Antenna

Volume 47(3) | 2023

Royal Entomological Society

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

Cover Picture: The compound eye lab structure on the Royal Entomological Society Garden at the RHS Chelsea Flower Show. Photo: Tammy Marlar.

Editorial

What a few months it has been! For many the month of May can only mean one thing, the Royal Horticultural Society Chelsea Flower Show.

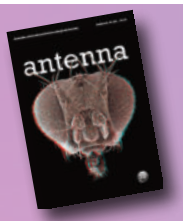
Held in the grounds of the Royal Hospital Chelsea, the show represents the pinnacle of horticultural excellence. This year it became a showcase for entomology and provided perhaps the biggest outreach event in the history of the Royal Entomological Society. The garden, brilliantly designed by Tom Massey, received a huge amount of attention from the assembled media. This attention shone a spotlight on the importance of insects and the small changes that people can make in their gardens and local environment. The key messages on providing habitats, nectar and other sources of food, shelter and nesting sites were made and communicated to a global audience.

It's perhaps little surprise then that this issue of *Antenna* has a strong Chelsea Flower Show flavour. A series of articles captures the huge effort made by many people to make the Chelsea Flower Show garden a reality. To this end you will find articles providing the background to the garden and, just as importantly, the future for the garden now that Chelsea has finished. The impact that the garden had is evidenced in articles describing the visitor engagement as well as engagement with partners and supporters of the Society. Garden designer Tom Massey gives an interview on his Chelsea experience and working with the Society. Finally, there are articles from volunteers and records of some of the species of insect that very quickly began to visit the garden. These last two points are surely cause for optimism on what can be done when a dedicated team comes together.

The theme continues with a reminder that 2023 is not the first time that entomologists have descended on the Chelsea Flower Show. There is also a reminder that orchids, whilst being a firm favourite at Chelsea, can provide an important focus when restoring meadow habitats.

The rest of this issue is packed with the many and varied activities that the Society does so well, with reports from the library, special interest group and evening meetings, art competitions and the student forum. With so much to report it is perhaps no surprise that one or two regular features are held over to the next issue.

Tom Pope



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Antenna

Bulletin of the Royal Entomological Society

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Letter from the President

What an amazing time for the Society to have a garden at the RHS Chelsea Flower Show! I feel very privileged to be President at a time when the Society has had this great opportunity to highlight how our gardens can be great for insects. What a week it was in May! But, of course, it was the culmination of very many months of dedicated hard work by a huge team of people. I hope many of you were able to visit, or see the coverage on the BBC each evening that the Show was running.

It was lovely to see how popular our RES garden was with the general public – and with many of the celebrities who attended the event. The design of the garden – that welcomed people and insects – clearly resonated with those who visited and wanted to find out more. Who would have thought that an RHS Chelsea garden would host Dandelions, and a Hazel bush that had already been munched by insects! At a time when many people are worried about insect declines, visitors were wanting to find out more about insect-friendly plants, and insect-friendly garden designs. As well as the crowds of people, it was fabulous to see many insects turn up on the garden, demonstrating their approval – the Crimson Clover was particularly popular.

The Society is very proud to have collaborated with the garden designer Tom Massey and be inspired by his design. The Society is also very grateful to Project Giving Back for the opportunity to collaborate with Tom, and we are so proud that Tom was awarded a Silver Gilt medal.

Our Society vision is to 'enrich the world with insect science', and Chelsea was an opportunity to focus on our priority to 'increase

Tom Massey, designer of the RES garden. Photo: Jane Hill.

public understanding of insect science'. This was a great occasion to spread our message about the importance of insects, and insect surveys were carried out by RHS entomologists during the show. I would like to thank all the brilliant volunteers who welcomed visitors to the garden throughout the week and explained to them the importance of insects. The evening events were an opportunity to raise funds for the Society, and we were also very proud to welcome members of the Royal Family to our garden.

I would also like to thank the RES staff team who worked so hard in making sure the Show was a success. You did an amazing job!

It was lovely to meet so many of you at Chelsea and have an opportunity to talk about insects in such fabulous surroundings with such great people. For those of you not able to visit RHS Chelsea, the garden is being relocated to IQL Stratford, at the site of the old 2012 Olympic Park in east London. I am really looking forward to building on this great success in the future and seeing the professionalism and ambition of our Society go from strength to strength.

Jane Hill OBE
President
Royal Entomological Society

The RES sign and Silver Gilt Award. Photo: Jane Hill.

Correspondence

Research Spotlight: *Luperina nickerlii demuthi*

Dear Editors,

I read Stuart Reynolds' *Research Spotlight* (*Antenna* **47**(1), 7–15) with great interest, especially of the existence of the antipodean Crambid moth *Hygraula nitens*, which occurs mainly in freshwaters but also feeds on *Zostera* in brackish waters. I would like to propose a single Lepidopteran to add to the list of marine species, based on the definition of these as including saltmarsh insects living "in burrows in the muddy substrate .... frequently inundated by seawater at high tide" (*Antenna* **47**(1): 10). *Luperina nickerlii demuthi* occurs in saltmarshes in south-east England where the larvae live half-buried in the anoxic mud where they feed on the roots of *Puccinellia maritima* and pupate under dense mats of grass. The eggs are inserted between the grass sheath and the stem, where they are safe from being washed away at high tide. Although probably largely confined to the upper saltmarshes, moth trapping shows that these populations are associated with the saltmarsh itself and not confined to the drier edges. At a well-known site near the road to the Isle of Mersea in Essex, this upper saltmarsh can be submerged over 250 times a year. I have found that the moths will, under experimental conditions, either stay where they are or move up or down the grass stems into brackish water when tidal inundation is replicated in a tank and they can remain under water for up to an hour, a film of air visible on their wings and abdomen. Movement down into water at high tide (also observed with saltmarsh beetles) is likely to be a way of avoiding surface water turbulence.

The other UK subspecies are also coastal but occupy habitat above the high-water mark. However, all the UK subspecies are under threat from climate change effects, in particular increased storminess and sea level rise.

In mainland Europe, other *Luperina nickerlii* subspecies are found up to 1950m in the Pyrenees and seem unlikely to possess this marine ability, although a colony similar in appearance to ssp. *demuthi* used to occur at Quiberon in Brittany (last recorded in 1963) and may have done so.

Adrian Spalding

The RES at the Chelsea Flower Show 2023

Soon after I started my new role at the Royal Entomological Society, I sought guidance from garden designer Tom Massey, to see what he thought was possible in developing the extensive grounds at Mansion House. Following visits and discussions, it was clear that Tom was hugely interested in insects and their study, resonating with the aspirations of how we wanted to build the impact of the RES.

It was at this point that Tom mentioned that to share the messaging around entomology, we could consider a garden at a major flower show. I listened and thought it would be good but at some point in the future. Then came the news that a new charity foundation, Project

Simon Ward and Hattie Ghaui CEO Project Giving Back. Photo: Tammy Marlar.

Giving Back, was awarding grants that focused on designing and building gardens for good causes, with a number being funded each year for a three-year period.

The first year had already passed and so, with little hesitation, we agreed to go for it! Having discussions with the Senior Leadership Team and trustees, everyone was on board. I then visited Daneway Banks with Tom and architects from Thread, based in Taunton, gaining inspiration from Dave Simcox (RES Conservation Project Manager) and Sarah Meredith (RES Conservation Project Officer).

Following that visit, designs started, and the compound eye lab structure quickly took hold. The design draft was completed and submitted. A few weeks later we heard that we had been shortlisted by Project Giving Back from over 200 applications.

The next round involved giving presentations to a large panel at Project Giving Back. As the pandemic was still in the very early stages of recovery, the panel was on Zoom. I had to describe the mission of the RES, the garden messaging and how we would make the most of the opportunity. Tom then gave a presentation on the design itself.

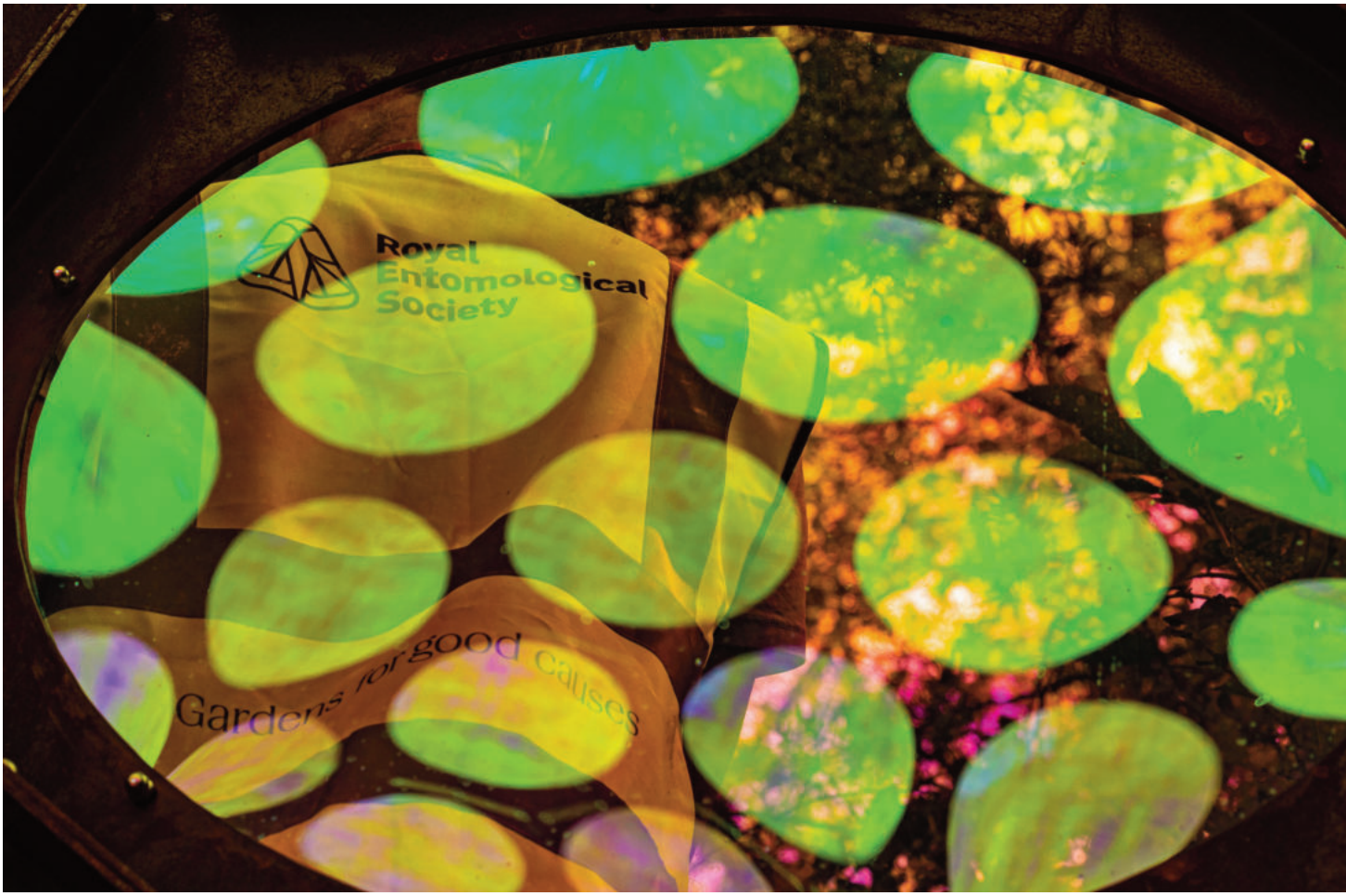
The wait then started and one month later we received an email to inform us that we had been successful, and we had the funding to take a show garden on Main Avenue at the Chelsea Flower Show. There was huge excitement but we still had to go through the RHS application process. Fortunately, we made it through this, too!

Over several months of significant planning, the RES embarked on a journey to the largest public engagement exercise it had ever been involved with. In total over 165,000 people visited the show and there was considerable international press and television coverage. The team of volunteers, staff and trustees made the whole experience very special. During the week we spoke to so many people about insects and the importance of studying them. We also made many connections that will allow the RES to partner and collaborate, extending the opportunity to achieve much more.

Overall, this experience has been fantastic for the Society. Our profile has been raised hugely and the opportunities for the future are significant.

Simon Ward
Chief Executive Officer

The RES Garden. Photo: Tammy Marlar.



Close-up of one of the lab roof panels. Photo: Tammy Marlar.

(Left to right) RES Staff members Luke Tilley, Fran Sconce, Anne Weinhold and Simon Ward before the crowds arrive. Photo: Tammy Marlar.

The view out of the lab. Photo: Tammy Marlar.

Bumblebee on Crimson Clover, a plant which generated particular interest on the garden. Photo: Tammy Marlar.

Large Red Damselfly (*Pyrrhosoma nymphula*). Photo: Tammy Marlar.

Follow-up interview with Tom Massey

Our garden designer, Tom Massey, was in huge demand throughout Chelsea week, but *Antenna* managed to grab a few minutes with him to gauge his impression on how things were going.

Tom Massey and HRH The Princess of Wales on the RES Garden. Photo: RHS / Oliver Dixon.

Nearly there now. How do you feel it's gone?
It's been a great week, the press and public have loved the garden, and most importantly the insects have arrived too!

What aspects gave you sleepless nights?
The lab had never been fully assembled, so it was a huge relief for the whole team when the final bolt went in and it all worked!

Tell me about the setting up. How long did it take and who was involved?
The build was three and a half weeks, and many people were involved. The Landscape Associates team was around 10–12 with sub-contractors like metalworkers and water feature specialists. Cake Industries had five building the lab and eight planting volunteers. Then there were the delivery drivers from Hortus Loci shipping plants to us at the show.

Insect hotel. Photo: Tammy Marlar.

Chelsea build team from Landscape Associates and Tom Massey Studios. Photo: Tammy Marlar.

Which famous people have talked to you about the garden during the week?
Press day is a hectic day where you meet so many people, I can hardly remember everyone I talked to! But we did have a surprise visit on press day from The Princess of Wales, who arrived in the midst of 100 school children visiting the garden! She was really good with the kids and seemed genuinely interested in the garden and the messaging. The King and Queen stopped by later that day too.

What has been the general reaction to 'weeds and rubble'?
Lots of people have liked seeing Dandelions in particular, and I think most people can see the beauty in the rubble too. At first glance, it looks like rugged natural stone. I've not heard anything negative yet, so I think the perception of Chelsea visitors is changing as to what is acceptable at the show. Quite a few gardens this year went down a

which highlights the importance of climate-adapted design solutions.

Has any particularly interesting insect shown up?
I am not an expert, but we had a snake fly (a fly with a long neck) arrive and conveniently land on a sample bottle. The RHS entomology team were doing Flower-Insect Timed Count (FIT) counts and recorded some 60 species at the show!

What happens next? Is it straight off to its new home or will it somehow be stored meanwhile?
We are still working on logistics including finalising planning permission, so it will be stored at Landscape Associates before they install it at IQL Stratford. The install should start in mid-August.

If you had the chance to start all over again, what would you have done differently?
In all honesty, nothing. I'm much more future focussed. This was the chance to test ideas, springboard a new look for RES and be a platform to take these concepts and ideas further. I am excited to see what we can do next!

Will you be continuing your relationship with the RES?
I would love to yes! I am excited to see what the next project might be.

similar route, so it didn't feel isolated, which is good news in my opinion!

Do you get the sense that we are trendsetting here?
I think the trend is well and truly set. Lots of designers are now looking for ways to creatively re-use waste, and to support wildlife (including insects).

Any favourite comments that you've heard?
I loved showing the kids around. They were full of excitement and interest in the microscopes and items we had around the lab such as sweep nets and samples. I can't remember specific comments, but they were so enthusiastic, which was great! Hopefully we inspired some future entomologists.

Has anything really surprised you this week?
The weather has been a bit crazy; no rain at all and high temperatures for the season. It seems like we are in for another long dry summer,

The RES Garden's pond. Photo: Tammy Marlar.

Volunteer reports

Filming in the garden. Photo: Tilly Collins

Tilly Collins

The mild chaos and excitement of an early Tuesday morning arrival at the RHS Chelsea Flower Show is an unusual experience. The throngs of people in different queues, the unloading of coaches, the palpable energy in the air as the gate attendants try to marshal assertive RHS members, visitors, workers, exhibitors and gardeners… In the middle of all this were some equally excited entomologists getting ready for their first real view of the RES's inaugural *Insect Positive Chelsea Garden*, designed by Tom Massey. Of course, we had all seen it the evening before when the BBC featured the garden on their show coverage, but being there amongst the hubbub and crowds to see it for real was quite another experience.

About 30 Members and Fellows had volunteered to spend a day or more being part of the interpretation team and supporting the RES core team who were leading the charge. After a half day of plant and philosophy training at Hortus Loci, the principal plant supplier which had been working with Tom for over a year to source and produce the components of the triumphant space, we were on our way. From the moment we arrived in the garden the questions started. There was barely time to pull on the purple 'ask me about insects' T-shirts and fill our hands with the garden information leaflets before the questions started. The RHS members who had exclusive access on the day I was there were rapidly six or seven deep around the boundaries, and their questions flew to us. That morning was all about the judging and many asked which medal the garden had been awarded (Silver Gilt). They then offered their theories as to why something so glorious didn't get Gold (slightly gone-over May trees, the brownfield visual vernacular not really being 'Chelsea', too naturally planted…). The next questions were mostly about plants - Viper's Bugloss and its many visiting bees were a hot topic, along with the other dry-land side plants such as Germander Sage, but there were also questions about what insects might come and what good things they might do. That side of things was so encouraging, the openness of the visiting crowd to see insects as other than pests and to ask about the whiches and whats and hows.

The volunteer team – ably organised by Fran Sconce into shifts – talked and answered and chatted and repeated themselves as people passed through admiring and questioning. I have no idea how many times I said "Hello, welcome to the Royal Entomological Society's Insect Positive garden designed by …", but all were responded to with such warmth and enthusiasm that my voice held out. The day was amazing, exhausting and rewarding and then segued into an evening of conviviality and drinks, and an auction of wonderful things donated to raise funds for the removal of the garden to its new home at IQL in Stratford, East London. In this new home, thanks to the support of the garden's sponsors and the kind donations received, it will help many more people appreciate and understand the value of insects. The volunteer contribution that we all made is only a small, small part of the work of the RES, but we were all glad to be there, all proud to contribute our time and energy, all there to help promote insect science and understanding.

A privilege really.

Photo: Tilly Collins.

PS: Another very popular question I had was 'where did you get your shoes?' (the answer to which is less-than-helpful – a second hand shop called Plato's Retreat in Hattiesburg, Mississippi).

Ben Hawthorne

PhD Student, Newcastle University

Volunteering at the RHS Chelsea Flower Show was such a fantastic opportunity. As an annual showcase of flora and garden design, it was great to be there representing fauna and the RES. There were many memorable moments, so I hope you all enjoy a brief account of how the day unfolded.

The Build-up and the Train Down

Coverage of the RES Show Garden had been plentiful in the days before I volunteered. It was great seeing horticulture legends visit our garden, like Monty Don walking through the Laboratory on the BBC, establishing our garden as a 'Must See' exhibit to Flower Show attendees! This really brought the RES and insect science in front of a new audience, connecting the Society with gardeners, which is

Ben Hawthorne talking with visitors about the garden. Photo: Dave Bird.

essential given that the way we manage our outdoor spaces has huge impacts on insects (I'm looking at you, artificial lawns…). Travelling from Newcastle gave me time to fit in some last-minute revision to absorb as much information about the garden as I could – the features, the planting list and what each plant variety looks like. This was supplemented with advice from members of the planting team, sharing the most asked questions on the first day so we could prepare responses just in case the same questions came up (which they did, fortunately).

On the Day

With doors opening at 8am, it was an early start to get to the RES Garden in time to prepare for the day. This consisted of loading up with leaflets for attendees and changing into the limited-edition RES volunteer T-shirts, printed with "Ask Me About Insects" on the back (some saw this as a challenge to ask the most difficult question they could think of). Talking to the first few visitors was a bit of a challenge, trying to remember all the talking points I had noted mentally. However, after the first few interactions, it became easier to flow through the key points organically.

Certain details which made impressions amongst visitors included the laboratory roof resembling the compound eye of an insect, and the functional, yet decorative, insect habitats around the garden. Very few people were unable to ditch the stubborn sensibilities on Dandelions, *Taraxacum officinale* agg.; most were able to welcome the plant as a great resource for insects by the end. In fact, it is noteworthy that the inclusion of 'weeds' in a Show Garden left people feeling guilt-free about having Dandelions or thistles amongst their planting beds!

The volunteer rota was arranged so we had two hours on the garden, one hour off, and repeat. The crowds were so engaged and enthusiastic, so when the end of my first shift came around, I almost didn't want to leave. However, the break was much needed on such a hot day and gave the perfect opportunity to go and explore the rest of the grounds. During my wander it was clear to see that wildlife was considered in a lot of the other Show Gardens. What's more, entomology was well represented, with the Bumblebee Conservation Trust stationed in the Pavilion with their 'Bee the Change' exhibit.

Many visitors were concerned about insect declines, with anecdotal stories about how they were noticing fewer insects this year. Whilst worrying to hear, this was a great opportunity to plug recording schemes and encourage gardeners to become scientists themselves, contributing to our understanding of the changing world. Having RHS staff on site conducting pollinator surveys was valuable for people to see, showing how accessible making scientific contributions can be.

Quarrels Over Common Names

There was one instance during the day where I was called upon to settle a dispute over whether a tree was May or Hawthorn. For those that don't know, *Crataegus monogyna* has many common names, so both were correct. It was great to talk about this and the importance of scientific names for species. My favourite example of extreme differences in regional names is the Woodlouse, also called pill-bugs, cheesy-bugs, roly-polies, chisel-hogs, and chucky-pigs, to name a few.

Most Asked Questions

"What is the red flower?" Adored by both people and insects, Crimson Clover, *Trifolium incarnatum*, was one of the stars of the show. Almost always there was astonishment to learn that this was a UK native plant, leaving a greater appreciation for our wildflowers (this was one of the questions the planting team had prepared me for.)

"Did you bring the insects with you?" The fact that the abundance of insects motivated people to ask this question emphasises just how well Tom Massey had done to design and create an entomological haven. The insects were not paid actors, but people were still shocked to learn they had made their way on their own accord, using olfactory cues and sight.

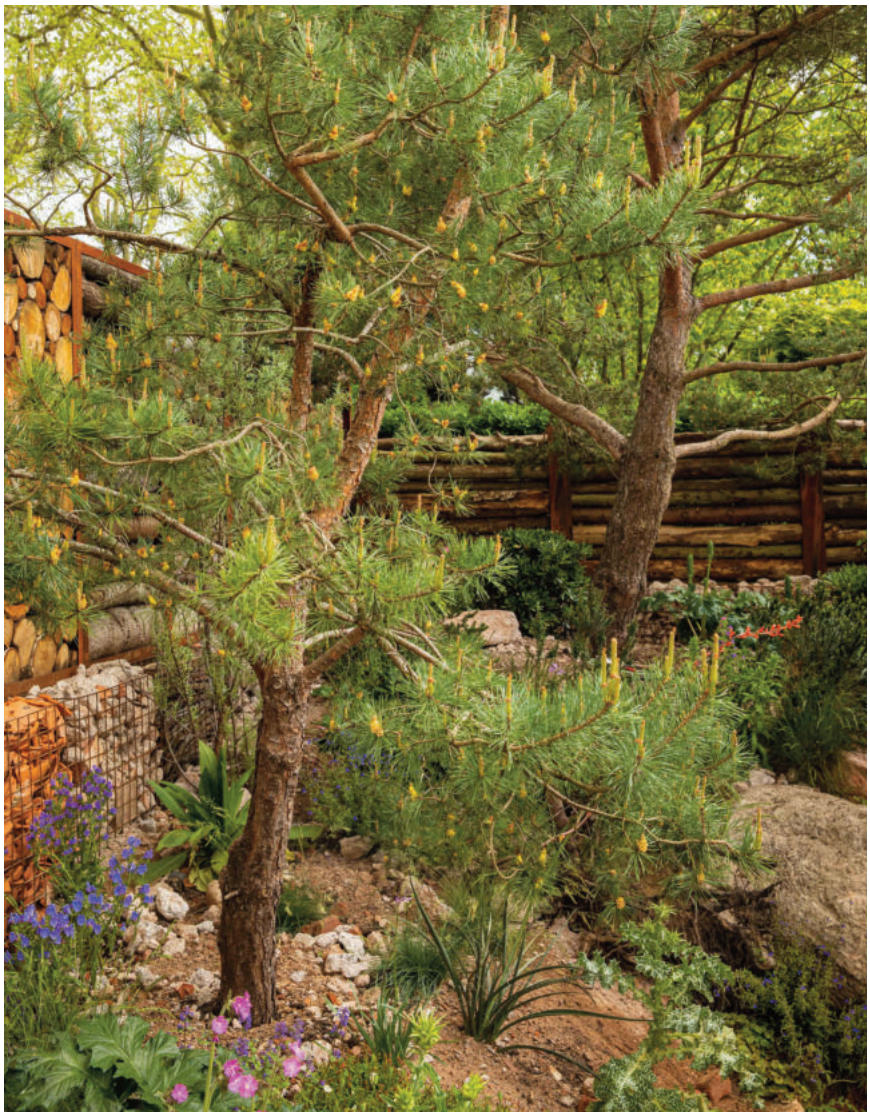
Final Remarks

The time went by very quickly, handing out what must have been hundreds of leaflets over the course of the day. One of the spectacles of the garden was seeing how the colours of the laboratory panels changed with the angle of the sun throughout the day, one of the reasons some people revisited the garden periodically. Another change was that of the pace of the crowds, particularly towards the end of the day. Fewer people were gathering by then, which allowed me to catch my breath.

Thank you to the RES team and everyone involved - I am so grateful to have had this opportunity. It was so much fun talking with people about insects, answering questions, and sharing interesting facts. This is what outreach is about: encouraging people to appreciate insects a little (or a lot) more!

Visitor engagement at the garden

Fran Sconce and Emilie Aimé



Garden visitors loved our interesting boundary walls made of reclaimed deadwood, rubble and twigs, including a felled tree from RES Headquarters, Mansion House. Photo: Tammy Marlar.

Our fantastic team of 30 volunteers were stationed around the garden to help bring it to life for the 170,000 visitors to the Show. One of their main roles was to distribute 25,000 leaflets about the RES garden, which included a description of habitats, information about Tom Massey and RES, planting list, plus a foldout poster of garden insects with illustrations by Richard Lewington.

Volunteers were invited to attend a briefing day at the nursery Hortus Loci, to see plants being grown for the garden and to hear from Tom and the RES about the opportunity. During the show volunteers were encouraged to start conversations with the public about insects in gardens and creating habitats. Common questions from the public included queries about particularly striking plants on the garden, especially the beautiful Crimson Clover which was a favourite for visiting pollinators. People were also interested of course in the different insect species found on the garden, more of which in a later article. Another point of interest was our hard landscaping with lots of people interested in recreating our striking gabion walls filled with reclaimed material of dead leaves, twigs and rubble.

On press day we had several famous faces visiting the garden, including Aisling Bee, Tom Allen,

Gardening television presenter Monty Don in the RES garden. Photo: Tammy Marlar.

Matt Tebitt, Raven Smith, Anthea Turner, Bill Bailey, Rich Hall, Maddie Moate, Patrick Grant, Felicity Rowbottom, Deborah Meaden and Ellie Harrison. We were particularly interested to hear that comedian Bill Bailey enjoys creating illustrations of insects in his spare time.

HRH Catherine, Princess of Wales, was our star guest. She met with RES CEO Simon Ward and Tom Massey our garden designer on a tour of the

HRH The Princess of Wales with Tom Massey and school children by the pond. Photo: Tammy Marlar.

Bill Bailey in the laboratory.
Photo: Tammy Marlar.

garden with a lucky local school group. On the same day we had around 100 local schoolchildren visiting the garden. They were encouraged to identify the different habitats in the garden where insects could live, to try out the equipment in the lab such as the sweep nets and the pooters, and to use the microscopes.

We received 300 sign ups during the week to a new public email newsletter, incentivised by a prize draw for signed copies of Tom's book *Resilient Garden*.

The press exposure for the Society during the show was unlike anything in our history. The garden was featured several times during the week of BBC coverage with a particular focus on our lab and the landscaping of the pond to create insect habitat. We also had a live broadcast from the BBC Breakfast weather presenter Carol Kirkwood, showing morning viewers around the garden and then giving the UK weather forecast!

As well as the BBC, both on television and online, the garden featured in most UK newspapers and several magazines, including: The Guardian, Mirror, Daily Telegraph, Mail Online, Mail on Sunday, Sunday Times, Times, Financial Times, Evening Standard, Metro, Hello!, Radio 6 Music, LBC, Gardens Illustrated, House & Garden, Good Housekeeping, Country living and over 200 local and trade publications.

Internationally we were featured by CBS TV Network and news publications from France, Poland and Finland.

BBC presenter Angellica Bell ready to record. Photo: Tammy Marlar.

Carol Kirkwood giving the BBC UK weather forecast from the RES garden.
Photo: Tammy Marlar.

Science on the RES Garden

Hayley Jones (RHS),
Jenna Lawson (UKCEH),
Fran Sconce (RES)

Marsh Hoverfly *Helophilus pendulus*. Photo: Tammy Marlar.

The RES Garden is 'a garden for insects and for those who love them'. We aimed to show visitors a range of different ways to study insects, from simple and accessible, to the latest cutting-edge technology. In the laboratory we displayed insect collecting equipment such as sweep nets and pooters, with hand lenses, dissection microscopes and insect field guides. Under the microscopes we had insects found in the garden, including rose aphids that were feeding on Teasel, and Two-spot Ladybirds that were on hazel. RES staff and collaborators also carried out different types of insect surveys in the garden.

RES staff and volunteers, including those from the RHS, recorded insects around the garden during the build period and the show. Sixty insect species were identified from eight taxonomic orders and 30 taxonomic families. In freshwater these included Marsh Hoverfly (*Helophilus pendulus*) and Southern Hawker Dragonfly (*Aeshna cyanea*), species on deadwood included Blue Mason Bee (*Osmia caerulescens*) and Black-headed Cardinal Beetle (*Pyrochroa coccinea*), deciduous trees attracted Spotted Snake-fly (*Phaeostigma notata*) and Alder Leaf Beetle (*Agelastica alni*). A highlight was seeing a Humming-bird Hawk-moth (*Macroglossum stellatarum*) visiting Red Campion (*Silene dioica*).

UK Centre for Ecology and Hydrology provided an automated monitoring of insects (AMI) moth trap for use in the garden. This aims to provide a practical and cost-effective solution for standardised monitoring that is non-biased, non-invasive and can be used at a wide spatial and temporal scale.

The AMI-trap consists of UV and white lights and high-resolution cameras for attracting and imaging insects, high-capacity data storage to collate images over long sampling periods, battery and solar power to allow the system to be deployed away from mains power, and customisable sampling schedules. The AMI-trap combines computer vision and an autonomous imaging system to capture images of moths in the field, locate them in the image, and classify them to species level.

RHS entomologists, led by Dr Hayley Jones, collaborated with RES to count pollinators visiting the plants in the garden. They used the Flower-Insect-Timed (FIT) count system developed by the UK Pollinator Monitoring Scheme to survey both native wildflowers and ornamental garden plants that were incorporated in the planting. This method uses ten-minute surveys focussing on the flowers of one plant type within a 50cm square and recording visitors to broad groups such as 'bumblebees, solitary bees, hoverflies, other flies and more'.

AMI moth trap lit in the garden. Photo: Fran Sconce.

Buff-tailed Bumblebee *Bombus terrestris* on Viper's Bugloss *Echium vulgare.* Photo: Tammy Marlar.

Baker Consultants exploring insect acoustics in soil. Photo: Tammy Marlar.

Hayley Jones (left), Emilie Aimé (centre) and Ashleigh Whiffin (right) doing insect surveys. Photo: Fran Sconce.

Over the course of the week Hayley and eight RHS colleagues completed 128 surveys, tallying 343 flower visiting insects in total. It was great to highlight how every little helps when providing flower resources for these essential insects. The observations have also provided some new candidate plants for the RHS Plants for Pollinators list, including Tree Germander (*Teucrium fruticans*) and Crimson Clover (*Trifolium incarnatum*).

Baker Consultants demonstrated the use of bio-acoustics for monitoring soil health. Soil samples were taken from the Chelsea site, a contact microphone was used to listen to the sounds of soil fauna moving through the sample, and a sonograph was displayed of the sound. Baker Consultants are building a database of soil fauna acoustics against which soil acoustic measurements can be compared.

Photo: Tammy Marlar.

The Society's partners and supporters

Anne Weinhold
Business Development and Fundraising Manager

Our garden at Chelsea wouldn't have been possible without the passionate and inspiring support of Project Giving Back. Project Giving Back is a registered charity, funded by two private individuals keen to support a wide range of charitable causes whose work suffered during the global Covid-19 pandemic. The charity carefully selects a set of UK-based charities and other charitable organisations through a competitive process every year. Each chosen organisation receives a grant for a fully-funded garden at the RHS Chelsea Flower Show, whilst following the usual Royal Horticultural Society selection process for gardens at the event.

Working with renowned multi-RHS medal winning garden designer Tom Massey, we were told that we had been successful with our funding application for a show garden in 2021. What followed were months of careful and detailed planning and preparations for the garden, supported by a whole host of partners and supporting organisations. The widely acclaimed Landscape Associates and Cake Industries were responsible for the structures and build of the garden, led by Tom Massey's design and inspiration in collaboration with the RES team. The plants for the garden were meticulously selected and nurtured by Hortus Loci, with further structural and landscaping elements supplied by N55, Anne Romme and Anne Bagger, Surrey Ironcraft, Water Artisans, Thread, the Grass Roof Company, Mule Studio and Ashwells Timber. Show gardens at Chelsea are a huge team effort, and we're delighted to have worked with so many expert partners in bringing our insect science garden to life.

During the week of the Chelsea Flower Show from 22nd to 27th May we hosted two evening receptions with partners, collaborators and funders joining us. We were delighted to receive generous support from Mishcon de Reya LLP who co-hosted our Tuesday evening Drinks at Dusk reception, inviting some key clients

to join on the night. Among our 130 guests we welcomed the Chair of the Met Office Rob Woodward, Tim Littlewood, Executive Director of Science at the Natural History Museum, BBC Blue Peter Producer Ellen Evans, and colleagues from Hogan Lovells LLP, the University of Oxford, and Dorling Kindersley among others.

We were also extremely grateful to those generous individuals and organisations who donated to our auction on Tuesday night, which raised in excess of £24,000 for the relocation of our insect science garden to Stratford, East London after the show. Auction highlights included a coffee experience for ten from Chimney Fire Coffee, a roastery based in Surrey, and a soil bioacoustics event in the winning bidders' own gardens from the industry leading Baker Consultants. The in-person garden consultation

Simon Ward and Jane Hill with one of the auctioned paintings. Photo: Tammy Marlar.

that our designer Tom Massey generously donated was snapped up in less than a minute, and two Chelsea garden paintings from the renowned modern impressionist Sherree Valentine Daines raised the significant majority of funds at over £21,000. Our thanks go to celebrity auctioneer James Lewis for his encouragement and enthusiasm that inevitably led to this fantastic result.

The celebratory event on Tuesday evening was followed by an after-hours gathering of supporters and close collaborators on Thursday. It was wonderful to be joined on our garden by so many friends and RES colleagues and their partners, with a prize draw of the award-winning Insect Week robber fly image raising more funds for the Society. Thank you to everyone who was part of our second and final reception at Chelsea, and for helping us make the evening such a success.

For both evening events we also welcomed colleagues from Lendlease, our strategic partner for the relocation of our garden to the International Quarter London (IQL) in the city's east end. Our Drinks at Dusk events provided a fantastic opportunity to share our thank you for their co-funding of the relocation, and providing a significant amount of support prior to the official launch of the relocated garden in 2024 and beyond. We are very much looking forward to the coming weeks and months as we will continue to raise funds to support the relocation, while working with local and national partners to bring our multi-year educational programme at the IQL to life.

Auctioneer James Lewis and artist Sherree Valentine Daines. Photo: Tammy Marlar.

Photo: Tammy Marlar.

The Future of the RES Chelsea Flower Show Garden

Simon Ward
Chief Executive Officer

Having a Chelsea Flower Show garden is a fantastic opportunity to raise the profile of the RES, which will help us increase our impact and relevance as an organisation. During the week there were opportunities to speak to the public as well as leaders of other charities and businesses, funders, Government Ministers and senior public sector representatives. In addition, the reach through media across the world is significant and the results mean that this is the greatest public engagement activity in the history of the Society.

Of course, whilst this engagement is significant and will act as a springboard to future partnerships, projects and reach for the Society, it is important to think about the legacy of the garden. It is also a criterion from this year set by both the Royal Horticultural Society and the funder, Project Giving Back, that the garden is as sustainable as

Tom Massey, HRH The Princess of Wales and visiting children explore the pond.
Photo: Tammy Marlar.

possible and must be relocated. This is, in part, due to the significant investment in infrastructure such as the new lab and landscaping. As well as this, many plants have been purchased to be part of the garden.

The question we had at the start of the project was where we could put the garden that would have the most beneficial impact to the RES and continue to engage many people for years to come so that they can learn more about insects, insect science and the Society as a whole.

It was early on in our planning that our garden designer, Tom Massey, had been in some initial talks on another project with Lendlease. This firm was leading the construction of the International Quarter (IQL) which formed part of the development in Stratford following the Olympics in 2012.

Initial discussions were had and there was real enthusiasm. There was also a significant amount of red tape to get through and agreement of funding to allow this to take place. However, the conversations continued along with numerous site visits. At the start of 2023 everything was finalised, and the relocation of the garden was agreed.

This venue was perfect as it was going to be in a plaza next to the offices of the British Council and close to the new UCL East campus, which house the People and Nature labs and the Connected Environments labs. It was also going to be close to the new buildings for the BBC, Sadlers Wells, University of the Arts, London and the Victoria and Albert Museum. The new site will therefore be where there is high footfall and with new signage, there will be a great opportunity to interact with the public and raise the profile of insect science and the RES.

The location for the lab and garden also gives an opportunity for the RES to engage in a new school education programme. Working with an education partner and other social enterprises in the local area, it is hoped that we can bring many children to the site to learn about insects and how they can study them. This is important, as the RES membership wanted to see education for schools developed as part of our ongoing work. This will hopefully engage young people and encourage more interest in insects, with some perhaps becoming the next generation of entomologists. It is hoped that the Society can raise funds through donations, philanthropy and grants to ensure we can get as many children as possible from disadvantaged backgrounds to use and engage with the garden.

A visiting schoolchild takes a closer look. Photo: Tammy Marlar.

Earlier in 2023 we ran a fundraising campaign to help fund the relocation of the garden and to start the education programme, allowing us to engage with as many young people as possible. This raised over £10,000 which was fantastic. During the Chelsea Flower Show we also raised over £24,000 through an auction and attracted further donations towards the project. Obtaining funds in the future will help us deliver further education opportunities for both this project and others both in the UK and globally.

In addition to public engagement and schools we hope that universities can use the garden for training opportunities with students. The garden will also provide possibilities to engage with the Society, for example during Insect Week, and by hosting exhibitions such as of images from the photography competition.

It is hoped that the garden will be built in the late summer and early autumn with a grand opening in spring 2024. Once established it is hoped the garden and education programme can be extended to other areas through various project opportunities. The garden relocation will be a wonderful way to mark the 190th anniversary of the Royal Entomological Society and provide opportunities to work with new funders, partners and collaborators to ensure insect science is at the forefront of discussion and understanding.

An entomologist at Chelsea

On the first evening of the Chelsea Flower Show 2023, the BBC included the Society's show garden in its evening programme. I was immediately reminded of my long association with Chelsea, and the entomological content of my exhibits there.

In 1961, I joined the University of Reading's Department of Horticulture, appointed by the Head of Department who, as a plant physiologist, had a genuine interest in what insects thought of modifications to plants made for horticultural purposes, such as the use of plant growth regulators, different fertilisers *etc.*

With no previous connection with horticulture, I thought it was incumbent on me to join the Royal Horticultural Society (RHS) and so I found myself at Chelsea in the early 1960s, as in those distant days RHS Fellowship included two free tickets to the annual Show. I was disappointed to see that the 'Educational Section' in the main marquee featured stands from several horticultural and agricultural colleges, but that none of the four universities offering horticulture degrees (Bath, Nottingham, Wye College of London University and Reading) were represented. The Head of Horticulture at Reading at the time had no interest in publicity, but when the headship changed in 1966, I approached the new incumbent to suggest that we might exhibit at Chelsea and promote our courses. I guess I might have anticipated his reply – "If you're willing to do all the work, go-ahead".

So, I found myself arranging the first Reading University stand at Chelsea in 1968 (Fig. 1), and exhibited plants with *Aphis fabae*, *Brevicoryne brassicae* and *Myzus persicae* on host plants in celluloid cages. I also had a push-button quiz with multiple-choice questions about aphids (*e.g.*, "With no mortality, what weight of aphids could accumulate after one year, starting with one mother? One ton, a hundred tons or a hundred million tons"). The quiz had flashing lights, proved very popular with the public and stimulated lots of questions. On the second day I came back from lunch to find a reception committee from the RHS waiting for me.

Fig. 1. The first Reading Horticulture Department exhibit at Chelsea in 1968. The push-button quiz and flashing lights are extreme left, next to the caged aphid cultures.

Helmut van Emden
University of Reading
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Apparently, I had not read the show rules carefully enough. 'Livestock' were expressly forbidden; in the eyes of the organisers, aphids qualified as 'livestock'. I immediately pointed out that directly opposite my exhibit was the RHS stand advertising their advisory service, and featuring a large, uncaged Gooseberry bush covered in Gooseberry Sawfly. The RHS officers retired hurt, and my exhibit remained intact.

After that first show, other members of staff at Reading expressed the wish to run a stand at Chelsea, and we finished up with a rota of about four of us well into the noughties. By then the Horticulture Department had been closed and the one surviving member of staff was not prepared to continue the tradition.

One of those first colleagues to do a stand was the late Robin Buckley. He based his stand on crop protection in orchards in the early part of the 20th century. The exhibit featured some ancient spraying equipment, as well as some of the early chemicals used for pest and disease control. These were actually harmless liquids, powders and crystals produced for us as excellent replicas by the Chemistry Department at Reading. Already on the first day, my colleague returned from lunch to find somebody had, presumably not with the best of motives, stolen the obvious poisons like lead arsenate and strychnine. However, it was not long before the thief was revealed. It was one of the RHS officers, who had removed the exhibits following a complaint from a member of the public that human poisons were being left unattended on our stand. Cue for a large notice making it clear that only replicas were on display.

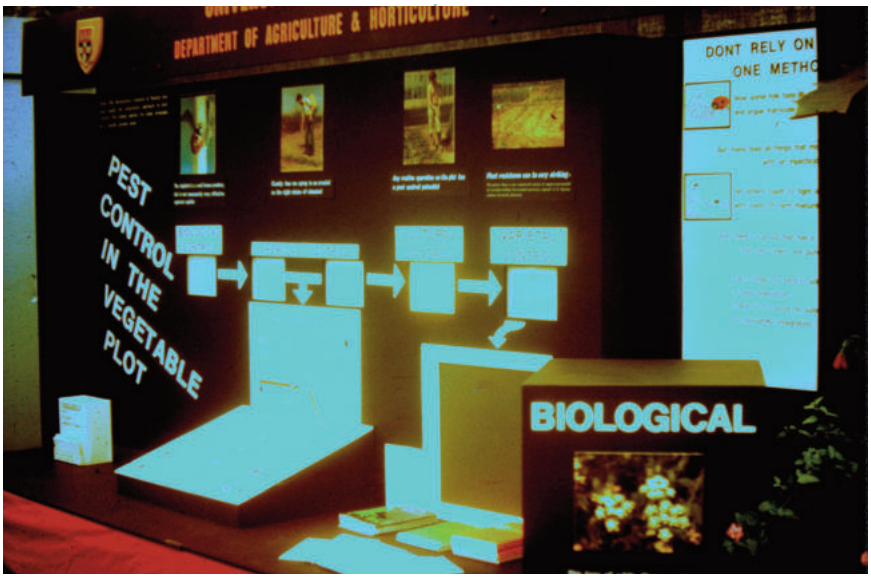

Fig. 2. The 'Pest Control in the Vegetable Plot' exhibit in Letraset, with the unfortunate cube bottom right.

Talking about notices reminds me that, in those early years, everybody had much more amateurish displays than you see today. Before computers made it easy to produce professional typescript, everyone used the product 'Letraset', including in theses to label the axes of graphs.


THE ROYAL HORTICULTURAL SOCIETY

Established 1804 Incorporated 1809

SILVER MEDAL

AWARDED TO University of Reading

at the Chelsea Flower Show 1999

For an exhibit of The Ways & Wherefores of Aphids

IN THE LINDLEY RANGE

Fig. 3. Silver Medal awarded to University of Reading in 1999.

The product was sheets of A4 with upper- and lower-case letters, numbers and symbols in different fonts and sizes, which could be transferred individually onto paper or card by rubbing over them with a ballpoint pen.

My second stand at Chelsea, entitled "Pest Control in the Vegetable Plot", was such a Letraset production and, having learned my lesson about 'livestock' at Chelsea, featured the insects as large photographs (Fig. 2). Large pictures were affixed to the sides of a large cube to illustrate Chemical Control, Biological Control, Cultural Control and Plant Resistance. This periodically stopped briefly every quarter-turn to display a different image, achieved by an electronic timer and a braking system based on a metal Maltese cross. Sadly, by the third day, prolonged use had somewhat freed the mechanism, and the cube now rotated past the next Maltese cross arm, and spun round recklessly at pace. A quickly produced notice "You may stop the cube with your hand" proved an effective, though amateurish, solution.

Over the next few years, we had to follow other exhibitors and progress from Letraset. We achieved this with the help of our Typography Department, who had the facilities for producing really professional display boards and offered that our Chelsea exhibits made ideal final year student projects. Of course, we had no control over whether the two students chosen each year were heading for a first or a third, which brings me to the 'year of the black delphinium'.

My theme for the exhibit that year was "improving insecticide use in the garden". It was all about retention of spray on the target, selective use to protect natural enemies, *etc.* Good stuff! But the display boards were a disaster, and it was far too close to finals to have another go. I'm sure it was very innovative and modern to use a tiny grey font entirely in lower case on a slightly darker grey board, but in terms of attracting attention it was a disaster. That year the number one excitement at Chelsea was that someone had succeeded in breeding a black delphinium and it was just my luck that my stand was exactly opposite this sensation. I spent a week watching the backs of heads walking past.

I was due to retire in 1999 without having been awarded a medal for my repeated efforts. Chelsea medals are much coveted, although they are no more than rectangles of cardboard with an embossed circle in the appropriate colour (gold, silver-gilt, silver and bronze).

I was keen to have one last go at a medal and persuaded my colleagues to allow me to run the Reading stand out-of-turn in my year of retirement. I had been given the wink that my problem had been a focus on insects rather than on plants, and so my next step seemed obvious – host alternation in aphids. I displayed specimens in pots of summer and winter hosts of six common pest aphids in front of a 4.8 x 2.3 metre canvas painting of aphids (see heading to article) by my wife Gill, also a Fellow of the Society.

It worked. I did get my medal (Fig. 3), and I also still have the Spindle plant, now a fine 3-metre-high specimen next to my Broad Bean patch.

Meadows and insect conservation

Marbled White (*Melanargia galathea*), Bernwood Meadow. Photo: Richard Harrington.

Creating a meadow, even of only a few square metres, can greatly extend the variety of insects in a garden

Wilson Wall
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There is no doubt that insect conservation is a hard sell to the general public, but there is a subtle way in which it can be achieved almost by stealth. Instead of approaching the question directly, targeting specific ecosystems can work wonders. Creating a meadow, even of only a few square metres, can greatly extend the variety of insects in a garden. By creating an even bigger meadow area, it becomes possible to increase the range of insects in an area that had not previously been recorded.

For many years I have been returning an over-grazed paddock of acid grassland back to a true meadow, that is a diverse, flower rich area with as many broad-leaved plants as grasses. This transition has taken time because of the scale of the conversion, but also because I wanted an ecologically balanced system at all times, rather than just reseeding the entire area with wildflowers that would be transient species. Very often the public perception of a meadow is nothing more than a ragged annual flower bed, or anything that is grass, but not a park. This, of course, is not what a meadow is, and annual flowers will often only provide a short food season for adult insects. Another aspect of a thriving meadow is that, even though it is regarded as a climax vegetation, it does require some intervention to maintain it in pristine condition.

A very effective method for getting people to develop a meadow and keep it is by encouraging them to plant orchids, as a statement of a long-term project. This may seem an odd thing, but it has the advantage that our native terrestrial orchids are long-lived plants and, for the most part, very picturesque. It is because they are simultaneously difficult to get started and long-lived that they represent a belief in the longevity of a meadow and the care that the landowner has put into the land. While it is quite usual to categorise land areas by virtue of their plant

communities, as in JNCC National Vegetation Classifications, this may not always be the best way of categorising the health of a meadow. My own experience with converting an overgrazed paddock back towards a diverse acid grassland meadow has shown that one of the best indicators of the current health of the land is in the range and population densities of insect species at any given time over the years it takes to make the conversion. By gradually changing the land use back towards a meadow, the fluctuation rate of population densities is slowed down, while the measurable rate of recruitment of new species remains constant.

I have watched the changing insect fauna with some interest as I decided not to take the path of amenity meadow construction, which usually involves a lot of death and destruction of the current plants and associated insects. Using a technique of slow change from short turf with only about 20 plant species and concomitant insect numbers, to full meadow with more than a hundred species, takes many years, the changes in flora being mirrored by the fauna. The first major change to the field, once livestock were excluded by improved fences, was that along one field edge a substantial growth of nettles started. This was something of a surprise on such a low-fertility soil, but is easily understood in the context of horse behaviour. Horses are creatures of habit and prefer to urinate in the same place. This increases the local nitrogen in the soil, which provides conditions perfect for stinging nettles. The second development, which was quite unexpected, was that the provision of fodder for the horses had left a lot of seed which, in the first year, sprouted to produce a large area of tall, coarse hay. Both of these plants needed to be controlled, though not eradicated, by selective cutting to reduce the stamina of the plants, while the nitrogen levels in the soil returned to a normal level.

One of the first changes which I noted in the insect fauna was a rapid increase in the grasshopper population. The largest increases came from two species, *Omocestus viridulus*, the Common Green Grasshopper, and *Chorthippus brunneus*, the Field Grasshopper. Besides these two widespread species, two years into the project I had a thriving population of Roesel's Bush Cricket, *Metrioptera roeselii,* which, as far as I could tell, was at the western limit of its range. This is a species that first appeared in Britain at the beginning of the twentieth century as a coastal species around the south and east of the country. From this original distribution, it has been gradually moving north and west until it arrived with us in north Worcestershire.

Part of the maintenance of a meadow involves at least one cut per year. This is mainly to control the grass and stop the foliage from lying flat like a thatch during the winter, blocking access to light. The grass was cut once a year in late summer or early autumn, depending upon the timing of the last flowers and the weather. It is important for the cut grass to be removed so that nutrients are not just recycled into the soil. Additional control of the grass was carried out by the introduction of Yellow Rattle, *Rhinanthus minor*. This is a species in the Orobanchaceae, which contains many obligate plant parasites. Yellow Rattle is a halfway house in this, in that it is partially parasitic on grass, amongst other hosts, stunting the growth of the grass to which it attaches itself. Yellow Rattle is a species which is very popular with bees of all sorts, being good for domestic Honeybees as well as bumblebees.

The meadow generally has about two bumblebee nests a year, one of which is usually a carder bee (*Bombus*) species and the other *Bombus terrestris*, the Buff-tailed Bumblebee, the nests of which are a delight to see, with the large number of strikingly coloured bees flying in and out. With the reduction in grass and the scrapes created by rabbits, I also started to see the Tawny Mining Bee, *Andrena fulva*, that seems to like the shorter sward and easier access to the soil that mixed growth provides.

In contrast to the bees, once the grass was under control the number of wasp nests declined, although only by one from the previous numbers of about 4 nests/ year. They also changed their position from being in the bulk of the grass, where they utilised vole holes, to where the rabbits had started digging. Rabbits had always been present, but the population went up once the grass component of the meadow started to decline. Strangely, although the bee colonies tended to be easier to spot, our local Badger seemed to prefer digging out the wasp nests, which are singled out on its regular travels across the meadow, living as it does

Bedeguar gall on Dog Rose. Photo: Wilson Wall.

Rutpela maculata. Photo: Wilson Wall.

about 1 km away. Besides the social wasps of the Vespidae, one of the most common wasps is *Diplolepis rosae*. Although this is not a frequently seen species, the results of its presence are easily spotted in the form of bedeguar galls on Dog Roses. These galls are very obvious large globes of a hairy red appearance, created by the larvae interfering with normal plant development. These were present in the field as a long-term species associated with the hedge line even while it had been a paddock. By counting the numbers of galls each year, it became apparent that, while changes to the field did not affect the population, there is a natural variation in numbers from year to year.

Another species that has demonstrated large variations in numbers between years is the Garden Chafer, *Phyllopertha horticola.* This beetle makes its presence known in May and June when it flies during the day. It is not a particularly agile flier, but it is interesting in that the larvae feed underground on roots while the adults are leaf-eaters. The underground phase of its life cycle has sometimes resulted in it becoming regarded unfavourably in gardens and golf courses by causing damage to turf when it is present in large numbers. There is, of course, a simple solution to this problem; stop being so obsessed with uniform grass monoculture. Although not using the meadow as a breeding site, one of our commoner Cerambycid beetles, *Rutpela maculata*, is now regularly found feeding on flowers in the meadow, having been lured in from surrounding woodland, a situation that would not have happened had the area been left as a grazing paddock. It is also reasonable to assume that other species are similarly attracted to meadows, not as sites for larval food, but as feeding places for the adults.

My large meadow extends over about 1.5 hectares and has areas of scrub, which is mostly made up of gorse and bramble, both very important food plants for adult and larval insects. While it is not easy to create useable scrub in a garden, it is possible to create a garden meadow. By introducing long-lived species, such as orchids, into a garden meadow you instil a sense of permanence which is reflected in the care that you give to the land and to its insect population.

Details of how to create a meadow can be found in *The Secret Life of a Meadow* by Wilson Wall and Dave Morgan, published by White Owl Books, June 2023.
JNCC National Vegetation Classification: jncc.gov.uk/our-work/nvc/#nvc-publications-nvc-volumes-british-plant-communities

Common Blue (*Polyommatus icarus*), College Lake. Photo: Richard Harrington.

Featured Insect

Violet Oil Beetle, *Meloe violaceus* Marsham, 1802

Scientific name: *Meloe violaceus* Marsham, 1802
Common name: Violet Oil Beetle
Order: Coleoptera
Family: Meloidae

I have a different favourite insect almost every day, but when pressed I usually plump for this wonderful oil beetle. I like it because oil beetles (genus *Meloe*) are quite scarce, because they are big and endearingly ungainly, and because of their weird life history. This one, *M. violaceus*, is probably the commonest British species, but even so you don't often see it. But I'm lucky because there's a resident population that lives in my garden and obligingly appears every spring right outside my kitchen door; the timing is quite variable, from early March to mid-June.

The beetle in the picture is a big female, about 35 mm long, and her huge abdomen is full of thousands of eggs. The larvae are parasites on solitary bees (my other near-favourite insects…) which abound in my garden. The female beetle lays her eggs in a hole that she excavates in compacted earth (often a path) and when they hatch, the first stage larvae ('triungulins') climb up a flower stalk and wait for a visiting pollinator. The larvae don't look like ordinary beetle grubs, but much more like adult insects, with dark sclerotised cuticle and long legs with prominent claws. They have been called 'hitchhikers from hell'! When a bee arrives to check out what the flower has to offer, the beetle larva grabs on to the bee, which obligingly takes it home to her well-provisioned nest. There the little horror settles down to eat the food that was intended for the bee larva, and eventually the larva itself. Gruesome, isn't it?

The life history of the beetle is particularly interesting to me because it's one of the best examples of hypermetamorphosis, in which a larva goes through several different body forms before eventually becoming an adult. Another interesting thing about beetles of this family is that they leak toxic haemolymph from their limbs when handled (this is the origin of their name). This is loaded with an irritating chemical called cantharidin, which has been used not only for 'legitimate' folk medicine (*e.g.*, to treat warts) but also as a supposed (actually dangerous) aphrodisiac.

This particular image (it's a phone picture) is technically not great, but I really like the way it shows that oil beetles frequently suffer the indignity of having to carry around phoretic mites (there's one on the oil beetle's thorax). In view of their own habits, it seems particularly undignified! No-one seems to know much about these mites, and it's been suggested that they are only there in error, having mistaken the oil beetle for some other kind of coleopteran. I'm afraid I find that hard to believe.

Stuart Reynolds

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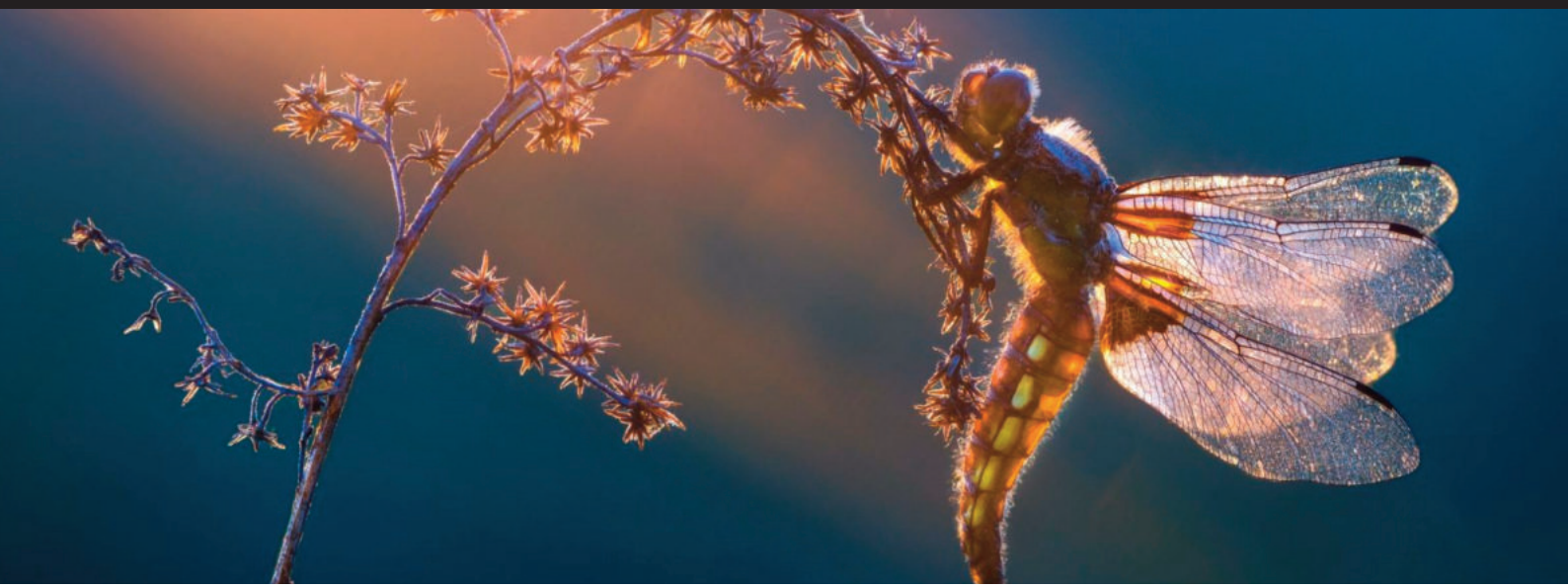


Libellula depressa. Photo: Petar Sabol.

News from Council

Council met online on 10th May with the President, Jane Hill, in the chair.

Simon Ward, CEO, presented progress with KPIs for the various strategy areas, all of which were on target bearing in mind that only two months of the reporting year had elapsed. Total membership was reported as 2,180. It will be important to convert the many free student memberships into paying memberships and to do everything possible to ensure that others who have not yet renewed do so. The publication of the 'Grand Challenges' paper had gained wide coverage through social media and been well received. It had already been used in relation to the government's call for evidence on insect declines and food security. The new Science, Policy & Society Committee will be asked to reflect on this interaction and how the Society might engage with government in future. The Big Give Campaign had raised more than £11,000. This will go towards relocating the Chelsea garden and establishing an education programme, which had been identified as a priority in the 2021 membership survey. Simon also reported on progress with the Chelsea garden, renewal of the Daneway Banks lease, recent events and engagement, and staff changes.

At a previous Council there had been agreement to move from our current home at The Mansion House. There was discussion on the commissioning of reviews that will be necessary to maximise the opportunities presented by the sale of The Mansion House and the acquisition of a new HQ. The appointment of a project manager had already been approved. Priority will be given to ensuring that the needs of the membership and staff feature first and foremost in all decisions.

A decision on whether or not to implement set term lengths for journal editors was deferred until the July meeting, pending further consultation with editorial teams.

Following a robust tender process, it was agreed that publication of the Handbook series would transfer from the Field Studies Council (FSC) to CABI with immediate effect, subject to scrutiny of a legal contract. FSC will continue its successful association with the Society in different ways.

A brief finance update was provided by Steven Lee, Director of Finance, who said that the current situation was far better than forecast, as a result of improved budgetary control. All trustees were invited to attend the next Finance Committee meeting with the auditors.

Luke Tilley, Director of Communications and Engagement, outlined plans and opportunities for Chelsea week.

There were reports from meetings of the Membership Committee, Meetings Committee, Publications Committee and Outreach Committee.

It was agreed that the July Council meeting would be in person over two days and include a review of strategy implementation to date. Online participation would be possible for those unable to attend in person.

Richard Harrington

Journals and Library

A year in the life of the RES Library

Rose Pearson
RES Librarian and Archivist

The library has existed since the founding of the Society in 1833, and I started in the role of Librarian and Archivist for the Society in January 2022, so despite having worked in libraries for over a decade, and an intensive handover period with previous librarian Val McAtear, it was a huge challenge to take on. Added to this challenge was the fact that I am not an entomologist; however, as I got to know the library and archive, the knowledgeable and passionate members of the RES, and our Library Committee, I quickly learned to tell my Odonata from my Orthoptera. After a year in the role, I thought members would be interested to learn more about our collections, what happens here, and our future plans.

With 12,000 books, including 1,500 rare volumes, 800 print and 200 online journal titles, as well as 250 boxes of archive material, I am always kept busy. Our book collection is organised by insect order, and we also hold material on applied entomology, natural history and botany, as well as biographies, and literature featuring insects. Some of the most beautiful items are in our rare books collection, many with hand-coloured etchings, holding real artistic and scientific value. Our print journals collection covers all aspects of entomology internationally and spans nearly 250 years, with publications from both large institutes and small societies. An audit found that we had a high percentage of rare material: in some cases, the RES holds the only known copy. Some titles have never been digitised, so I receive many requests to supply articles via our journal scanning service. Our archive holds documents relating to the running of the Society, including historic membership files and minute books dating back to 1833, as well as other material relating to the history of entomology, including letters, journals and notebooks of eminent naturalists and entomological illustrators.

Our St Albans site is open three days a week, and I assist visitors in searching the shelves, borrowing books, and researching in the archives. I also deal with many

Past President Helen Roy and current President Jane Hill view some of our rare books.

A visit from members of Harpenden Botanical Painting Group.

enquiries by phone and email. Enquirers may be professional entomologists, enthusiastic amateurs, or from a different field entirely. Family members often look for information on a relative who was a member, historians may be interested in the correspondence of Victorian naturalists, and artists are keen to view our collection of early entomological illustrations. Topics have included the egg-laying habits of furniture beetles, entomologists' gravestones, grasshopper taxonomy, entomology in colonial India, and the first female members of the Society.

To make it easier to discover and use this material I added more relevant information to our website (www.royensoc.co.uk/library), and you can now search our online catalogue without logging in. I also promote our collections on social media. Meetings at Mansion House are an opportunity to showcase some of our rarer material to members. Eighteenth century illustrated entomological books are favourites, and are also of interest to non-entomologists, such as the local botanical painting group who viewed a selection of our rare books, which feature insects and the plants that they feed on. Member Irene Boogerman said, "I think a few of us will be incorporating more insects into our drawings as a result." For those who are unable to visit our St Albans site, I have been meeting members and promoting the library and archive with a stall at events, including at Ento22 and the Verrall Lecture.

It is an exciting time for the library and archive. While continuing to build our print book collections through both purchases and donations, we also plan to offer more e-books and journals. We are looking at options for digitising part of our archive and rare books collections to make them more accessible to researchers. We also plan to host more open days and exhibitions at the library, as well as showcasing our collections and services at more RES events. We will be exploring the library and archive further in future issues of *Antenna*.

The library and archive are fantastic resources and I urge all Members and Fellows to make the most of them, whether through a visit, a remote enquiry, or by accessing our online resources. Email library@royensoc.co.uk or call 01727 899387 to make an appointment.

Library exhibit at Ento22.

A plate from '*A Natural History of English Insects*' (1720) by Eleazor Albin.

Meetings

Monthly Evening Meetings

Reports by Richard Harrington
(Chair of Meetings Committee)

From Monks Wood to Hollywood: 50 years in Insect Conservation

Lecture dedicated to Sally Hughes, co-founder with Bob of the 4th July Butterfly Counts and inveterate butterfly recorder, who died recently.

3rd May 2023

Robert Michael Pyle
Founder, The Xerces Society for invertebrate Conservation

I'm writing this the day before coronation day. It's wonderful to have a king who understands the value of wildlife and its conservation. Indeed, he has visited our Daneway Banks reserve. The title 'King of butterfly conservation' must, though, go to Bob Pyle, one of our Honorary Fellows and winner of our 2022 Award for Insect Conservation (see *Antenna* **46**(3) 156, where you can find out more about Bob's array of achievements in entomology and beyond). He took us on a fascinating and, for many, nostalgic journey through his entomological life.

As with many of us, Bob's interest in insects began as a youngster, in his case in Colorado, where he adored the butterflies and was horrified by habitat destruction. Having witnessed the loss from his stamping ground of the Olympia Marble (*Euchloe olympia rosa*) as a result of building playing fields for his own school, and of the Bronze Copper (*Lycaena hyllus*) to a car park for the local church, he lobbied the City Council to save habitat. His lifelong campaigning and action had begun. A Fulbright Scholarship brought him to Monks Wood Experimental Station to work and study with John Heath, who pioneered methods for monitoring, understanding and conserving insects, along with other greats such as Ernie Pollard, Eric Duffey, Kenneth Mellanby, Jack Dempster, Jeremy Thomas, Mike Morris and

Bob Pyle with his long-time net, Marsha. Photo: David Lee Myers.

Martin Warren. Bob talked us through those heady days, and explained how serious insect conservation in the UK began with the demise of the Large Copper butterfly (*Lycaena dispar*) from Woodwalton Fen, not far from Monks Wood, as a result of drainage. The Swallowtail (*Papilio machaon britannicus*) also suffered severe losses for the same reason.

Bob's work, and that of his colleagues at Monks Wood, especially Jeremy's with rare hairstreaks and the Large Blue (*Maculinea arion*) inspired him to found the Xerces Society in 1971, the first conservation organisation in the Americas devoted to insects. It was named in honour of the Xerces Blue (*Glaucopsyche xerces*) which was lost to the USA in 1943. The Society still flourishes as a major driver of policy and practice, with some 80 staff in 28 states. It has succeeded in mainstreaming invertebrate conservation, with many organisations wishing to be associated with its work. Under the guidance of Lincoln Brower and Bob, IUCN/WWF made the migratory Monarchs (*Danaus plexippus*) their number one world butterfly priority, a story that can be followed in Bob's book *Chasing Monarchs*.

The meeting came to a wonderful finale with Bob describing his conservation work in the Dark Divide, Washington State, where the indigenous people believe the legendary Bigfoot lives, and where the exceedingly rare and incredibly beautiful Golden Hairstreak (*Habrodais grunus*) has its only home in the state. His book on the subject, *Where Bigfoot Walks: Crossing the Dark Divide*, was made into a feature film, in which Bob is played by David Cross and Bob's late wife, Thea, by Debra Messing. The Golden Hairstreak enlivens the climax.

Mark Collins, a former colleague of Bob's and founder of the Swallowtail and Birdwing Butterfly Trust, asked Bob whether he was optimistic about the future of insect conservation and, if so, on what grounds. Bob said that he is a born optimist, though things look tough, and that his source of hope is stepping outside and seeing the butterflies that persist in spite of our worst. His great concern is that overzealous laws are discouraging children from discovering the wonders of insects for themselves, just when we need them. In California, for example, it is now illegal even to touch a Monarch butterfly. "Keep nets in the hands of kids" was, for me, the quote of the evening. Bob is also worried about climate change, citing the risks posed by increasingly frequent fires to the most threatened butterfly species in the USA, the Hermes Copper (*Lycaena hermes*), which he described as "too cute to be legal".

Jeremy Thomas, Bob's friend and soul-mate of fifty years, asked how the UK and Europe might help encourage butterfly conservation in the USA. This led to the suggestion of joint meetings or exchange visits between the RES and the Xerces Society which, it was agreed, should include young people. I very much hope that these aspirations can be brought to fruition.

In conclusion, I would highlight the great importance of dedicated, cohesive, well-led, long-lived teams, unfettered in their drive to achieve practical results. Bob clearly demonstrated how the team at Monks Wood has left a worldwide legacy. Monks Wood is no longer with us, and I do worry about the difficulties experienced in building and maintaining such teams these days.

Golden Hairstreak (*Habrodais grunus*). Photo: Keith Brady.

Bioinspired Pest Control Technologies: A New Frontier in Biological Control

Lecture dedicated to John Gatehouse who was an inspiration to all who worked with him and who developed the fusion-protein technology.

7th June 2023

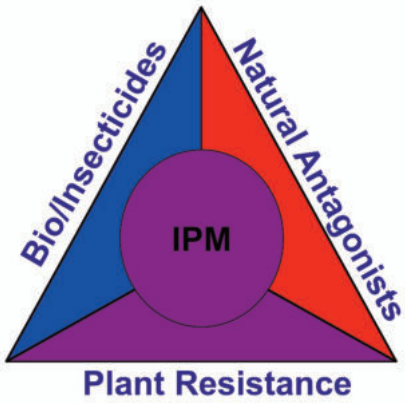
Angharad Gatehouse
Newcastle University

Angharad Gatehouse.

Food productivity must increase by 70% to feed an additional 2.3 billion people by 2050 – a huge challenge for science and society. Angharad explained that 40% of all crops planted are lost to pests, weeds and diseases, well over half of that loss being due to insects and the diseases they transmit. Reducing these losses is clearly important to food security. Currently we rely heavily on synthetic insecticides, which are part of the solution but also part of the problem in that they often adversely affect beneficial organisms.

As part of the EU project EcoStack (www.ecostack-h2020.eu/), Angharad is working on the generation of novel biopesticides from key antagonists of pests and pathogens. These were first used back in 1902 when *Bacillus thuringiensis* (*Bt*) was isolated from the gut of Silk Moth larvae and the crystal proteins it produces on sporulation used as an insecticide. Later, the toxin-producing genes were expressed in transgenic plants which are resistant to targeted pests.

Spiders are by far the biggest killers of insects, and Angharad is working on using their toxins as biopesticides. Atracotoxin is a neurotoxic polypeptide found in the venom of the Sydney Funnel-web Spider (*Atrax robustus*). The toxin targets the central nervous system (CNS) of prey, as do many synthetic insecticides. Many spider toxins are inhibitors of insect (but not mammalian) sodium, calcium and potassium voltage gated ion channels, leading to depolarisation of nerve impulses and death. The calcium channel inhibitors are amongst the most species-specific and hence the mode of action of choice. Unfortunately, the toxins don't work if consumed orally, so technologies are being developed to deliver the toxins to their target site of action, the CNS. Following ingestion, snowdrop lectin (GNA) can cross the insect gut barrier and is hence a potential carrier molecule. Having identified a potential carrier, a synthetic gene was made and expressed in a microbial expression system, and evidence found for binding of the resulting fusion protein to the CNS of lepidopteran larvae. It was found to be effective against Lepidoptera, Coleoptera and Homoptera. The big question was whether it can be used as a biopesticide rather than as a transgenic plant, and Angharad found that it can. Furthermore, extensive tests showed that it had no adverse effects on Honeybee development, mortality, behaviour or learning ability. Fortuitously, the bee calcium voltage gated ion channel is different from that of other insects.

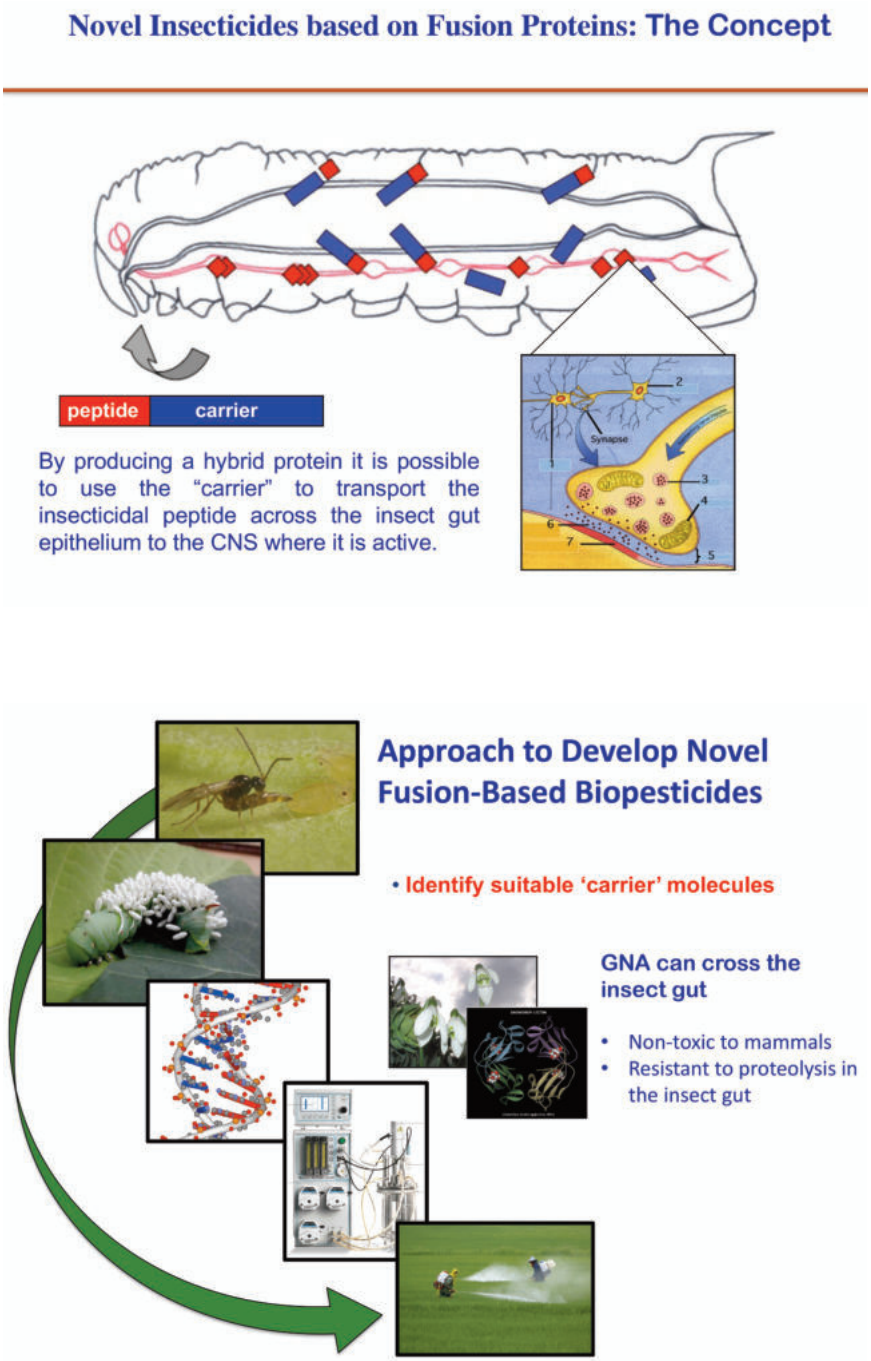


Different fusion proteins were found to be effective against the aphids *Myzus persicae* and *Acythosiphon pisum*, and against larvae of *Spodoptera littoralis* (Cotton Leafworm).

Angharad then discussed the potential of RNA interference (RNAi) techniques in targeting the CNS and immune system of insect pests. RNAi is highly species specific. Inhibition of a coleopteran sodium voltage gated ion channel led to an 80% reduction in adult emergence. Significant knockdown in the gene expressing of that ion channel was identified. Biosafety studies again found no deleterious effects on bee survival or immune response.

When a parasitoid envenomates a host, an arms race begins as the prey tries to encapsulate the parasitoid egg. Ankyrin molecules suppress the immune system and reduce encapsulation. Franco Pennachio and his team at Naples University are trying to exploit this as a biopesticide. When expressed in transgenic plants, the gene for ankyrin delays development and significantly decreases the survival of the host due to accumulation of bioprotein in the midgut epithelium, decreasing absorption. As with the spider toxins, fusion proteins have been made so that the molecules can be used as a biopesticide. Franco, who is also a visiting professor at Newcastle working with Angharad, is applying this technique to enhance the capacity of biocontrol agents. For example, knockdown of immunity genes using RNAi techniques leads to failure of *S. littoralis* to encapsulate parasitoid eggs. This suggests that double stranded RNA (dsRNA) molecules delivered under realistic field conditions have the potential to enhance *Bt* insecticide activity on *S. littoralis* larvae.

In collaboration with Gordon Port (also Newcastle University) Angharad found that RNAi in conjunction with the entomopathogenic fungus *Beauvaria bassiana* significantly enhanced mortality of Red Flour Beetle (*Tribolium castaneum*). Her group demonstrated that dsRNA has also been targeted to ryanodine receptors in the Tomato Leafminer (*Tuta absoluta*). Ryanodine is a calcium-channel blocking diterpenoid found in the South American plant *Ryania speciosais*, and knockdown of the TuRy (Tuta Ryanodine receptor) gene significantly reduces larval survival in *T. absoluta*. Effective delivery has now been achieved using chitosan nanoparticles, which allow slow release and enhanced efficacy. Hydroponics make a good delivery mechanism and Angharad is hopeful that commercialisation will be achieved before too long.



A lively Q&A session covered issues of scaling up, commercialisation, potential problems registering products in the EU, application methods in the field, barriers to wider use, and use of biopesticides against insect groups not covered in the talk.

This was a marvellous summary of exciting advances in pest control. One study has suggested that biopesticides could become the dominant methodologies by the mid 2000s. Angharad ended by making the point that we should never rely on a single technology for the control of pest insects and that biopesticides should be seen as one of many tools.

Finally, a request. Angharad reckons that the first reports of biocontrol against insects come from China where Ji Han (263–267) used ants to control pests of citrus. She would love to hear of any earlier examples – and so would we at *Antenna*.

Behaviour Special Interest Group

Online Meeting 26th April 2023

Convenors: Michelle Fountain and Jozsef Vuts

Report by Richard Harrington

The famous words of E.O. Wilson proclaiming that insects are 'the little things that run the world' are often quoted. I've always been somewhat concerned that bacteria might have something to say about that. This meeting rather backed that up, majoring as it did on the role of microbial communities in the functioning of insect communities, especially in the context of pest management.

Many entomologists have studied the role of volatile organic compounds (VOCs) from plants and insects in attracting and repelling insects. Bart Lievens (KU Leuven, Belgium) is working on VOCs from microbes (mVOCs) in this regard. Microbes emit mVOCs to attract insects for many reasons, including to aid dispersal (the microbes hitch a lift), and for protection and overwintering inside insects. Some microbes need insects to complete their life cycle. Likewise, insects respond to microbes for many reasons including the help that they give in digestion, breakdown of toxins and indicating suitable feeding or oviposition sites, or warning of dangers. Bart's aim is to assess the potential of mVOCs to improve biocontrol of the aphid *Myzus persicae* in Sweet Pepper, with its parasitoid *Aphidius colemani* and the hyperparasitoid *Dendrocerus aphidum* as a model system. He tested mVOCs from 30 bacterial strains in a Y-tube olfactometer and found that mVOCs from three strains (all *Bacillus* species) attracted *A. colemani*, and three repelled it. Volatiles from one strain were attractive to *A. colemani* and repellent to *D. aphidum*, so potentially ideal for enhancing biocontrol of *M. persicae*. As *Bacillus* looked especially promising, 40 more strains from more than 20 *Bacillus* species were collected from diverse situations and the olfactory response of *A. colemani* corresponded with bacterial phylogeny. Using gas chromatography coupled with electroantennography (GC-EAG), several compounds, including styrene and benzaldehyde, were physiologically active, with blends eliciting stronger responses than either individual chemical. In greenhouse trials, *A. colemani* was attracted by the compounds to sticky plates up to 5 m away. Bart hopes that such compounds will prove useful in insect monitoring, push–pull control strategies and 'attract and kill' traps for hyperparasitoids.

Mosquitoes are the deadliest animals in the world, killing more than half a million people every year. There are more than 3,500 species, of which only around 2% (from the genera *Aedes*, *Anopheles* and *Culex*) are disease vectors. With increasing insecticide resistance and anti-malarial drug resistance issues, Noushin Emami (NRI, University of Greenwich, UK) is hoping that a better understanding on the molecular 'language of transmission' (information networks among pathogens, hosts and vectors) could lead to novel disease control methods. She found, for example, that in the presence of red blood cells (*E*)-4-hydoxy-3-methyl-but-2-enyl pyrophosphate (HMBPP), a key malarial metabolite, enhances host seeking behaviour in vector species and increases their susceptibility to infection with the pathogen. Supplementing this compound in an optimised non-blood artificial solution with a toxin can attract, trap and kill vectors.

Lucien Dobel-Ober (Liverpool School of Tropical Medicine, UK) is investigating methods to control the contents of the mosquito microbiome and observe the effects of infection with a pre-selected community of microbes on the reproductive behaviour of *A. aegyptii*. This is known as gnotobiotics. Microbes are removed from the surface of mosquito eggs, egg growth is synchronised, larval water is inoculated with known microbes and larvae are reared in sterile conditions. The result is larvae and adults containing only the experimental microbes. These can be used to test whether the microbiome of the female affects egg-laying and other behaviours relevant to vector control efforts.

Moving from human to plant diseases, Acute Oak Decline (AOD),

Honeybee on Marigold flower in an annual wildflower mix. Photo: NIAB East Malling.

which is associated with the Two-spotted Oak Buprestid beetle (*Agrilus biguttatus*) is an emerging disease caused by the bacteria *Brenneria goodwinii*, *Rahnella victoriana* and *Gibbsiella quercinecans*. Gareth Thomas (Rothamsted Research, UK) is investigating the possibility of using mVOCs produced by these bacteria to tackle AOD. One area of study is the role of mVOCs in behaviour of the beetle. Using air entrainment to collect mVOCs and a behavioural assay using a 4-way olfactometer, the beetle showed a preference towards mVOCs from all three bacterial species. Using gas chromatography, he found two compounds produced only by *B. goodwinii*, and these were shown by GC-EAG to elicit a strong response in both male and female antennae. Gravid female beetles preferred the compounds to a solvent control in a 4-way olfactometer. The next step is to test the attractants in the field, with a view to developing a semiochemical lure for monitoring the beetle.

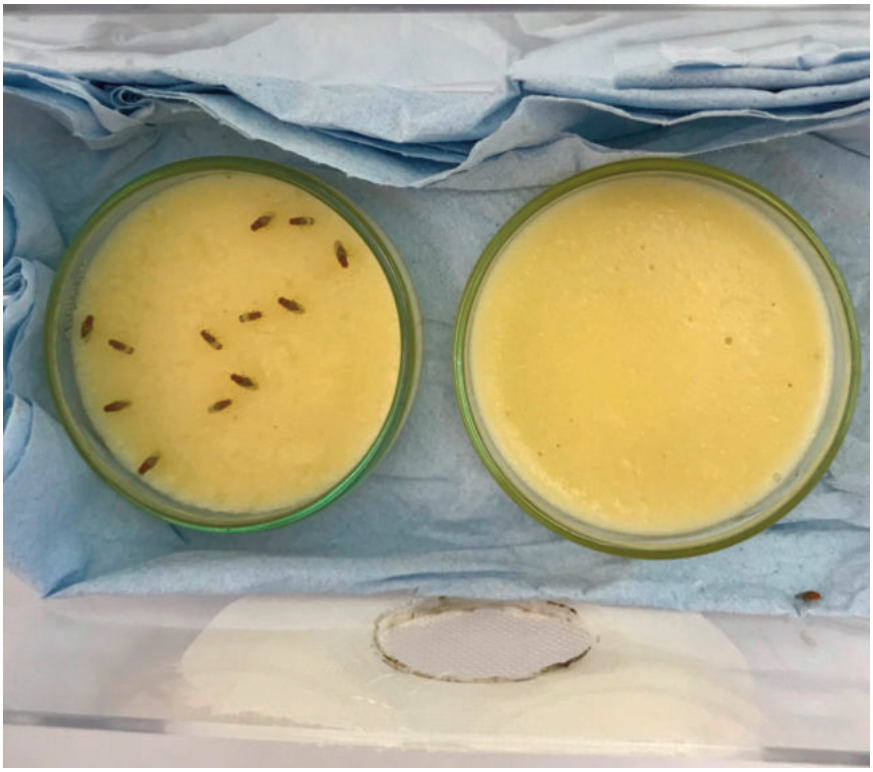
Two posters were on display over a lunch break that gave ample opportunity to do them justice. Tchoudjin Gertrude Loveline (University of Yaounde, Cameroon), is assessing the impact of land-use management on leaf-litter ant communities of the Dja biosphere reserve in the Congo Basin. A variety of trapping methods was tested in young and old cocoa plantations, a banana farm, a palm grove and a forest. Three-hundred-and-six ant species were identified from 57 genera. Anthropogenic disturbances adversely affected the composition and spatial distribution of soil myrmecofauna. Forty-nine species were common to all habitats, whilst 19, 12, 10, 8 and 4 were restricted to forest, banana, palm, old cocoa and young cocoa areas, respectively. These species could potentially be used to assess the conservation value of habitats. Habitat management should preserve a diverse vegetation, including an herbaceous layer that encourages the accumulation of leaf litter.

The other poster was by Sandra Cortes (Rothamsted Research, UK), who is looking at whether wheat rhizosphere microbial communities change in response to aphid herbivory. After two weeks of aphid infestation, bacterial diversity reduced but there was a higher abundance of actinobacteria and firmicutes. There was increased microbial metabolic activity in the rhizosphere, particularly in response to D-xylose, N-acetyl D-glucosamine and some amino acids. Aboveground volatiles involved in herbivore responses included limonene, alpha-cubebene and beta-ocimene.

Staying with aphids on cereals, Daniel Leybourne (University of Liverpool, UK) is asking whether facultative endosymbionts, known to have various beneficial impacts on aphids, also confer some fitness costs. From laboratory experiments, initial analyses suggested that endosymbionts can alter aphid fitness, modulating development time in populations harbouring *Fukatsia symbiotica*. Symbionts also altered feeding behaviour, but no change was detected in the transmission efficiency of Barley Yellow Dwarf Virus or in susceptibility to insecticides.

Microbes are key to Honeybee (*Apis mellifera*) immune function, but the bees are also plagued by various microbial diseases requiring the use of antibiotics. Brendan Daisley (University of Guelph, Canada) is trying to manage the microbiome by applying a novel probiotic formula called LX3, comprising *Lactiplantibacillis plantarum* strain Lp39, *Lacticaseibacillus rhamnosus* strain GR-1 and *Aoilactobacillus kunkeei* strain BR-1. A field study in Californian almond orchards was designed to determine the effects of LX3 on pathogens and on overall hive activity, and to assess the efficacy of LX3 using a pollen-patty delivery system and a spray. Spray-based LX3 led to more than a 100-fold reduction in *Ascosphaera apis*, a deadly fungal agent of Chalkbrood disease. Patty-based LX3 showed unique nutritional benefits. Spray-based LX3 was also highly effective against many opportunistic plant pathogens in the hive, suggesting that the method may be useful for reducing the vectoring of plant diseases by *A. mellifera*. Both application methods showed promise against European Foulbrood and *Varroa* mites, and improved brood production overall. Brendan also outlined the database BEExact (github.com/ bdaisley/ BEExact), a metataxonomic tool for high-resolution inference of bee-associated microbial communities, which could be used, for example, to look at unintended effects of pesticides on microbial life.

Rudra Gouda (Indian Agricultural Research Institute, New Delhi) is studying the physiological functioning of gut bacteria in *A. mellifera*. Fifty-one culturable aerobic gut bacteria species were identified in the guts of forager bees, and 32 in hive bees, and these bacteria were able to degrade cellulose, hemicellulose, pectin, sucrose and lipids, suggesting involvement in digestion. Further



Spotted Wing *Drosophila* choice test experiment. Photo: NIAB East Malling.

studies may lead to bioprospecting of enzyme activities for biotechnological or industrial applications.

Spotted-wing Drosophila (*Drosophila suzukii*) (SWD) is an invasive primary pest of soft fruits. It is adapted to lay eggs in undamaged fruit using its toothed ovipositor, causing direct damage in addition to secondary disease damage. It encounters diverse free-living fungi, and Kelly Hamby (University of Maryland, USA) is investigating whether SWD can be a fungal vector. Adults have a nuanced attraction to yeast, four species of which are found in the alimentary canal and support adult and larval fitness. Larvae are attracted to yeasts in frass, especially to *Hanseniaspora uvarum*. On the other hand, *Botrytis cinerea*, a filamentous fungus causing fruit rot, is repellent to adults and deters oviposition, but 100% of flies tested could vector it in a Petri dish experiment up to 48 hours post-exposure. *Cladosporium cladosporioides* could also be vectored.

SWD is also the target of work by Fardina Rahimi (University of Southampton and NIAB East Malling, UK), who aims to find chemical and physical repellents in oviposition substrates pre-exposed to various *D. melanogaster* lines, and to investigate whether removing the gut microbiome of *D. melanogaster* affects SWD egg laying behaviour. Experiments using *D. melanogaster* cultures reared in the presence of antibiotics, or following dechorionation at the embryonic stage, demonstrated a deterrent signal that was elicited by the bacterial microbiome of *D. melanogaster*. A different laboratory culture of *D. melanogaster* possessed a bacterial microbiome that increased SWD oviposition. Genetic crosses indicated that both the microbiome and the *D. melanogaster* genotype played a role in determining SWD's response to the interspecies signal. Fardina presented metagenomics sequence analyses of repellent and attractive *D. melanogaster* microbiomes and explained how this information may inform control of SWD.

Anastrepha fraterculus is an important tephritid pest of a wide spectrum of fruits in South America. Ana Laura Nussenbaum (Institute of Agriculture, Argentina) is assessing

Male Medfly in courtship mode. Photo: Boaz Yuval.

the role of gut bacteria on the behaviour and physiology of the fly with the aim of using symbiotic bacteria to improve mass rearing and the efficiency of the sterile insect technique in fly control. Protein reserves of both sexes were affected by antibiotic treatments, suggesting that nutrient reserves are affected, at least to some extent, by intestinal bacteria. Enterobacteria appear to make a positive contribution to fly fitness. Trials using potentially probiotic bacteria failed to improve fly fitness. Further work on better-characterised bacteria is needed to explain the negative results and move forward.

The effect of the microbiome on tephritid behaviour is also being studied by Boaz Yuval (Hebrew University, Israel). The microbiome affects foraging behaviour in larval Mediterranean Fruit Flies (*Ceratitis capitata*) (Medfly) and copulatory success of the adults, and oviposition behaviour in Olive Flies (*Bactrocera oleae*). In Petri dish experiments, Medfly larval movement increased when bacterial cues were present. In a choice assay, Medfly larvae were attracted to bacterial isolates identified as commensals, while bacteria identified as putative pathogens were shunned. Manipulation of the microbiome affected these patterns, indicating the presence of a dynamic and plastic microbiome–gut–brain axis. In Olive Fly, the number of oviposition attempts was reduced in axenic females (fed on antibiotics) compared to symbiotic females, but adding Olive Fly microbiome to the axenic females restored normal oviposition.

Finally, on a rather different topic, products from the Neem tree have long been known to have insecticidal properties. Roy Durlave (Bangladesh Open University) discussed the importance of such plant extracts in sustainable agriculture, highlighting their environmental credentials.

This fascinating meeting was enjoyed by 53 delegates from around the world. Understanding the role of the gut microbiome in pest and beneficial insects will likely lead increasingly to its manipulation in pest control and conservation. Many thanks to Michelle Fountain (NIAB East Malling, UK) and Jozsef Vuts (Rothamsted Research, UK) for convening the Behaviour SIG and organising another stimulating, and truly international, meeting. Many thanks to all speakers, poster presenters and their co-authors, and to RES staff for their usual high-quality support.

Insect Welfare and Ethics Special Interest Group

Hybrid Meeting at Writtle University College, 31st May 2023

Convenor: Eleanor Drinkwater

Report by Richard Harrington

It's a delight to welcome a new Special Interest Group (SIG) to the fold. This SIG was conceived and convened by Eleanor Drinkwater and provides a forum for balanced discussion on what might be considered by some to be a challenging topic: ethical aspects of working with insects. Although current animal welfare legislation doesn't cover insects, insect welfare has been a recognised issue for a long time, with the great bard alluding to it. Scientific papers on whether insects experience pain were published throughout the Twentieth Century, and in more recent years consideration of insect welfare has become ever more prominent.

First, I must introduce you to a term which, until this meeting, had passed me by: *nociception*. This refers to the processing of noxious stimuli by the central nervous system. *Pain*, on the other hand, is the unpleasant feeling sometimes, but not always, associated with nociception.

Meghan Barrett (California State University Dominguez Hills) is Director of the Insect Welfare Research Society (IWRS) (insectwelfare.com) and reviewed recent work on insect pain, the scale of insect use in different contexts, the welfare concerns insects may face, and work done and needed to make progress on insect welfare and ethics. A review of eight accepted pain-relevant neurobiological and behavioural criteria suggests pain is plausible in some adult insects. There is very strong evidence for sentience in octopuses (which meet seven of eight criteria), justifying their inclusion in the Animal Welfare (Sentience) Act of 2022. In the few insect orders for which research has been done, many of those same criteria for pain have been met. In adult Diptera and Blattodea, six of the eight criteria are met. Barrett suggested that a version of the precautionary principle could be adopted in our treatment of insects, which would encourage researchers and producers to apply personal harm reduction approaches in their work. The IWRS has produced guidelines for protecting and promoting insect welfare in research, and Barrett presented a case study involving the welfare of the Black Soldier Fly (*Hermetia illucens*). BSF larvae are reared as an alternative source of protein for aquaculture, animal feed, pet food and human nutrition; Barrett's research on slaughter methods shows how empirical research could help producers improve their welfare practices on farms.

Studying the cockroach, *Blaptica dubia*, David Fisher (University of Aberdeen) found motivational trade-offs in behaviour, evidencing central processing of noxious stimuli. Cockroaches starved for 48 hours (but not those starved for 24 hours) were more inclined to access food in sheltered than unsheltered areas, suggesting a trade-off between the needs for nutrition and safety. Light intensity did not affect their decision, suggesting limits to their sensitivity which could be taken into account when designing rearing regimes.

In another study involving nociceptive trade-offs, Andrew Crump (Royal Veterinary College) examined the motivational trade-off of bumblebees to avoid 55°C heat and consume high concentrations of sugar. Bees avoided heated feeders when unheated feeders contained high sucrose concentration, but progressively increased feeding from heated feeders as the sucrose concentration in unheated feeders decreased. Different sucrose concentrations were coloured differently, and bees learned colour cues for their decisions, suggesting that the trade-off was based on processing in the brain rather than just peripheral processing. This is consistent with a capacity for pain experience.

Many population and behavioural studies involve marking insects. Katie Townsend (Writtle Agricultural University) is examining the durability of paint types for marking *Blaptica dubia* and has found that oil-based paints are by far the most durable. Further studies are needed to evaluate potential welfare issues associated with marking insects with paint or other methods (*e.g.,*

there may be sublethal effects) and the suitability for other species.

Theraphosid spiders are large for invertebrates, and Benjamin Kennedy (Veterinary Invertebrate Society) reported on research conducted with colleagues Steve Trim (Venontech) and Alice Upton (Canterbury Christchurch), who had the idea that theraphosid spiders may be suited to the Plantar Hargreaves Test apparatus, which is usually used in rodents and involves walking on a heated pad to test thermal nociception. With approval from the Ethics Board of the Royal College of Veterinary Surgeons, the instrument was found to be sensitive enough to detect theraphosid tarsi, the spiders responding in a similar way to rodents by foot withdrawal at temperatures of around 50°C. Withdrawal latency means were 10 to 18 seconds and varied with species and size. A needle stick injury to the tarsus reduced latency for up to 52 days, suggesting that the spiders feel pain.

Larviposition choices in pregnant Tsetse Flies (*Glossina* spp.) are being studied by Andrea Adden (The Francis Crick Institute, together with collaborators at Liverpool School of Tropical Medicine). Tsetse give live birth to a single larva at a time, the larva immediately burrowing into a suitable substrate to pupate. Where the female chooses to larviposit is thus critical to offspring survival. Females abort their larvae when stressed by factors such as low temperature, bright lights and aversive smells. These stresses should be kept to a minimum when rearing and during experiments as, if stress free, more realistic behaviours are likely to be observed. For example, stress-free females chose to larviposit in leaf litter rather than sand.

Insecticides continue to be necessary to control many pests, and Zachary Stavrou-Dowd (Liverpool School of Tropical Medicine) asks whether there could be such a thing as an insect-friendly insecticide. He tested the contact insecticide, nitisinone (NTBC), a tyrosine metabolism pathway inhibitor, against the malaria vector *Anopheles gambiae*. The World Health Organization's standard for a pesticide is that it should kill >80% of its target insect in 24 hours. Using tarsal applications, NTBC performed as well as broad-spectrum insecticides for this criterion when applied against blood-fed mosquitos but not against unfed mosquitoes. Zachary plans more work to test mosquitoes for sublethal effects of NTBC and meanwhile reserves judgement on the concept of an insect-friendly insecticide.

Meeting convenor, Eleanor Drinkwater (Writtle University College), is concerned with how undergraduate students can be supported in their thinking and decision making about invertebrate welfare. She proposed a framework covering teaching content and delivery, course structure and project supervision. Communicating uncertainty in an appropriate way is important, as students can react to uncertainty with discomfort, stress and a sense of vulnerability. Thoughtful guiding of debates about ethical issues is essential. Students need to be able to feel comfortable in challenging supervisors over insect welfare issues, such as where their experimental insects will be sourced, what is an appropriate sample size, and how and where insects will be handled, and disposed of after study. A holistic approach and a supportive environment are required to help students navigate a landscape of rapidly evolving ethical and welfare standards.

This topic was also picked up by Jemma Dias (Colchester Zoo). She said that there tended to be less research and expertise in zoos on the welfare of 'lower vertebrates' and invertebrates compared to 'higher vertebrates'. Potential solutions include highlighting the value of research in the understudied groups, ensuring presentation and publication opportunities in zoo-based conferences and journals, providing awards for research in invertebrate husbandry and welfare, and stressing applications to conservation.

There has been a huge rise in the popularity of invertebrates in private and commercial collections, as witnessed for example by the attendance of around 3,000–4,000 people at the British Tarantula Society Exhibition – on a par with attendance at the International Congress of Entomology. Thus, there is growing demand for veterinary input. Benjamin Kennedy (Veterinary Invertebrate Society) described some of the challenges in invertebrate veterinary care, such as their small size, hard exoskeleton, and lack of red blood cells and albumin. In assessing the ethics of insect welfare, Benjamin invoked 'the five freedoms' developed in response to a 1965 UK Government report on livestock husbandry, *viz.*: freedom from hunger or thirst by ready access to fresh water and a diet to maintain full health and vigour; freedom from discomfort by providing an appropriate environment including shelter and a comfortable resting area; freedom from pain, injury or disease by prevention or rapid diagnosis and treatment; freedom to express (most) normal behaviour by providing sufficient space, proper facilities and company of the animal's own kind; and freedom from fear and distress by ensuring conditions and treatment which avoid mental suffering. He concluded that there is much that we still don't know about invertebrates and their capacity to suffer, but that we can diagnose disease, treat clinical symptoms and facilitate positive welfare outcomes.

A philosophical lecture from Bob Fischer (Texas State University) ended the meeting. He said that no framework exists to make principled trade-offs between biodiversity and individual welfare, and suggested conversion of the elements of the trade-off to a common scale. He presented and discussed the benefits and limitations of a classification framework for ways to measure 'willingness to pay', and a formula for accounting for welfare impacts of a biodiversity intervention, *viz.*, *Total value of a biodiversity intervention = (value of successful intervention x probability of success) - (disvalue of the welfare impacts x probability of those impacts).*

This was a thought-provoking meeting. I noted that the age demographic of participants was lower than usual but was assured, in answer to a question, that this did not indicate a lack of acceptance of the importance of the issue of insect welfare amongst many of those who have been around a little longer. It will be very interesting to follow the conversation and ensuing practice, and it is good that the RES is taking the discussion seriously. So, many thanks to Eleanor and her team, to all speakers and delegates (18 in-person, 30 online), and to RES staff.

Student Forum 2023

29th March 2023

Cardiff University

by Ayman Asiri, Ava Searles and Vera Kaunath

It was a damp morning in the dreamy city of Cardiff. Past monumental columns in the Corinthian style of the Glamorgan building and across the red carpet to the wood-panelled door, the much longed-for meeting awaited the 57 people who had travelled to the event and around 87 online attendees: the Student Forum, the place to be(e) for all varieties of enthusiastic nature-nerds: wasp-whisperers, beetle-buddies, insect-collectors, moth-magicians, grasshopper-gangsters and many more. They had travelled from many different places to share their passion for the six-legged (and yes, sometimes eight-legged) animals, crawling out of their own niches to share their discoveries with like-minded students.

On this day, the wonders of insect science began with a brilliant talk by Ashleigh Whiffin, Pelham-Clinton Entomology Genetic Collection Curator for National Museums Scotland, in which she spoke in her infectious and inspiring way about her journey to insect science and the steps she took to her current career. She also spoke of the power of social media: Ento-Barbies, songs about rove-beetles, daily discoveries in green patches at your front door and, importantly, of the need to let your passion shine through.

The opening talk was followed by exciting insights into current student research. The students dived into the impacts of connectivity of aquatic invertebrate communities, bonded over impressive, but disturbing, videos about the physical defence mechanism of specialised Heliconiine caterpillars, and attended the Worst Game of Hide and Seek Ever in Dawn Morgan's (University of Wolverhampton, UK) research on larval dispersal in residential areas.

The outstanding wasp-whisperer herself, Prof. Seirian Sumner from University College London, captivated us with the stunning diversity and 'endless forms' of wasps (over 100,000 species, who would have thought that?), and impressed us with her fearless costumes to get more people engaged and to rethink the bad perception of wasps amongst the public. Even if the audience was already among the supporters of the wasp, they still learned seven new reasons to appreciate and love these social, hugely diverse, marvels of evolution.

This event was 'one of the only places where you will not get strange looks for talking about your pinned insect collection', and so it was that Francisca Sconce, RES Senior Outreach & Learning Officer, told the gathering of the many ways to handle, label and pin insects in order to bring out their grace, beauty and important identification features – because if you collect them, you'd better pin them properly! To provide a fitting end to the day, the thirst for knowledge was quenched in a nearby pub, where delegates put their heads together to solve the many riddles of the ento-pub-quiz. Which insect is living in James's Giant Peach? And what happens when a male Honeybee reproduces?

The second day was filled with stories of roller coaster experiences of life in academia. The splendid bee-pathologist Dr Peter Graystock, from Imperial College London, recounted tales of his nomadic life between workplaces and how his research was able to significantly impact the policy surrounding the importation of bumblebees. This was followed by a whistle-stop tour of Dr Jordan Cuff's mind-boggling journey from PhD to postdoc in a pandemic; a passionate researcher from Newcastle University, who used the hardships he faced during the pandemic to captivate and inspire the audience in a humorous and

Beetle tattoos for the Ento-Fashion Contest.

Learning how to properly pin and label with Fran Sconce (RES).

very infectious manner, and who continues to enthusiastically advance the field of trophic interactions, sustainable agriculture and forestry with his research.

The student talks were varied and covered fireflies in India, ants cultivating plants and the dispersal of blow fly larvae. This was followed by Emilie Aimé, Head of Publishing at the RES, who explained the variety of RES journals and the (sometimes wicked) processes of publishing.

To finish off the event with glitter, joy, laughter and Welsh cakes, there were student prizes to be awarded. The best talk prize was won by Ritabrata Chowdhury (University of Cambridge, UK) with his thrilling research about the earlier-mentioned defence mechanism in caterpillars. Our runner-up prize went to Kate Graydon (University of Bristol, UK) for her captivating description of Honeybee egg size plasticity. The best poster was won by Zann Teo Jiexin (Nanyang Technological University, Singapore) with her excellent taxonomic work on Singapore dung beetles, and runner-up was awarded to Ben Hawthorne (Newcastle University, UK) with a well-crafted and fascinating poster on metabarcoding for biomonitoring. Finally, to bring ento-fashion back into the spotlight, Laura Campbell (Durham University, UK) won the prize for the ento-fashion contest with her marvellous moth-dress!

It all started with strangers who shared the same peculiar fascination for six-legged animals and the secret wonders hidden within their life cycles, but by the end of the two days more than a few connections and, more importantly, friendships were made, which may lead to collaborations that enrich the world with more insect science. Until the next Student Forum!

A huge thanks to the supporting forces in the background – Francisca Sconce, Bianca Saccone, Yvonne Liversidge, Emilie Aimé and Luke Tilley – without them the magic of the event would have not been possible.

Little get-together: Science communicator and curator Ashleigh Whiffin and Joshua Sammy, with matching ento-scarves.

Forest Invertebrate News

Forest Invertebrates – the beginnings of the Special Interest Group

Anne Oxbrough
Edge Hill University

In 2012, I returned to the UK after spending 12 years in Ireland and Canada working in sustainable forest management, focusing on promoting biodiversity and specialising in spider and beetle ecology. Taking up a position as lecturer at Edge Hill University and thinking about setting up my own research group, I realised I didn't really know many researchers in the UK! I thought a good way to start would be convening a group relevant to my research on forest ecology and beetles/spiders. Having attended my first RES annual meeting, the Special Interest Groups seemed like a great platform, but what topic for the group? What had always struck me about research meetings I attended, was that they were firmly split – forestry in one corner, and conservation in the other. In Canada I had found that the idea of conservation being discussed at a 'forest entomology' conference was unheard of...if it's not a pest, get out! I had always found this strange, since practical conservation management might provide conditions that promote pests, whereas a pest management approach might be detrimental to species of conservation concern – perhaps the two should be discussed together? So my goal in setting up the group was to bring together researchers, practitioners and all those interested in 'forest insects and their allies' (never one to leave out my 8-legged friends). Now known as Forest Invertebrates, the group goes from strength to strength! We have had seven annual meetings, with participation growing from 14 to over 50. Going forward, the group is in good hands led by an enthusiastic new team. I hope to see you all at a meeting soon!

Bee Beetle *(Trichius fasciatus)* foraging on a Melancholy Thistle (*Cirsium heterophyllum).* The larvae of this scarab beetle live and feed on dead birch (*Betula spp.*). Photo: Kirsty Godsman

Photo: Forestry England

New directions and a call for participation

Kirsty Godsman with Daegan Inward, Brenden Beckett, Talor Whitham & Abi Enston

The recent RES Grand Challenges in Entomology project identified eleven priority themes for the future of entomology, many of clear relevance to the Forest Invertebrates group and its participants including ecosystem benefits, conservation options, pest threats, fundamental research, and naturally at the heart of every SIG, engagement! Through open meetings and short articles, we aim to share knowledge and skills with one another, support and encourage the next generation of enthusiasts and scientists, and engage with the public on matters of interest and importance.

As Anne mentioned, increasing anthropogenic impacts and the need for conservation of forest invertebrates was a key motivation for this SIG. Some (planted) forests may not be the first habitat that springs to mind when it comes to biodiverse invertebrate communities, but the plethora of microhabitats available makes all forests important to invertebrates, not to mention the contribution of trees to many important ecosystem services, carbon capture, and social wellbeing. As much as forest habitat is important for the conservation of invertebrates, the organisms themselves contribute positively to forest ecosystems too. They may provide pest control, decomposition and recycling of nutrients, or pollination services. In contrast to this, a few species may become serious tree pests, and an area of interest amongst SIG members is to understand the drivers of such interactions and find solutions to the most important ecological and economic threats.

This SIG provides a friendly forum for the discussion of all aspects of research and outreach involving forest invertebrates. We hope this first article has piqued your interest for the upcoming meeting planned for early next year, and a regular 'slot' in *Antenna* magazine. We wish to challenge the idea that conservation and forestry are exclusive to professionals, and as such want to welcome a wider audience. We encourage students, practitioners, amateurs and academics, indeed anyone with an interest in forests and the invertebrates within them, to join us!

If you would like to contribute to Forest Invertebrate News in *Antenna* with a 200-250 word article and accompanying photo, please contact the convenor team (www.royensoc.co.uk/membership-and-community/special-interest-groups/forest-insects/). We are especially keen to hear about topics related to any of the grand challenges.

Insect Week 2022 art competition results

The Royal Entomological Society is excited to announce the results of the first Insect Week art competition for children, part of the annual celebration of insects. Entries were received from across the UK, Europe and Asia, across three age categories: 3 to 7 years, 8 to 12 years, and 13 to 18 years, with themes of 'endangered insects', 'moving insects' and 'people and insects'.

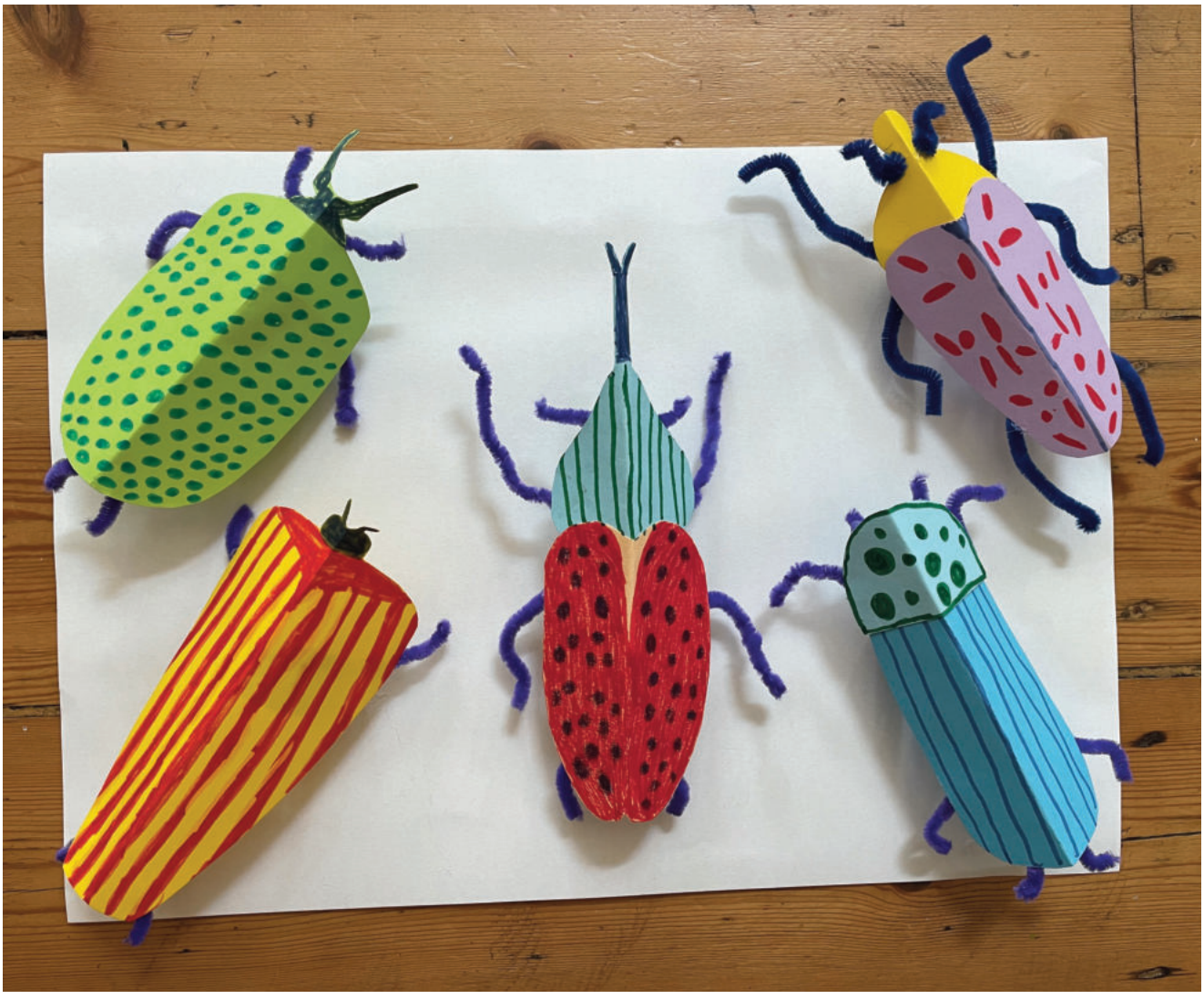
Dominique Vassie (freelance artist and biologist), Julie North (relief and intaglio printmaker and entomologist) and Hayley Jones (RHS Entomologist) judged the entries. They said "We were so delighted to see such a wonderful spread of insect art. We received a large number of entries, all of which were done to a very high standard, which made it so difficult to judge. Everyone did such a great job at bringing the beauty and character of insects to life. We hope you all continue to be curious about insects, inspire others to love them too and make beautiful art to share with the world."

3 to 7 years

1st place: Dragonfly Sparkle, by Cillian Farrell (age 5).

Judges' comments:
We loved the way the dragonfly was drawn on the move, flying through the air, and the use of colours and 3D glittering squares to show off its sparkle!

2nd place: Bumblebee, by Diya S. (age 7).



3rd place: Beetle Art, by Celina Wysocka (age 7).

8 to 12 years

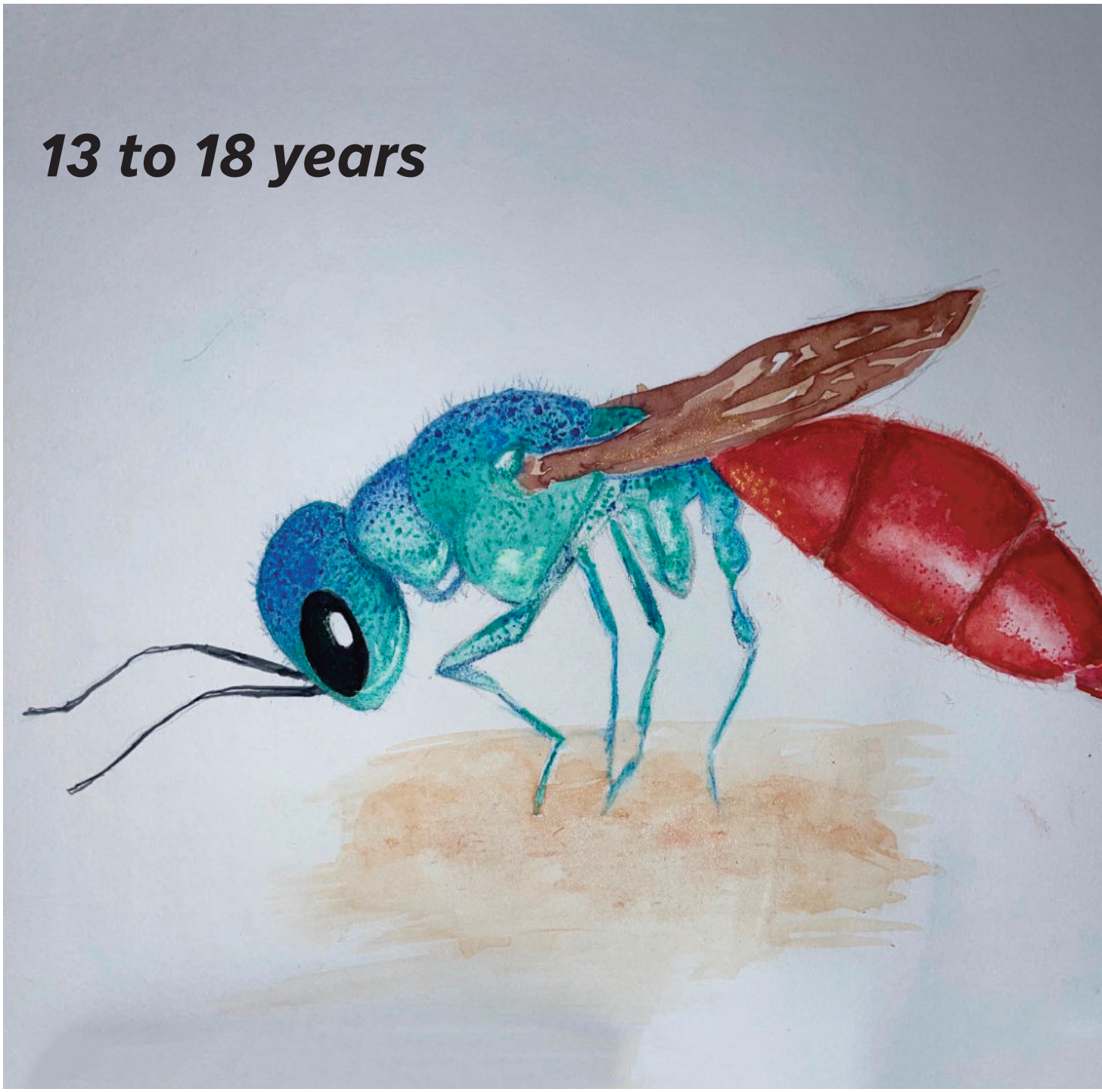
1st place: Legally protected and in flight after feeding on wild thyme, by Kate Presnell-Roberts (age 12).

Judges' comments:
We loved the colours and textures on this piece, the use of metallic paper to make the beetle's iridescent wings is very effective. It also brilliantly captures an insect in motion and we liked that it showed the beetle within its habitat too.

2nd place: Swallow Prominent resting on a finger, by Lola Clarke (age 12).

3rd place: The Wonderful Tansy Beetle, by Elle Houldsworth (age 11).

13 to 18 years



1st place: Fragment of Beauty, by Alexandria Coen (age 13).

Judges' comments

We thought this piece wonderfully used watercolours and glitters to depict the iridescence and textures of such a stunning wasp. The attention to detail in the shape of the insect was also impressive.

2nd place: On the Move, by Siyona Bhandari (age 13).

3rd place: Pinky Ponku, by Kushal Sai Kyabarsi (age 17).

Special categories

Winner, Endangered Insects: Big and brightly coloured bumblebee, by Aidan Warwick (age 9).

Judges' comments: We thought this bumblebee was drawn in a beautiful style and loved its hairy legs. Bumblebees are certainly a group of insects that are struggling and need our help but we felt there was something so hopeful about this little bee flying high into a sunny sky!

Winner, Moving Insects: Predators and the swamp, by Isaac Turtle (age 12).

Judges' comments: We loved how energetic and dynamic this drawing was! It captures movement of animals so well but also the movements and flow within the food chains insects are a part of. It is a very imaginative and entertaining interpretation of the theme.

Winner, People & Insects: Small creatures need big heroes! by Lorna Breuker (age 9).

Judges' comments: We found this piece such a unique and imaginative interpretation of the theme of People and Insects. The details on the characters are great and we liked the use of fantasy elements to inspire help for real insects.

Obituary

Professor John D. Mumford FRES

4th March 1953 to 29th December 2022

Professor John D. Mumford FRES, who died unexpectedly on December 29th 2022, was an entomologist, economist, risk analyst and modeller whose work against invasive species, disease vectors and the blighting of crops by insects helped minimise damage to the environment and transformed the lives, health and incomes of hundreds of thousands of people worldwide.

John Mumford, who was based for much of his career on the Silwood Park campus of Imperial College London, combined formidable intellect with dead-pan humour to teach, collaborate and address entomological challenges in a wide array of circumstances. His advice, rooted in deep scientific understanding and practical experience, was sought by United Nations agencies and governments on six continents, but his passion was to find accessible solutions when people's food, livelihoods or health were threatened by insect pests or other natural forces. His early work on low-cost control of the Cocoa Pod Borer became the model for hundreds of thousands of small growers in South-east Asia and later in Africa. Subsequently, he won the DfID Renewable Natural Resources Research Prize which led to collaborations in India where fruit flies were devastating millions of hectares of mango crops. Their simple bait-trap solution led to a three-fold increase in yield and meant that, as he put it, "Farmers can buy essentials and send their kids to school."

Mumford's expertise in decision support and policy development did not stop with insects, and he became a key international advisor in fisheries, invasive species, biosecurity, 'green' biological product innovations and governance of environmental risk management. This work included evaluating the risks from genetic modification of insects – mosquitoes or pests – to suppress populations carrying human diseases or damaging crops. His leadership of the Great Britain Non-native Species Risk Analysis Forum resulted in an approach to assessing invasive species that is emulated through much of Europe.

John was a trusted friend, a generous listener, an encouraging colleague and a dedicated and influential teacher – both inside the classroom and through many field, research and development projects. His substantial legacy includes the numerous Imperial alumni who are now working on environmental solutions throughout the world.

John is survived by his wife, (Mary) Megan Quinlan, and son, Will. He will be much missed by many.

Dr C. M. (Tilly) Collins

Obituary

Professor David Stanley Saunders

12th March 1935 - 22nd April 2023

David Saunders was born and raised in Pinner, some 15 miles northwest of London, and his pharmacist father had a great interest in insects, particularly butterflies. During the late 1940s and early 1950s, the two would spend time travelling southern England collecting Lepidoptera. At the age of 15 a father-promoted meeting with C.B. Williams, Head of Entomology at Rothamsted Experimental Station (now Rothamsted Research), encouraged David to study hard at school and pursue a university education. So, in 1953 he went to study Zoology at King's College, London University, along with a State Scholarship, awarded for his excellent performances in the final school Botany and Zoology exams.

At King's College David deftly juggled his academic studies with other interests to achieve a first-class degree. At this time David had become interested in the possibilities of using parasitic Hymenoptera as biological control agents so his search for a PhD programme led him to the London School of Tropical Medicine and a project on the eulophid wasp, *Syntomosphyrum glossinae,* a pupal parasitoid of Tsetse Flies. Field-collected Tsetse Fly pupae were mailed to David who found that there were actually two species of wasp emerging, one new to science. He discovered that there was little host specificity shown by these parasitoids and they could not oviposit in buried pupae so were unsuitable as control agents for Tsetse. David also ran a colony of another dipteran pupal parasitoid, *Nasonia vitripennis,* as a comparison, which suddenly stopped breeding as the larvae entered diapause, presumably due to the shortening days of autumn in his roof-top culture. Photoperiodism (the ability to respond to day length, and thus season, in temperate climes) was not new to biology or entomology but this personal observation focussed much of David's research interest for the rest of his life. In 1956, David joined the RES as a Fellow.

David hadn't finished his PhD, when his supervisor encouraged him to apply for an assistant lecturer position at the University of Edinburgh to teach medical and veterinary entomology. He was offered the job, started in 1958 and stayed until retirement in 1999. During that time, David moved from assistant lecturer onwards and upwards to Professor and Head of Department. He was greatly enthused by teaching and research, less so by administration, although colleagues thought him "even-handed in all his dealings".

Over the years, David delved into the mechanisms of photoperiodism, covering the *photoreceptors* required to distinguish light from dark, the *clock* mechanism that measures the duration of light or dark, the *counter* mechanism necessary to accumulate the information from successive light/dark cycles and the *physiology* which finally directs insect development towards diapause in short days or continued development in long days. David was particularly intrigued by how circadian rhythms/oscillations could be involved in time measurement. He, and colleagues, worked mainly with five different insect species from three different orders, switching species to take advantage of size, published background knowledge, to utilise genetic mutants and because David developed an allergy to one of the flies!

Together with Bob Lewis, David managed to pull together two seemingly opposite mechanisms for time measurement – one in which the clock mechanism was based on one or more circadian rhythms and the other in which time was measured in an hourglass fashion. Using theoretical models with oscillators that damped out over time, hourglass-like responses could be predicted. With M.F. Bowen, David removed the brains from tobacco hornworm larvae and exposed them *in vitro* to different daylengths before implanting them into diapause-destined larvae. The larvae developed according to the photoperiod experienced by the isolated brain. Thus, photoreceptors, clock, counter and physiology were all contained in the isolated brain.

Apart from numerous erudite articles, 40 or more post-retirement, David managed to produce three editions of his wonderful book, *Insect Clocks*, across 26 years, each updated to include the most recent findings and essential reading for anyone interested in the topic.

David enjoyed travel, often accompanied by his wife, Jean, and family to conferences and for periods of sabbatical leave to become familiar with techniques that would be useful for his research aspirations and further enlightenment. He was an extremely affable character, so newly-met colleagues soon became friends and willing collaborators.

During his early teens, David developed a life-long passion for cycling and cycle racing. He also enjoyed mountain walking, and rock and alpine climbing during his student days.

David's wife predeceased him by 5 years, and he is survived by their three sons and families. David's fondness and enthusiasm for his subject was not missed by the younger generation and all three sons became professional biologists.

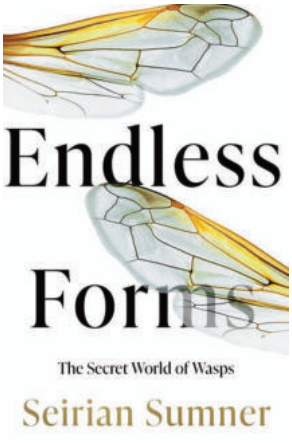
Jim Hardie and Marlies Vaz Nunes

Royal Entomological Society

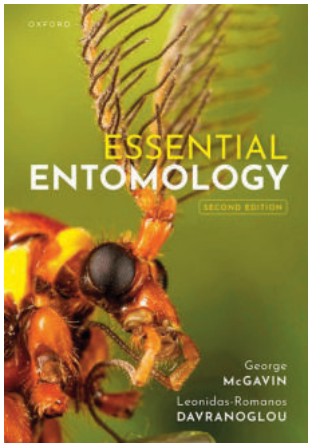
Antenna Reviews

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

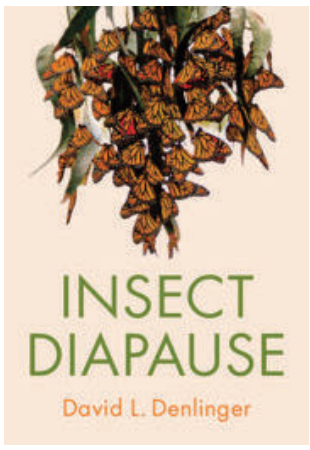
The following reviews have been added to the *Antenna* website:
www.royensoc.co.uk/publications/book-reviews/



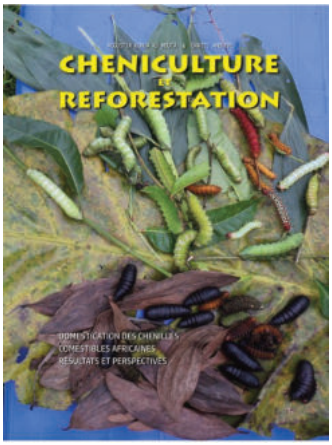
Endless Forms: the secret world of wasps
Seirian Sumner
Published by William Collins
ISBN 9780008394486 (paperbback)
Reviewed by Richard Jones



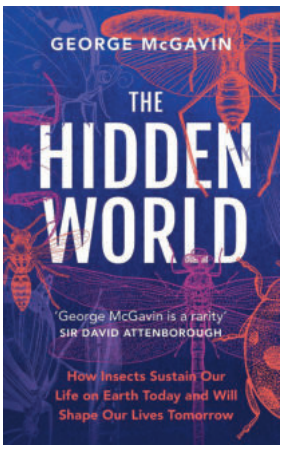
Essential Entomology (2nd edition)
George McGavin and Leonidas-Romanos Davranoglou
Published by Oxford University Press
ISBN 9780192843111 (hardback)
Reviewed by Tom Pope



Insect Diapause
David L. Denlinger
Published by Cambridge University Press
ISBN 9781108497527 (hardback)
Reviewed by Dmitri L. Musolin



Chenículture et reforestation: domestications des chenilles comestibles africaines, résultats et perspectives
Augustin Londa Ku Mbuta and Daniel Ambuehl
Published by Salvation Army (Switzerland) and Skyfood Publishing
ISBN 9783952476048
Reviewed by Thea Lautenschläger and Matthias Nuß



The Hidden World
George McGavin
Published by Welbeck Publishing Group
ISBN 9781802794939 (hardback)
Reviewed by Richard Harrington

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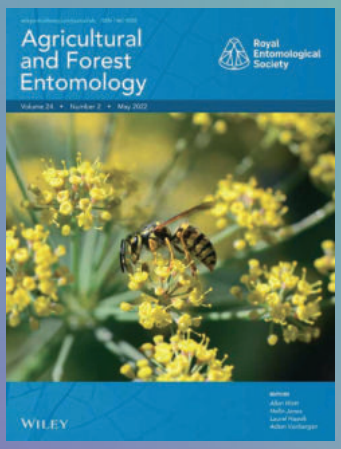

Agricultural and Forest Entomology
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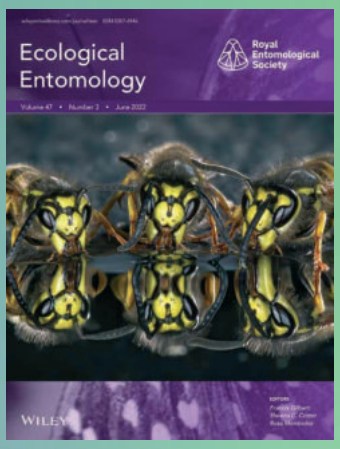

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Systematic Entomology
Impact Factor: 4.84
@Systematic_Ent

Insect Conservation and Diversity
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Insect Molecular Biology
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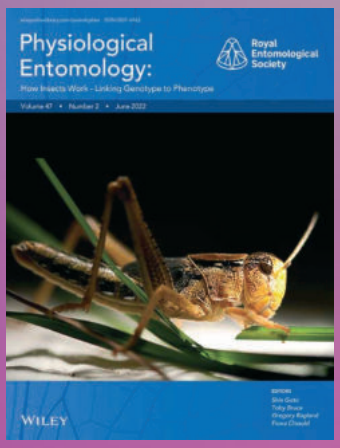

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EVENTS

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

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

September 2023

Tue **5** — 5 September – 7 September
Ento23

Mon **25** — 25 September – 26 September
Aquatic Insects Special Interest Group (SIG) 2023

Wed **27** — 27 September
Sustainable Agriculture: From monitoring to management (hybrid event)

October 2023

Wed **4** — 4 October
Online talk – Martin Kaltenpoth (virtual event)

Mon **16** — 16 October – 20 October
XII European Congress of Entomology (ECE) 2023 (external event)

November 2023

Wed **1** — 1 November
Online talk – Una Fitzpatrick (virtual event)

Wed **8** — 8 November
Orthoptera Special Interest Group (SIG) 2023

June 2024

Wed **1** — 24 June – 30 June
Insect Week 2024

August 2024

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

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