The Impact of Pesticides on Bee Health

Joint meeting of the
British Ecological Society, Biochemical Society
and the Society for Experimental Biology

22 – 24 January 2014
Charles Darwin House, London, UK

British Ecological Society

Biochemical Society
Advancing Molecular Bioscience

SEB
Society for Experimental Biology

British Ecological Society

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Members are our lifeblood and we encourage them to be active in their Society, e.g. by joining a Special Interest Group, commenting on consultations, proposing events, joining a committee, attending our meetings.

Email: info@BritishEcologicalSociety.org
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Biochemical Society
Advancing Molecular Bioscience

The Biochemical Society exists for the advancement of the molecular and cellular biosciences, both as an academic discipline and to promote its impact on areas of science including biotechnology, agriculture, and medicine. Biochemistry helps to play a key role in tackling global issues such as improving lifelong health, treatment of disease, biotechnology and food security. We achieve our mission though our publications and journals, scientific meetings, educational activities, policy work, awards and grants to scientists and students.

SEB
Society for Experimental Biology

The Society for Experimental Biology (SEB) believes that the broad nature and lack of "ology" boundaries implicit in Experimental Biology give it a pivotal role in the development of Life Sciences which are of considerable benefit to its members and to society. In particular, Experimental Biology contributes to knowledge that can be applied to the development of agriculture and medicine and to understanding the impacts of human activity on living organisms and ecosystems.

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Welcome!

We are delighted to welcome you to Charles Darwin House for the “The Impact of Pesticides on Bee Health” – the third joint meeting between the three societies.

The Biochemical Society, the British Ecological Society and the Society for Experimental Biology have a long history of organizing and supporting meetings on all aspects of biochemistry, cell biology and ecology. However, the separation of these disciplines is becoming increasingly blurred as techniques and ideas spread more widely; all are critical if we are to succeed in understanding real, complex, dynamic, biological and ecological systems.

We believe this joint meeting between the societies (to be held at the joint headquarters of the three societies) will succeed in bringing together experts from around the world, who are solving biological problems using multiple integrated approaches. We hope that this meeting will be a tremendous success and form part of many future meetings between our three societies.

The Biochemical Society, the British Ecological Society and the Society for Experimental Biology.

Introduction

We extend a warm welcome to the third joint meeting of the Biochemical Society, the British Ecological Society and the Society for Experimental Biology. This is a very timely meeting, given the recent implementation of the EU moratorium on the specific application of neonicotinoids to bee-friendly crops. I am sure that the benefits, shortfalls and risks of this policy will be discussed at the meeting.

The aims of the meeting are challenging as we attempt to present and discuss the evidence for, and against, the use of pesticides and in particular the neonicotinoids. A particular challenge is the disparate evidence obtained from laboratory and field studies. In the laboratory, conditions can be highly controlled and confidence in the result strong, but this is produced under artificial conditions that may not reflect the real environment. In contrast, field studies are poorly controlled and many other environmental factors can influence the findings. However, they do represent an example of a real environment where conditions may mimic those encountered in real life. Together, these studies may identify some common ground, improvements for future experimentation and key knowledge gaps.

Understanding the impact of pesticides on insect pollinators is a perfect example of the need for multidisciplinary approaches and a wide knowledge base that is offered by such joint society meetings and this is reflected in the diverse backgrounds of all participants (speakers and attendees). Importantly, this includes scientists from academia, industry and government (DEFRA) and covers a range of different scientific evidence and opinions. It is a great credit to all participants that you are here to engage in polite scientific debate on a complex and highly topical issue. The contribution that you will all make is of enormous benefit, not just to our scientific understanding, but also that of our policymakers, stakeholders and the general public. We hope that you will all enjoy this meeting and the opportunities it offers to develop your own ideas and make valuable contacts.

Christopher Connolly *(University of Dundee, UK)* and Geraldine Wright *(Newcastle University, UK).*

Chair: Chris Connolly

11:00 **Registration**, with lunch from 12:00

13:00 **Mr Randolf Menzel**
(Free University of Berlin, Germany)
Neonicotinoids interfere with navigation in honeybees
[B14.1]

13:30 **Prof Dave Goulson**
(University of Sussex, United Kingdom)
Impacts of pesticides on bumblebee colonies
[B14.2]

14:00 **Dr Nigel E Raine**
(Royal Holloway University of London, United Kingdom)
The impacts of pesticides on bumblebees: from individual behaviour to colony function
[B14.3]

14:30 Refreshment Break

15:00 **Dr G. Christopher Cutler**
(Dalhousie University, Canada)
Semi-field and field studies examining impacts of neonicotinoid insecticides on bee colony health
[B14.4]

15:30 **Mr Galen P Dively**
(University of Maryland, United States)
Field exposure, in-hive fate and impact of imidacloprid on honey bee colony health
[B14.5]

16:00 **Dr Peter J Campbell**
(Syngenta, United Kingdom)
A four year field program investigating long term effects of repeated exposure of honey bee colonies to flowering crops treated with thiamethoxam
[B14.6]

16:30 **Mr Olivier Samson-Robert**
(Laval University Horticulture Research Centre, Canada
Neonicotinoid-coated seeds: impacts on honey bees, bumble bees and water contamination.
[B14.7]

17:00 **Posters and Wine Reception**

18:00 **Buffet Dinner**

19:00 **Pat Willmer**
(University of St Andrews, United Kingdom)
A wider perspective: Conserving and supporting all the pollinators.
[B14.8]

20:00 End of Session

B14.1

13:00 Neonicotinoids interfere with navigation in honeybees

Randolf Menzel (Free University of Berlin, Germany), Johannes Fischer (Institut für Bienenkunde Polytechnische Gesellschaft, Germany), Bernd Grünewald (Institut für Bienenkunde Polytechnische Gesellschaft, Germany), Teresa Müller (Institut für Bienenkunde Polytechnische Gesellschaft, Germany), Uwe Greggers (Freie Universität Berlin, Germany)

Three neonicotinoids, imidacloprid, clothianidin and thiacloprid, agonists of the nicotinic acetylcholine receptor in the central brain of insects, were applied at sublethal doses in order to test their effects on honeybee navigation. A catch-and-release experimental design was applied in which feeder trained bees were caught when arriving at the feeder, treated with one of the neonicotinoids, and released 1.5 hours later at a remote site. The flight paths of individual bees were tracked with harmonic radar. The initial flight phase controlled by the recently acquired navigation memory (vector memory) was less compromised than the second phase that leads the animal back to the hive (homing flight). The rate of successful return was significantly lower in treated bees, the probability of a correct turn at a salient landscape structure was reduced, and less directed flights during homing flights were performed. Since the homing phase in catch-and-release experiments documents the ability of a foraging honeybee to activate a remote memory acquired during its exploratory orientation flights, we conclude that sublethal doses of the three neonicotinoids tested either block the retrieval of exploratory navigation memory or alter this form of navigation memory. These findings are discussed in the context of the application of neonicotinoids in plant protection.

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B14.2

13:30 Impacts of pesticides on bumblebee colonies

Dave Goulson (University of Sussex, United Kingdom)

The causes of pollinator decline, and in particular the relative contribution of pesticides in driving these declines, remains controversial. Here I will provide a review of the evidence, with a particular focus on neonicotinoids and their impacts on bumblebee colonies. A coherent and consistent body of research demonstrates that field-realistic exposure is likely to be causing significant harm to wild bumblebee populations. The prophylactic use of these broad-spectrum pesticides goes against the long-established principles of Integrated Pest Management (IPM), leading to environmental concerns that go beyond bees. I will discuss these broader issues relating to persistence of neonicotinoids in the environment, their accumulation in soils and their occurrence in waterways and non-target vegetation.

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B14.3

14:00 **The impacts of pesticides on bumblebees: from individual behaviour to colony function**

Nigel E Raine (Royal Holloway University of London, United Kingdom), John Bryden (Royal Holloway University of London, United Kingdom), Richard J Gill (Royal Holloway University of London Imperial College, United Kingdom), Vincent A A Jansen (Royal Holloway University of London, United Kingdom), Dara A Stanley (Royal Holloway University of London, United Kingdom)

Bumblebees are essential pollinators of many important agricultural crops and wild plants. While foraging in farmed landscapes bees are likely to be exposed to pesticides, and other agrochemicals, applied for crop protection. Although bees typically encounter these pesticides at sublethal levels, exposure can still have impacts on individual behaviour such as foraging or navigation. As social insects, bumblebee colonies depend on the collective performance of many individual workers. Therefore, while field-level pesticide exposure may have relatively subtle effects on individual behaviour, it is poorly understood whether bee societies can buffer such effects or whether they result in severe cumulative effects at the colony level. We have shown that chronic exposure to both neonicotinoid and pyrethroid pesticides have significant impacts on bumblebees (Bombus terrestris) at field-relevant levels, including reduced individual foraging efficiency and colony growth rate. Combined exposure to both pesticides significantly increased chances of colony failure. We have modelled pesticide stress on individual bees, which impairs colony function, and shown how some colonies fail while others thrive. Results from our computer models closely predict the dynamics of colony failure from our experiments. This suggests our model can explain the enigmatic aspects of bee colony failures, highlighting an important role for sublethal stress in colony declines.

Bryden J, Gill RJ, Mitton RAA, Raine NE, Jansen VAA (2013). Chronic sublethal stress causes bee colony failure. Ecology Letters 16: 1463-1469.

Gill RJ, Ramos-Rodriguez O, Raine NE (2012). Combined pesticide exposure severely affects individual- and colony-level traits in bees. Nature 491: 105-108.

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B14.4

15:00 **Semi-field and field studies examining impacts of neonicotinoid insecticides on bee colony health**

G. Christopher Cutler (Dalhousie University, Canada)

Neonicotinoid insecticides are widely used plant-systemic compounds that contain the active ingredients imidacloprid, thiamethoxam, and clothianidin. This class of insecticide has perhaps been subject to more scrutiny than any other potential cause of recent honey bee and wild pollinator declines. Laboratory-based studies have indeed shown that neonicotinoids may elicit various acute or chronic effects on bees. However, higher-tier studies, where dietary exposure to pollen and nectar occurs through plants grown from soil or seed-treatment applications, have failed to demonstrate significant effects. In this talk, I will describe results from semi-field and field studies we have conducted with honey bees and bumble bees that suggest exposure to neonicotinoid-treated crops has no significant effect on colony health. I will frame these results within the context of other semi-field and field studies, and other observations and analyses regarding declines and health of pollinators over the past few decades.

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B14.5

15:30 **Field Exposure, in-hive fate and impact of imidacloprid on honey bee colony health**

Galen P Dively (University of Maryland, United States

Imidacloprid is widely used on many pollinated agricultural crops, and increasing evidence indicates that it moves to some extent into pollen and nectar. Three studies reported here characterized exposure and addressed the risk assessment of imidacloprid on colony health. One study showed that potential exposure of neonicotinoid residues in pollen and nectar to pollinators depends on environmental conditions and the method and timing of application relative to flowering. Another study tracked the movement and degradation of imidacloprid within whole colonies exposed to known levels of imidacloprid residues entering the hive, and quantified the actual exposure dose to worker bees, brood and the queen via honey, brood food and honey jelly. A third study examined the chronic sublethal effects on whole honey bee colonies fed supplemental pollen diet containing imidacloprid at field relevant doses for 12 weeks. Various endpoints of colony performance and foraging behavior were measured during and after exposure, including winter survival.

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B14.6

16:00 **A four year field program investigating long term effects of repeated exposure of honey bee colonies to flowering crops treated with thiamethoxam**

Peter J Campbell (Syngenta, United Kingdom), Ed Pilling (JSC International, United Kingdom), Mike Coulson (Syngenta, United Kingdom), Natalie Ruddle (Syngenta, United Kingdom), Ingo Tornier (Eurofins, Germany)

Neonicotinoid residues in nectar and pollen from crop plants have been implicated as one of the potential factors causing the declines of honey bee populations. Indeed the European Commission has introduced a 2 year moratorium for the use of Imidacloprid, Thiamethoxam and Clothianadin on selected bee attractive crops. However, much of the data that has implicated neonicotinoids in the decline of honey bee health has been generated either under laboratory conditions or have used unrealistic exposure conditions. In this study, conducted under field conditions, the long-term risk to honey bee colonies was investigated following four years consecutive single treatment crop exposures to flowering maize and oilseed rape grown from thiamethoxam treated seeds at rates recommended for insect control. During the study honey bee mortality, foraging behavior, colony strength, colony weight, brood development, food storage levels and over wintering success are monitored and reported. The results confirm a low risk to honey bees from systemic residues in nectar and pollen following the use of thiamethoxam as a seed treatment on oilseed rape and maize. These results contribute towards reducing the gap in our understanding of exposure and risk to honey bees from the use of neonicotinoids as seed treatments under field conditions.

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B14.7

16:30 **Neonicotinoid-coated seeds: impacts on honey bees, bumble bees and water contamination.**

Olivier Samson-Robert (Laval University Horticulture Research Centre, Canada), Geneviève Labrie (CÉROM Grain Research Centre, Canada), Madeleine Chagnon (UQAM Department of Biological Sciences, Canada), Valérie Fournier (Laval University Horticulture Research Centre, Canada)

Multiple paths of exposure to neonicotinoid insecticides have been identified for pollinators. Contacts with sowing dust and collection or consumption of contaminated pollen, nectar and water are the most common. Neonicotinoid-coated seeds are ubiquitous, yet we understand very little of their impacts on pollinators in natural conditions. In this 2-year study, mortality levels of commercial apiaries (Apis mellifera) were monitored during the corn planting period. Exposed sites were located within 500 meters of fields with coated seeds whereas control sites were 3 km distant. Liquid chromatography tandem mass spectrometry was used to analyse samples of dead honey bees (N=70) and puddle water from nearby fields (N=74). In addition, one colony of bumble bees (Bombus impatiens) was installed at each study site and foragers were analyzed with quantitative PCR (N=82) to determine the expression level of acethylcholinesterase. Results showed a significant honey bee mortality increase in sites exposed to coated seeds. All water samples from exposed sites had neonicotinoid compound while all control sites' samples were clear. Clothianidin and thiamethoxam concentrations found in water samples collected one month following planting were well above honey bee lethal doses. Finally, bumble bees from exposed sites showed a significant increase in acetylcholinesterase expression. These findings provide evidence that extensive use of neonicotinoid-coated seeds exacerbates honey bee mortality levels and affects bumble bee neuronal activity. Finally, this is the first study to identify puddle water as a novel route of potential exposure to neonicotinoids for pollinators.

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B14.8

19:00 **A wider perspective: Conserving and supporting all the pollinators.**

Pat Willmer (University of St Andrews, United Kingdom)

Most of the key pollinators worldwide have been declining, as ecologists have known for at least 30 years; the recent explosion of interest in honeybee decline has at last initiated a wider discussion of consequences, and what can or should be done. But we must address all the potential causes, in context, and avoid measures that might affect one kind of animal-plant interaction, or one pollinator group, at the expense of others. Honeybees are terrific generalist flower visitors, and give a managed pollination service to key food crops worldwide. But they are often less efficient than the natives (especially bumblebees, other bees and hoverflies), with which they may compete; and they cannot pollinate some crops at all. So there is a somewhat controversial case to be made that, whatever the causes, some reductions in introduced honeybee numbers may be no bad thing. But if - AND ONLY IF - we also build on excellent recent research and take measures to enhance all the native pollinator communities, in both agricultural and more urban settings. Supporting current generations of both farmers and beekeepers of course matters, and we certainly cannot afford to add to the honeybees' and bumblebees' ongoing problems (on which this conference focusses). But let's grasp a longer perspective: take steps to conserve all the bees, and all the other pollinators, for the benefit of future biodiversity and our own food security.

B14.25 Little and often makes much: testing for persistence of dietary pesticides in bees.

Philippa J Holder (University of Exeter, United Kingdom), James E Cresswell (University of Exeter, United Kingdom)

Bumblebee and honey bee populations are exposed to pesticide residues in the nectar and pollen of treated flowering crops on which they feed. If a pesticide is persistent, even small, sublethal residues could build up in a bee's body over time and be detrimental to their health. The negative impacts of persistent pesticide residues could threaten pollination services to wildflowers and crops. Using a proposed new EU protocol, three pesticides found in nectar and pollen, two of which are included in the recent EU 2-year ban for use on bee-attractive crops, were tested for their persistence. Thiamethoxam and cypermethrin were found to act as non-persistent toxicants in both bumblebees and honeybees, whereas fipronil was persistent in both species. Current EU regulations for pesticide risk assessment for bees do not include persistence testing. The findings presented here suggest that the protocol adopted would be a useful addition in the EU's regulatory process for pesticide approval.

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B14.26 Drivers of honeybee population change: An evaluation by Hill's causality criteria

Emma L Wright (University of Exeter, United Kingdom), Peter Campbell (Syngenta, United Kingdom), James E Cresswell (University of Exeter, United Kingdom)

Whilst globally numbers are increasing, the number of managed honey bee colonies has fallen in the USA and parts of Europe with annual losses estimated at around 30% in recent years compared to previous rates of 5-10%. Various factors could be responsible including pesticides, pathogens, and forage availability. We used Hill's causality criteria to evaluate the importance of some of the most commonly identified factors as potential drivers of change in regional stocks of managed honey bees. This analytical method was first designed to determine whether there was sufficient evidence to link certain detrimental agents, like cigarettes, to human disease. Hill identified eight kinds of non-experimental evidence, which he segregated into 'criteria'. For each criterion, we use evidence from the scientific literature to assign a level of conviction to the proposition that a specified factor is a driver of change in honey bee stocks. We conclude that the strongest driver of honey bee stock change examined so far is market forces. If the cost of bee keeping is low and profit from selling products or pollination is high stocks can increase. The strongest driver for colony declines so far is varoosis, the combination of varroa mites and viruses. This agrees with the results of many other studies and the views of bee keepers. Dietary neonicotinoids scored negatively suggesting that, from the existing evidence, this is not a driver of honey bee declines.

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B14.29 Could early-stage honey storage behaviour influence pesticide spread in *Apis mellifera L.* colonies?

Mark K Greco (University of Bath, United Kingdom), Edward Feil (University of Bath, United Kingdom), Nicholas Oriest (University of Bath, United Kingdom)

Decision making in honeybees is based on information which is acquired and processed in order to make choices between two or more alternatives. These choices lead to the expression of optimal behaviour strategies such as floral constancy. Optimal foraging strategies such as floral constancy improve a colony's chances of survival however to our knowledge there has been no research on decision making based on optimal storage strategies. Here we show, using diagnostic radioentomology, that decision making in storer bees is influenced by nectar sugar concentrations and that, within 48 hours of collection, honeybee workers store carbohydrates in groups of cells with similar sugar concentrations in a non-random way. This behaviour, as evidenced by patchy spatial cell distributions, would by default separate, nectar pesticides in the hive via cells of similar sugar concentrations. Thus, colonies which exhibit optimal storage strategies such as these would have an evolutionary advantage and improved colony survival expectations over less efficient colonies and it should be plausible to select colonies that exhibit these preferred traits.

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B14.30 Bumblebees are not deterred by nectar secondary compounds

Erin Jo Tiedeken (Trinity College Dublin, Ireland), Jane C Stout (Trinity College Dublin, Ireland), Philip C Stevenson (University of Greenwich, United Kingdom), Geraldine A Wright (Newcastle University, United Kingdom)

Bees visit flowers to collect nectar and pollen that contain nutrients and simultaneously facilitate plant sexual reproduction. Paradoxically, nectar produced to attract pollinators often contains deterrent or toxic compounds. "Toxic nectar" can arise via two processes: 1.) systemic pesticides applied as seed dressings leach into nectar or 2.) natural plant compounds usually thought to deter herbivores are produced in nectar. The functional significance of both natural and synthetic nectar toxins is not fully understood, but they may have a negative impact on pollinator behaviour and health, and ultimately plant pollination. This study investigates whether a generalist bumblebee, Bombus terrestris, can detect field realistic concentrations of potentially deterrent nectar toxins. Using paired-choice experiments, we identified deterrence thresholds for five natural plant compounds (quinine, caffeine, nicotine, amygdalin, and grayanotoxins) and one systemic neonicotinoid pesticide (imidacloprid) found in the nectar of bee-pollinated plants. The deterrence threshold was determined when bumblebees significantly preferred a sucrose solution over a sucrose solution containing the compound. Bumblebees had the lowest deterrence threshold for the neonicotinoid imidacloprid, (0.001mM); all other compounds had higher deterrence thresholds, above the natural concentration range in floral nectar. Our data combined with previous work using honeybees indicate that generalist bee species have poor acuity for the detection of nectar toxins. The fact that bees cannot detect nectar relevant concentrations of naturally-produced compounds suggests it is difficult for them to learn to avoid flowers presenting toxic nectar, maintaining this trait in plant populations and exposing bees to potential sub-lethal effects of toxins.

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B14.32 The Varroa destructor RDL receptor pore lining region: a novel target for bee-friendly acaricides?

Sarah Lummis (University of Cambridge, United Kingdom), Kerry Price (University of Cambridge, United Kingdom), Mona Alqazzaz (University of Cambridge, United Kingdom), Martin Hailstone (University of Cambridge, United Kingdom)

The parasitic mite Varroa destructor is the major pest of the honeybee Apis mellifera. Chemical methods for its control have targeted members of the pentameric (Cys-loop) ligand gated ion channel (pLGIC) superfamily, however the Varroa pLGIC family has not been characterized. Here we report our studies on the Varroa ortholog of the insect GABA-gated RDL receptor. We have identified four differences in the amino acid residues that constitute the pore lining (M2) region of Varroa RDL when compared to those in Drosophila and other insects. We have investigated these by replacement of the corresponding Drosophila RDL residues, expression of these receptors in Xenopus oocytes, and their characterization by two-electrode voltage clamp electrophysiology. We find that N-7’H, T6’M, A20’S and A21’Q mutants have lower GABA EC50 s than WT receptors, and T6’M mutants are resistant to picrotoxin. The T6’ residue has previously been shown to be important for the binding of many insecticides, and a mutation here (T6’L) has been found in the southern cattle tick (Rhipicephalus microplus) where it is associated with resistance to the cyclodiene insecticides (Hope et al. 2010). Further characterization of the Varroa RDL receptor may reveal new approaches towards the development of selective acaricides.

Hope, M, Menzies, M, Kemp, D (2010) J. Econ. Entomol. 103 (4) 1355-9.

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B14.33 Double whammy? Impact of pesticides and parasites on bumblebee fitness

Gemma Baron (Royal Holloway University of London, United Kingdom), Nigel E Raine (Royal Holloway University of London, United Kingdom), Mark J F Brown (Royal Holloway University of London, United Kingdom)

Bees foraging in agricultural landscapes are exposed to numerous stressors such as pesticides and parasites, that can negatively impact individual and colony-level fitness. Pyrethroid pesticides are widely used throughout Europe, and the use of these compounds has nearly doubled since the 1990’s. Here we present data on the impacts of a commonly used pyrethroid, -cyhalothrin, on the colony success of a widespread and abundant native pollinator, the bumblebee Bombus terrestris, under laboratory conditions. In order to fully understand the impacts of pesticides on bees, it is vital to consider interactions with other stressors as well as individual effects. We investigated the effect of pesticide exposure on the susceptibility of worker bees to a prevalent trypanosome parasite, Crithidia bombi, and the combined impacts of pesticide and parasite exposure on individual worker survival. Under laboratory conditions, -cyhalothrin affects an important aspect of colony function, worker size, which may have important implications under field conditions. However, in our study, colonies were able to compensate for this effect, and no significant impact on the production of sexual offspring was found. Additionally, no effect of pesticide exposure was found on worker infection rates or survival, even when bees were also challenged with the parasite. In light of the recent policy discussion on the use of pesticides, we discuss the implications of our study for the management of a key group of wild pollinators.

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B14.34 Distribution scenario of a xenobiotic inside a honeybee colony

Ulrike Riessberger-Gallé (Institute of Zoology University of Graz, Austria), Wolfgang Schuehly (Institute of Zoology Graz, Austria), Javier Hernández-López (Institute of Zoology University of Graz, Austria), Jutta Vollmann (Institute of Zoology University of Graz, Austria), Karl Crailsheim (Institute of Zoology University of Graz, Austria)

A xenobiotic is a chemical compound which can be found in an organism but which is not normally produced or expected to be present in it. The study aimed at visualizing the internal distribution pattern of indigo carmine within a honeybee colony as an example of a distribution scenario for any water-soluble substance, e.g., a pesticide. Food containing the blue water-soluble dye indigo carmine was presented to a nucleus colony ad libitum. The status of cells was visually evaluated after 12 and 24 h. After 24 h, the colony was transferred to new wax foundations and the color of the newly formed cells was evaluated after 4 d. Already 12 h after feeding, indigo carmine could be detected in honey, pollen and brood cells. The majority of dye was stored in open honey cells. Even after 4 d on new comb foundations, indigo carmine could be detected in all newly built honey cells, which demonstrates the prevalence of the compound in the social stomach. For the experiments, a relatively high dose (c. 300 mg/colony) of marker substance was used. Our results indicate that, upon scaling down, the distribution pattern of very small amounts will be similar. Therefore, a hydrophilic xenobiotic will reach all cell categories and will stay with the colony even when the colony leaves the nest site.

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B14.35 Thiacloprid levels in *Brassica rapa* pollen samples in a Finnish field study

Mari Kukkola (Finnish Food Safety Authority Evira, Finland), Kati S Hakala (Finnish Food Safety Authority Evira, Finland), Lauri Ruottinen (Agrifood Research Finland MTT, Finland), Sakari Raiskio (Agrifood Research Finland MTT, Finland), Jarmo Ketola (Agrifood Research Finland MTT, Finland), Kimmo Peltonen (Finnish Food Safety Authority Evira, Finland)

Thiacloprid is a systemic insecticide used in Finnish turnip rape (Brassica rapa subsp. oleifera) cultivation. It differs from most of the other neonicotinoid compounds as it is applied as a spray treatment from budding to blooming periods. During blooming of the turnip rape, honey bees are exposed to thiacloprid residues. Thiacloprid is less toxic than some other neonicotinoids e.g. clothianidin. However, due to the application period and use levels it may have an adverse impact on honey bees. The aim of this study was to develop an analytical method for residue determination and to investigate thiacloprid residues in pollen samples. Samples were collected from hives nearby turnip rape fields treated with 0,3-0,4 l/ha thiacloprid (240 g/l). The sample preparation was based on modifications of QuEChERS method (Quick, Easy, Cheap, Effective, Rugged, Safe). Analysis was performed by ultra performance liquid chromatography-tandem mass spectrometry (UPLC-MS/MS). The determined thiacloprid levels will be presented and the suitability of the method will be discussed. The results of this study can be exploited in assessing the exposure of honey bees to thiacloprid residues in Finnish turnip rape production.

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B14.36 Are bee colonies affected by a chronic exposure to sub-lethal doses of thiacloprid?

Reinhold Siede (Landesbetrieb Landwirtschaft Hessen Bieneninstitut Kirchhain, Germany), Lena Faust (Institut für Bienenkunde Polytechnische Gesellschaft Goethe Universität Frankfurt, Germany), Christian Maus (Bayer CropScience Aktiengesellschaft, Germany), Marina Meixner (Landesbetrieb Landwirtschaft Hessen Bieneninstitut Kirchhain, Germany), Bernd Grönewald (Institut für Bienenkunde Polytechnische Gesellschaft Goethe Universität Frankfurt, Germany), Ralph Büchler (Landesbetrieb Landwirtschaft Hessen Bieneninstitut Kirchhain, Germany)

Traces of thiacloprid are found in honey and pollen collected from rape. Effects of this insecticide on individual bees are known but its relevance for colonies is controversially debated. With the goal to assess its risk potential on the colony level a three-year study was initiated in Germany. In July 2011, 2012 and 2013, 30 colonies were started from shook swarms, divided into three groups with ten colonies each, and migrated to an experimental yard. Five times per autumn they were provided with 5 l sugar syrup containing either 200 ppb or 2000 ppb thiacloprid or syrup alone (control). The colonies were scored four times in autumn and four times in spring till the succeeding May every 3 weeks. Food stores were sampled before and after wintering and analyzed for thiacloprid. All three groups performed similarly. Mean-numbers of bees per colony were 12599 for controls, 12598 for 200 ppb and 11705 for 2000 ppb and 10784, 10545 and 9977 for brood resp. (N observations = 200 per group, current state 11/ 2013). Differences were not significant (glm rep. measurements, spss, p bees ≥ 0.092; p brood ≥ 0.547) despite high recovery rates for thiacloprid in March (≤ 0.01mg/kg for controls, ≤ 0.13mg/kg for group 200ppb and ≤ 0.83 mg/kg for group 2000 ppb). So far our study does not indicate an impact from chronic exposure to sub-lethal concentrations of thiacloprid on colonies. This study is supported by funds of the German BMELV (via BLE under the innovation support program).

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B14.37 A sublethal dose of the neonicotinoid thiacloprid may affect social communication and foraging behavior in honeybees

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Honeybee foragers may be exposed to neonicotinoids during their foraging flights via pollen, nectar and guttation drops. It has been observed that neonicotinoids may compromise navigation in honeybees. Yet, the colony relies on the foragers' ability to locate food sources and bring pollen and nectar back to the hive. The successfully returning foragers will deposit pesticide containing substances in the hive which may accumulate over time. The waggle dance may also be affected by sublethal doses of these pesticides since neonicotinoids interfere with the nicotinic synaptic transmission in the central nervous system of insects possibly altering social communication processes. We trained a group of about 30 foragers from two colonies of honeybees Apis mellifera carnica in observation hives to two separate feeders located 340 meters from the respective hive. One group (from the experimental colony) foraged 4 weeks on a sucrose solution containing a sub-lethal dose (0.03 mM) of thiacloprid, and another group (from the control colony) foraged over the same time at a feeder containing only sucrose solution. Navigation abilities of these bees were tested in a catch-and-release design using the harmonic radar technique. In addition, bees´ waggle dances were video-recorded in both control and treated hives and the electric fields of the dancers were measured via electrodes. The traffic at each feeder was estimated using light-sensitive detectors at the feeders' entrances. We found that chronic exposure of a colony to a field-relevant dose of thiacloprid in field-realistic conditions may affect honeybees' social communication and foraging behavior.

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B14.38 Cholinergic pesticides cause mushroom body neuronal inactivation in honeybees

Mary J Palmer (University of Dundee, United Kingdom), Chris Moffat (University of Dundee, United Kingdom), Nastja Saranzewa (University of Dundee, United Kingdom), Jenni Harvey (University of Dundee, United Kingdom), Christopher Connolly (University of Dundee, United Kingdom)

Pesticides that target cholinergic neurotransmission are highly effective but their use has been implicated in insect pollinator population decline. Honeybees are exposed to two widely-used classes of cholinergic pesticide: neonicotinoids (nicotinic receptor agonists), and organophosphate miticides (acetylcholinesterase inhibitors). Although sub-lethal levels of neonicotinoids are known to disrupt honeybee learning and foraging behaviour, the neurophysiological basis of these effects is unclear. Here, using recordings from mushroom body Kenyon cells in acutely-isolated honeybee brain, we show that the neonicotinoids imidacloprid and clothianidin, and the miticide coumaphos oxon, cause depolarisation-block of neuronal firing and inhibit nicotinic responses. These effects are observed at nanomolar concentrations and are additive with combined application. Our findings demonstrate a neuronal mechanism for cognitive impairments caused by neonicotinoids, and predict that exposure to multiple pesticides that target cholinergic signalling will cause enhanced toxicity to pollinators.

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B14.39 Towards direct monitoring of sub-lethal effects of neonicotinoids in the honeybee brain.

Albrecht Haase (University of Trento Department of Physics Center for BrainMind Sciences, Italy), Mara Andrione (University of Trento Department of Physics Center for BrainMind Sciences, Italy), Marco Paoli (University of Trento BIOtech center, Italy), Elisa Rigosi (University of Trento BIOtech Center Center for BrainMind Sciences, Italy), Giorgio Vallortigara (University of Trento Center for BrainMind Sciences, Italy), Renzo Antolini (University of Trento Department of Physics Center for BrainMind Sciences, Italy)

Alarming reports on a decline of the honeybee population are coming also from Trentino, a province in northern Italy dominated by fruit and wine cultivation. Our laboratory for nonlinear bioimaging developed an experimental platform for in-vivo morpho-functional imaging of the honeybee brain via two-photon microscopy. We are going to apply this method in an optical study on the influence of pesticides to the honeybee brain. We will look at neuroplastic changes on different scales from entire brain regions, to single neurons and synaptic densities under the influence of neonicotinoids. Besides morphological changes, also the antennal lobe activation patterns as response to specific odour stimuli will be directly monitored via calcium imaging to individuate changes under neonicotinoid administration. With these studies we hope to identify neural dysfunctions and give thresholds for the onset of these sub-lethal effects. The achieved results will support the local agricultural industry to redesign their pest control strategies avoiding damage to the pollinators.

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Programme & Talks: Thursday 23 January

Chair: Geraldine Wright

09:00 **Prof Francesco Pennacchio**
(University of Napoli Federico II, Italy)
Effect of clothianidin on insect immunity and honeybee health
[B14.9]

09:30 **Mr Yves Le Conte**
(INRA UMR INRAUAPV Abeilles et Environnement, France)
Stresses interactions and honey bee losses
[B14.10]

10:00 **Dr Jeffery S Pettis**
(United States Dept. of Agriculture, United States)
Crop pollination exposes honey bees to pesticides which alters their susceptibility to the gut pathogen *nosema ceranae*
[B14.11]

10:30 *Refreshment Break*

11:00 **Ian Boyd (DEFRA)**

11:30 **Dr Louisa A Hooven**
(Oregon State University, United States)
Fungicides affect development of honey bee colonies
[B14.12]

11:45 **Dr Elaine C. M. Silva-Zacarin**
(Universidade Federal de São Carlos, Brazil)
Early side-effects of non-lethal doses of thiamethoxam in the midgut of Africanized honeybee and its interaction with Nosema spores inoculation.
[B14.13]

12:00 *Lunch Break*

13:00 **Prof May R Berenbaum**
(University of Illinois at Urbana-Champaign, United States)
Honeybee cytochrome P450s: how a 6-million-year-old genome copes with pesticide-intensive modern agriculture
[B14.14]

13:30 **Dr Reinhard Stöger**
(University of Nottingham, United Kingdom)
Exposure to low levels of imidacloprid affects metabolic network of honeybee larvae
[B14.15]

14:00 **Dr Christopher N Connolly**
(University of Dundee, United Kingdom)
Sub-lethal effects of neonicotinoids on neuronal function and dysfunction.
[B14.16]

14:30 *Refreshment Break*

15:00 **Mr Geoffrey Coates**
(Syngenta, United Kingdom)
Operation Pollinator 2001-2013
[B14.17]

15:30 **Dr Geraldine A Wright**
(Newcastle University, United Kingdom)
Interaction of dietary protein and neonicotinoids on the survival and nutrient balancing of the buff-tailed bumblebee, *Bombus terrestris*
[B14.18]

16:00 **Miss Elizabeth J Collison**
(University of Exeter, United Kingdom)
Investigating the effects of neonicotinoids on glucose oxidase- a honey bee hypopharyngeal gland secretion
[B14.19]

16:15 **Paula M. Garrido**
(Laboratorio de Artrópodos Universidad Nacional de Mar del Plata-CONICET, Argentina)
How apicultural practices and *Nosema ceranae* affect individual honey bee health?
[B14.20]

16:30 **Questions and Discussion**

16:45 **Posters and Wine Reception**

19:30 **Conference Dinner at The Kitchin (see page 24 for directions)**

B14.9

09:00 Effect of clothianidin on insect immunity and honeybee health

Francesco Pennacchio (University of Napoli Federico II, Italy), Gennaro Di Prisco (University of Napoli Federico II, Italy), Valeria Cavaliere (University of Bologna, Italy), Desiderato Annoscia (University of Udine, Italy), Paola Varricchio (University of Napoli Federico II, Italy), Emilio Caprio (University of Napoli Federico II, Italy), Francesco Nazzi (University of Udine, Italy), Giuseppe Gargiulo (University of Bologna, Italy)

Biotic and abiotic stress factors are both involved in the honeybee colony decline and eventual collapse, which are often associated with high loads of parasites and pathogens. This suggests that they are able to interfere with the immune defense barriers of honeybees. In particular, an immunodepression triggered by neonicotinoid insecticides has been hypothesized on the basis of their capacity to enhance pathogen impact on honeybees. Here we report the molecular mechanism underlying the neonicotinoid induced replication of the Deformed wing virus (DWV) in honeybees bearing covert infections. We have identified a negative regulatory pathway of NF- B immune signaling in insects, which is activated by clothianidin. Indeed, exposure to field realistic sub-lethal doses of this insecticide and of imidacloprid promotes viral replication in infected honeybees. This study will likely contribute to the definition of additional guidelines for testing chronic or sub-lethal effects of pesticides, which will take into consideration the immunomodulating effects of neuroactive substances. Moreover, we predict that it will foster new research on neural modulation of immunity in insects.

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B14.10

09:30 Stresses interactions and honey bee losses

Yves Le Conte (INRA UMR INRAUAPV Abeilles et Environnement, France), Claudia Dussaubat (INRA UMR INRAUAPV Abeilles et Environnement, France), Belzunces Luc (INRA UMR INRAUAPV Abeilles et Environnement, France), Jean-Luc Brunet (INRA UMR INRAUAPV Abeilles et Environnement, France), Cédric Alaux (INRA UMR INRAUAPV Abeilles et Environnement, France)

Massive honeybees losses have been reported in many places in the world, and usually the specific causes are unknown. Single factors have not yet explained this global decline, leading to the hypothesis of multifactorial syndromes. Consequently, testing the integrative effects of more than one stress is an interesting approach to understand colony losses. We tested the effects of an infectious organism and an insecticide on honeybee health. We demonstrated that a synergistic effect between both agents, at concentrations encountered in nature, significantly weakened honeybees.Nosemain combination with imidacloprid caused in the short term a higher rate of mortality and energetic stress than either agent alone. A measure of immunity, glucose oxidase activity, was significantly decreased only by the combined treatments, emphasizing their synergistic effects. We demonstrated an effect ofNosemaon worker pheromone production which shows that a pheromonal disruption related to different stresses could be involved in weakening colonies. We did not found an effect of imidacloprid on worker pheromone production yet. We also showed that the quality and diversity of pollen can affect honey bee health and demonstrated that diet diversity increase the immune-competence of honey bees, which suggest a link between protein nutrition and immunity. We will also present data on synergetic effect ofNosemain combination with imidacloprid on queen survival in natural conditions. We, thus, provide evidence for integrative effects of different agents and stress on honeybee health, both in the short and long term.

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B14.11

10:00 Crop pollination exposes honey bees to pesticides which alters their susceptibility to the gut pathogen *nosema ceranae*

Jeffery S Pettis (United States Dept. of Agriculture, United States), Elinor Lichtenberg (University of Maryland, United States), Dennis Van Engelsdorp (University of Maryland, United States)

Recent declines in honey bee populations and increasing demand for insect-pollinated crops raise concerns about pollinator shortages. Pesticide exposure and pathogens may interact to have strong negative effects on managed honey bee colonies. Such findings are of great concern given the large numbers and high levels of pesticides found in honey bee colonies. Thus it is crucial to determine how field-relevant combinations and loads of pesticides affect bee health. We collected pollen from bee hives in seven major crops to determine 1) what types of pesticides bees are exposed to when rented for pollination of various crops and 2) how field-relevant pesticide blends affect bees' susceptibility to the gut parasite Nosema ceranae. Our samples represent pollen collected by foragers for use by the colony, and do not necessarily indicate foragers' roles as pollinators. In blueberry, cranberry, cucumber, pumpkin and watermelon bees collected pollen almost exclusively from weeds and wildflowers during our sampling. We detected 35 different pesticides in the sampled pollen, and found high fungicide loads. The insecticides esfenvalerate and phosmet were at a concentration higher than their median lethal dose in at least one pollen sample. While fungicides are typically seen as fairly safe for honey bees, we found an increased probability of Nosema infection in bees that consumed pollen with a higher fungicide load. Our results highlight a need for research on sub-lethal effects of fungicides and other chemicals that bees placed in an agricultural setting are exposed to.

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B14.12

11:30 Fungicides affect development of honey bee colonies

Louisa A Hooven (Oregon State University, United States)

Fungicides are applied during bloom to control a variety of agricultural pathogens, based on the assertion that they have negligible toxicity to pollinators. However, beekeepers have observed effects on larvae weeks after their application. Laboratory studies have also suggested that certain fungicides exhibit larval toxicity. Long-term, colony level studies are needed to decipher whether specific fungicide affect colony health or growth. Using a semi-field approach, we introduced pollen to honey bee colonies containing field-relevant concentrations of iprodione, chlorothalonil, ziram, or a mixture of boscalid/pyraclostrobin. Our initial experiments suggested that iprodione and chlorothalonil treatments exhibit delayed effects on brood, ziram treatment resulted in loss of queens, while boscalid/pyraclostrobin had no effects compared to controls. We expanded our study of iprodione, a dicarboximide fungicide used on many crops. Our previous results were confirmed, and we found less increase in larvae and capped brood compared to controls several weeks after treatment. As commercial honey bees are moved from crop to crop during the growing season, they are directly sprayed and collect pollen contaminated with fungicides. Many fungicides also accumulate in beeswax. The significance of our results, demonstrating deleterious effects of iprodione on colony development, must be considered in the context of repeated and prolonged fungicide exposures to honey bees and other pollinators.

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B14.13

11:45 Early side-effects of non-lethal doses of thiamethoxam in the midgut of Africanized honeybee and its interaction with Nosema spores inoculation.

Elaine C. M. Silva-Zacarin (Universidade Federal de São Carlos, Brazil), Ales Gregorc (KIS, Slovenia), Roberta C.F. Nocelli (Universidade Federal de São Carlos, Brazil), Stephan M. Carvalho (Universidade Federal de Uberlândia, Brazil), Thaisa Roat (UNESP Campus de Rio Claro, Brazil), Daiana A. Tavares (UNESP Campus de Rio Claro, Brazil), Hellen M. Soares (UNESP Campus de Rio Claro, Brazil), Érica W. Teixeira (APTA Pindamoguangaba, Brazil), F bio C. Abdalla (Universidade Federal de São Carlos, Brazil), Osmar Malaspina (UNESP Campus de Rio Claro, Brazil)

Histopathological analyses of the workers midgut were performed in order to establish the synergistic effect of the insecticide thiamethoxam and Nosema infection in Africanized honeybees. Midgut presents the first contact with any orally administered insecticide and it is also the site of Nosema infection. For this purpose, newly emerged workers were divided in four treatment groups receiving: 0.0856 ng thiamethoxam/bee (LC50/50); 0.00856 ng thiamethoxam/bee (LC50/500); Nosema+0.0856ng/bee; Nosema+0.00856ng/bee. All bees were individually treated 'per os' with 4µL sucrose solution containing thiamethoxam and/or 60.000 Nosema spores. Seventy-two hours after the exposure, five individuals were sampled randomly from each treatment group and processed for histopathological diagnosis. Morphological alterations in the digestive cells of the midgut's posterior region were observed in dose-dependent thiamethoxam-exposed bees. The increase of both the nuclear chromatin compaction and cytoplasm vacuolization, as well as the increase of the apocrine secretion in digestive cells and the cell elimination to the lumen were evident. Some regenerative cells of the midgut's posterior region presented morphological alterations only at the highest dose of thiamethoxam. Midgut's anterior region kept intact in bees exposed to both thiamethoxam treatments. Nosema-treated bees presented the midgut epithelium similar to the untreated bees. In bees exposed to either thiamethoxam doses and simultaneously to Nosema, an increase of the apocrine secretion in digestive cells and the cell elimination to the lumen was found. In our report we further discuss about morphological alterations in midgut tissue after thiamethoxam and Nosema spores synergism.

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B14.14

13:00 Honeybee cytochrome P450s: how a 6-million-year-old genome copes with pesticide-intensive modern agriculture

May R Berenbaum (University of Illinois at Urbana-Champaign, United States)

As a managed pollinator, the honeybeeApismelliferais critical to the American agricultural enterprise. Persistent colony losses are thus of continuing concern; possible explanations for bee decline include nutritional deficiencies and exposures to pesticide and pathogens. Genome sequencing revealed in 2006 the honeybee genome contains far fewer cytochrome P450 genes associated with xenobiotic metabolism than do most other insect genomes. The dominance of the CYP6AS family appears to relate to its role in processing phytochemicals encountered by honeybees in their distinctive diet of (processed) honey and beebread.Toxicological studies indicate that competition for access to catalytic sites of CYP9Q enzymes that detoxify pesticides may result in synergistic interactions among pesticides, a phenomenon likely exacerbated by honeybee exposures to agricultural pesticides and in-hive acaricides, over and above dietary exposures to naturally occurring dietary phytochemicals. Moreover, dietary phytochemicals play a hitherto unrecognized role in upregulation of genes associated with both immunity and defense, a finding linking nutrition to the ability to withstand both pesticides and pathogens.

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B14.15

13:30 Exposure to low levels of imidacloprid affects metabolic network of honeybee larvae

Reinhard Stöger (University of Nottingham, United Kingdom), Kamila Derecka (University of Nottingham, United Kingdom), Martin J. Blythe (University of Nottingham, United Kingdom), Sunir Malla (University of Nottingham, United Kingdom), Diane Genereux (Westfield State University, United States), Alessandro Guffanti (Genomnia srl, Italy), Paolo Pavan (Genomnia srl, Italy), Anna Moles (Genomnia srl, Italy), Charles Snart (University of Nottingham, United Kingdom), Thomas Ryder (Parks Apiaries, United Kingdom), Thomas Ryder (Parks Apiaries, United Kingdom), Catharine A. Ortori (University of Nottingham, United Kingdom), David A. Barrett (University of Nottingham, United Kingdom), Eugene Schuster (Versity College London, United Kingdom)

Evolutionarily new environmental stressors such as the neonicotinoid class of crop-protecting agents have been implicated in the population declines of pollinating insects, including honeybees (Apis mellifera). We asked if field-relevant levels of the neonicotinoid insecticide imidacloprid could influence the physiology of worker bee larvae. Over a period of 15 days, we provided syrup tainted with low levels (2µg/L-1) of imidacloprid to beehives located in the field. We measured transcript levels by RNA sequencing and established lipid profiles using liquid chromatography coupled with mass spectrometry from larvae of imidacloprid-exposed (IE) and unexposed, control (C) hives. Within a catalogue of 300 differentially expressed transcripts in larvae from IE hives, we detect significant enrichment of genes functioning in lipid-carbohydrate-mitochondrial metabolic networks. Altered metabolism is also implied by our lipid profiling results, where we observed significant differences in ratios of around 15% of the sampled lipid metabolites between IE and C larvae. Collectively, we identify a multifaceted, physiological response of worker bee larvae to an evolutionarily novel stress factor. We discuss how pesticide exposure in early life could lead to persistent changes in gene expression patterns that are mediated by epigenetic programming mechanisms.

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B14.16

14:00 Sub-lethal effects of neonicotinoids on neuronal function and dysfunction.

Christopher N Connolly (University of Dundee, United Kingdom)

Insect pollinators are exposed to neonicotinoids in the environment at very low (ppb) doses but the effects of this exposure are still hotly debated. We have determined the delivery rate of ingested imidacloprid to the brains of Apis mellifera and Bombus terrestris and related this exposure level to neuronal function. At field-relevant doses, imidacloprid in bumblebees reaches neuroactive levels and can induce neuronal damage. At even lower levels in bumblebees, imidacloprid can increase neuronal vulnerability to other, normally innocuous, insults. Field studies indicate that the level of Varroa infestation does not correlate with overwintering failures in honeybees suggesting that most beekeepers are successfully controlling Varroa destructor. Furthermore, miticide treatment itself does not appear to have a major impact on colony survival rates. Therefore, the impact of pesticides and how they interact with nutritional deficits and disease remain critical questions in the understanding of insect pollinator declines.

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B14.17

15:00 Operation Pollinator 2001-2013

Geoffrey Coates (Syngenta, United Kingdom)

In 2001 the Buzz project sponsored by Syngneta Unilever and DEFRA commisioned reseach into the Greening of the CAP (Common Ag Policy)after concerns form the farming community about how it would effect the businesses and landscape. Buzz showed that these measures could deliver the greening and biodiversity to the landscape whilst continuing to farm in the same field . From these results in 2005 Operation Bumblebee was formed and over 1200ha of vital Pollen & Nectar habitat were established in the UK. In 2009 the project moved to Europe and now exists in 16 countries , there are 15 different seed mixes to suit climate soil type and pollinator. And the value as yield and quality of the Pollination services that it brings to the landscape are being developed as ecosystem services to mass flowering crops. There are a number of research projects undertaking this work in academic institutions across Europe. Operation Pollinator demonstrates that commercial sustainable food production and positive environmental management can co-exist in our landscape – after all its food for us and food for wildlife in the same field”

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B14.18

15:30 Interaction of dietary protein and neonicotinoids on the survival and nutrient balancing of the buff-tailed bumblebee, *Bombus terrestris*

Geraldine A Wright (Newcastle University, United Kingdom), Sophie Derveau (Newcastle University, United Kingdom), Daniel Stabler (Newcastle University, United Kingdom), Jessica Mitchell (Newcastle University, United Kingdom)

Poor nutrition, diseases and exposure to pesticides in modern agriculture are all like to contribute to the decline of wild pollinators. We know surprisingly little about the nutritional needs of wild pollinators and whether or not they obtain sufficient nutrients from modern agricultural landscapes. Several controversial studies have shown that colonies of buff-tailed bumblebees, Bombus terrestris, exposed to neonicotinoids in food have impaired brood rearing, compromised foraging, and poor worker survival. Nutrition could be an important mitigator of the survival of wild pollinators when they are exposed to low doses of pesticides. Here, we used the Geometric Framework for nutrition to identify the optimal nutrition of adult foraging workers of Bombus terrestris for diets composed of protein and carbohydrates. We also we tested nutrition the bumblebee's susceptibility to the neonicotinoid pesticide, imidacloprid. Using a paired-diet design, our experiments identified the intake target (IT), or optimal ratio of protein-to-carbohydrate (P:C) to be 1:75. When bees were exposed to imidacloprid, they ate significantly less food. As expected if pesticides increased the demand for nutrients, the bumblebees' IT shifted towards a diet higher in protein. Contrary to our expectations, however, bees fed diets containing protein had a significantly greater risk of dying than bees fed sucrose alone. We predict that bees that consume neonicotinoids face a trade-off between consumption of protein that they need for reproduction and somatic maintenance and their survival. Our data identify a possible mechanism for the previously observed slow declines of wild bee populations exposed to neonicotinoids

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B14.19

16:00 Investigating the effects of neonicotinoids on glucose oxidase - a honey bee hypopharyngeal gland secretion

Elizabeth J Collison (University of Exeter, United Kingdom), Heather J Hird (Food and Environment Research Agency, United Kingdom), Charles R Tyler (University of Exeter, United Kingdom), James C Cresswell (University of Exeter, United Kingdom)

The honey bee hypopharyngeal gland (HPG) synthesises several proteins important for colony function. Major Royal Jelly Proteins (MRJPs) are secreted from the HPG of nurse bees to feed the brood, whilst secretions from older foragers are dominated by Glucose Oxidase (GOX) to sterilise colony honey supplies. Honey bee workers experimentally exposed to the neonicotinoid imidacloprid and the microsporidian pathogen Nosema spp in combination have been shown to have a reduced GOX activity (Alaux et al., 2010). This was not the case when exposed to these two factors separately. Recent studies have also found that oral exposure to sublethal doses of imidacloprid resulted in a reduction in the diameter of the acini in the honey bee HPG (Heylen et al., 2010; Smodis Skerl and Gregorc, 2010; Hatjina et al., 2013). Following these findings, the European Food Safety Authority (EFSA) new guidance document (July 2013) outlined that an assessment of honey bee HPGs should be included in pesticide risk assessment. Here we investigated the effect of imidacloprid and thiamethoxam on GOX activity in honey bees. We observed an increase in GOX activity in imidacloprid-exposed honey bees, but found no effect of thiamethoxam exposure. We hypothesise that this increase may result from a reduction in HPG size, leading to a shift from MRJP-secretion to GOX-secretion, but this needs investigation for verification. These findings support the hypothesis that imidacloprid may lead to a premature shift from nurse to forager role in worker honey bee development.

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B14.20

16:15 How apicultural practices and *Nosema ceranae* affect individual honey bee health?

Paula M. Garrido (Laboratorio de Artrópodos Universidad Nacional de Mar del Plata-CONICET, Argentina), Karina Antúnez (Departamento de Microbiología Instituto de Investigaciones Biológicas Clemente Estable, Uruguay), Martín P. Porrini (Laboratorio de Artrópodos Universidad Nacional de Mar del Plata-CONICET, Argentina), María B. Branchiccela (Departamento de Microbiología Instituto de Investigaciones Biológicas Clemente Estable, Uruguay), Giselle M. Martínez Noël (Instituto de Investigaciones en Biodiversidad y Biotecnología, Argentina), Pablo Zunino (Departamento de Microbiología Instituto de Investigaciones Biológicas Clemente Estable, Uruguay), Martín J. Eguaras (Laboratorio de Artrópodos Universidad Nacional de Mar del Plata-CONICET, Argentina)

Honey bee colonies are exposed to pesticides used in agriculture or within bee hives by beekeeper intervention. The organophosphate coumaphos and the pyrethroid tau-fluvalinate are widely used to control Varroa destructor. These acaricides are applied directly to bee hives, accumulate in wax and had been detected even in commercial bee wax foundation. Nosemosis caused by Nosema ceranae is one of the most prevalent and pathogenic disease that affect adult honeybees. Interactive effects between N. ceranae and sublethal dosis of these acaricides (at concentrations found in honey) on immune related genes were assessed. In order to allow honeybee development under a free-acaricide environment, plastic foundation was used and bees drawn out the foundation. Gene expression changes in nurse bees were measured using qPCR. This work demonstrates that chronic exposure with tau-fluvalinate significantly reduced the transcription of genes encoding the antimicrobian peptides abaecin and hymenoptaecin. Coumaphos decreased vitellogenin and lysozyme expression and, in combination with N. ceranae infection, reduced levels of abaecin and enhance phenoloxidase transcripts. Only defensin and glucose dehydrogenase genes were not altered by the different treatments. Immune response at individual level and susceptibility to pathogens may be compromised when honeybees are exposed not only to sublethal doses of acaricides but N. ceranae infection and their interactive effects.

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B14.31 Relation between treatment of bee colonies with coumaphos or amitraz on their residue levels in honey, bee brood and beeswax

Tomaz Snoj (Veterinary faculty University in Ljubljana, Slovenia), Blanka Premrov Bajuk (Veterinary faculty University in Ljubljana, Slovenia), Katarina Babnik (Veterinary faculty University in Ljubljana, Slovenia), Luka Milcinski (Veterinary faculty University in Ljubljana, Slovenia), Vlasta Jencic (Veterinary faculty University in Ljubljana, Slovenia), Metka Pislak Ocepek (Veterinary faculty University in Ljubljana, Slovenia), Martina Skof (Veterinary faculty University in Ljubljana, Slovenia), Silvestra Kobal (Veterinary faculty University in Ljubljana, Slovenia)

The aim of the study was to assess the accumulation of coumaphos and amitraz residua in honey, bee brood and beeswax after the treatment of honeybee colonies against varosis (Varroa destrucor). The study was conducted in two apiaries on two different locations. In the first location ten bee colonies of Apis melifica carnica were treated with coumaphos (CheckMite, Bayer, Germany) and on other location five bee colonies were treated with amitraz (Apivar, Veto-Pharma, France). Non-treated colonies served as controls. Honey, wax and brood samples were collected before and six weeks after the treatment. Detection of coumaphos and amitraz and its metabolites DPMF, DMF and DMA in honey and brood was performed by HPLC with UV detection, while wax coumaphos and amitraz and its metabolites were determined using GC. Coumaphos levels in honey from treated and non-treated bee colonies were found bellow MRL (100 µg/kg). In the brood from treated colonies coumaphos levels ranged between 49.0 and 784.1 µg/kg. Interestingly, coumaphos in wax was found in treated and non-treated bee colonies. The levels of coumaphos in the wax were high and ranged between 0.19 and 36 mg/kg. High coumaphos residua accumulation in wax in both treated and untreated colonies are probably the results of the bee colonies treatments with coumaphos before the reasearch. However, the levels of amitraz and its metabolites were found bellow limit of detection. Our study shows that coumaphos accumulates in wax and brood, while amitraz and its metabolites do not accumulate in honey, brood nor wax.

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B14.40 A novel assay to assess the impact of chemicals on learning behavior and locomotion in honey bees

Nicholas Kirkerud (University of Konstanz Neurobioloy, Germany), David Gustav (University of Konstanz Neurobioloy, Germany), Giovanni Galizia (University of Konstanz Neurobioloy, Germany)

Recent results suggest that pesticides, especially neonicotinoids have impacts on learning, memory and locomotion of honey bees even at sub-lethal doses. So far assessment of these effects has been accomplished through time-consuming, expensive and/or technically challenging PER (Proboscis Extension Response)-conditioning, RFID-tagging or video analysis of movement assays. We recently developed a flexible conditioning device, APIS (Automatic Performance Index System), where effects of chemicals such as pesticides can be quantified in a standardized and convenient way: Bees are introduced into a walking chamber where they learn to associate injected odors with mild electric shocks. The bees' movement is continuously sampled by infrared photosensors, enabling us to quantify learning and locomotion by analyzing different movement parameters. All controlling elements are integrated in a single device, and operated through a single program. This allows us to use a variety of training protocols where the bee's behavior governs the triggering of stimuli (operant conditioning). To demonstrate APIS as a diagnostic tool, we present results from two different experiments: One where the acute effect of the neonicotinoid Acetamiprid is tested in an operant differential conditioning-paradigm and another where the short-term effect of Thiamethoxam is tested in an operant absolute conditioning-paradigm. Our results show that bees treated with sub-lethal doses of these two commonly used neonicotinoids have impaired performance

compared to untreated bees, in that they fail to recognize the reinforced odor from the neutral odor.
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B14.41 An examination of targets of organophosphorus pesticides in human and honey bee brains.

John W Grzeskowiak (School of Medicine University of Nottingham, United Kingdom), Fryni Drizou (School of Medicine University of Nottingham, United Kingdom), Ian Mellor (School of Life Sciences University of Nottingham, United Kingdom), Amaia M Erdozian (Department of Pharmacology University of the Basque Country, Spain), Benito Morentin (Department of Pharmacology University of the Basque Country, Spain), Luis F Callado (Department of Pharmacology University of the Basque Country, Spain), Wayne G Carter (School of Medicine University of Nottingham, United Kingdom)

Organophosphorus (OP) compounds are widely used as commercial and domestic pesticides. Toxicity of OP compounds arises from the targeted inhibition of acetylcholinesterase (AChE), a serine hydrolase active on the post synaptic membrane of neurons. Pesticides that target cholinergic neurotransmission have been shown to be highly effective in controlling populations of pest insects, however both organophosphate and neonicotinoid pesticides have been implicated in the decline of honey bee populations. In addition to cholinesterases OP pesticides have been shown to bind and adduct other secondary protein targets. This promiscuous binding remains a health concern to humans and animals, with an association between low-level exposure to OPs and impaired neurobehavioral function being recently suggested (Ross et al., 2013). Furthermore a recent letter in nature communications indicates that sublethal levels of neonicotinoids are able to disrupt honeybee learning and behaviour, principally through postsynaptic depolarization meditating block of neuronal firing (Palmer et al., 2013).
We have examined post-mortem human brain tissue and brains from honey bees to assess the presence of secondary OP targets. Human and bee brain tissue was fractionated by differential centrifugation and proteins radiolabelled with the broad serine hydrolase inhibitor tritiated-diisopropylfluorophosphate (3 H-DFP). From quantitation of radiolabelling, and protein resolution by one dimensional and two dimensional gel electrophoresis, we aim to characterise secondary OP targets in both tissues.
Once identified their influence on cellular and homeostatic mechanisms can begin to be dissected. PALMER, M. J. et al. 2013. Nat Commun, 4, 1634.
ROSS, S. M. et al. 2013. Crit Rev Toxicol, 43, 21-44.
Email: stxjwg@nottingham.ac.uk

B14.42 An examination of targets of organophosphorus pesticides in human and honey bee brains

Fryni Drizou (School of Medicine Nottingham University, United Kingdom), John Grzeskowiak (School of Medicine Nottingham University, United Kingdom), Ian Mellor (School of Life Sciences University of Nottingham, United Kingdom), Amaia M. Erdozian (Department of Pharmacology University of the Basque Country, Spain), Benito Morentin (Department of Pharmacology University of the Basque Country Spain, Spain), Luis F. Callado (Department of Pharmacology University of the Basque Country, Spain), Wayne G. Carter (School of Medicine Nottingham University, United Kingdom)

Organophosphorus compounds (OPs) have been widely used as commercial and domestic pesticides for many years, although historically some OPs have been banned because of their toxicity to non-target organisms. Toxicity of OPs arises from the targeted inhibition of acetylcholinesterase, a serine hydrolase active within nerve synapses. However, OP pesticides also bind and adduct other secondary protein targets. This promiscuous binding remains a health concern to humans and non-target organisms such as bees. Honey bees are essential insects for life existence on the planet because of their role as pollinators. It is as yet equivocal as to whether pesticides such as OPs contribute to the existing problem of bee population decline, but the need to understand how OPs directly affect bees, and from their environmental persistence affect other organisms as well as humans, is a crucial research topic. We have examined post-mortem human brain tissue and brains from honey bees to assess the presence of secondary OP targets. Human and bee brain tissue was fractionated by differential centrifugation and proteins radiolabelled with the broad serine hydrolase inhibitor tritiated-diisopropylfluorophosphate (3 H-DFP). From quantitation of radiolabelling, and protein resolution by one dimensional and two dimensional gel electrophoresis, we aim to characterise secondary OP targets in both tissues. Once identified their influence on cellular and homeostatic mechanisms can begin to be dissected.
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B14.43 Nutrition and immunity in honeybees: a lab study

Gennaro Di Prisco (University of Naples, Italy), Francesco Pennacchio (University of Naples, Italy), Geraldine Wright (Newcastle University, United Kingdom)

Honeybees (Apis mellifera L.) play a key-role in the environment and are essential for pollination of many crop plants. Honeybee immunity can be adversely affected by a number of biotic and abiotic stress factors, which can synergistically interact. In the past few years, an increasing occurrence of colony decline and eventual collapse has been reported globally. These declines are often associated with colonies containing high loads of pathogens and parasites, with bees exhibiting clear signs of bee immunosuppression, but are also associated with increased exposure to pesticides and acaricides. One critical factor that could improve bee resistance to pesticides, parasites and pathogens is colony nutrition. Here we tested whether access to essential amino acids in diet influenced adult worker bee susceptibility to the neonicotinoid pesticide, imidacloprid. We also measured immunocompetence in this population and pathogen load of deformed wing virus (DWV). Our results indicate that diets high in amino acids reduce survival and promote a more intense proliferation of DWV. The effect of diet on survival was amplified by exposure to imidacloprid. Our study shows that there are potentially severe and unpredictable interactions between dietary components and pesticides on immunocompetence and survival that are likely to account for honeybee colony collapse.
Email: gennaro.diprisco@unina.it

B14.44 Understanding and managing honey bee health in the UK: beekeeper knowledge and engagement with science and policy

Emily Adams (Lancaster University, United Kingdom), Rebecca Ellis (Lancaster University, United Kingdom), Ken Wilson (Lancaster University, United Kingdom)

Insect pollinators have become well-recognised symbols of environmental issues and biological decline for the media and general public. Much attention has focused on honey bees. In the UK, beekeeping has become very popular, with membership of beekeeping organisations rising rapidly. Simultaneously, there has been a rapid expansion in academic research on insect pollinators in the UK and elsewhere. However, little of this has focused directly on beekeeping communities, despite their role in supporting honey bee populations during a period when they have been challenged by multiple, interacting stressors (including pests and diseases, habitat loss and fragmentation, and climatic variation). Using semi-structured interviews, participant observation and experimental work, we investigated beekeeping knowledge and engagement with science and policy in beekeeping communities in north west England. We found that whilst many beekeepers are passionate about

honey bees, expending time and resources on ensuring the health of their colonies, this does not always translate into an interest in wider environmental issues. We reflect on what implications this could have for the future, whether it is reasonable to expect hobby beekeepers to become stewards for a key ecosystem service like pollination, and how future engagement between academia and the beekeeping community could be carried out.
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B14.45 Effects of field relevant concentrations of imidacloprid and clothianidin on bee neuronal function
Christopher Moffat (University of Dundee, United Kingdom), Mary J Palmer (University of Dundee, United Kingdom), Christopher N Connolly (University of Dundee, United Kingdom)
Neonicotinoids are nicotinic acetylcholine receptor agonists displaying high affinity in insects. Worldwide, these insecticides are used in veterinary products and as agricultural pesticides. Their high affinity and specificity to insects has underpinned their commercial success but there are increasing concerns regarding their effects on important pollinators. While there is mounting evidence that sub-lethal doses of neonicotinoids can have detrimental effects on bees; there is continuing controversy over the precise levels of pesticides to which bees are exposed in the field and stemming from this the levels that reach bee brains. This study investigated the levels of imidacloprid: the archetypal neonicotinoid reaching bee brains and the effects of concentrations within this range on neuronal health and function. 18 hour to 8 day feeding experiments were conducted with Apis melliferra and Bombus terrestris using food laced with environmentally relevant levels of imidacloprid. Experiments revealed low levels in the brains of both species that were sufficient to cause rapid neuronal damage in Bombus terrestris only. Chronic exposure of cultured Bombus Kenyon cells to low (nM) imidacloprid produced vulnerability to normally sub-toxic insults. Electrophysiological recordings from Bombus Kenyon cells revealed that sub-nanomolar concentrations of clothianidin had an apparent desensitising effect on nicotinic acetylcholine receptors. In conclusion, exposure of bees to field-relevant levels of neonicotinoids may result in brain concentrations that affect neuronal function.
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B14.46 The herbizide Paraquat induces neuronal cell death and locomotor dysfunction in a *Tribolium castaneum* model of Parkinson´s disease
Annely Brandt (Bieneninstitut Kirchhain, Germany), Ralph Büchler (Bieneninstitut Kirchhain, Germany), Andreas Vilcinskas (IME Fraunhofer Institut, Germany)
Paraquat (N,N -dimethyl-4-4-4 -bypiridinium) is a widely used herbicide in agriculture. Epidemiological and experimental studies point Paraquat as an etiological agent for Parkinson´s disease. The damage done by Paraquat is caused by oxidative stress that leads to the damage of lipids, proteins, RNA, and DNA. Paraquat induces Parkinson-like pathologies, e.g. degeneration of dopaminergic neurons in the brain and locomotor dysfunction in rodents as well as in insect-model organisms. We established a Paraquat-based Parkinson-model in the red flour beetle Tribolium castaneum with the aim to screen for neuroprotective substances. Paraquat treated beetles showed a significant increase in the number of apoptotic neurons in the brain, impaired climbing ability, and increased tonic immobility. We found that the known Parkinson-drug L-DOPA, but also Curcumin, hempseed flour, Ascorbic acid and tea extracts of Uncariae ramulus had neuroprotective effects.
Email: annelyb@web.de

B14.47 Investigating sublethal effects of a neonicotinoid pesticide on bumblebee navigation and foraging behaviour
Dara A Stanley (Royal Holloway University of London, United Kingdom), Nigel E Raine (Royal Holloway University of London, United Kingdom)
Bumblebees are essential pollinators of many important agricultural crops and wild plants. While foraging in agricultural farmland bees are likely to be exposed to pesticides applied for crop protection. Although bees typically encounter these pesticides at sublethal levels, exposure may still have impacts on factors such as behaviour or reproduction with potential consequences for colony fitness. Here we examined the impact of field realistic doses of a neonicotinoid pesticide, thiamethoxam, on foraging and navigation in a common bumblebee Bombus terrestris. We used Radio Frequency IDentification (RFID) tag technology to monitor colonies in a semi-field experiment. Colonies were located in the lab but had free access to forage for nectar and pollen outside. Our results indicate varying effects of pesticide exposure on both bumblebee foraging and homing ability.
Email: dara.stanley@rhul.ac.uk

B14.48 The levels of neonicotinoids that pollinators are exposed to whilst foraging on oilseed rape
Kristopher D Wisniewski (Keele University, United Kingdom), Dr Falko Drijfhout (Keele University, United Kingdom), Dr William D.J Kirk (Keele University, United Kingdom)
Honey bees, bumble bees and stingless bees only represent a small proportion of insect pollinators; however, they provide important and economically valuable pollination services to agriculture and many terrestrial ecosystems. The recent documented decline of social pollinators has been a central concern to the scientific and wider communities, with pesticides being identified as a key contributing factor to the falling numbers.
Chronic exposure to low levels of pesticides, whereby direct mortality does not occur, has been shown to induce sublethal effects, which can have profound effects on both the individual and ultimately the overall functioning and survival of a colony. Various methods of pesticide exposure have been identified; including contaminated pollen and nectar collected during foraging; but at what levels? In this poster we present the levels of three neonicotinoids found in the pollen and nectar collected from oilseed rape.
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B14.49 Modelling the impacts of various pesticide effects on the honeybee colony
Jack CO Rumkee (University Of Exeter, United Kingdom), Matthias A Becher (University of Exeter, United Kingdom), Juliet L Osborne (University of Exeter, United Kingdom)
Studies have shown that the sublethal effects of pesticides may have a significant effect on the behaviour or development of the honeybee (Dai et al. 2010, Schneider et al. 2012 for example) and that this may lead to adverse effects on the colony as a whole. We have been using the BEEHAVE model (Becher et al. currently under reveiw), to investigate the effects of brief periods of increased foraging mortality, reduced egg-laying and disturbed larval development on the health of the colony, with an intent to aid further pesticide risk-assessment, as it has been suggested that a more solid understanding is required before sublethal effects can be confidently included in the risk assessment (Thompson and Maus 2007). BEEHAVE is an individual-based model that includes multiple stressors acting on a honey bee colony, allowing a more realistic model of the reaction of the colony to, for example, the introduction of a pesticide to the landscape. The use of modelling in this investigation is of great value as to conduct field experiments with enough power to answer the same questions has already proven to be difficult (Cresswell 2010), and to continue the trials over

long periods of time is a difficult task. The results produced show that the effects are very dependent on the timing of the effects through the year and that sublethat effects can have a significant effect on the colony health."
Email: jr401@ex.ac.uk

B14.50 Ectopic expression of Apis mellifera voltage-gated Ca2+ channel subunit reveals an original phospholipid-dependent regulation of Ca2+ currents

Matthieu Rousset (CNRS, France), Thierry Cens (CNRS, France), Michel Bellis (CNRS, France), Claude Collet (INRA, France), Raymond Valérie (Université d'Angers, France), Pierre Charnet (CNRS, France)

Insecticides have been suspected to participate in abnormally elevated mortalities occurring in domestic honeybee apiaries worldwide. Among the currently commercialized pesticides, Pyrethroids are synthetic insecticides broadly used for their major neurotoxic action on the insect nervous system. These chemically engineered compounds, mainly described as targeting Na+ channels, have also been suspected to inhibit invertebrate and vertebrate voltage-gated Ca2+ channels. However, the molecular tools needed to precisely study the impact of these drugs on the physiology and toxicology of the honeybee are still lacking. We have identified in the genomic honeybee database three pore-forming CaV subunits that could belong to the CaV1, CaV2 and CaV3 families, a single CaV and three CaV 2- subunits. We report here the cloning, expression and characterization of the unique CaV subunit (AmCaV). AmCaV is expressed in thorax and leg muscles, and in different structures of the honeybee brain. When expressed in Xenopus oocytes with the mammalian CaV2.2 or CaV2.3 Ca2+ channel subunit, the Apis subunit increases the current amplitude and shifts the current-voltage curve toward hyperpolarized potentials. Interestingly, the AmCaV subunit also slows the inactivation kinetics of the current. In the presence of AmCaV subunit, the slow inactivation is regulated by drugs that affect the level of phosphoinositides. This regulation is also found in honeybee neurons in primary culture, thus suggesting that the AmCaV subunit can regulate channel inactivation via dynamic interactions with the plasma membrane. These results may help to understand the functional diversity of voltage-gated Ca2+ currents recorded in honeybee muscle and neurons.
Email: matthieu.rousset@crbm.cnrs.fr

B14.52 Can honeybees sense neonicotinoids? Reception of Imidacloprid in *Apis mellifera*

Matthias Schott (Justus Liebig University Giessen, Germany), Annely Brandt (LLH Bieneninstitut Kirchhain and Fraunhofer IME Giessen, Germany), Andreas Vilcinskas (Justus Liebig University Giessen and bLLH Bieneninstitut Kirchhain, Germany)

Neonicotinoids are regularly discussed in the context of the honey bee colony losses. The amount of applied neonicotinoids in agriculture has rapidly increased since 2006. Up to now, it is not known if honey bees are able to sense neonicotinoids. If they are able to detect these chemicals that are relatively new to their environment, this could be one reason for unusual behavior. As Imidacloprid is one of the top-selling pesticides worldwide, we started our electroantennographic investigation with this neonicotinoid, to answer the question if they could smell it. We measured the reaction ofApis melliferato different concentrations of Imidacloprid by connecting dissected foraging worker antennae in an antenna holder chip. Thereupon we recorded the summed voltage emitted by the antennae sensilla after air puffs loaded with specific amounts of Imidacloprid. Our first data indicate thatA. melliferais able to sense Imidacloprid in environmentally significant concentrations. We will discuss our findings in the context of the infochemical effect. They are a starting point for further investigations that may prove the honey bee's misinterpretation of the neonicotinoid signal.
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B14.53 Spatial variation of metal concentrations found in honeys around Greater Manchester

David De Peña (Manchester Metropolitan University, United Kingdom)

Honey bees (Apis mellifera) forage up to 4km, and can access around 50km² from their apiaries, thus sampling a huge number of individual points, from all environmental compartments such as water, air and soil. As honey is considered a composited random sample, it has the potential of providing the most representative values for the average concentrations of bio available elements in an areas environment. In this study, the contents of Al, As, Ba, Ca, Cd, Co, Cu,Fe, K, Mg, Mn, Mo, Na, Ni, P, Pb, S, Sr, and Zn were determined by inductively coupled plasma optical spectrophotometry (ICP-OES) on honey samples collected from members of the Manchester and District Beekeepers Association (MDBKA) around Manchester during 2012 and 2013. Multidimensional statistical analysis of the honey samples showed that there were correlating factors present in the distribution of the metals determined within the honey samples, and relationships between geographical location and metal content were clearly seen. Confirmation of this was also seen from the GIS contour maps which showed the spatial distribution of the heavy metals determined from the ICP-OES analysis, with lead being distributed mainly amongst the south of the study area and arsenic around the north. The results of this study indicate that honey can serve in the detection of spatial patterns of metal concentrations within the environment, even at relatively low levels of pollution.
Email: daviddepena@gmail.com

Programme & Talks: Friday 24 January

Chair: Chris Connolly

09:00 **Richard Schmuck**
(Bayer CropScience, Germany)
A causal analysis of the role of neonicotinoid insecticides in the reported declines of bee colonies (Apis mellifera)
B14.21

09.30 **Peter Neumann**
(University of Bern)
The neonicotinoids in solitary bees
B14.22

10:00 **Maj Rundlöf**
(Lund University, Sweden)
A replicated landscape scale field study of impacts of clothianidin seed dressing in oilseed rape on wild and managed bees
B14.23

10:15 *Coffee/tea break*

10:45 **Matthias Becher**
(University of Exeter, UK)
BEEHAVE: An integrated honey bee model and its application to pesticide scenarios
B14.24

11:15 **Discussion: Knowledge gaps, policy changes and future risks**

12:00 **Questions**

B14.21

09:00 **A causal analysis of the role of neonicotinoid insecticides in the reported declines of bee colonies (*apis mellifera*)**
Richard Schmuck (Bayer CropScience, Germany), Christian Maus (Bayer CropScience, Germany)
Reported declines in overwinter survival of bee colonies (Apis mellifera) in Western Europe, and the onset of colony collapse disorder in 2006 in North America encouraged many researchers to investigate the causative factors behind the bee health problem. Throughout many study reports on this subject, there is a peculiar hierarchy of reasoning: first that the increased numbers of bee losses are due to multiple causes, including stress caused by unspecified pesticides, then that pesticides must be given priority in the investigation of the effects, and then that neonicotinoids are the pesticides of concern. There have been incidents of acute toxicity that appear to be linked to exposure of bees to dust from neonicotinoid seed treatments, but these are unrelated to the kind of chronic toxicity and effects from sublethal exposure that have been postulated. The authors performed a causal analysis of reported declines in bee colonies with a special emphasis on the role of neonicotinoid insecticides.
Email: richard.schmuck@bayer.com

B14.22

09:30 **The neonicotinoids in solitary bees**
Peter Neumann (University of Bern)

B14.23

10:00 **A replicated landscape scale field study of impacts of clothianidin seed dressing in oilseed rape on wild and managed bees**
Maj Rundlöf (Lund University, Sweden), Georg KS Andersson (Lund University, Sweden), Riccardo Bommarco (Swedish University of Agricultural Sciences, Sweden), Ingemar Fries (Swedish University of Agricultural Sciences, Sweden), Veronica Hederström (Lund University, Sweden), Lina Herbertsson (Lund University, Sweden), Björn K Klatt (Lund University, Sweden), Thorsten R Pedersen (Swedish Board of Agriculture, Sweden), Johanna Yourstone (Lund University, Sweden), Henrik G Smith (Lund University, Sweden)
Sublethal doses of neonicotinoids have been shown to negatively impact the health of bees. However, studies to date have only artificially fed bees with low doses and no well designed and replicated study has examined if such impacts are observed for bees foraging under field conditions. We used a study system of 16 spatially separated (>4 km) spring oilseed rape fields, where eight of the fields were randomly assigned to be sown with clotianidin dressed seeds and the other eight as controls, to assess neonicotinoid residues and impacts on wild and managed bees in Sweden. Six equally sized Apis mellifera colonies, from controlled queen origin, six commercially bred Bombus terrestris colonies, and 27 cocoons of Osmia bicornis were placed at each field. Colony development was monitored for honey bees and bumble bees, foraging trip duration and survival for bumble bees, reproduction for bumble bees and solitary bees and density of all foraging bees in fields and borders. Samples to detect insecticide residues were taken from field border vegetation during sowing and of pollen and nectar from honey bees foraging in the experimental fields and of bees at the hives during rape flowering. Five neonicotinoids, including clothianidin, were detected in the samples. Samples from the treated fields generally had an order of magnitude higher clothianidin concentrations compared to those from control fields. The study can reveal the level of neonicotinoid exposure in agricultural landscapes, as well as the field-realistic impacts of clothianidin seed dressing on bees foraging in such landscapes.
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B14.24

10:45 BEEHAVE: An integrated honey bee model and its application to pesticide scenarios

Matthias Becher (Environment Sustainability Institute, University of Exeter, United Kingdom), P. J. Kennedy (Environment Sustainability Institute, University of Exeter, United Kingdom), J. L. Osborne (Environment Sustainability Institute, University of Exeter, United Kingdom)

Notable losses of managed honeybee colonies have been reported, mainly in the Northern Hemispere, which are presumed to be caused by a combination of stressors. Among these stressors, varroa mites and varroa transmitted viruses (esp. Deformed Wing Virus), forage quantity and quality, and exposure to pesticides are regularly considered as being important. To improve our understanding of the complex interactions within a colony and its environment, we developed BEEHAVE, a honeybee model that integrates colony dynamics, agent-based foraging in realistic landscapes and population dynamics of varroa mites, acting as vectors for viruses (Deformed Wing Virus and Acute Paralysis Virus). Pesticide exposure scenarios can be addressed with this model and we present results from simulations of increased forager mortality. The output of the model suggests that the impact of pesticide exposure on colony dynamics can depend on the season and on the availability of food in the landscape and may increase with repeated exposure over several years. BEEHAVE is currently under review and will be publicly available for download and use in the near future.

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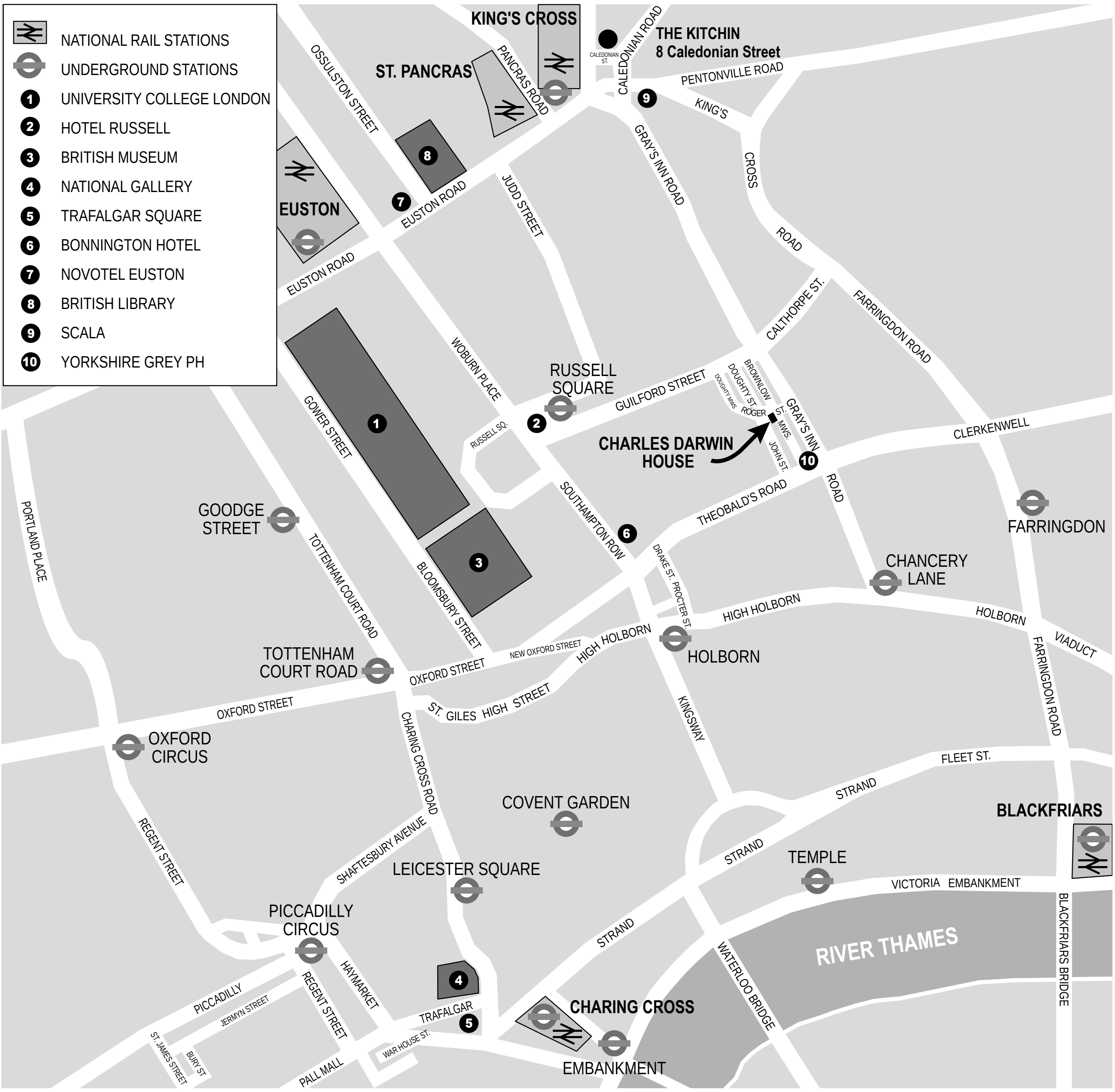
Venue

Lectures and registration will take place at:
Charles Darwin House
12 Roger Street
London WC1N 2JU
Tel: 020 7685 2400

Venue Map



Registration

Registration will take place from 11:00 to 13:00 on Wednesday 22 October at Charles Darwin House reception. Staff will be on hand throughout the meeting should you need any assistance.

Badges must be worn for the duration of the meeting, both for security purposes and for entry to the lectures and social events.

Delegate Information

Meals and Refreshments

The registration fee includes lunches, refreshments throughout the meeting and the conference dinner on Thursday 23 January.

Lunch and refreshments will be served at the following times:

Wednesday 22 January

Lunch	12:00 – 13:00
Coffee/tea	14:30 – 15:00
Drinks reception and buffet dinner	17:00 – 19:00

Thursday 23 January

Coffee/tea	10:30 – 11:00
Lunch	12:00 – 13:00
Coffee/tea	14:30 – 15:00
Drinks reception	16:45 – 19.00
Conference Dinner	19.30 – 21.30

Friday 24 January

Coffee/tea	10:15 – 10:45

Social Programme

We have organised a number of informal networking and social events throughout the meeting; these are all optional, but we encourage all delegates to attend to get the most from the conference.

Drinks receptions will be held in the break out area of Charles Darwin House, where lunch and Wednesday's buffet dinner will be served. The conference dinner will be held at The Kitchin, the price of which is included in the registration fee. Directions to the restaurant are below.

Wednesday 22 January

Poster session with drinks reception and buffet dinner	17:00 – 19:00

Thursday 23 January

Poster session with drinks reception	16:45 – 19.00
Conference Dinner	19.30 – 21.30

It takes approximately 15 minutes to walk from Charles Darwin House to the conference dinner venue, 'The Kitchin'. Please follow the instructions below and refer to the map on page 23. The Kitchin is located on 8 Caledonia Street, Kings Cross, London, N1 9AA.

When you exit Charles Darwin House, go straight ahead to the main street (Gray's Inn Road) and turn left. Follow Gray's Inn Road for about 10 minutes then bear right onto Caledonia Road. At the junction of Pentonville Road (the Scala will be on your right), cross straight over and take the first left onto Caledonian Road. The Kitchin is on your left.

Information for Speakers

All lectures will take place in the Charles Darwin Lecture Theatre.

Speakers should contact a member of staff in advance of their presentation to upload their talk; it is recommended that talks are uploaded as soon as possible to avoid queues.

Information for Poster Presenters

At this conference, we encourage cross-disciplinary interactions as much as possible and want every delegate to have the opportunity to look at as many posters as feasible – so we encourage all delegates to attend both poster sessions.

Poster Sessions

Poster presenters are requested to stand alongside their posters during their session. Velcro will be provided at the registration desk. Poster display has been split into two groups:

Group 1:
abstracts numbered B14.25 – B14.39

Authors with posters in this group should hang their posters upon arrival on morning of 22 January; they will present their posters at lunchtime and on the evening of 22 January. Posters should be removed after that poster session.

Group 2:
abstracts numbered B14.40 – B14.53

Authors with posters in this group should hang their posters on the morning of 23 January; they will present their posters at lunchtime and on the evening of 23 January. Posters should be removed at the end of the meeting.

The Societies cannot be held responsible for lost or damaged posters.

Facilities Information

Accommodation

Accommodation is not included in the registration fees; all delegates are advised to make their own accommodation arrangements.

Parking

There is no parking available at Charles Darwin House; delegates are advised to use public transport services where possible as parking places in central London are limited and subject to high charges.

Bars

There are many pubs and bars available in close proximity to Charles Darwin House; for further details please visit the Registration Desk.

Medical Services

Please contact the Registration Desk in the case of a minor incident; if it is an emergency, please call 999 directly and inform staff at the Registration Desk.

Internet Access

Wireless internet access is available free of charge in all areas of Charles Darwin House. To access our wireless network, within your available wireless networks select SSID: CDH; when prompted for a password, enter time2work. In case of any connection difficulties, please visit the Registration Desk.

Shopping and Banking Facilities

There are numerous shopping and banking facilities available in close proximity to Charles Darwin House, for further details please visit the Registration Desk.

Certificates of Attendance

Attendees requiring a Certificate of Attendance for the meeting should contact the Registration Desk.

Delegate List

A delegate list will be sent by email to all attendees after the conference. Please note that this list is intended for use only to promote networking between scientists. You do not have permission to use this list for any other purpose, and any other use may infringe the Data Protection Act 1998. The list contains the names and affiliations of all attendees. Contact details are included only for attendees who gave their permission during the registration process.

Liability

The Biochemical Society, British Ecological Society and Society for Experimental Biology will assume no responsibility whatsoever for damage or injury to persons or property during the meeting. Participants are advised to arrange their own personal travel and health insurance.

Tweeting and Blogging

The societies encourage the discussion of its conferences via Twitter, Facebook and similar social networks. In order to promote discussion and the exchange of information, delegates who wish to tweet are asked to use the joint meeting hash tag: #Bees2014.

Speakers will be made aware of this policy and have the right to ask delegates not to disseminate their research via the internet; if a Speaker makes this request, delegates are asked not to discuss the relevant work in this way. Delegates are respectfully asked to refrain from communicating using mobile devices whilst lectures are in progress.

Photography

Please note that photographs taken at this event may be used for promotional purposes by any of the three societies, e.g. by inclusion on our websites and/or marketing materials. If you have any concerns or queries regarding this, please visit the Registration Desk.

Charles Darwin House Reception	+44(0) 20 7685 2400

Airports

Heathrow Airport (www.HeathrowAirport.com)	+44 (0) 870 000 0123
Lost Property	+44 (0) 20 8745 7727
Heathrow Express (www.HeathrowExpress.com)	0845 600 1515 (UK only)
Gatwick Airport (www.GatwickAirport.com	+44 (0) 870 000 2468
Lost Property	+44 (0) 870 000 2468
Gatwick Express (www.GatwickExpress.co.uk)	+44 (0) 845 850 1530
Gatwick Airport Travel Line	0870 574 7777 (UK only)
Stansted Airport (www.StanstedAirport.com)	+44 (0) 870 000 0303
Lost Property	+44 (0) 1279 663 213
Stansted Express (www.StanstedExpress.com)	+44 (0) 845 850 0 150
London City Airport (www.LondonCityAirport.com)	+44 (0) 20 7646 0088
Lost Property	+44 (0) 20 7646 0088
London Luton (www.London-Luton.co.uk)	+44 (0) 1582 405 100
Lost Property	+44 (0) 1582 405 100
Manchester Airport	+44 (0) 161 489 3000

Local Taxi Services

Bloomsbury Cars	+44 (0) 20 7379 0555

Taxis are very common around the venue and can be hailed from the pavement; please only use licensed taxis.

Other Transport Services

Transport for London (www.tfl.gov.uk)	+44 (0) 20 7222 1234
National Express Coaches (www.NationalExpress.com)	+44 (0) 990 80 80 80
National Rail Enquiries (www.NationalRail.co.uk)	+44 (0) 8457 48 49 50
Eurostar Reservations (www.Eurostar.com)	+44 (0) 20 8882 4412