation and Diversity explicitly associates the two concepts of insect diversity and insect conservation for the benefit of invertebrate conservation. The journal places an emphasis on wild arthropods and specific relations between arthropod conservation and diversity.
RES Members: print £100, online £50
2020 print or online prices: UK £996, Euroland €1,268, USA $1,840, Rest of World $2,142
2020 print and online prices: UK £1,246, Euroland €1,585, USA $2,299, Rest of World $2,678

Insect Molecular Biology is dedicated to providing researchers with the opportunity to publish high quality original research on topics broadly related to insect molecular biology. *IMB* is particularly interested in publishing research in insect genomics/genes and proteomics/proteins.
RES Members: print £161, online £80
2020 print or online prices: UK £1,608, Euroland €2,043, USA $2,972, Rest of World $3,463
2020 print and online prices: UK £2,010, Euroland € 2,553, USA $3,715, Rest of World $4,330

Medical and Veterinary Entomology is the leading periodical in its field. It covers all aspects of the biology and control of insects, ticks, mites and other arthropods of medical and veterinary importance.
RES members: print £94, online £47
2020 print or online prices: UK £944, Euroland €1,205, USA $1,750, Rest of World $2,041
2020 print and online prices: UK £1,181, Euroland €1,507, USA $2,187, Rest of World $2,552

Physiological Entomology is designed primarily to serve the interests of experimentalists who work on the behaviour of insects and other arthropods. It thus has a bias towards physiological and experimental approaches, but retains the Royal Entomological Society's traditional interest in the general physiology of arthropods. RES Members: print £87, online £44
2020 print or online prices: UK £874, Euroland €1,109, USA $1,608, Rest of World $1,878
2020 print and online prices: UK £1,091, Euroland €1,386, USA $2,010, Rest of World $2,347

Systematic Entomology encourages the submission of taxonomic papers that contain information of interest to a wider audience, e.g. papers bearing on the theoretical, genetic, agricultural, medical and biodiversity issues. Emphasis is also placed on the selection of comprehensive, revisionary or integrated systematics studies of broader biological or zoogeographical relevance.
RES Members: print £153, online £76
2020 print or online prices: UK £1,528, Euroland €1,944, USA $2,825, Rest of World $3,296
2020 print and online prices: UK £1,909, Euroland €2,430, USA $3,532, Rest of World $4,122

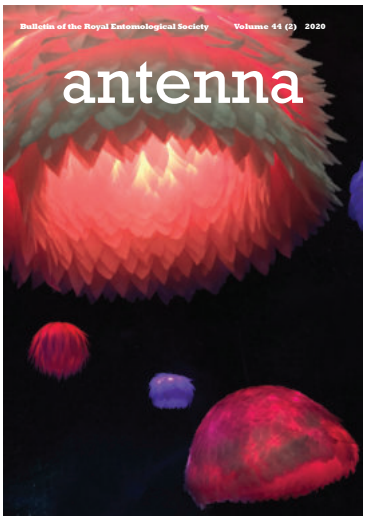
Subscription and correspondence concerning back numbers, off-prints and advertising for the seven principal journals of the Society should be sent to the publishers, John Wiley & Sons Ltd, 9600 Garsington Road, Oxford OX4 2DQ. (cs-journals@wiley.com)

Antenna (Bulletin of the Society). Free to Members/Fellows. Published quarterly at an annual subscription rate of £60 (Europe), £65 (outside Europe). This journal contains entomological news, comments, reports, reviews and notice of forthcoming meetings and other events. While emphasising the Society's affairs, *Antenna* aims at providing entomologists in general with a forum for their views and news of current trends in entomology. Subscriptions and advertising enquiries should be sent to the Business Manager at The Mansion House, Chiswell Green Lane, Chiswell Green, St Albans, Hertfordshire AL2 3NS and any other enquiries to the Editors (antenna@royensoc.co.uk).

Handbooks for the Identification of British Insects. This series now covers many families of various orders. Each Handbook includes illustrated keys, together with concise morphological, bionomic and distributional information. A full list of Handbooks with order form is available. See website www.royensoc.co.uk

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

CONTENTS



COVER PICTURE

The Nectary Installation
(see The Nectary and the "Hum of the Earth" by Christopher Hassall)

antenna

Bulletin of the Royal Entomological Society

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
(Newcastle University)
Dr Richard Harrington

Editoral Assistant:
Dr Jennifer Banfield-Zanin

Consulting Editor:
Prof. Jim Hardie

Assistant Editors:
Prof. Adam Hart (University of Gloucestershire)
Prof. Hugh Loxdale MBE (Cardiff University)
Mr Peter Smithers (University of Plymouth)
Dr Tom Pope (Harper Adams University)
Ms Alice Mockford (University of Worcester)

Business Manager: Registrar

COPY DATES
For *Antenna* **44** (3) – 1st July 2020 (RH)
For *Antenna* **44** (4) – 1st October 2020 (DG)
Diary Copy date:
five days before *Antenna* copy date above.

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

The Royal Entomological Society is a scientific society founded in 1833 and incorporated by Royal Charter in 1885 for the improvement and diffusion of entomological science exclusively.

Library: Mrs Valerie McAtear, Librarian (lib@royensoc.co.uk)
The Library is open to Fellows and Members from 9.00am to 3.30pm Monday to Friday. The Library is not open on Saturdays and Sundays or public holidays, and such other times as may be notified in *Antenna*.

Subscription Rates 2020
The following are the subscription rates due on 1st March 2020: Fellows £68; Members £62; Students £33; Fellows and Members over 65 £45. The journals of the Society are available to individual Fellows and Members at preferential rates via the Subscriptions Department at The Mansion House. *Antenna* is supplied free of charge to Fellows and Members not in subscription arrears. **Cancellation of Journal subscriptions must be notified to Subscriptions Department before the 31st October in the year preceding cancellation.**

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

EDITORIAL

Hello and welcome to *Antenna* 44(2). Writing this Editorial in mid-April, it's hard to focus on anything else besides the ongoing COVID-19 pandemic. By the time this issue reaches you, the social distancing measures in place across the UK will have, hopefully, proven successful and been relaxed. Nevertheless, the impact of the pandemic is likely to have long-lasting and far-reaching effects for us all, wherever we are. In the shorter term we're working hard at *Antenna* to ensure we can still bring you the latest entomological news and views uninterrupted, though with the UK lockdown forcing many RES activities to be postponed we're anticipating a drop in our usual copy flow. As an introduction to this issue we feature a 'call to arms' to you all to help us fill this expected gap in these extraordinary times. This is followed by a couple of gratefully received letters from our readership in the Correspondence section, one from Daniel Hackett in response to a recent Spotlight, and the other highlighting an exciting entomological opportunity in Bali from David Lowenthal.

We open our Articles section with another thought-provoking Spotlight from Stuart Reynolds. Special thanks are due to Stuart for preparing this latest instalment on 'Impatient Damsels: Glowworms in Essex' at a time when his expertise and writing have been in high demand, both due to COVID-19 (see https://www.brlsi.org/events-proceedings/events/where-do-viruses-come, and https://www.brlsi.org/events-proceedings/events/testing-coronavirus) and Brexit (see https://blogs.bath.ac.uk/iprblog/2020/03/02/future-farming-brexit-agriculture-and-wildlife/). If you've been enjoying Stuart's Spotlights, you'd be well advised to visit these links for some extra listening and reading. Other articles in this issue range from Lars Chittka's 'Entomological Rock Music' (with lyrics!), through Roger Morris's 'Photographic taxonomy – a strategic issue?', to an appetising offering on entomophagy in Welsh schools from Verity Jones.

Insects as Food and Feed also feature in Society News, with a report on the 2019 SIG of the same name from Peter Smithers. Christopher Hassall provides a further reminder of the public engagement potential of entomology with his report on The Nectary – a science-art installation that was delivered as part of the 2019 Leeds Light Night initiative. Another notable pre-pandemic gathering was this year's Verrall Lecture, delivered by Professor Sir Charles Godfray and reported on herein by *Antenna*'s own Richard Harrington. Prof Lin Field is the subject of 44(2)'s Honorary Fellow Interview, with Peter Smithers providing an inspiring insight into Lin's career in entomology and her long-standing and hugely significant contribution to the RES, covering everything from pesticides to peer-review! This issue also includes the winning and 'runner-up' submissions from the 2019 Student Essays Award, as well as our usual selection of Book Reviews and notifications.

Wherever we find ourselves by the time this issue reaches you, the *Antenna* team hope that 44(2) finds you safe and well in these challenging times.

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.

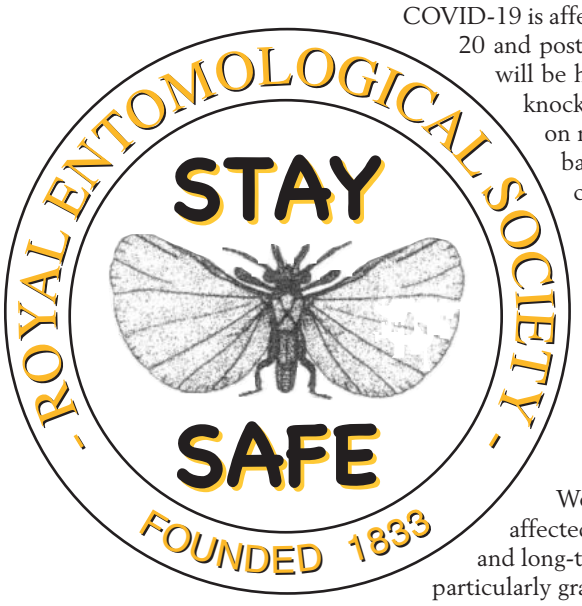
To give an idea as to what happens when the image is not of sufficient size, take a look at these two photographs. One is 300dpi and the other is 72dpi.

300dpi

72dpi

Announcement

Covid-19 and *Antenna*



COVID-19 is affecting us all in a range of ways. The Society has had to cancel ENTO 20 and postpone Special Interest Group and other meetings. Hopefully these will be held in due course but, in the meantime, there will inevitably be a knock-on effect on material for *Antenna*, which usually provides reports on meetings. Issue 44(3) (copy-date 1st July) is likely to be particularly badly affected and, quite possibly, 44(4) (copy-date 1st October). This could potentially be turned into an opportunity. Do you have any ideas to fill the gap?

Could you write an article?

Could you suggest a topic for an article that we might ask somebody else to write?

Could you review an entomological app that you use?

Do you have a completely novel idea for *Antenna*?

We would like to put together an article on how COVID-19 has affected entomological research and practice, and what the short, medium and long-term implications of the virus might be in this regard. We would be particularly grateful if you could send in some notes of your personal experiences or thoughts on this, not only on the problems, but also on work that has continued despite the pandemic. We will then pull these together.

Please send any ideas or contributions to antenna@royensoc.co.uk. It would be very useful if you could notify us in advance that you intend to prepare something, so that we can plan ahead.

Many thanks, Richard Harrington and Dave George

Correspondence

Light pollution as one of the causes of nocturnal insect decline

Editors,

A recent issue of *Antenna* 43(4) brought several thoughts and queries to mind. Reynolds' article (pp.159-163) on light pollution as one of the causes of nocturnal insect decline begged a couple of questions. Can one see nocturnal insects in greater decline than diurnal ones? Could the nocturnal ones be adapting, i.e. becoming less fixated on artificial man-made light? If they were able to steer by the celestial layout (stars, polarisation, moon?) as input to their internal compasses and ignore polluting man-made light, they might get around successfully. But this seems unlikely as an adaptation taking place over the time frame available. We observe that moths are very variable both in species terms, plus weather and moon phase, as to whether they end up in light traps. Indeed, some of the light traps in the Rothamsted array, although their design will not have been changed, may well have been affected by light-emitting buildings and street lighting, leading to lower catches. And the Rothamsted data are the most objective that is likely to be available. That is, "old timers" telling us tales of clouds of moths would be true, but unquantifiable.

The Morris and Edwards article on diurnal pollinator (Hoverflies and Aculeates) decline postulates that adverse weather events are a contributing factor; hot spells, in particular. For some time, I have wondered if there was something going on, barring insidious, largely undetected insecticide residues getting everywhere (à la *Silent Spring*). Neonicotinoids, toxic in tiny amounts, would be one candidate. But shock weather events might be a more likely contributing factor, as the authors suggest in a predominantly Atlantic biozone. East will suffer more than West, as long as the westerlies we are usually subject to, prevail. I believe there was a SE/NW tendency to split in the Rothamsted moth data, which would fit.

I wrote to Roger Morris with a suggestion, based on ideas researched during my PhD on diapause. If overwintering diapause were to be disrupted by spurious environmental cues, such as a shortish cold spell in early winter, say, November/ December, (insect takes this as winter and diapause development = vernalisation takes place) followed by a warm spell (normal development proceeds – and now this is spring, the insect assumes). When followed by another cold period, all is lost through premature emergence. Could this have been happening insidiously?

In the UK we joke that you can have four seasons in a day. But this could cause havoc for insects. They occupy a temperature niche and cannot tolerate or adapt to great departures from this. Russell Coope from 1959-2013 published on quaternary insect faunas from subfossil remains. *Antenna* (1991) 15: 158-163 featured this work. One of the take-home messages was that insects, particularly beetles, became extinct in the UK but retreated to areas where the climate suited them, rather than adapt to the new conditions of changed climate. Range shrinkage is the norm, even though the climate change at that time was far slower than that which we are experiencing now.

Roger Morris kindly forwarded a link to C. Román-Palacios and J. Wiens (2020) *PNAS* 117(8): 4211-4217 article, entitled "Recent responses to climate change reveal the drivers of species extinction and survival". They assembled datasets on 538 plant and animal species suffering local extinction taken from transects along altitude gradients. Insects are in there somewhere! They found maximum temperature but not average temperature correlated best with the extinctions. This tends to suggest, since roughly speaking, average is maximum plus minimum divided by two, that extreme weather (hot and cold) is more important than average. It connects with the idea that it is weather shocks that are so hard to cope with for insects and other organisms.

Of course, diapause and migration are life history strategies adapted to utilise resources varying in space and time, or both. But if these resources are no longer predictable, how would an insect adapt successfully? We do see insects adapt to insecticide pressure, of course, but this is a relatively simple process compared to reorganising thermodynamic behaviour, I would suggest. A parallel example would be that biological control agents are more likely to be sustainable than chemical insecticides because defensive adaptations to them are much more complicated for the pest.

How our insects (and which ones) will "win" and which ones will "lose", remains to be seen. For now, the 'r' selected ones with no particular narrow niche requirements (non-specialists, exemplified by certain pest aphids), would be likely to be okay. What a boring world that would be!

Daniel Hackett

Urgent Appeal – Exciting Opportunity!

Dear *Antenna* readership,

I decided to move to Bali, Indonesia in 2001. I swiftly fell in love with the island and the very creative, calm, kind, tolerant Balinese – 19 years on and I am still happily residing there. In 2005 I decided to dedicate the majority of my time to create a Bali Wildlife Encyclopaedia/book and have been photographing/monitoring the wildlife in Bali ever since.

We have made good progress. However, as neither my Balinese assistant or myself have a science background we are at the point where we really do need professional help.

I am fortunate to have secured a solo wildlife exhibition this coming October at the prestigious Arma Museum, which will run for a month (10th October to 11th November 2020). I believe the exhibition would be a perfect time to launch the Bali Wildlife Encyclopaedia/book.

I am writing to *Antenna* in the hope of finding an entomologist or other scientist to assist in any or all of the following areas:

- Lead and assist with species identification;
- Create a suitable format for the Encyclopaedia;
- Create/format the book's appendix;
- Write the preface for the book (possibly more);
- Provide any ideas for improving the project's website: baliwildlife.com

My wife and I would be very pleased to offer accommodation and meals for the researcher/s and can pretty much guarantee them a really interesting/lovely time in Bali. (The house has stunning gorge, jungle and Mt Agung views.) We are a very flexible easy-going couple and would welcome an open discussion with regards to all matters.

I would like to point out that I am driven by my passion for the Natural World and the Bali Wildlife project will be an educational gift for the Balinese/Indonesian people. In due course we may open an educational facility/gallery.

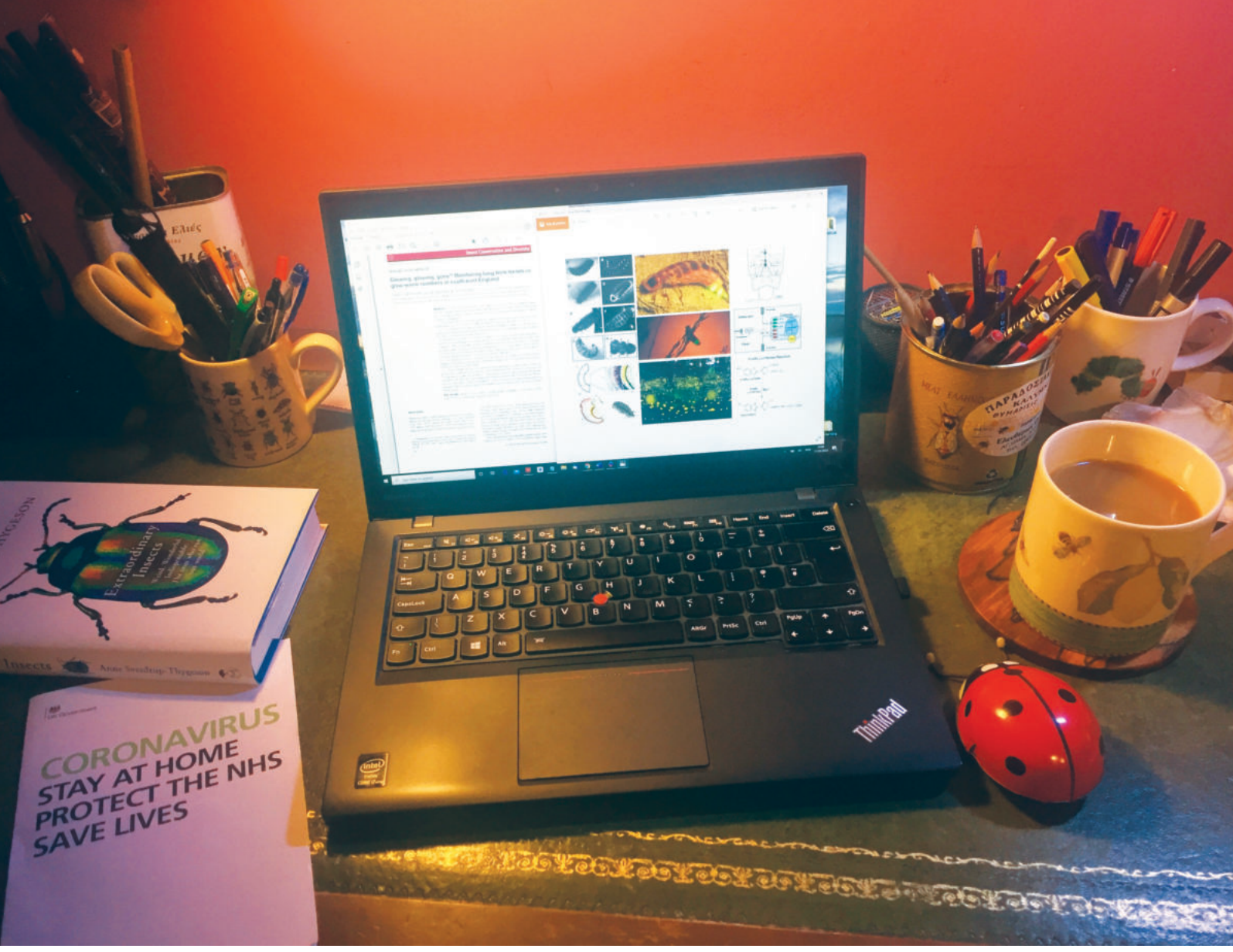
We are very happy to give full credits both in the book and Encyclopaedia for colleagues who are offering their very kind assistance and time.

Kindly contact me if you feel this project might be of interest to yourself or a colleague.

With warm regards,

David Lowenthal

Email : davidlowe2010@yahoo.co.uk
Whatsapp : +6281337561515
Instagram : @davidbaliwildlife
Facebook : davidbaliwildlife
baliwildlife.com (not for correspondence)



RESEARCH SPOTLIGHT

Impatient Damsels: Glowworms in Essex

Stuart Reynolds

Department of Biology and Biochemistry, University of Bath

The chilling night-dews fall:—away, retire;
For see, the glow-worm lights her amorous fire!
Thus, e'er night's veil had half obscur'd the sky,
Th'impatient damsel hung her lamp on high:
True to the signal, by love's meteor led,
Leander hasten'd to his Hero's bed.

Gilbert White (1789) *The Naturalist's Summer Evening Walk*

The glow-worm shows the matin to be near,
And gins to pale his uneffectual fire.

William Shakespeare (1604/5) *The Tragical Historie of Hamlet,* Act 1, Scene 5.

Another declining insect?

In my last *Research Spotlight* piece (Reynolds, 2020) I wrote about the effects of **A**rtificial **L**ight **A**t **N**ight (ALAN) on insects and other arthropods. I found the subject so interesting (I hope that you did too!) that in this article I'm again going to write about insects and light, but this time from a completely different perspective - insects that emit light.

As readers will recall, I have written about several other cases of putative insect declines in previous articles in this series (Reynolds, 2019a; 2019b). So, it's not surprising that my attention was captured by an excellent paper (Gardiner & Didham, 2020), which recently appeared in a special issue of one of the Royal Entomological Society's own journals, *Insect Conservation and Diversity*. It reports a long-term decline in the abundance of an iconic light-emitting insect, the glowworm, *Lampyris noctiluca*, in South-East England (Fig. 1A).

I liked this paper very much because it is totally honest in documenting the sometimes very great difficulties that accompany attempts to describe long-term general declines in populations that are highly variable from place to place and year to year. As Didham *et al.* (2020) have observed, it's important to get this right, because it won't help our ability as entomologists to get policymakers to take us seriously if we aren't completely scrupulous in reporting the uncertainties inherent in our data. Another rather more positive way of putting this is to say that the challenge of how to investigate and document insect declines is also an excellent opportunity to develop really good ecological methods. However, before we start, I'll say that Gardiner and Didham's paper really does show that British glowworms are in trouble.

As always, by the way, I urge you to read the original paper for yourself. Although my commentary is quite detailed, it's meant to be an appetiser rather than the last word.

A long term survey of glowworms in South East England

The glowworm is of course not a "worm" at all, but a beetle; its highly speciose genus is placed within the coleopteran Family Lampyridae, in the large Superfamily Elateroidea. If you haven't seen one before, then prepare to be charmed; a close-cropped meadow in which hundreds of glowworms are shining is a fantastic, magical sight. The English Romantic poet William Wordsworth was a fan of glowworms and called them "earth-born stars" ("The Pilgrim's Dream, or The Star and the Glowworm", 1818). Actually, of course, the insect's light has more prosaic purpose. As noted at the head of this article, the incomparable great eighteenth-century clergyman-naturalist Gilbert White used uncharacteristically direct language to point out that the intent of the female glowworm's light is to signal her sexual availability (look up the story about Hero and Leander if that part of his text seems a bit obscure). Wordsworth's chum Samuel Taylor Coleridge, a poet perhaps better in tune than his friend with the light's true purpose, knew this too. He wrote "many a glowworm in the shade lights up her love torch" ("The Nightingale", 1798).

The name "glowworm" is sometimes applied to all lampyrids, but since it is by far the most frequently encountered light-emitting insect in the UK, in this article when I say "glowworm" I mean *L. noctiluca*. A related but much smaller lampyrid, *Phosphaenus hemipterus*, also occurs

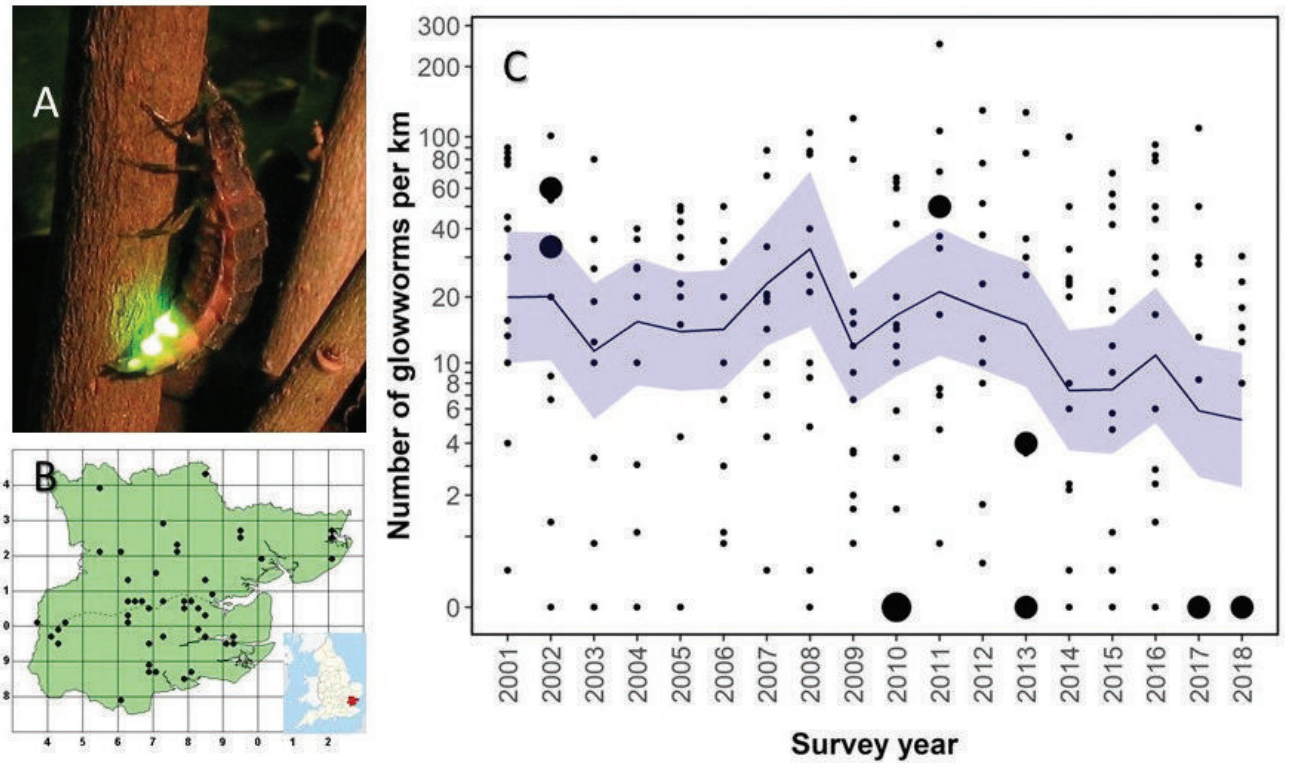


Figure 1. **A.** Adult female glowworm, *Lampyris noctiluca*. Image by Noé Conservation, 31 July 2013, Flickr (CC BY-NC 2.0). **B.** Glowworm sites in the English county of Essex. Map adapted from Gardiner (2001). **C.** Estimates from a best-fit generalised additive mixed model (GAMM) of predicted glow-worm abundance (±95% confidence limits) across 19 sites in Essex, UK, 2001-2018. Estimates take into account varying annual climate and seasonal phenology and control for differences in survey effort and random temporal trajectories in abundance across all sampling sites. Model predictions are shown at the mid-point of seasonal phenology (within years), with data points (filled circles) showing the raw data for survey 2 in each year (circle size is scaled according to the number of overlapping points). Note the logarithmic scale for the vertical axis (number of glowworms). Reproduced with permission from Gardiner and Didham (2020).

in the UK but is rare. Like those of *L. noctiluca*, larvae of *P. hemipterus* emit light but adult females do not shine brightly. So if in the UK, when you see what looks like a brightly shining glowworm, it is *L. noctiluca*.

As a larva, the glowworm is a specialist predator of small slugs and snails and lives mostly on lightly-grazed permanent grassland. Although both larvae and adults of both sexes emit low levels of light, it is the adult female that really shines, her pure bright-green light being emitted from two pairs of special light organs located in the posterior abdomen. The spectrum of light emitted by *L. noctiluca* is a single peak centred around 555nm (Booth *et al.*, 2004).

From about the 1960s, many concerns have been raised about declining UK numbers and local extinctions of these iconic insects. I myself have noticed that glowworms are now absent from places where I used to see them. But of course, anecdotal evidence like this is insufficient either to be sure that a general decline in this species is really occurring, or to justify large scale expenditure on conservation measures.

A paper by Atkins *et al.* (2016) reports a number of longitudinal local surveys of glowworm numbers that were undertaken by volunteers at 15 sites in southern England between 1992 and 2015. The surveys simply counted glowing insects. Survey methodology was not standardized between sites, and the surveys lasted different lengths of time. Counts at each site were therefore analysed separately with no attempt being made to analyse the data all together. Eight sites had enough data to allow a trend to be discerned, with a regression of number vs year at five of these sites showing a significant negative slope (i.e. a decline) over the measured period. Unfortunately, however, the paper has faults. The methods used to calculate the regression line or to test for statistical significance are not reported, and it is quite plain that there is great year-to-year variation in the data at every site, with peaks at some sites being recorded in the same years as troughs at other sites. With the best will in the world, this study doesn't provide strong support for the assertion that glowworms in the UK are suffering a general decline.

Perhaps, then, we can see these reports of glowworm declines in the UK as being part of a wider global pattern? Concern for the conservation status of bioluminescent insects is so great that an IUCN specialist group has recently been formed (IUCN, 2018). Lewis *et al.* (2020), writing on behalf of this group, have recently reviewed the evidence that bioluminescent insects are currently experiencing population declines on a global level. But actually, it turns out that there is remarkably little published work that produces quantitative evidence for such a global downward trend. Lewis *et al.* (2020) do cite some papers that describe instances of local habitat destruction and consequent loss of luminescent insects (Jusoh & Hashim, 2012, is a good example) but clearly something more is needed. Lewis *et al.* (2016) fall back on an e-mail survey of experts. Contacting 350 correspondents around the world, they received 49 responses to a questionnaire about the perceived level of threat to glowworms, fireflies and other light-emitting species. This group of entomologists, selected because of their common interest in light-emitting insects, would of course be expected to be concerned about the conservation status of their own specialist group. However, they weren't asked to comment on whether a general decline is taking place, and the paper doesn't provide evidence for this. Rather unhelpfully, from the point of view of enthusiasts for general decline, Evans *et al.* (2019) have recently found that the number of firefly observations logged by volunteers in the USA actually increased during the period 2008-2016. Of course, that doesn't necessarily mean that the actual numbers of fireflies increased.

Thus, a long-term careful study like that of Gardiner and Didham (2020) is very welcome. Their data are derived from systematic seasonal transect surveys conducted to a strict protocol in peak glowworm season (July and August) by a small army of volunteers at 19 different known glowworm sites in the English county of Essex (Fig. 1B). 6034 glowing females were recorded in 591 surveys over a 17-year period, from 2001 to 2018. Not every site was sampled every year, and a complex statistical model (a generalised additive mixed model or GAMM) was necessary to control for varying sampling effort, temporal autocorrelation, non-stationarity of seasonal phenology, annual climate variation, and nonlinearity of temporal trajectories across sites. Nevertheless, this kind of data is very much better than anything that has gone before.

But even a study as good as this one inevitably has its limitations. You'd think, wouldn't you, that it would be easy to count insects that advertise their presence by turning on a bright green light at night? But of course, it isn't. As Shakespeare noted more than 400 years ago (quoted at the head of this article), the time of night may be important. What if the glowworms are there but don't shine? As I read the bard's words, spoken by the ghost in Act 1 of *Hamlet*, he is here implying that glowworms glow all night and cease to shine with the approach of dawn's light.

Is there any truth in Shakespeare's idea? Most literature asserts that female *L. noctiluca* stop shining before midnight (Gardiner, 2006) and in the study being reviewed here, all counts were done between 22:00 and 24:00 hrs. But when I asked Tim Gardiner about this, rather to my surprise he said that it's possible that Shakespeare was right, and that early in the reproductive season (i.e. in June), and perhaps in very dark conditions, glowworms may continue to emit light much later than midnight (Gardiner, 2009). Is it possible that some glowworms might be eccentric in their timing? If that were the case, then those insects would be missed because they shone too early or too late in the night to be counted. I think that I might just have to go out and have a look… But then I'm not very keen to stay up all night! (I suppose too that this story says something about the hours kept by the young Shakespeare when he was out and about in the countryside as an amorous youth).

Even when the human observer is in the right place at the right time, the weather affects whether glowworms glow, as well as whether entomologists can see them. Even the phase of the moon has been reported to affect the ardour of the female glowworm. Moreover, you have to be sure to go out and count glowworms in the limited reproductive period of the year when females glow in order to attract males (it peaks in July in Southern England). So if you're attempting to monitor glowworm numbers over a period of many years, then you have to take note of the fact that the peak dates for glowworm bioluminescence not only shift according whether it has been warm or cold during the spring that preceded the peak dates, but must also register that the glowworm season has also systematically advanced to earlier dates with the progress of global warming. On the other hand, at least some glowworms can be seen to shine over a long period during the summer in the UK. Gilbert White noted that he saw a

glowworm in Selborne Hampshire on 14th June 1766, while Dorothy Wordsworth recorded in her journal on 17th October 1800 that glowworms were to be seen "in abundance" at Grasmere in the Lake District. In fact, in Gardiner and Didham's study, this year-to-year variability in seasonal phenology turned out to be the most important single factor affecting glowworm numbers.

And even then, an individual female glowworm only glows if she is unmated; she mates only once, and when inseminated she ceases to shine. This means that if there are lots of males, then she may well emit light only for a night or two. But if there are few males (or if they can't find her) then she may well glow for much longer. Thus, a larger total number of observations of glowing glowworms over many nights doesn't necessarily mean that more glowworms are glowing, and the number of glowworm sightings may not be straightforwardly proportional to the population density.

All these confounding factors are consistent with the fact that counts of glowworms are typically highly variable from place to place and from year to year. Some of that variability might be a real reflection of populations and some might not. But the important thing is at least to be consistent in the method of data collection.

Thus, the great difficulties in making a quantitative estimate of an insect's population decline over an almost 20-year period of work are made very clear in this fine paper. An example of such a problem is that despite the care taken in the design of the sampling regime, some sites declined during the project to such an extent that glowworms were no longer found there at all; under such circumstances it is not surprising that volunteer sampling at such zero-return sites had to be discontinued. The authors comment that the true level of glowworm decline may have been underestimated in their study for this reason.

All of the above caveats made it hard for Gardiner and Didham to be absolutely certain that the Essex glowworms are in trouble, but their best-fit model did show that a statistically significant overall decline had occurred. The authors cautiously conclude that in the early 21st century, *L. noctiluca* numbers fell by about 3.5% per year, the total predicted 17-year decline being about -40% (see Fig. 1C), or one quarter of the population per decade. This is a real achievement for the scientists who did the work, but it's not good news for glowworms or for glowworm-lovers.

Some of the problems that I have discussed above arise from the fact that the health of a glowworm population is assured not by having enough light-emitting events, but by having enough glowworms. Counting individual "love torches" doesn't actually count glowworms; it's only a proxy. Would there be any other way of counting glowworms that didn't suffer all these methodological difficulties? A completely different approach would be to use the mark-release-recapture method. This hasn't as far as I know been done with *L. noctiluca* but has been successfully tried with the Japanese Heike firefly *Aquatica lateralis* (formerly *Luciola lateralis*) (Koji *et al.*, 2012). Although it would be time consuming and difficult to do, this might at least be a way of validating the easier light-counting method.

Why are glowworms in trouble?

In discussing why a general glowworm decline might be occurring in the UK, Gardiner and Didham (2020) identify a number of possible explanations.

One candidate for long-term change in glowworm numbers would be a change in the weather. There is already some evidence in favour of this. Atkins *et al.* (2016) noticed that glowworm numbers at one of the more intensively studied of their study sites (near West Malling in Kent) were strongly influenced by rainfall. Total numbers of observations of females glowing during the season, the mean number of glowing females observed on any one night, and the total length of the glowing season were all positively correlated with the number of wet nights, and total numbers of glowing glowworms for any one season were proportional to total annual rainfall. But is this effect of precipitation direct or indirect? And to what extent is the effect immediate? Evans *et al.* (2019) actually found that it was last year's weather that has the greatest effect on the number of firefly observations in the USA. Maximum temperatures in the preceding winter and spring were most important, followed by rainfall and soil moisture over the previous 20 months.

This is where the GAMM methodology of Gardiner and Didham (2020) shows its strength. In all of the different models used in their UK glowworm study, the most important explanatory variable was always seasonal phenology, with annual climate variation always subsidiary to this. This could be a real effect of the weather on glowworm numbers, but it could also be due to the unexpectedly early or late emergence of adult glowworms, so that they were not counted (as noted above, early and late glowworms might also glow at the "wrong" time).

Although anthropogenic climate change leading to warmer spring temperatures and phenological advance has to be considered as a possible contributor to decline, site-specific factors turned out be far more important in this survey. Fig. 1C shows the very great geographic variability in population density estimates, even after allowing for known confounding factors. In fact, density varied between individual sites over a range of no less than two orders of magnitude, and some sites clearly prospered at times when other sites were in decline.

Sensitised to this issue by my previous *Research Spotlight* article, I can see that two obvious candidates for site-specific glowworm decline are local habitat loss (for example a different land management programme at the site), and an unsuitable local artificial light regime (which itself might be viewed as a special case of habitat degradation). Habitat transformation of various sorts is probably always the strongest candidate as a causal factor in insect declines (Wagner, 2020). But neither Atkins *et al.* (2016) nor Gardiner and Didham (2020) were able to identify this as a cause in UK glowworm declines.

On the other hand, there is plenty of experimental evidence that artificial lighting can disturb light-emitting insects. Streetlights and/or skyglow might be expected *a priori* to confuse the light-based sexual signalling that is so characteristic of *L. noctiluca*. But there is plenty of experimental evidence that artificial lighting does indeed disrupt light perception and signalling in lampyrids and other bioluminescent insects (reviewed by Owens and Lewis, 2018). Lewis *et al.* (2020) went on to argue that artificial light is one the most important factors in what they describe as a global decline in luminescent insects.

So far, however, actual evidence from population surveys that supports an important role for ALAN in glowworm and firefly declines is at best sketchy. As far as I can see there are

only three papers that provide relevant evidence, all of which refer to light-emitting insects in city parks (Viviani *et al.* 2010; Picchi *et al.*, 2013; Mbugua *et al.*, 2020), not to natural environments. Gardiner and Didham (2020) did collect categorical information about artificial lighting conditions at their glowworm sampling sites in Essex, but their GAMM analysis did not detect a significant effect of lighting on glowworm abundance.

Gardiner and Didham commented in their paper that detailed studies of the influence of ALAN on *L. noctiluca* reproductive success are urgently needed, although they didn't spell out why. Here is one reason why we need this information: if artificial night lighting reduces the efficiency with which male glowworms can find females, then we would expect the number of nights on which females shine to be greater in artificially-lit sites than in dark ones, and the size of the population would therefore be falsely overestimated.

Moreover, ALAN might lead to subtle effects on female fecundity. Male glowworms use the light intensity of female glow as a proxy for fertility, perhaps because in the dark it is difficult to measure other possible indicators such as size. There is a clear positive correlation between lantern size and fecundity, and under experimental conditions males markedly prefer to approach the brighter of a pair of artificial lanterns (Hopkins *et al.*, 2015). Artificial lighting may diminish the accuracy with which males can distinguish among females, thus leading to non-optimal distribution of male fitness among females. For all these reasons, I completely agree with Gardiner (2009) that there is a strong case that putting streetlights to bed early may benefit glowworms and other bioluminescent insects (and it would save energy and reduce carbon emissions too).

My guess is that, as for other declining insect populations, the cause of glowworm decline will eventually emerge as being multifactorial, with intensive agriculture and land management practice being key factors. Gardiner and Didham did attempt to factor into their model categorical information about the condition of the environment at each of their glowworm sites, but this was not a useful predictor. Probably, the most severely degraded sites don't have any glowworms at all, and so you can't count them; that's what local extinction means.

I suppose that a key adaptation conferring ability to survive the many insect extinctions that must be the inevitable consequence of these widespread declines will be the ability to recruit human sympathy. Those insects that are "popular" will be first in line for practical assistance in the form of targeted conservation programmes. Glowworms, ever popular with poets, will certainly do well in such an insect celebrity contest.

Acknowledgements

I am grateful to Dr Tim Gardiner (UK Fisheries Biodiversity & Geomorphology, Environment Agency, Ipswich) who corresponded with me about *Lampyris noctiluca* and provided a Shakespearian surprise. If on reading this, you are keen to do your bit to help glowworms in the UK, then start by visiting this URL: https://www.glowworms.org.uk/

References

Atkins, V., Bell, D., Bowker, A. et al. (2017) The status of the glow-worm *Lampyris noctiluca* L. (Coleoptera: Lampyridae) in England. *Lampyrid* **4**, 20-35.

Booth, D., Stewart, A.J.A. & Osorio, D. (2004) Colour vision in the glow-worm *Lampyris noctiluca* (L.) (Coleoptera: Lampyridae): evidence for a green-blue chromatic mechanism. *Journal of Experimental Biology* **207**, 2373-2378.

Didham, R.K., Basset, Y., Collins, C.M. et al. (2020) Interpreting insect declines: seven challenges and a way forward. *Insect Conservation & Diversity* **13**, 103-114.

Evans, T.R., Salvatore, D., van der Pol, M. & Musters, C.J.M. (2019) Adult firefly abundance is linked to weather during the larval stage in the previous year. *Ecological Entomology* **44**, 265-273.

Gardiner, T. (2001) Essex glow-worm survey. http://www.galaxypix.com/glowworms/glowrep.doc (Accessed 10 April 2020)

Gardiner, T. (2006) Effect of survey start time on counts of the Glow-worm *Lampyris noctiluca* (Col.: Lampyridae). *Entomologists Record* **118**, 184-185.

Gardiner, T. (2009) Lights out for glow-worms *Lampyris noctiluca* (Col.: Lampyridae). *Entomologists Record and Journal of Variation* **121**, 4-5.

Gardiner, T. & Didham, R.K. (2020) Glowing, glowing, gone? Monitoring long-term trends in glow-worm numbers in south-east England. *Insect Conservation and Diversity* **13**, 162-174.

IUCN (2018) IUCN Firefly Specialist Group 2018 Report. [https://www.iucn.org/sites/dev/files/2018_firefly_sg_report_-_publication.pdf - Accessed 10 April 2020]

Jusoh, W.F.A.W. & Hashim, N.R. (2012) The effect of habitat modification on firefly populations at the Rembau-Linggi estuary, Peninsular Malaysia. *Lampyrid* **2**, 149-155.

Koji, S., Nakamura, A. & Nakamura, K (2012) Demography of the Heike firefly *Luciola lateralis* (Coleoptera: Lampyridae), a representative species of Japan's traditional agricultural landscape. *Journal of Insect Conservation* **16**, 819-827.

Mbugua, S.W., Wong, C.H. & Ratnayeke, S. (2020) Effects of artificial light on the larvae of the firefly *Lamprigera* sp. in an urban city park, Peninsular Malaysia. *Journal of Asia-Pacific Entomology* **23**, 82-85.

Picchi, M.S., Avolio, L., Azzani, L. et al. (2013) Fireflies and land use in an urban landscape: The case of *Luciola italica* L. (Coleoptera: Lampyridae) in the city of Turin. *Journal of Insect Conservation* **17**, 797-805.

Reynolds, S. (2019a) Bugpocalypse? The Krefeld paper and large-scale declines in insect populations. *Antenna* **43**(1), 5-9.

Reynolds, S. (2019b) Pollinator ups and downs. *Antenna* **43**(2) 57-62.

Reynolds, S. (2020) A trick of the light? Artificial light at night, insects and spiders. *Antenna* **43**(4) 159-164.

Wagner, D.L. (2020) Insect declines in the anthropocene. *Annual Review of Entomology* **65**, 457-480.

Entomological Rock Music

Lars Chittka

School of Biological and Chemical Sciences,
Queen Mary University of London,
Mile End Road, London E1 4NS

I have researched bees for the last three decades, and it's probably fair to say that I'm a little obsessed with them. I always felt, however, that my fascination with their strange world could only partially be captured in my scientific writings. So, I decided to write some song lyrics about bees. I dug up the guitar that had gathered dust since my teenage years and formed a band, the *Killer Bee Queens*, featuring bassist and singer Katie Green and guitarist Rob Alexander. Together we have released a concept music album, entitled "*Strange Flowers*" in which all song lyrics are inspired, one way or another, by the realm of bees. All proceeds from the music will go to invertebrate conservation charity Buglife.

It was important for me not to write sentimental texts about quaint summer meadows and buzzing bees. As I am learning every day as someone who studies the psychology of bees, the world of pollinators and flowers is full of manipulation, trickery and death. Take the lyrics of the song "*Dying Killer Bee Queen*" – a rather Shakespearean tale, but inspired by the real biology of honeybees, on how the queen's life began with murdering her sisters and then subsequently all her lovers died, too. Another example is the song "*I Stung Gwyneth Paltrow*" – the background is that the actress revealed some years ago that she uses bee stings as a form of beauty therapy – in a process that requires killing the bees. The somewhat bible-inspired song text takes the vantage point of a bee sacrificed for this purpose.

It is hoped that public awareness for the fascinating world of bees is raised through this unconventional pathway of popularising science. Everyone has heard that bees (as many other insects) are in trouble from habitat destruction, pesticide overuse and other man-made factors, and hence we have teamed up with invertebrate conservation charity Buglife. We want to support their invaluable work to bring threatened insect populations back from the brink. Please consider donating to them by purchasing our music on the following webpage:

https://killerbeequeens.bandcamp.com

For your entertainment, there is also a music video, in which I have combined the song "*The Beekeeper's Dream*" with clips from classic experimental film "*Wax or the Discovery of Television by the Bees*" (with permission from film director David Blair). Enjoy the music, and be kind to bees!

https://www.youtube.com/watch?v=jxJcEgfrV44&t=106s

DYING KILLER BEE QUEEN

Seven summers, but I liked the winters best,
Darkness, sweetness and stories.
For months, only stories,
Or were they dreams? Who knows?

In the beginning,
I murdered my royal sisters.
There was no choice,
It was written.

I killed my lovers too,
Or they killed themselves.
Who remembers? Who cares?
It is so long ago.

But my children. My daughters! My babies.
Flying girl soldiers. Poison arrow princesses!
Dead before their mother, almost all.
Do you know I gave each of them names?

How proud I was of the first one.
Little Eve who wanted to be a courtesan,
And dreamed of flying to the moon.
You give them sweets and they're off to war.

We conquered a continent,
We crossed the Amazon,
And the Panama Canal,
In formation flight!

How I longed for our heroines to return,
To tell the stories of our glorious victories.
But their bodies litter the battlefields
From Sao Paulo to San Francisco.

The ones that come back: cowards!
Their quaint stories of pretty meadows.
I never cared for flowers much,
Or the foragers' dainty dances.

Now I am a cave animal.
I remember everything,
But I am tired of hexagons,
And of wax and of war.

Here they come again,
"It's time for another egg!"
I have given you all the eggs I have.
I have nothing else to give.

Kill me, my daughters,
I have seen enough!
Don't let me croak like an old dog,
Let me die like a warrior.

I STUNG GWYNNETH PALTROW

I have died for your sins,
So you may shine eternally.
Pierced for your transgressions,
Crushed for your iniquities.

I gave you my greatest gift,
The ultimate sacrifice.
In the name of undying beauty,
I took the fate that you try to evade.

But I will rise from the dead,
So you and I can meet again.
I shall judge you righteously,
There will be weeping and gnashing of teeth.

And no eye has ever seen,
Nor the heart of man imagined,
The sweet revenge I have prepared.
A six-legged goddess awaits you.

Introducing Edible Insects into Welsh School Canteens

Dr Verity Jones

Senior Lecturer and Online Project Lead,
Department of Education and Childhood,
3S303, Frenchay Campus,
University of the West of England,
Bristol, UK.

Insects as food is not a new idea. In the Old Testament's book of Leviticus, a list of permissible foods is given; insects include locusts, crickets and grasshoppers. The Romans and Greeks were known to dine on beetle larvae, and Aristotle wrote about the best ways of harvesting cicadas to eat. While in some countries the tradition has continued, with the large-scale agricultural revolution of the West, insects have transformed from food to foe. What was seen as a tasty morsel has metamorphosed in many a society's imagination into something that is dirty and disease-carrying, an unwanted pest.

However, with a focus on a more sustainable future, many people are now rethinking their relationship with insects. It has been suggested that global meat consumption will have to increase by 76% by 2050 (WRAP, 2015) if we are to feed our growing global population. This will demand an estimated 42% more crop land with associated intensification of farming practices (UNFAO, 2013). Wang & Beydoun (1999) consider the societal impacts of this, while Springmann *et al.* (2018) note a number of negative implications for the environment, including increased deforestation, pressure on limited water supplies and increased greenhouse gas emissions.

In response to the current global climate and ecological emergency, many organisations including the Food and Agriculture Organisation of the United Nations (UNFAO) have recognised the benefits of entomophagy (eating insects). People in the West, where the practice of entomophagy is less common, have been urged to adopt this dietary change (van Huis *et al.*, 2013): however, this brings with it a number

of challenges. How can we begin to encourage people to make the shift? While some work has begun with researching behaviour change in adults, young people have, until recently, been largely neglected in this discussion.

People of school age number around 10 million in the UK and are becoming increasingly more visible and vocal in their desire to see more sustainable action. With regular climate protests and the work of young activists, such as Sweden's Greta Thunberg and India's Licypriya Kangujam, being communicated through social media, this group is showing its desire for change.

The purpose of the study reported here was to begin to establish how young people negotiate new, sustainable foods in school, and to develop a better understanding of how they view entomophagy. It was anticipated that this approach would support informed directions for future enquiry and contextualise the complexity of sustainable food in school.

The Welsh Context

Wales is home to Grub Kitchen, the only restaurant in the UK with edible insects as the daily focus on the menu, sited at The Bug Farm visitor and research centre. This award-winning and popular venture in Pembrokeshire, West Wales, has a mission to educate people on the importance of insects in modern society. Founders, chef Andy Holcroft and entomologist Dr Sarah Beynon, have also developed a range of edible insect products through their company Bug Farm Foods, a food manufacturing, wholesale and retail business based on-site. Of relevance to this research is their development of a product called VEXo™; an insect and plant protein mince specifically designed to reduce saturated fat in food for young people as a way to help tackle childhood obesity in Wales. The Welsh Government and Innovate UK provided support for this development through their Small Business Research Initiative and VEXo was taken into three Welsh schools in 2018 as a pilot project.

The research focussed on the experiences of *c.*200 pupils from years 2, 4, 6, 7 and 9 (respondents ranging in age from 7 to 14 years). Pre- and post-workshop questionnaires, observations of workshops and focus groups were undertaken with pupils. Having the opportunity to try the food was considered essential and supports House's (2016) call for research to shift away from that which only theoretically forecasts acceptance. To date, studies focusing on actually tasting edible insects have been restricted, with just a few notable exceptions with adults (*e.g.* Looy & Wood, 2006 and Megido *et al.*, 2014).

Thematic analysis exposed three issues to consider when supporting young people in shifting their attitudes towards an acceptance of edible insects: (1) uncertainties surrounding the possible health impact of consuming insects; (2) questions regarding the source of the insects and how they are farmed; and (3) concerns about what the food products they were going to be asked to try might look like.

Rozin & Fallon (1980) note that the new consumer can be repelled by a food they assume to be 'dirty' or 'nasty', in this case an insect's perceived habitat and /or behaviour could be off-putting. This repulsion can take a physical form with people feeling unwell at the thought of eating the product: results from this study echo this. Initially, young people reported feeling sick at the thought of eating insects and were relieved when the products looked, smelled and tasted familiar. VEXo has been purposefully designed to look like, in the case of the pilot study, a burger and Bolognese.

Results of the project showed that, before tasting VEXo, only 27% of young people reported that they would consider

choosing edible insects as a lunchtime option at school. After tasting the product, 74% of young people were positive about its taste, with 100% of comments relating to the taste of VEXo Bolognese being positive.

School dinner take-up is around 50% for those schools taking part in the pilot project and, when VEXo Bolognese was put on the menu, 60% of young people eating hot meals chose VEXo. This provides an initial indication that the introduction of such food may have the ability to increase school dinner take-up when compared to current take-up. Interestingly, after the workshops, 80% of young people noted that they wished to learn more about sustainability, suggesting that an intervention like this could have wider sustainability benefits. As one pupil commented: "We all know that looking after the planet is important – right? But we don't learn about what we can actually do to make a difference [at school]. This [VEXo] is real. We can actually make changes to what we eat and that might actually make a difference".

As a result, we would argue that the normalisation of edible insects into recognisable forms is essential for the acceptance of them as a food source by young people. Our findings echo other studies undertaken with adults (Pascucci & de-Magistris, 2013; Megido *et al.*, 2016; Menozzi *et al.*, 2017; Sogari, Menozzi & Mora, 2017) as well as observations at Grub Kitchen and Bug Farm Foods. This work provides initial evidence to assist with sustainable food policy design, improve acceptance of sustainable food systems in schools and increase the accessibility of healthier and more sustainable consumer options in a context where young people have not previously been the focus.

For a more detailed insight into the analysis of this project and discussion of its integration with environmental education more widely, please see Jones & Beynon (2020).

Acknowledgments

This article is based on research undertaken with Bug Farm Foods Ltd, funded by Welsh Government and Innovate UK's Small Business Research Initiative. Thanks go to Dr Sarah Beynon for co-authoring the original paper and for commenting on a draft of this article and to Dr Sarah Beynon and Andy Holcroft for assistance during workshops. To find out more about VEXo, please contact Bug Farm Foods directly – www.bugfarmfoods.com – @bugfarmfoods – info@bugfarmgoods.com.

References

House, J. (2016) Consumer acceptance of insect-based foods in the Netherlands: Academic and commercial implications. *Appetite*, 107, 47-58.

Jones, V. & Beynon, S.A. (2020) Edible insects: applying Bakhtin's carnivalesque to understand how education practices can help transform young people's eating habits. Children's Geographies, doi.org/10.1080/14733285.2020.1718608.

Looy, H. & Wood, J. (2006) Attitudes toward invertebrates: Are educational "bug banquets" effective? *Journal of Environmental Education*, 37, 37-48.

Megido R., Gierts, C., Blecker, C., Brostaux, Y., Haubruge, É. & Alabi, T. (2016) Consumer acceptance of insect-based alternative meat products in Western countries. *Food Quality and Preference*, 52, 237-243.

Megido, R.C., Sablon, L., Geuens, M., Brostaux, Y., Alabi, T., Blecker, C., Drugmand, D., Haubruge, E. & Francis, F. (2014) Edible insects acceptance by Belgian consumers: promising attitude for entomophagy development. *Journal of Sensory Studies*, 29, 14-20.

Menozzi, D., Sogari, G., Veneziani, M., Simoni, E. & Mora, C. (2017) Eating novel foods: An application of the theory of planned behaviour to predict the consumption of an insect-based product, *Food Quality and Preference*, 59, https://www-sciencedirect-com.ezproxy.uwe.ac.uk/science/article/pii/S0950329317300319 [16.05.19].

Pascucci, S. & de-Magistris, T. (2013) Information bias condemning radical food innovators? The case of insect-based foods in the Netherlands. *International Food and Agribusiness Management Review*, 16, 1-16.

Rozin, P. & Fallon, A. (1980) The psychological categorization of foods and non-foods: A preliminary taxonomy of food rejections. *Appetite*, 1, 193-201.

Sogari, G., Menozzi, D. & Mora, C. (2017) Exploring young foodies' knowledge and attitude regarding entomophagy: A qualitative study in Italy. *International Journal of Gastronomy and Food Science*, 7, 16-19.

Springmann, M., Clark, M., Mason-D'Croz, D., Wiebe, K., Bodirsky, B.L., Lassaletta., L., de Vries, W., Vermeulen, S.J., Herrero, M., Carlson, K.M., Jonell, M., Troell, M., DeClerck, F., Gordon, L.J., Zurayk, R., Scarborough, P., Rayner, M., Loken, B., Fanzo, J., Godfray, H.C. J., Tilman, D., Rockström, J. & Willett, W. (2018) Options for keeping the food system within environmental limits. *Nature,* 562, 519-525.

UN FAO (2013) How to feed the world by 2050. Report available at: http://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf [25.05.19].

van Huis, A., Van Itterbeeck, J., Klunder, H., Mertens, E., Halloran, A., Muir, G. & Vantomme, P. (2013) Edible Insects: future prospects for food and feed security, UNFAO https://library.wur.nl/WebQuery/wurpubs/fulltext/258042 [last accessed 16.05.19].

Wang, Y. & Beydoun, M.A. (1999) Meat consumption is associated with obesity and central obesity among US adults. *International Journal of Obesity*, 33, 621-628.

WRAP (2015) *Food Futures: from business as usual to business unusual.* http://www.wrap.org.uk/sites/files/wrap/Food_Futures_%20report_0.pdf [25.05.19].

Chrysops sepulcralis female © Steven Falk on Flickr.com

Photographic Taxonomy – A Strategic Issue?

Roger Morris
Syrphid58@gmail.com

Recently I received a 'letter' from Flickr, the photographic hosting website (Flickr, 2019). In it, the management advised that the platform was losing money and that it urged more users to sign up to its 'Pro' package (a subscriber service). This set alarm bells ringing for me because, in my view, Flickr has been a major influence in the growth of photography as a form of biological recording and live animal taxonomy.

Some users post the most amazing photographs; and when Stuart Ball and I started to develop our WILD*Guide* to Britain's Hoverflies (Ball & Morris, 2013) we drew extensively on the work of several of them (with their permission). This facility remains one of the best sources of high-quality photographs and doubtless developers of other guide books will have also made use of it. It is, however, a potentially transient resource as it has alerted users to its financial predicament. Losing the library of photographs is arguably now a matter of strategic concern to the biological recording community in the UK but is probably equally important elsewhere. It is rapidly becoming the photographic equivalent of a major national museum; but, why should this matter to entomologists when there are already museums stuffed full of preserved specimens?

In 2005, Paul Jepson published an article in *British Wildlife* in which he argued that photography was the new paradigm in biological recording. I, like many others, reacted strongly against this view on the grounds that so many organisms require detailed microscopy to arrive at a reliable identification; however, there is no denying that the advent of high-resolution digital photography has been a game-changer. It meant that for the first time a wide spectrum of wildlife enthusiasts could photograph the animals and plants

that they saw and, at least occasionally, could get a reliable identification using one of several platforms such as the now defunct '*Wild About Britain*'.

The development of *iSpot* (2019) was the first official stage in developing photography as a biological recording medium; the subsequent launch of *iRecord* (2019) took the process a stage further. Today, vast numbers of records are posted on *iRecord* each year (Morris, 2019) and photographs are used to verify many of those records. Those photographs are now the equivalent of museum voucher specimens, and the electronic record of identification and verification is the equivalent of the stack of det (i.e. 'determined by') labels on a pin beneath a specimen.

Thus, we now have a new science of 'photographic taxonomy'. Although derided by some specialists (I have had several colleagues question my use of time on this discipline) it is now an established part of biological recording and also of taxonomy. The reality is that many invertebrates look very different when alive: they are bigger, more colourful and often hold characteristic poses that set them apart from similar species. These traits take time to recognise, but a simple one can be seen in older keys to the Hymenoptera (e.g. Saunders, 1896) in which pale areas are described as 'white', when in real life they are varying shades of yellow! In the case of organisms that are mainly stored in alcohol, photography of live animals may be the only way of recording what they really look like!

The live-animal taxonomist working from photographs can, however, only use characters depicted by the lens. This limitation means that some animals can never be identified to species but may be taken to a higher taxon (species group, genus, tribe or family) (Morris, 2019). Nevertheless, within limits there is scope for descriptions of new species (Marshall & Evenhuis, 2015); indeed, a combination of live animal photographs and a preserved specimen offers the best facility for detailed descriptions. New species are now being described in this manner (Winterton *et al.*, 2012) and there have been several species recognised as new to Britain through this medium (as yet unpublished and hence not named).

A critical resource under threat?

Online photographic hosts are inevitably transient, especially those where the user pays a yearly subscription fee. What happens to that immense library when the user dies? A fantastic resource may be lost for ever; taxonomists and other researchers may also lose a combination of important records and perhaps even species new to science! Those who write specialist taxonomic guides will lose a valuable source of illustrations. Many of the users of Flickr and other online hosts do not realise the importance of their photographs; furthermore, the academic world is still only waking up to the potential of photography both as a taxonomic facility and in its contribution to biological recording. It has its limitations (Morris, 2020), but as an adjunct to specialist science it can be a very powerful research tool.

At the moment, there is no national repository for wildlife photographs. The medium is so recent that its strategic importance has yet to be fully understood. The letter from Flickr helps to highlight the issue; it hosts the comprehensive online guide to various invertebrate taxa compiled by Steven Falk (Falk, 2019). This resource is widely used by wildlife recorders and specialists alike (a similar approach has been adopted by Ian Smith for marine Molluscs – see Morddyn, 2019). From a personal perspective, when validating records submitted to *iRecord* and to the UK Hoverflies Facebook group (Facebook, 2019), I refer regularly to this facility when trying to make a firm determination of some hoverflies (Diptera, Syrphidae). Reliable resources by acknowledged experts are essential, as there are innumerable mistakes in the wider online community.

It therefore seems to me that there is an urgent need for taxonomists across the World to evaluate the real potential of photographic taxonomy and the most effective ways of utilising a remarkable resource that is almost certainly transient. It is an issue that extends way beyond the interests and capacity of the unpaid specialist community and deserves the financial resources that are required to make the most effective use of its potential. Ultimately, it seems to me that there is a need for a national repository for the best photographs that are of taxonomic and biological recording importance.

References

Ball, S. & Morris, R., 2013. *Britain's Hoverflies: An Introduction to the Hoverflies of Britain*. Princeton University Press. 296pp.

Facebook, 2019. https://www.facebook.com/groups/609272232450940/ (for hoverflies). Accessed on 20 December 2019.

Falk, S., 2019. https://www.flickr.com/photos/63075200@N07/collections/72157629222209764/ Accessed on 20 December 2019.

Flickr, 2019. https://www.flickr.com/ Accessed on 20 December 2019.

iRecord, 2019. https://www.brc.ac.uk/irecord/ Accessed on 20 December 2019.

iSpot, 2019. https://www.ispotnature.org/ Accessed on 20 December 2019.

Jepson, P., 2005. Natural History Re-mastered. *British Wildlife*, 17(1), 27-31.

Marshall, S.A. & Evenhuis, N.L., 2015. New species without dead bodies: a case for photo-based descriptions, illustrated by a striking new species of *Marleyimyia* Hesse (Diptera, Bombyliidae) from South Africa. *ZooKeys*, **525**: 117-127. https://doi.org/10.3897/zookeys.525.6143

Morddyn, 2019. https://www.flickr.com/photos/56388191@N08/albums Accessed on 20 December 2019.

Morris, R.K.A., 2019. Understanding common misidentifications of British hoverflies (Diptera, Syrphidae). *British Journal of Entomology & Natural History*, **32**: 351-363.

Morris, R.K.A., 2020. Imperfect detection: photographic recording and its implications. *British Journal of Entomology & Natural History*, **33**: 41-56.

Saunders, E., 1896. *The Hymenoptera Aculeata of the British Islands*. London: Reeve and Co., pp.viii + 391

Winterton, S.L., Guek, H.P. & Brooks, S.J., 2012. A charismatic new species of green lacewing discovered in Malaysia (Neuroptera, Chrysopidae): the confluence of citizen scientist, online image database and cybertaxonomy. *Zookeys*, **214**: 1-11. doi:10.3897/zookeys.214.3220

Society News

Meetings

The Royal Entomological Society's Special Interest Groups

Richard Harrington
SIG Co-ordinator
richard@royensoc.ac.uk

Meetings are a major part of the Royal Entomological Society's remit, *i.e.* '*the improvement and diffusion of entomological science*', and the Special Interest Groups (SIGs) form the backbone of the Society's programme. There are currently 22 SIGs (below). The latest list and information on each can be found at www.royensoc.co.uk/special-interest-groups.

- Aphids
- Aquatic Insects
- Behaviour
- Climate Change
- Conservation
- Data
- Ecology
- Electronics and Computing
- Food and Feed
- Forest Insects
- Genomics
- Imaging
- Infection and Immunity
- Medical and Veterinary
- Orthoptera
- Outreach
- Parasitoids
- Pollination
- Rearing
- Sustainable Agriculture
- Symbionts
- Taxonomy

On average, each SIG meets for one day every two years, but the frequency and duration of meetings varies, as does the location. Registration fees are kept very low but are slightly higher for non-members. A typical meeting has an invited speaker and several offered talks and posters, all presented in a friendly atmosphere to engender discussion and interaction. Some meetings include lab or field visits and some are followed by a social gathering. Participants are encouraged to establish a community that exchanges ideas between meetings. There is inevitably overlap in the subject matter covered by different SIGs and thus joint meetings are encouraged, as are joint meetings with other organisations.

Get involved

Some SIGs have long-term convenors, some change their convenors after each meeting. Being a convenor is very rewarding; a great way to make an impact on your area of entomology and, if a student or early-career researcher, a great way to become better-known. Convenors are fully supported by the SIG Coordinator, the Meetings Committee Chairperson and the Staff of the Society.

Please look carefully at what is on offer and come to the meetings that interest you. If you identify a gap in SIG coverage, please let us know, regardless of whether or not you are willing to consider filling it by becoming a convenor. If you have any ideas for a theme for a meeting of one of the existing SIGs, again please do get in touch.

The Verrall Lecture

4th March 2020

Richard Harrington

Professor Sir Charles Godfray

Driving ambition: can and should we use gene drive to knock out the major mosquito vectors of malaria?

For those not "in the know", the famous, and hugely enjoyable, Verrall Supper is not a Royal Entomological Society (RES) event. Rather, it is run by the Entomological Club, a select band of entomologists who organise it in memory of George H. Verrall, the originator of this great tradition back in 1887. The Verrall Lecture, on the other hand, is organised by the RES and is the Society's most prestigious annual lecture. Since the RES left its Queen's Gate HQ in 2007, the lecture has been held at the Natural History Museum. Dr Tim Littlewood, the Museum's Director of Science, welcomed us to the Museum and introduced our President, Prof. Chris Thomas who, in turn, introduced the speaker. As George Verrall was a dipterist, it was highly appropriate that this year's lecture majored on mosquitoes, and was presented by one of the Country's most distinguished entomologists, and Verrall veteran, Charles Godfray, Director of the Oxford Martin School. In the unlikely event that you are not familiar with Charles' story, take a look at the interview with him in *Antenna* 43(3), 144–146 (2019).

There are 200 million clinical cases of malaria a year, with more than half a million (mostly children) dying. Charles reminded us of the life-cycle, distribution and ecology of the *Plasmodium* parasite and its mosquito vector and showed that there had been substantial progress in its control over the last ten to fifteen years, largely through the use of insecticide-treated bed-nets and indoor residential spraying (both targeting the vector), and artemisinin-based combination therapy (targeting the parasite). There is now, though, widespread resistance to both the insecticides used against the mosquito and drugs against the parasite, and it is vital that we prepare for the failure of current strategies. Strategies under development include new drugs, vaccines and novel ways to target vectors. The latter include improving sterile insect techniques, interfering with transmission through use of *Wolbachia* bacteria and, the subject of this lecture, gene drive technology.

Biased gene transmission, whereby one allele is favoured over another during meiosis, can occur naturally and is sometimes so strong that only one allele is present in the gametes. Homing endonuclease genes (HEGs), found naturally in some yeasts and algae, cause such an extreme bias by effectively converting a heterozygote into a homozygote. A HEG present on one chromosome causes a break in the DNA on the other chromosome precisely opposite its insertion. The cell repairs the gap by copying the missing section from the homologous chromosome, hence the heterozygote becoming a homozygote (Charles described HEGs as "selfish genes that cheat Mendel"). Professor Austin Burt (Imperial College), who was present at the lecture, realised that HEGs had potential in "applied evolution" to control vectors and pests, and set up the Target Malaria project to control African mosquito vectors. The project now uses synthetic gene drives ("driving endonuclease genes" or DEGs) using CRISPR to do precise chromosome cutting that leads to more efficient spread.

There are various ways in which DEGs might be used. They could be designed so that the recognition site is in the middle of a gene which is essential to the mosquito, so that the homozygotes die. They might be used in "population replacement" whereby they target a mosquito gene essential for malaria transmission and knock it down, although such a gene has not yet been found. They might be incorporated into the Y chromosome and have a recognition site on the X chromosome, causing the X chromosome to be destroyed because it doesn't pair with the Y, thus resulting in sperm being produced with only the Y chromosome, strongly skewing the sex ratio towards males and driving the population to extinction.

It is counter-intuitive that a gene can spread in a population and yet control that population at the same time. Modelling done by Charles and Austin with Ace North (University of Oxford) and previously Anne Deredec (Imperial College) is designed to understand this and to reveal gaps in biological knowledge that can then be investigated experimentally. The group has developed a fully spatial model of a large part of West Africa including the whole of Burkina Faso. *Anopheles gambiae* feeds almost entirely on human blood, so can be modelled as living in villages and breeding in local water sources. Thus, permanent water courses and all villages have been mapped. Spread is predicted by modelling movement of mosquitoes between villages. At first, the model revealed a large area where mosquitoes could apparently not persist but, in reality, do. Investigation of the anomaly showed that local dispersal of mosquitoes was likely underestimated by existing data. Correcting this improved the model prediction but the inclusion of processes such as aestivation or long-distance dispersal on seasonal winds is required to match observations. Surprisingly little is known about how *An. gambiae* spends the summer and better data on movement would be very helpful.

The model predicts that an ideal DEG allele can spread and quickly cause region-wide elimination of mosquitoes. Some DEGs can persist in a colonisation–extinction equilibrium whilst still causing population suppression. Multiple releases with small numbers of mosquitoes containing the harmful gene drive are predicted to be more effective than a smaller number of larger releases.

There are regulatory challenges in introducing this technology, involving scientific, institutional and social issues.

For example, *An. gambiae* is part of a species complex, with no gene flow expected outside the complex. No gene flow outside the complex has been observed, but can this be completely excluded? Another issue is whether it is right to attempt to get rid of *An. gambiae* completely. Does it do anything useful? Is it part of a food-web? Both seem unlikely but better data are needed (Target Malaria is working on this). And how does one genuinely incorporate the values and perspectives of people living in affected countries into questions about how best to control malaria?

Charles tried to answer the questions posed in his talk title. Though much needs to be done, he thinks it highly likely that gene drive will be a potentially very valuable tool. But should it be done? That, in his view, is not his or his colleagues' call; it's a question for all of us, scientists or not.

Insects as Food and Feed SIG, April 2019

Peter Smithers

SW Region Hon. Secretary

As the 2018 meeting had been such a success the organisers decided to return to The Royal Agricultural University at Cirencester for a second year. We had expanded the format to a two-day meeting in order to be able to focus on the separate issues of food and feed. The author opened the conference and outlined developments in the field since the last meeting. Sainsbury's now sell part of the Eat Grub product range in selected stores and the Norwegian company Skretting feed their farmed salmon on insect meal made from black soldier fly, while insect-fed trout have recently gone on sale in the French supermarket chain Auchan. Investment in insect farming in Europe has dramatically increased. The Dutch company Protix raised €5 million and Y Insect in France raised €110 million. This sector is evolving rapidly. Professor Louise Manning then offered a warm welcome on behalf of the RAU. This was followed by a series of excellent talks on Day 1, summarised below.

Day 1

Andy Holcroft, Grub Kitchen

Andy discussed the origins and genesis of Dr Beynon's Bug Farm, outlining the original aims and how these had evolved. It is now a research centre, insect zoo and ento art gallery, as well as being the home of Grub Kitchen.

Andy's interest in insects as food was piqued by the UN's Rome report on IAFF, so he ordered some mealworms online and experimented with them. He then analysed what had worked and what hadn't. He decided on a 'softly, softly' approach to presenting insect meals to the public; it was important to make the food look good as well as taste good.

The Bug Burger has been Grub Kitchen's most popular dish, selling out in half an hour on the first day, so Andy began to use insect protein in other dishes customers are familiar with, such as Scotch eggs. "I feel that society is becoming more open to new foods, our regulars see other diners enjoying insect-based dishes and become curious", he stated. Grub Kitchen has also been endorsed by high-profile chefs such as James Martin, Stephen Perry and Michel Roux Jr., who said, "This is the future of food".

Bug Farm Foods is now up and running and will produce their own insect-based product 'VEXo'. Dishes using VEXo have been trialled in Welsh schools with great success (as reported in the current issue), and they are developing an associated teaching aid to go into the Welsh curriculum.

Gary Needham, Syngenta

Gary Needham runs the insectary for Syngenta, which produces vast numbers of insect species for the company's research programmes. Gary discussed the variety of culture methods required in order to rear the diverse range of insects in his insectary. He discussed the range of environmental conditions that are required to produce large numbers of insects, and went on to describe the range of cage designs required and the composition of the many artificial and natural diets that he uses. Monitoring the health of a given population was also important. Recording the numbers of failed pupae and deformed adults gives an insight into the health of the population along with regular checks on the bacteria present.

Roko Bosnjak, Entocycle

Entocycle have developed an automated climate-controlled rearing chamber for the production of Black soldier fly (BSF). This optimises the ratio of larvae to waste, counts the number of flies that emerge and auto-releases optimum numbers of flies into breeding cages. The larvae are automatically harvested from the waste when they reach the final instar. The chamber also extracts and sequesters ammonia from the system.

The rearing and harvesting chambers will be loaned or sold to farmers at the source of the waste materials, where the farmers will then grow and harvest the BSF which can then be collected by Entocycle for processing. The company is currently based in central London using waste from local coffee houses. Entocycle's potential markets are aquaculture and pet food, and they hope to have increased production to a point where they can replace 30% of fish meal in the Scottish salmon industry by 2025.

Audience and discussion panel at IAFF.

A series of 'rolling introductions' were then made from;

EatBugs

MM & JE Ware & Son

Soil Association

Veterinary Invertebrate Society

Peter Gulian

Fera Science

James Suckling, Centre for Environment and Sutainability at University of Surrey

Molly Rogers, Bristol University

Peregrine Live Foods

iProtein

Ian Folds, African Insect Protein

University of York, AgriFood.

University of Stirling

Panel discussion

After lunch the mornings speakers, plus Freya Lemmon, a lawyer from Michelmores, sat as a panel to field questions from the audience.

Drinks and insect canapés at Farm 491

Following the afternoon's discussion, the assembled company made a short walk across the RAU campus to the innovation unit "Farm 491", which had recently moved into a new state-of-the-art building. Farm 491 had kindly supplied the drinks for the reception and Andy Holcroft had spent the afternoon preparing a range of insect-based canapés which were now on offer. The head of Farm 491 welcomed everyone to the reception and Andy then explained what each dish was and how it had been prepared. There was then a tentative exploration of the delicacies on offer, which quickly transformed to enthusiastic dining. In fact, there was so much on offer that some of us were wishing that the dinner itself was several hours later!

Conference dinner

The conference dinner took place in the University's oak-panelled dining room. The meal was an extremely convivial affair and Andrew Swift gave an excellent off-the-record after-dinner talk on "*Insect biomass conversion: clean growth and agricultural productivity under the UK Industrial Strategy*".

In the first half of 2018, Fera Science was invited by the Agricultural Productivity Working Group (APWG) under the Food and Drink Sector Council (FDSC) to draw together stakeholders from the wider community impacted by insect bioconversion, to review the current status of this emerging manufacturing technology and its potential impact for the UK economy. Specifically, they were asked to make recommendations to the Government;

- on the potential for insect biomass conversion to drive future domestic and international economic growth from a 'new' and 'clean' industry,
- to illustrate the UK's competitive promotion (strengths and weaknesses) versus other 'first mover' economies; and
- to recommend what help or stimuli the Government should consider to accelerate development of the sector for 'UK plc'.

This work culminated in the compilation of a phase 1 report to the APWG, from which they envisage on-going effort in 2019 and thereafter. Andrew discussed how this Task and Finish Group was formed, set about its mission and highlighted several of the key conclusions and recommendations of the report.

Day 2

The day began in the worst possible way. Sleepily checking my emails over a first cup of coffee before getting up, I was suddenly awake. One of the speakers for that morning had made contact saying he was very sorry but he couldn't make it. As panic appeared on the horizon, I tried to stay calm!

Adjourning to breakfast and wondering how to resolve the issue, and having resigned myself to one less speaker, I then recalled that Benjamin Kennedy, an invertebrate vet who had offered a talk a couple of months prior (but by which point we had a full program), was in attendance. "Ok", he had said, "if anyone drops out I am happy to step in" although I was sure that a request on the day was not what he meant. It would be beyond any expectation that he would be willing to give such an impromptu talk but if I didn't ask I would never know! So, as people were filing in for the first session, I put this question to Benjamin expecting a polite refusal.

Insect snacks at the drinks reception.

There was an anxious silence but then to my amazement he agreed! He had something he could modify if I could give him a little time. We reserved the third slot and Benjamin gave a stunning talk on invertebrate veterinary medicine.

Paul Wright, the MD of Multibox

Paul gave an overview of the challenges facing producers of insect-based animal feeds. He identified two approaches to insect farming, which were waste valorisation or protein maximisation. Multibox is the latter. He explained how Multibox used software to map the location and availability of potential waste streams to feed to their black soldier fly. The main considerations were: is it legal to do so and is it logistically ok?

A survey of IPIFF (International Platform for Insects as Food and Feed) members found that 70% of them feed cereals to the insects that they rear. Waste streams are not yet a popular larval food source. In the aquaculture industry, fishmeal has been increasing in price, so soya meal is being used to replace it. Multibox is aiming to produce BSF meal at prices that compete with soya, but at the moment the pet food market seems the best market for them to aim for. Paul also discussed insect frass, which is a by-product of the rearing process and is an excellent organic fertiliser, but which has to compete with digestate and solids from sewage processing plants. Once insect farms are in full production, he envisages that frass disposal will become a problem that will incur a disposal cost.

At the moment there are 50 European companies in the insect rearing business, seven of these in the UK. These have raised $480 million of investment and produced 6,000 tons of insect meal last year. Paul predicted that the industry will generate up to $1 billion in the future, although production has to grow with customer demand.

Chris Leonard, IMBT and Tristan Cogan, Bristol University

Chris and Tristan discussed antimicrobial peptides (AMPs) as a rapidly emerging alternative to antibiotics. AMPs were discovered in 1979 in Sweden and have been found in many natural products, including milk and honey. Chris became aware of them when dealing with a maggot farm for the angling industry. The fly larvae were fed on salmonella-infected chickens, but when the larvae were then fed to fish, the fish grew well and showed no signs of salmonella infection. The larvae seemed to be controlling the salmonella. Intrigued, he began to research the process.

Standard research methods were to induce septic shock to generate AMPs. This involved pricking individual larvae with a contaminated pin, a method that is clearly not scalable for mass production. IMBT developed a technique that provided a molecular signature that would induce septic shock without the pathogen. They isolated a non-pathogenic bacterium which the insects perceived as an infection and caused them to produce the AMPs. The process is not yet fully understood, but briefly AMPs attach to the surface of bacteria and attract T cells which trigger a wider immune response. A range of AMPs can be produced by challenging the insects with different bacteria for different lengths of time and at different stages in the larval development. The AMP-inducing bacteria can be introduced into the larval feed as a supplement.

Eight years ago, IMBT conducted trials with poultry that were infected with campylobacter. Birds fed with an AMP supplement had a ten-fold reduction in the levels of campylobacter and an increase in weight compared to those feed on non-stimulated insect meal. Additionally there was an observed increase in AMPs produced by the poultry themselves. IMBT plan to offer a high protein food with anti-microbial properties that would reduce the need for antibiotics.

Benjamin Kennedy, Veterinary Invertebrate Society

Ben described the processes and tools he uses to examine and treat invertebrates. The examples were all arachnid cases, as this '11th hour' presentation had been rapidly adapted from a previous talk over the course of the morning session.

Case 1

The case involved the treatment of a scorpion that had dyskinesia, the symptoms of which are jittery uncoordinated movement. The cuticle was swabbed and sent for analysis. Results indicated a bacterial infection of *Pseudomonas*. The

Intense discussions at IAFF.

treatment was to inject antibiotics into the abdomen. The initial response was good, but then deteriorated so the animal was euthanised. It was then examined post-mortem, with histological examination of the heart revealing inflammation of the heart (inflammation manifests itself as deposition of melanin), which would explain the symptoms.

Case 2

The case involved mites on a tarantula. The tarantula was anaesthetised and then examined under a stereo microscope, where mites and eggs were clearly visible on the soft tissue between the cephalothorax and the abdomen. The spider was cleaned with alcohol using a fine paint brush, removing individual mites and eggs. The spider was much better within 24 hours. Further examination under anaesthetic revealed no mites.

Case 3

Or, The case of the Deserta Grande wolf spider (*Hogna ingens*) from Bristol Zoo, where the conservation population fell from fifty to eight. They were not eating and not moving, and were flicking off legs. An examination under anaesthetic revealed melanisation (thus inflammation) of the legs. Samples of dead spiders were sent for histological examination, with swabs revealing the presence of bacteria and fungi. Antibiotics were administered orally and the treatment reduced the progression of the disease, but could not stop it. The histology report revealed the presence of fungal hyphae in the heart muscles. Sections of the lung also showed inflammation between the lung layers. This case showed that microscopic examination and post-mortem histology can identify problems and allow treatment of the remaining population and support the modification of husbandry techniques.

After lunch the morning's speakers, plus Rachel O'Connor, a lawyer from Michelmores, sat as a panel to field questions from the audience. The meeting then broke up into small informal groups to network and exchange contact details and ideas.

The meeting had attracted 110 people over the two days, with 12 posters also being exhibited. It had been a great success.

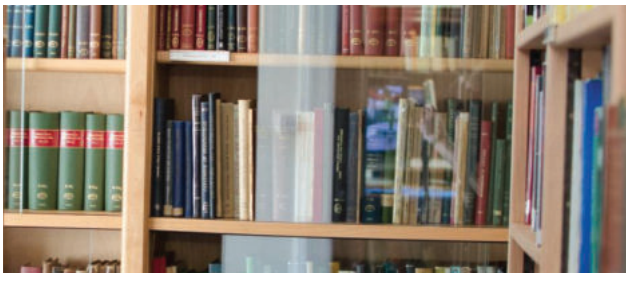
I would like to thank the Royal Agricultural University for their hospitality, and Mark Ramsden, Rachel O'Connor and Freya Lemmon for their hard work and enthusiasm, which made this meeting possible. I would also like to thank Michelmores for the loan of their PR officer and for funding the short video that was shot during the conference, Farm 491 for their generosity in hosting the drinks reception, and Andy Holcroft, who slaved in the kitchen all afternoon to ensure that we had the banquet of insect delights at the drinks reception.

Journals and Library

Library Committee – New members wanted

Professor Simon Leather
Chair of the Library Committee

The Library Committee is looking for additional members so that it better represents the Fellowship and Membership of the Society. The duties of the Committee are not onerous. We meet once a year and peruse a selection of entomological books that have been published since the last meeting. Members of the Committee rank each book and the top ranked books are then purchased for the Library. If you are interested in joining us, please contact me as soon as possible (simonleather@harper-adams.ac.uk).



Honorary Fellow Interviews

Lin Field
A Tale of Two Organisations

by Peter Smithers

Visiting Rothamsted is always a pleasure, so walking from Harpenden railway station on a cold rainy day just before Christmas did not dampen my spirits. I had arranged to meet Lin in reception and then adjourn to the now famous Trev's Caffe for lunch, but it was the staff Christmas dinner that day and there was 'no room at the inn'. So, armed with a sandwich we adjourned to Lin's office to talk about her career.

Have you always been an entomologist?

"No, I wasn't, it came about unexpectedly in what was a rather unusual career path for me. After leaving school with just 'O' levels, I worked at Glasshouse Crops Research Institute in Sussex as a lab technician. I was doing very routine tasks and I only took the job as it was just around the corner from my parents' house, so I could cycle to work. I then married and moved to Cambridge where I acquired a similar job. My new boss, Dennis Butcher, kept telling me I could have gone to university, which was something that had never occurred to me. No one in my family had ever gone on to higher education so I was not at all sure about it. Eventually he persuaded me, so I applied to do an Open University degree. The lab in Cambridge then closed down and we were transferred to Rothamsted where the job was similar, but I became more involved in many of the experiments, and used some of them, on crown gall disease and club root of brassicas as my OU projects. I can honestly say that if it hadn't been for my mentor Dennis, I wouldn't have become a scientist."

"While I was working at Rothamsted and still doing my OU degree, I was talking to my then Head of Department, Michael Elliott, one day when he asked me how the degree was going. I said, "I had really enjoyed the biochemistry and genetics and was thinking of applying to move to the Plant Science Department so that I could work in these areas". He said, "No don't do that, we need someone here to work on

Lin and Prof James Logan during National Insect Week.

insecticide resistance". So, I stayed in his department and started working on the mechanisms of resistance in aphids, investigating how insects develop it, what the genetic changes are and how they are selected. So, I guess you could say that this was when I became an entomologist, thanks to my second mentor, Michael."

"I was then promoted to a more scientific role at Rothamsted and having gained a first in my OU degree, I registered for a PhD, again in insecticide resistance. The OU degree had been very broad which was a great help in my PhD and also more recently when running the department. I was promoted again after gaining my PhD and some time later I became Deputy Head of Department, working with the then Head, John Pickett. When John reached an age where under the Rothamsted rules he could no longer be Head of Department, something that is illegal now, John and I swapped roles and I became the Head of Department."

"There comes a point in your career when you have to move away from what I call 'wet science' and becoming HOD was it for me. But I still hung on to supervising PhD students so I could look at data and help to write papers and continue doing some science, rather than work being all administration. Over my career my focus has varied, my OU degree was very broad then I narrowed into insecticide resistance, but as HOD I have broadened out again as the whole of our crop protection work now falls under me."

"The Open University is a great organisation. After my PhD I went back and taught summer school which I really loved. One regret I have in working here is the lack of teaching, but I have an honorary role at Nottingham University where I teach undergraduates, which I really enjoy."

How did you become involved with the RES?

"My first encounter with the RES was when I was asked to edit the journal Insect Molecular Biology (IMB). I was not a member of the Society but once in post I applied to be a Fellow. At that time IMB saw itself as a molecular biology journal, but once I was in post I began attending RES meetings and the Publications Committee and slowly became more involved. I was asked to go onto Council and then out of the blue Jim Hardie rang me to ask if I would be the next RES President. I was very surprised, but also very honoured, so I accepted it enthusiastically. The week I took up the post it was National Insect Week, so I found myself standing in a river looking for freshwater invertebrates and hunting for insects with children on a farm, which was great fun. I also gave a talk on mosquitoes with James Logan. After that I chaired Council and undertook other more down to earth duties, but I really enjoyed my time as President. When this was up, I was asked to be the Honorary Editorial Officer, so I stepped down from editing IMB to do this."

Looking for freshwater invertebrates in the River Wandle.

National Insect Week at Carr Farm.

You have worked mainly on insecticide mode of action and resistance, how has our approach to insecticides changed over your career?

"Some of the early pesticides were very broad spectrum and killed a wide range of insects, not just the target pests. Rachel Carson's book *Silent Spring* drew attention to this, and more focused pesticides were developed in response. The most successful of these were the pyrethroids, which were developed here at Rothamsted by my old boss Michael Elliott. As they were nontoxic to mammals, they were popular in crop protection, but also in the control of mosquitoes and the spread of many vector-borne diseases. There is no doubt that Michael's work has saved many, many lives."

"When resistance to pyrethroids began to appear, they were then replaced by the newly developed neonicotinoids; coincidentally at the same time the European Union changed the way it legislated on pesticides, shifting from risk-based system to a hazard-based system. So, if a pesticide is potentially toxic to non-targets, it's considered a hazard, even though if it is used correctly, it would not be a risk. The change led to a restriction on the use of neonicotinoids as seed treatments in Europe, and this became the topic of much debate."

"I was heavily involved in the debate and went to Brussels to try to bring the science into the discussion, but nothing in the neonicotinoid debate seemed to be about the science. I was trying to say, "let's weigh up the positive aspects of crop protection which prevents losing 30-40 % of a harvest against the off-target effects". But there was a groundswell of opposition; people who knew nothing about insecticides became involved. The ban was introduced and in the first year, cabbage stem flea beetle devastated the UK oilseed rape crop. So, farmers sprayed several applications of pyrethroids to control them which was certainly not good for our bees and other beneficial insects. I think this is a good illustration of unintended consequences and the need to assess the use of insecticides on a case-by-case basis. When I first became involved in the neonicotinoid debate my colleagues told me I was mad, but unless everyone involved in the decision-making process is informed, policies are made by people with little understanding of the issues. Scientists who are knowledgeable in a field should be willing to share their expertise with a wide audience, though scientists are often not very good at this. Plus, the press often don't like scientists as we don't say yes or no."

"I led a discussion on pesticides at a 'cafe scientific' held in the nearby pub, *The Silver Cup*. I started by asking who thought pesticides were a good thing; not many hands went up. I then explained some of the benefits, for example that they improve yields, which in turn reduces imports and also stops pathogens and pests accumulating in crops. After this most of the audience acknowledged that pesticides can do a good job. Of course, we should be trying to replace conventional insecticides with more environmentally-friendly crop protection methods, and at Rothamsted we are now working on a range of alternatives, such as integrated pest management, biological control and the use of field margins plus the development of selective chemicals which kill pest but not beneficial insects."

What does the future hold for agrochemicals?

"We won't get rid of agrochemicals overnight; the alternatives are slower to implement. Personally, I feel that chemistry should be a fire-fighting tool. We should try other things first and if they fail bring in chemicals. We need to integrate them into wider pest management systems. If we don't limit their use, there is also the risk of resistance, and then the legislation surrounding their use becomes more complex. The agrochemical companies have lost interest in Europe as the market for their products is shrinking. All of the development is now in the tropics, where the market for agrochemicals is still healthy. Another downside to reducing agrochemicals is that most insecticides used in vector control have come to the market on the back of crop protection products, which is where the money is. There is little profit in vector control, as by definition those that need it most are the poorer societies around the world. If companies are not developing new crop protection chemicals, then where will the insecticides come from to control future vectors of disease? There are philanthropic companies working in this area, the Gates Foundation for one. But these are the exception."

What are your thoughts on 'eco-agriculture'?

"There are two schools of thought regarding how agriculture and biodiversity can co-exist: 'sharing', which seeks to combine farming and biodiversity on the same site; and 'sparing', where the roles are separated, and high-quality agricultural land remains in intensive farming while less productive land is managed to maximise biodiversity. We don't really have conclusive evidence as to which is the best option, but data from work on birds indicates that sparing might be better. At the moment, the debate is affected by the fact that in Europe there is no shortage of food and it has been sold very cheaply, so most people are not aware there is a problem. Crops have also been bred to produce high yields, which has resulted in reduced resilience but also lower nutritional values. I think people should pay a bit more for high quality food, but then what should society do about the people on low incomes who can't afford the increases? It rapidly becomes a political issue."

As the RES Editorial Officer what are your views on the publishing scene?

"The process of peer review is under threat as it is becoming increasingly difficult to persuade scientists to do this, as it takes time and you often get no credit for it. We all do it because we are members of the scientific community. Now, the pressure is on to move to open access and I am worried that if someone is paying to publish, then it tempts the journal to accept lower standards."

"The RES is currently looking closely at when our journals might move to open access. In conjunction with our publishers, Wiley, we are deciding which journals are at a stage to move over, but we have to accept that such a move is always accompanied by a dip in income. There is a perception that the profits from producing journals go into the pockets of corporate publishers, but it is not appreciated that journals produced by societies like ourselves are our main source of income. This is what pays for National Insect Week, the SIGs and student grants. Most of the subscriptions received by the Society pay for the publication and distribution of *Antenna*. Even the Handbooks don't make money, as we run them as a service to entomology."

"Most of our journals no longer sell many hard copies; it's all online access now, which is good, as it saves paper and it means that papers don't have to wait for a space in the journal to be available. Even libraries don't take many hard copies; the whole publishing model is about to change. There are so many journals and papers today it's hard to keep up. The volume of new journals is huge; I receive regular invitations to become an editor of some new obscure journal. This ever-increasing number of journals must lead to the breaking of the peer review model. These journals must receive thousands of papers, so finding reviewers has to be a problem. A recent trend is to put pre-prints on-line for comment, but if just anyone is able to comment then where is the oversight? Overall, I am not sure where science publishing is going. It will be interesting to see. While I don't do social media, the recent trend of flagging papers of interest on twitter seems to work well."

How would you describe yourself?

"Overall, if asked what I do as an entomologist I would say I try to promote pest control that minimises adverse effects on beneficials and the wider environment. Some people feel if you work on killing insects you are not an entomologist, but I disagree. I do see myself as an entomologist and am proud to be one. I am getting close to retirement, but I am still not sure exactly when. Once I am retired, I definitely won't be out counting butterflies or ladybirds as many retired entomologists tend to do. I would like to do something that makes a difference in the community. For many years I was a Samaritan, so I would possibly like to return to something in that line."

Over the four decades that Lin has worked at Rothamsted, she has been witness to dramatic changes in the way we view and use agrochemicals. While her early work was focused on understanding the mechanisms of insecticide resistance, as her career has progressed, she has become involved in the development of a broader, more integrated approach to crop protection. She is a pragmatist, who will argue passionately in favour of a balanced approach to the use of chemicals in food production, but always one based on the science; a passion that I recall generated a fierce debate between herself and Dave Goulson at the Society's annual conference in Dublin back in 2015.

While her many papers on the molecular biology/genetics of insecticide resistance have made her an authority in this field, her many roles within the RES have enabled her to make significant contributions to the wider field of entomology. As Chair of the Publications Committee, Lin has encouraged the adoption of new ideas and has played a vital role in navigating the challenging move towards open access and online journals, while as President she was always willing to discuss and support new and innovative approaches to the public dissemination of entomology.

Lin's firm but modest demeanour belies the enormous contribution that she has made to both insect science and the RES. So, when the time comes to step down from her post at Rothamsted, while she won't be counting ladybirds, I am sure she will continue to make a difference; and as an entomologist, will also continue to fondly regard the aphids that she spent so much time working on, and will remain fascinated by the many other small things that run the world.

Grant Report

The Nectary and the "Hum of the Earth"

By Christopher Hassall

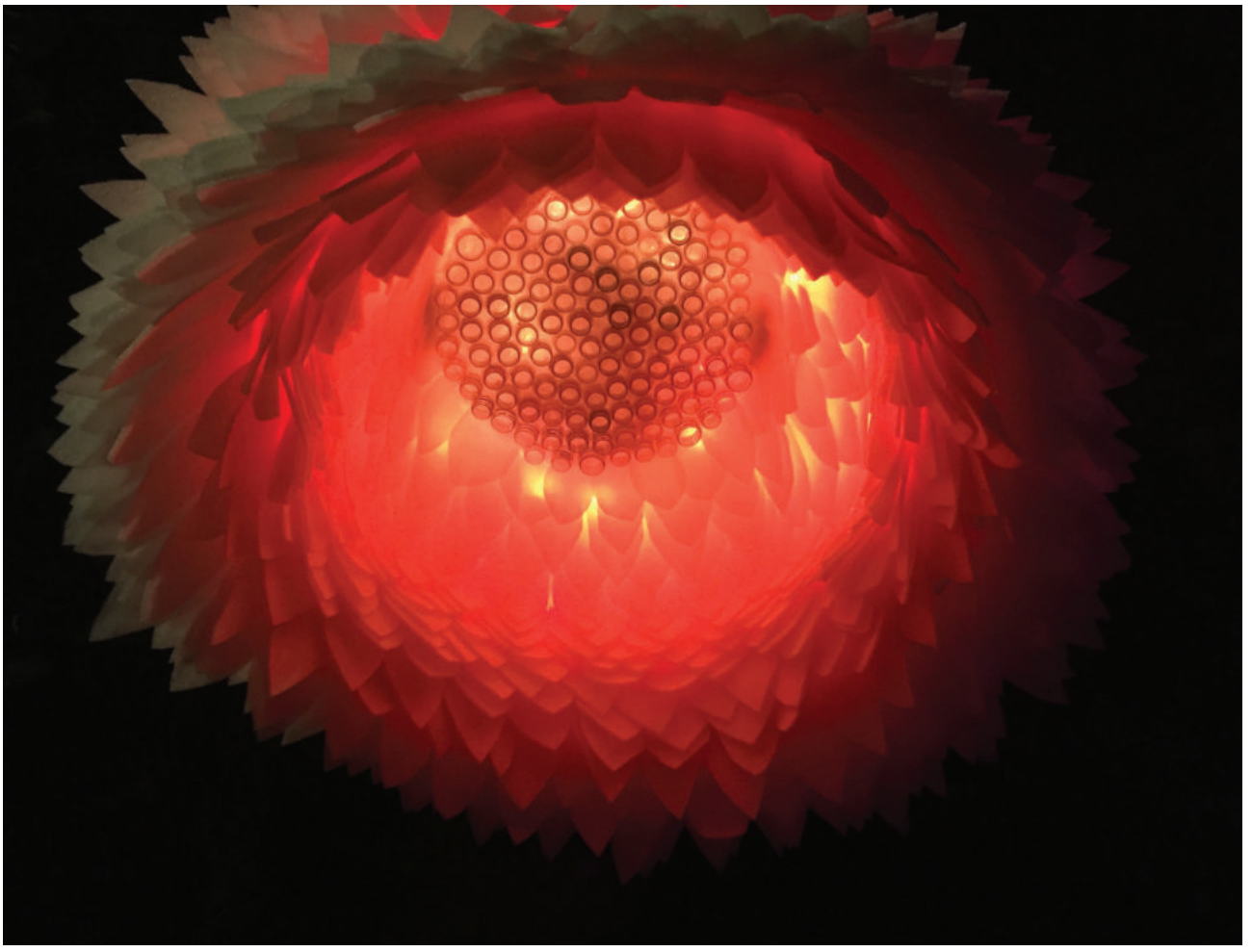
We are fortunate that in recent times the public relations campaign concerning the importance of insects has yielded considerable progress. Now, when asked which animals we should conserve, the public are more likely to say "bees" than "tigers", "lions" or "rhinoceroses". However, we still live in a world where people are cut-off from the nature that is all around them and the benefits that come along with being immersed in that nature. Reconnecting people with local nature was part of the motivation for the design of a new art-science collaboration: *The Nectary*.

The Nectary was an invitation to passers-by to immerse themselves in nature, to gain a new perspective on the life of a pollinating insect, and to mimic their behaviour as they moved through the installation. Participants could find the patch of flowers as they moved through the Light Night exhibits, attracted to the bright colours just as pollinating insects often are. Once at the exhibit, people were able to enter the large, suspended flowerheads to be fully immersed in the exhibit. Within each flowerhead, a different pollination soundscape played – recorded at one of three wildflower sites around Leeds that varied in the number of pollinating insects. The public could hear a 360-degree acoustic panorama of the wildflower meadow while rippling lights simulated the passing of other insects. As the audience moved through the patch of flowers, they moved from one flowerhead to the next, mimicking the movement of pollinators through wildflower patches.

Alison Smith, a local artist specialising in environmentally-focused and -inspired art, and I were originally brought together by a funding scheme at the University of Leeds that was designed to facilitate blue sky collaborations among artists and scientists. We developed *The Nectary* as an installation to be produced for Leeds Light Night – as the name suggests, a nocturnal event that involves a trail of installations across the city over two nights. Alison and I collaborated to produce a view of my entomological work through the prism of her artistic media: sculptures made from recycled materials and enhanced with audio-visual technologies. The piece was supplemented with interpretative signage that described both the science of pollination and insect declines as well as the underlying meaning of the piece.

Within *The Nectary*, our soundscapes acted as an outreach tool to illustrate the diversity and abundance of insects that visit flower meadows. However, the soundscapes are also a rich source of data that can be analysed using bioacoustic methods to quantify the number of insects present in a landscape and to obtain an approximate measure of the number of broad "types". Indeed, the audience were listening to data from a research project exploring the link between acoustic and observational measures of pollinator numbers that is being written up for publication at the moment. This technique, along with citizen science recording of pollinators along transects, will be used from this summer to monitor insect populations on the University of Leeds campus.

I feel strongly that creative media are an exciting and effective way in which to engage the public in science, above and beyond what can be accomplished through traditional



broadcast media. *The Nectary* attracted at least 750 people over two nights, many of whom spent time reading background materials and actively engaging with the exhibit. Scientist and artist were both on hand to co-curate the piece to offer our different perspectives on the meaning and importance of the ideas. Other methods, such as creative writing, can provide productive spaces to explore difficult or complex topics such as environmental issues about which people often have strong views. We hope that *The Nectary* has gone some way to changing a few perspectives on the natural world by taking a creative, immersive approach to public engagement around entomology.

Alison and I are both very grateful to the Royal Entomological Society for contributing generously to the creation of The Nectary from the Society's Outreach Fund. It is hoped that *The Nectary* will be exhibited again at Leeds Light Night in October 2020 and will feature in several other touring exhibitions around the country and internationally.

Competitions

Student Essay Competition 2019

1st Prize

The ANTicipation for a trip which BLOWed

Christina Conroy
University of Greenwich

Location: Masai Mara, Kenya

Date: 28/10/19

Target: *Charaxes candiope* (green-veined charaxes)[1]

The target kept its distance, the others in my team served as decoys, confusing the target and pushing it closer to me. My adrenaline began to spike, my legs trembled in anticipation and I eyed my surroundings with glee. Is this it? Have I accomplished my task…? I gave chase! Joy turned to confusion as my knees went weak, and one sandaled foot slipped over the edge of the nearby chasm, my balance was thrown off by the overstuffed rucksack on my shoulders. The green-veined charaxes butterfly I was chasing mockingly floated in front of my face as I plummeted into a trap of my own making. An audible tearing sound could be heard as my mind went blissfully quiet. The world went black.

Waking I felt like a beetle in a pitfall trap[2], the gash in my leg was open and my head swam with nausea. I screamed for help before succumbing to the quiet darkness once more. My mind played the following two days in a montage. People lying me on a stretcher, checking my now smelling wound. My skin felt too tight, the light too bright and angry purple bruises mottled my body.

Something moved under the sheet covering my body. Yelping I twisted, but the roughly woven cloth aggravated every bruise, scrape and cut on my body. Lights danced in front of my eyes and it took several deep breaths before my mind refocused. I slowly removed the sheet and instantly wished I hadn't. Maggots covered my thigh, my stomach convulsed, and a wave of nausea overcame me. Strong hands held me down as my mind raced and memories came flooding back.

'*Maggot therapy: the use of sterilised maggots (from the blow fly) which are placed into the soft tissue. Enzyme secretions from the maggots cause the breakdown of necrotic or dead tissue which the maggots feed upon. The healthy tissue is left intact and it helps to prevent infection*'[3,4].

I forced myself to relax, briefly wished the wriggling maggots were in a sanitised polyvinyl alcohol bag[5] and glared at my heroic saviours. Gritting my teeth, I watch as the vermin were flushed from my wound. The camp's 'doctor', a Maasai moran (an indigenous tribal man)[6], gave a decidedly manic smile before introducing me to his next torture device, driver ants (*Dorylus helvolus*). Their gaping jaws were unlike anything I'd ever seen before, my heart quickened, and I tried to pull away[7].

The doctor grasped the first ant in his hand before bringing it towards my wound. It bit me, I screamed and in a seemingly practised movement he ripped the body off leaving the jaws clamped around the wound. A perfect suture holding the wound together. One down, nine to go. To block the pain, I chanted facts in my head like it was my own personal mantra.

'*Driver ants live in colonies of around 20 million individuals. There is a single queen laying eggs and many sterile female workers and soldiers…*' [7,8]

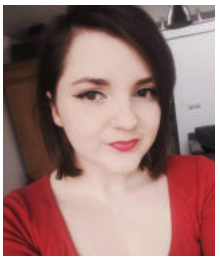
I winced again as the fourth ant sank its mandibles into me. I continued my chant.

'*… Male ants leave the colony after hatching. When a colony of driver ants find a sexually mature male, his wings are ripped off and he is taken to a virgin queen to mate. He dies soon after*'[7–9].

I suddenly hoped I wasn't the male ant, destined to die after being found by a colony. I cried out as the last ant bit into my flesh and the agony finally, blissfully lessened. I was informed that a man with a car would be passing through in two days. He would take me to the large town. I thanked them and began to wonder if collecting butterflies from the Masai Mara for the Kipepeo butterfly project[10] was worth it. Looking at the row of dead ant heads I thought maybe the Natural History Museum would make a better trip for next year.

References

1. Someren, V. G. L. & Someren, R. A. L. The life-histories of certain African nymphalid butterflies of the genera *Charaxes*, *Palla*, and *Exuxanthe*. *Trans. R. Entomol. Soc. Lond.* **74**, 333–354 (2009).
2. Greenslade, P. J. M. Pitfall trapping as a method for studying populations of Carabidae (Coleoptera). *J. Anim. Ecol.* **33**, 301–310 (1964).
3. Mumcuoglu, K. Y. *et al.* Maggot therapy for the treatment of intractable wounds. Pharmacology and therapeutics. *Int. J. Dermatol.* **38**, 623–627 (1999).
4. DellAntonio, J. Understanding maggot debridement therapy. *Nurs. Made Incred. Easy* **15**, 22–25 (2017).
5. Jukema, G. N. *et al.* Amputation-sparing treatment by Nature: "Surgical" maggots revisited. *Clin. Infect. Dis.* **35**, 1566–1571 (2002).
6. The Wild Co. The Maasai culture and traditions – Maasai wilderness conservation. *Maasai Wilderness Conservation Trust* http://maasaiwilderness.org/maasai/ (2016).
7. Schiappa, J. & Van Hee, R. From ants to staples: History and ideas concerning suturing techniques. *Acta Chir. Belg.* **112**, 395–402 (2012).
8. Gotwald, W. H. Predatory behavior and food preferences of driver ants in selected African habitats 1. *Ann. Entomol. Soc. Am.* **67**, 877–886 (1974).
9. Hermani, H. *Social insects. Volume IV Volume IV*. (1982).
10. Kipepeo Butterfly Project – promoting nature conservation & community livelihood. http://kipepeo.org/ (2016).



2nd Prize

The Long-Lost Tale of the Mother Earwig

Amy Carter
Harper Adams University

The sun dips below the horizon and makes way for a full moon. The sky above is replaced with navy blues and twinkling stars, and a soft dew settles in glistening droplets across the stems of a grassy opening. The coolness of the air settles in for the night and everything is still and quiet. In a small burrow, at the bottom of the garden, something is stirring. A male earwig, stocky and dark brown, runs from a small hole, quickly followed by a female. Their long legs move furiously as she chases him away, raising her mandibles viciously at him. His work here is done. She needs to be alone. As soon as he is out of sight, she raises her large head, her black compound eyes glisten in the moonlight. She is readying herself for something. Her antennae brush along the grass as she moves through the undergrowth. A fallen apple provides a relieving meal and she munches at the bruised edges of a crevice, perhaps previously created by a hungry slug. A rustling nearby echoes through the stillness, sending vibrations under her. She stops. A small field mouse runs by, seemingly uninterested by her and now the coast is clear. She moves down from the fallen fruit, her elongated body moving to the curvatures of the soil, her cerci are straight, moving gently above the ground. She is close to the burrow now; it is time.

Beneath a large leaning apple tree is a long piece of slate that conceals the entrance to her chamber. It is small and modest, two inches under the ground. The earth around her is moist, providing well-needed shelter and warmth. She is safe here. She spends the next few moments moving around, ensuring everything is cleared and ready. A ripple rolls through her swollen abdomen, her wing cases tight against her body. The time is here, egg laying has begun. One after the other, she lays them in a specially made shallow egg cell. 1, 5, 10, 30, 35….she continues until forty tiny white eggs take up the space beneath her, but something is not quite right. She looks at her eggs and the urge to move them around one by one is strong. Gently holding them in her mandibles she shuffles them around until they are perfectly organised. That's much better. Before the sun begins to rise, she curls up around her brood. She must rest.

The nights go by, and the mother earwig tirelessly turns and cleans her eggs. She removes any dirt and fungus and keeps them aerated. Come the seventh night, the eggs begin to move. She peers over her brood tracing them with her antennae; they are hatching now, one by one. Her tiny pale-white babies chew their way from within their casings, a handy first meal. The real job at hand starts now.

In order to give her brood the best chance at survival in a world full of predators, she must protect them, even from her own kind. She will not even risk them leaving before they are old enough to find food. She will forage and regurgitate, much like parent birds do with their chicks. After many risings of the moon pass by, the mother earwig looks on as most of the brood thrives and with every moult they become more like her. Elegant and fierce. Their bodies shine a deep brown, brushing harshly against each other. Her chamber is too small for them now and they are becoming boisterous. It's time to leave. The mother runs to the opening of a place she's held strong for many months. Her brood stare at her, their eyes watching her as she moves away. Mother is gone now. Is it time for us to go now too? The first of her brood, and one of the largest, rushes through the corridor to the entrance, closely followed by her siblings. They peer out. Cold fresh air washes over them and after short hesitation, they all disperse in different directions.

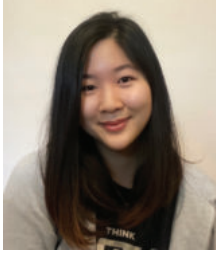
It is their turn now. Her daughters will go on to build similar chambers nearby, attracting males, and to eventually mate and care for broods of their own. As for her sons, they won't be as lucky as to have a stronghold. Instead they will spend most of their time congregating in bark crevices with other males.

The world of insects is a harsh place. One where even leaving shelter to find food can be treacherous, and everything eats everything else. But before you clear away earwigs from your gardens and greenhouses, remember the tale of the mother earwig who gave up her life to raise her young, and the male who spends his life running from her...

References

Staerkle, M. & Kolliker, M. 2008. Maternal food reguritation to nymphs in earwigs (*Forficula auricularia*). *Ethology*, **114**, Pp.884-850.

Lamb, R.J. & Wellington, W.G. 1975. Life history and population characteristics of the European Earwig, *Forficula auricularia* (Dermaptera: Forficulidae), at Vancouver, British Columbia. *Canadian Entomologist*, **8**(104), 819-824.



3rd Prize

Mozzy's Christmas Wishes

Rebecca Sim Shu Yu
Royal Veterinary College

Aedes aegypti

"Whoosh!" An electric racket came swooping towards me. I expertly escaped it.

Phew…What a close shave! Thank goodness for my acute senses. Imagine if I had the same type of eyes as those evil humans. I would have been dead by now. My eyes are my assets—my compound eyes are made up of small lenses that allow me to have a wider range of vision.

Oh dear, pardon my forgetfulness, I have yet to introduce myself.

Hi! My name is Mozzy! I am what humans name mosquitoes, specifically *Aedes aegypti*. A Greek found out about us and decided to name us *Aedes* because, for some absurd reason, they think that we are unpleasant. Maybe it is because we might be a little noisy. Maybe it's because they itch a little after we have a blood meal. These days, we lay our eggs in stagnant water on potted plants, bottles or window ledges.

However, we think that it is mainly because these people believe that we are bad omen. For some odd reasons, after a

bloodmeal, our hosts always end up ill. Sometimes their bodies turn extremely hot. Sometimes they complain about pain in their body. Sometimes they stop moving and eventually, stop breathing and start to turn cold.

However, all we wanted was just a bit of blood to feed our babies and survive.

We have come a long way and overcome many adversities over generations.

Back in the days, our ancestors resided in West Africa. Later, slave ships began coming to the coast of West Africa and we discovered new sites for us to lay our eggs – tanks full of stagnant water. This has helped us come to a foreign land called America. In 1900 a human named Walter Reed announced that we were the cause of Yellow Fever.

Imagine how wronged my ancestors must have felt! It was obviously the virus's fault! We are merely vectors…

In the 1930s, we started seeing fewer and fewer people falling sick after we had bloodmeals. Apparently, it was because they had a needle poked into their arms. These humans categorized themselves as "vaccinated".

Despite knowing that we are not the ultimate culprit, humans find ways to kill us. They spray their bed nets with insecticides to deter us from getting to them. Hah! Foolish beings! They must have mistaken us for *Anopheles gambiae*! We are *Aedes aegypti* and feed in the day.

Over the years, humans started building more and more concrete forests. Many of them started living in cities. We love cities! It is where we can feed to our heart's content! However, people started falling ill when we fed on them again. They started putting up signs screaming "Dengue Fever Hotspot", warning people to get rid of us by clearing stagnant water. We were no longer commonly known as *Aedes* mosquitoes. People called us "Dengue Mosquitoes" even though the true culprit is Dengue Fever Virus. We were once again wrongly accused.

When humans become dangerous, we turn to their pets. About six months ago, my grandmother fed from a dog, however just yesterday the dog was put to sleep. I had a peek at its post-mortem examination and to my horror, I saw white long worms entangled within its heart. Ugh, it was disgusting!

These days, when the humans' reflexes cannot out-win our speed, they devise other ways to kill us. They capture us and modify our male counterparts' genes such that we can no longer have children when we mate. They carry out fumigation that instantly kills us. They spray foul scents on themselves to deter us from getting near them.

Life is just unfair, isn't it? Humans took advantage of our saliva and invented anti-clotting medicine for themselves to treat cardiovascular and blood diseases. Yet they are still so bent on killing us.

At a ripe old age of 50 days old, I know that my time is almost up and I cannot help but worry about my future generations. I have heard that over the years, we have been migrating northwards as the temperature rises again. One day, we will reach the limit. Perhaps, our greatest fear isn't humans. Our greatest fear is the day when the coldest part of Earth becomes too hot for us to survive. That is the day when we will completely cease to exist.

This Christmas, I wish for global warming to end. This Christmas I wish for people to know me as Mozzy, not "Unpleasant" or "Dengue". This Christmas, I wish for the end of our series of unfortunate events.

Will my wishes be fulfilled?

References:

Reiter, P. Climate change and mosquito-borne disease. Environ Health Perspect 109(suppl 1):141–161 (2001)

Etymologia: *Aedes aegypti*. (2016). Emerging Infectious Diseases, 22(10), 1807. doi:10.3201/eid2210.ET2210

Lacroix R, McKemey AR, Raduan N, Kwee Wee L, Hong Ming W, Guat Ney T, et al. (2012) Open field release of genetically engineered sterile male *Aedes aegypti* in Malaysia. PLoS ONE 7(8): e42771. https://doi.org/10.1371/journal.pone.0042771

Miller BR, Monath TP, Tabachnick WJ, Ezike VI. Epidemic yellow fever caused by an incompetent mosquito vector. Trop Med Parasitol 40:396–399 (1989).

Monath TP. Yellow fever. In: The Arboviruses: Epidemiology and Ecology, Vol V (Monath TP, ed). Boca Raton, FL:CRC, 1988;139–231.

Nasidi A, Monath TP, DeCock K, Tomori O, Cordellier R, Olaleye OD, Harry TO, Adeniyi JA, Sorungbe AO, Ajose-Coker AO, et al. Urban yellow fever epidemic in western Nigeria, 1987. *Trans R Soc Trop Med Hyg* 83:401–406 (1989).

Runner up

It's All Songs in Love and War

Charlie Rose

Harper Adams University

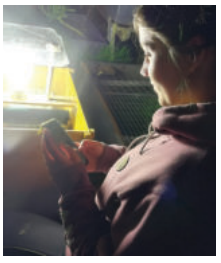
He had been wandering for hours, calling all the while in hopes of attracting a female. None had come and neither had he stumbled across one. The sun had dropped below its zenith a few hours ago and it wouldn't be long until the evening chill would set in, putting paid to any chance of striking upon a receptive mate until tomorrow. He'd decided to head for shelter when he was halted by a sound, the summoning call of another male, attempting to attract a mate. Unfortunately for this new rival, not only could our male detect from his song that it had a burrow, but also that he was likely significantly weaker than himself. The truth of this not easily hidden when singing.

Our male made his way towards the sound of his new rival. After a few short minutes he broke through the dense tussocky grass into a small clearing, still lit by the last rays of the evening sun. There, across the clearing, the source of the foreign song, a male just short of average size perched in the mouth of his burrow. This real estate was a prize well worth competing for. In a sudden rush he was there, at the mouth of the burrow head to head with the rival male, whose song instantly changes from long intermittent thrummings to a series of short, sharp chirrups. Their antennae flicked forward and began to lash those of their opponents, assessing while trying to intimidate the other into submission. While it was indeed true that the rival was smaller, what he lacked in strength he made up for with his defensible position. Being in the mouth of his burrow he limited the direction of assault to a full frontal one. It was soon evident that the rival, bolstered by his fortified position, was not going to surrender quickly. Rocking back and forth our male tried to strike an imposing form, aggressively lurching toward his opponent. Not shaken in the slightest the rival chirped loudly, rubbing the raised ridge of one wing across the serrated edge of the other in sharp quick motions. Not to be

outdone our male also began to stridulate. This barrage of sound continued seemingly with no end in sight. The frequency and volume of their chirps decreasing, the evening chill settling around them. This confrontation had to end soon if our male was to have any chance of mating today. In a sudden snap of motion our male's mandibles flew open, gaping wide and displaying to his rival just how big his impressive jaws were. Somewhat rattled by this display his rival's song ceased, but he couldn't afford to surrender yet, after all, this burrow was his best chance of increasing his attractiveness to mate beyond what his smaller stature could engender. He too splayed open his jaws attempting desperately to put off his adversary. At this lackluster show of defiance our male saw his opportunity, locking jaws with his rival he wrestled him out into the open, ceding ground and drawing the rival out of his burrow. With final crushing pressure the rival uncoupled his jaws from his adversary and made a hasty retreat into the grass reluctantly surrendering his burrow and all the hard work that it represented. Victorious, our male strode into the burrow, exultantly claiming it as his own.

Exhausted from the confrontation, he settled on one last bout of song in a last-ditch attempt to attract a female before day's end. By luck or chance soon after he had resumed his song a stranger entered the opening. Was this a new rival or a potential mate? The distance too great to know for sure. The stranger crossed the expansive clearing investigating the source of the song. Our male stood in the opening of his new home, his antennae flicking forwards grazing those of the new comer, the sensory hairs upon them tasting, smelling. At last. It was certain, the chemical signature being produced by the newcomer was undeniably that of a female.

With a surge of energy, he started to court the female singing in a low buzzing stridulation, interspersed with high sharp chirrups. Walking out of his burrow he turned presenting his back to the female while continuing to sing to her, if he was lucky, she would find him attractive enough to mount. If not, she would leave. The female, obviously interested, brushed her antennae over the male's cerci, the two projections arising from his rear end, pushing back enticingly the male lowered his abdomen. Finally, she climbed on top of him. Ceasing his song, the male quickly coupled with her, not allowing her to change her mind, producing his sperm packet and attaching it to her. Success! Now he will guard her to make sure that she doesn't devour his sperm packet before there is time for enough to be absorbed and to fend off any other potential suitors and in the hope of procuring more matings, fertilizing more of her eggs and ensuring more of her offspring will be his. If he does his job well, his line will continue.



Runner up

Moth Life Magazine –Lepidora's Story

Bea Kerry

Harper Adams University

Moth Life — Issue 32, November– December 2019 Page 3

I'm pregnant but who's the father? My Gold Swift Orgy experience *WITH PICTURES* **Page 10**

Which political party has the tastiest clothes? Our clothes moth reporter gets the low down from Corbyn's hemp coat to Boris' polyester socks **Pages 12-14**

ELECTION SPECIAL

I left my proboscis in a plum! A midnight snack turns nightmarish for one reader **Page 4**

My weight nearly got me killed, but now the men come to me!

One moth on her transformational journey from fugly to famous

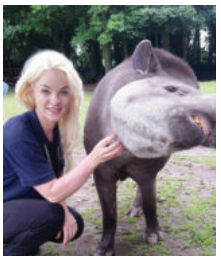
As a young larvae, Lepidora was driven by one thing—food. The quest to find her favourite snack of Marsh Cinquefoil took over her life and the pounds piled on, yet she just couldn't stop. It took a near brush with death to make her rethink her life choices, and today she bravely opened up to **Moth Life** about her journey:

'It was probably about 10 in the morning and I was just taking a nap under a leaf after a long night of eating, when suddenly I saw this beady little eye staring straight at me. The next thing I know this bird beak was stabbing repeatedly at me, narrowly missing my head. I tried to shuffle away as quickly as I could but with all the extra weight I was carrying the outer part of the leaf just couldn't support me and I fell to the floor. I just lay there curled into a ball waiting for the bird to come back and finish what it started, but the death blow never came. The almighty Insecta must have been watching over me that day, and I managed to climb back into my hiding space terrified but unharmed.'

Lepidora shows off her new body whilst sipping nectar at her home in Shrewsbury

However, the experience had shaken Lepidora to the core and she resolved to make a change in her life. 'After that I knew that something had to change. I couldn't keep living my life like that. So I found a twig, made a cocoon and promised myself I wouldn't come out until I had a whole new body. It took a lot of determination but the thought of my near-death experience drove me forwards. Then one day I looked at myself and knew I was ready, so I pushed my way out of the chrysalis and emerged into the beautiful springtime sunshine.'

'Now I've got this gorgeous new body all it takes is a spritz or two of pheromones and the boys just all fly to me. I sleep all day and party all night, I'm really living the dream. For all the girls out there feeling bad about themselves, just take that leap of faith and pupate. I promise it will all be worth it in the end!'



Runner up

Curriculum vitae – Worker Honey Bee

Rachel Turner

Harper Adams University

Curriculum vitae

Worker Honey Bee *Apis mellifera*

Address: 2900th Cell, The Hive, The Orchard

Home pheromone: Queen mandibular pheromone

Work pheromone: 2-heptanone

Email: Apismelifera@beemail.com

Personal statement

Having served my queen and my hive for most of my life I am now looking to wind-down and assume the role of an undertaker bee until I am unable to serve my queen and leave the hive to retire in the orchard. I have worked hard for my queen and my sisters over the last 6 weeks, completing all tasks to a high standard staying focused on the job in hand, for the greater good of the colony.

Key Skills

- Hard Working
- Working well with a team or alone
- Communication skills
- Taking a great deal of pride in all jobs and tasks
- Selfless
- Family orientated

Employment History

Forager (Day 22 – present)

Achievements and Responsibilities:

- Carrying half my body weight of pollen in the scopa hairs and pollen baskets, otherwise known as corbiculae, on my hind legs whilst travelling up to 5 miles
- Collecting nectar from flowers using my long tongue, called a proboscis, and storing it in my honey stomach
- After collecting the nectar and processing it I either deposit it in the honey store or give it to a nurse
- Performing the Waggle Dance for my foraging team to communicate the location of resources
- Navigating using the sun, always returning to the hive safely
- Avoiding predatory species, such as spiders
- Being prepared to use my modified ovipositor which is barbed to sting enemies with venom if I feel myself or the colony's lives are being threatened (although I have never had to use it)
- Gathering water for the hive in my crop
- Gathering propolis, otherwise known as bee glue or bee penicillin, used for several purposes including sealing cracks in the hive

Guard & Ventilator (Day 18 – 21)

Achievements and responsibilities:

- Inspect all bees that enter the hive by their scent to check they belong to my colony, I do this by examining their front legs and antenna
- Being prepared to sting and remove any intruders
- Spreading a thin layer of water on the rims and tops of sealed brood cells for the water to evaporate and cool the hive
- Fanning my wings inside the nest to help ventilate and cool the nest

Hive builder & general handy bee work (Day 12 – 17)

Achievements and responsibilities:

- Producing wax flakes through the glands in my abdomen, then chewing them till they are pliable for building
- Building hexagonal wax cells
- Help the nectar to ripen into honey by aerating the nectar with my wings creating an airflow to allow water to evaporate from the nectar
- Storing food
- Maintaining cleanliness of the hive

Nurse (Day 3-11)

Achievements and responsibilities:

- Tend to the young brood by feeding them honey and pollen otherwise known as bee bread
- Feeding the brood Royal Jelly made up of water, protein, sugar, vitamins and minerals
- Feeding the general worker bees Royal Jelly for three days then bee bread until they pupate at 21 days
- Feeding queen bee larvae Royal Jelly until they pupate after 16 days
- Feeding male drone larvae Royal Jelly for 3 days then bee bread until they pupate at 24 days

Housekeeper (Day 1-2 straight after metamorphosis)

- Cleaning cells in preparation for eggs or food storage
- Maintaining the temperature of the brood at around 34-35 ˚C by vibrating my wing muscles

Education

Explosives Detection

- Held in a specially designed bee harness so I could stay still and focus
- Trained by a scientific officer to stick out my proboscis when I smelt explosives vapours, I did this to obtain a nectar reward
- After I had been trained, which took only several minutes, I travelled in a transportation box to various sites to detect explosives
- I had a camera that could zoom in on my proboscis to see if I was sticking it out
- After 4 days I was returned to the hive and my colony to continue serving for my queen

Hobbies & Interests

My main hobby is to perform, I enjoy dancing especially the Waggle Dance. My Waggle dance lets the other foraging bees know the direction and distance the best pollen carrying flowers are.

I am most interested in flowers especially yellow flowers, this of course depends on the time of year and availability of the flowers. My favourite spring flowers are dandelions, but they can be hard to come by.

To access QR codes, scan with smart phone camera.

Reference

- The Queen – Work pheromone: queen retinue pheromone
- More available on request

Eskov, E. 2019. *The Origin and Organization of the Bee Colony Apis mellifera L.* Cambridge: Cambridge Scholars Publishing.

Georgia Tech College of Computing. 2011. *The Waggle dance of the Honeybee.* [0nline Video]. YouTube Available from: https://www.youtube.com/watch?v=bFDGPgXtK-U. [Accessed 18 December 2019].

Los Alamos National Lab. 2008. *Scientists train honeybees to detect explosives.* [online video]. YouTube. Available from: https://www.youtube.com/watch?v=_T7d0bze4kM. [Accessed 18 December 2019].

Morse, R. A. 1994. *The new complete guide to beekeeping.* New York: The Countryman Press.

Page Jr, R. E., & Peng, C. Y. S. 2001. Aging and development in social insects with emphasis on the honey bee, Apis mellifera L. *Experimental gerontology*, *36* (4-6), pp 695-711.

Vidal-Naquet, N. 2015. *Honeybee Veterinary Medicine: Apis Mellifera L.* 5M Publishing.

Waring, C. 2014. *The Bee Manual: The Complete Step-by-Step Guide to Keeping Bees.* Sparkford: Haynes Publishing.

SCHEDULE OF NEW FELLOWS AND MEMBERS

as at 4th March 2020

New Honorary Fellows
None

New Fellows (1st Announcement)
Dr Yannick Wurm
Dr Juliano Morimoto
Dr Arjun Shukla

Upgrade to Fellowship (1st Announcement)
Dr David Thomas Williams
Dr Islam S Sobhy

New Fellows (2nd Announcement and Election)
Professor Noah K. Whiteman (as at 4.12.2019)
Dr Kolla Sreedevi (as at 4.12.2019)
Dr Simon Tristram Segar
Dr Alasdair Justice Nisbet
Dr Mathyam Prabhakar

Upgrade to Fellowship (2nd Announcement and Election)
None

New Members Admitted
Mr Michael Chapman-Pincher (as at 4.12.2019)
Mr Carl David Huckstep
Miss Aoife Crowe
Mr Payman Shafighi
Dr Chooi Khim Phon
Dr Bhagwati Uniyal

New Student Members Admitted
Miss Fiona Plenderleith (as at 4.12.2019)
Miss Imogen Freia Alexandra Chakrabarti (as at 4.12.2019)
Miss Alicia Showering (as at 4.12.2019)
Miss Kathryn Powell
Mr Marco Corradi
Dr Sally Burgess
Miss Claire Hoarau
Mr James Cameron Pearce
Mr Frederick Sarathchandra
Ms Chanida Fung
Ms Aythya Lena Young

Re-Instatements to Fellowship
None

Re-Instatements to Membership
None

Re-Instatements to Student Membership
Mr Harrison Lambert

Deaths
Prof T Jones Hon.FRES, 1953, UK
Dr D J Bellamy OBE Hon. FRES, 2010, UK
Prof H V Daly, 1973, USA
Dr J R Chiswell, 1954, UK

Reviews

Britain's Dragonflies: A Field Guide to the Damselflies and Dragonflies of Great Britain and Ireland (4th ed.)

Dave Smallshire & Andy Swash

Wild Guides

ISBN 978-0-691-18141-7

£17.99

Britain's Dragonflies is without doubt the most comprehensive field guide available to the UK's Odonata. In my review of the third edition I said that it had set the bar for future field guides and this is certainly still true.

The fourth edition is only subtly different from the previous one. The cover is now plasticized, which makes it more durable, and there is a flap at the front that has a list of the symbols and annotations used in the species accounts. This means that it can be folded out and inserted anywhere in the text, while on the rear flap there is a short index.

The very first section of the book is a photographic guide to the main groups of damselfly and dragonfly which allows easy access to the main keys. Prior to the species accounts there is now a photographic introductory section to the blue damselflies, the darters and the large dragonflies, the latter of which also includes a guide to them in flight.

The vagrant emperor has been moved from the 'Vagrants' section into the main species accounts, as it is now on the British list and its distribution has been updated. The sections on where to look for 'rare and uncommon dragonflies' plus the one on 'watching' and 'photographing' dragonflies have been moved to the back of the book.

While the fourth edition contains comparatively minor updates, it is still the best guide to our dragon- and damselflies available. If you have a copy of the third edition it is not really worth updating to this one, but if you are still to own a copy of this field guide, this is the book for you. If you have not yet discovered the joy of our Odonata buy this book and go hunt some dragons.

Peter Smithers

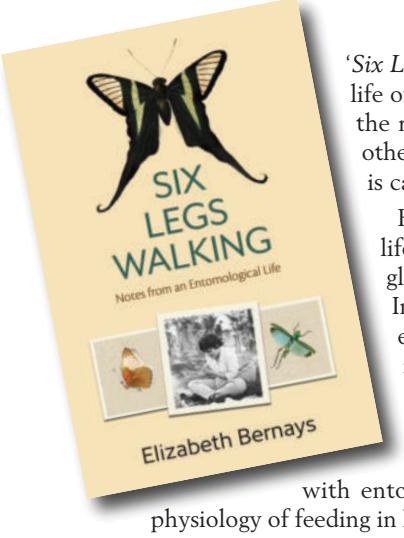
Six Legs Walking: Notes from an Entomological Life

Elizabeth Bernays

Raised Voice Press

ISBN 978-1-949-25903-2

£13.99



'*Six Legs Walking*' is a series of essays that offer an insight into the life of Elizabeth (Liz) Bernays – the life of a research scientist with all its ups and downs, triumphs and disappointments, essays that detail the research she was undertaking and the friends and colleagues that she worked with. But, unlike other memoirs, hers are frank, honest, intimate and deeply personal. She writes with an openness that is captivating, engaging and sometimes even shocking, but always with great sincerity.

From her childhood in Australia, where the insects in her garden were a constant fascination, to life at university, then travels in Europe and a teaching job in England, these essays sweep across the globe documenting her work at the Anti-Locust Research Centre in London, to field work in Africa, India, and on to a professorship in the USA. Her account of life in London in the early seventies is eye-opening in its frankness, and her arrival at Berkeley only to find three empty rooms as her labs-in-waiting reveals the stark differences between British and American academia. The anecdotes are lyrically written, often having musings on human nature, nostalgia, curiosity and other things woven into them.

While these essays offer a very personal view of Liz and her colleagues, they are also packed with entomology and read as a history of our understanding of insect–plant interactions, such as the physiology of feeding in locusts, the role that the surface wax on leaves plays in herbivory, and her time-consuming studies of herbivore–predator interactions in the field.

Six Legs Walking is a celebration of a life in entomology and of entomology itself. It is a story of the pursuit of answers to questions encountered by a relentless curiosity, a celebration of the beauty of the places Liz visited and of the people that she encountered. If you need reminding of why you are an entomologist, this is the book for you. If you love life, the natural world and people, this is a read you are sure to enjoy.

Peter Smithers

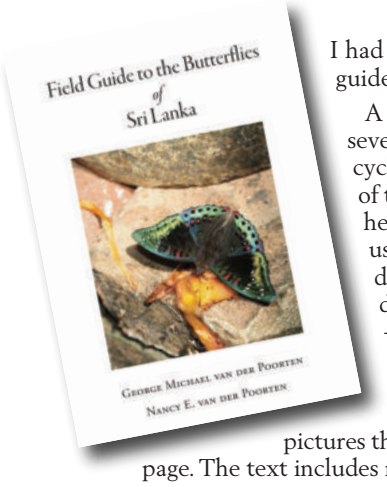
Field Guide to the Butterflies of Sri Lanka

G.M. and N.E. van der Poorten

Lepodon Books

ISBN 978-1-771-36605-2

£49.99



I had the pleasure of reviewing the 'full' version of this book for *Antenna* two years ago. This is the field guide, produced by popular demand by the same authors.

A short preface is followed by a map of Sri Lanka, contents page, topographic and climatic maps and several illustrated pages of introduction to the country, its habitats and climatic zones. The butterfly life cycle, conservation and introduction to the butterflies and text layout follow and lead to the main part of the field guide – butterfly identification. Pages 25-203 deal with the *ca.* 250 butterfly species, including hesperiids, occurring on Sri Lanka. This book must rank as one of the most comprehensive yet easy to use guides on the market. Similar species are grouped together regardless of taxonomic association; distinguishing features are clearly and helpfully identified, using arrows where necessary to highlight differences; and keys – including a simple guide on how to use the keys for those unfamiliar with them – are provided for difficult groups. In a high percentage of cases the pictures alone are enough to make a positive identification and text lies on the page directly opposite each species, together (in some cases) with a map of Sri Lanka on which distribution records are plotted. The text is succinct, well written, informative and adjusted and adapted to fit neatly into the layout, however many pictures there are of the adult butterfly (e.g. *Cirrochroa thais* warrants 11 pictures on 132-133) on the opposite page. The text includes notes on ecology and behaviour in addition to morphological data, times of appearance *etc.*

Of course, difficult groups remain difficult to identify (e.g. brown *Pelopidas* and associated hesperiids; *Eurema*; some *Parantica* / *Ideopsis*), but I suspect there is no better book by which a visitor is likely to be able to identify almost any butterfly they come across. No doubt some will be disappointed by the continued use of *Mycalesis* in preference to *Mydosama*, although the authors are far from being alone in this – and for the purposes of a field guide, who cares.

Appendices contain further distribution maps (although I cannot distinguish between red and orange dots on the maps – orange represents dubious records); a systematic species checklist and taxonomic notes; larval and nectar plant names in English, Sinhala and Tamil; glossary of terms used; photographic and illustration credits; references; a species index; some notes about the authors, and acknowledgements.

As with George and Nancy van der Poorten's comprehensive precursor, *The Butterfly Fauna of Sri Lanka*, the standard of photography is outstanding and almost all the illustrations depict living butterflies; the authors have successfully managed to illustrate species differences and diagnostic features without using many set specimens. The size of the book is perfect for a jacket pocket or day sack and the card cover is sturdy. I cannot imagine any interested professional or amateur naturalist setting foot on Sri Lanka without it.

John Tennent

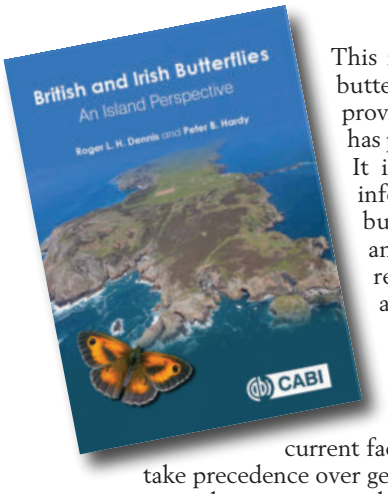
British and Irish Butterflies: An Island Perspective

Roger L.H. Dennis & Peter B. Hardy

CABI

ISBN 978-1-786-39506-1

£75.00



This is a superb book. Originally planned as an updated version of a previous book on islands and butterflies by the lead author (Dennis & Shreeve 1996), this is in fact a completely new study which provides an overview of fast developing research on butterflies on islands. It shows how far our knowledge has progressed in recent years, owing much to the huge scientific contribution made by Professor Dennis. It is crammed with information, supported by 15 appendices as well as online supplementary information. It is illustrated with colour plates of island landscapes and 83 small plates of adult butterflies including rare migrants, but the main figures are the maps, diagrams, bar charts, flow charts and models that illustrate and expand our understanding. The science is based on 3,865 butterfly records for 393 of the 900 British and Irish islands over 10ha. It is perhaps not an easy book to review as it is full of very detailed information; it will undoubtedly become an essential reference tool.

The "islands" include Britain and Ireland, as well as the multitude of offshore islands. The book starts with a basic model of island biogeography based on equilibrium theory and continues with a geological and historical outline, reviewing glacial-interglacial cycles and shifting sea levels. It is clear from these chapters on the one hand that geological history (evolutionary scale issues) can dominate current factors (ecological scale issues), whereas on the other hand human impacts in the Anthropocene may take precedence over geographical parameters and historical events. Chapter 3 discusses the interpretation of records where one needs to appreciate the colonisation and migration ability of each species established from four migration capacity variables and ten colonisation ability variables (e.g. low scores for *Satyrium pruni* and high scores for *Pararge aegeria*). Chapter 4 summarises the situation showing mainland Britain and Ireland as a distinct European butterfly region.

Chapters 5 to 9 set the discussion within the context of Europe, Ireland and mainland Britain which act as key sources of species for the smaller islands. Species incidence may be related both to island area and isolation from source populations, with low latitude being the key variable for endemicity and the presence of rare species. Geographical variables (in connection

with life histories and ecology) allow us to predict which species are most likely to occur on an island. Chapter 7 discusses changing species patterns, e.g. on the Isles of Scilly where grazing regime changes led to movements of butterfly populations and shifts in population genetics (note the recent removal of rats from St Agnes and Gugh, with proven impacts on the Scilly Shrew and potential effects on rabbit populations, may have a significant effect on butterfly populations). There is hope that some of the 70 or so additional butterfly species predicted as potential occupants of the UK mainland by 2050 due to climate change may colonise at least some of the offshore islands where the resource-based habitat requirements match the changing environment.

Chapter 8 provides an evolutionary perspective; where island populations persist in the long term and face deleterious changes in conditions they may undergo spatial and temporal change as well as changes in life history traits, genotype and phenotype (although it should be noted that some of these changes may have occurred before the butterflies arrived on the island). However, it is unusual to find endemism in butterflies on smaller offshore islands as there is a greater probability of populations becoming extinct or being "rescued" by immigrants – although there are examples of nanism (e.g. for *Hipparchia semele* and *Plebejus argus* on the "virtual island" of Great Orme's Head). Chapter 9 provides a brief view ahead, using island geography and species distributions to predict the number of species for a large number of offshore islands as well as the presence/absence of individual species. The message for conservation is that we need to protect both large island populations and their mainland butterfly sources, except perhaps where small islands function as metapopulations (e.g. the Isles of Scilly); for example, species recorded as absent or as lost from the Isle of Man are those that have declined along the coastal fringes of Wales and Lancashire. In some cases, some populations may have persisted on the large islands throughout the entire Holocene, e.g. *Coenonympha tullia* on Skye. Finally, the authors suggest that a focus on island butterfly ecology and population genetics is the next step for research; evidence-based management is crucial to successful future management for butterflies.

The book is completed by on-line supplementary material at https://www.cabi.org/openresources/95061, including a searchable digital copy (in pdf) of Dennis & Shreeve (1996), a large searchable excel data file for the butterflies of British and Irish offshore islands and predictions for species richness and incidence. It is fully referenced (nearly 50 pages) with an excellent glossary (words found in the glossary are highlighted in bold in the text), including several words new to the reviewer. I have a small quibble over the order of the references, which should ideally be fully alphabetical. This book is a must for anyone interested in butterflies. Now we need a similar book for moths.

Reference

Dennis, R.L.H. & Shreeve, T.G. 1996. *Butterflies on British and Irish Offshore Islands: Ecology and Biogeography*. Gem Publishing Company, Wallingford, Oxon.

Adrian Spalding

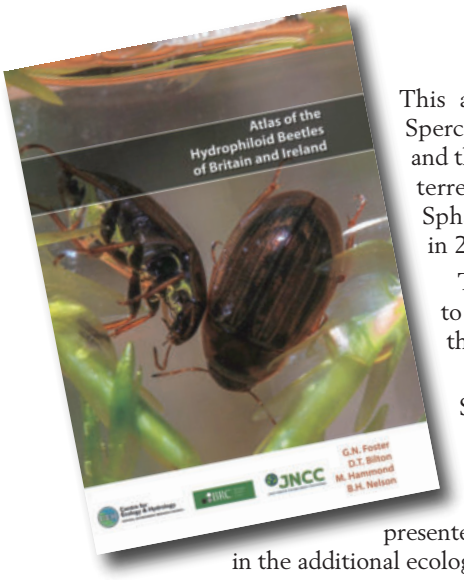
Atlas of the Hydrophiloid Beetles of Britain and Ireland

G.N. Foster, D.T. Bilton, M. Hammond & B.H. Nelson

F.S.C. Publications

ISBN 978-1-906-69863-8

£27.99



This atlas covers the 104 species in the families Helophoridae, Georissidae, Hydrochidae, Spercheidae and Hydrophilidae recorded in the British Isles. This includes the whole of Ireland and the Channel Islands. The majority of species are water beetles but for taxonomic reasons many terrestrial species, including those associated with dung and decaying vegetation (e.g. the Sphaeridiinae), are included. It complements the atlas of the predaceous water beetles published in 2016.

These groups of beetles are not always the easiest to identify but are very well recorded thanks to a tradition of good quality identification guides and a long history of recording effort through the Balfour-Browne Club. The names of over 600 recorders are given in the acknowledgements.

The introduction covers this recording effort, which has resulted in over 149,000 records. Sections on the immature stages, natural enemies, flight and trends in distribution follow. A very useful table is given which covers the status of all the beetle species from this and the previous atlas in Great Britain as a whole, Ireland, the Isle of Man and the Channel Islands.

The distribution maps and species accounts provide the bulk of the book. These are clearly presented, with an introduction to each family and genus. As a general naturalist I am most interested in the additional ecological information given alongside the distribution maps. This is excellent and enhanced by the inclusion of about 40 photos which show typical habitats for a range of species, vital information when seeking out these beetles in the field. Fascinating distributions are shown, such as the lesser silver water beetle *Hydrochara caraboides*, which has been long known from the Somerset Levels, but only in the 1990s was a large population discovered on the Cheshire Plain, showing that exciting discoveries can still be made in this field. For some species, advances in the ease of genetic analysis have facilitated re-evaluation of historic identification problems. For example, the common and widespread species *Hydrobius fuscipes* is now thought to be a complex of four species and presents an opportunity for new research into their ecology and distribution.

I look forward to using this atlas in my personal studies and highly recommend it to anyone with an interest in British beetles.

John Walters

Obituary

Sir Michael Berridge FRS

22 October 1938 - 13 February 2020

Stuart Reynolds

Sir Michael Berridge scaled the heights of global scientific eminence. He was without a doubt the most eminent insect physiologist of his time. His main discovery, lauded by many honours and prizes, was the role of the intracellular second messenger inositol *tris*-phosphate (IP_3) in mediating signalling between animal cells, and that this is accomplished through its action in mobilizing the release of divalent Calcium ions from intracellular stores. The significance of his work extended far beyond insects, having profound implications for the basic biochemistry, cellular regulation and intercellular signalling of all organisms, but readers of *Antenna* should not forget that Berridge was primarily a student of insect science and that for much of his career, insects were the main experimental organisms in his laboratory.

Berridge was born and grew up in Gatooma (now Kadoma), a small town in the then British colony of Southern Rhodesia, now Zimbabwe. He attended the University College of Rhodesia and Nyasaland (now University of Zimbabwe), where he was inspired by Professor Einer Bursell, an authority on the tsetse fly *Glossina morsitans*, vector of *Trypanasoma brucei*, the parasite that causes sleeping sickness. Encouraged by Bursell and with a Commonwealth Scholarship to support him, Berridge left southern Africa for Cambridge, UK, where he had secured a scholarship to study for a PhD in the department of Zoology under Sir Vincent Wigglesworth, then the most eminent insect physiologist in the world. His PhD project was to investigate nitrogen excretion in the cotton stainer, *Dysdercus fasciatus* (Hemiptera, Pyrrhocoridae), a topic which first introduced him to the physiology of fluid transport and insect Malpighian tubules.

Subsequently, Berridge went on to postdoctoral study in the United States, first with Dietrich Bodenstein at the University of Virginia (where he was a colleague of fellow postdocs and Wigglesworth alumni, Peter Lawrence and Brij Gupta) and then at Case Western Reserve University in Cleveland, Ohio, where he worked with Bodil Schmidt-Nielsen, Howard Schneiderman and Michael Locke (and where he was a friend and colleague of Jim Oschman and Betty Wall). While in the USA Berridge worked on a number of different projects, all concerned in various ways with salt and water regulation in insects. Crucially though, it was while at Case Western that, together with Narayan G. Patel, he discovered the stimulatory actions of serotonin and cyclic AMP on the salivary glands of the bluebottle *Calliphora erythrocephala* (Diptera, Calliphoridae). This was the experimental preparation that eventually propelled Berridge into the first ranks of twentieth century biological science.

In 1969 Berridge returned to Cambridge to join the AFRC Unit of Insect Physiology, located within the Department of Zoology, originally set up by Wigglesworth himself, but now directed by John Treherne. This was where he now began a serious fundamental investigation of the cell physiology of fluid transport using the blowfly salivary gland as a model. Probably not coincidentally, but planned by Treherne, the AFRC Unit also housed the laboratory (just across the corridor in fact) of Simon Maddrell, also working on the basic physiology of fluid transport, but using the Malpighian tubules of the blood-sucking insect *Rhodnius prolixus* (Hemiptera, Reduviidae). Work in the two laboratories was complementary and often very closely linked. I was a student in Maddrell's lab at the time and can recall that expensive pharmacological reagents would often be shared.

Initially, Berridge's work focused on the mediation of serotonin action on salivary gland cells by the intracellular second messenger, 3'5'-cyclic AMP, but it soon became clear that serotonin's actions were in fact mediated by two separate receptors with different transduction mechanisms. In 1979, Berridge, together with a visiting researcher John N. Fain, discovered that the second arm of cellular regulation in the blowfly salivary gland is mediated by hydrolysis of the

membrane lipid phosphatidyl inositol to release IP_3 as an intracellular second messager; IP_3 in turn acts through an elevation of intracellular Ca. In 1983, he showed with Robin Irvine from Babraham that this same mechanism operated in a classical biochemical model of cellular activation, the pancreatic acinar cell. Their paper in *Nature* propelled Berridge into scientific stardom.

Berridge did not make this discovery out of nowhere; mobilisation of inositol phospholipids from cell membranes during cellular activation had been noted in the early 1950s by Mabel and Lowell Hokin at McGill University in Montreal, and Bob Michell at the University of Birmingham had speculated as early as 1975 that this might be of fundamental importance. But it was Berridge who picked up the hypothesis and ran with it. His outstanding success in doing this was partly serendipitous; the blowfly salivary gland is a superb experimental preparation – quickly prepared from readily available material, it responds rapidly to stimulation, works *in vitro*, and is (just) large enough to yield samples suitable for biochemical analysis. But also, after a decade's work on blowfly salivary glands, Berridge was mentally prepared to dissect apart the two cellular signalling pathways. Significantly, the Cambridge AFRC Unit allowed him to work as a full-time researcher with very few distractions. Perhaps most importantly, Berridge was not only a meticulous, focused and tireless researcher who did his experiments with his own hands, but was also widely read and prepared to recognise that insect salivary glands were excellent models for phenomena important right across the tree of life.

In 1990, the AFRC Unit moved from the Department of Zoology to a new home at the AFRC Babraham Institute. While he was there, Berridge's reputation grew and he travelled all over the world as a cell signalling celebrity. He was appointed honorary Professor of Cell Signalling at Cambridge and, following his retirement as Head of Cell Signalling at Babraham in 2003, he was appointed an Emeritus Fellow at the Babraham Institute.

A man of extremely regular working habits, always gracious and good humoured, Berridge was universally admired. His scientific work was acknowledged by many prizes and distinctions. He was a Fellow of the Royal Society (1984) and received its Croonian Medal (1988) as well as the Royal Medal (1991). He was a member of EMBO (1991); a founding member of the Academy of Medical Sciences (1998); and a foreign associate of the US National Academy of Sciences (1999). Among others prizes, he received the Louis-Jeantet Prize for Medicine (1986), the King Faisal International Prize (1987), the Lasker Award in Basic Medical Sciences (1989), the Wolf Prize (1995/96), and the Shaw Prize in Life Science and Medicine (2005). He was knighted in 1997.

Alfred Russel Wallace Award 2020

For post-graduates awarded an outstanding PhD in Entomology!

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

Requirement

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

Who Can Enter?

All post-graduates who have been awarded a PhD degree, on the basis of a thesis written in the English language, within the period 1 October 2019 - 31 December 2020.

Prizes

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

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

Entries

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

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

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

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

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

The Judges

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

Closing Date

The closing date for entry is 31st December 2020. Winners will be announced in the Spring 2021 edition of *Antenna* and on the RES website **www.royensoc.co.uk**

Diary

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

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

MEETINGS OF THE ROYAL ENTOMOLOGICAL SOCIETY

COVID-19

Our events over the next few months are now postponed or cancelled due to #COVID19, our Society building and library are no longer open to visitors. Our online shop remains open.

National Insect Week 2020 - Entomology at home
Monday, 22 June – Sunday, 28 June 2020
National Insect Week #NIW2020 will not involve physical events, to reduce the transmission of Covid-19 virus. We hope you will join us in a virtual campaign to celebrate the little things that run the world. Over the next weeks and months we will be expanding our online resources and activities, linking out to the many National Insect Week partner organisations, so that as many as possible can do entomology at home.

Behaviour Special Interest Group
Tuesday, 8 September, 2020
NIAB EMR, New Road, East Malling Kent ME19 6BJ

Symbionts Special Interest Group and Infection & Immunity Special Interest Group
Thursday, 24 September – Friday, 25 September, 2020
Emmanuel College, Cambridge

Data, Ecology and Electronics & Computing Special Interest Groups meeting on E-ecology
Monday, 19 October, 2020
World Museum Liverpool, Liverpool

Scottish Regional Meeting
Wednesday, 4 November, 2020
SASA Edinburgh

Pollinators in Agriculture meeting in collaboration with the AAB
Wednesday, 11 November – Friday, 13 November, 2020
Copthorne Hotel , Slough

NON-SOCIETY MEETINGS

XXVI International Congress of Entomology, Helsinki, Finland, Re-scheduled 18-23 July, 2021
'Entomology for our planet'

International Conference on Urban Pests, ICUP2020, Re-scheduled 13 -15 September 2021, Barcelona

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

author guidelines

We are always looking for new material for *Antenna* – please see below if you think you have anything for publication

AIMS AND SCOPE

As the Bulletin of the Royal Entomological Society (RES), *Antenna* publishes a broad range of articles. Articles submitted to *Antenna* may be of specific or general interest in any field related to entomology. Submissions are not limited to entomological research and may, for example, include work on the history of entomology, biographies of entomologists, reviews of entomological institutions/methodologies, and the relationship between entomology and other disciplines (e.g. art and/or design).

Antenna also publishes Letters to the Editor, Meeting Reports, Book/App/Website Reviews, Society News, Obituaries and other items (e.g. selected Press Releases). *Antenna* further includes details of upcoming entomological meetings in its Diary Section and features information and reports on RES activities including National Insect Week, Insect Festival and National, Regional and Special Interest Group meetings. Details of RES Awards and recipients are also covered, as is notification of new Members (MemRES), Fellows (FRES) and Honorary Fellows (HonFRES).

READERSHIP

Antenna is distributed quarterly to all Members and Fellows of the RES, as well as other independent subscribers.

INSTRUCTIONS FOR AUTHORS

Standard articles are normally 2,000-6,000 words in length, though shorter/longer submissions may be considered with prior approval from the Editorial Team. The length of other submitted copy (e.g. Letters to the Editor and meeting reports) may be shorter, but should not normally exceed 2,000 words. The use of full colour, high quality images is encouraged with all submissions. As a guide, 4-8 images (including figures) are typically included with a standard article. Image resolution should be at least 300 dpi. It is the responsibility of authors to ensure that any necessary image permissions are obtained. Additional supplementary material may also be submitted for consideration for publication on the members' area of the RES website.

Authors are not required to conform to any set style when submitting to *Antenna*. Our only requirement is that submissions are consistent within themselves in terms of format and style, including that used in any reference list.

PAGE CHARGES

There is no charge for publication in *Antenna*. All articles, including images, are published free-of-charge in full colour, with publication costs being met by the RES for the benefit of its membership.

REVIEW AND PUBLICATION PROCESS

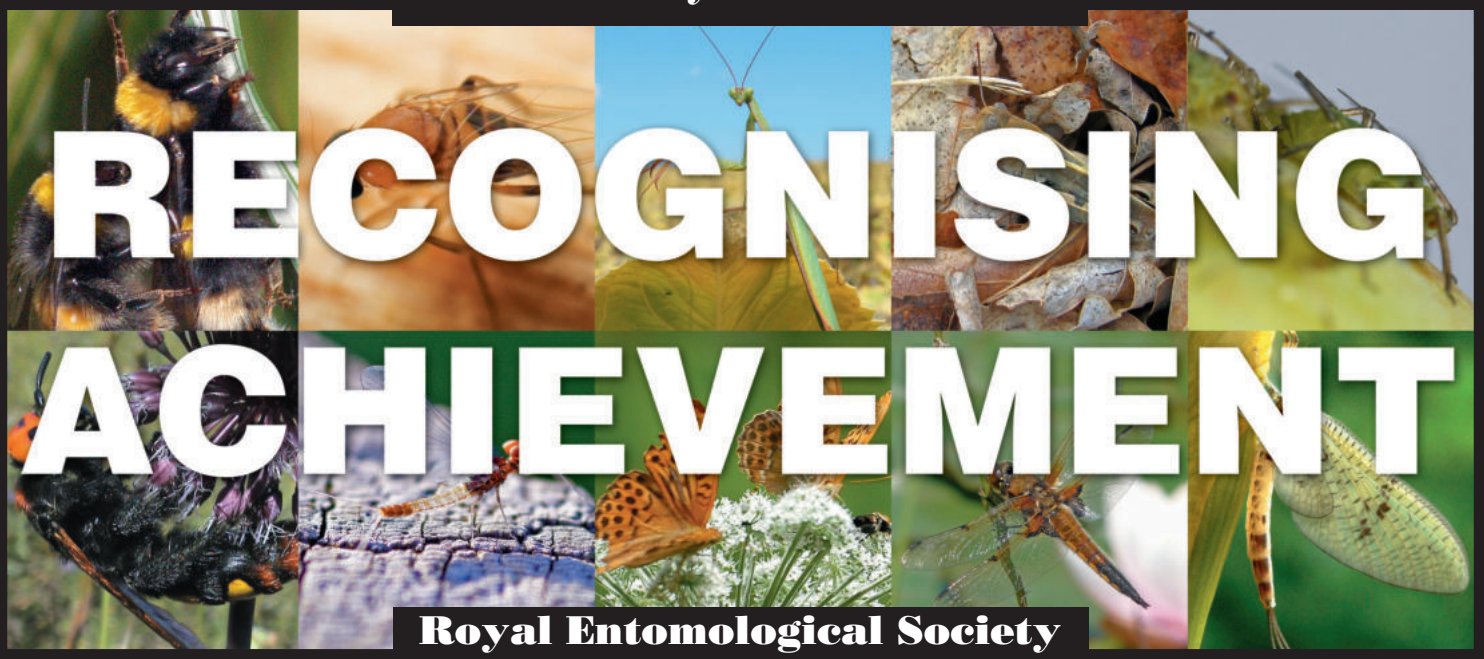
All submissions are reviewed and, where necessary, edited 'in-house' by the *Antenna* Editorial Board, though specialist external review may be sought in some cases (e.g. for submissions that fall outside the Editorial Board's expertise). Receipt of submissions will be provided by email, with submitting authors of accepted articles being offered the opportunity to approve final pdf proofs prior to publication. Where appropriate, authors will be requested to revise manuscripts to meet publication standards.

SUBMISSION PROCESS

All submissions should be sent electronically to 'antenna@royensoc.co.uk', preferably in MS Word format with images sent as separate files (see above). Image captions and figure headings should be included either with the text, or as a separate file.

EDITORIAL BOARD

www.royensoc.co.uk



RECOGNISING ACHIEVEMENT

Royal Entomological Society
– Society Awards –

For more details on these Society Awards please see www.royensoc.co.uk

THE ROYAL ENTOMOLOGICAL SOCIETY STUDENT AWARDS

Award Criteria: Any article about an entomological topic that would be of interest to the general public. The article to be easy to read, in a popular style and no longer than 800 words.

Prize: Winner £400, runner up £300, third place £200, all three articles published in *Antenna*.

THE L.J. GOODMAN AWARD FOR INSECT BIOLOGY

Award Criteria: For advancing the education of the public in the knowledge, understanding and appreciation of all aspects of insect physiology and behaviour, thereby promoting the control and conservation of insect species.

For promoting research into aspects of insect physiology and behaviour through online, digital or printed material.

For supporting exhibitions, meetings, lectures, classes, seminars and courses that widen the understanding of insect physiology and behaviour.

Grant: No individual award shall exceed £3,000 and not more than £6,000 shall be awarded each year.

THE ALFRED RUSSEL WALLACE AWARD POSTGRADUATE AWARD

Award Criteria: For postgraduates who have been awarded a PhD, whose work is considered by their Head of Department to be outstanding. The research involved should be a major contribution to the science of entomology.

Prize: £800 plus certificate, plus one year's free membership. The winner will also be invited to present their work at a Society Meeting.

J.O. WESTWOOD MEDAL – AWARD FOR INSECT TAXONOMY

Award Criteria: The best comprehensive taxonomic work on a group of insects, or, related arthropods (including terrestrial and freshwater hexapods, myriapods, arachnids and their relatives). Typically, this will be a taxonomic revision or monograph.

Prize: A specially struck silver gilt medal inscribed with the winner's name. Also costs incurred in attending the International Congress of Entomology, European Congress of Entomology, or other major meeting (specified by the adjudicators) to present his/her work.

RES JOURNAL AWARDS SCHEME

Award Criteria: The best paper published in each Society Journal over a two year period. Each of the Society Journals participates biennially.

Prize: £750 and certificate for each participating Journal.

THE WIGGLESWORTH MEMORIAL LECTURE AND AWARD

Award criteria: The outstanding services to the science of entomology. The award will be made to a researcher who has contributed outstanding work to the science and who best reflects Sir Vincent Wigglesworth's standards of personal involvement in every aspect of his/her research.

Prize: A specially struck gilt medal inscribed with the winner's name. Also the costs of attending the International Congress of Entomology to give the Wigglesworth Lecture.

BOOK PURCHASE SCHEME FOR FELLOWS AND MEMBERS IN DEVELOPING COUNTRIES

Award Criteria: To provide assistance in purchasing specialist taxonomic books, that will assist in the identification of insect groups being studied in developing countries and their regions. Applicants will be required to demonstrate need and specify particular texts.

Prize: Any one applicant may be awarded up to £250 in a three year period. The Society will purchase the texts awarded and send them to the applicant. The applicants may, themselves, provide any additional funds in excess of the amount awarded.

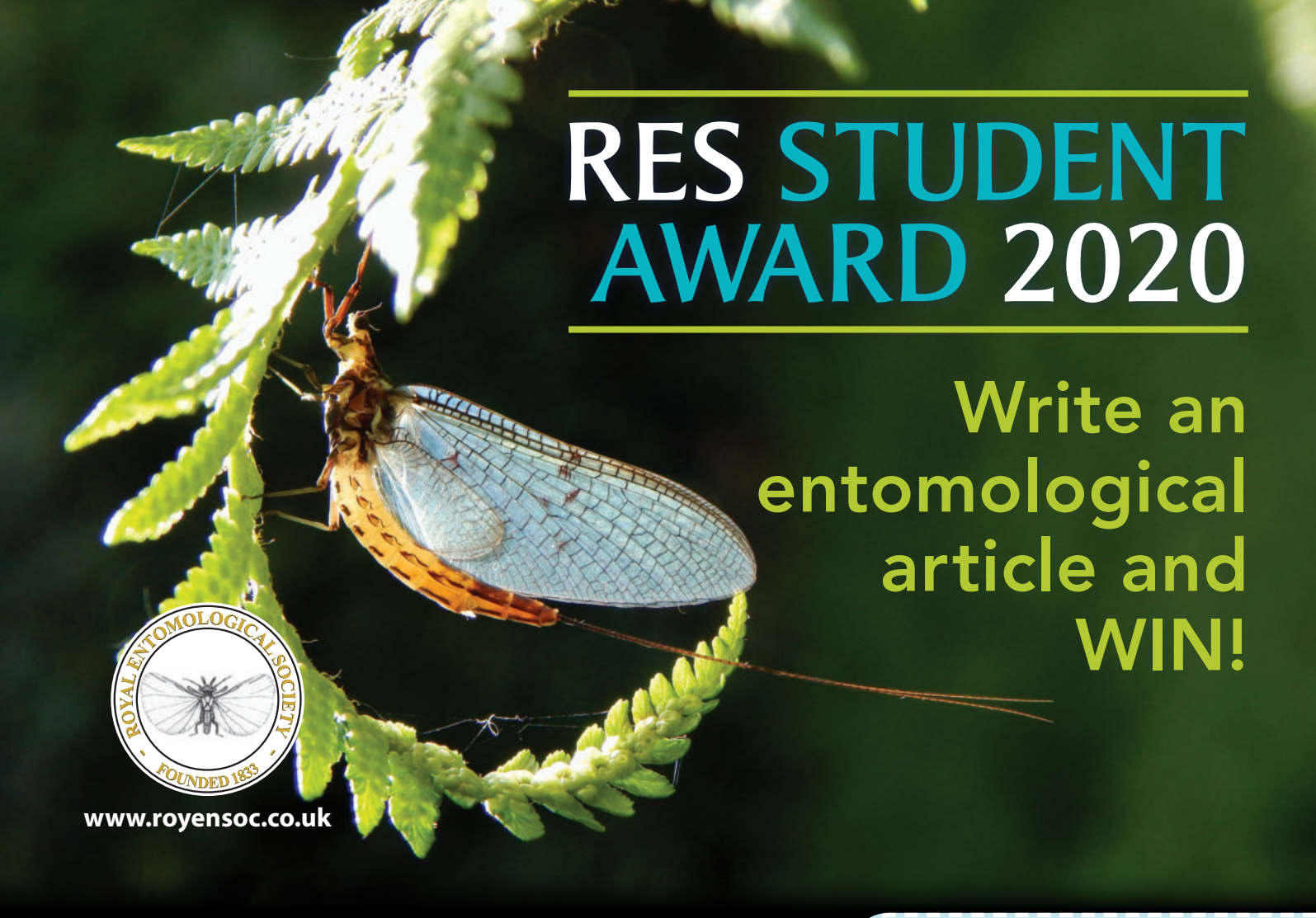
OUTREACH AND CONFERENCE PARTICIPATION FUNDS

Award Criteria: ORF: Grants to support activities which further the Society's aims. This may range from, help to purchase equipment, to help in funding expeditions/meetings. CPF: Grants to assist applicants who are participating in a meeting or conference in some way, e.g. presenting a paper/poster.

Prize: ORF: Monetary grant. CPF: Monetary grant.

Royal Entomological Society
www.royensoc.co.uk

The Mansion House, Chiswell Green Lane, St. Albans, Herts AL2 3NS, UK
Tel: +44 (0)1727 899387 • Fax: +44 (0)1727 894797
E-mail: info@royensoc.co.uk



RES STUDENT AWARD 2020

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 2020. The winner will be announced in the Spring 2021 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:

_____

_____