Ento22

14-16 September 2022

Annual conference in-person and online

WEDNESDAY, 14 SEPTEMBER, 2022 TO
FRIDAY, 16 SEPTEMBER, 2022

Programme & Abstracts

CONVENORS:
SHEENA COTTER, GRAZIELLA IOSSA & PAUL EADY

VENUE: UNIVERSITY OF LINCOLN, UK

UNIVERSITY OF LINCOLN

Royal Entomological Society

Ento22

14-16 September 2022

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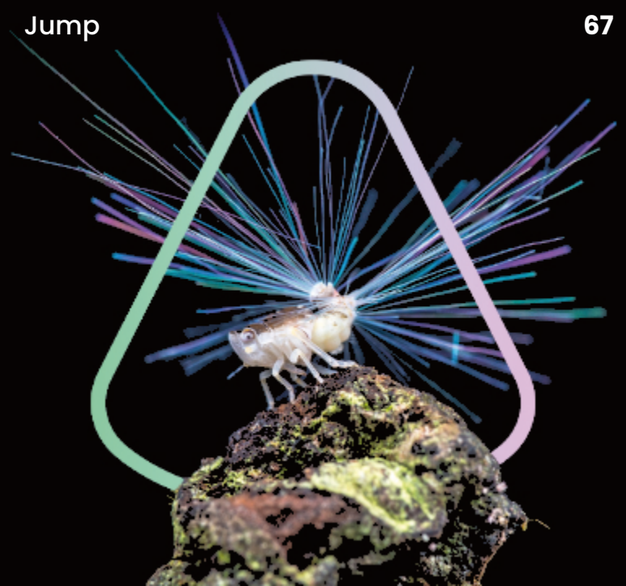


Royal Entomological Society

UNIVERSITY OF LINCOLN

WELCOME FROM PROF. HELEN ROY OBE HON.FRES PRESIDENT OF THE ROYAL ENTOMOLOGICAL SOCIETY

On behalf of the convenors and trustees of the Royal Entomological Society, I welcome you to Ento22 here at the University of Lincoln and online. This is the first time the Society has been back to an in-person conference since the Covid-19 pandemic, and it is a great pleasure for us to be in Lincoln for three days of fascinating entomological presentations and workshops.

The Royal Entomological Society has a vision to *enrich the world with insect science*, devoted to the promotion and development of entomology, and the annual Ento meetings are an important opportunity to share and celebrate entomological research from around the world. I hope everyone will use Ento22 to catch up with friends and colleagues, and to establish new collaborations.

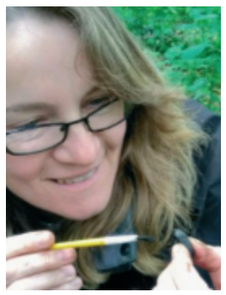
I look forward to talking to as many of you as possible and wish you a productive and enjoyable conference.

CONVENORS WELCOME TO ENTO22 – ‘THE GRAND CHALLENGES’

In the current climate and biodiversity crises, insects are being increasingly recognised for their value as service providers, indicators of biodiversity loss and models for understanding ourselves and other animals. The RES recently recognised a series of ‘Grand Challenges in Entomology’, and at Ento22, our first in-person meeting for 2 years, we will provide a platform for some of the headline themes. The University of Lincoln is a modern and growing university, with internationally recognised research in entomology covering biophysics, thermal ecology, ecosystem services and host-parasite interactions. With strong links to agriculture, the wildlife trusts and local nature recovery sites, we work closely with stakeholders to address issues exacerbated by the climate and biodiversity crises and so are well placed to host this year’s meeting

The meeting will include three plenary speakers, one each morning, followed by ‘Grand Challenges’ sessions on **Anthropogenic impacts and conservation**, **Ecosystem services and disservices** and **Taxonomy**. We also have exciting parallel sessions on Society engagement, Ecology and evolution, Medical and veterinary entomology and Biophysics.

We look forward to welcoming you to the beautiful and historic city of Lincoln and to offer a tour of a local rewilding site, ‘Wilder Doddington’.



Sheena Cotter

Graziella Iossa

Paul Eady

INFORMATION

Venue – University of Lincoln

All talk sessions and plenary presentations will be streamed online

Conference Spaces

The conference will use the following buildings on campus:

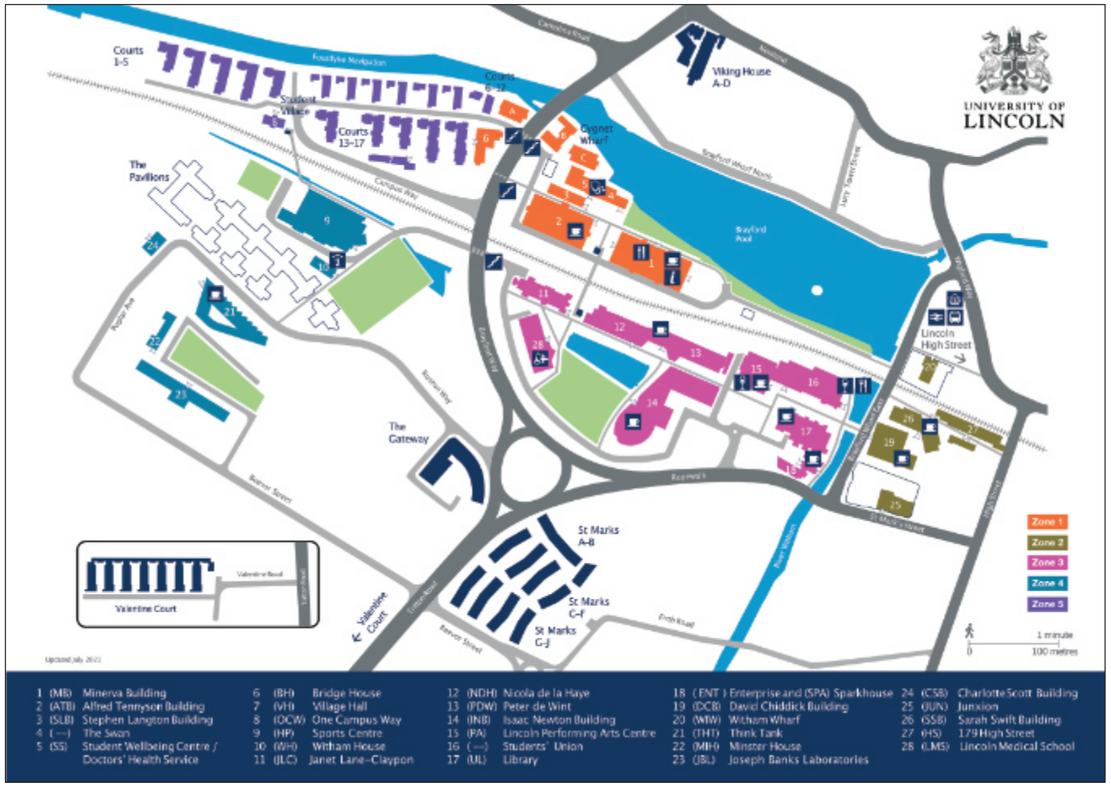
Isaac Newton Building – Building Number 14

- Registration
- Plenary presentations
- Talk sessions
- Daytime catering
- Posters
- Exhibitors
- Wine Reception
- AGM

Lincoln Medical School – Building number 28

- All talk sessions and plenary presentations will be streamed online, accessed from **www.entoconference.com**. Your login was emailed to you in advance.

University of Lincoln Campus Map



Getting Here

We recommend that delegates travel to Lincoln via the most sustainable method of transport.

TRAIN: The University of Lincoln is a 3/5-minute walk from the train station and is served by several operators including LNER and East Midlands Trains. If you feel able to walk from the station to campus, then we recommend you do rather than take a taxi for such a short distance. Google maps or equivalent will be able to guide you to campus.

There is also a train station at Newark which has a regular connection to Lincoln by train if needed or you can continue your journey via car or bus.

DRIVE: We are well served by the following network of roads: A46/ A1/ M1/ M180 / A15 making traveling to Lincoln by car one of the easiest ways to get to us. If you are planning on driving to the conference, then please be aware that there is no parking available on campus and you will need to park in local pay and display car parks on arrival. We recommend that you use either St Marks Shopping Centre / NCP High Street.

If you require a disabled parking space, please contact the conference organisers in advance and they will be happy to arrange this on campus for you.

AIR: The closest airports to Lincoln are Humberside Airport, Robin Hood (Doncaster) Airport and East Midlands Airport. If arriving at London Gatwick and Heathrow airports then there are train services operated as outline above.

COACH: The bus station in Lincoln is served by local provider Stagecoach as well as National Express meaning you can travel to us via coach for longer distances. The Bus Station is also next to the Train Station and a short walk to campus.

Security

If you need to speak to a member of our Security team at any point then they are based in the Minerva Building, 24/7. Please call 01522 886062 if you wish to speak to them.

University of Lincoln WIFI

The University has free wifi available for delegates, you can either log on via Eduroam or you can create an account to access our Visitor Wifi Network. The network is available in all University buildings on campus including University accommodation.

- **If you are a visitor:** Select the wireless network "UoL – Visitor", a browser window will automatically open which instantly redirects to a University of Lincoln landing page. Here you will be asked to input information to create an account.

CODE OF CONDUCT

Our Ento22 conference provides a harassment-free experience for everyone, in-person and online, regardless of gender, gender identity and expression, age, sexual orientation, disability, physical appearance, body size, race, ethnicity, religion (or lack thereof), or technology choices. We do not tolerate harassment of conference participants or staff in any form. Sexual language and imagery is not appropriate for any conference venue, including talks, workshops, social occasions and on all social media. Conference participants violating these rules, in-person or online, may be sanctioned or expelled from the conference without a refund at the discretion of the conference organisers.

We wish everyone a safe and enjoyable conference!

CONFERENCE ACTIVITIES

PRE-CONFERENCE MIXER – IN-PERSON ACTIVITY

From 19.00 on Tuesday 13th September
Venue: The Horse & Groom, Carholme Rd, Lincoln LN1 1RH

An informal mixer for those wanting to meet up for a chat, food and drink before the conference begins.

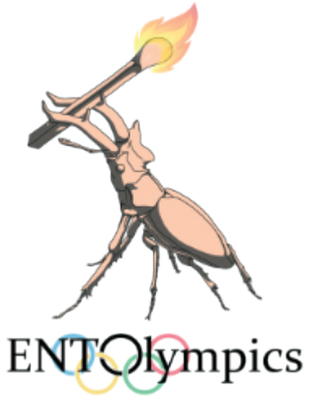
ROYAL ENTOMOLOGICAL SOCIETY – ANNUAL GENERAL MEETING

Wednesday 14th September: 13.30-14.30
Venue: Isaac Newton Building

The Royal Entomological Society Annual General Meeting, open to RES members only.

ENTOLYMPICS – IN-PERSON ACTIVITY

This activity is included in the ticket price.
19.00 on Wednesday 14th September
Venue: Pier Cafe, Minerva Building – Building number 1



The Royal Entomological Society is delighted to announce the EntOlympics – A fun and competitive entomology quiz and team building competition for student and early career* insect scientists.

This will be a pub quiz activity with competitors taking part in-person. Teams of 2-4 people will compete using their entomological general knowledge and insect ID skills for a team prize!

Each player must register individually – don't worry if you do not have a team as we can assign you to one.

This event is in association with the Royal Entomological Society's Ento22 conference, but separate registration is required (There will be a box to indicate your intention to take part in EntOlympics – Please select 'Yes' for this upon purchasing your ticket).

You can still sign-up to take part on the day. We look forward to seeing you then, and good luck!

*Early career is defined as no more than 5 years of professional experience.

PRESIDENT'S WINE RECEPTION – IN-PERSON ACTIVITY

17.30 – 19.00 on Wednesday 14th September
Venue: Isaac Newton Building

A welcome reception for delegates, hosted by RES President, Prof. Helen Roy

During the reception, there will be a performance of JUMP, a musical collaboration between composer Karen Wimhurst and entomologist Peter Smithers Hon.FRES featuring insect, amphibian and clarinet musics (See Page 66 for more information about the musical composition).

WOMEN IN ENTOMOLOGY BREAKFAST – IN-PERSON ACTIVITY

8.00-9.00 on Thursday 15th September
Venue: Isaac Newton Building

All genders are welcome. An opportunity to network and celebrate women in entomology. For the first time, the RES and Entomological Society of America (ESA) will both have women presidents, Prof. Jane Hill and, plenary speaker, Prof. Jessica Ware, respectively. Come and meet them and others for breakfast!

WORKSHOP: HOW TO GET PUBLISHED?

13.30-14.30 on Thursday 15th September
Venue: Isaac Newton Building

Ever wondered how to choose the right journal for your work? Or what editors look for in papers they accept for publication? Join the RES Head of Publishing, Emilie Aimé and several expert journal editors from the RES journals for this interactive panel discussion to find out!

THE REWILDING TOUR – IN-PERSON ACTIVITY

This activity involves a separate ticket purchase from the registration desk at £15. First come, first served.
14.00-17.30 on Thursday 15th September
Venue: LPAC Building – Building number 15
(next to Isaac Newton Building)

Join us for a tour of the Doddington Hall Estate. This tour will be taking place Thursday 15th September between 1-5pm (transport provided).

Wilder Doddington is a 100 year nature recovery project covering 770 hectares, situated just 4 miles west of Lincoln. In its early stages, the land entered nature recovery between 2019 and 2021, as arable farming ended. The vision is for the reinstatement of wood pasture, managed by low intensity grazing by Lincoln red cattle, deer, pigs and ponies. During a baseline invertebrate survey in 2021, 778 species were recorded, reflecting a range of different soils and habitats.
We will run a visit to this exciting new project on the afternoon of September 15th. The visit will include an introduction to the site, a guided tour and refreshments, before heading back to Lincoln in time for the conference dinner.

Learn more about the site at: www.doddingtonhall.com/wilder/

ENTO22 CONFERENCE DINNER

19.00 on Thursday 15th September
Venue: DoubleTree by Hilton, Brayford Wharf N, Lincoln LN1 1YW

The Conference Dinner is due to take place on Thursday evening at the DoubleTree by Hilton Lincoln Hotel to have fun and communicate with fellow entomologists and enthusiasts. Tickets were available in advance and are regretfully sold out.

MENTORSHIP BREAKFAST – IN-PERSON ACTIVITY

8.00-9.00 on Friday 16th September
Venue: Isaac Newton Building

The RES is developing a new mentorship programme. Come along to contribute your ideas and see if you would be interested in becoming a mentor or mentee.

WORKSHOP: WHAT'S DRIVING INSECT DECLINE (AND WHAT'S NOT)? – IN-PERSON ACTIVITY

13.30-17.30 on Friday 16th September
Venue: LPAC Building (Building number 15, next to Isaac Newton Building)

The GLobal Insect Threat-Response Synthesis (GLiTRS) project (**https://glitrs.ceh.ac.uk/**), is synthesising the available evidence for trends in insect populations globally, and the threats which are driving them. To fill in gaps for taxa and regions where field data do not exist, we will be running a global expert elicitation process in 2023, to gather expert opinion on how each group of insects is responding to each threat.

Before we can do this, we need to decide how to structure the process. Through a series of workshops, we will develop a ranking of the importance of threats to every insect Order, and an understanding of the key taxonomic, geographic or trait-based differences in how insects respond to threats. To our knowledge, this is the first time such a task has been attempted for all insects (building on previous work by Miličić et al 2021 **https://doi.org/10.1111/conl.12814**).
The third of these workshops will take place at Ento22 on 16th September from 13:30-17:30 (with break), and we would love for you to join us. We are looking for a room full of experts, who we will divide in to groups based on their taxonomic expertise. Each group will use a simple card game to identify and rank the most important IUCN threats driving population declines in their focal Order, before having an opportunity to critique the rankings produced by other groups. Complete instructions will be provided at the start.

If you would like to attend the workshop, then it would be useful for our planning if you could sign-up in advance using this form: **https://forms.gle/mhjjyiCAA5hQreKm7**. However, you are also welcome to join the session without signing up, and to invite other colleagues at the conference to do the same.

If you are unable to attend the session, but are interested in contributing to the project, please fill in the form and select "Cannot attend" in answer to question 3.

We look forward to seeing you in the workshop on 16th September!

REGISTRATION

Time	**Tuesday 13 September – Afternoon**
14:00 - 14:15	**Registration open – Isaac Newton Building**
14:15 - 14:30	
14:30 - 14:45	
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18:30 - 18:45	
18:45 - 19:00	
19:00 - 23:00	**Pre-conference mixer – The Horse & Groom pub**

DAY 1: ANTHROPOGENIC IMPACTS AND CONSERVATION

All activities on Day 1 to be held in Isaac Newton Building

Time	**Wednesday 14 September – Morning**
08:30 - 08:45	**Registration**
08:45 - 09:00	
09:00 - 09:15	
09:15 - 09:30	**Refreshments**
09:30 - 09:45	**Welcome - Prof. Libby John / Prof. Helen Roy**
09:45 - 10:00	
10:00 - 10:15	**PLENARY - Sylvain Pincebourde** Anthropogenic impacts – The role of microclimate at fine scales in driving exposure of ectotherms to climate change: integrating biophysics, physiology and ecology
10:15 - 10:30	
10:30 - 10:45	
10:45 - 11:00	
11:00 - 11:15	**Posters / Refreshments**
11:15 - 11:30	
11:30 - 11:45	**Anthropogenic impacts and conservation** **T01** Michael Pocock - *Insect Conservation & Diversity* Journal Award Winner/Speaker "Is light pollution causing insect declines?"
11:45 - 12:00	
12:00 - 12:15	**T02** Helen Roy – "Understanding patterns and trends in the distribution of ladybirds in the UK through citizen science"
12:15 - 12:30	**T03** Joshua Moon Sammy – "Habitat specialisation and range shifts in human associated invertebrates"
12:30 - 12:45	**T05** Chris R. Shortall – "Unearthing Otherwise Unknown Insect Responses to Change Using a Unique Archive"
12:45 - 13:00	**T04** Tien Thuy Thi Nguyen – "Heliconius butterflies: colour, altitude, and thermal tolerance"
13:00 - 13:15	**Lunch**
13:15 - 13:30	

All activities on Day 1 to be held in Isaac Newton Building

Time	**Wednesday 14 September – Afternoon**
13:30 - 13:45	**AGM** (online members - tickets in advance for zoom access) For RES members
13:45 - 14:00	
14:00 - 14:15	
14:15 - 14:30	
14:30 - 14:45	**Anthropogenic impacts and conservation (cont.)** **T06** Franz Loffler - Early Career Award Winner "Insects on the move – Orthoptera range shifts and community dynamics in response to global warming"
14:45 - 15:00	
15:00 - 15:15	**T07** Joseph Millard – "Developing a global threat-response model for insect biodiversity change"
15:15 - 15:30	**T08** Robert J. Wilson – "The role of topography in buffering the responses of mountain butterflies to climatic variation"
15:30 - 15:45	**T09** Alex Dittrich – "The challenges of rewilding in urban areas and effective insect monitoring using undergraduate students"
15:45 - 16:15	**Posters / Refreshments**
16:15 - 16:30	**Anthropogenic impacts and conservation (cont.)** **T10** Elizabeth Duncan – "All hail the queen? How do neonicotinoids affect honeybee (*Apis mellifera*) worker behaviour?"
16:30 - 16:45	**T11 (online)** Enakshi Ghosh – "Host plant chemistry differentially reduces parasitoid success by enhancing herbivore immunity"
16:45 - 17:00	**T12 (online)** Jalanie Marohomsalic – "Diversity and Distribution Pattern of Tiger Beetles (Coleoptera: Cicindelidae) in Lanao del Sur, Philippines"
17:00 - 17:15	**T13** Andrew Bladon – "Summarising the evidence for conservation actions for butterflies & moths"
17:15 - 17:30	**T14** Julia Simons – "Do micro-habitat quality and host-plant density influence oviposition in the High Brown and Dark Green Fritillaries?"
17:30 - 17:45	**President's wine reception / Posters** **Venue: Isaac Newton Building**
17:45 - 18:00	
18:00 - 18:15	
18:15 - 18:30	
18:30 - 18:45	
18:45 - 19:00	
19:00 - 23:00	**ENTOlympics / Student Social** **Venue: Pier Cafe, Minerva Building**

DAY 2: ECOSYSTEM SERVICES AND DISSERVICES I

Split talks from 10am onwards – talks will be taking place at the same time in different spaces

Time	**Thursday 15 September – Morning**	
08:00 - 08:15 *08:15 - 08:30* *08:30 - 08:45* *08:45 - 09:00*	**Women in Entomology Breakfast * (open to all)**	
09:00 - 09:15 *09:15 - 09:30* *09:30 - 09:45* *09:45 - 10:00*	**PLENARY - Jessica Ware *** "Diversity in entomology: creating space while studying insect evolution"	
10:00 - 10:15 *10:15 - 10:30*	**Ecosystem services and disservices I** **T15 (online) *** Elia Guariento – Ecological Entomology Journal Award Winner "The nutritional ecology of ant communities on the alpine tree line ecotone"	**Society Engagement** **T31 **** Leah Fitzpatrick, Ashley Dear, Amy Farrow – Student Award Winners "A choose your own adventure, biomimicry and libel: public engagement advice from the winners of the 2021 RES Student prize"
10:30 - 10:45	**T16 (online) *** Aisling Moffatt – "Creating a sustainable, 21st century IPM toolkit to combat a historic pest issue; Tipula larvae in agricultural settings"	**T32 **** Amma Simon – "Entomology in global Higher Education: who is training the next generation insect scientists?"
10:45 - 11:00	**T17 *** Matt Tinsley – "Variable diets shape the evolution of insect resistance to pathogens used in biocontrol"	**T33 **** Helen Leggett – "Building on a beetle legacy to inspire scientists of the future"
11:00 - 11:15 *11:15 - 11:30*	**Posters * / Refreshments**	
11:30 - 11:45 *11:45 - 12:00*	**Ecosystem services and disservices (cont.)** **T18 (online) *** Kiran Horrocks - Agricultural & Forest Entomology Journal Award Winner "Can natural enemies of current insect pests provide biotic resistance to future pests?"	**Ecology and Evolution** **T34(online) **** Naoki Matsuda – Physiological Entomology Journal Award Winner "Transgenerational seasonal timer as an adaptation to spring short days in the pea aphid"
12:00 - 12:15	**T19 *** Natasha Stevens – "The Invasive Invertebrate Project"	**T35 **** Eleanor Bladon – "The evolutionary demise of a social interaction: social partners differ in the rate at which interacting phenotypes are lost"
12:15 - 12:30	**T20 (online) *** Claire Dumenil – "Fruit odour coding in the brain of the agricultural pest *Drosophila suzukii*: Towards olfactory-guided pest management"	**T36 (online) **** Carita Lindstedt – "Group living and cooperation within a group in a haplodiploid pine sawflies"
12:30 - 12:45	**T21 *** Louise McNamara – "Improving monitoring and management of BYDV in Ireland"	**T37 (online)**** Inon Scharf – "Desert ants learn to solve mazes and avoid falling into pitfall traps on their way to a food reward"

*** Isaac Newton Building**

**** Lincoln Medical School – Building number 28**

Time	**Thursday 15 September – Morning (cont.)**	
12:45 - 13:00	**T22 *** David Stanford-Beale – "Thrips in the Genomic Era: Advancements in Phylogenetics, Mitochondrial Evolution, and Virus Coevolution in thrips"	**T38 **** Sophie Van Meyel – "Cost and benefits of sibling deprivation during family life in adult earwigs"
13:00 - 13:15 *13:15 - 13:30*	**Lunch**	

Time	**Thursday 15 September – Afternoon**	
13:30 - 13:45 *13:45 - 14:00* *14:00 - 14:15* *14:15 - 14:30*	**Workshop: How to get published? (open to all) ***	
14:30 - 14:45 *14:45 - 15:00*	**Taxonomy** **T23 (online) *** Dave Clarke - J.O. Westwood Medal "The weevil fauna preserved in Burmese amber – snapshot of a unique, extinct lineage"	**Tour of Doddington rewilding site (Register in advance)**
15:00 - 15:15	**T24 *** Andrew Polaszek – "*Megaphragma* 8 years on - Integrative taxonomy of the worlds species completed"	
15:15 - 15:30	**T25 *** Gael J. Kergoat – "Eighteen years of researches on noctuid stemborers (Lepidoptera, Noctuidae, Apameini, Sesamiina), from field work to integrative taxonomy and macroevolutionary studies"	
15:30 - 15:45	**T26 (online) *** Aparna Kalawate – "Diversity of forensic important trogid beetle in India"	
15:45 - 16:15	**Posters * / Refreshments**	
16:15 - 16:30 *16:30 - 16:45*	**Medical & Veterinary** **T27 (online) *** Omar Akbari - *Insect Molecular Biology* Journal Award Winner "Using Precision guided sterile insect technique to suppress mosquito populations"	
16:45 - 17:00	**T28 *** John C. Bradley – "Fitness for Purpose of "Raised Bait" Methodology in Investigating Blowfly Oviposition"	

*** Isaac Newton Building**

**** Lincoln Medical School (LMS005 ground floor)**

ECOSYSTEM SERVICES AND DISSERVICES I (CONT.)

Time	**Thursday 15 September – Afternoon (cont.)**	
17:00 - 17:15	**T29 (online) *** Lorna Culverwell – "Characterisation of the RNA Virome of Nine *Ochlerotatus* Species in Finland"	**Tour of Doddington rewilding site (Register in advance)**
17:15 - 17:30	**T30 (online) *** Nancy Dawam – "Socio-economic Status and malaria prevention among members of Giri community Federal capital territory Nigeria"	
17:30 - 17:45	**Posters ***	
17:45 - 18:00		
18:00 - 18:15	**Break**	
18:15 - 18:30		
18:30 - 18:45		
18:45 - 19:00		
19:00 - 23:00	**Conference Dinner - DoubleTree Hilton Hotel (Register in advance)**	

*** Isaac Newton Building**

DAY 3: ECOSYSTEM SERVICES AND DISSERVICES II

Split talks from 10am onwards – talks will be taking place at the same time in different spaces

Time	**Friday 16 September – Morning**	
08:00 - 08:15	**RES Mentorship Breakfast * (open to all)**	
08:15 - 08:30		
08:30 - 08:45		
08:45 - 09:00		
09:00 - 09:15	**PLENARY - Nalini Puniamoorthy *** "Insect reproduction: Understanding evolutionary diversification and seeking sustainable solutions"	
09:15 - 09:30		
09:30 - 09:45		
09:45 - 10:00		
10:00 - 10:15	**Ecosystem services and disservices** **T39 (Online) *** Sean Schoville - Systematic Entomology Journal Award Winner "Has past climate change affected cold-specialized species differentially through space and time?"	**Biophysics** **T48 **** Michael Thomas Smith – "Tracking the orientation and 3D path of flying insects"
10:15 - 10:30		
10:30 - 10:45	**T40 *** Rosa Menendez – "Identifying the best reforestation method for restoring dung beetle biodiversity and function in the Australian Wet Tropics"	**T49 **** Charlie Woodrow – "The Scuba Diving Orthopteran: A secondary function of the katydid ear canal in a novel anti-predator behaviour"
10:45 - 11:00	**T41 (online) *** Rajath Siddaganga – "Life of giant honey bees in a tropical megacity"	**T50 **** Clara Montgomery – "Do flowers dream of electric bees? The role of electric charge in plant-pollinator communication"
11:00 - 11:15	**Posters * / Refreshments**	
11:15 - 11:30		
11:30 - 11:45	**Ecosystem services and disservices (cont.)** **T42 *** Linzy Jay Thompson – "Pesticide effects on bumblebee queens"	**Medical & Veterinary** **T51 (online) **** Isobel Ronai - *Medical & Veterinary Entomology* Journal Award Winner "Developing control strategies for the highly invasive Asian longhorned tick to prevent tick-borne diseases"
11:45 - 12:00	**T43 *** Will Nash – "Genome wide signatures of range expansion in a key UK pollinator"	
12:00 - 12:15	**T44 (online) *** Eugenia Fezza – "Catch me if you can – improving Vine Weevil, *Otiorhynchus sulcatus* F. (Coleoptera: Curculionidae), Monitoring Tool Design"	**T52 (online) **** Meghan Barrett – "Farmed Black Soldier Fly, *Hermetia illucens* (Diptera: Stratiomyidae), Welfare Considerations: A Model for the Insects as Food and Feed Industry"
12:15 - 12:30	**T45 *** Elizabeth Duncan – "Same, same but different: How does one genome give rise to different phenotypes?"	**T53 (online) **** Frank Mechan – "Behaviour of host-seeking *An. gambiae* around damaged pyrethroid-PBO bed nets: implications of hole location of bloodfeeding and bioefficacy"
12:30 - 12:45	**T46 (online) *** Emma Aspin – "Saving the wine one parasitoid at a time: analysis of *Goniozus jacintae* as a potential biocontrol agent of the Light Brown Apple Moth"	**T54 **** Julien Devilliers – "Evolution of the sensory system and emergence of blood feeding behaviour in Diptera"

*** Isaac Newton Building**

**** Lincoln Medical School (LMS005 ground floor)**

ECOSYSTEM SERVICES AND DISSERVICES II (CONT.)

Time	**Friday 16 September – Morning (cont.)**	
12:45 - 13:00	**T47 *** Jordan Cuff – "Stacking ecosystem services in ecological networks with molecular tools to optimise agricultural habitat management"	**T55 (online) **** Paul Brett – "The seasonal prediction of *Lucilia spp.* in New Zealand using climatic data"
13:00 - 13:15	**Close**	
13:15 - 13:30		

*** Isaac Newton Building**

**** Lincoln Medical School (LMS005 ground floor)**

Time	**Friday 16 September – Afternoon**
13:30 - 13:45	**GLiTRS Post-conference workshop on insect decline (open to all)**
13:45 - 14:00	
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17:15 - 17:30	

PLENARY SPEAKERS

Professor Sylvain Pincebourde
Director of Research, CNRS, France: **Anthropogenic impacts**

Sylvain Pincebourde obtained his PhD in 2005 at the University of Tours (France) on the environmental biophysics of endophyte insects under the supervision of Prof. Jérôme Casas. After a postdoc on the thermal ecology of a prey-predator relationship in the intertidal ecosystem at the University of South Carolina (USA), he joined the CNRS in 2009 to work at the Insect Biology Research Institute (Tours, France) on the impacts of climate change on insects. His integrative work mixes ecology, physiology, physics, chemistry and biometeorology, using both experimental and modelling approaches, to consider the microclimatic temperature that small creatures are experiencing in their microhabitat. He is now Director of Research at the CNRS to pursue on how insects perceive and respond environmental changes.

Ento22 Talk: The role of microclimate at fine scales in driving exposure of ectotherms to climate change: integrating biophysics, physiology and ecology

Professor Jessica Ware
Associate curator in invertebrate zoology, American Museum of Natural History, USA: **Taxonomy/ Society Engagement**

Jessica Ware is an associate curator in invertebrate zoology at the American Museum of Natural History. Dr. Ware's research focuses on the evolution of behavioral and physiological adaptations in insects, with an emphasis on how these occur in Odonata (dragonflies and damselflies) and Dictyoptera (termites, cockroaches, and mantises). She holds a BSc from the University of British Columbia in Canada, and a PhD from Rutgers, New Brunswick. Dr. Ware is the past president of the Worldwide Dragonfly Association and serves as current president of the Entomological Society of America. Jessica co-founded the Entomologists of Color, a group devoted to diversifying the field of entomology and serves as the current Diversity Director of the Society of Systematic Biologists. She was recently awarded a PECASE medal from the US government for her work on insect evolution.

Ento22 Talk: Diversity in entomology: creating space while studying insect evolution

Professor Nalini Puniamoorthy
Reproductive Evolution Lab, National University of Singapore: **Ecosystem services/Conservation**

Dr. Nalini Puniamoorthy leads the research at the Reproductive Evolution Lab at National University of Singapore, where they study sexual selection and biological diversification. They focus on widespread insect species and use experimental methods involving fieldwork, geometric morphometrics as well as Next-generation-sequencing techniques to study macro-evolutionary patterns as well as micro-evolutionary processes involved in reproduction. They also focus on ecologically relevant insect models to seek solutions to diverse problems: From estimating polyandry and gene flow in mosquitos to studying reproductive diversification ecosystem service providers like dung beetles and even to engineering black soldier fly reproduction for sustainable food waste management.

Ento22 Talk: Insect reproduction: Understanding evolutionary diversification and seeking sustainable solutions

WE ARE ALSO LUCKY TO WELCOME TALKS FROM OUR RECENT AWARD WINNERS

J.O. Westwood Medal

David J Clarke Ph.D.
Research Associate, Department of Biological Sciences, University of Memphis

Early Career Entomologist Winner

Dr. Franz Löffler
Osnabrück University, Germany
Landscape Ecologist

Student Award Winners

Leah Fitzpatrick (Winner)
British Press Association vs the Noble False Widow spider

Ashley Dear (2nd place)
Mimicry Is the Highest Form of Flattery

Amy Farrow (3rd place)
Choose your own evolutionary pathway – a brief exploration of the evolution and diversity of four major insect orders.

Journal Award winners

You can read all the winning papers in our virtual issue: **bit.ly/RESJournalPrizes22**

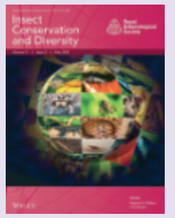
Agricultural and Forest Entomology

Kiran J. Horrocks (pictured), **Darren Ward & David M. Suckling**
Can natural enemies of current insect pests provide biotic resistance to future pests?

Ecological Entomology

Elia Guariento (pictured), **Wolfgang Wanek & Konrad Fiedler**
Consistent shift in nutritional ecology of ants reveals trophic flexibility across alpine tree-line ecotones

Insect Conservation and Diversity



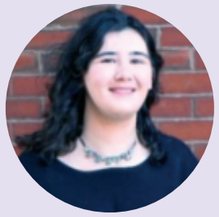
Michael J. O. Pocock (pictured), **Douglas H. Boyes, Darren M. Evans, Richard Fox, Mark, S. Parsons**
Is light pollution driving moth population declines? A review of causal mechanisms across the life cycle

Insect Molecular Biology

Chaverra-Rodriguez, D., Dalla Benetta, E., Heu, C.C., Rasgon, J.L., Ferree, P.M. and Akbari, O.S. (pictured)
Germline mutagenesis of Nasonia vitripennis through ovarian delivery of CRISPR-Cas9 ribonucleoprotein

Journal Award winners

Medical and Veterinary Entomology



Ronai, I. (pictured), **Tufts, D.M. and Diuk-Wasser, M.A.**

Aversion of the invasive Asian longhorned tick to the white-footed mouse, the dominant reservoir of tick-borne pathogens in the U.S.A.

Physiological Entomology

Naoki Matsuda (pictured), **Takashi Kanbe, Jun Endo, Shin-Ichi Akimoto and Hideharu Numata**

Suppression of autumnal sexual morph production in spring by a seasonal timer in an aphid

Systematic Entomology

Sean D. Schoville (pictured), **Tierney C. Bougie, Roman Y. Dudko and Matthew J. Medeiros**

Has past climate change affected cold-specialized species differentially through space and time?

ORAL PRESENTATIONS

Symposium – Anthropogenic impacts and conservation
Tues. 10.00-11.00
Venue: Isaac Newton Building

Sylvain Pincebourde
(Plenary Speaker)

Anthropogenic impacts

See details on page 19

All talks from 10am onwards – talks will be taking place in the Isaac Newton Building on the first day

Michael Pocock[2], Douglas H. Boyes[1, 2, 3], Richard Fox[3] and Mark S. Parsons[3]
T01

Is light pollution causing insect declines?

1. Newcastle University, UK
2. UK Centre for Ecology & Hydrology, Wallingford, UK
3. Butterfly Conservation, Wareham, Dorset, UK

This talk is based on the *Insect Conservation and Diversity* best paper award winning article. There is a burgeoning number of studies showing that ALAN has consequences for ecosystems, with growing evidence that it is potentially contributing to declines in insect populations. Recent studies have shown how street lights disrupt adult moth behaviour and the pollination services they provide, but it is still unclear whether light pollution directly impacts moth populations. We review the literature to assess the effects of ALAN across moth life cycles and found evidence of diverse impacts across most life stages and key behaviours. We find strong evidence for effects of ALAN (including varying effects of lamp technology) on moth behaviour and physiology, but little rigorous, direct evidence that this scales up to impacts on populations, arguing that more research was necessary in this important area. This work is impacting policy and management.

This work was led by Douglas Boyes, a talented early career entomologist, who very sadly died shortly after the *Insect Conservation and Diversity* paper was published.

Helen Roy[1] and Peter M.J. Brown[1]
T02 – Isaac Newton Building

Understanding patterns and trends in the distribution of ladybirds in the UK through citizen science

1. UK Centre for Ecology & Hydrology, UK

People have been contributing their wildlife observations from across the UK for centuries. Simple biological records (what, where and when a species was seen) can be made by anyone, anywhere. Technological developments such as smart phone apps are increasing the number of people participating in such citizen science initiatives. The information accruing from them is enabling us to track changes in wildlife over time and address many ecological questions. The UK Ladybird Survey is one of the volunteer recording schemes hosted by the Biological Records Centre (UK Centre for the Ecology & Hydrology) and encompasses the Harlequin Ladybird Survey which was initiated in 2005 in response to the arrival of the non-native species *Harmonia axyridis* within the UK. Formerly the Coccinellidae Recording Scheme, the UK Ladybird Survey has been active since the early 1970s. Much has changed over the last 50 years but the success of this citizen science initiative has contributed substantially to our understanding of the ecology of ladybirds and more broadly non-native species. *Harmonia axyridis* is a charismatic species that has been instrumental in engaging people in non-native species ecology and encouraging public participation in surveillance and monitoring. In 2019 we published the latest ladybird distribution trends using the UK Ladybird Survey dataset. Many species are showing declines in distribution but there have also been some expansions and indeed some new arrivals. Here we will provide an overview of the UK Ladybird Survey and celebrate the role of volunteers, through citizen science, in underpinning ecological studies with benefits for nature and people.

Joshua Moon Sammy[1],
Prof. Chris D. Thomas[1] and
Dr. Andy Salisbury[2]
T03 – Isaac Newton Building

Habitat specialisation and range shifts in human associated invertebrates

1. University of York, UK
2. RHS Wisley, UK

We assume that human associated species are likely to be generalists, but this assumption is not strictly true. Species of invertebrate in Europe have lived with the influence of human activity for thousands of years, and continue to live with this impact. It is conceivable that invertebrates, having lived in such an environment for this period of time, exist along a spectrum of specialisations, with species that are associated with human activity, and species that are avoidant of human activity. In such a spectrum, species associated with human activity may be expected to increase in range, as land use by humans continues to grow, and the impact of human activity intensifies. This study investigated the relationship between species' preferred habitats, found through habitat association modelling of citizen science data, and the human-association expected for each of these habitats, found through expert elicitation interviews. We found that human association had a positive relationship with range change, and that more human associated species were more likely to be specialists. This challenges the assumption that range changes are being driven by generalists, and that human associated species are more likely to be generalists.

Tien Thuy Thi Nguyen,
Patricio Salazar-Carrión and
Nicola Nadeau
T04 – Isaac Newton Building

Heliconius butterflies: colour, altitude, and thermal tolerance

The University of Sheffield, UK

With the onset of climate change, understanding insect thermal responses has become an increasingly relevant topic for investigation. *Heliconius* butterflies, famous for their müllerian mimicry and polymorphism, have a wide distribution across the neotropics and occupy a wide range of temperatures, mainly due to their distribution on the slopes of the Andes. However, the mechanisms that underpin *Heliconius* thermal adaptation have been relatively understudied. Environmental gradients, such as altitude, can be used as a fantastic proxy to understand temperature-driven responses due to possible local adaptation within species across the gradient. Here we investigate the effect of altitude on the wing colour variation of *H. erato* and *H. melpomene*, distantly related mimics often found in the same locations. Specifically, we present evidence that there is variation in the extent of black coverage and the hue of red colour, associated with elevation, with individuals from higher elevations being darker, with increased black coverage, consistent with "thermal melanism". This was done by processing standardised digital photographed wings with a "K-distance clustering approach", in which similar pixels in standardised images are made to cluster together to give the percentage and hue of each colour in the image. We used individuals from common-garden and temperature-controlled rearing to establish the extent to which this variation is due to genetic differences between populations, versus environmental effects. We then test for a relationship between wing colour and thermal tolerance. Overall, our results indicate local adaptation to altitude in *Heliconius* butterflies.

Chris R. Shortall and James Bell
T05 – Isaac Newton Building

Unearthing Otherwise Unknown Insect Responses to Change Using a Unique Archive

Rothamsted Research, UK

The recent decade has seen an increased interest in long-term trends in insects, with a range of publications documenting declines in insect abundance and biomass. What is clear from this work is that there are relatively few long-term studies in insects and that many taxa are un- or understudied.

The Rothamsted Insect Survey suction-trap network was founded in 1964 to monitor aphid migration. Since 1974 the bycatch from this work has been stored and provides a wealth of material to research species' responses to change over the late 20th and early 21st century.

For example, research has uncovered long-term trends in biomass, phenological change in disease vectoring midges, abundance increase in pollen beetles and migration synchrony between parasitoids and their aphid hosts. More recently, as part of the

DRUID (Drivers & Repercussions of UK Insect Declines) consortium we have been investigating trends in functional groups such as decomposers and parasitoids over time. This talk will cover the recent history of the Rothamsted Insect Survey's investigation of the suction-trap archives and looks at what is hoped for in the future.

Franz Löffler and
Prof. Dr. Thomas Fartmann
T06 – Isaac Newton Building

Insects on the move – Orthoptera range shifts and community dynamics in response to global warming

Osnabrück University, Department of Biodiversity and Landscape Ecology, Germany

Land-use change is the major driver behind the severe declines in insect diversity throughout Europe. Since the 1950s, both agricultural intensification and abandonment caused a substantial loss of semi-natural habitats, which has led to marked population declines in many species. More recently, climate change has become another important driver of changes in insect diversity. Whereas thermophilic species expanded their distributions polewards and to higher elevations, species adapted to lower temperatures or wet habitat conditions are increasingly threatened by the effects of global warming.

Since they are highly sensitive to both land use and climate, Orthoptera are excellent indicators to the study the effects of current environmental changes. The results of my recent research show, that the majority of Central European Orthoptera species historically suffered from large-scale habitat loss. Range retractions were especially related to habitat specialists with a low mobility, which were mostly associated with High Nature Value farmland. By contrast, thermophilic species with a high mobility rapidly expanded their distribution ranges during recent decades. At the same time, the Central European distribution of less mobile habitat specialists remained stable, which is likely a results of increased conservation actions since the 1990s. According to these results, further studies revealed that Orthoptera assemblages within temperate grasslands have changed significantly during recent decades. Whereas range expansions of mobile habitat generalists generally have contributed to an increase of species richness in well-managed habitats, grasslands with low habitat quality are increasingly affected by biotic homogenization.

The findings of these studies highlight key challenges for Orthoptera conservation in times of global change. Conservation actions should especially aim to promote the persistence of species with a limited ability to adapt to climate change. This includes increasing habitat heterogeneity and maintaining large-scale habitat networks within a heterogeneous landscape matrix. In addition, there is a need for biodiversity monitoring to identify threats and to counteract them at an early stage.

Joseph Millard
T07 – Isaac Newton Building

Developing a global threat-response model for insect biodiversity change

The Natural History Museum, UK

A number of recent studies have documented declines in insect abundance, biomass, diversity, and occupancy, leading researchers to conclude that insect decline might be a worldwide phenomenon. If true, the implications would be concerning, given the importance of insects to ecosystems services such as pollination. In understanding insect biodiversity change, one core problem relates to the lack of available data for much of the world. But even for geographic regions for which we do have data, differences in the response of insects among taxonomic groups and methodological approach make it difficult to fully understand the extent of change. Moving forward, ideally we need a single predictive framework of insect biodiversity change, that incorporates evidence of multiple types and accounts for the various dimensions through which insect biodiversity can be described.

In this talk I describe initial work in developing a global threat-response model for insect biodiversity change, as part of the project GLITRS. In particular, I set out a philosophy as to how space-for-time models, expert elicitation, and meta-analyses might be combined to better predict insect abundance change. I conclude by providing an overview as to how an insect threat-response model might be validated against time series, and then projected forwards in time to predict temporal and spatial regions of vulnerability to insect biodiversity change.

Robert J. Wilson[1], Guim Ursul[1], Mario Mingarro[1], Juan Pablo Cancela[2], Ana Burón-Ugarte[1], Adrián Sánchez Albert[1], Sara Castro-Cobo[1] and Helena Romo[3]

T08 – Isaac Newton Building

The role of topography in buffering the responses of mountain butterflies to climatic variation

1. Museo Nacional de Ciencias Naturales (MNCN-CSIC), Spain
2. CE3C
3. CIBC-UAM

Understanding how topography influences ecological responses to the climate could shed light on the capacity of mountains to act as refugia from climate change. Here, we test how topographic variation buffers the effects of climatic variation on butterflies in the Iberian Peninsula, by combining 10 km atlas data with repeat field samples from 78 sites in four mountain ranges. At 10 km resolution, more topographically variable regions showed reduced rates of change between 1901-1979 and 1980-2016 both in climatic conditions and butterfly community responses to the climate. In contrast, whilst communities at many of the field sites are now increasingly composed by warm- or dry-adapted species compared with recent decades, local communities differ markedly in their rates or trajectories of change. The results suggest that regional faunal changes are moderated in topographically heterogeneous regions by local variation in ecological responses. Protecting sites varying in topography or habitat across landscapes is therefore important for adapting conservation to climate change.

Alex Dittrich

T09 – Isaac Newton Building

The challenges of rewilding in urban areas and effective insect monitoring using undergraduate students

University of Cumbria, UK

Rewilding or wilding for insects involves restoring or returning a site back to its natural state following a period of cultivation. Engaging the public with this process, especially in urban areas is often a challenge, particularly when these sites transition through a 'messy' phase of restoration to the desired goal of a more natural landscape. Similarly, getting the public enthused about insect conservation is a well-documented challenge. This study looks at one urban project, a former golf course in the northwest of England that is being restored as a resource both for insects and the local community, managed by Cumbria Wildlife Trust's Get Cumbria Buzzing team and Carlisle City Council. Management includes the development of a wet meadow area and a scrape, removal of some of the old infrastructure and felling of non-native trees. This study looks at how sites like this can provide a great training resource for students and heighten awareness to both insects and habitat conservation. We discuss the challenges faced getting this project off the ground, plans for long term invertebrate monitoring and how these are actively linked to undergraduates. In monitoring, three taxonomic groups were investigated: butterflies, ground beetles and Auchenorrhyncha. These taxa chosen predominantly for two reasons; the effectiveness of these taxa as indicator species and their usefulness as training tools in identification. Insect groups were compared on the site across differing management strategies, scrapes, and wet meadow. In the first year there appeared to be some difference between the two management strategies but the diversity of all taxa appeared low at this early stage with students effectively identifying most species. Monitoring however is ongoing and should reveal more long-term trends. The outcome of this work was twofold, it highlighted that early-stage rewilding projects can be used as affective training tools giving undergraduates real experience of species level insect whilst effectively monitoring the regeneration and wilding of the former golf course site, raising awareness of the site and its importance to the local community.

Elizabeth Duncan, Dr Rosie Knapp, Jessica Bouwer, University of Leeds and Emily Ross

T10 – Isaac Newton Building

All hail the queen? How do neonicotinoids affect honeybee (*Apis mellifera*) worker behaviour?

University of Leeds, UK

In honeybee colonies, there is only one reproductive female, the queen. All of the other female members of the hive, the workers, perform all of the other duties, including feeding and grooming the queen, rearing her young, foraging and defending the colony. This colony cohesion is mediated, at least in part, by pheromones produced by the queen and her brood. Honeybee queen mandibular pheromone (QMP) is one of the key pheromones in the colony. QMP stimulates retinue response behaviour, ensuring that workers feed and groom the queen and distribute her pheromones throughout the hive. QMP also inhibits ovary activity in workers and slows the behavioural transition from nurse to forager. These functions of QMP and the correct response of workers to QMP are integral for colony productivity and survival. Therefore, environmental contaminants or agrochemicals that interfere with the QMP signalling or response in the colony can potentially be detrimental to honeybee colonies. Here, we begin to address this by focusing initially on the neonicotinoid imidacloprid.

The adverse effects of sub-lethal neonicotinoid exposure on honey bees are well documented. Neonicotinoids are associated with reduced foraging activity, impaired navigation, interrupted motor function, impaired learning and memory and decreased colony performance and productivity. Here we examine whether the neonicotinoid, imidacloprid, interacts with how honeybees respond to QMP and discuss what this may mean at a whole-colony level.

Enakshi Ghosh[2], Paul Ode[1] and Ryan Paul[2]

T11 Online – Isaac Newton Building

Host plant chemistry differentially reduces parasitoid success by enhancing herbivore immunity

1. Colorado State University, USA
3. Oregon State University, USA

How insect herbivores respond to the simultaneous challenges of bottom-up effects of plant quality (including, defensive chemistry) and the top-down effects of natural enemies (i.e. pathogens, parasites/parasitoids, predators) remains a central focus of plant-insect ecology. Plant defensive chemistry is widely appreciated to regulate plant-insect herbivore interactions and, increasingly, how plants and herbivores interact with higher trophic levels. Plant defense toxins are well known to have negative effects on natural enemies (e.g., parasitoids, insects whose immatures are parasitic on host insects but adults are free-living) if the latter directly encounter unmetabolized or sequestered toxins in their herbivore hosts or if ingestion of plant toxins by the host reduces its quality, indirectly compromising parasitoid growth and survivorship.

A third, far less studied, mechanism by which plant defense chemistry may affect herbivore–parasitoid interactions is through the modulation of the herbivore's ability to mount a successful immune response against the parasitoid. Most studies to date have found that herbivores feeding on plants containing higher levels of defensive chemistry are immunocompromised and therefore more susceptible to attack by parasitoids. Nearly all these studies have focused on herbivores that are either sequester (accumulate) plant toxins for their own defense or have no specialized mechanism of detoxifying plant toxins, which readily pass unmetabolized into their bodies.

Here, we present data on the effects of plant toxins on a specialist herbivore that efficiently detoxifies plant toxins, preventing nearly all toxins from passing into their hemolymph, and its two parasitoids. We show that feeding on plants containing higher levels of defensive toxins enhances the cellular immune system of this specialist herbivore at the cost of reduced herbivore growth rates and body size. However, whether this enhanced immune system is effective in providing defense against parasitoid attack depends on the species of parasitoid. Whereas enhanced cellular immunity provided increased protection against a gregarious parasitoid (lays multiple eggs per host) it did not provide protection against a solitary parasitoid (lays one egg per host) that was successful in evading the host's immune system.

We suggest that the direction in which plant toxins affect herbivore immune systems depends strongly on the detoxification ability of the herbivore. Furthermore, the effectiveness of an elevated immune system depends strongly on parasitoid identity and the ability to evade herbivore immune responses. Generalist herbivores that do not effectively metabolize plant toxins and specialists that sequester plant toxins are more likely to rely on accumulated toxins in their bodies to defend against parasitoids. Specialist herbivores that are efficient at metabolizing plant toxins rely on enhanced immune responses to protect against the likelihood of parasitism. Furthermore, solitary parasitoids are expected to invest stronger mechanisms to evade host immune responses whereas gregarious parasitoids may rely on increased clutch sizes to ensure that at least some offspring survive.

Jalanie Marohomsalic, Dr. Olga Nuneza and Dr. Radomir Jaskula

T12 Online – Isaac Newton Building

Diversity and Distribution Pattern of Tiger Beetles (Coleoptera: Cicindelidae) in Lanao del Sur, Philippines

MSU-Iligan Institute of Technology, Philippines

This study aimed to assess the diversity and distribution patterns of tiger beetles in Lanao del Sur province. Adult tiger beetles were collected through opportunistic sampling from 9 April to 4 August 2019. A total of 289 individual tiger beetles were collected belonging to four genera, all of which are new record in Lanao del Sur. *Tricondyla* (*Tricondyla*) *elongata* W. Horn, 1906 (66.8%) found to be the most abundant and most widely distributed species followed by *Tricondyla* (*Stenotricondyla*) cavifrons Schaum, 1862 (10.48%), *Cylindera discreta elaphroides* (11.4%), *Calomera angulata* (9.7%), *Neocollyris cf. albitarsis* Erichson, 1834 (1.4%), and *Neocollyris similior* Horn, 1893 (0.4%). On the other hand, results showed that diversity of species is relatively low although S6 (H'=0.8) and S9 (H'=0.7) indicated highest species diversity. Highest species richness was recorded in S6 (n=3) while S10 (n=1) found to have the lowest species richness. Moreover, results indicate that S9 had the most even species (E'=0.99) while lowest evenness values were observed in S1 (E'=0.59) and S2 (E'=0.60). Anthropogenic pressures and on-site disturbances were observed suggesting the need to conserve the natural habitats of tiger beetles in the province.

Andrew Bladon, Dr Rebecca Smith and Prof William Sutherland

T13 – Isaac Newton Building

Summarising the evidence for conservation actions for butterflies & moths

University of Cambridge, UK

Lepidoptera (butterflies and moths) are the second most speciose group on the planet, and play a vital role in many terrestrial ecosystems as pollinators and primary consumers. Butterflies in particular are probably the most popular and well-known group of insects, and in an era of increasing concern about global declines in insect abundance, much of the best evidence comes from butterflies and moths. Despite facing a wide-range of threats, from habitat loss and conversion, to pollution and climate change, only around 1,500 species of Lepidoptera (of ~180,000 described) have been assessed for the IUCN Red List, the majority of which are butterflies. From these assessments, around 30% of species are thought to be in decline, and 5-10% are threatened with extinction. Conservation management is required to reverse these declining population trends, and to recover species that have suffered local extinctions.

Evidence-based knowledge is key for planning successful conservation strategies and for the cost-effective allocation of scarce conservation resources. Targeted reviews may be carried out to collate evidence on the effects of a particular conservation action, but this approach is labour-intensive, expensive and ill-suited for areas where the data are scarce and patchy. The evidence for the effectiveness of conservation actions aimed at insects is scarcer than for vertebrate taxa, and accordingly, only a small number of targeted reviews on butterflies and moths exist. Assembling the existing evidence for butterfly and moth conservation actions in one place, alongside information for other taxa, facilitates easy-access for both conservation scientists and conservation practitioners.

We used a subject-wide evidence synthesis approach to simultaneously summarise the evidence for all actions dedicated to the conservation of butterflies and moths. By simultaneously targeting the entire range of potential actions, we were able to review the evidence for each action cost-effectively. The resulting synopsis can be updated periodically and efficiently to incorporate new research. I will present the theory behind the Conservation Evidence approach, and discuss the findings from our recently published synopsis. The synopsis is freely available online and, alongside the Conservation Evidence online database, is a valuable asset to the toolkit of practitioners and policy makers seeking sound information to support butterfly and moth conservation.

Julia Simons[1], Anne Oxbrough[1], Rosa Menendez Martinez[2] and Paul Ashton[1]

T14

Do micro-habitat quality and host-plant density influence oviposition in the High Brown and Dark Green Fritillaries?

1. Department of Biology, Edge Hill University, UK
2. Lancaster Environment Centre, Lancaster University, UK

The survival of butterfly populations depends on successful oviposition strategies. The preference-performance hypothesis suggests that females select sites that maximise offspring performance. However, as land use changes and climate shifts are altering habitat conditions and micro-climate, some species may adapt ovipositing strategies to the new conditions and flourish while others, with narrow niche requirements, may be unable to respond and vanish.

This research investigates the relevance of the preference-performance hypothesis in a changing environment through field observations of egg-laying females and analysis of micro-habitat quality in the High Brown (*Fabriciana adippe*) and Dark Green (*Speyeria aglaja*) Fritillary butterfly species. The High Brown Fritillary is considered a narrow niche species while the Dark Green Fritillary has broader requirements.

We determine the relative importance of a range of habitat variables for oviposition site selection and explore niche separation between these two similar species with differing population trends (declining and increasing, respectively) in the same area.

104 oviposition behaviour observations were made in 69 1m2 quadrats at one site within the Morecambe Bay Limestones area, in NW England. Our results show that the cover of live Bracken (*Pteridium aquilinum*) and grass were most important for oviposition site selection in both species (P>0.01) with High Brown Fritillaries tolerating less Bracken and grass cover than Dark Green Fritillaries. This contrasts with previous work on the High Brown Fritillary which suggests that the cover of Bracken litter is a driving factor in site selection. Hostplant density is only of significance (P>0.05) for site selection in the High Brown Fritillary.

The UK population of the critically endangered High Brown Fritillary has experienced a steep decline in abundance and range, now surviving in only four landscape areas. This research is timely as current management is based on research undertaken over 25 years ago. Results are discussed in the context of environmental change and the implications for successful conservation of an endangered butterfly.

Symposium – Ecosystem services and disservices I
Weds 9.00-10.00
Venue: Isaac Newton Building

Jessica Ware
(Plenary Speaker)

Diversity in entomology: creating space while studying insect evolution

See details on page 19

Split talks from 10am onwards – talks will be taking place at the same time in different spaces –
- **Isaac Newton Building**
- **Lincoln Medical School (LMS005 ground floor)**

Elia Guariento[1], Wolfgang Wanek[2] and Konrad Fiedler[3]

T15 Online – Isaac Newton Building

The nutritional ecology of ant communities on the alpine tree line ecotone

1. Institute for Alpine Environment, Eurac Research, Italy
2. Center for Microbiology and Environmental Systems Science, University of Vienna, Djerassiplatz 1, A-1030 Vienna, Austria
3. Department of Botany & Biodiversity Research, University of Vienna, Rennweg 14, A-1030 Vienna, Austria

Alpine ant communities are poorly studied from an ecological perspective, even in central Europe. At 5 mountains situated in the Central Alps, elevational transects from the upper montane forests into the alpine environment, crossing the tree line ecotone, were investigated focusing on the change of ant community composition, their feeding ecology and the trophic position of dominant ant species.
Ant species richness and functional diversity was

found to be highest directly at the tree line ecotone, indicating a denser species packing at the tree line sites. Mound-building red wood ants dominated numerically in the forests, while the subordinate alpine slave-ant *Formica lemani* dominated in alpine grasslands. Ant community composition was mainly shaped by shrub cover and elevation, however, wood ant density also influenced the presence and abundance of all other ant species.

Feeding preferences were investigated using a combined experimental (baiting) and chemical (stable isotope) approach. Sugar resources were most preferred by the whole ant community in the alpine environment and at the tree line and were therefore likely limiting in these habitats. This shift was not detected within the two dominant ant taxa occurring across the whole gradient, viz. the slave ant *Formica lemani* and mound-building wood ants (*Formica s. str.*).

Yet, stable carbon (C) and nitrogen (N) isotope signatures of both these ant species likewise revealed a shift in resource use over the ecotone, from a lower trophic position in subalpine forests to a more carnivore-dominated lifestyle in alpine grasslands. Moreover, wood ants were found to occupy a slightly higher trophic position compared to *F. lemani*.

In conclusion, energy resources turned out to be more limiting for ants in the alpine environment, but less so in subalpine forests. The low trophic position of these ant species in the forests is considered to be a result of abundant trophobiotic associations with honeydew-producing homopterans that occur in far larger numbers on conifer trees in the forests.

Aisling Moffat

T16 Online – Isaac Newton Building

Creating a sustainable, 21st century IPM toolkit to combat a historic pest issue; *Tipula* larvae in agricultural settings

Teagasc, SRUC and the University of Edinburgh, Ireland

Within the last decade, a record number of chemical insecticides have been withdrawn for agricultural use within the EU. This follows the heightened awareness regarding the health and environmental risks associated with their use. For many pests, there needs to be a complete renewal of the control management strategies available to farmers from an integrated pest management (IPM) perspective. To help farmers meet these challenges, effective solutions are needed. Here we outline ongoing research that aims to create a modern IPM toolkit specifically for grassland farmers when dealing with *Tipula* larvae (leatherjacket) infestations. *Tipula* larvae have been studied in many areas globally, as they cause significant damage in many industries including amenity grasslands, turf sod production and agriculture. Two species are known to cause significant agricultural damage; *Tipula paludosa* and *Tipula oleracea*. Both actively feed on the roots and shoots of grasslands and cereals, severing the plant at key developmental stages and reducing the overall yield. The lifecycle of each species differs substantially. *T. paludosa* can spend up to 11 months in the soil, actively feeding, whereas *T. oleracea* is bivoltine. Therefore correctly identifying the larvae is vital from a pest management perspective and should always be the first step when designing an IPM approach.

Previously, annual surveys of leatherjacket occurrence in agricultural settings were conducted in England (1940s-1970s), Northern Ireland (1970-1980s) and Scotland (1980s-2000s). No surveys of this kind have previously be conducted in the Republic of Ireland. For the purpose of this research, a national survey of farms across Ireland was conducted to determine (i) the *Tipula* larval species of agronomic importance, and (ii) the soil factors that limit larval survival/occurrence, hence gathering soil management advice for farmers.

The survey outlined that grassland farmers were disproportionally affected by leatherjacket infestations as ploughing, which is known to reduce larval populations by 50%, was often not an economically viable option. Subsequent larval feeding experiments were established to identify optimum grassland sward compositions for highly infested fields, with an aim of gathering effective sward management advice. Soil microbiome analysis from fields across Scotland and Ireland was also carried out to investigate the microbial communities present in fields with high and low pest pressure. These experiments will give insight into potential biocontrol agents for future control options, and will complete our IPM toolkit.

The majority of larvae collected were *Tipula paludosa*. This species has a much longer soil dwelling phase, which presents a very narrow opportunity for targeting vulnerable stages in its lifecycle. Larval feeding experiments were conducted with six plant monocultures and a mixed-species sward containing all six species. Comparisons of larval survival, yield loss and overall sward performance were made.

Larval feeding led to significantly decreased yields ($p<0.005$) in the white clover swards, while diverse swards seemed more tolerant. Through better understanding the pest we are dealing with, the role of soil properties and cultivar choice, we aim to provide farmers with an IPM toolkit for a pest where there is currently limited control options for growers.

Matt Tinsley[1], Rosie Mangan[1], Marcelo Mueller[2], Ricardo Polanczyk[2] and Luc Bussière[3]

T17 – Isaac Newton Building

Variable diets shape the evolution of insect resistance to pathogens used in biocontrol

1. Biological and Environmental Sciences, Stirling University, Stirling, UK
2. Universidade Estadual Paulista (UNESP). Campus de Jaboticabal. Faculdade de Ciências Agrárias e Veterinárias (FCAV), Brasil
3. University of Gothenburg, Department of Biological & Environmental Sciences, Gothenburg, Sweden

Insect resistance to infection is of strong relevance for sustainable agriculture because insect pathogens are increasingly used as ecologically benign biopesticides for crop protection. Host populations are often highly genetically variable for pathogen defence traits, but the factors shaping this genetic variation are incompletely understood. Fluctuating ecological conditions experienced by hosts can prevent selective sweeps of resistance alleles, thereby promoting persistence of genetic variation for infection resistance. This is because the ability of a particular genotype to defend against infection can be strongly influenced both by the environment a host inhabits, and the genetic identity of pathogen strains encountered. This environmental sensitivity of genotype fitness can be quantified as a genotype by environment interaction. We compared the potential for two different factors to drive genotype by environment interactions for infection defence: host diet differences and pathogen strain variation. We studied fungal pathogen resistance in a major global lepidopteran crop pest, the polyphagous cotton bollworm, *Helicoverpa armigera*. Or work revealed extensive genetic variation for infection resistance. Evolutionary paradigms often suggest that strong host-parasite specificity underpins infection defence; however, for our generalist fungal pathogens, the crop diet that larvae fed on was a much stronger driver of genotype by environment interactions than was the identity of the pathogen. Next, we investigated the life-history processes underpinning these strong diet-induced genotype by environment interactions for pathogen defence. *Helicoverpa armigera* populations were highly genetically variable for their ability to feed and grow on different crop plants. Furthermore, a genotype's ability to defend against fungal infection was correlated to its ability to feed and grow on a particular crop plant. Our data indicate that the ability to acquire resources from a given diet is a strong driver of an insect pest genotype's ability to defend against infection. Agricultural landscapes are often ecologically homogeneous and pesticides for crop protection are often applied uniformly, generating highly consistent selection pressures for resistance. Our results suggest that farmers could manage the threats of pest resistance evolution to fungal biopesticides by diversifying the crop plants grown in agricultural ecosystems.

Kiran Horrocks[1], Professor Max Suckling[2] and Dr. Darren Ward[3]

T18 Online – Isaac Newton Building

Can natural enemies of current insect pests provide biotic resistance to future pests?

1. University of Auckland, New Zealand
2. The New Zealand Institute for Plant and Food Research Limited; University of Auckland, New Zealand
3. Manaaki Whenua Landcare Research; University of Auckland, New Zealand

As the frequency of insect pest invasions to new areas increases globally, so too does the economic damage they cause. An environmentally friendly and self-sustaining method commonly utilised to control insect pests is classical biological control (CBC), which entails the importation and release of exotic natural enemies. However, enforced pre-release risk assessment protocols for CBC agents restrict their timely approval in many countries, and little is known about the extent to which resident natural enemies may contribute to the suppression of pests that are yet to arrive. Biotic resistance theory posits that communities may resist species invasions due to the presence of natural enemies. We investigated the potential of the resident exotic parasitoid wasp fauna (intentionally and unintentionally introduced species) to provide biotic resistance against possible future pest invasions to New Zealand. We constructed a dataset containing resident exotic *ichneumonoid* parasitoid species in New Zealand, their known global host ranges, and the pest status of each host, to infer

biotic resistance potential. The 65 known exotic *ichneumonoid* species in New Zealand could potentially provide some level of resistance against 442 global pest species that have not yet invaded New Zealand. Furthermore, as the number of introduced parasitoid species accumulates overtime, so too does the potential for biotic resistance. However, the degree of suppression provided by resident parasitoids remains unknown and would likely vary substantially amongst species. This approach could be employed to inform preparedness against potential future pest invasions worldwide. Future research should investigate the relative potential for biotic resistance amongst resident parasitoid species, and how this could be used to inform decisions surrounding CBC introductions.

Natasha Stevens and
Christy-Jo Scipio O'Dean

T19 – Isaac Newton Building

The Invasive Invertebrate Project

St Helena National Trust, St Helena

St Helena is a small remote island (47sqm) located in the South Atlantic Ocean. Despite its size, it hosts over 400 endemic terrestrial invertebrate species; it has more invertebrate species than the UK and all other overseas territories put together, making it a location of immense global importance. Many of these endemic species are under threat from invasive non-native invertebrate species. An innovative new project will facilitate endemic invertebrate recovery and re-establish their associated ecosystem functions, by testing and establishing invasive invertebrate control methods. The focus will be on the Common wasp (*Vespula vulgaris*), Big-headed ant (*Pheidole megacephala*) and the Springbok mantis (*Miomantis caffra*).

Claire Dumenil, Albrecht Haase and
Gianfranco Anfora

T20 Online – Isaac Newton Building

Fruit odour coding in the brain of the agricultural pest Drosophila suzukii: Towards olfactory-guided pest management

CIMeC- University of Trento, Italy

Many species of insects severely damage our food production. The best protection so far is heavy pesticide application which has proven to also affect beneficial species leading to the alarming decline of pollinating insects. One example is the fly *Drosophila suzukii*, a close relative of *D. melanogaster* which severely damages the production of berry and stone fruits including strawberries, raspberries, blueberries and cherries. Since its first captures in Europe in 2008 and UK in 2012, its population increased and established causing an estimated loss of £30 million each year in the UK alone.

Flies locate fruit hosts by their attractive odours, detected and encoded by a highly specialized olfactory system before being translated into behaviour. The corresponding information processing pathway is not yet fully understood, especially the step that evaluates the attractiveness of odours. An alternative pest management method would be to use odours to which in particular *D. suzukii* adults are sensitive to lure them into traps or repel them from fruits without affecting other species.

The damaging effect of *D. suzukii* is the female's preference to lay eggs in ripening fruits on plants thereby occupying a diverse ecological niche from D. melanogaster thriving on overripe and fermenting fruits on the ground. With evidence of genetic changes in the repertoire of olfactory genes, the host shift appears to be associated with changes in the detection of ripe fruit odours and fermentation odours in *D. suzukii*.

However, it is unclear what distinguishes the brains of *D. suzukii* and *D. melanogaster* to cause the crucial difference in host selection, also because one of the tools that have proved extremely useful in studying the brain of *D. melanogaster* was not available for *D. suzukii*, namely transgenic insect lines that allow brain activity to be mapped.

We are studying the olfactory pathway leading to attraction to ripe fruits in *D. suzukii* using a transgenic fly line expressing the genetically encoded calcium sensor GCaMP7. We use minimally invasive 3D in vivo two-photon microscopy to image neural activities to characterize the neuronal responses to environmental odours and to follow the processing pathway of these stimuli in a comparative study with *D. melanogaster*. We present the first differences between the two species in the olfactory code with 3D mapping of the responses to selected odours on the antennal lobe. We expect the results to improve the general understanding of olfactory coding and its role in the host shift.

Louise Mc Namara[1], Liam Sheppard[1],
Tom Pope[2], Joe Roberts[2], Sacha White[3]
and Stephen Byrne[1]

T21 – Isaac Newton Building

Improving monitoring and management of BYDV in Ireland

1. **Teagasc, Crop Science Department, Oak Park, Carlow R93 XE12, Ireland**
2. **Harper Adams University, Newport, Shropshire, TF10 8NB, UK**
3. **ADAS, ADAS Boxworth, Cambridgeshire CB23 4NN, UK**

Aphids are economically important cereal pests that reduce grain quality and crop yield through direct feeding and vectoring Barley/Cereal Yellow Dwarf Virus (B/CYDV). Controlling aphids and therefore managing B/CYDV is increasingly difficult due to insecticide resistant aphid populations, climate change and fewer insecticide options. Current B/CYDV management is achieved through pyrethroid insecticide applications, however these decisions aren't made using pest thresholds as they don't exist. Insecticide application decisions are typically based on aphids being identified in a crop during routine crop-walking, a process that is time consuming and dependent on specialist expertise/tools to accurately identify aphids or diagnose disease. There is an urgent need for enhanced understanding and detection of B/CYDV to inform control decisions. This is particularly important as there are no post diagnosis treatment options for B/CYDV, making surveillance of its vectors key to achieving effective control. Previous work indicated that BYDV-MAV was the most predominant isolate of B/CYDV in Irish cereal crops and it was thought that it is either the only serotype of the virus found or the most common strain. However, these identifications were ELISA based (not able to discriminate between BYDV-PAV and BYDV-PAS, and demonstrates cross reactivity between MAV & PAV). As different serotypes may cause differences in severity of damages and may be unaffected by crop resistance/tolerance to other serotypes, advanced detection of B/CYDV is needed to determine if this previous BYDV observation still applies almost a decade later. A pilot RNA sequencing survey of symptomatic barley plants from around Ireland has identified many BYDV serotypes (with BYDV-GAV and BYDV-PAS being prominent) and co-infection; these viral genome sequences will be available to develop advanced detection approaches with greater specificity.

We aim to tackle existing disease diagnosis limitations using parallel approaches: (1) Validating different aphid monitoring methods in both spring and winter cereals, include visual searching, yellow trapping and the Irish suction tower network for indicating BYDV pressure. (2) Developing advanced diagnostics to establish the risk posed by migratory and in-field aphid populations as well as the viral loads needed to pose risk of yield loss. (3) Determining best use of tolerant/resistance cereal varieties for control of B/CYDV. Together these approaches can be used to develop decision support systems (DSS) that determine whether control is required and to optimise insecticide applications. The first field survey, which occurred in spring 2022, has been completed as part of a 3-year survey to validate aphid monitoring methods as a DSS for farmers. Spring barley crops on 17 farms across major tillage growing regions in Ireland were monitored for cereal aphids vectoring BYDV using yellow trapping and visual searching. Leaf sampling was conducted and crops were visually assessed for BYDV infection. Aphids were tested for BYDV and insecticide resistance and leaf samples were tested for BYDV.

David Stanford-Beale and
Dr Stephen L Cameron

T22 – Isaac Newton Building

Thrips in the Genomic Era: Advancements in Phylogenetics, Mitochondrial Evolution, and Virus Coevolution in thrips

Purdue University, USA

Members of the order *Thysanoptera* (*Paraneoptera*), commonly named thrips, amount to over 6,000 described species. A small number of species are responsible for extensive damage to agriculture and horticulture directly through mechanical feeding damage and indirectly through the spread of tospoviruses, a damaging plant virus group. Previous studies on the phylogenetic relationships of this order lacked the resolution of family and subfamily relationships, especially in the *Thripinae* subfamily which has previously been shown to be paraphyletic.

We investigated intraordinal relationships between families and used fossils to time calibrate their divergence from one another. Monophyly was tested for the suborders, families, recognized subfamilies, and proposed lineage groups. We built phylogenies using 2050 known orthologs assembled using aTRAM 2.1. We sampled 57 thysanopteran species including

representatives of five of the nine families, 51 genera and all *Phlaeothripinae* lineage groups. The two suborders, *Tubulifera* and *Terebrantia*, are recovered as monophyletic. The two most speciose families, *Thripidae* and *Phlaeothripidae*, as well as *Aeolothripidae*, were also recovered as monophyletic. The inferred phylogeny has strong nodal support across the tree, clarifying relationships between families, subfamilies, and the relationships between the lineage groups within *Phlaeothripidae*. Further sampling is needed to test the relationships of *Uzelothripidae*, *Stenurothripidae*, and *Fauriellidae*; families missing from both the current analysis and previous studies.

We will show examples of how this phylogeny has already impacted thrips research and share results of two downstream studiesthat rely on theinferred phylogeny: cophylogenetic analysis of Tospoviruses and their Thripsvectors; , and the pattern of rapid mitochondrial genome rearrangements in Thysanoptera.

Dave Clarke[1], Ajay Limaye[2], Duane D. McKenna[3] and Rolf G. Oberprieler[4]

T23 – Isaac Newton Building

The weevil fauna preserved in Burmese amber – snapshot of a unique, extinct lineage

1. University of Memphis, USA
2. Australian National University, Australia
3. University of Memphis, USA
4. CSIRO, Australian National Insect Collection, Australia

Until recently, knowledge of the Burmese amber weevil fauna consisted of few scattered isolated descriptions. Although most taxa were misclassified, some of them showed unusual and specialized characters unknown in extant weevils. Others suggested surprisingly ancient minimum ages for extant groups. In this paper we present the results of a study that integrates these previously known fossils with a much larger and diverse sample of Burmese amber weevils, producing a revised taxonomic scheme. We studied type specimens of nearly all previously described Burmese amber weevils and prepared all amber blocks containing new specimens to maximize visibility of critical structures. We employed high-magnification light microscopy, CT scanning (selected specimens) and comprehensive microphotography to document morphological diversity. We redescribe most previously described taxa and describe 52 new species in 26 new genera, making this contribution one of the largest monographs to date covering Burmese amber fauna. We conclude that only the families *Nemonychidae* and the newly recognized *Mesophyletidae* are thus far confirmed from Burmese amber. The combination of characters in most *Mesophyletidae*, including geniculate antennae, a long rostrum and exodont mandibles indicate that they were highly specialized phytophages of early angiosperms preserved in the amber, likely ovipositing in flowers or seeds. Numerous additional specimens are now known and have greatly expanded the known morphological diversity of the group. Burmese amber weevils appear to represent an extinct mid-Cretaceous ecosystem and fill a critical gap in the fossil record of weevils. An increasing knowledge of this fauna will therefore facilitate future evolutionary studies of this megadiverse insect lineage.

Andrew Polaszek1, Alexey Polilov[2], Gennaro Viggiani[3], and Lucian Fusu[4]

T24 – Isaac Newton Building

Megaphragma 8 years on – Integrative taxonomy of the world's species completed

1. Natural History Museum, UK
2. Department of Entomology, Moscow State University, Russia
3. Dipartimento di Agraria, Università degli Studi di Napoli "Federico II" Italy
4. Faculty of Biology, Alexandru Ioan Cuza, Iasi, Romania

The preliminary results of an integrative morphological and molecular investigation into the world species of the parasitoid genus *Megaphragma* were presented at the 10th European Congress of Entomology in 2014. Eight years on the study is complete and published. *Megaphragma* species are important models for basic organismal research, and many are potential pest control agents. We present the first extensive revision of species of the genus *Megaphragma* based on morphological and genetic data. Our revision includes all previously described species, 6 of which are synonymized, and 22 new species are described We also provide the first key to all species of the genus, and reconstruct the phylogeny based on 28S and CO1 molecular markers. Some extraordinary patterns of species distributions are revealed by extensive global sampling, and hypotheses for such distributions are presented.

Gael J. Kergoat1, Noémie M.-C. Hévin[2], Fabien L. Condamine[3], Emmanuel F.A. Toussaint[4], Jérôme Barbut[5], Andrew Mitchell[6], Alberto Zilli[7], Anne-Laure-Clamens[1], Claire Capdevielle-Dulac[8], Paul Z. Goldstein[9] and Bruno P. Le Ru[8]

T25 – Isaac Newton Building

Eighteen years of researches on noctuid stemborers (*Lepidoptera*, *Noctuidae*, *Apameini*, *Sesamiina*), from field work to integrative taxonomy and macroevolutionary studies

1. INRAE / French National Research Institute for Agriculture, Food and Environment, France
2. Université de Poitier, France
3. CNRS, France
4. Muséum de Génève, Switzerland
5. MNHN, France
6. Australian Museum, Australia
7. NHM, UK
8. IRD, France
9. USDA, Smithsonian Institution, USA

Noctuid stemborers (*Noctuidae*: *Apameini*: *Sesamiina*) are a lepidopteran group including possibly more than 300 species that are mostly distributed in the Afrotropics. This clade is best known by its economic impacts, since it encompasses a dozen pest species that collectively attack important crops such as maize, sorghum or rice. In 2004, an ambitious research program was initiated on this group in Africa. It was based on extensive field surveys in 17 sub-Saharan countries and in the Palearctic region, targeting wild habitats rich in Poales combining infested host-plant collections and light traps, allowed us to obtain about 80,000 specimens, of which over 52,000+ larvae were reared from 250 identified species of grasses and sedges.

For years we worked on the taxonomy of the group, focusing on revising and disentangling several species complexes. To do this, we progressively ramped up our integrative approaches, building up on the many recent developments in the emerging field of integrative taxonomy. In parallel, we began to study the diversification dynamics of the group, first by exploring patterns of evolution of host-use and integrating environmental proxies into diversification analyses. We have also more recently examined the impact of past climatic and geological events on their diversification dynamics, not only to reconstruct historical biogeography patterns, but also to assess the impact of the repeated changes of biome composition in Africa.

Here I will present the most recent results we have obtained on the systematics and macroevolutionary dynamics of *noctuid stemborers*, based on the latest integrative analyses we carried out, as well as on the results of macroevolutionary analyses of a dated molecular phylogeny encompassing no less than 229 *Sesamiina* species.

Aparna Kalawate

T26 Online – Isaac Newton Building

Diversity of forensic important trogid beetle in India

Zoological Survey of India, Western Regional Centre, Pune, India

Trogidae is a small, cosmopolitan family consisting of about 300 species. The family name *Trogidae* was proposed by MacLeay. Trogid beetles are commonly called hide beetles and and keratin beetles. The beetles of this family are necrophagous and are of forensic importance. These insects utilize a wide array of food containing keratinous material. They feed on carcasses and are the last among other groups of organisms to feed on the carcass. They have been reported feeding on bat guano in caves, locust eggs, fly maggots and also on products which contain animal keratin, like an old carpet, coat, etc. India harbors a very rich *Trogidae* fauna, but work carried out on this family is less in comparison to other parts of the world. At present, 13 species of *Trogidae* are known from India. This group is not studied properly particularly in India. In the present paper emphasis has been given to properly account the trogid fauna of India.

Omar Akbari

T27 Online – Isaac Newton Building

Using Precision guided sterile insect technique to suppress mosquito populations

UCSD, USA

Mosquitoes are considered to be the world’s deadliest animals. They can transmit numerous pathogens such as Malaria and Dengue fever wreaking havoc on humanity. New technologies are needed to combat mosquitoes and the pathogens they transmit. Here I will describe a new CRISPR based technology termed

precision guided sterile insect technique (pgSIT) which can safely be used to suppress and eliminate mosquitoes.

John c. Bradley
T28 – Isaac Newton Building

Fitness for Purpose of "Raised Bait" Methodology in Investigating Blowfly Oviposition

University of Wolverhampton, England, UK

Blowfly nocturnal oviposition has been investigated throughout the world for decades via both fieldwork and laboratory models. However, the methodology utilised within fieldwork-based investigations may not be as fit for purpose as previously believed and may have extremely significantly biased the results of these investigations. Although shifting changes in climate may result in nocturnal environments with sufficient temperature and humidity to facilitate ovipositional activity and therefore blowfly lifecycles, it remains axiomatic that blowflies cannot oviposit onto substrates that they cannot access.

Though fit for the purpose of general entomological capture projects and diurnal studies, utilising raised baits – a methodology in which suitable baits are suspended or placed onto platforms over a meter above ground level – creates a scenario in which blowflies almost certainly cannot access raised baits at night given that blowflies cannot maintain precise guided flight in dark environments even when other environmental factors are conducive to ovipositional activity. Furthermore, and of significant forensic relevance, raised/suspended baits are not an accurate representation of ground-level remains in outdoor locations at night to which blowflies already in the area can readily navigate via walking.

A meta-analysis performed on 598 replicate experiments investigating blowfly nocturnal oviposition shows a statistically extremely significant correlation between the decision to use raised/suspended baits and observing no instances of nocturnal oviposition ($p = <.00001$, $N = 598$) when compared to ground-level baits.

These results were used to inform the methodology of a regional (South Staffordshire, UK) investigation into blowfly nocturnal oviposition, the results of which were that significantly more eggs were laid on ground-level baits than were on raised/suspended baits at the same fieldwork locations (article pending publication).

Consequently, raised/suspended baits should not necessarily be considered a fit for purpose methodology in investigations of blowfly nocturnal oviposition in outdoor environments nor any such similar scenario in which specific climatic factors are being investigated to determine their potential effect(s) on blowfly behaviour.

Lorna Culverwell, Phuoc T. Truong Nguyen, Maija T. Suvanto, Essi M. Korhonen, Ruut Uusitalo, Olli Vapalahti, Teemu Smura and Eili Huhtamo
T29 Online – Isaac Newton Building

Characterisation of the RNA Virome of Nine *Ochlerotatus* Species in Finland

University of Helsinki, Finland

RNA viromes of nine commonly encountered *Ochlerotatus* mosquito species collected around Finland in 2015 and 2017 were studied using next-generation sequencing. Mosquito homogenates were sequenced from 91 pools comprising 16-60 morphologically identified adult females of *Oc. cantans*, *Oc. caspius*, *Oc. communis*, *Oc. diantaeus*, *Oc. excrucians*, *Oc. hexodontus*, *Oc. intrudens*, *Oc. pullatus* and *Oc. punctor*/*punctodes*. In total 514 viral RdRp polymerase sequences of 159 virus species were recovered, belonging to 25 families or equivalent rank, as follows: *Aliusviridae*, *As-piviridae*, *Botybirnavirus*, *Chrysoviridae*, *Chuviridae*, *Endornaviridae*, *Flaviviridae*, *Iflaviridae*, *Negevirus*, *Partitiviridae*, *Permutotetraviridae*, *Phasmaviridae*, *Phenuiviridae*, *Picornaviridae*, *Qinviridae*, *Quenyavirus*, *Rhabdoviridae*, *Sedoreoviridae*, *Solemoviridae*, *Spinareoviridae*, *Togaviri-dae*, *Totiviridae*, *Virgaviridae*, *Xinmoviridae* and *Yueviridae*. Of these, 147 are tentatively novel vi-ruses. One sequence of Sindbis virus, which causes Pogosta disease in humans, was detected from *Oc. communis* from Pohjois-Karjala. This study greatly increases the number of mosqui-to-associated viruses known from Finland and presents the northern-most mosquito-associated viruses in Europe to date.

Nancy Dawam
T30 Online – Isaac Newton Building

Socio-economic Status and malaria prevention among members of Giri community Federal capital territory Nigeria

Plateau State University Bokkos, Nigeria

Malaria is most prevalent in sub-Saharan Africa, and this has been linked to poverty. Despite efforts to promote measures such as the use of insecticide-treated nets and sprays, Nigeria accounts for about a quarter of the global malaria cases and deaths annually. Although control measures have contributed to a decline in malaria cases and deaths over the years, malaria remains a public health challenge in Nigeria. This study aims to examine the knowledge, attitude, and practices of people from the Giri community towards malaria control interventions using quantitative methods. The study will also assess the impact of socio-economic status on accessibility and utilisation of malaria control tools among members of the Giri community. The results from this study will identify key areas that need to be considered and improved when developing policies for malaria control in poor communities in Nigeria.

Leah Fitzpatrick[1], Ashley Dear[2] and Amy Farrow[2]
T31 Online – Lincoln Medical School

A choose your own adventure, biomimicry and libel: public engagement advice from the winners of the 2021 RES Student prize

1. Oxford Brookes University, England, UK
2. Harper Adams University, Newport, Shropshire, TF10 8NB, UK

Through sensationalist articles published in newspapers that fan the flames of animal phobias, reality television programmes using invertebrates as punishment and the inspiration for many horror or sci-fi monsters coming from invertebrates, the general public has always had an overwhelming negative impression of entomology. With 3.8% of the global population having a specific animal phobia, including invertebrates (Wardenaar et al., 2017) and a decline in the level of trust between public and science, never has there been a greater need for effective public engagement. The Royal Entomology Society started their Student Prize in 2017, asking for students to submit an 800 word essay on an entomology topic of their choice, while writing in a way that would be both accessible and engaging for the general public. The top three are picked by a panel of RES Fellows and a cash prize of £400, £300 and £200 is given respectively. All three of the authors were this year's winners (1st Fitzpatrick, 2nd Dear and 3rd Farrow). Here, we discuss our motivations for the competition, why we picked our topics, what we felt worked best about our pieces and what we were surprised people enjoyed about ours. For all of us, we agreed that the incentive of a cash prize is an enormous benefit for encouraging participation and was a significant factor for us. We also enjoyed the freedom to write in a non-academic style that allowed us to explore our topics and made the experience very enjoyable. We also agreed that it was an excellent way to highlight the society and made us more aware of what the RES has to offer as a student. For lecturers, we would recommend trying to incorporate a competition as part of an assignment. We hope that our experience and suggestions will encourage fellow students to write for this years prize, lectures or supervisors to include competitions as part of their modules and for other groups to consider the best way to increase student engagement.

Amma Simon
T32 – Lincoln Medical School

Entomology in global Higher Education: who is training the next generation insect scientists?

Keele University, England, UK

Insects are the most diverse class of animals in the world, underpinning natural, agricultural, and horticultural ecosystems. Even outside of ecosystem functions, insects have inspired music, art, video games and film. In the face of biodiversity loss, climate crisis, and social inequalities there is an urgent need for entomologists.

At present there is only anecdotal evidence suggesting a lack of entomological teaching at Higher Education Institutes (HEI's) in the UK (UK). Here I present a thorough investigation into the presence of "invertebrate modules" and "insect modules" in UK HEI's and the top universities around the world for the 2022/23 academic year. Curriculums investigated were from the following scientific disciplines: Agriculture, Biochemistry, Biology, Biodiversity, Conservation, Ecology, Forestry, Horticulture, Natural sciences, Plant Sciences and Zoology.

For the UK, 8899 modules across 329 undergraduate and postgraduate curriculums at 80 HEI's were investigated. Most curriculums had no insect or invertebrate modules, a dire situation for UK entomology.

To determine where the UK sat on the world stage, 9016 modules across 249 curriculums at 70 of the top Universities in Europe (excluding the UK), North America, South America, Africa, Oceania, and Asia were compared to the top UK universities. The UK had the worst representation of insect modules at both undergraduate and postgraduate levels. The top African and Asian universities had higher than global average representations of undergraduate insect modules.

Seven recommendations for increasing entomological teaching at HEI's are provided so students can receive a more comprehensive education and ensure there will be enough people with insect knowledge who can contribute to the next generation of insect inspired scientific research, conservation, technology, and art.

Helen Leggett, Dr Kelly Edmunds, Jean-Charles de Coriolis and Jaime Duarte-Niemen

T33 – Lincoln Medical School

Building on a beetle legacy to inspire scientists of the future

University of East Anglia, UK

In 2021, during a reorganisation of research facilities at the University of East Anglia (UEA), dozens of boxes containing specimens of Rain beetles, *Pterostichus melanarius* in vials of ethanol were found. These specimens had been in freezer storage for more than two decades after being collected by the late Prof Godfrey Hewitt in the 1990s. There were 5250 specimens in total, all with collection notes. With the research group involved in their collection no longer known, their intended use is a total mystery but undeterred, a team from the UEA have embarked on an ambitious project to use these samples to inspire and educate scientists of the future.

During the summer of 2022, the team began cataloguing and digitising the samples as part of the 'It's Raining Beetles' Citizen Science project. This project will educate members of the public to use ImageJ software to take morphometric measurements of the beetles, with the aim of answering a variety of hypothesis driven research questions, such as the differences between the sexes, collection sites and dates, as well as the reliability of citizen science data collection. With education at its core, this project is ambitious in both its scale and scope. The project team so far has already included school students on Nuffield Studentships, undergraduate and postgraduate students, as well as members of Faculty. The official launch of 'It's Raining Beetles' will take place in February 2023 at the Norwich Science Festival. Following this, the project plans include additional fieldwork and molecular work to address further questions that will be combined with embedding the project within taught undergraduate modules, final-year research projects, and creating opportunities for students to gain research experience during summer breaks.

This talk presents the development and findings of this unique project so far. We welcome any feedback, especially if you have information about Prof Hewitt's original research plans for these beetles or have a research question you think this incredible beetle collection and/or project could help answer.

Naoki Matsuda[1], Takashi Kanbe[2], Jun Endo[3], Shin-ichi Akimoto[2] and Hideharu Numata[3]

T34 Online – Lincoln Medical School

Transgenerational seasonal timer as an adaptation to spring short days in the pea aphid

1. National Institute for Basic Biology, Japan
2. Hokkaido University, Japan
3. Kyoto University, Japan

Most aphid species adapt to seasonal environmental changes, by switching from viviparous parthenogenesis in spring and summer to oviparous sexual reproduction in autumn. Sexual generations are induced by short days. Under short-day conditions in the laboratory, however, the appearance of sexual morphs is suppressed by a transgenerational seasonal timer after hatching of stem mothers from sexually produced eggs.

In the present study, we examined whether the seasonal timer measures the number of days or the number of generations from hatching in the pea aphid, *Acyrthosiphon pisum*. To distinguish the number of days and generations, we reared two lineages in which either early-born or late-born progenies were allowed to produce the next

generation. The ability to produce sexual morphs was completely suppressed in stem mothers, and gradually recovered over successive generations produced during a few months. It was shown that the duration of the seasonal timer depended on the number of days from hatching, but not on the number of generations from hatching, by comparing the duration until the recovery of the ability to produce sexual morphs between early-born and late-born lineages. Moreover, the duration of the seasonal timer depended on temperature, but not on photoperiod.

Then we tested a hypothesis that the seasonal timer suppresses an unseasonal appearance of sexual generations which is induced by short days in spring, by rearing *A. pisum* under natural photoperiods and temperatures. Stem mothers with the operative seasonal timer produced only parthenogenetic progenies in spring. In contrast, parthenogenetic females with the expired seasonal timer produced sexual progenies besides parthenogenetic ones in spring. These results show that photoperiods in spring induce sexual morph production as those in autumn, and the seasonal timer suppresses unseasonal appearance of sexual generations in spring.

Eleanor Bladon[1], Sonia Pascoal[1], Nancy Bird[2], Rahia Mashoodh[1] and Rebecca M. Kilner[1]

T35 – Lincoln Medical School

The evolutionary demise of a social interaction: social partners differ in the rate at which interacting phenotypes are lost

1. University of Cambridge, UK
2. UCL, UK

Phenotypic plasticity enables animals to flexibly adjust their behaviour to their social environment – sometimes through the expression of adaptive traits that have not been exhibited for several generations. We investigated how long social adaptations can usefully persist when they are not routinely expressed by using experimental evolution to document the loss of social traits associated with the supply and demand of parental care. Populations of burying beetles *Nicrophorus vespilloides* were evolved over 48 generations - in 'Full Care' populations traits associated with the supply and demand of care were expressed, whereas in 'No Care' populations we prevented expression of these traits experimentally. We then revived trait expression in the No Care populations at generations 24, 43 and 48 by allowing parents to supply post-hatching care, and compared these social traits with those expressed by the Full Care populations. We found that offspring demands for care decayed in the No Care populations more rapidly than a parent's capacity to supply care. Furthermore, male care decayed faster than female care. We suggest that this reflects differences in the strength of selection on offspring, males and females, for the expression of alternative traits which are more likely to enhance fitness when post-hatching care is disrupted.

Carita Lindstedt and Raphael Ritter

T36 Online – Lincoln Medical School

Group living and cooperation within a group in a haplodiploid pine sawflies

University of Helsinki, Finland

Group members can benefit from the dilution of predation risk or predator confusion and cooperative joint effort in antipredator defence such as deterring the predator with defensive secretions. Many of these cooperative defence strategies are based on public goods i.e. individually costly acts that benefits all the group members. However, public goods are susceptible to exploitation and individual's contribution to cooperative act can depend on the group size. We investigated these aspects experimentally with haplodiploid semisocial *Diprion pini* and *Neodiprion sertifer* pine sawfly larvae that perform cooperative chemical group defence. The benefit of this system is that there is genetic and phenotypic variation in the cooperative behaviour and relatedness among cooperating individuals. We can also manipulate the levels of cooperativeness as well as social and ecological environments experimentally, and measure responses in reproductive and life-history traits. In factorial rearing experiments and behavioral assays, we tested investment to costly cooperative defense and its correlated fitness effects under different larval group sizes. We found that cooperativeness increases survival of the group against predators, but individual's contribution to cooperative defence also depends on the group size as fewer individuals contribute to cooperative defence in larger groups. We also show that in the wild populations individual's defensive behaviour depends on both sex-ratio and group size.

Inon Scharf, Adi Bar and Tomer Gilad
T37 Online – Lincoln Medical School

Desert ants learn to solve mazes and avoid falling into pitfall traps on their way to a food reward

Tel Aviv University, School of Zoology, Israel

Desert ants (*Cataglyphis spp.*) are excellent navigators, which use a variety of tools when searching for food and returning to their nest. Such ants are solitary foragers, so each worker navigates and learns the path on its own. We conducted a series of lab experiments on the desert ant *Cataglyphis niger* to examine learning in the context of foraging. We demonstrate that desert ants solve a maze faster with accumulating experience. Such experience also assisted trained colonies when competing against naïve colonies, which were not trained to solve the same maze. However, larger untrained colonies still solved the maze faster and reached the food faster than smaller trained colonies, probably because larger colonies possessed more foragers. Spatial learning is not the only mechanism responsible for fast maze solving, because as ants learn that food exists nearby, their searching motivation increases. We conducted a similar experiment with pitfall traps on the way to the food reward instead of a maze. Ant workers discovered food more slowly when pits were in their path. The presence of pits also led to longer tracks by ants and slower movement. However, with experience, the ants fell into such pits less often and reached the food more quickly. In short, these experiments exemplify how obstacles (a maze or pitfall traps) delay the ant arrival at the food and how ants overcome such obstacles with experience.

Sophie Van Meyel[1] and Joël Meunier[2]
T38 – Lincoln Medical School

Cost and benefits of sibling deprivation during family life in adult earwigs

1. Department of Forest Sciences, University of Helsinki, Finland
2. Insect Biology Research Institute, University of Tours, France

The benefits of parental care are commonly considered essential in the evolution of family life. However, recent studies show that sibling interactions can also confer important benefits to juveniles. In this study, we tested a new hypothesis suggesting that the need for juveniles to access sibling interactions may encourage juveniles to remain in a family group, thereby consolidating the early stages of family life evolution when parental care is facultative. We used the European earwig, a species with family life but facultative maternal care, and set up three treatments where juveniles have grown up either alone, with siblings, or with siblings and their mother. Then, we quantified the effects of these treatments on the development, morphology, and four fitness-related behaviours of the resulting adults. We found that isolated juveniles reached adulthood more quickly and that these adults were overall larger but showed an impaired aggregation behaviour when compared to juveniles raised together with siblings or with siblings and their mother. By contrast, sibling deprivation did not affect offspring survival, male forceps length (an ornament involved in reproductive success), and three other behaviours in adults (boldness, general activity, and exploration). All these results were independent of adult sex, although females overall reached adulthood earlier and were larger than males. Overall, our findings suggest that the potential benefits of sibling interactions measured in this study play a minor role in the maintenance of earwig family life. They also emphasize the need to study the evolutionary drivers of family life in species where all members can switch from family to solitary life - a scenario that probably prevailed in the early evolution of sociality.

Symposium – Ecosystem services and disservices II
Thurs. 9.00-10.00
Venue: Isaac Newton Building

Nalini Puniamoorthy
(Plenary Speaker)

Insect reproduction: Understanding evolutionary diversification and seeking sustainable solutions

See details on page 19

Split talks from 10am onwards – talks will be taking place at the same time in different spaces –
- **Isaac Newton Building**
- **Lincoln Medical School (LMS005 ground floor)**

Sean Schoville
T39 Online – Isaac Newton Building

Has past climate change affected cold-specialized species differentially through space and time?

TBC

Following their discovery in 1913, ice crawlers (*Grylloblattodea*: *Grylloblattidae*: *Gryllobatta*) garnered considerable attention among entomologists due to their cold-specialization and uncertain placement in the insect tree of life. Ice crawlers forage nocturnally at freezing conditions (0˚C), typically on snow, and are highly distinctive (placed within their own insect order), but are part of a large Neopteran radiation that took place after the Permian–Triassic mass extinction event (~250 million years ago). Much remains to be learned about their basic biology, and specimens remain exceedingly rare in entomological collections. The goal of this paper was to improve our understanding of their biodiversity and evolutionary relationships in North America, and how that was shaped by past climate variation. By developing a large genetic dataset for a set of ice crawler samples spanning their known geographical range, we show that there is substantial undescribed, cryptic species diversity and very high endemism at local geographical scales. Using spatial reconstructions of ancestral ranges based on the geographic and genetic data, we estimate that species retreated to nearby, highly localized refugia at the edge of ice sheets during glacial episodes, and we identify the location of these glacial climate refugia with greater detail than previous work on highly-dispersing plants and animals. Finally, using a modeling approach to assess when ice crawler species were formed through time, we show that, surprisingly, dry climatic periods during the Miocene (rather than cold, glacial conditions in the Pleistocene) caused ice crawlers to diversify. This suggests that for cold-specialized insects such as ice crawlers, unfavorable dry conditions may have led to long periods of isolation and allowed for evolutionary lineages to proliferate.

Rosa Menendez[1], Geoff B. Monteith[2], Penny van Oosterzee[3] and Noel D. Preece[3]
T40 – Isaac Newton Building

Identifying the best reforestation method for restoring dung beetle biodiversity and function in the Australian Wet Tropics

1. Lancaster Environment Centre, Lancaster University, UK
2. Queensland Museum, Australia
3. BIOME5, Australia

Tropical rainforests support more than half of global biodiversity, making them of high conservation priority. However, continuous loss and fragmentation of these habitats has led us to the point where we can no longer rely entirely on intact primary rainforest to safeguard tropical, and indeed global, diversity. Recent studies suggest that all existing types of human-managed forests hold reduced biodiversity compared with primary undisturbed rainforest. For some areas that leaves reforestation as the only solution to prevent diversity loss. Unfortunately, we know very little about which reforestation methods will deliver the highest biodiversity in tropical regions. Here, we present results from the early stages of a a long-term rainforest restoration project on how dung beetle communities and their ecosystem functions (dung removal and secondary seed dispersal) responded to different reforestation methods in the Australian Wet Tropics. We compare experimental plots planted with different diversities of native trees to pasture plots, the starting point, and to rainforest plots, the desired end point of restoration. After only 6 years, 10 rainforest specialist dung beetles have colonised the experimental plots. Restoration plots have a higher dung beetle abundance than pasture plots and dung beetle diversity was also higher in plots planted with a higher diversity of native

trees. There were no significant differences in dung removal between treatments, but seed dispersal was higher in the restoration plots that were planted with a high diversity of native trees. These results suggest that environmental conditions in the planting plots are likely progressing towards those found in the rainforest. However, dung beetle diversity, abundance, and function in the experimental plots are not yet to the levels observed in the adjacent rainforest plots. In conclusion, we found evidence for a positive, although moderate, recovery of dung beetle communities and their associated functions. Plots with high diversity of trees represent the best restoration option in the early stages of dung beetle re-colonisation.

Rajath Siddaganga[1], Shrihari Hegde[2], Syed Shoaib Qasim[3], Aswathy Nair[1], Axel Brockmann[1] and Smitha Krishnan[2]

T41 Online – Isaac Newton Building

Life of giant honey bees in a tropical megacity

1. National Centre for Biological Sciences - Tata Institute of Fundamental Research, India
2. Bioversity International, Bangalore, India
3. Department of Zoology, Bangalore University, Bangalore, India

The giant honey bee, *Apis dorsata*, is one of the most important pollinators in India. *A. dorsata* colonies naturally prefer big trees or rock cliffs as nesting sites. In crowded cities, tall human-made structures such as water towers, roof overhangs and balconies of high-rise buildings are also attractive. Due to their threatening defensive behaviour, it has become a common procedure to remove *A. dorsata* colonies that nest in places accessed by humans. Currently, very little is known about the colony density, biology, ecology and management of this tropical pollinator.

We recently started a series of studies to explore the life of *A. dorsata* colonies in the city of Bangalore. Our aims were to (1.) estimate *A. dorsata* colony density within Bangalore city (2.) determine the annual colony life cycle (3.) estimate the magnitude of colony losses due to removal and (4.) develop outreach strategies to reduce the number of destructive colony removals.

We used a grid-wise (2.25 Km2 grids) sampling method to evaluate the density of *Apis dorsata* colonies in Bangalore. About 10% of these grids were randomly selected and surveyed. We found that the density of colonies was 1.81(±1.83) colonies per square kilometre. The preferred nesting sites seemed to be tall buildings and trees (46% and 47% respectively) as opposed to other sites such as water tanks, stone cliffs etc., which had around 2% of colonies per nesting substrate. However, the low preference for the latter could also be that these nesting substrates were fewer.

Our annual life cycle study of *A. dorsata* colonies (N=191) in residential buildings showed that most colonies stayed only for two to three months. In addition, we observed that *A. dorsata* colony numbers were lowest during the monsoon months (July to September). These findings suggest two distinct types of migration in this species: (I.) a seasonal migration, which is an innate behaviour regulated by hormones similar to the long-range migration of butterflies (II.) a "within season" nest relocation, which is induced by declining food resources, deteriorating conditions of the nesting site and other detrimental factors. We also observed reproductive swarming of colonies in March and April after the major flowering season as well as in November and December.

To estimate the magnitude of human-bee conflicts, due to their nesting on high-rise buildings, we are developing multiple citizen science projects. An online questionnaire survey was administered to the residents of apartment buildings to assess methods used to manage the colonies. The survey indicated that colonies were primarily removed by beekeepers (61.53%) and pest-management companies (35.89%) with only a few left undisturbed (2.56%). We are also in the process of deploying a smartphone app, which we expect to have a larger reach in monitoring *A. dorsata* nesting sites in and around Bangalore. We hope this will also help us better understand their annual colony life cycle and migration pattern. Our current study provides baseline information on an important wild pollinator that urgently needs to be conserved.

Linzi Jay Thompson[1], Alison O'Reilly[1], Jane Stout[2] and Dara Stanley[1]

T42 – Isaac Newton Building

Pesticide effects on bumblebee queens

1. University College Dublin, Dublin, Ireland
2. Trinity College, Dublin, Ireland

Bumblebee queens receive little attention in understanding how pesticides may affect them. Queens are responsible for founding colonies and the production of new queens towards the end of the colonies life, making them important for ensuring stable populations with genetic diversity. During this time, they may be exposed to a variety of pesticides

when foraging in the landscape and preparing for diapause and colony founding. In this experiment we researched how a field realistic dose of either the fungicide prothioconazole, the insecticide acetamiprid or a combination of both effected their ability to survive a 12 week artificial diapause and their survival and colony development for 25 weeks, post diapause. Here, we find that acetamiprid can reduce longevity of bumblebee queens and therefore may have serious consequences for populations over time. Bumblebee queens need to be considered in environmental risk assessment due to their important role in reproduction and the serious consequences which could occur if they are harmed by exposure to pesticides.

Will Nash[1], Adam Ciezarek[1], Angela Man[1], Seanna McTaggart[1], Wilfried Haerty[1], Vanessa Huml[2], Jon Ellis[2], Mairi Knight[2], Ryan Brock[3] and Andrew Bourke[3]

T43 – Isaac Newton Building

Genome wide signatures of range expansion in a key UK pollinator

1. The Earlham Institute, UK
2. University of Plymouth, UK
3. The University of East Anglia, UK

The current ecological crisis is driving increased levels of extinction in many taxa, with this trend being expressed particularly strongly in insects. Given this great threat to biodiversity, it is interesting to consider species that are thriving in conditions that challenge others. First recorded in the UK in 2001, the Tree Bumblebee (*Bombus hypnorum*), has since rapidly colonised the UK and Ireland, and is now one of the UK's most abundant bumblebee pollinators. Using a population dataset composed of 285 individuals and spanning the spatial (continental Europe, UK) and chronological history (2002-2015) of this range expansion, we build from previous work and are investigating the origin, population structure, and genome-wide divergence within the European population of the Tree Bumblebee. We are specifically focusing on the genomic signatures associated with the rapid range expansion of this species and their implications. We report a previously undiscovered history of population bottlenecks within the UK and European populations, low levels of divergence, and provide insights into population differentiation within the UK.

Eugenia Fezza[1], Joe M. Roberts[1], Tom W. Pope[1], Toby J. A. Bruce[2], Lael E. Walsh[3] and Michael T. Gaffney[3]

T44 Online – Isaac Newton Building

Catch me if you can' – improving Vine Weevil, *Otiorhynchus sulcatus F.* (Coleoptera: Curculionidae), Monitoring Tool Design

1. Harper Adams University, UK
2. Keel University, UK
3. Teagasc

The black vine weevil (*Otiorhynchus sulcatus*) is one of the most economically important pests of soft-fruit and ornamental crops worldwide. Controlling the black vine weevil can be challenging as growers currently lack effective monitoring systems to determine their presence within crops. To develop an effective and reliable monitoring system for adult vine weevil, this study investigated, under laboratory condition, the influence of a number of characteristics relating to the design of monitoring tool (e.g., colour, height and entrance position) that have been shown to influence the number of adult weevils caught. Results indicated that vine weevil adults in a simple two-choice experiment, preferentially entered in monitoring tools that were black rather than those that were white. Vine weevils provided with a range of coloured refuges (blue, green, red and yellow) in addition to black and white refuges showed to enter black or blue monitoring tools than those that were green, red, yellow or white. Furthermore, vine weevil adults entered in monitoring tools containing entrances at the base than those with entrances located on the side or top, and chose taller monitoring tools compared to shorter monitoring tools.
Trap design is shown here to play a role in determining the response of adult weevils to monitoring tools. Understanding the factors that affect weevil responses to monitoring tool is an essential step in developing novel designs with improved performance for monitoring purposes for use within an IPM programme.

Elizabeth Duncan[1], Kane Yoon[1], Rosie Knapp[1], Anthony Bracuti[1] and Mackenzie Lovegrove[2]

T45 – Isaac Newton Building

Same, same but different: How does one genome give rise to different phenotypes?

1. University of Leeds, England, UK
2. University of Otago, New Zealand

All animals respond to their environment, but some have the remarkable ability to change their development, biology, behaviour and reproduction in response to an environmental cue – a phenomenon known as phenotypic plasticity. Phenotypic plasticity is found throughout the animal kingdom, but the most striking and well-studied examples are found in insects. We aim to understand the consequences and limits of plasticity; why are some traits or phenotypes plastic and some are not? To address this, we need to know how phenotypic plasticity works. How do insects sense the environmental cues? How are environmental cues transmitted to the affected tissues? And how does this lead to a stable change in their biology? We are using two examples of reproductive phenotypic plasticity to address these questions, the honeybee *Apis mellifera* and the pea aphid *Acyrthosiphon pisum*. Honeybee workers don't usually reproduce, but if the queen is lost from the colony and the workers cannot replace her, workers will sense this environmental cue and their ovaries undergo complete remodelling to produce eggs. Aphids respond to day length and temperature, reproducing asexually in summer and sexually in winter. These two different modes of reproduction are associated with marked differences in ovarian morphology, developmental time and developmental processes. Here I will discuss our recent work linking environmental cues with the plasticity in these species, the similarities and differences in plasticity between these two species and the possible real-world implications for the control of agricultural pests and preservation of pollination services.

Emma Aspin[1], Ian Hardy[2], Mike Keller[3] and Maryam Yazdani[4]

T46 Online – Isaac Newton Building

Saving the wine one parasitoid at a time: analysis of *Goniozus jacintae* as a potential biocontrol agent of the Light Brown Apple Moth

1. University of Nottingham/University of Adelaide, UK/Australia
2. University of Helsinki, Finland
3. University of Adelaide, Australia
4. CSIRO, Australia

Before releasing a biocontrol agent into the field, we should first understand how it interacts with its target and other environmental components, including competitors.

We conducted an array of experiments to explore the behavioural ecology of the parasitoid wasp *Goniozus jacintae Farrugia* (Hymenoptera: *Bethylidae*), to develop the understanding of the parasitoid as a potential biocontrol agent for the light brown apple moth (LBAM), *Epiphyas postvittana* (Walker) (Lepidoptera: *Tortricidae*), a pest of grapevine, *Vitis vinifera L.* (*Vitaceae*), and other crops in Australia. We aimed to answer the following questions:
How does the parasitoid find a host? A wind tunnel experiment found host-stage dependent foraging behaviour in *G. jacintae*: timing, frequency, and duration of foraging behaviours of *G. jacintae* varied among host instars.

How does the parasitoid utilise selected hosts? We observed the egg laying behaviour of *G. jacintae* when presented with different sized hosts. Average clutch size increased with bigger host instars.
How does the parasitoid select its host when faced with competition? We tested the host discrimination ability of *G. jacintae* when presented with hosts of varying quality: unparasitised or parasitised by an allospecific. Discrimination ability of *G. jacintae* was influenced by both the order in which the different hosts types were presented and time since parasitisation.

Jordan Cuff[1], James J.N. Kitson[1], Fredric M. Windsor[1], Gaëtan Semandi-Corda[2] , Samantha M. Cook[2], S. Aifionn Evans[1], I. Angel Porteous[1], Julia Quiñonez[1], Maximillian P.T.G. Tercel[3] and Darren M. Evans[1]

T47 – Isaac Newton Building

Stacking ecosystem services in ecological networks with molecular tools to optimise agricultural habitat management

1. Newcastle University, UK
2. Rothamsted Research, UK
3. Cardiff University, UK

Achieving global food security for a rapidly growing human population is among the greatest challenges of the 21st century. Conventional agricultural practices are environmentally catastrophic and increasingly ineffective, with massive yield losses attributed to insect pests. Integrated pest management using conservation biocontrol offers a sustainable alternative, but it can lack efficacy, especially if land management poorly balances the provision of ecosystem services (e.g., pollination, biocontrol) and disservices (e.g., crop herbivory). Semi-natural habitat margins are a vital reservoir of both pest and beneficial arthropods into crops, but this provision depends on the structure and type of habitat bordering crop fields. To optimise ecosystem service provision, we must first understand the frequency and identity of species interactions associated with the different semi-natural habitats surrounding our crops.

We are constructing ecological networks using both traditional and molecular approaches to assess ecosystem service provision within and between semi-natural habitats and oilseed rape. We carried out field surveys across 20 oilseed rape farm sites in northeast and southeast England in April-September 2021. Fields with grassland, hedgerow and woodland margins were surveyed, and interactions between plants, herbivores, flower visitors, parasitoids and leaf miners recorded in the field. Individual invertebrates and bulk community samples were collected for DNA metabarcoding-based biomonitoring and network construction. I will present our first findings from these data and the pitfalls and promises of merging traditional and DNA-based data for constructing highly resolved ecological networks. Using these data, we will assess ecosystem service provision over space and time and identify optimal semi-natural habitat margins.

Michael Thomas Smith

T48 – Lincoln Medical School

Tracking the orientation and 3d path of flying insects

University of Sheffield, UK

Tracking the location and orientation of insects in the landscape at the meso-scale [<40m] gives us access to pose/location data key to learning and cognitive modelling, for example revealing where insects are looking. It allows exploration of the responses to landscape changes and enables researchers to learn about the ontogeny of features such as learning flights or foraging behaviour. For other researchers, being able to automate the monitoring of pollinator behaviour (tracking which flowers are visited more / less) allows the scaling of experiments.

Our previous work performed real-time tracking of insects in the field using retroreflective tags and a system of cameras and flashes. These have since been improved to make them more robust and easy to use. In our latest work we have added three important components to widen their range of applications:
- 3d (probabilistic) flight path reconstruction.
- Individually identifiable tags: Using colour retroreflectors.
- Inferring orientation: Using multi-colour tags that allow the orientation of the insect to be inferred from the tag colour.

We demonstrate the system by recording and exploring the structure of learning flights in bumblebees (*Bombus terrestris*).

In summary: This system provides a low-cost platform for tracking behaviour at the meso-scale: opening up a window on to insect behaviour largely hidden from us.

Charlie Woodrow[1], Benjamin Bluck[2], Juan Sebastian Ulloa[3], Fabio Sarria-S[4] and Fernando Montealegre-Z[1]
T49 – Lincoln Medical School

The Scuba Diving Orthopteran: A secondary function of the katydid ear canal in a novel anti-predator behaviour

1. University of Lincoln, UK
2. University of Southampton, UK
3. Alexander von Humboldt Biological Resources Research Institute, Colombia
4. University of Buenos Aires, Argentina

Katydids (Orthoptera) possess sophisticated ears in their foretibia to detect the sounds of con-specifics and predators. The main entry of sound into the ear is via the acoustic trachea, or ear canal, that runs through the forelegs from a specialised spiracle in the prothorax. In one neotropical katydid, of the genus Ragoniella, behavioural observations suggested that the ear canal has a secondary function in holding oxygen for respiration during a previously undocumented aquatic anti-predator behaviour. Here, we describe this behaviour in the field, and carry out ex-situ experiments to investigate the effects of water volume and temperature on submergence times. In addition, we repeat the experiments with the ear canal blocked, to investigate whether the air stored in the ear canal is beneficial to this behaviour. We demonstrate that submergence times decrease with decreased water volume, increased water temperatures, and when the ear canal is blocked. These findings are discussed in the context of diving behaviours across insects.

Clara Montgomery[1], Jozsef Vuts[2], Christine Woodcock[2], David Withall[2], Michael Birkett[2], John Pickett[3] and Daniel Robert[4]
T50 – Lincoln Medical School

Do flowers dream of electric bees? The role of electric charge in plant-pollinator communication

1. Harper Adams University, UK
2. Rothamsted Research, UK
3. Cardiff University, UK
4. University of Bristol, UK

Many insects, including bees, are electrically charged in nature. In bumblebees, this electric charge enhances pollen transfer between plant and pollinator, and allows the bee to sense electric cues provided by flowers. The electric charge of flying bumblebees is itself affected by environmental variables such as relative humidity. In this talk I will outline methods for measuring the electric charge on insects, and show how electric charge may affect plant-pollinator communication. Many flowering plants use scent comprising of volatile organic compounds (VOCs) to attract potential pollinators. The timing of VOC emission by flowering plants often coincides with pollinator foraging activity. VOC emission is often considered to be paced by environmental variables, such as light intensity, and/or by circadian rhythmicity, but some VOC emissions can also be induced by mechanical stimuli such as herbivory. The question arises as to what extent pollinating insects provide information about their presence, in keeping with their long co-evolution with flowering plants. We tested the hypothesis that the electric charge of foraging bumblebees (*Bombus terrestris*) increases the floral volatile emissions of bee pollinated plants. We investigated the change in VOC emissions of *Petunia integrifolia* exposed to the electric charge typical of foraging bumblebees. *P. integrifolia* slightly increases its emissions of a behaviourally and physiologically active compound in response to visits by foraging bumblebees, presenting on average 121 pC of electric charge. We show that for *P. integrifolia*, strong artificial electrical stimulation (600-700 pC) promotes increased volatile emissions, but this is not found when using weaker electrical charges more representative of flying pollinators (100 pC). This study opens a new area of research whereby the electrical charge of flying insects may provide information to plants on the presence and phenology of their pollinators. As a form of electroreception, this sensory process would bear adaptive value, enabling plants to better ensure that their attractive chemical messages are released when a potential recipient is present.

Isobel Ronai[1], Hannah Pooley[2], David Emery[2], Danielle Tufts[3] and Maria Diuk-Wasser[4]
T51 Online – Lincoln Medical School

Developing control strategies for the highly invasive Asian longhorned tick to prevent tick-borne diseases

1. Harvard University, USA
2. University of Sydney (Australia)
3. Columbia University/University of Pittsburgh, USA
4. Columbia University, USA

The highly invasive Asian longhorned tick (*Haemaphysalis longicornis*) is a major threat to human and animal health, as a vector of emerging infectious diseases in the United States and the Asia-Pacific. In China this tick species transmits a virus that causes a haemorrhagic disease in humans with a fatality rate up to 30%. The Asian longhorned tick is also implicated in transmitting the protozoan *Theileria orientalis* and causing oriental theileriosis disease in cattle, costing the livestock industry millions of dollars annually. Worryingly, no effective control strategy for the Asian longhorned tick exists and it has established invasive populations in Australia and the USA, where its range has rapidly expanded to 18 states. The fundamental biology of the Asian longhorned tick is not well understood, which impedes the development of novel control strategies for this highly invasive tick species.

Field studies of the Asian longhorned tick in the USA suggested this tick species was avoiding small mammalian native hosts, such as the white-footed mouse (*Peromyscus leucopus*), which is the primary reservoir for the causative agent of Lyme disease (*Borrelia burgdorferi*). In the laboratory we placed unfed larval ticks on the white-footed mouse, 65% of the larvae moved off the host within a short period of time and none attached. We then developed a laboratory behavioural assay to quantify the interaction of the Asian longhorned tick with mammalian host species. The Asian longhorned tick larvae were less likely to enter the hair of the white-footed mouse and humans compared to the hair of domestic cats, domestic dogs, and white-tailed deer. Our study identifies a tick-host hair interaction behaviour, which can be quantified in a laboratory assay to predict tick-host associations and provides biological insights for the development of tick repellents. The microbiota of ticks (including vertebrate pathogens) is a key determinant of tick survival and fitness. However, the impact of vertebrate pathogens on the Asian longhorned tick is not well understood. We are currently investigating how pathogenic *Theileria orientalis* effects the fitness of Asian longhorned ticks (larvae, nymphs and adults) and characterising the microbiota. A better understanding of Asian longhorned tick fitness, survival and microbiota will inform the development of novel tick and tick-borne disease control strategies.

Meghan Barrett[1], Shaphan Yong Chia[2], Bob Fischer[3] and Jeffery K. Tomberlin[4]
T52 Online – Lincoln Medical School

*REVISED ABSTRACT SUBMISSION: Farmed Black Soldier Fly, *Hermetia illucens* (Diptera: Stratiomyidae), Welfare Considerations: A Model for the Insects as Food and Feed Industry

1. California State University Dominguez Hills, Rethink Priorities, USA
2. Wageningen University, Netherlands
3. Texas State University, Rethink Priorities, USA
4. Texas A & M, USA

Insect agriculture is being actively explored across the globe, with uses for insects as livestock feed; fishmeal replacement; biodiesel; human, animal, and food waste management; and even sustainable human protein. In the next decade, the insects-as-food-and-feed (IAFF) industry is expected to grow, producing up to 500,000 metric tons of insects per year – representing an increase from 1 trillion to nearly 8 trillion individuals farmed each year. Given that insects are about to become one of the largest groups of animal livestock, there have been calls for scientific guidance on species-specific welfare considerations by numerous producers, academics, and industry societies. Using the black soldier fly (BSF, *Hermetia illucens* (Diptera: Stratiomyidae)) as a model, we conducted a species-specific review of industry-relevant welfare concerns that could be used to improve BSF welfare in the IAFF industry. We review factors that relate to BSF welfare in commercial rearing facilities, including: diseases/parasites, abiotic conditions (temperature, humidity/moisture, substrate aeration, light, pupation substrates, and adult spatial needs), adult and larval nutritional considerations, injury and crowding, handling-associated stress, selective breeding and genetic modification, environmental contaminants, and slaughter methods. We discuss the most pressing welfare concerns for the industry, recommendations for altering the conditions that give rise to them, and suggestions for future research directions that would lend valuable insights to BSF welfare. We conclude by

identifying vital partnerships (across disciplinary, or academic-industry, boundaries) that might lead to the fastest gains in our understanding of key welfare concerns for insects. While the discussion will be BSF-centric, the core topic of animal welfare applies to all insect models currently, or in the future, produced as food and feed.

Frank Mechan, Lisa J. Reimer, Nicola Fletcher and Philip J. McCall
T53 – Lincoln Medical School

Behaviour of host-seeking *An. gambiae* around damaged pyrethroid-PBO bed nets: implications of hole location of bloodfeeding and bioefficacy

Liverpool School of Tropical Medicine, UK

Long-lasting Insecticidal nets (LLINs) protect against the bites of malaria transmitting mosquitoes yet accumulate physical damage with operational use. The impact of this damage on bloodfeeding and bioefficacy is not well described. Existing literature indicates the behaviour of *An. gambiae* is strongly focused on the top of the net, but it is not well established if holes in the top of the net are associated with an increased risk of bloodfeeding. This knowledge gap is further complicated by the widespread emergence of pyrethroid-resistance *An. gambiae* and the development of net designs that contain the synergist piperonyl butoxide (PBO) to restore efficacy against resistant mosquitoes.

To evaluate the impact of hole location on protective effect, behavioural experiments with free-flying pyrethroid-resistant *An. gambiae* around human-occupied holed nets were conducted. Volunteers lay below a net in a climate-controlled testing room (27°C ± 2°C, 80% relative humidity), with 20 non-bloodfed 3-5 day old *An. gambiae* females released and recollected after 60 minutes. Assays were performed for nets with one of three categories of damage: completely intact, one 15cm diameter hole in the centre of the side, one 15cm diameter hole in the centre of the top. Mosquitoes were assessed for bloodfed-status (fed or unfed), 1hr knockdown, and 24hr mortality. All damage categories were evaluated for both a pyrethroid-only net ("Olyset") and the equivalent pyrethroid-PBO net ("Olyset Plus).

There was no difference in bloodfeeding outcomes between the pyrethroid-only and pyrethroid-PBO net for any hole location (top: p=0.076, side: p=0.446, no hole: p=1.000). Across both net types assessed, bloodfeeding success was far greater when the hole was on the top compared to the side (24.74% vs 2.51%)(Olyset Plus: OR= 10.71, 95% CI=5.95-15.47, p<0.001). No mosquitoes bloodfed when there were no holes in the net. Bioefficacy outcomes were greatly improved with the addition of PBO, for both 1hr knockdown (37.88% vs 11.80%, p<0.001) and 24hr mortality (36.30% vs 8.68%, P<0.001). The proportion of mosquitoes that both bloodfed and survived the assay was very low for Olyset Plus regardless of hole location, with 96.1% (95% CI: 91.2-100) dead after 24 hours.

A hole in the top of a bed net was observed to result in tenfold greater bloodfeeding compared to an equivalent hole in the side. Currently, WHO guidelines on assessing the serviceability of nets sampled from the field do not consider hole location yet these findings indicate that bloodfeeding risk is highly variable between the top and the side. There is a pressing need for further work to investigate the relationship between hole location and protective outcomes to develop an appropriate weighting in serviceability assessments. Additionally, we observed no difference in bloodfeeding success between nets with and without PBO, consistent with previous literature indicating that improved bioefficacy does not necessarily provide improved personal protection once the net is damaged.

Julien Devilliers
T54 – Lincoln Medical School

Evolution of the sensory system and emergence of blood feeding behaviour in Diptera

University of Leicester, UK

Blood feeding behaviour (hematophagy) has evolved multiple times throughout the Diptera lineage including mosquitoes (*Culicidae*), drain flies (*Psychodidae*), tsetse flies (*Glossinidae*) and horseflies (*Tabanidae*). While the variety of biting appendages is well described, the emergence of such specific behaviour remains unclear. Hematophagy requires an enzymatic machinery, specific to the host, to isolate and detoxify blood. The crucial choice of the correct host is made using a combination of multiple sensorial cues including vision, olfaction, audition, thermosensation, CO2 detection, chemosensation and taste. Host availability in the environment varies through time and space with a strong impact on individual fitness, highlighting the need of high adaptative capacities to an inconstant environment for blood feeding species. These adaptative

capacities are reflected in diversification of sensory gene families. To investigate the expansion and losses of sensory-related gene families, here we focus on mosquitoes (vector of various human diseases) and drain flies as hematophagous groups, as well as related non-hematophagous families, all of which are members of the most basal group in Diptera. Whole proteomes were used to infer phylogenetic relationships. We define gene families of photosensitive pigments (opsins), olfactory receptors, odorant binding proteins, gustatory receptors, mechanosensitive proteins (PIEZO channels), heat sensitive proteins (TRP channels) and ionotropic receptors, and infer their history of duplications and losses. Expansion of opsin genes through mosquitoes, as well as other gene families tend to support the link between hematophagy and sensory gene diversification. Lastly, adaption to a specific host is likely to tune the protein sequence of the sensory system genes through selection. Thus, we will aim to test for specific site selection in the sequences.

Paul Brett[1], Dr. Kristene Gedye[1], Associate Professor Kevin Lawrence[1], Professor Paul Kenyon[2] and Professor William Pomroy[1]
T55 Online – Lincoln Medical School

The seasonal prediction of *Lucilia spp.* in New Zealand using climatic data

1. **School of Veterinary Science, Massey University, New Zealand**
2. **School of Agriculture and Environment, Massey University, New Zealand**

Flystrike is a considerable welfare and production issue for sheep in New Zealand. It is primarily caused by two species of Diptera, *Lucilia cuprina* and *Lucilia sericata*. Due to the arrival of *L. cuprina* in the late 1970s, flystrike has changed from being a disease that was seen to be of minimal concern to one which costs the New Zealand economy approximately $60 million annually (B+LNZ Genetics, 2014). Currently, the seasonality of flystrike is unpredictable which limits a farmer's ability to apply appropriate integrated pest management strategies to mitigate this disease.
A series of studies were conducted to gather population data to help create prediction models for these two calliphorid species, which would allow farmers to implement preventative treatments at an appropriate time leading to improved animal welfare outcomes and reduced reliance on chemicals as a management tool.

A series of studies were conducted to firstly gather data on eight farms across New Zealand over two seasons (2018/2019 and 2019/2020) using the commercial flytrap, LuciTrap® with a Stickytrap attachment. These flies were initially identified using just morphological characteristics, however, there is a noted difficulty in the literature regarding the consistent identification of these species. Further validation of this method was performed by sequencing the 28s region of the fly's genome and the ND4 region of the fly's mitochondria. The morphological identification was not found to be consistently accurate, upon a comparison to the molecular method. Thus, the counts of both species were combined. Data exploration and modelling were undertaken to determine which climatic and environmental variables influenced the number of *Lucilia spp.* and which of the variables could be of potential use to predict seasonality.

Two prediction models were developed. The first model utilized data from the 2018/2019 season to predict the occurrence of these species by using onsite weather station data, with lagged climatic variables in a hurdle model. A second model was developed utilizing the closest virtual climate station data from the 2018/2019 season, to predict the seasonality of *Lucilia spp.* at the start of the season using a mixed-effects logistic regression model. Both models were found to be accurate to within three weeks of the observed occurrences of *Lucilia spp.* on each farm using the following climatically relevant variables to infer an effect on the biological life cycle: 10 cm Soil Temperature, Rainfall, Photoperiod, Soil Moisture, Maximum Temperature.

The results of these studies demonstrated the use of both a on-farm weather station and the virtual climate station could be used to predict the occurrence of *Lucilia spp.* in New Zealand conditions. The results of these studies are of practical use for sheep farmers in New Zealand and should help farmers to manage their sheep proactively in regards to mitigating flystrike. Further work is required to validate the climatic variables under controlled, varying environmental conditions throughout New Zealand with the long-term aim to turn the final model into an usable online tool for farmers.

POSTERS

All posters will be taking place in the Isaac Newton Building

Amma Simon[1], Olubukola Ajigboye[2], Toby J. A. Bruce[1] and Rumiana V. Ray[2]

P01 – Isaac Newton Building

Fusarium head blight infection by Nivalenol chemotype of Fusarium graminearium attracts *Sitobion avenae* in wheat

1. Keele University, England, UK
2. University of Nottingham, UK

Fusarium graminearum causes Fusarium head blight (FHB) disease on small grain cereals and produces the mycotoxin nivalenol (NIV) in the grain, which is harmful to humans and animals, when consumed. The English grain aphid (*Sitobion avenae*) feeds on the ears of cereal crops and infestations can cause widespread damage through nutrient removal and virus transmission. The pest and the pathogen coincide on the ears of their shared cereal host and interact, but less is known about the effect of NIV on aphid behaviour.

Here we investigated how an infection by a NIV producer alters *S. avenae* behaviour and the role of semiochemicals in their interaction. Susceptible or resistant FHB wheat genotypes were inoculated with the NIV chemotype of *F. graminearium* or a tri5 knock-out of the NIV wild type isolate. Whole plant aphid choice experiments were carried out within one hour post inoculation and semiochemicals were collected from inoculated ears at 0, 7 and 14 days post inoculation. In both whole plant and semiochemical choice experiments, *S. avenae* were more attracted to the FHB susceptible genotype infected with the NIV producer. Disease severity was also greater on wheat heads inoculated with the wild type NIV isolate compared to the knock out strain. Antennal electrophysiology and chemical analysis were used to identify and quantify semiochemicals underpinning *S. avenae* preference for NIV producer inoculated plants.

Infection by the NIV producer rendered the wheat host more attractive but also more vulnerable to aphid infestation, increasing the potential for damage and consequent yield loss.

Amparo Mora[1], Rosa Menéndez[2] and Andy Wilby[2]

P02 Online – Isaac Newton Building

Cultural landscapes abandonment: butterflies track the advance of forest over grasslands

1. Lancaster University, UK / Picos de Europa National Park, Spain
2. Lancaster University, UK

European rural landscapes have undergone considerable changes in the last 50 years. Agriculture intensification has taken place in western regions while land has been abandoned in eastern and southern regions. The negative impacts of agricultural intensification on butterflies and other insects in Western Europe have been well studied. But, less is known about the impacts of abandonment on mountain and humid areas of Eastern and Southern Europe, where landscapes have been well conserved.

Butterfly and plant communities were sampled in 19 hay meadows abandoned long ago (18 years) or few years ago (3-7 years) and compared to meadows continuously managed in a traditional way. We assessed how abandonment and landscape variables affected butterfly communities in cultural landscapes in the Picos de Europa National Park (Spain), which is under a continuous process of rural abandonment.

Butterfly communities were affected by abandonment, with an overall increase in the density of individuals in the long term. Community composition appears to undergo major change over time, with a species turnover of around 50% in the first few years of abandonment, rising to around 70% after 18 years of abandonment. There was a tendency of species with higher preference for closed habitats to increase their densities as time since abandonment proceeded. Landscape variables had a major impact on butterfly communities, stronger than the effect of meadow management. Community preference for closed habitats was associated with higher forest cover in the surroundings of the meadows but heterogeneous landscapes (in their composition or configuration) mitigated this effect.

Our findings suggest that we should try to provide conditions such that communities have time to react

to the diverse stressors imposed by global change. Promoting landscape heterogeneity and connectivity could facilitate survival to all kinds of functional and taxonomic groups.

Ava Searles, Dr Sheena Cotter and Dr Marcello Ruta

P03 – Isaac Newton Building

Factors effecting shape variation in the aposematism stripe of the burying beetle

University of Lincoln, UK

Shape is generally important in biology, often providing variability for selection to take place and therefore shape analysis is utilized in taxonomic classification. However, shape has been widely disregarded when studying signalling, with focus being on salience, colour and size. When studying aposematism, up until recently, the social interaction of the prey species was also neglected, with focus on the social environment of the predator being the factor applying pressure to the selection of the prey species. This study uses geometric morphometrics to analyse the shape of the warning signal in the burying beetle (*Nicrophorus vespilloides*) which exhibits two sets of orange stripes across its elytra, that display their distastefulness to predators – known as aposematism. Using photographs of beetles from a previous study, twenty-four landmarks were placed on each beetle to reflect the basic shape of their elytra and their two sets of aposematic stripes. The coordinates of these landmarks were then analysed to look for variation in shape and then whether this variation showed a relationship to: the level of parental care the beetle received, the amount of defensive fluid it produced and its sex. Prior study of burying beetles has found that the overall size of the signal was an indicator to its degree of chemical defence and that both the size of the signal and the amount of anal exudate produced had high broad-sense heritability. Therefore, we need to analyse whether the case is the same for shape and/or whether signal shape is affected by the beetles' environment prior to pupation and whether this signal exhibits the extent of the beetles' chemical defence.

Awatif Khidir[1] and Dr. Brian Taylor[2]

P04 – Isaac Newton Building

Ants from Sudan

1. Elsheikh Abdallah Elbadri University, Sudan
2. Oxford Natural History Museum, UK

Sudan is a huge country with highly diverse habitats ranging from desert in north , semi desert , poor savanna and rich Savanna, this diversity in geographical habitats led to a large diversity in species of animals and plants.

Ayman Asiri[1], Carsten Muller[1], Peter Graystock[2] and Sarah E. Perkins[1]

P05 – Isaac Newton Building

The smell of infection: is smell associated with *Melisococcus plutonius* infection in honey bee larvae?

1. Cardiff University, UK
2. Imperial College London, UK

Honey bees are one of the world's most important pollinators, particularly for agricultural monocultures, where wild pollinator biodiversity can be sparse. Apiculture worldwide is under threat by the emergence and persistence of infectious diseases such as American foulbrood (AFB) and Varroa mite. Many of these diseases are not specific to honey bees and can spill-over into wild pollinator populations. It is therefore in our best interest to have efficient surveillance of disease in honey bees, from both an agricultural and conservation standpoint.

European foulbrood (EFB) is one of the most understudied honey bee diseases, yet one of the most virulent. Currently, beekeepers detect EFB in their hives by manually inspecting the brood for characteristic symptoms, such as discoloured larvae accompanied by an unpleasant sour smell. Infectious diseases are known to change the volatile organic compounds (VOCs) profiles in humans and livestock, and this may also be true for honey bees. Better knowledge of which VOCs are associated with different diseases will help to develop detection systems, with the potential for identifying the presence of a disease before typical symptoms present, which is often too late to treat.

The current study aims to identify VOCs associated with honey bee larvae inoculated with the causative agent of EFB, *Melisococcus plutonius*, and whether a shift in the VOC profile precedes the onset of symptoms. VOCs from 48 EFB infected L2 larvae and 48 uninfected L2 larvae were collected daily over a

seven day period from inoculation until death. Three colonies were sampled and 48 L2 larvae from each colony were cultured and fed with larval food inoculated with 1000 CFUs of *M. plutonius*, or uninoculated food. Five-hundred ml of headspace VOCs were sampled daily onto thermal desorption tubes from each batch of 48 larvae after placing them into polythene bags for 30 minutes at 30°C, and then analysed using TD-GC-MS-TOF.

We identify a potential method of detecting EFB before the onset of symptoms, therefore improving the prognosis of infected hives. Olfactory cues, such as VOCs, may also play an important role in triggering hygienic behaviour by signalling infected brood for removal by hygienic workers. Our future studies will use behavioural assays to assess whether the identified VOCs are a mechanism underlying hygienic behaviour.

Christine Noronha[1], MD Bahar[1], Natasha Mosher-Gallant[2] and Suqi Liu[1]

P06 Online – Isaac Newton Building

Horizontal and vertical movement of wireworms, *Agriotes Sputator* (Coleoptera: *Elateridae*) through soil

1. Agriculture and Agri-Food, Canada
2. Prince Edward Island Department of Agriculture and Land, Canada

The larvae of the click beetles (Coleoptera: *Elateridae*), wireworms, are identified as a major pest of potatoes and other vegetable crops worldwide. Over the past ten years, a steady increase in the population of an invasive species *Agriotes sputator* in Prince Edward Island (PEI), Canada, resulted in its spread into un-infested crop land. Information on the movement of wireworms within the soil profile is lacking making it difficult to ascertain the correct time for installing bait traps to monitor populations. In this study, we investigate the horizontal and vertical movement of the wireworms in the soil. Using 5cm diameter tubes, we studied the time required and distance traversed through soil by a wireworm towards a food source. Results show that 15 and 20% of medium and large size wireworms respectively moved a distance 3.6m in 24 hours to find a food source. Results also show that if a food source is found some wireworms will feed for a short time and move in search of another food source. This information is critical for determining the time required from bait instillation to removal to obtain an accurate representation of the population. To study vertical movement, tubes were used to take soil cores to a depth of 80cm. Wireworms 10/tube were placed at the top of the tube and the bottom was sealed with mesh cloth to prevent wireworms from escaping. Each tube was reinstalled into the same location where the core was collected. Once a month from November to June, tubes were removed and the number of wireworms at different depths was recorded. Results show that wireworms can move down to a depth of 80cm. The majority of wireworms spend the winter months at a depth just below the frost line until April when they begin to move up as the soil temperature rises. All wireworms were at the surface between May to June.

Dawn Morgan, Dr Christopher Rogers, Dr Gina Manning and Dr Michael Whitehead

P07 Online – Isaac Newton Building

Larval dispersal within a residential setting – where do they go?

University of Wolverhampton, UK

Forensic entomology is the study and/or use of insects or other arthropods in a legal context. Insects as crucial items of evidence has been used in both criminal and civil cases for many years (Gennard, 2012; Greenberg and Kunich, 2002). While insect evidence is used in cases of violent and unexpected deaths, it can also be helpful and used where the deceased has died from either natural causes or accidently in their own home.

One of the main uses of insect evidence is to estimate the post-mortem interval (pmi), or the minimum amount of time that the body has been exposed to insects. For the PMI to be as accurate as possible, the oldest specimen at a scene needs to be found. The standards (Amendt et al., 2007) do state that in an indoors setting to check under carpets, skirting boards etc, and that they could be found in different rooms. It does not however, state if they will travel up or down a staircase or go under doors which are closed. Therefore, the aims of this set of experiments was to answer such questions as, will they travel upstairs/downstairs?, will they disperse under doors?.

Using published forensic entomology case studies (Greenberg, 1985; Goff and Odom, 1987; Benecke, 2005, 1998; Bugelli et al., 2014) and reputable online news sources (Sky News, 2022; BBC News, 2014), a number of areas within a residential setting were identified as being where deceased persons are typically found. Locard House, the University of Wolverhampton's dedicated crime scene house was

utilised, along with post-feeding larvae bought from a local fishing bait shop. The larvae were placed in a set area within the house, observations were made visually, photographed using an iPhone 12 Pro, and time lapse videos using an Apeman H80 Wildlife camera.

Preliminary results are showing that larvae will cover more ground than anticipated, they will go under not one, but two closed doors, as well as migrate to different floors using ceiling spaces.

Electra Poluha, Graziella Iossa, Paul Eady and Jamie Smith
P08 – Isaac Newton Building

The negative impacts of extreme temperatures/heatwaves on the larval stages of Lepidoptera species

University of Lincoln, UK

There is clear evidence that climate change is happening and is having an effect on biodiversity. There is an urgent need to investigate the impacts that climate change has on species, and to reverse the downward population trends that we are witnessing. Temperature has a significant impact on the distribution and the abundance of species, especially ectotherms such as insects. Insects are useful models for assessing the impact of climate change on ecological systems, due to their short generation times and sensitive ecological requirements. This causes them to respond quickly to climatic changes and provides them with a strong evolutionary potential for coping with selection from climate change. Lepidoptera are one of the most studied, diversified, and widely distributed animal groups, making it an excellent model for climate change study. Being ectotherms, they have limited physiological control, so behavioural mechanisms are crucial in adapting to climate change. This study aims to investigate the effects of heat stress on the larval stages of lepidoptera and in particular, behavioural thermoregulation on their host plant. The position on the plant and temperature of the leaf were recorded for heated groups of larvae and controls of several species of gregarious butterflies. Temperature was also recorded for wild patches of larval host plants in the field. Surprisingly, there was an increasing temperature gradient from top to bottom leaves in wild host plants when compared to experimental plants. The findings are discussed in relation to setting up realistic laboratory settings for heat experiments.

Enrique A. Mundaca, Diego Muñoz-Concha, Orlando Aponte and Juan E. Barriga-Tuñon
P09 – Isaac Newton Building

Adventive ladybird beetles (Coleoptera: Coccinellidae) in the desert of Northern Chile

Universidad Católica del Maule, Chile

The North end of Chile is an area characterised by having a dry tropical biome, ranging from semiarid to extremely arid climates. This area belongs to a major biodiversity hotspot, namely the Tropical Andes. This hotspot includes two main ecoregions: the South American High Plateau (ranging from 3600 to 4500 m) and the interphase between the central valley of Chile and the western Andean Range called the Andean Precordillera (ranging from approximately 1500 to 3600 m). The latter shows a variety of vegetation formations with their associated entomofauna, and has been described as containing a very high number of endemic species, which remain rather poorly studied. Within this context, we report the finding of three species of adventive ladybird beetles, namely: *Hippodamia variegata*, *Hippodamia convergens* and *Harmonia axyridis*, collected during a biodiversity survey carried out in May 2019. We document new records, extending the geographical distribution of these three species in the Andean Precordillera. We also discuss the implications of these new records in the biodiversity hotspot of the Tropical Andes, in the light of their history of introduction to Chile, as well as their potential interactions with still relatively undocumented native *Coccinellidae* species present in the area.

Fernanda Herrera-Mesías, Imen Kharrat Ep Jarboui and Alexander Weigand
P10 – Isaac Newton Building

Validating a metabarcoding pipeline for the assessment of local wild bee biodiversity in Luxembourg

Musée national d'histoire naturelle de Luxembourg (MNHNL), Ruhr-Universität Bochum (RUB), Luxembourg and Germany

Over the past few decades several investigations have reported large declines in insect diversity, abundance, and biomass, a trend from which wild bees are not excluded. The potentially catastrophic implications of this situation call for effective conservation efforts targeting wild bees. However,

considerable documentation gaps complicate the implementation of efficient management strategies in Central Europe. Conservation projects aiming to protect local wild bee populations must first retrieve accurate taxonomic information, applying the pertinent tools. While facing the current shortage of taxonomic experts, the development of new DNA-based approaches rises as a promising alternative for large data gathering. Among them, DNA metabarcoding is one of the leading techniques for biodiversity assessment, having the potential to become a cost-effective tool to identify large amounts of specimens. Here we present the advances made in the development and validation of a metabarcoding pipeline targeting local wild bee biodiversity in Luxembourg. A sample processing designed for specimen-saving DNA extraction and customized metabarcoding protocols are at the core of a survey strategy that aims to supply valuable insights regarding the biodiversity of European wild bees in the country, providing genetic and ecological data to be considered in national conservation strategies.

Fiona McKiernan[1], Jack O'Connor[2], William Minchin[2], Alan Dillon[3], Martina Harrington[3] and Annetta Zintl[1]
P11 Online – Isaac Newton Building

A pilot study on the prevalence of lice in Irish beef cattle and the first Irish report of deltamethrin tolerance in the cattle louse *Bovicola bovis*

1. School of Veterinary Medicine, University College Dublin, Ireland
2. MSD Animal Health Ireland
3. Teagasc, Ireland

Introduction: Pediculosis in cattle causes significant irritation and stress, often resulting in skin damage and poor coat condition. Control is chiefly dependent on synthetic pyrethroids and the macrocyclic lactones. In recent years, pyrethroid tolerance has been reported in British and Australian livestock.

Objectives: The objectives of this pilot study were to evaluate the prevalence of louse infestations and species in Irish beef cattle herds and to assess the efficacy of the synthetic pyrethroid deltamethrin on lice collected from heavily infested herds.

Materials and methods: 17 beef farms were visited during the winter of 2019 and 2020. Louse, bovine skin scurf and hair samples were collected by combing 13cm2 areas (wither, shoulder, topline, flank and the rump/tail) 15 times using a fine-tooth plastic headlouse comb. Lice were identified to species using a dissection microscope and taxonomic keys. In vitro contact bioassays to assess the efficacy of deltamethrin were carried out as per the method described by Levot and Hughes (1990). Treatment efficacy was also assessed in vivo by conducting repeat sampling of herds following treatment with a commercial deltamethrin based cattle louse treatment.

Results: Lice were detected in 16 (94%) out of 17 herds visited. Samples collected were identified to species either as *Bovicola bovis* (Present on 87.5% of farms) or *Linognathus vituli* (Present on 56.25% of farms). In vitro contact bioassays showed evidence of deltamethrin tolerance in *B. bovis* lice collected from 4 farms where animals were heavily infested with lice. Deltamethrin tolerance was confirmed in vivo on one farm by repeatedly assessing the levels louse infestation on animals within the herd that had been treated with a commercial deltamethrin based louse treatment.

Conclusions: This is the first record of insecticide tolerant populations of Irish cattle lice. The results also provide new data on the prevalence and species of lice infesting beef cattle in Ireland.

Acknowledgements: This project was funded by MSD Animal Health Ireland.

Freddy Sarathchandra
P12 – Isaac Newton Building

Bug-beats: using wing beat patterns for automated detection of mosquitoes

LSHTM, UK

How can the sound of a mosquito be used to detect their presence in the field? Could it be possible to perform species identification using the sounds they produce when flapping their wings? This project investigates how biological information of a mosquito such as its morphology and physiology, could be detected using their signature acoustic wing-beat (sometimes known as their annoying buzz).

A range of bespoke test environments have been designed and constructed, for use with calibrated, high precision aerospace acoustic equipment to create a novel, stable measurement space. This allows accurate acoustic measurements to be made of mosquitoes in free-flight, to investigate how their sound changes when exposed to differing

environmental and biological conditions.

Following preliminary measurements, the question also arose of how tethered flight is also of interest for acoustic characterisation. The measurement setup was modified and now allows precise acoustic measurement of tethered mosquitoes, for comparison with their free-flying counterparts.

Due to COVID restrictions and uncertainty during the development of this project, the entire setup has been designed to be portable. The semi-anechoic measurement chamber can be readily deployed to any lab should the need arise due to lockdowns, and can easily be moved around in a backpack if required. The chamber features a suite of sensors and cameras for monitoring its internal climate, and mosquito specimens are introduced into the chamber using a novel semi-automated airlock system. A novel turntable-conveyor has also been designed for controlling the distance and angle of a tethered mosquito relative to a measurement microphone.

The application of this? If an accurate description of the main factors which influence mosquito acoustics can be made, a simple device could actively "listen" for the same sound patterns in the field. Such a device could be used to actively identify mosquitoes in the field by listening to their sounds and comparing against the dataset currently being compiled during this project. And as a result, this may allow a novel method of automated mosquito surveillance.

Guim Ursul[1], Mario Mingarro[1], Sara Castro-Cobo[1], Ana Burón-Ugarte[1], Juan Pablo Cancela[2], Adrián Sánchez Albert[1], Helena Romo[3] and Robert J. Wilson[1]

P13 Online – Isaac Newton Building

Changes over space and time in the elevation ranges of butterflies in mountain systems in central Spain

1. Museo Nacional de Ciencias Naturales (MNCN-CSIC), Spain
2. CE3C, Spain
3. CIBC-UAM, Spain

Mountain ranges in the Mediterranean region acted for many taxa as refugia against historical changes to the climate. However, their role in protecting species against ongoing climate change is yet to be tested widely, partly because of a lack of fine-resolution information on species distributions from recent decades. We tested how the elevational distributions of butterflies varied over space and time across four mountain ranges in central Spain by conducting repeat samples between 2017 and 2022 at 78 field sites with historical butterfly data from 1985-2005. Trends over time in the lower, upper and average elevations occupied by butterfly species appeared to differ among the mountain ranges. We consider how regional differences in community composition, topography, and climate can lead to differences among mountain systems in species responses to climate change, and the implications for conservation.

Hafiza Maira Munir

P14 – Isaac Newton Building

Nutritional biology and ultrasonic signaling in male lesser wax moth (*achroia grisella*)

University of Lincoln, UK

Wax moths are important economic pests of honey bees. They are often investigated as a model organism for studying insect physiology. Understanding how organisms select nutrients is vital for determining how organisms grow, reproduce, die and underpins within-species variation in life history strategies. The geometric framework for nutrition has demonstrated that animal behaviors, animal performance and their physiology is strongly influenced by the balance of nutrients rather than any specific nutrient. Thus, knowledge of these nutritional needs imposed by different behaviour as well as how these behaviours are balanced within life histories are particularly important to understand how and why organisms manage their nutrition. My research aims to approach the major contribution of dietary impacts on growth, survival, reproduction and life history trade-offs in Lesser wax moth. 120 *Achroia grisella* larvae were kept individually in 25 cell petri dishes having 10g of different diet concentrations (15%, 25%, and 50% of protein) of experimental diet followed by 1 control group with standard diet. Four trials in two replicates were conducted to estimate the effects of protein percentages on larval growth rate. Significant main effect ($p < 0.05$) showed that larval growth increased significantly when fed with high protein percentages. Larvae were equally likely to survive to pupation across all diets. The fastest pupation rate was at 25% protein, slower but intermediate at 15% and 50% for pupation. For 15% protein they took ~7.9 days to pupate and for 25% protein pupation rate took ~ 6.2 days to pupate. For diet 50% pupation completed in 7.2 days and for control group it was approximately 10 days to pupate. By comparing, it become visible that high nutritional diet increased the growth and survival rate of caterpillars then low nutritional diet. To optimize a diet effectively particular diet characteristics and presence of essential nutrients must be considered. Therefore, artificial diet must be chemically stable, edible to insects, nutritionally complete, support growth, development and reproduction.

Ilma Qonaah[1], Toby J A Bruce[2], Duncan Warner[3], Rumiana V Ray[1]

P15 – Isaac Newton Building

Phenotyping antixenosis and antibiosis resistance against aphid in commercial wheat varieties

1. University of Nottingham, UK
2. Keele University, UK
3. Syngenta

Sitobion avenae and *Rhopalosiphum padi* are two of the most economically important cereal aphids in Europe. They damage plants directly by feeding of their phloem, and indirectly by transmitting Barley Yellow Dwarf Virus. Recently, aphid infestations have become more severe due to a lack of effective control caused by the development of insecticide resistance in aphid populations. This has driven the need to develop more sustainable methods to control *S. avenae* and *R. padi*. One of the potential control options is to increase wheat resistance to the aphid pests. Here we aimed to characterise aphid resistance in selected wheat genotypes and identify potential sources for future wheat breeding. We developed rapid phenotyping methods to quantify antixenosis and antibiosis resistance in wheat to *S. avenae*. The techniques were applied to twenty commercial *Triticum aestivum* varieties. Commercial variety R1 and S1 were most susceptible, and were both attractive to aphids, and able to support increased birth rate. In contrast, C1 and K3 showed the lowest aphid attraction and aphid birth rate, respectively. Aphid feeding behaviour assays using electrical penetration graph (EPG) and volatomic assays will be used to gain better insight into the mechanisms of antibiosis and antixenosis resistance, respectively. Following the identification of contrasting wheat genotypes with aphid resistance, mapping populations will be created to identify quantitative trait locus (QTLs) for the resistance.

Jamie Smith, Graziella Iossa, Paul Eady, Electra Poluha

P16 – Isaac Newton Building

The impact of heatwaves on the fertility of the large white butterfly

The University of Lincoln, UK

Global biodiversity is experiencing large declines in response to climate change and global warming. More frequent exposure to heatwaves of greater severity, distribution and duration is occurring and placing increased thermal stress on ecosystems. It is widely accepted that thermal stress can decrease fertility in endotherms, with much less known on its effects in ectotherms, particularly insects. This is concerning as they are vastly more abundant, potentially more vulnerable and provide key ecosystem services. Using the large white butterfly *Pieris brassicae*, we tested the impacts of simulated microclimate heatwaves on fertility and reproductive fitness in an ecologically relevant setting. Developing pupae were a) heated (<72 hours into pupation) to conditions of +5°C live outdoor ambient temperatures or b) kept at ambient conditions for 5 consecutive days. Micro heaters with thermocouple sensors and resistive wire cages were used to dynamically heat individual host plant environments to the target offset. Subsequent cross-matings in a factorial design took place in outdoor cages to determine the impacts on fecundity (egg laying and offspring survival) compared to ambient control groups. Sex differences in the susceptibility to fertility loss were determined via cross-matings. Dissection analysis was conducted to examine if heatwave exposure led to differences in physiological reproductive biology. It is predicted that the simulated microclimate heatwaves run in this study result in decreased fertility of the large white butterfly, impacting egg laying and survival. Furthermore, it is predicted that sperm function will be the most affected trait leading to the presence of male-skewed fertility loss. Our experiments look to reveal how heatwaves in nature may disrupt the fertility of insects and potentially severely disrupt local populations as the effects of climate change become more severe.

Jasvinder Kumar
P17 Online – Isaac Newton Building

Study on the succession of *histeridae* beetles on carcass in Mullanpur Garibdass, Punjab, India

Punjab University, Chandigarh, India

The most significant death witness that aids in the resolution of medico-legal disputes is thought to be the presence of entomofauna on a cadaver. Various gases are produced during the degradation that lures dipterans, beetles, spiders, etc. *Histeridae* beetles are among the many beetles that have been spotted on corpses. All members of the *histeridae* are predators; they eat the eggs and larvae of blowfly species. These coleopterans were found on corpses after the dipterans. Since the maggots under the soil pupate in a damp environment, certain *histeridae* are also found under the soil for eating and reproducing. By carefully studying the *histeridae* on successive bodies, we may determine the minimal postmortem duration and decomposition stages. Beetle diversity and abundance surged during the breakdown process' active degradation stage. In contrast to all of these things, the identification of forensically important *histeridae* beetles has a more significant impact on the research and aids in understanding the diversity and distribution of species. We collected 2281 *histeridae* beetles for this investigation from the genera S*aprinus*, *Merohister*, *Hister*, *Atholus*, etc.

Keywords. PMI (Post-mortem interval), *Histeridae*, Taxonomic identification, Succession

Moses Musonda
P18 – Isaac Newton Building

The effects of physicochemical parameters of water on the abundance of *Anopheles* larvae in various breeding sites of Kapiri mposhi District of Zambia

Broadway Secondary School, Zambia

Malaria is a global public health problem, caused by malaria parasites transmitted by a vector female *Anopheles* mosquitoes, belonging to the order Diptera. Their developmental cycle under goes a complete holometabolous with the larval stages associated with aquatic habitats. It is envisaged that the larval control measures are intended to reduce malaria transmission when vector development is prevented. This is due to the fact that for some reasons, most drug treatments coupled with other bed net insecticide treatments of adult mosquitoes are increasingly failing. In this study, it was important to determine whether the abundance of *Anopheles* mosquito larvae in different water sites was associated with the following parameters: (i) particular pH level, (ii) particular temperature (iii) the Total Dissolved Solids (TDS) (iv) or a particular electrical conductivity of water. It was also essential in this study to establish the species composition of adult *Anopheles* mosquitoes in Kapiri Mposhi district of Zambia. Both larvae and adult mosquitoes were identified using a morphological key. To achieve relevant results, a variety of qualitative and quantitative analytical methods were involved, inclusive of Polymerase Chain Reaction (PCR) and numerous multivariate statistical analyses involving SPSS version 21.0. Out of the total of 489 *Anopheles* larvae that were collected from breeding sites and reared in the insectary, only 45% emerged into adults. It was observed that the *Anopheles* larvae was absent in Rivers and dam breeding sites. Further molecular results revealed that the most abundant mosquito species in Kapiri Mposhi were *An. gambiae* (60%) and breeds well in temporal water ponds, followed by *An. arabiensis Paton* (35%) and 5% were no amplified results. A positive significance was recorded on Pearson Correlation for physicochemical parameters of electrical conductivity (p = 0.003), Total Dissolved Solids (TDS) (p =0. 004), temperature (p =0.001) and pH (p = 0.000).Consequently, it was, concluded that electrical conductivity, pH, temperature and Total Dissolved Solids (TDS) of water in various mosquito breeding sites of Kapiri Mposhi has an effect on the abundance of *Anopheles* larvae. This study has also shown that *Anopheles* mosquitoes thrive better in fresh mineral water.Keywords: Malaria, *Anopheles* mosquito, Larvae, Physicochemical parameters, Kapiri Mposhi

Moumi Ganguly, and Krishna Karmakar
P19 Online – Isaac Newton Building

Species complex and Intraspecific Variants of Rice Sheath Mite in Eastern India

Bidhan Chandra Krishi Viswavidyalaya, India

Steneotarsonemus Beer (Acari: *Tarsonemidae*) is one of the most diverse genera in the family *Tarsonemidae* comprising 84 species around the world. Mites of this genus exclusively feed on monocotyledonous plants, including some economically important plants like rice. Worldwide, Rice agroecosystems are inhabited by a number of *Steneotarsonemus* species with various host plant relationships and taxonomic identities, though, *S. spinki* is considered to be the only

Steneotarsonemus mite that directly feeds upon rice by dwelling in their leaf sheath and hence commonly known as 'Rice Sheath Mite' till date. To clarify if any other *Steneotarsonemus* is infesting rice or not, a large-scale survey was initiated in rice growing belts of eastern India and this revealed that not only *Steneotarsonemus spinki* Smiley, 1967, but *S. subfurcatus* Lin and Zhang, 1990 is also infesting rice and creating the similar type of damage. Additionally, the population of *S. spinki* and *S. subfurcatus* were found to be differentially distributed across five different agroclimatic zones of West Bengal with *S. spinki* being the dominant species. We also found three intraspecific variants within the population of *S. spinki* which are differentially distributed in nine separate locations covering four states across eastern India.

Panagiotis Ioannidis, Venetia Koidou and John Vontas
P20 Online – Isaac Newton Building

Insecticide detoxification in the malpighian tubules of the olive fly

Institute of Molecular Biology and Biotechnology, Foundation for Research and Technology – Hellas, Greece

The olive fly, *Bactrocera oleae* (Diptera: Tephritidae), causes the most significant problems in cultivation of olive trees, affecting both the quality and the quantity of the olive oil. Its control in Greece largely relies on chemical insecticides, such as pyrethroids. However, cases of insecticide resistance have been documented in olive fly field populations recently. The detoxification of insecticides as well as other harmful substances takes place in the malpighian tubules of insects, which are blind-ending tubes with excretive and osmoregulative role. Malpighian tubules are located at the junction of the midgut and the hindgut. In an attempt to gain a better understanding of insecticide detoxification, malpighian tubules were dissected out from individuals of two populations; one susceptible and one resistant to the pyrethroid insecticide α-cypermethrin. Sequencing of the extracted RNA was performed using the Illumina platform in three biological replicates for each one of the two populations. Sequencing reads were used in order to identify up- and down-regulated genes, in the resistant population compared to the susceptible. The results of this work contribute to a better understanding of insecticide resistance in the olive fly, aiming to contribute to the development of improved insecticide formulations.

Rahul Kumar and Ajay Kumar Sharma
P21 Online – Isaac Newton Building

Study of moulting behaviour of a morpho-variant of *Myrmaplata plataleoides* O. Pickard-Cambridge, 1869 (Araneae: Salticidae) reveals the presence of temporal ant mimicry among these spiders

University Department of Zoology, Vinoba Bhave University, Hazaribagh-825301, India

An isolated population of a rare morpho-variant of the ant mimicking jumping spider *Myrmaplata plataleoides* O. Pickard-Cambridge, 1869 was reported from Hazaribagh Wildlife Sanctuary, Hazaribagh, Jharkhand, India, which is also the first record of this species from the state of Jharkhand, India. Thorough morphological investigations of male and female spiders reveal the exact similarity in palp and genital structures respectively with male and female spiders of the original species which led us to consider the collected specimens as morpho-variants. Many other characters like number of teeth on chelicerae, leg colour pattern, placement of eyes, etc. are also consistent with the description of original species. Female's exuviae and eggs have also been studied. Microscopic studies reveal the presence of compartmentalized yolk inside eggs. We have studied its moulting, feeding and sexual behaviour in detail, and have recorded various unique behavioural aspects like debris rolling behaviour, photokinetic response, starvation response and oxygen deprivation response which were never documented before. We have found many behavioural and some external morphological differences between the morpho-variants and the original species too. We report hereby the occurrence of this spider near the colonies of the ground nesting ant *Camponotus compressus* Fabricius, 1787. This spider is known to mimic the Asian weaver ant *Oecophylla smaragdina* Fabricius, 1775, which are greenish orange to red in colour. Specimens collected by us are dark brown to black in colouration whereas the commonly reported specimens are often greenish orange to red. We propose that the darker colouration would have been naturally selected via sympatric mode in this isolated population of *M. plataleoides* as an adaptation to co-exist with *C. compressus* which are also black in colouration and are abundant around the spiders. Study of moulting behaviour of the morpho-variant further reveals the display of temporal mimicry where different moulting stages of the spider have been found to mimic different sub-castes of *C. compressus* workers for better chances of survival of the morpho-variant population.

Rosa Menendez, Lucy R. Gunson and Michael R. Roberts

P22 – Isaac Newton Building

Are rear end populations genetically important for the conservation of cold adapted species? The Scotch argus butterfly in Britain as a case study.

Lancaster Environment Centre, Lancaster University, UK

Climate change is becoming a major threat for many species and in particularly for cold-adapted species. Understanding the adaptative potential of those species, by exploring the genetic make-up of populations across the species range, is critical for informing conservation strategies. We compared the genetic structure and differentiation of populations of Scotch argus (*Erebia aethiops*), a cold-adapted butterfly, between the core of the current range in Britain, situated in Scotland, and the very south limit, situated in the north of England.

We found significant differences in genetic diversity among populations, with higher diversity occurring in the English populations. Genetic diversity was negatively related to latitude, supporting the idea that current differences in genetic diversity levels are likely the result of historical range changes. Populations were also genetically differentiated among regions, meaning that losing the English populations at the most southern range limit may prove detrimental for the survival of the species as a whole. These populations are likely better adapted to cope with warmer climates than those in Scotland, the current core range. Our results highlight that populations at the rear edge may prove to be key for the survival of cold-adapted species under global warming, so these populations should be considered of high conservation priority.

Samuel Asamoah[1], Amma L. Simon[1, 2] Olubukola Ajigboye[1], Toby J. A. Bruce[2], Dong-Hyun Kim[3] and Rumiana V. Ray[1]

P23 – Isaac Newton Building

Fatal attraction on the shared wheat host: *Rhopalosiphum padi* and deoxynivalenol producing *Fusarium graminearium*

1. **Division of Plant and Crop Sciences, School of Biosciences, University of Nottingham, Sutton Bonington, LE12 5RD, UK**
3. **Centre for Analytical Bioscience, Advanced Materials and Healthcare Technologies Division, School of Pharmacy, University of Nottingham, Nottingham NG7 2RD, UK**
3 **School of Life Sciences, Keele University, Keele, ST5 5BG, UK**

Fusarium head blight (FHB) caused by *Fusarium graminearum* is an economically damaging fungal disease of wheat associated with significant yield loss, and harmful to humans and animals mycotoxins in grain. The English grain aphid (*Sitobion avenae*) and the Bird cherry-oat aphid (*Rhopalosiphum padi*) are common wheat pests with devastating effects on their wheat hosts by sap-feeding and virus transmission.

Interactions between *S.avenae* and *F. graminearium* on their shared wheat host have been shown to result in an increased disease severity and mycotoxin accumulation. Infection by a deoxynivalenol (DON) chemotype of *F. graminearium* repels *S.avanae* and results in increased mortality and decreased fecundity of the pest. However, the effects of infection by DON producer of *F. graminearium* on *R.padi* behaviour and development have not been previously investigated.

This study determined the behaviour, development, and fecundity of *R. padi* when exposed to DON chemotype of *F.graminearum* on wheat ears In contrast to *S.avenae*, *R.padi* was attracted to plants inoculated with DON producing *F. graminearum*. However direct interactions resulted in increased mortality and decreased reproduction rate for *R.padi*. The results suggest that *R.padi* is likely to have evolved to occupy a separate niche to S. avenae or DON producing *F. graminearium*. Furthermore, this aphid species does not appear to be well-adapted to share direct head space with DON producers leading to an attraction that is fatal to the pest.

Sara Hellström, Karsten Seidelmann and Robert J. Paxton

P24 Online – Isaac Newton Building

The ground-nesting bee *Anthophora plumipes* as a potential test organism for investigating risks to bees of pesticide residues in soil

Martin Luther University Halle-Wittenberg, Germany

Pesticide exposure has been identified as a risk to non-target insects, particularly bee pollinators. In agrochemical risk assessment, the honeybee has long been the main test species of interest. Recently, wild pollinators such as *Bombus terrestris* have been included in standard risk assessment, and the solitary *Osmia bicornis* is on track to be included. Although these additions help broadening the knowledge on risks of pesticide exposure to wild bees, virtually nothing is known about the impact of pesticide residues in soils on ground-nesting bees, even though the vast majority of wild bees nest in soil. In order to address this issue, we established a protocol for rearing the ground-nesting bee *A. plumipes* in artificial nest boxes. We successfully harvest brood cells containing provisions, larvae, and adult bees for controlled laboratory exposure and fitness measures. We experimentally test nesting success in soil contaminated by a neonicotinoid insecticide by placing nest boxes next to a natural aggregation, quantifying the number of brood cells, brood survival and parasitation rate between treated and untreated soil. We also propose a new method for assessing risk of pesticide contamination from soil to larval provision by testing the uptake of compounds from contaminated soil through the brood cell wall into provisions and bee bodies. In conclusion, the introduction of a novel test species for soil residue risk assessment is a much-needed addition to the ongoing work to elucidate the hazard of pesticides to bees.

Sonal Ladwa and Sheena Cotter

P25

How does resource availability and age mediate reproductive trade-offs in Burying beetles, *Nicrophorus vespilloides*?

University of Lincoln, UK

In resource-limited environments, animals are unable to maximise every life history trait, resulting in trade-offs that impact their fitness. Parents who have multiple offspring are commonly faced with a dilemma: do I produce a few, large offspring, or lots of small offspring? To resolve this, parents must make decisions on where to invest based on resource availability, and the best solution may differ depending on the sex or age of each parent. We see this in Burying beetles, *Nicrophorus vespilloides*, who have a complex reproductive system, where they breed on resource-limiting carrion and exhibit bi-parental care. We know that burying beetles regulate the size of their brood and that this is impacted by resource availability and age. We asked how the beetles' sex, age and the size of the breeding resource, interact to drive variation in the size and number of offspring they produce. First, bigger carcasses supported more, larger beetles on average. However, this depended on the beetles' age; older beetles had fewer and larger offspring, and this effect was stronger in males. We suggest that this is driven by reproductive senescence particularly in male beetles, that potentially fail to fertilise all of the eggs the female produces, resulting in fewer and consequently larger offspring. Conclusively, we have encapsulated a wider view of how these individual variables interact with one another to better understand how burying beetles mediate trade-offs in offspring traits.

Susmita Aown[1], Prof. Alan Stewart[1] and Dr Michelle Fountain[2]

P26 – Isaac Newton Building

Dangers of drinking from plants! Host plant relationships of insect potential vectors of *Xylella fastidiosa*

1. **University of Sussex, UK**
2. **NIAB, East Malling, UK**

Xylella fastidiosa is a bacterial pathogen that causes disease symptoms in plants, such as leaf scorch and plant dieback. *X. fastidiosa* is of high research concern due to the outbreak of the bacterium in Italy, which has caused massive olive dieback and other losses in the agri-economy. *X. fastidiosa* has been spread globally through transport of infected plant material. Consequently, there is a high chance that *X. fastidiosa* could enter the UK from continental Europe sometime in the future. Meadow spittlebug *Philaenus spumarius* is the main insect vector which has spread *X. fastidiosa* locally in agricultural habitats in southern Europe. *X. fastidiosa* bacterium can be transmitted from infected plants to healthy plants by *P. spumarius* feeding. Understanding the behaviour of vector that spread plant pathogens is very important in planning management strategies to control pest and pathogen outbreaks.

My research at the University of Sussex and NIAB, East

Malling, is focussed on understanding the feeding behaviour of *P. spumarius*, specifically the host plant preferences of the insect in the UK. I am conducting field experiments and vineyard surveys to determine if *P. spumarius* have a species and /or variety preference for lavender, and grapevines in the UK. My research is still in early stages. I have setup the lavender experiment at the University of Sussex in the summer of 2022, and am gathering preliminary data of *P. spumarius* abundance on different lavender varieties from Wisley Gardens and Downderry Nursery. Please come and visit my poster and have a chat with me if you want to know more about *P. spumarius* feeding behaviour on lavender and grapevines in the UK.

Vera Kaunath and Jana A. Eccard
P27 – Isaac Newton Building
Light attraction in Carabid beetles: comparison among animals from the inner city and a dark sky reserve

University of Potsdam, Animal Ecology, Germany

Artificial light at night (ALAN) is altering the behaviour of nocturnal animals in a manifold of ways. Nocturnal invertebrates are particularly affected, due to their fatal attraction to ALAN. This selective pressure has the potential to reduce the strength of the flight-to-light response in insects, as shown recently in a moth species. Here we investigated light attraction of ground beetles (Coleoptera: Carabidae). We compared among animals (three genera) from a highly light polluted (HLP) grassland in the centre of Berlin and animals collected at a low-polluted area in a Dark Sky Reserve (DSR), captured using odour bait. In an arena setting tested at night time, HLP beetles (n = 75 across all genera) showed a reduced attraction towards ALAN. Tested during daytime, HLP beetles were less active in an open field test (measured as latency to start moving), compared to DSR (n = 143). However, we did not observe a reduced attraction towards ALAN within the species most common at both sides, *Calathus fuscipes* (HLP = 37, DSR = 118 individuals) indicating that not all species may be equally affected by ALAN. Reduced attraction to ALAN in urban beetles may either be a result of phenotypic selection in each generation removing HLP individuals that are attracted to light, or an indication for ongoing evolutionary differentiation among city and rural populations in their light response. Reduced attraction to light sources may directly enhance survival and reproductive success of urban individuals. However, decrease in mobility may negatively influence dispersal, reproduction and foraging success, highlighting the selective pressure that light pollution may have on fitness, by shaping and modifying the behaviour of insects.

Victor Soria-Carrasco, Anna Jordan, Dr Mike Darrington
P28 – Isaac Newton Building
The Entomology and Insectary Platform at the John Innes Centre

John Innes Centre, UK

The Entomology and Insectary Platform main aim is to support and promote excellent entomological research within the John Innes Centre, but we are also seeking to engage in national and international collaborations with academic and commercial partners. The platform has a quarantine insectary with several controlled environment rooms and rearing chambers where the team follow high-quality quarantine standards and holds a Defra licence to import, rear and work with over forty species of prohibited invertebrates. The Entomology team are highly experienced in establishing colonies of a wide range of invertebrate species. We are specialised in small-scale highly-controlled experimentation, usually involving the development of standard operating protocols from scratch using innovative approaches. Our main focus is on the study of plant-invertebrate and plant-pathogen-invertebrate interactions, but also carry out research on the discovery of invertebrate-associated natural products of interest and conservation of endangered invertebrate species. The platform is unique in its capability to generate and analyse invertebrate genomic resources using evolutionary approaches. In particular, we are interested in using genomic data to learn about genetic diversity, population structure, and migration dynamics of pests, and to understand genotype-phenotype interactions of traits of interest. We are also working towards integrating data of herbivore invertebrates by developing information hubs that enhance re-usability and support plant-health-related entomological research.

Francisca Sconce and Luke Tilley
P29 – Isaac Newton Building
Outreach activities at the Royal Entomological Society

Royal Entomological Society, UK

The Royal Entomological Society's second strategic priority is to increase public understanding of insect science. Our poster presentation summarises activities to date such as Insect Week, EntoSci conference for young people, Insect Festivals, and publications including INSTAR magazine and Garden Entomology. We introduce some of our future plans, in particular for Insect Week 2023. We welcome collaboration for our activities within the UK and internationally, please contact Fran Sconce.

Graziella Iossa
P30 – Isaac Newton Building
The ecological function of micropyles in insect eggs

University of Lincoln, Department of Life Sciences, UK

Insect eggs are fertilised through minute channels in the external layer of the eggshell. These micropyles as they are known, show remarkable variation in number, arrangement and structure across insect orders. Despite being almost ubiquitous across insects, they have received little attention. Micropyles are one of the key egg morphological features retained post-fertilisation. It is therefore plausible that some micropyle diversity is adaptive, supporting other egg structures during embryo development. So, whilst egg fertilization is the primary function of micropyles, they could aid embryo development and be shaped by natural, as well as sexual selection. I used a combination of comparative methods and a dataset spanning 24 hexapod orders to investigate micropyle presence, number and variation in primitive insects. I hypothesised that micropyle number correlated with: (i) aeropyle presence facilitating oxygen exchange; (ii) aquatic oviposition supporting development in water; and is influenced by (iii) critical bioclimatic variables. Micropyle number was strongly positively related to: i) egg size, with larger eggs having more micropyles; ii) the presence of aeropyles; iii) annual precipitation, with eggs developing in habitats with low annual precipitation exhibiting fewer micropyles; and iv) negatively related to micropyle width, insect eggs having fewer larger micropyles or numerous smaller ones. Overall these findings point to an adaptive ecological function of egg micropyles in addition to their primary fertilisation function. This is consistent with the hypothesis that micropyles aid embryo survival, and so this almost ubiquitous trait across insects is shaped by sexual and natural selection pressures during this critical life stage.

Jess Taylor
P31 – Isaac Newton Building
Kinematics and energetics of grasshopper (*Schistocerca gregaria*) jumping from compliant substrates

University of Lincoln, UK

LaMSA (Latch Mediated Spring Actuated) jumping insects are ubiquitous. In nature, these insects jump from a variety of compliant substrates such as leaves and grasses. To study how LaMSA jumpers interact with these compliant substrates, we have used the grasshopper (*Schistocerca gregaria*) as a model system. Grasshoppers were jumped from two diving board-like balsa wood platforms with varying masses and stiffnesses. The first being more massive than the grasshopper, with fixed end being stiffer than the grasshopper and the distal end being less stiff than the grasshopper. The second platform being half the mass of the first, with similar varying stiffnesses along its length. Despite greatly differing in mass, both platforms showed similar results in that the grasshoppers' average velocity ±SD decreased by 16% from 1.55±0.37m/s on a rigid substrate down to 1.19±0.30m/s at the least stiff end of the platform. This preliminary data suggests that grasshoppers, under these mechanical conditions, lose energy to the substrate and cannot recover it on recoil. Both of these platforms were of greater mass than the grasshopper, so a third platform was developed at 0.84g and had a greater stiffness (from 24N/m to 98N/m) and a lower mass than the grasshoppers (>0.84g and <6N/m). This set up the hypothetical conditions to allow grasshoppers to recover energy from the recoiling platform and produce greater velocities than from less favourable compliant substrates. Analysis into energy recovery for the third platform is currently underway, as well as further kinematic measurements across all three platforms. This initial data has highlighted that despite the highly compliant conditions, grasshoppers are able to account for this and only lose 16% of their energy to the substrate.

Elia Guariento[1], Rüdisser Johannes[2], Fiedler Konrad[3], Paniccia Chiara[1], Stifter Simon[1], Tappeiner Ulrike[1, 2], Seeber Julia[1, 2] and Hilpold Andreas[1]

P32 – Isaac Newton Building

Diversity versus simplicity: strong contrast between the butterfly communities of extensive grasslands, intensively used farmland and urban areas

1. Institute for Alpine Environment, Eurac Research, Viale Druso 1, 39100 Bozen, Italy
2. Department of Ecology, University of Innsbruck, Technikerstrasse 25/Sternwartestrasse 15, 6020 Innsbruck, Austria
3. Department of Botany and Biodiversity Research, University of Vienna, Rennweg 14, 1030 Vienna, Austria

The severe biodiversity decline in European agricultural landscapes demands a specific evaluation of the various land-use practices. Many butterflies, as an important ecological indicator and pollinator taxon, require in Europe human interventions to sustain their populations in cultivated landscapes. However, land-use changes and management intensification are currently responsible for their decline. In this study, we compared 93 butterfly communities recorded from seven contrasting land-use types in the Alpine region of South Tyrol. The study was conducted in the framework of the Biodiversity Monitoring South Tyrol (BMS).

We recorded a high species diversity in high nature-conservation value (HNV) grasslands (extensive meadows and pastures). These were all extensive grassland sites, subsidized by the province and encompass habitats listed in the EU Habitats Directive. All other land-use types showed significantly lower conservation value, with decreasing scores in (semi-)intensive meadows, vineyards, arable land, settlements and apple orchards. Moreover, functional traits uncovered a general trend: extensive grasslands supported communities of more specialized and sessile species, whilst all other land-use types harboured communities characterized by mobile generalists. Community composition was driven by the land-use type and explained by land-use intensity, habitat openness and elevation related variables.

We found supporting evidence for the effectiveness of regional Agri-Environmental Measures (AEMs) for butterfly conservation in European cultural landscapes and for the European conservation schemes to focus at least partly on the preservation of HNV grasslands with extensive management. Furthermore, we clearly show the poor ecological state of butterfly communities in more disturbed land-use types (including urban areas) and propose adopting measures to improve butterflies' conservation status in these environments.

Zoltán Tóth and Zsófia Kovács

P33 – Isaac Newton Building

The effects of chronic acetamiprid exposure on buff-tailed bumblebees (*Bombus terrestris*)

Department of Zoology, Plant Protection Institute, Centre for Agricultural Research, ELKH & University of Debrecen

Bumblebees are important pollinators in natural habitats and are used to guarantee the pollination of different crops in agricultural production. Due to recent regulation changes, acetamiprid has become the only neonicotinoid substance that can be used without restrictions and in open field cultivations in the European Union from 2021. However, a clear understanding of the sub-lethal effects of chronic acetamiprid exposure on bumblebees is still lacking, whereas its concentration in many agroecosystems is likely to increase drastically in the coming years. In this study, we investigated how a 14-day long exposure to low (25 ppb; corresponding to lasting residue concentrations in pollen and nectar) and high (2500 ppb; corresponding to residue concentrations in flowers 4–6 days after the application of acetamiprid-containing pesticides) concentrations of acetamiprid in syrup affected the mortality, mass and foraging behaviour of individual bumblebees. We found that acetamiprid did not affect food patch preference (control vs. treated), latency to feed for the first time or the amount of consumed syrup during the foraging trials compared to the controls, but the latency from landing on the artificial feeder to feeding significantly increased with the applied acetamiprid concentrations. As expected, mortality and change in mass during the experiment were not influenced by the applied acetamiprid treatments. Our findings provide experimental evidence that chronic exposure to a field-realistic acetamiprid concentration may have detrimental effects on some aspects of bumblebees' foraging behaviour and indicates that more research is needed if we are to better understand the long-term impacts of this neonicotinoid on bumblebees and other non-target organisms.

Andie L. Goodwin

P34 – Isaac Newton Building

What drives the age at which animals die?

University of Lincoln, UK

In the absence of predation and infection, and with adequate food, animals should live the full length of their natural lifespan, but this could be modified by the environment they experienced as juveniles, or amount of effort they put into reproduction.

Burying beetles, *Nicrophorus vespilloides*, are a biparental species that use carcasses to breed and rear their young, and can breed multiple times during their adult lifespan. We asked whether early life effects (parental age and size of carcass beetles were reared on) or late life effects (reproductive output) determined adult lifespan.

We found that longevity of the beetles was not heritable, but that older mothers produced longer lived offspring whilst older fathers producing offspring that died sooner. The environment also mattered; beetles reared on larger carcasses had an increased lifespan. We discuss the implications of social and environmental drivers of lifespan.

Michael Thomas Smith

P35 – Isaac Newton Building

Tracking the Orientation and 3d Path of Flying Insects

University of Lincoln, UK

Tracking the location and orientation of insects in the landscape at the meso-scale [<40m] gives us access to pose/location data key to learning and cognitive modelling, for example revealing where insects are looking. It allows exploration of the responses to landscape changes and enables researchers to learn about the ontogeny of features such as learning flights or foraging behaviour. For other researchers, being able to automate the monitoring of pollinator behaviour (tracking which flowers are visited more/less) allows the scaling of experiments.

Our previous work performed real-time tracking of insects in the field using retroreflective tags and a system of cameras and flashes. These have since been improved to make them more robust and easy to use. In our latest work we have added three important components to widen their range of applications:

- 3d (probabilistic) flight path reconstruction.
- Individually identifiable tags: Using colour retroreflectors.
- Inferring orientation: Using multi-colour tags that allow the orientation of the insect to be inferred from the tag colour.

We demonstrate the system by recording and exploring the structure of learning flights in bumblebees (*Bombus terrestris*). In summary: This system provides a low-cost platform for tracking behaviour at the meso-scale: opening up a window on to insect behaviour largely hidden from us.

Natasha Stevens

P36 – Isaac Newton Building

The Invasive Invertebrate Project

University of Lincoln, UK

St Helena is a small remote island (47sqm) located in the South Atlantic Ocean. Despite its size, it hosts over 400 endemic terrestrial invertebrate species; it has more invertebrate species than the UK and all other overseas territories put together, making it a location of immense global importance. Many of these endemic species are under threat from invasive non-native invertebrate species. An innovative new project will facilitate endemic invertebrate recovery and re-establish their associated ecosystem functions, by testing and establishing invasive invertebrate control methods. The focus will be on the Common wasp (*Vespula vulgaris*), Big-headed ant (*Pheidole megacephala*) and the Springbok mantis (*Miomantis caffra*).

EXHIBITORS

CABI

CABI is an inter-governmental, not-for-profit scientific research and publishing organization governed by a United Nations treaty-level agreement. Our mission is to improve people's lives by providing information and applying scientific expertise to solve problems in agriculture and the environment. In our global publishing programme we produce books, journals, and databases that hold over 10 million records. Unlike other publishers, we use our surpluses to support scientific and rural development projects that help improve the lives of the world's poorest people.

FIELD STUDIES COUNCIL

Field Studies Council is one of the UK's leading publishers of wildlife identification guides. From our popular WildID guides through to authoritative guides for enthusiasts, recorders and professionals, including the Royal Entomological Society's Series of Insect Identification Handbooks.

RES PUBLICATIONS

Catch up with our journal editors, browse the latest research and our new handbook, and find out how publishing with our journals supports the Society's work.

Royal Entomological Society

RES LIBRARY

The RES library collections date back to the founding of the Society in 1833. Visit our stand for a look at some of our rare books, and, if you're a new fellow, come and sign our book of obligations, to have your name listed alongside Charles Darwin and Miriam Rothschild.

JUMP

A musical collaboration between composer **Karen Wimhurst** and entomologist **Peter Smithers Hon.FRES** featuring insect, amphibian and clarinet musics.

Many precious voices across the globe are vanishing fast. Hold on to them for dear life.

In our rightful place, humanity is one small voice within an exuberance of wild song. Yet today, as the chirping, clicking, buzzing thrum of insects is lost, the croaking and calling of frogs disappears, the brightness of bird song ebbs away, our children's songlines are ripped apart.

We are the perpetrators of a terrible silencing.

"Insects make up the bulk of known species on earth and are integral to the functioning of terrestrial and freshwater ecosystems, performing vital roles such as pollination, seed dispersal and nutrient cycling. They are also food for numerous larger animals, including birds, bats, fish, amphibians and lizards. If we don't stop the decline of our insects there will be profound consequences for all life on earth."

David Goulson FRES

In lockdown, I lay on a riverbank suddenly throbbing with grasshoppers. This was a brief window in our lives when we learnt that things can change fast. We understood we can all spring into action at a moment's notice. We can take a running leap to profound change. We can ***JUMP***.

There was a time when the joint was jumping, jumping with life.

Let's move into a world in which we all

leap, bound, hop, bounce, skip, bob, caper, trill, whirr, croak, buzz, chirp, squeak, chirrup and jump for joy

with the best of them.

THE CAST

Bog Bush Cricket

This cricket is most abundant in southern areas of the UK. It is found in damp habitats in lowland areas

Mottled grasshopper

This is a common grasshopper across the UK that is found in habitats with short vegetation and bare ground.

Cicada *Neotibicen winnemanna*

Known as Dog Day cicadas. A North American species that lives in deciduous woodland. The nymphal cicadas spend the autumn and winter underground emerging as adults in the summer.

SE Asian field cricket *Teleogryllus emma*

Known as Emma Koorogi. This cricket is common in fields and other areas with short vegetation across SE Asia. It is often collected for its song.

Midwife toad *Alytes obstetricans*

An introduced species that has established at a small number of sites across the east of the UK

Common toad *Bufo bufo*

This species is wide spread in the UK and can be found in a broad range of habitats.

Pool frog *Pelophylax lessonae*

This species occurs in a small number sites in south eastern England. It prefers groups of small ponds in open woodland. The native populations had become extinct but a reintroduction program is underway.

Karen Wimhurst *Homo sapiens*

Often seen in summer in her native habitat, swimming in the River Stour, Dorset, or emerging with a clarinet in various locations in the UK and beyond.

www.karenwimhurst.co.uk

Ento22

14-16 September 2022

UNIVERSITY OF LINCOLN

Royal Entomological Society

www.royensoc.co.uk/event/ento22

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