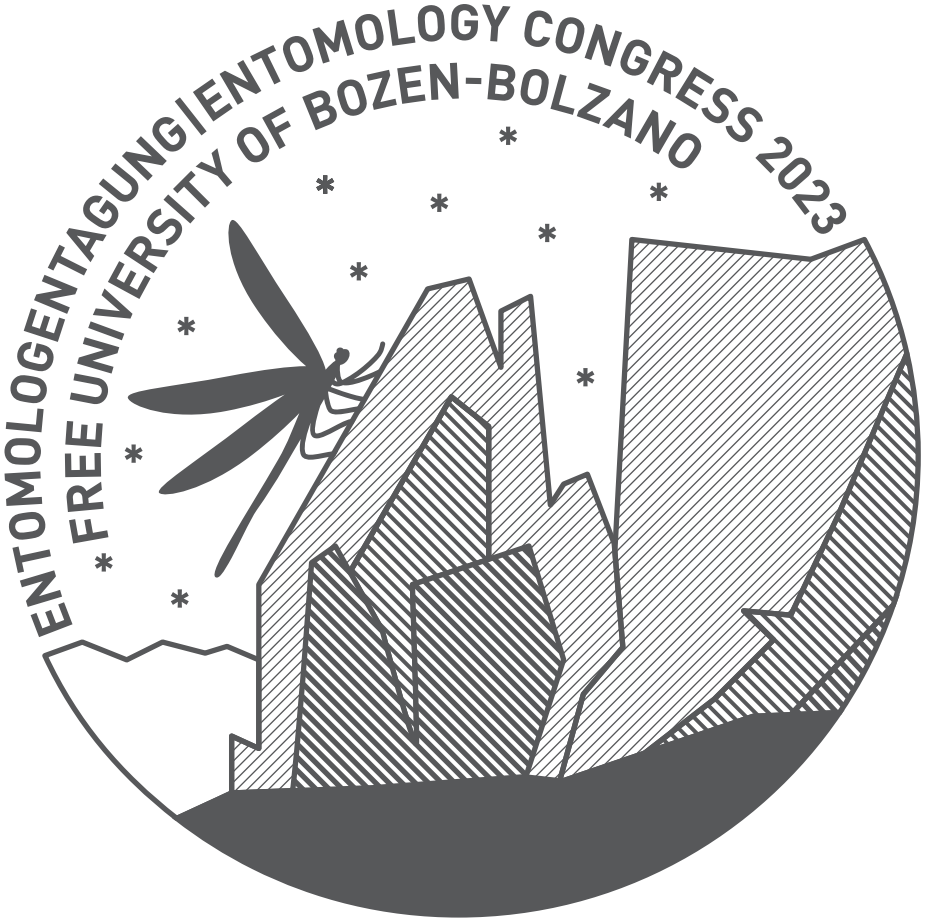
Programm / Program



Deutsche Gesellschaft für allgemeine und angewandte Entomologie (DGaaE)

Accademia Nazionale Italiana di Entomologica (ANIE)

Società Entomologica Italiana (SEI)

Accademia Nazionale Italiana di Entomologia

DGaaE

Società Entomologica Italiana

Überarbeitete, elektronische Ausgabe /
Updated, electronical edition

Zitiervorschlag für den Tagungsband / Proposed reference for congress volume:

Köhler, A., Kramp, K., Folie, R., Angeli, S. & Blank, S.M. (Hrsg./eds.) 2023: Entomologentagung 2023 in Bozen /Entomology Congress 2023 in Bolzano 20.–23.02.2023 Programm/Program – Bozen.

Danksagung und Sponsoren / Acknowledgments and sponsors

Für die finanzielle und logistische Unterstützung der Tagung danken wir folgenden Firmen:
For financial and logistic support of the conference we thank the following companies:

BAYER

syngenta

PENSOFT®
Publisher of 12+ open-access peer-reviewed journals in entomology

PIANO GREEN

Agrifutur
COLTIVA LA VITA

Springer

AULA

QM

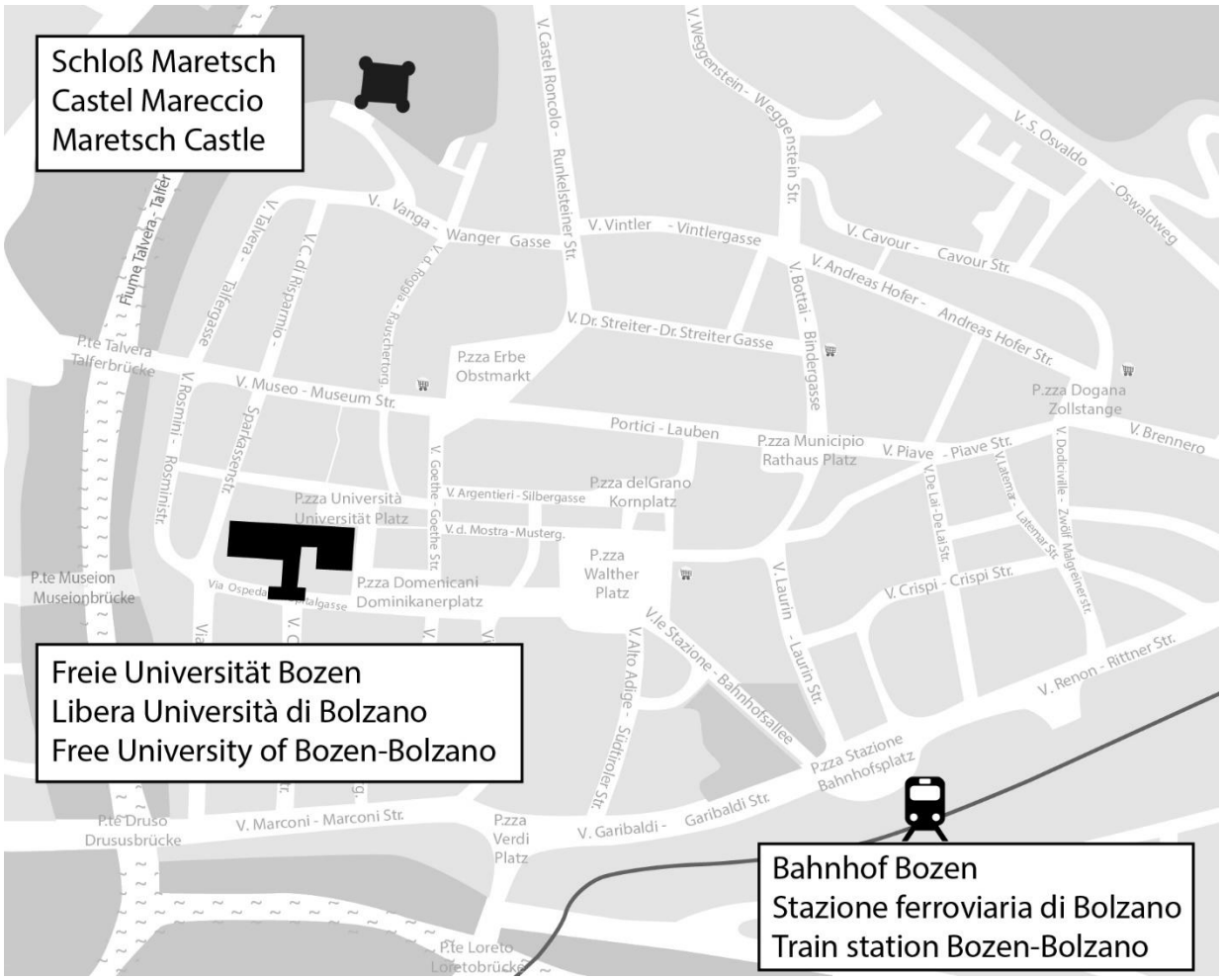
IN LITTERIS VIS 1826

capio lumen 1790

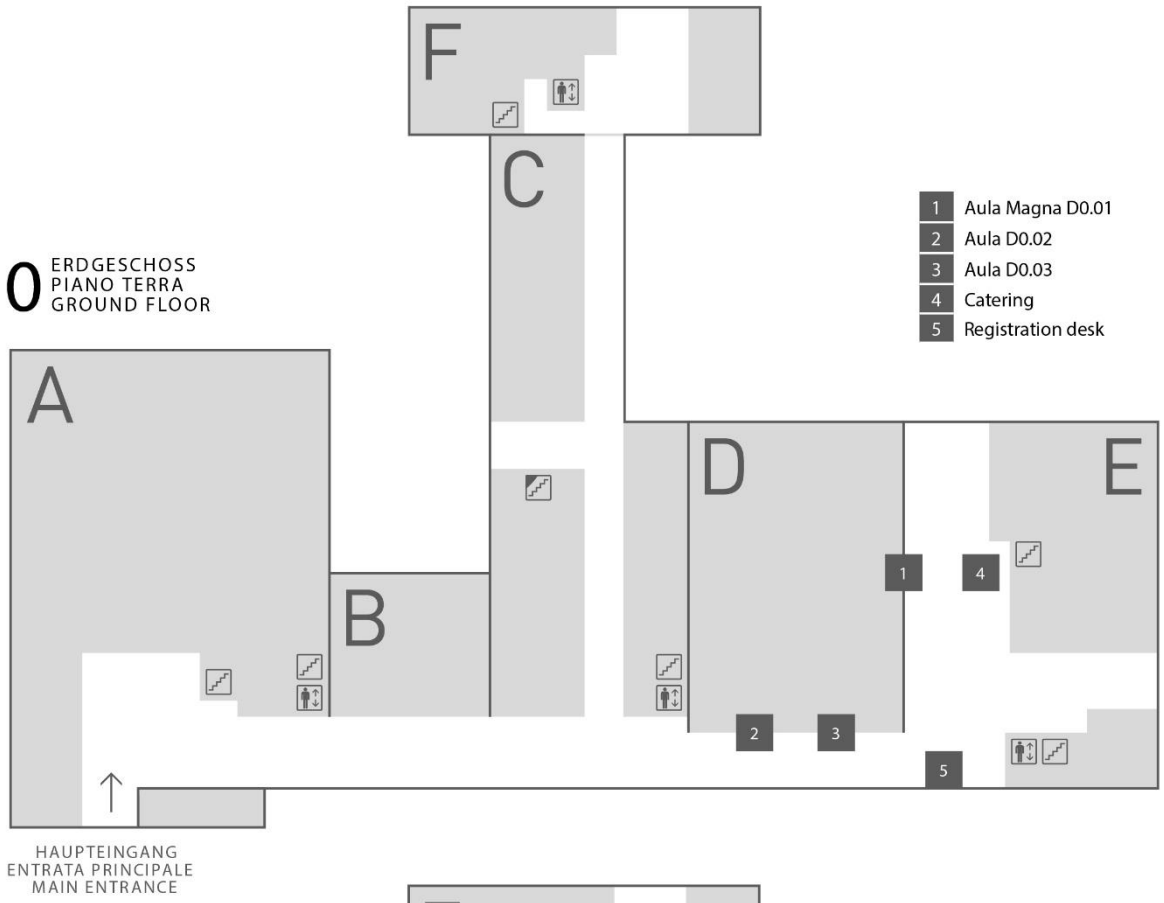
Schweizerbart Borntraeger

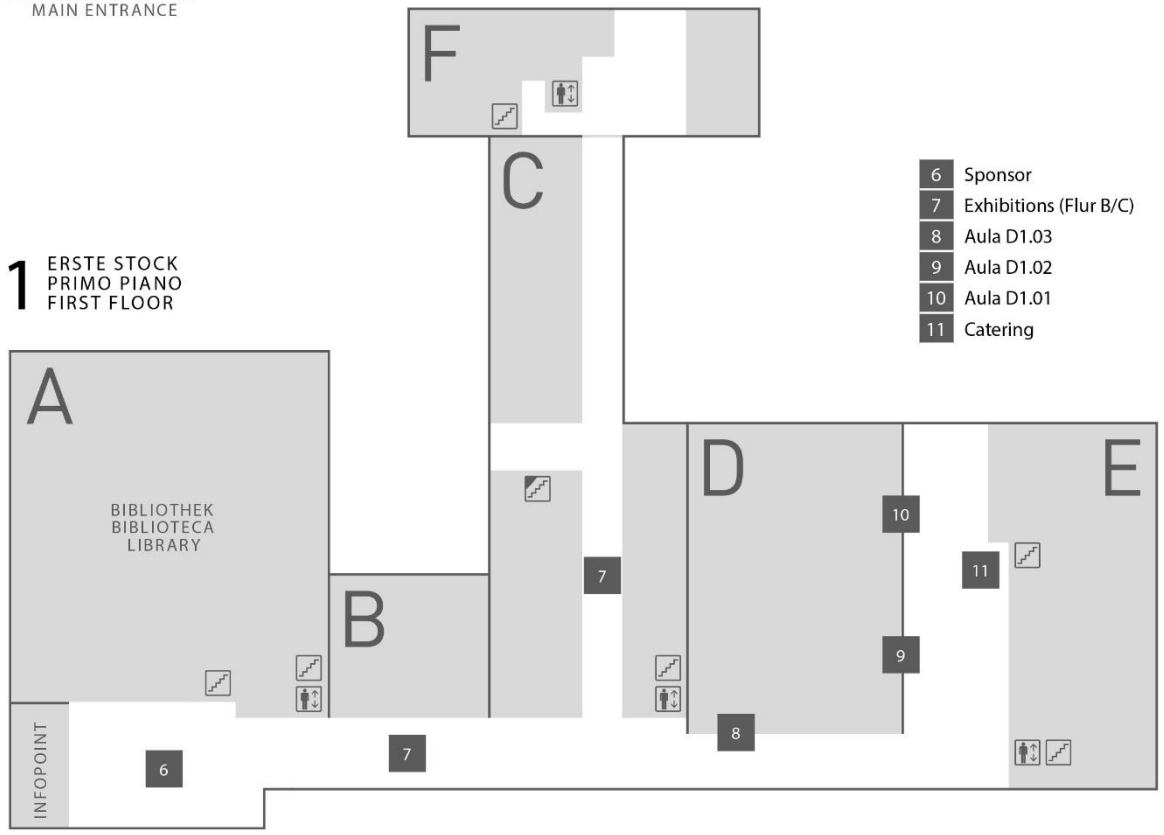
Herzlichen Dank an die Mitarbeiter:innen der Entomologentagung!
Cordial thanks to the service staff of the Entomology Congress!

Übersichtsplan Bozen / General plan Bolzano



Gebäudeplan / Building layout





Allgemeine Hinweise / General information

Registrierung / Registration

Das Tagungsbüro befindet sich im Erdgeschoss des Hauptgebäudes der Freien Universität Bozen-Bolzano, Universitätsplatz 1, Bozen.

The conference office is located on the ground floor of the main building of the Free University of Bozen-Bolzano, Universitätsplatz 1, Bolzano.

Öffnungszeiten des Konferenzbüros / Opening hours of the conference office

Montag / Monday, 20.02.2023	12:00–18:00 Uhr	/	12:00 am–6:00 pm
Dienstag / Tuesday, 21.02.2023	8:00–18:00 Uhr	/	8:00 am–6:00 pm
Mittwoch / Wednesday, 22.02.2023	8:00–16:00 Uhr	/	8:00 am–4:00 pm
Donnerstag / Thursday, 23.02.2023	8:00–10:30 Uhr	/	8:00 am–10:30 am

Konferenzgebühren / Conference fees

Für diejenigen, die noch nicht bezahlt haben: Bitte bezahlen Sie die Konferenzgebühren bei Ihrer Registrierung im Tagungsbüro. Bitte haben Sie Verständnis, dass wir nur Barzahlung akzeptieren können.

For those who have not yet paid the conference fees, please pay upon registration. Please understand that we can only accept payments in cash.

Informationstafel / Information board

Mitteilungen für andere Tagungsteilnehmer können an der Informationstafel neben dem Tagungsbüro befestigt werden. Auf dieser Tafel werden auch kurzfristige Änderungen im Programm bekannt gegeben.

Messages for other conference participants can be left at the information board close to the registration desk. Also short-term changes of the conference program will be presented on this board.

Covid-19 Prävention / Covid-19 prevention

Um eine Verbreitung des SARS-CoV-2-Virus während der Entomologentagung 2023 zuverhindern, erhält jeder Tagungsteilnehmende mit seiner Tagungstasche vier Antigen-Schnelltests. Wir möchten Sie bitten, dass Sie diese vor jedem Besuch der Tagung benutzen und bei einem positiven Testergebnis nicht an der Tagung teilnehmen.

To prevent the spread of the SARS-CoV-2 virus during the Entomology Congress 2023, each conference participant will receive four rapid antigen tests with their congress bag. We would like to ask you to use them before each visit to the congress and, in case of a positive test result, not to participate in the congress.

Garderobe / Wardrobe

Leider verfügen wir diesmal über keine Garderobe. Am Abreisetag können Sie Ihr Gepäck im Bereich des Tagungsbüros hinterlegen. Wir bitten um Ihr Verständnis, dass die Veranstalter keine Haftung übernehmen können.

Sorry, but no wardrobe will be available. At the day of your departure, you can leave your baggage in the area of the conference office. The organizers cannot assume responsibility for your belongings. Thank you for your understanding.

Internet

Während der Tagung steht eine freie WLAN-Verbindung zur Verfügung. Zugangsinformationen sind in den Vortragsräumen ausgehängt und im Tagungsbüro erhältlich.

During the conference a free WLAN-connection is available. Information for access is posted in the lecture rooms and available from the conference office.

Vorträge / Oral presentations

Hauptvorträge	30 min Redezeit + 10 min Diskussion
Kurzvorträge	15 min Redezeit + 5 min Diskussion
Pitch-Vorträge	3 min Redezeit

Bitte halten Sie die Zeitvorgaben ein! Bevorzugtes Dateiformat ist Windows PowerPoint. Mac-Benutzer: Bitte prüfen Sie rechtzeitig, ob Ihre Präsentation kompatibel ist.

Key-note lectures	30 min for the talk plus 10 min time for discussion
Regular talks	15 min for the talk plus 5 min time for discussion
Pitch-Vorträge	3 min for the talk

Please keep to the schedule! Accepted file format is Windows PowerPoint. Mac users: Please check your files for compatibility well in advance.

Abgabe der Vorträge / Submissions of oral presentations

Aus logistischen Gründen kann keine zentrale IT-Station eingerichtet werden. Alle Vortragenden einer Sektion werden gebeten, ihre PowerPoint-Präsentationen so früh wie möglich, spätestens jedoch in der Pause vor dem Vortragstermin bei der/dem Technikverantwortlichen für den jeweiligen Hörsaal abzugeben.

By logistic reasons there will be no central IT-point. We therefore kindly ask all speakers of a session to upload their presentations on the computer in the pertaining lecture hall as early as possible, at latest during the coffee or lunch break preceeding the actual presentation time.

Poster-Präsentation / Poster presentation

Die Präsentation der Poster erfolgt im 1. Stock des Universitätsgebäudes. Jedem Poster ist eine laufende Nummer zugeordnet. Die Posternummern finden Sie auf Seite 26 ff. sowie im elektronischen Supplement dieses Programmheftes (die QR-Codes sind auf Seite 30 ff. abgedruckt). Bitte hängen Sie Ihre Poster nach Ihrer Registrierung auf, um ihre Wirkung zu maximieren. Die Poster sind während der ganzen Tagung zugänglich. **Wir bitten die Autoren, während der Postersession am Dienstag, 21. Februar von 16:00 bis 18:00 Uhr, an ihrem Poster anwesend zu sein.** Die Poster sollten spätestens am Donnerstag vor 10:00 Uhr abgehängt werden. Poster, die bis zu diesem Zeitpunkt nicht abgenommen wurden, müssen leider entsorgt werden.

The posters will be presented on the 1st floor of the university building. Each poster is assigned a running number. You will find the poster numbers on page 26 ff or in the electronic supplement of this programme booklet (the QR codes are printed on page 30 ff). Please put up your posters after your registration for maximizing their impact. Posters will be accessible during the entire congress. **We kindly ask authors to be present at their poster during the poster session on Tuesday, February 21 at 4:00–6:00 pm.**
Posters should be removed latest on Thursday before 10:00 am. Remaining posters will be disposed.

Posterprämierung / Poster awards

In Ihren Tagungsunterlagen finden Sie einen Stimmzettel. Bitte füllen Sie ihn während der Poster-Session aus und geben Sie ihn im Tagungsbüro bis Mittwoch, 22. Februar 15:00 Uhr ab. Die Preisträger/innen werden während des Gesellschaftsabends im Schloss Maretsch bekanntgegeben.

Conference participants will be able to cast a ballot for the poster awards. A pertaining form is included in the conference materials. Please return it to the conference office until Wednesday, February, 22 at 3:00 pm. Laureates will receive their prices during the Social Evening at the Maretsch Castle.

Young Entomologists' Challenge

In der Young Entomologists' Challenge können junge Entomolog:innen (bis zwei Jahre nach der Promotion) ihre eingereichten Beiträge zusätzlich in Form eines spannenden Pitches von drei Minuten präsentieren. Die Young Entomologists' Challenge findet am Montagnachmittag und am Dienstagvormittag in der Aula Magna D0.01 statt. Den genauen Zeitplan finden Sie auf Seite 24–25. Die drei besten Pitch-Vorträge werden von einer Jury, die sich aus Vertreter:innen der DGaaE und der Società Entomologica Italiana besteht, prämiert. Die Preisträger/innen werden während des Gesellschaftsabends im Schloss Maretsch bekanntgegeben.

In the Young Entomologists' Challenge, young entomologists (up to two years after their doctorate) can additionally present their submitted contributions in the form of an exciting three-minute pitch. The Young Entomologists' Challenge will take place on Monday afternoon and Tuesday morning in the Aula Magna D0.01. The exact schedule can be found on page 24–25.The three best pitch presentations will be awarded prizes by a jury consisting of representatives of the DGaaE and the Società Entomologica Italiana. Laureates will receive their prices during the Social Evening at the Maretsch Castle.

Publikation der Tagungsbeiträge / Publication of conference contributions

Die Tagungsbeiträge werden in den „Mitteilungen der DGaaE“ als „extended abstracts“ publiziert. Wir bitten die Autoren, ihre Manuskripte während der Tagung bei der/dem zuständige/n Sektionsleiter/in abzugeben, oder sie so bald wie möglich bei Joachim Händel (joachim.haendel@zns.uni-halle.de) einzureichen. Die entsprechenden Richtlinien für Autoren entnehmen Sie bitte der Tagungshomepage:

https://www.dgaae.de/files/user-upload/downloads/Autorenhinweise_Tagung_2023_deutsch.pdf

Contributions will be published in the "Mitteilungen der DGaaE" as "extended abstracts". We kindly ask contributing authors to submit their manuscripts to the head of the pertaining section during the conference, or as soon as possible to Joachim Händel (joachim.haendel @zns.uni-halle.de). For author guidelines please consult the conference website:

https://www.dgaae.de/files/user-upload/downloads/Autorenhinweise_Tagung_2023_englisch.pdf

Ice-Breaker

Der Ice-Breaker wird am Montag, den 20. Februar von 18:30–19:30 Uhr im ersten Stock des Universitätsgebäudes stattfinden. Es werden Getränke und Snacks angeboten. Für angemeldete Teilnehmer/innen der Entomologentagung sind die Kosten in der Tagungsgebühr enthalten. Nach dem Ice-Breaker wird genügend Zeit für den Besuch eines der nahegelegenen Restaurants sein.

The ice-breaker will take place on Monday, February, 20, from 6:30–7:30 pm in the 1st floor of the university building. Drinks and snacks will be provided–free of charge for those who have registered for the Entomology Congress. After the ice-breaker, there still will be sufficient time to have dinner at one of the nearby restaurants.

Gesellschaftsabend / Social Evening

Der Gesellschaftsabend wird am Mittwoch, den 22. Februar von 19:30–23:00 Uhr im Schloss Maretsch (Via Claudia-de-Medici Straße 12, siehe Übersichtplan Seite 4) stattfinden. Bitte vergessen Sie nicht, den Coupon mitzubringen, den Sie bei der Registrierung erhalten, wenn Sie sich für diese Veranstaltung angemeldet haben.

The Social Evening will take place on Wednesday, February, 22, between 7:30 and 11:00 pm in the Schloss Maretsch (Via Claudia-de-Medici Straße 12, see map on page 4). Please do not forget the coupon, which you will receive upon registration if you have booked your attendance.

DGaaE-Mitgliederversammlung / Meeting of DGaaE members

Die Mitgliederversammlung findet am Mittwoch, dem 22. Februar 2023, von 16:00 bis 18:30 Uhr in der Aula Magna D0.01 statt. Im Rahmen der Mitgliederversammlung erfolgt die Verleihung der Meigen-Medaille an Frau Prof. Dr. Hannelore Hoch (Berlin), Laudator: Frau Prof. Dr. Gerlind Lehmann (Berlin), und der Weiss-Wiehe-Preise an Herrn Dr. Maximilian Lehenberger (Jena), Laudator: Herr Prof. Dr. Peter H.W. Biedermann (Stegen-Wittental), und Herrn Dr. Franz Löffler (Osnabrück), Laudator: Prof. Dr. Thomas Fartmann (Osnabrück).

The meeting of members of the society will take place on Wednesday, Febuary, 22, 4:00–6:30 pm in the Aula Magna D0.01. During the meeting, the Meigen Medal will be awarded to Prof. Dr Hannelore Hoch (Berlin), laudation by Prof. Dr Gerlind Lehmann (Berlin) and the Weiss-Wiehe Prizes to Dr Maximilian Lehenberger (Jena), laudation by: Prof. Dr Peter H.W. Biedermann (Stegen-Wittental), and to Dr Franz Löffler (Osnabrück), laudation by: Prof. Dr Thomas Fartmann (Osnabrück).

Treffen der Mitglieder der International Society of Pest Information (ISPI) / Member meeting of the International Society of Pest Information (ISPI)

Das Treffen der Mitglieder der der International Society of Pest Information (ISPI) findet am Donnerstag, 23. Februar, 09:10 Uhr in der Aula Magna D0.01 statt. Organisator ist PD Dr. Jürgen Gross.

The meeting of the members of the International Society of Pest Information (ISPI) will take place on Thursday, 23 February, 9:10 am in the Aula Magna D0.01. The organiser is PD Dr. Jürgen Gross.

Öffentlicher Vortrag / Public lecture

Professor Dr. Urs Wyss wird am Dienstag, 21. Februar von 19:30 bis 21:00 Uhr in der Aula Magna D0.01 einen öffentlichen Vortrag mit Filmvorführung mit dem Titel „Highlights aus verborgenen Insektenwelten“ halten. Der Vortrag wird simultan ins Italienische übersetzt.

Professor Dr Urs Wyss will make a public lecture (including a scientific film) titled “Highlights from a hidden insect world” at the Aula Magna D0.01 on Tuesday, February, 21, from 7:30–9:00 pm. The lecture will be simultaneously translated into Italian.

Wissenschaftliche Filme / Scientific movies

Professor Dr. Urs Wyss (www.entofilm.com) wird am Dienstag, 21. Februar von 14:40 bis 16:00 Uhr in Raum D.0.03 wissenschaftliche Filme vorführen. Eine Liste der vorgesehenen Filme finden Sie im Tagungsprogramm.

Professor Dr Urs Wyss (www.entofilm.com) will present some of his scientific films in room D.0.03 on Tuesday, February, 21 from 2:40–4:00 pm. For a list of the films selected, please see the conference program.

Kaffeepausen / Coffee breaks

Kaffee, Tee, Kaltgetränke und Snacks werden im Foyer des Universitätsgebäudes angeboten (Montagnachmittag, Dienstag und Mittwoch vor- und nachmittags).

Coffee, tea, cold drinks and snacks will be offered in the foyer of the university building on Monday afternoon, and on Tuesday and Wednesday mornings and afternoons.

Programm / Program

Hauptvorträge / Keynote lectures

Section title	Author, Titel	Time, room no.
Plenarvorträge / Plenary talks	**Andrea Battisti** Complex responses of herbivore insect pests to climate warming	Mo. / Mon. 18:00 Uhr / 6:00 pm Aula Magna D0.01
	Francesco Pennacchio Insect multitrophic interactions and sustainable plant protection	
Vorträge der Weiss/Wiehe-Preisträger / Weiss/Wiehe award lectures	**Maximilian Lehenberger** Ecology and evolution of symbiotic microbial communities in fungus-farming ambrosia beetles	Mi. / Wed. 12:10 Uhr / 12:10 am Raum / Room D1.01
	Franz Löffler & T. Fartmann Grasshoppers facing land-use and climate change: Range shifts, community dynamics and implications for conservation	Mi. / Wed. 15:20 Uhr / 3:20 pm Raum / Room D1.02
Öffentlicher Vortrag / Public lecture	**Urs Wyss** Highlights aus verborgenen Insektenwelten / Highlights from hidden insect worlds (entomologische Filme / entomological movies)	Di. / Tue. 19:30 Uhr / 7:30 pm Aula Magna D0.01
Imkerei und Bienengesundheit / Apiculture and Bee Health	**Francesco Nazzi** Pesticide impact on honey bees under realistic field conditions is still debated but the matter is clearer from a systems biology point of view	Mi. / Wed. 14:00 Uhr / 2:00 pm Raum / Room D1.03
Chemische Ökologie und Verhalten / Chemical Ecology and Behavior	**Nina Fatouros** Don't put all your eggs in one basket! Ecology and evolution of insect egg-killing plant responses	Di. / Tue. 14:00 Uhr / 2:00 pm Aula Magna D0.01
Biodiversitätsverlust und Insektenschwund / Biodiversity Decline and Loss of Insects	**Josef Settele** Insects in the context of Science-Policy activities (incl. IPBES and IPCC)	Mo. / Mon. 16:00 Uhr / 4:00 pm Raum / Room D1.01
	Robert Trusch & O. Karbiener: Wandel der Nachtfalterfauna Südwestdeutschlands seit 1970	Di. / Tue. 8:30 Uhr / 8:30 am Raum / Room D1.01
	Michael Schade Agroecosystem transformation to revert biodiversity decline: The LivinGro™ case study	Di. / Tue. 14:00 Uhr / 2:00 pm Raum / Room D1.01
Biogeographie und Faunistik / Biogeography and Faunistics	**Marco A. Bologna** Diversity and checklist of the Italian insects	Mi. / Wed. 8:30 Uhr / 8:30 am Raum / Room D0.02
Biologische Schädlingsbekämpfung / Biological Control	**Tim Haye** Consequences of competitive interactions between parasitoids for biological control	Mo. / Mon. 16:00 Uhr / 4:00 pm Raum / Room D1.02
Schädlingsbekämpfung im Pflanzen- und Vorratsschutz / Insect Control in Plants and Stored Products	**Marc F. Schetelig** Neoclassical approaches for species-specific control of agricultural pest insects	Di. / Tue. 14:00 Uhr / 2:00 pm Raum / Room D1.03
Wald-/Forstentomologie / Forest Entomology	**Peter H.W. Biedermann** The role of fungi in shaping the ecology and behavior of bark and ambrosia beetles	Mi. / Wed. 8:30 Uhr / 8:30 am Raum / Room D1.01
Insekten-Mikroorganismen Interaktionen / Insect-Microorganism Interactions	**Domenico Bosco** The bioecological traits of spittlebugs and their implications on the epidemiology of *Xylella fastidiosa* in Europe	Mo. / Mon. 16:00 Uhr / 4:00 pm Raum / Room D1.03

Section title	Author, Titel	Time, room no.
Invasive Arthropoden / Invasive Arthropods	**Lara Maistrello** *Halyomorpha halys*: A tale of intriguing disruptive invaders, from citizen science to classic biocontrol	Mi. / Wed. 8:30 Uhr / 8:30 am Raum / Room D1.02
Landschaftsökologie und Naturschutz / Landscape Ecology and Nature Conservation	**Simona Bonelli** The challenges of the UE 2030 agenda: Lesson from butterflies	Mi. / Wed. 14:00 Uhr / 2:00 pm Raum / Room D1.02
Medizinische Entomologie / Medical Entomology	**Helge Kampen** & **Doreen Werner** Monitoring and pathogen-screening of mosquitoes (Diptera: Culicidae) in Germany	Di. / Tue. 8:30 Uhr / 8:30 am Raum / Room D0.02
Morphologie, Systematik, Evolution / Morphology, Systematics, Evolution	**Sven Bradler** Cryptic or flashy: Evolution of defensive strategies in the stick and leaf insects	Di. / Tue. 14:00 Uhr / 2:00 pm Raum / Room D0.02
Molekulare Entomologie / Molecular Entomology	**Georg Petschenka** Adaptations to plant defenses as a driver of insect-plant coevolution	Mi. / Wed. 14:00 Uhr / 2:00 pm Raum / Room D0.02

Eröffnungsveranstaltung / Opening ceremony

13:00 Begrüßung und Moderation durch Prof. Dr. Sergio Angeli als Vertreter des Organisationsteams
Welcome by Prof. Dr Sergio Angeli as representative of the organizing team

13:10 Begrüßung durch Prof. Dr. Johann Gamber, Vizerektor der Freien Universität Bozen
Welcome by Prof. Dr Johann Gamber, vice rector of the Free University Bozen-Bolzano

13:20 Eröffnungsworte durch die Präsidenten der entomologischen Gesellschaften
Opening of the conference by the presidents of the entomological societies
PD Dr Jürgen Gross (DGaaE), Prof. Dr Marco A. Bologna (SEI), and Prof. Dr Andrea Battisti (ANIE)

13:30 Musik / Music

13:40 Verleihung der Fabricius-Medaille an Prof. Dr. Ekkehard Wachmann in Würdigung seiner herausragenden Leistungen auf dem Gebiet der Insekten-Morphologie durch den Präsidenten der DGaaE. Laudator: Prof. Dr. Michael Schmitt
Award of the Fabricius Medal to Prof. Dr Ekkehard Wachmann honouring his outstanding achievements in the field of insect morphology by the President of the DGaaE. Laudator: Prof. Dr Michael Schmitt

14:00 Verleihung der Fabricius-Medaille an Axel Hofmann in Würdigung seiner herausragenden Forschungsleistungen zu den Rotwidderchen (Zygaeninae) durch den Präsidenten der DGaaE. Laudator: Prof. Dr. Gerhard Tarmann
Award of the Fabricius Medal to Axel Hofmann in recognition of his outstanding research achievements on Zygaeninae moths by the President of the DGaaE. Laudator: Prof. Dr Gerhard Tarmann

14:20 Verleihung der Escherich-Medaille an Prof. Dr. Monika Hilker in Würdigung ihrer herausragenden Verdienste auf dem Gebiet der chemischen Ökologie durch den Präsidenten der DGaaE. Laudatorin: Prof. Dr. Nina E. Fatouros
Award of the Escherich Medal to Prof. Dr. Monika Hilker honoring her merits in the field of chemical ecology by the President of the DGaaE. Laudator: Prof. Dr Nina E. Fatouros

14:40 Musik / Music

14:50 Sergio Angeli: Future trends of sustainable agriculture and pest control in South Tyrol

15:20 Organisatorische Hinweise / Organisational information

15:30 Kaffeepause / Coffee break

16:00 Vortragsprogramm (siehe Seite 15) / Lecture program (see page 15)

18:00 **Plenarvortrag / Plenary talk**
A. Battisti: Complex responses of herbivore insect pests to climate warming

18:30 **Plenarvortrag / Plenary talk**
F. Pennacchio: Insect multitrophic interactions and sustainable plant protection

19:00 Kurze Pause / Short break

19:30 Ice Breaker im ersten Stock des Universitätsgebäudes
Ice Breaker on the 1st floor of the university building

20:30 Veranstaltungsende / End of session

	Monday – 20.02.2023					
	Location: **Aula Magna** D0.01 (see site map on page 5)					
13:00	**Opening ceremony** Welcome by the local organizers, the vice rector of the Free University Bozen-Bolzano, and the President of the DGaaE Award of the *Escherich Medal* and the *Fabricius Medal* (see separate program on page 13)					
15:30	**Coffee break**					
	Room D1.01	**Room D1.02**	**Room D1.03**		**Aula Magna D0.01**	
	Biodiversity Decline and Loss of Insects	Biological Control	Insect-Microorganism Interactions		Young Entomologists' Challenge	
	Chair: R. Trusch	*Chair: U. Ehlers*	*Chair: M. Schebeck*		*Jury: S. Bradler, K. Kramp, L. Maistrello, & F. Nazzi*	
16:00	Settele, J.: Insects in the context of Science-Policy activities (incl. IPBES and IPCC)	Haye, T.: Consequences of competitive interactions between parasitoids for biological control	Bosco, D.: The bioecological traits of spittlebugs and their implications on the epidemiology of *Xylella fastidiosa* in Europe			
16:40	Drukker, E. et al.: Soil-plant-insect interactions on herbaceous green roofs: How does it start?	Gonthier, J. et al.: Can we combine parasitoids with an entomopathogenic virus to efficiently control *Tuta absoluta* ?	Schuler, H. et al.: Diversity and evolution of symbionts in psyllids of the genus *Cacopsylla*		Young Entomologists' Challenge	
17:00	Enns, D. et al.: Flushing Away the Future: The Effects of Wastewater Treatment Plants on Aquatic Insects	Köneke, A. & Böckmann, E.: Wheat undersowing for pest insect regulation in white cabbage	Corretto, E. et al.: Assessing factors influencing the acquisition efficiency of the apple proliferation phytoplasma in *Cacopsylla melanoneura*			
17:20	Guariento, E. et al.: Butterfly communities in South Tyrol erode from extensive grasslands to intensively used farmland and urban areas	Posada-Vergara, C. et al.: Root colonization by fungal entomopathogen systemically primes belowground plant defense against cabbage root fly	Štarhová Serbina, L. et al.: Seasonal wild dance of dual-obligate symbionts in the pear psyllid *Cacopsylla pyricola* (Hemiptera: Psylloidea)			
17:40	**Short break**					
	Location: **Aula Magna** D0.01 (see site map on page 5)					
18:00	**Plenary talk of the Entomology Congress 2023** Andrea Battisti & Francesco Pennacchio: Insects and their interaction with the environment: New challenges and opportunities					
19:00	**Short break**					
	Location: **Ground floor unibz-Building** (see site map on page 5)					
19:30	**Ice Breaker**					
20:30	End of Ice Breaker					

Tuesday – 21.02.2023 (Locations: see site map on page 5)						
	Room D1.01	**Room D1.02**	**Room D1.03**	**Room D0.02**	**Aula Magna D0.01**	
	Biodiversity Decline and Loss of Insects	Biological Control	Insect-Microorganism Interactions	Medical Entomology	Young Entomologists' Challenge	
	Chair: M. Schade	*Chair: T. Haye*	*Chair: H. Schuler*	*Chair: J. Amendt*	*Jury: S. Bradler, K. Kramp, L. Maistrello, & F. Nazzi*	
8:30	Trusch, R. & Karbiener, O.: Wandel der Nachtfalterfauna Südwestdeutschlands seit 1970			Kampen, H. & Werner, D.: Monitoring and pathogen-screening of mosquitoes (Diptera: Culicidae) in Germany		
9:10	Krahner, A. et al.: Standardizing bee sampling: A systematic review of pan trapping and associated floral surveys	Poudel, R. et al.: Combining banker plants and tailored flower strips: what can flowering plant species provide for optimizing bio-control?	Dudzic, J.P. et al.: Screening for viruses in natural spotted wing *Drosophila* populations in British Columbia, Canada	Schaub, G.: Comparison of the bacteriolytic activity and the pattern of bacteriolytic compounds in the saliva, stomach and small intestine of the haematophagous bug *Triatoma infestans* (Reduviidae)–A review	Young Entomologists' Challenge	
9:30	Martini, J. et al.: The last hideout: Abundance patterns of the not-quite-yet extinct mayfly *Prosopistoma pennigerum* in the Albanian Vjosa River network	Schulze-Sylvester, M. & Tálamo, A.: Can artificial sugar supplements interrupt the mutualism between Argentine ants and vine mealybugs?	Enciso, J. et al.: Bacterial diversity and distribution of core microbiome in *Scaphoideus titanus* (Hemiptera: Cicadellidae)	Pospischil, R.: Dermestidae–A challenge in pest management		
9:50	Sedlmeier, J.E. et al.: Neonicotinoid exposure mimicking spray drift exposure strongly reduces plant bug abundance (Heteroptera: Miridae) on meadows	Tscholl, T. & Walzer, A.: Thermal stress in an acarine predator-prey relationship: shifts in development, fecundity and predation success induced by heat waves may more harm the predator than its prey	Milenovic, M. et al.: Plant-mediated rifampicin treatment of *Bemisia tabaci* disrupts but does not eliminate endosymbionts	Uttah, E. & Uttah, C.: Metacercarial infection of edible crab (*Sudanautes*), and crab-eating behavior in transmission of paragonimiasis in Calabar suburbs, Nigeria		
10:10	Sittinger, M. & Herz, A.: DIY camera trap for automated insect monitoring	Becker, C. et al.: Behavioural and immunological defense traits of Lobesia botrana larvae are affected by host plant phenology and cultivar as well as indirectly by atmospheric CO_2 concentrations	Stauffer, C. et al.: Unidirectional incompatibility in the European cherry fruit fly, *Rhagoletis cerasi* : 50 years of research on a *Wolbachia* -insect relationship			
10:30	**Coffee break**					
	Tuesday – 21.02.2023					
		Room D1.02	**Room D1.03**	**Room D0.02**	**Aula Magna D0.01**	
		Biological Control	Insect Control in Plants and Stored Products	Medical Entomology	Young Entomologists' Challenge	
		Chair: T. Haye	*Chair: C. Stauffer*	*Chair: R. Pospischil*	*Jury: S. Bradler, K. Kramp, L. Maistrello, & F. Nazzi*	
11:10		Bischoff, R.T. et al.: Modelling Predator-prey Interactions between the Earwig *Forficula auricularia* and the Woolly Apple Aphid *Eriosoma lanigerum* in Apple Orchards	Bänsch, S. & Schumann, M.: Phenotyping of beet moth damage	Lutz, L. et al.: On the influence of environmental factors on the oviposition activity of necrophagous flies	Young Entomologists' Challenge	
11:30		Dorn, F. et al.: Temperature modulates via behavioural changes the intraguild predation between the predatory mites *Neoseiulus californicus* and *Euseius stipulatus*	Wolf, M. & Gruber, A.: Erhebungen und Untersuchungen zum Befall durch heimische Borkenkäferarten im Südtiroler Apfelanbau	Amendt, J. & Lutz, L.: Entomologie der Verwahrlosung und Vernachlässigung in der rechtsmedizinischen Praxis		

11:50		Ehlers, R.-U. & Godina, G.: Can naturally occurring antagonists supported by re-establishment of entomopathogenic nematodes secure sustainable, insecticide-free production of oilseed rape?	Favaro, R. et al.: Ethanol traps to reduce the damage of the ambrosia beetle *Anisandrus dispar* in apple orchards	Kamtsap, P. et al.: Molecular systematics of black flies (Diptera: Simuliidae) in Cameroon, Ethiopia, Tunisia, Nigeria, and Germany		
12:10		Ekejiuba, E. et al.: Colour preference and attraction of *Encarsia formosa* (Gahan) towards LED monitoring traps	Carnio, V. et al.: *Cydia pomonella* (Lepidoptera: Tortricidae) management through female removal in apple crop of Trentino-Alto Adige Region			
12:30	**Lunch break**					
	Tuesday – 21.02.2023					
	Room D1.01	**Room D1.02**	**Room D1.03**	**Room D0.02**	**Aula Magna D0.01**	**Room D0.03**
	Biodiversity Decline and Loss of Insects	Biological Control	Insect Control in Plants and Stored Products	Morphology, Systematics, Evolution	Chemical Ecology and Behavior	Entomologische Filme Entomological movies
	Chair: A. Krahner	*Chair: U. Ehlers*	*Chair: C. Stauffer*	*Chair: S. Bradler*	*Chair: J. Gross*	
14:00	Schade, M.: Agroecosystem transformation to revert biodiversity decline: The LivinGro™ case study		Schetelig, M.F.: Neoclassical approaches for species-specific control of agricultural pest insects	Bradler, S.: Cryptic or flashy: Evolution of defensive strategies in the stick and leaf insects	Fatouros, N.: Don't put all your eggs in one basket! Ecology and evolution of insect egg-killing plant responses	
14:40	Uhl, B. et al.: There are no "winners of climate change"–Increasing temperatures and their effect on Mediterranean moth communities	Falagiarda, M. et al.: Introduction and establishment of the parasitoid *Trissolcus japonicus* in South Tyrol: A three-year release program	Fürstenau, B. & von Moltke, P.: Toxic effects of the major constituents of thyme and caraway essential oils on stored product pest beetles	Mirzaee, Z. et al.: More species than ever thought in the enigmatic mantid genus *Holaptilon* Beier, 1964 (Gonypetidae, Gonypetinae)	Austel, N. et al.: Of glucosinolates and saponins–Pollen beetles can cope with general but not with specific plant defence compounds in crucifers	Wyss, U: Entomologische Filme / Entomological movies
15:00	Uhler, J. et al.: "nützLINK"–A citizen science based approach to monitor beneficial arthropods in agricultural landscapes in Germany	Furtwengler, J. & Böckmann, E.: Development of a rearing system for the potential biocontrol agent *Pemphredon lethifer*	Bovio, M. et al.: Identifying thrips resistance in wild accessions of *Chrysanthemum*	Jung, S.V. & Hörnig, M.K.: Standing the test of deep time–Cockroach ootheca from the Early Cretaceous to the present day	Nuotclà, J.A. & Nachbaur, F.: Ambrosia beetles adjust social investment based on expected inclusive fitness benefits	
15:20	von Berg, L. et al.: InsectMow: Development and Evaluation of insect and spiderfriendly mowing techniques	Godina, G.: Potential of entomopathogenic nematodes to control the oilseed pests *Psylliodes chrysocephala* (Coleoptera: Chrysomilidae)	Abdelgader, H.: Effects of some soft insecticides on the egg parasitoid *Trichogramma cacoeciae* Marchal (Hym. Trichogrammatidae)	Salden, T. & Peters, R.S.: Putting ceraphronoid wasps (Hymenoptera: Ceraphronoidea) back on the map	Rüde, D. et al.: Phenotyping for chemical defence of *Sinapis alba* and *Brassica napus* seedlings against herbivory by cabbage stem flea beetle (*Psylliodes chrysocephala*)	
15:40		Caarls, L. et al.: Breeding for enhanced attraction of natural enemies by crop plants		Yilak, A.: *Simulium* vectors of onchocerciasis in different ecological zones of Ethiopia: A paradigm of parasite-vector associations	Wimmer, E.A. et al.: Sulfate conjugation as intermediate step in the safe production of harmful defensive secretions in beetle stink glands identified by transcriptomics and the genome-wide phenoytpic screen iBeetle	
16:00	**Coffee break and …**					
	… Poster session					
18:00	End of sessions on Tuesday					
	Location: **Aula Magna** D0.01 (see site map on page 5)					
19:30	**Public lecture / Öffentlicher Vortrag:**					
20:30	Urs Wyss: Highlights aus verborgenen Insektenwelten / Highlights from hidden insect worlds (Simultaneous translation into Italian)					

Wednesday – 22.02.2023						
	Room D1.01	**Room D1.02**		**Room D0.02**	**Aula Magna D0.01**	
	Forest Entomology	Invasive Arthropods		Biogeography and Faunistics	Chemical Ecology and Behavior	
	Chair: M. Lehenberger	*Chair: A. Reineke*		*Chair: M. Wendt*	*Chair: T. Meiners*	
8:30	Biedermann, P.H.W: The role of fungi in shaping the ecology and behavior of bark and ambrosia beetles	Maistrello, L.: *Halyomorpha halys* : A tale of intriguing disruptive invaders, from citizen science to classic biocontrol		Bologna, M.A.: Diversity and checklist of the Italian insects		
9:10	Frühbrodt, T. et al.: Avoiding the masses: Infestation density dependent release of the aggregation inhibitor verbenone from Norway spruce logs infested with the Eurasian spruce bark beetle, *Ips typographus* (L.)	Hartung, V. & Schneider, A.: Quantitative analysis of citizen science data on Heteroptera: Example of the invasive heteropteran *Halyomorpha halys* distribution		Ivković, S. et al.: Patterns of intraspecific differentiation in the bush-cricket *Isophya modestior* (Orthoptera: Tettigoniidae)	Betz, A. et al.: Monarchs sabotage milkweed to acquire toxins, not to disarm plant defense	
9:30	Hofmann, S. et al.: Influence of oscillating temperatures on the developmental rate of *Ips typographus*	Preti, M. et al.: *Halyomorpha halys* mass trapping in northern Italy: Preliminary results		Nooten, S. et al.: The abundance, biomass and distribution of ants on earth	Boevé, J.-L. & Rozenberg, R.: Sawflies containing toxic peptides	
9:50	Lawall, A.: IPSolut – Erforschung von Grundlagen für die Entwicklung eines Verfahrens zur minundativen biologischen Bekämpfung des Buchdruckers (*Ips typographus* L.)	Preti, M. et al.: Cimice.Net: An area-wide program to monitor *Halyomorpha halys* in northern Italy		Balthasar, C. et al.: Do forest fires have an impact on moth communities?	Ruther, J. et al.: Yet they do it–De novo biosynthesis of fatty acids in parasitic wasps	
10:10	Spann, E.: EIVES – Entwicklung innovativer Verfahren zur naturnahen Regulierung des Großen Buchdruckers (*Ips typographus* L.) durch Antagonisten	Eben, A. et al.: New information on *Halyomorpha halys* from SW-Germany–Data on monitoring, specific fruit damage, and parasitoid presence in orchards		Trusch, R. et al.: Wiederentdeckung der eunivalen Schmetterlingsart *Psodos wehrlii* nach 86 Jahren für Südtirol (Lepidoptera: Geometridae)	Singh, P. et al.: More evidence for strain, not species steering phenotype expression in *Nasonia* parasitoid wasps (Hymenoptera: Chalcidoidea: Pteromalidae)	
10:30	**Coffee break**					
	Wednesday – 22.02.2023					
	Room D1.01	**Room D1.02**	**Room D1.03**	**Room D0.02**	**Aula Magna D0.01**	
	Forest Entomology	Invasive Arthropods	Insect Control in Plants and Stored Products	Biogeography and Faunistics / Molecular Entomology	Chemical Ecology and Behavior	
	Chair: P.H.W. Biedermann	*Chair: C. Borghesi*	*Chair: N. Austel*	*Chair: R. Trusch*	*Chair: N. Fatourus*	
11:10	Henkel, M.: Biologische Borkenkäferprävention – Ein entomopathogener Pilz als Teil eines nachhaltigen Produktkonzepts	Häussermann, I. et al.: Population genomic analyses and de novo whole genome sequencing of invasive cerambycids in Europe to decipher the invasion patterns	Meiners, T. & Will, T.: Back to the future–New ways of plant protection against insect pests	Wendt, M. et al.: Untangling the mito-nuclear discordance of the alpine butterfly *Erebia pronoe*	Greenberg, L. et al.: Finding an egg in a haystack: Variation in chemical cue use by egg parasitoids of herbivorous insects	
11:30	Heber, T.: Mass trapping of the large pine weevil *Hylobius abietis* –Challenges and chances	Salah, C. et al.: Effect of traps directions on the density of the peach fruit fly, *Bactrocera zonata* (Diptera: Tephritidae) in Gezira State, Sudan	Rostás, M. et al.: Current research on the biology and management of the planthopper *Pentastiridius leporinus* , a vector of the new sugar beet disease Syndrome “Basses Richesses”	van der Linden, C. et al.: Museomics reveals patterns of within-species divergence and diversification in *Troides* birdwings (Lepidoptera: Papilionidae)	Niemann, J.-U.: Attract, confuse, repel: Visual perception and possibilities of optical manipulation of insect pests	

11:50	Hallas, T. et al.: Towards a holistic risk assessment of Norway spruce dominated forests under climate change	Schulze-Sylvester, M. & Reineke, A.: Climate change impacts on mealybugs vectoring grapevine leafroll disease	Kuhn, D. et al.: Using a Farnesene Isomer Mixture as an Insecticide Alternative for Aphid Control	Amineni, V.P.S. et al.: dsDNA is a potential competitor for dsRNA degrading nucleases in the watery saliva of *Halyomorpha halys*	Rahman, S. et al.: Drought matters: Higher aphid performance and reduced parasitoid attraction to plant volatiles alter tritrophic interactions in sugar beet	
12:10	**Weiss/Wiehe award lecture** Lehenberger, M.: Ecology and evolution of symbiotic microbial communities in fungus-farming ambrosia beetles	von Adelmannsfelden, S.: Beute- und Nistplatzpräferenzen der neozoischen Grabwespe *Isodontia mexicana* (Hymenoptera: Sphecidae)	Schmidt, S. et al.: A novel "attract and kill" control strategy against *Drosophila suzukii* in cherry orchards	Jaume-Schinkel, S.: GBOL III: Two years shining light into the dark taxa: The moth flies project (Diptera: Psychodidae)	Ronchetti, F. et al.: Worker-worker similarity of both gut microbiome and cuticular hydrocarbon profile is higher between nestmates rather than between sisters in a eusocial sweat bee with heavy nest-drifting behaviour	
12:30	**Lunch break**					
	Wednesday – 22.02.2023					
	Room D1.01	**Room D1.02**	**Room D1.03**	**Room D0.02**	**Aula Magna D0.01**	
	Forest Entomology	Landscape Ecology and Nature Conservation	Apiculture and Bee Health	Molecular Entomology	Chemical Ecology and Behavior	
	Chair: T. Frühbrodt	*Chair: T. Fartmann*	*Chair: S. Angeli*	*Chair: R. Trusch*	*Chair: J. Ruther*	
14:00		Bonelli, S.: The challenges of the UE 2030 agenda: Lesson from butterflies	Nazzi, F.: Pesticide impact on honey bees under realistic field conditions is still debated but the matter is clearer from a systems biology point of view	Petschenka, G.: Adaptations to plant defenses as a driver of insect-plant coevolution		
14:40	Brunkau, M.: Detektion und Überwachung des Auftretens invasiver Arten mittels transportabler Ionenmobilitätsspektroskopie (IMS) und neuartigem Monitoringverfahren – Erste Ergebnisse aus dem Projekt DETMON	Siggelkow, C.: Museum collections and field monitoring schemes give insight into *Phengaris* butterfly populations and their main distribution in Bavaria	Balogh, J. et al.: Habitat effects on sucrose responsiveness reveal the STRANGEness of honeybees	Rank, A. et al.: Microgels as a novel delivery platform for RNAi-mediated insect pest control	Rahman, S. et al.: Drought differentially affects the preference and performance of *Pegomya cunicularia* by altering the plant chemistry of sugar beet	
15:00	Zankl, T. et al.: The role of parasitoids and pathogens in the collapse of a spongy moth, *Lymantria dispar* L. (Lep., Erebidae), outbreak in Lower Austria	Blümel, S. et al.: Attractiveness of different flower strips for beneficial arthropods of agricultural landscapes	Favaro, R. et al.: Honeybee pollen loads to monitor pesticides residues and pesticide drift in alpine valleys	Bubeníková, K. et al.: Chalcid wasps and their genomic background: Life strategy and its influence on genes	Rostás, M. et al.: Ecological functions of *Trichoderma* spp. volatiles in the interaction with soil arthropods and root pathogens	
15:20		**Weiss/Wiehe award lecture** Löffler, F. & Fartmann, T.: Grasshoppers facing land-use and climate change: Range shifts, community dynamics and implications for conservation			Meiners, T. et al.: Fruit in a dish–An assay to test the influence of raspberry varieties and compounds on spotted-wing *Drosophila* development	
15:40	**Coffee break**					
	Location: **Aula Magna** D0.01 (see site map on page 5)					
16:00 **18:00**	**DGaaE-Mitgliederversammlung / General meeting of the DGaaE members** including the award of the *Meigen Medal* and the *Ingrid Weiss/Horst Wiehe Prize*					
	Location: **Maretsch Castle / Schloss Maretsch** (see site map on page 4)					
19:30	**Farewell party / Gesellschaftsabend** Poster awards & awards of Young Entomologists' Challenge / Posterpreise und Preise der Young Entomologists' Challenge Access opened from 7 pm / Einlass ab 19 Uhr					
23:00	End of Farewell Party					

Thursday – 23.02.2023						
		Room D1.02	**Room D1.03**	**Room D1.01**	**Aula Magna D0.01**	
		Landscape Ecology and Nature Conservation	Apiculture and Bee Health	Molecular Entomology	ISPI Meeting	
		Chair: J. Schumacher	*Chair: S. Angeli*	*Chair: M. Wendt*	*Chair: J. Gross*	
9:10		Obwegs, L. et al.: Multi-taxonomic comparison of arthropod groups between extensive orchard meadows and intensive apple orchards	Lara, E. et al.: Neuartige Markierungen von Bienen mit buntem bzw. fluoreszierendem Mehl sowie ihr digitale Kartierung in georeferenzierten Datenbanken und nachfolgende Detektion mit Online-Kamerasystemen	Cheng, S. et al.: Ecdysone starts dorsal closure and is targeted by selection for fast developing beetle eggs	**ISPI Meeting: Member meeting of the International Society of Pest Information.** The agenda has already been mailed to ISPI members.	
9:30		Plunger, J. et al.: Soil Biodiversity Monitoring as a useful tool on a way to a sustainable, biodiversity-friendly agriculture	Salah, F.E.E.: Effect of communication towers on the performance and behavior of *Apis mellifera* L. (Hymenoptera: Apidae) (the external activity)	Plate, C. et al.: Characterization and functional analysis of ABCB transporters in the leaf beetle *Chrysochus asclepiadeus*		
9:50		Steinwandter, M. et al.: Diversity patterns, community and functional composition of (high) alpine ground-dwelling invertebrates	M. Mustafa: t.b.a.			
10:10						
10:30	**Ende der Entomologentagung 2023 / End of the Entomology Congress 2023**					

Plenary talks / Plenar Vorträge

Insects and their interaction with the environment: New challenges and opportunities

Complex responses of herbivore insect pests to climate warming

A. Battisti

Although it is well known that insects are sensitive to temperature, how they will be affected by ongoing global warming remains uncertain because these responses are multifaceted and ecologically complex. We reviewed the effects of climate warming on 31 globally important phytophagous (plant-eating) insect pests to determine whether general trends in their responses to warming were detectable. We included four response categories (range expansion, life history, population dynamics, and trophic interactions) in this assessment. For the majority of these species, we identified at least one response to warming that affects the severity of the threat they pose as pests. Among these insect species, 41% showed responses expected to lead to increased pest damage, whereas only 4% exhibited responses consistent with reduced effects; notably, most of these species (55%) demonstrated mixed responses. This means that the severity of a given insect pest may both increase and decrease with ongoing climate warming. Overall, our analysis indicated that anticipating the effects of climate warming on phytophagous insect pests is far from straightforward. Rather, efforts to mitigate the undesirable effects of warming on insect pests must include a better understanding of how individual species will respond, and the complex ecological mechanisms underlying their responses.

Andrea Battisti, Università di Padova, Legnaro, Italy
andrea.battisti@unipd.it

Insect multitrophic interactions and sustainable plant protection

F. Pennacchio

Reduction of pesticide use in agriculture requires the sustainable exploitation of ecosystem services provided by functional biodiversity, and an increasing availability of low-impact tools and strategies of pest control.
Current research being carried out seeks to develop novel, highly specific biopesticides based on knowledge obtained from the understanding of the molecular mechanisms underlying multitrophic associations among plants, insects and their natural antagonists.
This approach allows to use biocontrol agents beyond the organism level, to develop control strategies based on their virulence factors or on molecular technologies that reproduce their negative impact on pests. Host regulation factors and strategies adopted by insect natural antagonists are a nearly untapped source of bioinsecticide molecules currently being explored to develop bioinspired pest control tools for sustainable plant protection.
Moreover, an in-depth understanding of the mechanisms underlying insect multitrophic interactions allows the definition of protection strategies for beneficial insects and the ecosystem services they provide.

Francesco Pennacchio, University of Napoli "Federico II", Portici, Italy
f.pennacchio@unina.it

Weiss/Wiehe-Preis Vorträge / Weiss/Wiehe award lectures

Ecology and evolution of symbiotic microbial communities in fungus-farming ambrosia beetles

M. Lehenberger

The cultivation of fungi by insects is not unique to attine ants and certain termites. In fact, wood-boring beetles, which are inoculating and culturing species-specific fungi within the nutrient-poor xylem of trees, are a famous example of a third highly evolved mutualism between insects and microbes. This active farming of nutritional, so-called ambrosia fungi evolved independently in at least twelve lineages of weevils (Curculionidae: Scolytinae, Platypodinae) and one lineage of ship-timber beetles (Lymexylidae), which are jointly termed ambrosia beetles. The beetles obligately depend on their ambrosia fungi not only because they serve as the sole source of nutrition, but also because they can provide several further benefits to their beetle host. For instance, they can act as detoxifiers of host-tree defense compounds, degraders of woody polysaccharides, and putative sources of natural product compounds with bioactive capabilities. However, despite years of research on these insect-microbe system, only little is known about the ecology of the ambrosia fungi themselves up to date. Studies on these fungi are crucially needed, especially since some invasive ambrosia beetles and their introduced fungal crops are globally threatening forest ecosystems, plantations, and the timber industry. Increased knowledge of the benefits of mutualistic fungi for the beetles may be used for the improvement of management tools like biological pest control.
In my presentation, I will highlight the ability of ambrosia beetle fungi to outcompete ubiquitous pathogenic fungi by a general tolerance towards ethanol, naturally produced by weakened and recently dead trees, the preferred substrate of ambrosia beetles. Moreover, I will present my recent findings about the translocation of essential elements via mutualistic fungi and their accumulation on the gallery walls in the nests of ambrosia beetles. The availability of these elements is of crucial importance as they are the base for various metabolic processes such as the formation of amino acids. These amino acids in turn act as key players in the emission of a vast variety of volatile organic compounds, the source of the intriguing and long-known characteristic fruity smell of ambrosia fungi. Beyond this, only little is known about individual volatiles as well as about changes in the volatile profile between different fungi. In the last part of my presentation, I will provide novel insights into emitted volatiles of such mutualistic fungi and speculate about their function in ambrosia beetle systems. These findings have a high potential for practical applications such as monitoring of beetle populations and may additionally serve as basis for future pest management strategies.

Maximilian Lehenberger, Max Planck Institute for Chemical Ecology, Jena, Deutschland
mlehenberger@ice.mpg.de

Grasshoppers facing land-use and climate change: Range shifts, community dynamics and implications for conservation

F. Löffler & T. Fartmann

Land-use change is the major driver behind the severe insect declines in Europe. Since the 1950s, both agricultural intensification and abandonment caused a substantial loss of semi-natural habitats, which has led to marked population declines in many species. More recently, climate change has become another important driver of changes in insect diversity. Whereas thermophilic species expanded their distributions poleward and to higher elevations, species adapted to lower temperatures or wet habitat conditions are increasingly threatened by the effects of global warming.
Since they are highly sensitive to both land use and climate, grasshoppers are excellent indicators to study the effects of current environmental changes. The results of our recent research show, that the majority of Central European grasshopper species historically suffered from large-scale habitat loss. Range retractions were especially related to habitat specialists with a low mobility, which are mostly associated with High Nature Value farmland. By contrast, thermophilic species with a high mobility rapidly expanded their distribution ranges during recent decades. At the same time, the Central European distribution of less mobile habitat specialists remained stable, which is likely a results of increased conservation actions since the 1990s. According to these results, further studies revealed that grasshopper assemblages within temperate grasslands have changed significantly during recent decades. Whereas range ex-

pansions of mobile habitat generalists generally have contributed to an increase of species richness in well-managed habitats, grasslands with low habitat quality are increasingly affected by biotic homogenization.

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

Franz Löffler, Universität Osnabrück, Osnabrück, Deutschland
franz.loeffler@uos.de

Zeitplan Young Entomologists' Challenge / Schedule Young Entomologists' Challenge

20.02.2023 16:40–17:40 Uhr

16:40 **S. Rahman**: Drought matters: Higher aphid performance and reduced parasitoid attraction to plant volatiles alter tritrophic interactions in sugar beet

16:45 **P. Singh**: Experimental evolution of inherited symbionts in novel hosts

16:50 **S. Rahman**: Drought differentially affects the preference and performance of *Pegomya cunicularia* by altering the plant chemistry of sugar beet

16:55 **J. Köhler**: From red list species to an agriculture threat–The planthopper *Pentastiridius leporinus*, vector for the agent of the sugar beet disease “Syndrome des basses richesse”

17:00 **A. Koßmann**: Looking for an attractive scent–First steps of developing a novel push-pull-kill strategy against *Halyomorpha halys* in organic fruit and vegetable production

17:05 **J. Martini**: The Vjosa River network–The last hideout of *Prosopistoma pennigerum*

17:10 **M. Pink**: What's your favorite colour?–An insight in hoverfly flower preferences

17:15 **C. Balthasar**: Do forest fires have an impact on moth communities?

17:20 **M. Wendt**: Is love blind?–Frequent interspecific hybridization of *Erebia pronoe*

17:25 **R. Bischoff**: Biocontrol with Predators–What drives predation?

17:30 **J. Gonthier**: Can we combine parasitoids with an entomopathogenic virus to efficiently control *Tuta absoluta*?

17:35 –

21.02.2023 9:10–10:30 Uhr

09:10 –

09:15 **E. Drukker**: BiodiverCity: Do herbaceous green roofs promote insect diversity?

09:20 **F. Dorn**: Recruiting micrococcinellids for the "standing army"

09:25 **M. Mayrhofer**: Parasitoids as biological pest control agents in oak forests

09:30 **M. Bjeljac**: The use of yeasts in an attract-and-kill approach against *Drosophila suzukii* in cherries

09:35 **M. Preti**: Kaolin and zeolite applications can reduce the *Halyomorpha halys* damage in pear crop

09:40 **M. Henkel**: Biological bark beetle prevention–An entomopathogenic fungus as part of a sustainable product concept

09:45 **T. Zankl**: Parasitoids and pathogens causing the collapse of a popualtion outbreak of the spongy moth, *Lymantria dispar*

09:50 **J. Balogh**: Habitat and behaviour: the STRANGE case of honeybees

09:55 **S. Blümel**: Flower strips and beneficial arthropods: A complicated love story

10:00 –

10:05 **A. Evlanova**: Crossing the red line: A broken symbiosis can compromise generalist fruit fly's ecological niche

10:10 **E. Riedel**: Fruit fly fitness, tainted turfs and microbiota mixing and mismatching

10:15 –

10:20 **M. Fluch**: Using a molecular gut analysis to reconstruct the feeding behavior of the brown marmorated stink bug *Halyomorpha halys* in South Tyrol

10:25 **M. Preti**: Developing a mass trapping approach for *Halyomorpha halys* management

21.02.2023 11:10–12:30 Uhr

11:10 **J. Enciso**: Bacterial diversity and distribution of core microbiome in *Scaphoideus titanus* (Hemiptera: Cicadellidae)

11:15 **M. Preti**: A monitoring network to manage *Halyomorpha halys*

11:20 –

11:25 **S.V. Jung**: Just his type(s)–The bees and wasps of Johann Ludwig Christ

11:30 **A. Ferrari**: Man-made obstacles to insect foraging: does urbanization select for greater flight ability in bees and wasps?

11:35 **C. van der Linden**: Speciation in Sundaland: Museomics reveals patterns of diversification in *Troides* birdwings

11:40 **V.P.S. Amineni**: Insect pest management demands new and sustainable solutions.

11:45 **K. Bubeníková**: Little bodies giant secrets–The library in a grain of rice

11:50 **A. Rank**: Microgels as a novel delivery platform for RNAi-mediated insect pest control

11:55 **E. Papek**: Small-scale population genetic structure of the spruce bark beetle *Ips typographus* in the Southern Alps

12:00 **S.V. Jung**: Perfect in form and reproduced–Cockroach ootheca from the Early Cretaceous to the present day

12:05 **L. Lutz**: Tough egg to crack–Understanding the oviposition behaviour of necrophagous flies in the field

Postertitel / Titel of posters

Sektion Imkerei und Bienengesundheit / Section Apiculture and Bee Health

Poster 01 **C. Polidori** et al.: Climate and land-use influence on the reproductive success of *Osmia* bees: towards an optimal trap-nesting management nearby almond orchards in Southern Europe

Sektion Chemische Ökologie und Verhalten /
Section Chemical Ecology and Behavior

Poster 02 **R. Favaro** et al.: Wireworm responses to CO_2 and plant root volatiles

Poster 03 **C. Gómez-Ramirez** et al.: Chemical signalling between flowers and bumble bees

Poster 04 **J. Köhler** et al.: From red list species to an agriculture threat–The planthopper *Pentastiridius leporinus*, vector for the agent of the sugar beet disease "Syndrome des basses richesse"

Poster 05 **A. Koßmann** et al.: First steps of developing a novel push-pull-kill strategy against the brown marmorated stink bug *Halyomorpha halys* in organic fruit and vegetable production

Poster 06 **A. Melet** et al.: No evidence for social closure but highly diverse cuticular-hydrocarbon profiles in an ambrosia beetle

Poster 07 **I. Muktar** & O. Riabinina: Calcium imaging of ORCO-positive cells in larval malaria mosquitoes

Sektion Biodiversitätsverlust und Insektenschwund /
Section Biodiversity Decline and Loss of Insects

Poster 08 **F. Bott** & C. Ludreschl: BALIN–Insect conservation at railway stations through insect friendly lighting

Poster 09 **A. Hilpold** et al.: Grasshopper results from the Biodiversity Monitoring South Tyrol

Poster 10 **A. Krahner** et al.: Competition or facilitation? The impact of flowers around pan traps on bee sampling results

Poster 11 **A. Krahner** et al.: Size matters: Wider pan traps collect more bee individuals than smaller pan traps

Poster 12 **A. Linde** & F. Weiß: How precise are size-weight equations for estimating carabid biomass and how could they be improved?

Poster 13 **H. Melcher** & M. Rohlfs: Local effects of autumn mowing on the abundance and biomass of arthropod communities

Poster 14 **M. Pink** et al.: Developing artificial model flowers for hoverfly monitoring

Sektion Biogeographie und Faunistik / Section Biogeography and Faunistics

Poster 15 **C. Balthasar** et al.: Intra-specific weight variability of moth individuals in a rapidly changing post-fire ecosystem

Poster 16 **M. Falagiarda** et al.: Monitoring of stink bugs and their egg parasitoids in agroforestry ecosystems in South Tyrol

Poster 17 **H. Käfer** et al.: Critical thermal maximum of three life stages of the paper wasp *Polistes dominula* (Christ, 1791)

Sektion Biologische Schädlingsbekämpfung / Section Biological Control

Poster 18 **M. Brunner** et al.: Dynamic interactions between trap crops and *Metarhizium brunneum* boost the control performance against a soil-dwelling insect pest

Poster 19 **F. Dorn** et al.: Compatibility of a micrococcinellid aphidophagous predador with current biocontrol agents in sweet pepper crops

Poster 20 **F. Dorn** & K. Kloth: Phloem-based plant resistance to aphids: SLI1's involvement in wound responses

Poster 21 **J. Martin** et al.: First experimental releases of parasitoids for biological control of the spotted wing *Drosophila* in protected berry cultures in Germany

Poster 22 **M. Mayrhofer** et al.: Parasitoids as biological pest control agents in oak forests

Poster 23 **R. Meyhöfer** & B. Grupe: Einsatz von LED-Fallen zur Thripsbekämpfung: von verbessertem Monitoring zum Massenfang?

Poster 24 **M. Parth**: Prüfung von alternativen und natürlichen Stoffen für die Bekämpfung der Marmorierten Baumwanze *Halyomorpha halys*

Poster 25 **S. Wenz** & A. Reineke: Increasing plant diversity in organic berry cropping systems for sustainable insect pest control

Poster 26 **T. Zankl** et al.: Pupal parasitoids of the European oak leafroller, *Tortrix viridana* L. (Lep., Tortricidae), in an outbreak population in Central Hungary

Sektion Schädlingsbekämpfung im Pflanzen- und Vorratsschutz /
Section Insect Control in Plants and Stored Products

Poster 27 **M. Bjeljac** et al.: The comparison of two different yeasts in an attract-and-kill approach against *Drosophila suzukii* in cherries

Poster 28 **C. Borghesi** et al.: Creating a universal method for separating male and female insects in pest control programs using the Sterile Insect Technique (SIT)

Poster 29 **M. Preti** et al.: Geomaterial applications on pear crop to control *Halyomorpha halys* damage in northern Italy

Poster 30 **M. Schöller** et al.: Selektive Detektionswahrscheinlichkeit häufiger Vorratsschädlinge mit dem „Beetle Sound Tube"

Sektion Wald-/Forstentomologie / Section Forest Entomology

Poster 31 **B. Budin** et al.: The influence of warmer autumn temperatures on diapause induction in *Ips typographus*

Poster 32 **G. Holighaus** et al.: Olfactory and behavioural responses of the bark beetle *Ips typographus* to Isophorones–Insights into a complex olfactory system and new opportunities for bark beetle control?

Poster 33 **H. Löcken**: On the importance of site effects in ecological field studies–Where you stand is who you are

Poster 34 **S. Netherer** et al.: DECIDE for prophylactic forest protection adapted to a changing climate

Poster 35 **E. Papek** et al.: Temperature-dependent development and host tree preference of the pine bark beetle *Ips acuminatus*

Poster 36 **E. Ritzer** et al.: *Ips acuminatus* and its fungal associates with particular emphasis on ophiostomatoid species

Sektion Insekten-Mikroorganismen Interaktionen /
Section Insect-Microorganism Interactions

Poster 37 **Z. Abbas** et al.: Transcriptomic responses reveal putative reciprocal adaptations in a non-parasitic insect-fungus antagonism

Poster 38 **A. Evlanova** & M. Rohlfs: Crossing the red line: A broken symbiosis can compromise generalist fruit fly's ecological niche

Poster 39 **S. Krüger** & M. Rohlfs: Do *Drosophila* fruit flies form species-specific associations with microorganisms?

Poster 40 **E. Riedel** et al.: Microbiota-by-environment interactions in *Drosophila melanogaster* development

Poster 41 **M. Ripamonti** et al.: Impact of climate change on the *Bemisia tabaci* transmitted virus ToLCNDV

Poster 42 **N. Solaiman** & M. Rohlfs: Do sweeter and more sour substrates improve fruit fly fitness by changing its microbial composition?

Sektion Invasive Arthropoden / Section Invasive Arthropods

Poster 43 **G. Bulgarini** et al.: Diapause termination in the South Tyrolean population of Brown Marmorated Stink Bug in response to photoperiod

Poster 44 **M. Fluch** et al.: Using a molecular gut analysis to reconstruct the feeding behavior of the brown marmorated stink bug *Halyomorpha halys* in South Tyrol

Poster 45 **D. Gil-Tapetado** & C. Polidori: Across the 'fireflyverse': Comparison of niche suitability of an exotic firefly in its colonized and native range

Poster 46 **D. Gil-Tapetado** et al.: Climate change as a driver of insect invasions: Dispersal patterns of a dragonfly species colonizing a new region

Poster 47 **B. Lutsch** et al.: AI-supported early detection of wood boring beetles in plant health control: The development of a smartphone application

Poster 48 **U. Schulz** & O. Brauner: Ausbreitung neozoer „südlicher" Heuschrecken in einer „nördlichen" Stadt (Abundanzentwicklung, Habitatanforderungen und Dispersion von *Eumodicogryllus bordigalensis* und *Meconema meridionale* in und um Eberswalde)

Poster 49 **U. Spitaler** et al.: Invasive apricot aphid (*Myzus mumecola*), a new pest in Europe

Poster 50 **M. Wiemers** & D.J. Lohmann: The invasion of the Lime Swallowtail in Australasia and its effect on endemic populations in the Lesser Sunda Islands

Sektion Landschaftsökologie und Naturschutz /
Section Landscape Ecology and Nature Conservation

Poster 51 **A.K. Gathof** & **A.J. Grossmann**: Who can pass the urban filter? An investigation concerning abundance, functional diversity and community structure of wild bees in Berlin

Poster 52 **E. Guariento** et al.: Biodiversity Monitoring South Tyrol: A multi-taxon long-term monitoring scheme with arthropods as a main focus

Poster 53 **K. Schweissgut**: Exploratorium Lebendiges Wittental – Artenschutz auf dem Campus

Poster 54 **J. Seeber** et al.: Changes in carabid species distribution, body traits and associated microbiota along an elevational gradient

Sektion Morphologie, Systematik, Evolution /
Section Morphology, Systematic, Evolution

Poster 55 **M. Csader** et al.: Structure and function of the musculoskeletal ovipositor system of *Leptopilina heterotoma* (Cynipoidea, Figitidae)

Poster 56 **B. Eggs** et al.: Terebra movements of a chalcidoid wasp: actuation, mechanisms and eco-evolutionary significance

Poster 57 **S.V. Jung** & F. Geller-Grimm: Lost but found–In quest of hymenopteran type material from the 18th century

Poster 58 **Z. Mirzaee** et al.: Full with life: Mantid ootheca are microhabitats for many different arthropods

Poster 59 **A. Ferrari** & C. Polidori: Man-made obstacles to insect foraging: Does urbanization select for greater flight ability in bees and wasps?

Poster 60 **C. Polidori** et al.: *Leptoconops* biting midges (Diptera: Ceratopogonidae) from a Mediterranean area: new observations on structures involved in host-searching and host attack

Sektion Molekulare Entomologie / Section Molecular Entomology

Poster 61 **E. Papek** et al.: Small-scale population genetic structure of the spruce bark beetle *Ips typographus* in the Southern Alps

Weitere Poster / Additional posters

Poster 62 **J. Ruther** & N. Schöfer: Sublethal effects of insecticides on the chemical orientation of parasitic wasps

QR-Codes: Zusammenfassungen der Vorträge und Poster / QR-codes: Abstracts of talks and posters

	Abstracts der Vorträge / Abstracts of Talks	Abstracts der Poster / Abstracts of Posters
Imkerei und Bienengesundheit / Apiculture and Bee Health		
Chemische Ökologie und Verhalten / Chemical Ecology and Behavior		
Biodiversitätsverlust und Insektenschwund / Biodiversity Decline and Loss of Insects		
Biogeographie und Faunistik / Biogeography and Faunistics		
Biologische Schädlingsbekämpfung / Biological Control		

	Abstracts der Vorträge / Abstracts of Talks	Abstracts der Poster / Abstracts of Posters
Schädlingsbekämpfung im Pflanzen- und Vorratsschutz / Insect Control in Plants and Stored Products		
Wald-/Forstentomologie / Forest Entomology		
Insekten-Mikroorganismen Interaktionen / Insect-Microorganism Interactions		
Invasive Arthropoden / Invasive Arthropods		
Landschaftsökologie und Naturschutz / Landscape Ecology and Nature Conservation		

	Abstracts der Vorträge / Abstracts of Talks	Abstracts der Poster / Abstracts of Posters
Medizinische Entomologie / Medical Entomology		
Morphologie, Systematik, Evolution / Morphology, Systematics, Evolution		
Molekulare Entomologie / Molecular Entomology		

Talks
sorted by sections and main authors

Sektion Imkerei und Bienengesundheit / Section Apiculture and Bee Health

Keynote

Pesticide impact on honey bees under realistic field conditions is still debated but the matter is clearer from a systems biology point of view

F. Nazzi

Agrochemicals, and in particular neonicotinoid insecticides, are implicated as one of the drivers of honey bee colony losses. Indeed, their negative effects on the physiology and behavior of honey bees have been clearly demonstrated under lab conditions. Nevertheless, well-replicated field experiments, to date, have failed to provide clear insights on neonicotinoid effects under realistic field conditions.
We adopted a systems biology approach to gain insights into the web of interactions amongst the factors influencing honey bee health. We put the focus on the properties of the system that depend upon its architecture and not on the strength, often unknown, of each single interaction. We demonstrated that the immune-suppressive capacity of the widespread pathogen of bees, deformed wing virus, can introduce a critical positive feedback loop in the system causing bistability. Therefore, honey bees under similar initial conditions can experience different consequences when exposed to the same stressor, including prolonged survival or premature death. The latter can generate an increased vulnerability of the hive to dwindling and collapse.
In conclusion, we showed that the impact of toxic compounds on honey bee health can be shaped by the concurrent stressors affecting bees. Our results have important implications for the application of field studies to complex systems.

Francesco Nazzi, Dipartimento di Scienze AgroAlimentari, Ambientali e Animali, Università di Udine, Udine, Italy
francesco.nazzi@uniud.it

Habitat effects on sucrose responsiveness reveal the STRANGEness of honeybees

J. Balogh, J. Bock, E. Rudolf & B. Grünewald

Honeybees (*Apis mellifera*) forage from a wide variety of plants for pollen and nectar. Factors shaping their foraging choices include the quality of available resources, weather, and intrinsic individual traits. One characteristic related to foraging decisions is sucrose responsiveness which expresses the probability of a bee extending its proboscis in response to varying concentrations of sugar. Individual sucrose responsiveness depends on several intrinsic and extrinsic factors such as age, social role, and foraging conditions. In addition, the average sucrose responsiveness of a honeybee colony changes throughout the year. However, it is unknown whether these changes are due to seasonal, ecological, or in-hive factors. Our data indicate that sucrose responsiveness differs with habitat conditions. For example, in June, bees from the mountain habitat were more responsive, as expressed by sucrose response scores (SRS). SRS are the sum of the responses of an individual bee to the six offered sucrose solutions and range from 0–6. A low SRS indicates high selectivity since bees would only have responded to the higher sucrose concentrations. SRS were significantly higher at our mountain habitat characterised by colder temperatures and dense forests. The bees responded to all sucrose concentration (SRS = 6), while colonies at our three other locations (forest, agricultural, urban) displayed SRS of two and three. We also confirm the previous finding that SRS increase in August and September, when SRS were six at all our sites. Our results suggest a link between environmental factors and the sugar perception of honey bees. We expect our ongoing analysis to reveal specific habitat conditions linked to sucrose responsiveness and our further research aims to provide insights into factors shaping the foraging- and pollination- related behaviour of honeybees. Furthermore, our findings have implications for animal research as a hole in light of the recently proposed STRANGE framework which has the objective to mitigate potential sampling biases in animal behavioural research (Webster & Rutz 2020). It discusses how the experimental animals STRANGEness–their Social background, Trappability, Rearing history, Acclimation, Natural changes in responsiveness, Genetic make-up, and Experience–can affect the observed behaviours and reduce replicability and generalizability of experimental results. Our research shows seasonal and environmental effects on the

behavioural responsiveness of honeybees, underling the value for researchers to consider STRANGE when designing and discussing studies.

Webster, M.M. & Rutz, C. (2020): How STRANGE are your study animals?–Nature, 582, 337–340, DOI: 10.1038/d41586-020-01751-5.

Julia Balogh, Bee Research Institute, Goethe University Frankfurt, Oberursel, Germany
J.Balogh@em.uni-frankfurt.de

Honeybee pollen loads to monitor pesticides residues and pesticide drift in alpine valleys

R. Favaro, E. Bucher, E. Rizzi & S. Angeli

Val di Sole (Trentino) is an alpine valley which altitude ranges from 500 m in the valley floor up to over 1,700 m. The valley floor is about 50 km long including also two lateral deadened valleys of Val di Pejo and Val di Rabbi of the Stelvio National Park. Val di Sole is characterized by apple orchards in the lower part and meadows and pastures in the upper part. In order to monitor the presence and the dispersal of pesticides and heavy metals along the valley, we selected 22 bee apiaries located along the valley floor and we gathered the bee-collected pollen at the hive entrance. The average distance between apiaries was 2.5 km. The pollen loads were collected after apple blossom in May and in July 2019. Each of the 42 pollen samples was made pooling together the pollen collected by two hives of the same apiary, considering two subsequent weekends of pollen collections, in order to mediate bee preference within the foraging area. Pollen samples were then analysed with accredited methods for multi-residuals to determine the amount of pesticides and three heavy metals. In parallel, we also performed the palynological analyses on all the samples in order to understand the relevance of every botanical species on sample composition. In total, we detected of 63 pesticides, among which 15 insecticides, 43 fungicides, 3 herbicides and 2 plant growth regulators. The most frequent pesticides were Phosmet, Dithiocarbamates, Fluazinam and Captan. Several pesticide residues have been reported in five of the 22 monitored locations in both the two periods, whereas in 17 locations at least one residue has been found for each period. Five locations of the most upper valley were pesticide free. The most critical situations for the number of molecules have been observed in two stations located in the apple-growing area where about 30 substances per period were detected. Phosmet, Dithiocarbamates, Fluazinam, Captan, and Folpet showed also an extended drift along the valley floor and within Val di Rabbi. Indeed, residues of these pesticides have been found ca. 10 km away from the apple orchards. The toxicity to honeybees has been calculated by using the Pollen Hazard Quotient. Heavy metals are also present in all the monitored areas. Copper settled on 10 ppm, while lead has a very high peak (1,680 ppb) in Pellizzano compared to less than 100 ppb in the other areas. The palynological analyses detected the specific botanical composition typical for each period and location. Up to our knowledge, this is the first study that considered such a detailed coverage of the territory for the investigation of pesticide residues in pollen loads. The agricultural use and the topography of the valley allowed to explain the long distance of the pesticide drift along the valley floors, showing that in some cases it can be substantial.

Riccardo Favaro, University Innsbruck, Bolzano, Italy
riccardo.favaro@unibz.it

Effect of communication towers on the performance and behavior of *Apis mellifera* L. (Hymenoptera: Apidae) (the external activity)

F.E.E. Salah

Beekeeping of honey bee (*Apis mellifera*) and the multiplication of this insect is one of the most important branches of agricultural investments. Bees are one of the best and most active pollinators, representing 80% of pollinated insects of cultivated crops. Many factors affect their activities, one of them is electro–magnetic radiation. The aim of this study was to investigate the effect of the radiation emitted by communication towers on the behavior of honey bee communities externally. The experiments were conducted in the apiaries of the College of Agricultural Sciences and Engineering in Al-Jadriyah area. The first location was 500 m, the second location was 150 m from the telecommunication tower and the third transaction was placed directly under the tower. The height of the tower was 30 m and the amount of radiation emitted from it was 925 MHz. The results of the external activity of the foraging workers recorded the first treatment as highest average followed by the second treatment at an average while the third treatment recorded the lowest average for the foraging bees. The triple overlap between the site, the time and date recorded the second treatment as the highest rate for evening time, followed by the first treatment in the morning. While the third treatment recorded the lowest average for the foraging bees. The activity of collecting pollen was highest in the second treatment, followed by the first treatment. The

lowest rate of collection was recorded in the third treatment. The triple overlap between the site, time and date showed significant differences between treatments. The total activity of bee nectar or water collection recorded the highest activity rate in the first treatment, followed by the second treatment and the lowest activity in the third treatment. The triple overlap between the site, the time and date recorded the first transaction on the date of 9/5 pm the highesrate, followed by the second treatment for the morning time on the same date. The lowest rate for the preparation of the workers of the whole nectar or water was recorded in the third treatment for morning. The effect of the radiation emitted by the tower on the ability of bees in the metabolism showed no significant differences between the rates (wet weight, dry weight, protein ratio, fat percentage). The results of the analysis showed significant differences in carbohydrate levels and the ash content). At the end of the experiments, the total weight of honey was calculated for all the cells according to their location. The treatment at the distance of 500 m gave 8 kg for the treatment, while the lowest was in the treatment under the tower (6.99 kg). It could be concluded that communication towers have negative effect on the activities of *Apis mellifera*.

Faiza Elgaili Elhassan Salah, University of Gezira, Wad Medani, Sudan
faizaruba2@gmail.com

Neuartige Markierungen von Bienen mit buntem bzw. fluoreszierendem Mehl sowie ihr digitale Kartierung in georeferenzierten Datenbanken und nachfolgende Detektion mit Online-Kamerasystemen

E. Lara, U. Schulz, J. Eckhardt, & T. Würfel

In diesem deutschsprachigen Vortrag werden neuartige Methoden vorgestellt, mit denen Honigbienen markiert und an Trachtpflanzen bzw. Bienenbeuten detektiert werden können. Versuche dazu wurden am Lehr- und Forschungsbienenstand der Hochschule für nachhaltige Entwicklung Eberswalde, auf landwirtschaftlichen Versuchsflächen und am Forstbotanischen Garten in Eberswalde durchgeführt.
Bei den Markierungen wurde mit herkömmlichen Markierungsfarben und mit neuartigen Möglichkeiten durch buntes bzw. fluoreszierendes Mehl experimentiert. Dazu wurden sogenannte Holi-Farbpulver verwendet, mit denen sich – inspiriert durch indische Frühlingsfeste – auch in Europa zunehmend Jugendliche z. B. bei Open-Air-Festivals bewerfen. Bei den Honigbienen (*Apis mellifera*) wurden Maisstärkepulver mit sechs verschiedenen Lebensmittelfarben (Markenname „Polvo Holi“) und ergänzend fluoreszierende Varianten benutzt. An künstlichen Futtertränken und an verschiedenen Bienenbeuten wurden die Applikation der Farben auf die Bienen mit verschiedenen Geräten und die Detektion der markierten Bienen mit verschiedenen Kamerasystemen getestet. Mit studentischen Gruppen wurde dann zeitgleich an verschiedenen Trachtpflanzen im Forstbotanischen Garten und auf landwirtschaftlichen Versuchsflächen der Eberswalder Hochschule blütenbesuchende Honigbienen markiert. Andere Studierendengruppen bzw. online verschaltete Kamerasysteme an und in den Bienenbeuten nahmen die Ankunft der markierten Bienen auf.
Zusätzlich werden die Beobachtungen zu den Trachtpflanzen, auch bezüglich weiterer Blütenbesucher wie Wildbienen, in eine georeferenzierte Onlinedatenbank eingegeben. Diese nutzen Studierende noch im Gelände auf ihren mobilen Endgeräten oder Tablets.
Die bisher erfolgreichsten Methoden und Geräte bei den Farbmarkierungen und Detektionen werden vorgestellt. Alle Methoden wurden an Honigbienen erprobt, sind aber auch auf einige Wildbienenarten, z. B. innerhalb der Mauerbienen und Hummeln, übertragbar.

Eric Lara, Hochschule für nachhaltige Entwicklung Eberswalde, Eberswalde, Deutschland
Eric.Lara@hnee.de

Sektion Chemische Ökologie und Verhalten / Section Chemical Ecology and Behavior

Keynote

Don't put all your eggs in one basket! Ecology and evolution of insect egg-killing plant responses

N.E. Fatouros

Evolutionary arms-races between plants and insect herbivores have long been proposed to generate key innovations such as plant toxins and detoxification mechanisms that can drive diversification of the interacting species. An unexplored novel front-line of plant defence is the killing of herbivorous insect eggs. Egg-killing traits are known from species across the plant kingdom, but their evolutionary and genetic basis remains relatively unexplored. My research focusses on co-evolutionary interactions between Pierid butterflies and their crucifer host plants (Brassicaceae). Some crucifer species express a hypersensitive response (HR)-like cell death underneath deposited butterfly eggs that leads to eggs desiccating or falling off the leaf. The last couple of years, I have studied the ecology and genetics of this trait. In my talk, I will focus on the effect of HR-like on different butterfly eggs, how eggs elicit the response, its phylogenetic distribution as well as possible counteradaptations by butterflies to it.

Nina E. Fatouros, Biosystematics Group, Wageningen University & Research, Wageningen, The Netherlands
nina.fatouros@wur.nl

Of glucosinolates and saponins–Pollen beetles can cope with general but not with specific plant defence compounds in crucifers

N. Austel, C. Böttcher, P. Werner, E. Diederichsen & T. Meiners

The pollen beetle (*Brassicogethes aeneus*) is one of the major insect pests of oilseed rape (*Brassica napus* L., Brassicaceae) causing significant seed yield losses. Since pollen beetles become increasingly resistant to pyrethroids, alternative control strategies within the framework of integrated pest management are urgently needed. To develop new strategies against the pollen beetle we studied the natural chemical variation in brassicaceous plant species and identified plant compounds mediating reduced feeding damage. Reduced feeding damage has rarely been observed in oilseed rape and *B*. *napus* resyntheses, but could be demonstrated for *Barbarea vulgaris*, *Eruca sativa*, and *Sinapis alba*. The beetles´ sex and the plant accession affected the feeding response of the pollen beetle to these three species.
To identify feeding deterrent secondary plant compounds, we compared semi-polar metabolite fraction profiles of *B*. *vulgaris*, *E*. *sativa*, *S*. *alba* and *B*. *napus* by a non-targeted approach. Here we selected the discriminating features showing negative correlation with the beetles´ feeding behaviour and identified several glucosinolates, flavonoids and saponins. We tested the direct influence of single metabolites achieved as commercial standards or from fractionated plant extracts in a newly designed dual-bud-choice assay. Whereas we observed no effects for the flavonoids, all five saponins from *B*. *vulgaris* deterred the beetles from feeding. From the six tested glucosinolates, mainly the *B*. *vulgaris*-specific glucobarbarin strongly deterred the beetles from feeding.
We conclude that pollen beetles are well adapted to defence compounds from a wide range of cruciferous species, but not to specific compounds from *B*. *vulgaris*. Furthermore, we highly recommend securing correlations between metabolites and feeding behaviour by performing dose response experiments with single putative marker compounds to unravel the chemical signals mediating plant-insect interaction in crop plants.

Nadine Austel, Julius Kuehn Institute, Institute for Ecological Chemistry, Berlin, Germany
nadine.austel@julius-kuehn.de

Monarchs sabotage milkweed to acquire toxins, not to disarm plant defense

A. Betz, R. Bischoff & G. Petschenka

Sabotaging by monarch caterpillars (*Danaus plexippus)* on milkweed (*Asclepias* spp.) is a textbook example for disarming plant defense. By severing latex-containing cells (laticifers), monarch caterpillars are thought to inhibit latex allocation to their feeding site. Here we show that sabotaging by late instar caterpillars of the monarch butterfly likely supports sequestration of cardenolides for defense against predators and is not an adaptation to circumvent exposition. Based on comparisons with the related but non-sequestering common crow (*Euploea core*), we found three lines of evidence supporting our hypothesis. First, monarch caterpillars sabotage inconsistently while crows sabotage obligatorily before every feeding event. Second, monarch caterpillars eagerly drink latex and ingest copious amounts of cardenolides during sabotaging,

while crow caterpillars dislocate latex from sabotaged leaf petioles. And third, monarchs raised on latex-free leaves acquired higher total amounts of cardenolides when latex-drinking was mimicked by artificial latex supply. In conclusion, we suggest that an ancestral behavior of tolerance was converted into defense-cooption in caterpillars of the monarch butterfly.

Anja Betz, University Hohenheim, Stuttgart, Germany
anja.betz@uni-hohenheim.de

Sawflies containing toxic peptides

J.-L. Boevé & R. Rozenberg

From the 1970's, toxic peptides were detected and identified in the larvae of some Argidae (genus *Arge*) and Pergidae (*Lophyrotoma*, *Perreyia*) sawfly species (Hymenoptera: Symphyta). They caused the death of livestock in Australia, Denmark and South American countries. The chemicals were studied, here, to elucidate their involvement in ecology, evolution, physiology and behavior of the sawflies. Liquid chromatography–tandem mass spectrometry of extracts from single larvae revealed that the peptides occur commonly in the two sawfly families. A phylogenetic approach pointed to evidence that the peptides may have driven the evolution of these sawflies by allowing frequent "defense shifts", that is, switches between cryptic and conspicuous appearances, and levels of gregariousness. The toxic peptides proved to vary in quality and quantity across species, and in quantity across populations. Such results led to canceling the use of a pergid (*Heteroperreyia hubrichi*) as a biocontrol agent of an invasive weed. In *Arge berberidis* the chemicals were detected not only at larval stage but also in the prepupal and adult stages. By isolating organs from larvae of *Lophyrotoma zonalis* and *Arge pagana*, the chemicals were detected mainly in the hemolymph and integument, and little or none in the digestive tube. Finally, bioassays revealed that Pergidae and especially *Arge* larvae are well defended against ants, with ant responses determined by the body size and behavior of the larva such as raising the abdomen. Thus, combined with other antipredator defense mechanisms, the toxic peptides seem to constitute an essential element in the biology and ecology of Argidae and Pergidae sawflies.

Jean-Luc Boevé, Royal Belgian Institute of Natural Sciences, Brussels, Belgium
jboeve@naturalsciences.be

Finding an egg in a haystack: Variation in chemical cue use by egg parasitoids of herbivorous insects

L. Greenberg, M.E. Huigens, A.T. Groot, A. Cusumano & N.E. Fatouros

Egg parasitoids of herbivorous insects use an interplay of short- and long-range chemical cues emitted by hosts and host plants to find eggs to parasitize. Volatile compounds that attract egg parasitoids can be identified via behavioral assays and used to manipulate parasitoid behavior in the field for biological control of herbivorous pests. However, how and when a particular cue will be used varies over the life of an individual, as well as at and below species level. I will especially discuss our recent results investigating how and when egg parasitoids utilise the "chemical-espionage-and-ride" strategy. In these cases, the parasitoid exploits its host's pheromones to locate an adult host on which it can travel to fresh eggs. Future research should expand taxonomic coverage to explore variation in chemical cue use in more natural and dynamic settings. More nuanced understanding of the variability of egg parasitoid host-finding strategies will aid in disentangling the underlying genetics and further enhancing biological control.

Liana Greenberg, Wageningen University, Rhenen, The Netherlands
liana.greenberg@wur.nl

Fruit in a dish–An assay to test the influence of raspberry varieties and compounds on spotted-wing *Drosophila* development

T. Meiners, U. Temp, T. Wöhner & C. Böttcher

The invasive spotted-wing *Drosophila* [*Drosophila suzukii* (Matsumura) (Diptera: Drosophilidae)] attacks intact, ripening and mature fruits of many fruit species and has become an economically important pest in fruit growing worldwide. Less susceptible varieties could contribute to the control of the spotted-wing drosophila. Susceptibility to *D. suzukii* varies greatly within different fruit varieties. The aim of this study was a) to develop a Petri-dish assay to investigate the influence of chemical fruit parameters on developing spotted-wing drosophilas and b) to identify chemical markers in two raspberry cultivars (*Rubus idaeus*) differing in suitability for the flies.
We developed a Petri-dish assay using a fruit-puree agar and different measures and degrees of sterilisation to determine differences in larval development, hatching time and mortality rate of the flies. The assay

should mimic roughly the natural situation in the fruit with increasing growth of fly introduced yeasts and fungi on the one hand and allow standardisation of parameters on the other hand.
Using the fruit-puree agar test we found cultivar effects on larval survival and development as well as on the growth of symbiotic yeasts and fungi. Chemical analyses of the raspberry cultivars using liquid chromatography with mass spectrometry coupling and High Resolution LC/ESI-TOF mass spectrometry revealed differences in anthocyanin content and pattern. By manipulating anthocyanin and protein levels in the agar, we were able to show that anthocyanins do not have a direct effect on larval development, but act indirectly via inhibition of yeasts and fungi, which serve as a protein source for the feeding larvae.
The developed fruit-puree agar assay can be adapted for testing other fruits or specific compounds in medium or even high-throughput fashion against *D. suzukii*.

Torsten Meiners, Julius Kühn Institute, Berlin, Germany
torsten.meiners@julius-kuehn.de

Attract, confuse, repel: Visual perception and possibilities of optical manipulation of insect pests

J.-U. Niemann

The optical manipulation of insect pests, together with other preventive measures, forms the basis for integrated crop protection systems. The manipulation of the visual perception makes it more difficult for insects to find their hosts and thus reduces the initial infestation rate. Particularly in the case of insects with high reproduction rates, the reduction in initial infestation can already be decisive for keeping below later damage thresholds. The basis for this lies in the visual ecology of insects and their visual perception and subsequent behaviour. The approaches to optical manipulation that emerge from this perception range from the use of contrast effects to coloured traps and the use of repellent materials. Developments in the field of light-emitting diodes have also made it possible to use narrow-band light for optical manipulation. Current methods of optical manipulation and their possible applications are described using examples.

Jan-Uwe Niemann, Julius Kühn Institute, Braunschweig, Germany
jan-uwe.niemann@julius-kuehn.de

Ambrosia beetles adjust social investment based on expected inclusive fitness benefits

J.A. Nuotclà & F. Nachbaur

In some of the most common European ambrosia beetle species, fertilized adult daughters remain in their natal nest for extended periods of time to invest in brood care rather than reproducing themselves. This complex cooperative breeding strategy allows to maintain higher offspring numbers per nest compared to such species that rely only on simple parental care. The final dispersal decision should be based on the relative value of helping behaviour versus forfeited reproduction. This is corroborated by correlative data which suggests that adult daughters may delay their dispersal based on the number of needy offspring within a nest. It is however yet unclear whether the length of the philopatric phase is predetermined or if individual beetles actively decide to delay dispersal for potential inclusive fitness benefits, as the number of larvae naturally correlates negatively with nest age. Experimental data that would allow to disentangle helping propensity from nest age or own reproductive activity has unfortunately been lacking so far, as existing laboratory rearing techniques allow only for limited experimental manipulation once nests have been established.
To fill this important gap, we developed a more advanced rearing method and individual marking techniques that allow for in situ experimental manipulation of larval numbers and long-term individual-based behavioural observations. Our fist experimental data revealed that adult daughters of the native ambrosia beetle species *Xyleborinus saxesenii* (Ratzeburg, 1837) adjust their dispersal decisions dynamically based on the expected inclusive fitness benefits. We shall discuss these results in detail and demonstrate how such situational decision-making leads to developmental speed dependent differences in social investment. Further, we want to outline how these techniques may allow experimental hypothesis testing regarding the evolution of the eusocial lifestyle in ambrosia beetles.

Jon Andreja Nuotclà, Forest Entomology and Protection, Albert-Ludwigs-Universität Freiburg, Stegen-Wittental, Germany
jon.nuotcla@forento.uni-freiburg.de

Drought matters: Higher aphid performance and reduced parasitoid attraction to plant volatiles alter tritrophic interactions in sugar beet

S. Rahman, M. Rostás & I. Vosteen

Climate change leads to more frequent droughts and thus to abiotic stress in crops. Consequently, drought stress may alter tritrophic interactions in agroecosystems by changing bottom-up and top-down effects on herbivorous insects. This study investigated drought stress in the tritrophic system consisting of sugar beet (*Beta vulgaris*), an aphid (*Aphis fabae*), and its parasitoids (*Aphidius colemani*). Experiments with drought stressed sugar beet showed that *A*. *fabae* benefitted from drought due to faster development and higher reproduction rate. Drought-stressed plants also emitted less volatiles, which resulted in reduced attraction of the parasitoid *Aphidius colemani* to aphid-infested plants. Attenuated parasitoid performance was evidenced by lower emergence rate, production of fewer females, and reduced body size; however, mummification rate was highest on highly drought-stressed plants. Reduced parasitoid attraction and performance on drought-stressed plants may exert lower top-down pressure on aphid populations, which could further weaken drought-stressed plants. Our findings highlight the necessity of studying multiple trophic levels and the importance of including HIPVs and parasitoid attraction when assessing combined abiotic and biotic stresses in crops.

Shahinoor Rahman, Georg August University of Göttingen, Göttingen, Germany
shahinoor_ent@yahoo.com

Drought differentially affects the preference and performance of *Pegomya cunicularia* by altering the plant chemistry of sugar beet

S. Rahman, M.Z. Surovy, F. Hadacek,
I. Vosteen & M. Rostás

Climate change leads to more frequent drought events that can severely impact sugar beet (*Beta vulgaris*) production in Europe. Insects also reduce sugar beet yield but there is little knowledge on the interactions between drought and herbivory. Here we comprehensively investigated how herbivory by the leaf miner fly *Pegomya cunicularia* (Diptera: Anthomyiidae) and two magnitudes of drought alter the morphology and physiology of *B*. *vulgaris* and whether such changes affect the insect's behaviour and performance. Increasing drought stress led to stunted growth, lower biomass, higher root-to-shoot ratio, reduced leaf area and fewer leaves. However, leaf water content was not significantly different between controls and moderately drought-stressed plants. Increasing drought stress alone resulted in decreasing photosynthetic capacity measured as chlorophyll fluorescence. In combination with herbivory, however, the strongest negative impact was found at moderate drought levels, which correlated with the most extensive feeding damage. Moderate drought also resulted in a higher number of emerging larvae and enhanced pupal and adult weights. Primary metabolome analysis showed that increasing drought increased concentrations of amino acids, organic acids, fatty acids, and sugar metabolites but led to reduced emission of plant volatile organic compounds. This correlated with female flies preferring control plants for oviposition compared to plants experiencing moderate and high drought stress. Flies were also more strongly attracted towards the scent of control plants than to biotic and abiotic stressed plants in a Y-tube olfactometer. In summary, the present study suggests that moderate drought favours *P*. *cunicularia* which may lead to negative synergistic effects in sugar beet cultivation.

Shahinoor Rahman, Georg August University of Göttingen, Göttingen, Germany
shahinoor_ent@yahoo.com

Worker-worker similarity of both gut microbiome and cuticular hydrocarbon profile is higher between nestmates rather than between sisters in a eusocial sweat bee with heavy nest-drifting behaviour

F. Ronchetti, T. Schmitt, P. de la Rua,
A. García-Reina, A. Keller,
I. Steffan-Dewenter & C. Polidori

The cuticular hydrocarbon (CHC) profile and the gut microbiome are two of the most important traits that shape the life of bees. The first plays an important role in both inter- and intraspecific communication and the latter is crucial for the development and functioning of the immune system.
Recent studies have shown that the gut microbiome of highly eusocial bees (e.g., honeybees) is composed of a species-specific and highly conserved microbial community. The species with such complex social behavior also typically possess a CHC profile that differs between colonies on intraspecific level. These two traits interact finely as the nestmate recognition signals (CHC) are partially defined by gut microbiome characteristics shared among workers.

However, most of the bees show primitive eusocial traits, including moderate genetic relatedness among members of the colony.
The study of primitively eusocial bees may therefore represent an opportunity to explore the interaction between CHC profile and gut microbiome by separating the role of the larval developmental site (colony of origin) from the role of the environment in which the adult lives (occupied colony).
Here, we investigated the genetic relatedness, the CHC profile, and the gut microbiome of the primitively eusocial digger bee *Halictus scabiosae* (Halictidae) by analyzing workers from 18 different nests belonging to two large aggregations in a Mediterranean area.
Interestingly, we found the following evidence: 1) a high rate of nest-drifting by part of workers and a consequent highly variable intracolonial relatedness, 2) a significative association between the genetic distance and the distance in both the CHC profile and the gut microbiome, and 3) a significative association between the distance in the CHC profile and distance in the gut microbiome, mediated by genetic distance.
Hence, the CHC profile and the gut microbiome appear to be more influenced by the environment during the developmental stages rather than by colony relatedness at the adult stage.
The lack of intimate trophic interactions within the colony, such as trophallaxis, common in highly eusocial bees but not in the Halictidae, could partially explain our results.

Federico Ronchetti, Julius-Maximilians University Würzburg, Magenta, Italy
ronchetti.federicouniwurz@gmail.com

Ecological functions of *Trichoderma* spp. volatiles in the interaction with soil arthropods and root pathogens

M. Rostás, M. Slonka, E. van Zijll de Jong, A. Mendoza-Mendoza, J. Hampton & I. Vosteen

The capacity to produce a plethora of secondary volatile and non-volatile molecules, in addition to their easy propagation, has made Trichoderma species one of the most extensively used fungi in agriculture, where they are applied as biofertilisers, biocontrol agents or plant protectants. *Trichoderma* spp. emit species-specific blends of volatile organic compounds (VOC), which were shown to serve multiple intraspecific and interspecific purposes. The fungus *T*. *virens*, for instance, emits predominantly a range of volatile sesquiterpenes, while blends of *Trichoderma* sp. “atroviride B“ and other species are characterized by high amounts of 6-pentyl-alpha-pyrone. In this talk, we report on the antagonistic function of *Trichoderma* VOCs against soil inhabiting arthropods and root-pathogenic fungi, while exploring also the effects of intraspecific variability in VOC blends. A mutant of *T*. *virens* impaired in volatile sesquiterpene emission, by deletion of the terpene cyclase vir4, was used to test the behaviour and fitness of the fungivorous collembolan *Folsomia candida*. Food choice and olfactory experiments revealed that collembolans preferred mutants impaired in sesquiterpene synthesis compared to wild type *T*. *virens*. Although grazing on the mutants reduced the survival rate of collembolans, no effect on their reproduction and growth was found. Sesquiterpenes therefore seem to play a role in fungal defence as repellents but not as feeding deterrents or toxins against this fungivore. Studying the fungistasis activity of VOCs emitted by 59 isolates of *Trichoderma* sp. “atroviride B“ against the pathogen *Rhizoctonia solani* we found that fungistasis varied considerably within the same species. There was a significant direct correlation between VOC number/quantity and bioactivity against *R*. *solani*. Testing the roles of individual fungal compounds, 11 VOCs, including 6-pentyl-alpha-pyrone, inhibited *R*. *solani* growth, some by >50%. We suggest that the biocontrol activity of *Trichoderma* spp. may be enhanced by deciphering the various roles of VOC blends and individual VOC compounds and also by identifying appropriate fungal isolates.

Michael Rostás, Georg August University of Göttingen, Göttingen, Germany
michael.rostas@uni-goettingen.de

Phenotyping for chemical defence of *Sinapis alba* and *Brassica napus* seedlings against herbivory by cabbage stem flea beetle (*Psylliodes chrysocephala*)

D. Rüde, S.M. Cook, B. Ulber, T. Pöhnl & M. Rostás

The cabbage stem flea beetle (CSFB, *Psylliodes chrysocephala*), is a major pest of winter oilseed rape (OSR) in Europe. Adult beetles feed on the cotyledons and young leaves, threatening the establishment and vigour of the crop. There are currently no CSFB resistant OSR cultivars available, meaning farmers must rely on synthetic insecticides for control. This study aimed to develop a reliable phenotyping method for testing the resistance of the cotyledon stage of Brassicaceae to CSFB feeding and explored potential resistance mechanisms.

Three winter OSR (*Brassica napus*) and four mustard (*Sinapis alba*) accessions were screened for cotyledon-resistance against feeding of CSFB adults, using laboratory and semi-field bioassays for phenotyping (no-choice). The primary metabolome and the glucosinolate concentrations were analysed using GC-MS and HPLC, respectively. In a dual-choice bioassay, characteristic compounds for susceptible and resistant accessions were tested for antixenotic or stimulating effects.
The laboratory screening showed a general trend of *S. alba* accessions being less susceptible than *B. napus*. Also, a resynthesized OSR accession exhibited reduced palatability, although there was an effect of seed age. Results from the semi-field trial mostly supported the findings of the laboratory bioassays. Application of candidate compounds, identified by metabolome analyses, on leaf discs in dual-choice tests revealed significant antixenotic effects, but also feeding stimulation was found.
These results contribute to the exploration of chemical defences in Brassicaceae against CSFB feeding that could play a role in breeding insect resistant OSR.

Daniel Rüde, Georg August University of Göttingen, Göttingen, Germany
daniel.ruede@uni-goettingen.de

Yet they do it–De novo biosynthesis of fatty acids in parasitic wasps

J. Ruther, M.-T. Multerer, L. Prager & M. Wendler

Fatty acids and fatty acid derivatives are vital nutrients for most organisms. They are used, for example, to store metabolic energy, to form biomembranes or as precursors for signaling molecules. Therefore, most organisms on earth not only rely on the supply of fatty acids through their diet but can also convert other primary nutrients into fatty acids. The most important and highly conserved pathway performing this function is lipogenesis, the conversion of sugars and other carbohydrates into fatty acids and triacylglycerides. The ubiquity of lipogenesis has been questioned by a number of studies reporting that newly emerged individuals of many parasitic wasp species did not accumulate additional lipids despite having had unlimited access to carbohydrates. The lack of lipid accumulation in many parasitic wasps was equated with their general inability to synthesize fatty acids from sugars and interpreted as an evolutionary loss of a metabolic pathway. Given the central importance of fatty acids to organisms, we have reexamined the de novo biosynthesis of fatty acids in parasitic wasps using a 13C-labeling approach. We fed seventeen species of parasitic wasps from seven families with 13C-labeled glucose and found that all of them are able to convert the labeled sugar into fatty acids. This indicates that lipogenesis is widespread and not absent in parasitic wasps. We used the model organism *Nasonia vitripennis*, one of the species previously thought to be incapable of lipogenesis, to demonstrate the biological significance of fatty acid biosynthesis in parasitic wasps. We found that glucose-fed females synthesized low amounts of palmitic, stearic, oleic, and linoleic acid as well as di- and triacylglycerides de novo, even when their lipid reserves were still intact. However, fatty acid biosynthesis increased significantly in females whose constitutive fat reserves were partially depleted due to ageing and oviposition. In addition, we found that sugar-fed females incorporated de novo synthesized fatty acids into their eggs and laid more eggs than water-fed control females. These results indicate that lipogenesis is a fitness-relevant trait in parasitic wasps and that sugar feeding affects the fatty acid status in two ways: first, by slowing the consumption of constitutive fat reserves and second, by replenishing declining fatty acid reserves through de novo biosynthesis.

Joachim Ruther, University of Regensburg, Regensburg, Germany
joachim.ruther@ur.de

More evidence for strain, not species steering phenotype expression in *Nasonia* parasitoid wasps (Hymenoptera: Chalcidoidea: Pteromalidae)

P. Singh, J. Schwarzer & R.S. Peters

Interspecific differences in behavioural traits have been investigated only in few parasitoid wasp species. Here we show the interspecific phenotypic differences of complex behavioural traits in parasitoid wasps, *Nasonia* spp. The differences reflect local adaptations and might fortify the prezygotic isolation in sympatric populations, i.e., being directly related to speciation. We identified and quantified the interspecific differences of host finding traits in two closely related species, *Nasonia vitripennis* (Walker, 1835) and *Nasonia longicornis* (Darling, 1990). Both wasps parasitize fly puparia, are microsympatric and interfertile, but the former is a host and habitat generalist and the latter is a specialist. For the study we used laboratory grown strains for both generalists (AscymCX) and specialists (IV7 & NLMN8510).

The behavioural trait in focus is host acceptance time, i.e., the time a female specimens needs from encountering the host to starting the process of oviposition. We demonstrated that the expression of the trait is more related to strain than to species, depending on the previous host experience of the females. We hypothesize that strains behave as an individual identity for host finding traits. This phenotypic plasticity may be beneficial for a strain that encounters and parasitizes a range of host species in the nature. Our findings showed that strain is important at different stages of host selection especially in specialist strains. It is important to emphasize what factors other than interspecific differences could affect differences between and within species. Other than prezygotic isolation, it is critical to address factors that separate species and with species that aid in the formation of new species in the long run of speciation. Finally, we discussed the possible explanations for these differences and their consequences on our understanding of parasitoid wasp speciation and diversification.

Pratyaksh Singh, German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Leipzig, Germany
pratyaksh.singh@idiv.de

Sulfate conjugation as intermediate step in the safe production of harmful defensive secretions in beetle stink glands identified by transcriptomics and the genome-wide phenoytpic screen iBeetle

E.A. Wimmer, B. Atika, S. Lehmann,
K. Feußner & I. Feußner

Tribolium castaneum is a significant worldwide pest of stored grains. It produces and releases harmful defensive secretions containing several specific varieties of substituted benzoquinone compounds. These defensive chemicals act as toxic, repellent, bacteriostatic and fungistatic oils. Unveiling the metabolic pathway, its regulation, and the enzymes participating in a safe synthesis of these defensive chemicals is essential for understanding how the production of semiochemicals and defensive compounds is spatially organized and how this organization avoids self-intoxication of the animal.
Here, we present a large set of genes whose disruption interferes with the function of the odoriferous defensive stink glands. This gene set is the result of a large-scale systematic phenotypic screen using RNA interference applied in a genome-wide forward genetics manner. In this first-pass screen termed iBeetle, we analyzed more than 13,000 genes and identified 247 genes, whose knock-down causes altered gland morphologies and partially also gland content. In addition, the new annotation of the *Tribolium* genome sequence allowed us to identify 249 genes, whose expression is enriched in the stink gland tissue. Only five out of the transcriptomics identified genes overlap with the gene set identified in iBeetle, providing altogether a set of 491 genes likely involved in stink gland function.
Phenoytpic analysis showed, that many of the identified genes are necessary specifically for benzoquinone synthesis. Among those, we recognized a set of four genes involved in sulfate metabolism. Since sulfonation had been described in insects for the detoxification of phenolic compounds, we further analyzed these genes, whether they are involved in the self-protected production of benzoquinones in the defensive stink glands of the *Tribolium*. In the knock-down situation for some of these genes, we can observe sulfonated precursors of benzoquinones, which indicates that sulfate conjugation serves as an intermediate step in the self-protecting synthesis of toxic substances in the beetle defensive stink glands.

Ernst A. Wimmer, Georg August University of Göttingen, Göttingen, Germany
ewimmer@gwdg.de

Sektion Biodiversitätsverlust und Insektenschwund / Section Biodiversity Decline and Loss of Insects

Keynote

Agroecosystem transformation to revert biodiversity decline: The LivinGro™ case study

M. Schade

Biodiversity loss is a serious threat to our planet's ecosystem. Given its importance in the complexity of this system, the entomofauna has been of outstanding interest for entomologists, ecologists, and for the public. Over the past decades, "Insect decline" has been a key topic in the scientific and even in the public press.
Given the fact that almost half of the planet's usable land surface is employed for agricultural purposes, solutions to reverse the trend of biodiversity loss cannot thrive without changes in our today's agricultural practices.
Once we transform farming practices, we have great power to provide enough healthy food for a growing world population while protecting nature and mitigating the adverse effects of climate change.
LivinGro™ is an international project supporting regenerative agriculture by developing science-based methodologies to enhance biodiversity and soil health in agroecosystems. The goal is to generate robust data that reliably reveals how modern agricultural technologies and crop management practices can be combined with multifunctional areas, which consist of indigenous flowering plants, to boost ecosystem diversity above and below ground, in and beyond the field.

Michael Schade, Syngenta Crop Protection, Basel, Switzerland
michael.schade@syngenta.com

Keynote

Insects in the context of Science-Policy activities (incl. IPBES and IPCC)

J. Settele

After a brief introduction to the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), this talk presents the Platforms main aspects related to insects specifically, but also to the wider biodiversity and ecosystem services with a focus on the role of and impacts on insects. This is first based on the key results of the pollination assessment which was completed in 2016, where the focus is on trends of pollinators, the reasons for mostly negative trends and in particular the options to counteract those trends. The second part of the presentation will then focus on the Global Assessment of IPBES and some elements of recent IPCC reports.

Josef Settele, Dept. of Conservation Biology & Social-Ecological Systems, Helmholtz Centre for Environmental Research, Halle (Saale), Germany
josef.settele@ufz.de

Keynote

Wandel der Nachtfalterfauna Südwestdeutschlands seit 1970

R. Trusch & O. Karbiener

Für die 2022 publizierte Studie (Karbiener & Trusch 2022) wurden 25 über Südwestdeutschland verteilte Quadranten der Topographischen Karte 1:25.000 (Untersuchungsgebiete, UG) 2019–2020 hinsichtlich ihrer Nachtfalterfauna kartiert. Die ausgewählten 25 UG (≙2% der Landesfläche) repräsentieren aus naturschutzfachlicher Sicht besonders hochwertige Landschaftsausschnitte und weisen einen umfangreichen Bestand an historischen Nachtfalterdaten für 1971–2000 in der Landesdatenbank Schmetterlinge Baden-Württembergs (www.schmetterlinge-bw.de) am Staatlichen Museum für Naturkunde Karlsruhe auf.
Die zweijährige Kartierung erbrachte >30.000 Artnachweise von insgesamt 778 Arten. Dies entspricht 82% aller in den letzten 50 Jahren landesweit nachgewiesenen Nachtfalterarten. Im Durchschnitt wurden auf den 25 UG 301 Arten festgestellt, davon 42 Arten der Roten Liste Baden-Württembergs (RL). Die artenreichsten UG zeichnen sich durch eine hohe Dichte sowohl trockener als auch feuchter Offenland- und Wald-Biotope mit unterschiedlichen Expositionslagen aus. Besorgniserregend niedrig waren die Ergebnisse in den Feuchtgebieten großräumig ebener Lagen; bezüglich Arten der RL auch in Gebieten mit einem geringen Anteil an mageren Offenland-Biotopen.
Der historische Vergleich ergab, dass die Artenzahlen in den 25 UG im Zeitraum 2001–2020 (344 Arten) gegenüber 1971–2000 (392 Arten) um durchschnittlich 12% zurückgingen. Darüber hinaus wurde in einer differenzierten Analyse festgestellt, dass im Arteninventar des Neuzeitraumes lediglich ø 71% = 279 Arten des Altzeitraumes 1971–2000 enthalten sind. Allerdings kommen nach dem Jahr 2000 ø 17% = 65 Arten neu hinzu. Je Quadrant wurden somit ø 113 der vormals gemeldeten Arten nicht mehr bestätigt! Für die RL-Arten ist festzustellen, dass die Anteile an Wieder-

funden von Arten aus dem Altzeitraum mit durchschnittlich 52% (ø 32 von ehemals 61 Arten) nochmals geringer und die Anteile an neu nachgewiesenen Arten mit ø 31% (19 von ehemals 61 Arten) deutlich höher ausfallen.
Aus den 25 UG liegen seit 1971 Nachweise von 881 Arten vor. Dies entspricht 93% der Nachtfalter-Landesfauna der letzten 50 Jahre. Nach der Zusammenfassung von 24 Arten zu 11 Artkomplexen wurde für 868 Arten bzw. -gruppen der Verbreitungstrend auf den Quadranten in den beiden Zeiträumen analysiert. Demnach zeigen 54% (465 Arten) eine rückläufige Anzahl an Nachweisen nach dem Jahr 2000, für 21% (186 Arten) wurde eine gleichbleibende Verbreitung ermittelt und für 25% (217 Arten) war ein Anstieg an Nachweisen festzustellen. Insgesamt sind in den 25 UG 50 Arten nach dem Jahr 2000 verschollen. 30 Arten traten hingegen erstmals nach der Jahrtausendwende auf.
Die Art-Nachweise der 25 UG wurden zudem getrennt nach den Zeiträumen 1971–2000 und 2001–2020 entsprechend ihrer Habitat-Präferenzen, Arealtypen und Höhenstufen-Präferenzen analysiert. Der Vergleich der Habitat-Präferenzen ergab, dass die Artenzahlen aller Biotoptypen rückläufig sind, einige aber deutliche Unterschiede im Trend aufweisen. Überdurchschnittlich hoch sind die Verluste mit -15% bei Arten von Offenland-Biotopen, welche durch nährstoffarme Standortverhältnisse gekennzeichnet sind. Des Weiteren wurden hohe Verluste bei Arten der feuchten Gebüsche und Säume sowie im Artenspektrum der beerstrauchreichen naturnahen Nadelwälder festgestellt. Die geringsten Rückgänge sind bei den Arten der Trockenwälder zu verzeichnen. Dieser Biotoptyp fällt auch durch Zunahmen in etlichen einzelnen UG aus dem Rahmen. Beim Vergleich der Arealtypen wurde festgestellt, dass die Nachweise von mediterran getönten Arten im Neuzeitraum um 7% gegenüber dem Altzeitraum zugenommen haben, während die Nachweise kontinental getönter Arten (= Haupt-Anteil der Landesfauna) nach der Jahrtausendwende um 15% abnahmen. Hinsichtlich der Höhenstufen-Präferenzen wurde für alle Arten ein durchschnittlicher Rückgang festgestellt. Er fiel für Arten mit einem Schwerpunkt in der planaren Stufe mit ø -9% deutlich geringer aus als für Arten mit montanem Schwerpunkt, deren Anteilssummen ø um 16% zurückgingen. Die landesweit naturbedingt geringen Anteilssummen der Arten mit hochmontaner Verbreitung waren mit -19% am stärksten rückläufig.

Weitere Informationen siehe: https://pudi.lubw.de/detailseite/-/publication/10421
Karbiener, O., Trusch, R. (2022): Wandel der Nachtfalterfauna Baden-Württembergs seit 1970. Band 1–2. – Andrias 22, Karlsruhe.

Robert Trusch, Staatliches Museum für Naturkunde Karlsruhe, Karlsruhe, Deutschland
trusch@smnk.de

Soil-plant-insect interactions on herbaceous green roofs: How does it start?

E. Drukker, C.W. Quist, N. Fatouros & M.E. Schranz

Green roofs can provide habitat and resources to insect communities. As space becomes increasingly limited in cities, green roofs are an increasingly common solution for green metropolitan areas with little space. Yet, it is unclear to what extent green roofs can promote biodiversity. Research is often limited to simple *Sedum* (or extensive) roofs – that have a relatively low diversity of plant species compared to more modern green roofs – or to the difficulty in locating comparable roofs. To address this, we study insect and soil fauna communities by comparing newly constructed green roofs of similar height, surface area location and a native plant species composition. With this setup, we can quantify biodiversity by measuring the development of soil fauna, plants and above-ground insects over time. As the interactions through which soil organisms can affect aboveground insects are mostly plant-mediated, we specifically study how this soil-plant-insect interaction network is formed on green roofs. Here, first results are presented on soil-plant-insect communities after the first year of green roof construction.

Eva Drukker, Wageningen University, Wageningen, The Netherlands
eva.drukker@wur.nl

Flushing Away the Future: The Effects of Wastewater Treatment Plants on Aquatic Insects

D. Enns, S. Cunze, N. Baker, J. Oehlmann & J. Jourdan

As the Anthropocene develops, so too does one of its biggest challenges, the defaunation of global ecosystems. Despite insects being an incredibly diverse group and providing fundamental ecosystem services, they are highly susceptible to defaunation. Amongst the most threatened insects are those within the aquatic realm, which have shown reductions in both diversity and abundance of not

only specialist taxa but, more worryingly, of generalist taxa as well. Beside climate change and habitat degradation, water pollution is a major contributor to the current aquatic insect decline and, with the invention and release of novel chemicals and their unknown environmental consequences, presents an ever-growing concern. Wastewater treatment plants (WWTPs) represent point-sources of nutrients and chemicals in freshwaters as they fail to adequately eliminate micro pollutants, such as personal care products, pharmaceuticals, pesticides, hormones, etc. Studies, mostly focused on single WWTPs, have shown general trends of freshwater invertebrate communities becoming dominated by pollution tolerant taxa. To expand on these findings, and to the best of our knowledge, the current study is the first to comprehensively investigate the effects of 170 WWTPs on invertebrate taxonomic composition. We compared several diversity and pollution indices, as well as the taxonomic composition both upstream and downstream of the WWTPs (366 sampling sites). The two most negatively impacted insect orders were the Plecoptera and Trichoptera, while the Ephemeroptera showed slight decreases and the Diptera increased in abundance. On lower taxonomic levels, the overall "losers" (i.e., significant abundance declines) were *Rithrogena semicolorata* Gr. and *Isoperla* sp., whereas *Baetis vernus* and *Ceraclea albimacula* were the overall "winners", increasing significantly from upstream to downstream sites. Although strong changes in community composition were observed, demonstrated by a mean species turnover rate of 65%, commonly used diversity indices did not noticeably change between sites, highlighting their potential inadequacy in accurately assessing ecological health. Our results indicate that WWTPs change downstream conditions in favour of pollution tolerant taxa, which replace the more sensitive ones. Order-level taxonomic responses can be informative but should be interpreted with caution, since they can be driven by a few taxa, or oppositional responses of members can result in an overall low order-level response. Upgrades of WWTPs with a tertiary cleaning step (e.g. granular or powdered activated charcoal and advanced oxidation processes) might be beneficial, provided upstream sections are unimpacted and/or are in a good chemical and structural condition.

Daniel Enns, Goethe University Frankfurt, Frankfurt am Main, Germany
enns.d1@web.de

Butterfly communities in South Tyrol erode from extensive grasslands to intensively used farmland and urban areas

E. Guariento, J. Rüdisser, K. Fiedler, C. Paniccia, S. Stifter, U. Tappeiner, J. Seeber & A. Hilpold

The biodiversity crisis occurring in the European agricultural landscapes demands an evaluation of the different land-use practices. In Europe, butterflies are considered an important ecological indicator for biodiversity and a pollinator taxon, especially in grasslands. Most butterfly species require human interventions to sustain their populations, however, land-use changes and management intensification are currently responsible for their overall decline.

We compare butterfly communities occurring on 93 sites in seven widely distributed land-use types, viz. extensive meadows and pastures, semi-intensive meadows, vineyards, arable land, settlements, and apple orchards in South Tyrol. Data were collected within the long-term project Biodiversity Monitoring South Tyrol. Overall, we recorded high diversity in supposedly high nature value (HNV) grasslands, consisting of extensive meadows and pastures. All other land-use types scored significantly lower, with decreasing diversity from semi-intensive meadows to intensive apple orchards. Functional traits uncovered a general trend: extensive grasslands supported communities of more specialized, threatened and sedentary species whilst all other non-HNV land-use types supported communities characterized by mobile generalists. Community composition differed among land-use types and was influenced by plant-based indicator values for nutrients, light and temperature. Important life-history traits further correlated with site variables confirming the shift from specialists to generalists along increasing land-use intensity gradients and the effect of the thermal environment on phenological traits.

We found supporting evidence for the effectiveness of regional Agri-Environmental Measures (AEMs) and the general European conservation strategy focused on the preservation of HNV grasslands. We suggest a dedicated subsidies program for extensive pastures, especially at lower elevations, where a diverse and threatened community was recorded. Furthermore, we recommend taking steps leading to an extensification of non-subsidized (semi-)intensive meadows (avoiding additional management intensification) and to a radical change in the management of apple orchards,

both would greatly benefit the butterfly fauna in the region.

Elia Guariento, Institute für Alpine Umwelt, Eurac Research, Bolzano, Italy
elia.guariento@eurac.edu

Standardizing bee sampling: A systematic review of pan trapping and associated floral surveys

A. Krahner, A.C. Dietzsch, T. Jütte,
J. Pistorius & J. Everaars

A number of methodological studies and conceptual frameworks offer guidance on the standardized sampling of bees with pan traps (aka bee bowls, Moericke traps). However, a large methodological variety persists in bee studies using pan traps. Due to this lack of standardization, it is problematic to compare sampling results among studies, particularly in light of an ongoing debate about how high availability of floral resources around pan traps impacts the number of bees sampled.
We systematically reviewed all peer-reviewed studies in English published until spring 2022 that were listed in the Web of Science core collection using pan traps for bee collection. In addition to pan-trap characteristics, we extracted information on the methodology used to sample flower abundance and diversity around pan traps from a subset of those studies. We also extracted information on the kind of correlations between sampled floral and bee abundance/diversity found in these studies.
Our systematic search yielded 369 references in total; detailed information was extracted from 290 studies. Although pan trap methods varied considerably among studies, in many methodological aspects a consensus seems to emerge, which is adhered to more or less closely in most studies. Floral sampling methods vary considerably among studies. Overall, we find no clear indication with regard to correlations between floral and bee sampling results. Due to the lack in standardization and the small pool of data, the relation between pan trap results and surrounding floral context should be investigated more systematically in the future.

André Krahner, Julius Kühn Institute, Braunschweig, Germany
andre.krahner@julius-kuehn.de

The last hideout: Abundance patterns of the not-quite-yet extinct mayfly *Prosopistoma pennigerum* in the Albanian Vjosa River network

J. Martini, F. Walther, T. Schenekar,
E. Birnstiel, R. Wüthrich, R. Oester,
B. Schindelegger, T. Schwingshackl,
O. Wilfling, F. Altermatt, M.V. Talluto,
G. Singer & S. Vitecek

The free-flowing Vjosa River is of key importance for the survival of the mayfly *Prosopistoma pennigerum* (Müller, 1785). With up to 302 individuals per m^2, she hosts the most abundant known population of this rare ephemeropteran. The species occurs regularly, in a 150 km stretch of the Vjosa main stem and its major tributaries. Except occasional findings from southern Spain and a section of the Volga River in Russia the species is now lost elsewhere in Europe. This loss has been attributed mostly to river fragmentation. Therefore, we characterize the population in the free-flowing Vjosa River, with a specific COI primer for a targeted eDNA approach combined with standard multi-habitat samples. We sampled in spring and autumn 2018 and autumn 2019, in 43 sites along the river network. This network scale sampling allowed us to define a theoretically available niche space. Thus, we assessed the species-specific niche space at a large scale in the Vjosa River. We further validated this niche space by predicting an increasing probability of presence (θ) towards downstream sections. Moreover, we predict a high θ in the tributaries Shushica and Drinos. However, physical observations in these sites were low, indicating habitat degradation and dispersal limitations. If present, we modeled the expected abundances (λ) in function of a set of environmental variables including discharge and sediment dynamics. We predict abundant populations in both downstream and midstream reaches underlining the value of the Vjosa River for the species. In addition, we measured the size distribution of nymphs along the Vjosa River. Simultaneous occurrences of very small to large mature nymphs suggest an asynchronous life cycle. This life cycle strategy is advantageous in a dynamic ecosystem as it allows fast recolonization of disturbed habitat patches. Frequent disturbances are high in the Vjosa network due to its hydromorphologically intact character. To conclude, the Vjosa River is a vital habitat for this peculiar mayfly and *P. pennigerum* is well adapted to this ecosystem. Thus, we suggest

P. *pennigerum* as Flagship species for the future Vjosa National park.
https://doi.org/10.1111/icad.12620

Jan Martini, University of Innsbruck, Innsbruck, Austria
jan.martini@uibk.ac.at

Neonicotinoid exposure mimicking spray drift exposure strongly reduces plant bug abundance (Heteroptera: Miridae) on meadows

J.E. Sedlmeier, C. Brühl, I. Grass &
G. Petschenka

Although considered a major driver of the insect decline, experimental evidence for the detrimental effects of insecticides on terrestrial insect communities is scarce compared to effects on individual species. Studies on individual nontarget insect species revealed sublethal effects and a widespread contamination of the terrestrial environment by insecticides is increasingly recognized. Although a range of ecotoxicological studies are required for insecticide approval, they only cover a limited set of indicator species in standardized laboratory and (semi-) field trials. Results of these studies are then extrapolated to estimate whether the impact of the insecticide on non-target insects is acceptable. An important but understudied endpoint are the potential differences in susceptibility of nontarget insects. Here, we chose plant bugs (Heteroptera: Miridae) as a model group to study the effects of sublethal insecticide exposure on non-target insect communities. Plant bugs are highly abundant in field margins and open grassland and thus represent a group of non-target insects likely exposed to insecticide spray. We conducted a field trial comprising 20 semi-open field plots (mesocosms) placed on open grassland. An Acetamiprid-based neonicotinoid insecticide was applied to the mesocosms at three different concentrations including a typical field application dose (100%), 30%, and 0.15% of the field application rate. As a control, an additional set of mesocosms was sprayed with water. Effects on the local plant bug community were assessed by regular sweep net sampling during the first month after insecticide application. Specimens were counted and identified to species level.
Acetamiprid at the typical 100% and a 30% field rate, mimicking insecticide spray drift and overspray, led to a strong reduction of plant bug nymphs and adults. The mean difference in abundance in the 30% treatment compared to the control was 72% for nymphs and 53% for adults. Remarkably, different species showed varying degrees of susceptibility. A continuous insecticide application may thus not only lead to an overall decline in plant bug diversity, but also induce a shift towards more insecticide tolerant species. According to a report of the European Food Safety Authority, drift amounts may exceed 30% of the field dose in narrow field margins representing a typical habitat of plant bugs. Therefore, our findings indicate that pesticide registration requirements may severely underestimate the effect of insecticide exposure on non-target insects. In addition, the study of only a handful of model organisms is not sufficient to fully understand the environmental consequences of an insecticide.

Jan Erik Sedlmeier, University of Hohenheim, Friolzheim, Germany
jan.sedlmeier@uni-hohenheim.de

DIY camera trap for automated insect monitoring

M. Sittinger & A. Herz

Monitoring of insect populations is essential to investigate potential drivers and their impact on the widespread decline of insect abundance and diversity and to design effective conservation strategies. Traditional monitoring methods (e.g. Malaise traps) require high time and labor inputs while often yielding data at relatively low spatiotemporal resolutions. Automated, noninvasive methods can extend the ecologists' toolbox and enable a continuous insect monitoring with comparatively low time and labor inputs. Several commercial and open source systems with opto-electronical sensors or cameras are already available, but high costs or complicated assembly and programming can be an obstacle to wider deployment apart from specialized user groups. We developed a DIY camera trap system combining scientific requirements (open source, standardized, low-cost) with the ease of use of commercial products, which can be used for automated monitoring of flower-visiting insects. The system is based on a Raspberry Pi in combination with the OpenCV AI Kit (OAK-1), a camera with an integrated chip that can run artificial neural networks on-device. A specifically trained object detection model detects insects landing on a platform with artificial flowers in real-time. To avoid repeated counting of an individual insect in the same frame, an object tracker is used to track all insects moving on the platform and assign individual tracking IDs. For each insect, cropped images are saved to SD card every second, combined with relevant metadata like timestamp, tracking ID and detection confidence. These images can be used for automated identification of the insects with a

custom classification model in a second step. Due to its low power consumption, a small 9 W solar panel is sufficient to power the device. Two lithium-ion batteries as backup power source and the PiJuice Zero HAT for precise power control make the device truly self-sufficient. All electronic components are integrated into a weatherproof enclosure, which enables a continuous monitoring in the field during the whole season. A dedicated documentation website with detailed instructions on hardware assembly, software setup and programming together with all software released open source on GitHub enables everybody to build their own smart camera trap system.

Maximilian Sittinger, Julius Kühn Institute, Dossenheim, Germany
maximilian.sittinger@julius-kuehn.de

There are no "winners of climate change"– Increasing temperatures and their effect on Mediterranean moth communities

B. Uhl, M. Wölfling & C. Bässler

In the temperate regions of Central Europe, climate change favors the establishment of southern European and warm-adapted species, while cold-adapted species are vanishing. Therefore, warm-adapted species are often called "winners of climate change". Yet, very few studies have addressed, whether these species do also profit from warmer temperatures in their original distributional ranges or if the species' temperature optima might at some point be exceeded, leading to local biodiversity declines. We took advantage of a 20-year-moth survey and asked the question, how increasing temperatures affect moth communities in a Mediterranean coastal forest reserve. We especially focused on the effects of temperature during larval development, as the larval stage might be most prone to heat and drought stress. Our data revealed a significant decline in moth diversity, when temperatures during larval development were high. Especially summer developing species reacted sensitively to increasing temperatures, indicating that these species might struggle with hot and dry Mediterranean summers.
Climate change therefore might amplify insect decline in the Mediterranean region, pointing at the fact, that even for thermophilous species, there is no such thing as "winners of climate change".

Britta Uhl, Goethe University Frankfurt, Niederwerrn, Germany
britta.uhl@web.de

"nützLINK"–A citizen science based approach to monitor beneficial arthropods in agricultural landscapes in Germany

J. Uhler, F. Briem, E. Früchtenicht, H. Hamm, P. Kassel, M. Pink, M. Sittinger & A. Herz

The global loss of biodiversity and in particular the decline of insects has serious consequences for many ecosystems worldwide. In agriculture, important ecosystem services such as crop pollination and natural pest control are at risk. Due to agricultural intensification, beneficial arthropods such as predators and parasitoids are frequently exposed to pesticides and fertilizers. Lack of (semi-) natural structures prevents them from recovering in habitats less affected by chemical inputs. Regular monitoring of their populations in agricultural landscapes is therefore necessary to detect changes in their communities and the ecosystem services they provide. On the other hand, a standardized monitoring program can also help to record positive effects of agroecological measures on biodiversity. Adult hoverflies are important pollinators, while the larvae of many species are effective predators of various field crop pests (e.g. aphids). Due to their life cycle and high mobility, many hoverfly species roam in very different habitats. Their populations are influenced by the availability of resources and potential disturbance factors across a wide spatial range. As part of the collaborative project MonViA[1] (National Monitoring of Biodiversity in Agricultural Landscapes), a long-term monitoring of their populations will serve as an indicator for the condition of agricultural landscapes. Orchard meadows embedded in the agricultural landscape are extensively managed agroforestry systems that provide temporary refugia and resources for many insect groups, including hoverflies. As low-disturbance ecotones, they can serve as a spatial matrix for establishing a long-term monitoring of the target insect taxa. Furthermore, many orchard meadows are maintained by citizens, communities and associations. This network of interested stakeholders can contribute to document the occurrence of hoverflies and other beneficial insects within the Citizen Science approach "nützLINK" of our project (https://www.agrarmonitoring-monvia.de/en/news-details/nuetzlink-goes-online). Currently, parameters such as biomass, abundance and diversity of the target taxa and the assessment of their population trends are recorded with a combination of conventional (yellow pan traps, malaise traps) and new methods where Citizen Scientist can be involved. These methods include the less

invasive use of eDNA analyses[2], the development of artificial flowers as well as a camera trap for the automated monitoring of flower-visiting insects. The concept of this monitoring program and initial results are presented in this paper.

[1] On behalf of the Federal Ministry of Food and Agriculture, a total of 12 specialist institutes of the Thuenen Institute and the Julius Kühn Institutee as well as the Federal Office for Agriculture and Food are working together in the project MonViA (https://www.agrarmonitoring-monvia.de/en/).
[2] In cooperation with Sinsoma GmbH, Austria.

Johannes Uhler, Julius Kühn Institute, Dossenheim, Germany
johannes.uhler@julius-kuehn.de

InsectMow: Development and Evaluation of insect and spiderfriendly mowing techniques

L. von Berg, O. Betz, M. Sann, J. Steidle, J. Frank & S. Böttinger

A number of studies demonstrate that large amounts of insects and spiders living on agricultural grassland are injured and/or killed during mowing. Thus, it can be assumed that frequent mowing of intensively used grassland is analogous to overfishing and significantly contributes to the current insect decline in agricultural areas. The interdisciplinary research project ”InsectMow“ aims to study how negative effects of mowing on grassland ecosystems can be reduced by technically modified standard disc mowers. Our main project goals are the development of (1) an insect scarecrow that is mounted in front of the mower to chase away insects and (2) an optimized, arthropod-friendly disc mower that damages/kills significantly less insects and spiders during operation. We study important pollinators (e.g. wild bees, hoverflies, butterflies), herbivores (crickets, grasshoppers, true bugs, some carabid beetles), carnivorous insects (carabid beetles, rove beetles) and spiders. If the project manages that manufacturers of mowing machines integrate the tested and approved modifications into prototypes and final products, it will considerably contribute to the conservation of biodiversity and the maintenance of ecosystem services in agricultural fields with only limited impact on productivity.

Lea von Berg, University of Tübingen, Tübingen, Germany
lea.von-berg@uni-tuebingen.de

Sektion Biogeographie und Faunistik / Section Biogeography and Faunistics

Keynote

Diversity and checklist of the Italian insects

M.A. Bologna & R. Poggi

The history of the Italian entomological research is briefly summarized especially with regard to the faunistic studies. The first regional catalogues were published in the late XVIII century and other studies, mostly focused on southern Italy, were published before the Unification in 1861. After the foundation of the Società Entomologica Italiana (Italian Entomological Society) (1866) and the beginning of relevant expeditions also in the tropics (especially in eastern Africa and South-East Asia) as well as the increasing of faunistic entomological studies also in Italy, produced the storage of a rich knowledge on several orders of Hexapoda. This information was synthesized along the XIX and XX centuries in monographs as those on beetles, ants, flies, and butterflies. In this extraordinary period for the Italian entomology, also relevant applied studies were made by G.B. Grassi, A. Berlese, F. Silvestri, G. Grandi. After the II WW, the recovery of faunistic research was supported by special projects of the Verona Museum and the Consiglio Nazionale delle Ricerche (National Council of Research) and through the care of the Comitato Scientifico per la fauna d'Italia (Scientific Committee for the Italian Fauna, CSFI), founded in 1952. The financial support of the Ministry of the Environment was directed to the publication of the volumes of the series "Fauna d'Italia" (1956–now), until now 54, most of which target insect taxa, and to the "Checklist delle specie della Fauna d'Italia" (1993–1995), divided in 110 issues and concerning the geographic boundaries of Italy. For each species the distribution in macro-areas and the endemicity are noticed. According to that Checklist, the Hexapoda of Italy include 37,303 species, about 20% endemic or sub-endemic, most of which Coleoptera (12,005), Hymenoptera (7,509), Diptera (6,601), Lepidoptera (5,086). Since 2018 the CSFI started a new project aimed at upgrading the Checklist, in which an increasing of about 7% of the number of species is estimated. Until now, lists of more than 35,000 species were completed with information relative to the presence in each Italian region. Some examples of the new checklists of insects are proposed with comparison between the previous and the new lists.

Marco A. Bologna, Dipartimento di Scienze (Department of Sciences), Università Roma Tre (University Roma Tre), Roma, Italy
marcoalberto.bologna@uniroma3.it

Do forest fires have an impact on moth communities?

C. Balthasar, T. Schmitt & M. Wiemers

Over the last years, forest fires have strongly increased in number due to drought and heat. While wild fires are an essential factor for ecosystem health in several parts of the world, fires are not necessary for German ecosystems. However, such fires are challenges which we are increasingly facing due to climate change, but still little is known about the resulting consequences.
The federal state of Brandenburg has had the highest rate of tree cover loss due to fire events in Germany over the past two decades. Particularly since 2018, 4,000 ha of easily flammable pine forests have burned there. Therefore, the Pyrophob consortium established various forestry treatments on sites that burnt in 2018 and 2019 in southwestern Brandenburg. The aim is to elaborate an optimised treatment of burned sites to establish drought-resistant healthy forest ecosystems. In this part of the project, moths were chosen as bioindicators because they are herbivorous insects and represent an important food resource for birds and bats in forest ecosystems. Furthermore, they are species-rich and taxonomically as well as ecologically well-understood. Moths were collected by standardized automatic light window traps on 15 different sites from March to November in 2021 and 2022.
In our research, we address several post-fire aspects: We assess 1) how moth communities are changing in the first years after forest fires, 2) how the successional stage is reflected in the moth community and 3) how the ecological traits of the moth communities differ among the different treatments. We analyse ecological traits and community composition on burned and unburned sites. Preliminary results based on analyses of ca. 4,000 individuals are presented in this talk.

Cathrina Balthasar, Senckenberg German Entomological Institute, Müncheberg, Germany
cathrina.balthasar@senckenberg.de

Patterns of intraspecific differentiation in the bush-cricket *Isophya modestior* (Orthoptera: Tettigoniidae)

S. Ivković, D. Chobanov, L.-S. Dey, F.M. Buzzetti, I.Ș. Iorgu, G. Puskás, E. Warchałowska-Śliwa, L. Horvat & A. Hochkirch

Isophya modestior is a species distributed in central and south-eastern Europe, where its distribution is largely separated by two large rivers (Sava and Danube). The species is mainly common in the southern part of its distribution (south-western Romania, north-western Bulgaria, northern North Macedonia, the inland part of Montenegro, Bosnia and Herzegovina, Kosovo, northern Albania and Serbia), whereas it has a patchy distribution in its northern range. It mainly occurs on some Pannonian island mountains in northern Serbia, Croatia, Hungary, Slovakia, Austria, Slovenia and north-eastern Italy.
Members of the genus *Isophya* are flightless and have a low dispersal ability, and, therefore, represent good candidates as target species for phylogeographic studies. The species are difficult to identify using morphological traits alone, resulting in a high cryptic diversity. In recent years, numerous endemic and cryptic species have been documented in the eastern Balkan Peninsula and Carpathian Basin, classified by the male calling song as the main differentiating character. Besides bioacoustics, cytogenetic studies also showed partial correspondence to the morphoacoustic groupings. Thus, cytogenetics can also be used as an effective tool for identification of closely related species within this genus.
We examined biogeographic patterns in bioacoustics, genetics, cytogenetics and morphology in *I. modestior* in order to obtain a comprehensive overview of differentiation across its geographic range. Analyses of the male calling songs and morphology of the stridulatory file showed that the species is separated into two main groups–one present in the central part of the Balkan Peninsula (representing *Isophya modestior* sensu stricto), with the second group occurring in the Pannonian Basin, Dinarides, Slovenia and NE Italy. The most reliable difference between the groups is the duration of the main syllable, the number of stridulatory teeth and number of pulses in the main syllable, where all values are higher in specimens from the Balkan Peninsula. Additional analyses showed that within the second group, there are differences in analysed characters between specimens from the Pannonian Basin and specimens from the Dinaric area, the latter ones having intermediate song characteristics, closer to the group from the Balkan Peninsula.
Our phylogenetic analyses revealed the existence of two major clades within *I. modestior* with very high bootstrap values and posterior probabilities–Clade A: present on the Balkan Peninsula, Slovenia (Inner Carniola), Italy, Pannonian Serbia (Vršac Mts and Deronje) and Austria (Burgenland and Lower Austria); Clade B: present in Slovenia (Upper Carniola), Croatia and Austria (Carinthia), Pannonian Serbia (Fruška Gora Mt.) and Hungary. A comparison of chromosomes revealed discrete differences between the karyotypes within 51 analysed specimens. The physical characteristics of the karyotypes included chromosome number (2n), sex chromosome (X) morphology and C-banding patterns. The standard chromosome complement of 50 specimens from different localities is characterized by 2n = 30+X0 in males. In one male collected in Fruška Gora Mt. (Andrevlje), the chromosome number was reduced to 2n = 28+neo-XY. Our analyses revealed complex intraspecific biogeographic patterns in *I. modestior*, providing insights into differentiation patterns, fostered by isolation on island mountains of the Balkans.

Slobodan Ivković, University of Trier, Trier, Germany
s6slivko@uni-trier.de

The abundance, biomass and distribution of ants on earth

S. Nooten, P. Schultheiss, R. Wang, F. Brassard, M.K.L. Wong & B. Guénard

Knowledge on the distribution and abundance of organisms is fundamental to understanding their roles within ecosystems and their ecological importance for other taxa. Such knowledge is currently lacking for insects, which have long been regarded as the “little things that run the world”. Even for ubiquitous insects, such as ants, which are of tremendous ecological significance, there is currently neither a reliable estimate of their total number on Earth nor of their abundance in particular biomes or habitats. We compile data on ground-dwelling and arboreal ants to obtain an empirical estimate of global ant abundance. Our analysis is based on 489 studies, spanning all continents, major biomes, and habitats. We conservatively estimate total abundance of ground-dwelling ants at over 3×1,015 and estimate the number of all ants on Earth to be almost 20×1,015 individuals. The latter corresponds to a biomass of ~12 megatons of dry carbon. This exceeds the combined biomass of wild birds and mammals and is equivalent to ~20% of human biomass. A-

bundances of ground-dwelling ants are strongly concentrated in tropical and subtropical regions but vary substantially across habitats. The density of leaf-litter ants is highest in forests, while the numbers of actively ground-foraging ants are highest in arid regions. This study highlights the central role ants play in terrestrial ecosystems but also major ecological and geographic gaps in our current knowledge. Our results provide a crucial baseline for exploring environmental drivers of ant-abundance patterns and for tracking the responses of insects to environmental change.

Sabine Nooten, University of Würzburg, Würzburg, Germany
sabine.nooten@gmail.com

Wiederentdeckung der eunivalen Schmetterlingsart *Psodos wehrlii* nach 86 Jahren für Südtirol (Lepidoptera: Geometridae)

R. Trusch, N. Pöll, M. Falkenberg, M. Sauter, F. Pühringer & G. Tarmann

Der tagaktive Schmetterling „Wehrlis Gletscherspanner“ (*Psodos wehrlii* Vorbrodt, 1918) galt seit 1935 im östlichen seiner beiden eng umgrenzten Teilareale der Alpen als verschollen. Während der Hochsommer 2021 und 2022 widmeten wir uns der Erforschung dieser extrem lokalen, hochalpinen und wohl einzigen eunivalen (d. h. ausschließlich in der Schneezone der Berge lebenden) Schmetterlingsart – wenn nicht sogar Tierart – der Alpen. Nachdem über Jahrzehnte die Suche nach dem Falter durch viele Lepidopterologen vergeblich verlief, konnte die Art im Nationalpark Stilfserjoch im Jahr 2021 nach 86 Jahren wiedergefunden werden. Ihre Wiederentdeckung ist insofern erstaunlich, als mit der Erderwärmung und dem Rückgang von mehr als der Hälfte der Alpengletscher seit 1850 die Befürchtung bestand, dass diese Tierart in Südtirol bereits verschwunden sein könnte. Was durch uns erfreulicherweise widerlegt wurde! Im Vortrag werden einige Hintergründe zur Art, ihrer Entdeckung und das vermutliche Habitat in der Ortler-Gruppe beschrieben. Schließlich werden noch einige Tipps zum Erkennen von *Psodos wehrlii* im Gelände im Vergleich zu simultan fliegenden, ähnlichen Arten gegeben. Schließlich werden die neunen Beobachtungen aus Südtirol (Italien) im Vergleich zum weltweit zweiten Vorkommen bei Zermatt (Schweiz) diskutiert.

Zur Erinnerung an den Wiener Lepidopterologen und Alpinisten Rudolf Kitschelt (14.12.1868–21.01.1936), den Verfasser der Schmetterlingsfauna Südtirols

Robert Trusch, Staatliches Museum für Naturkunde Karlsruhe, Karlsruhe, Deutschland
trusch@smnk.de

Museomics reveals patterns of within-species divergence and diversification in *Troides* birdwings (Lepidoptera: Papilionidae)

C. van der Linden, E.L. Reboud, E. Chevalier, M. Eurlings, T. Léger, S.L. Sutton, P. Verbaarschot, R. de Vos, N. Wahlberg, F.L. Condamine & S. Simon

Biogeographical patterns of Sundaland’s incredibly diverse fauna remain largely understudied from an insect perspective. By applying modern “museomics” techniques to a species group of the charismatic *Troides* birdwing butterflies, we generated an inter- and intraspecific genomic dataset from museum specimens collected between the 1890’s and 1990’s. Thereby enabling investigation of the historical biogeography, diversification and species status of Sundaland’s endemic birdwings.

Corné van der Linden, Wageningen University, Wageningen, The Netherlands
corne.vanderlinden@wur.nl

Untangling the mito-nuclear discordance of the alpine butterfly *Erebia pronoe*

M. Wendt, D. Kulanek, Z. Varga, L. Rákosy & T. Schmitt

Several morphological and mitochondrial lineages of the alpine ringlet butterfly species *Erebia pronoe* have been described, indicating a complex phylogenetic structure. We combined mitochondrial and nuclear markers with morphometric data of the male genitalia and the infection patterns with *Wolbachia* strains, based on a WSP analysis to reconstruct it´s biogeographical history.

Martin Wendt, Leibniz Centre for Agricultural Landscape Research, Müncheberg, Germany
martin.wendt@senckenberg.de

Sektion Biologische Schädlingsbekämpfung / Section Biological Control

Keynote

Consequences of competitive interactions between parasitoids for biological control

T. Haye

Parasitoids play a vital role in ecosystems as regulators of herbivorous insects, and interspecific competition can influence the nature and outcome of interactions across different trophic levels. Although the competitive exclusion principle dictates that no two species can co-exist in the exact same niche, the reality is that what appears as co-existence can generally be accounted for by adaptation of one or both species to permit co-occurrence. Parasitoids that share the same host resource are likely to encounter hosts that are already parasitized, and will either accept or reject the host depending on whether they can detect the presence of another parasitoid, and whether this makes the host less suitable for development of their own offspring. Host suitability in this context depends on the probability of offspring survival from the species that oviposits in an already-parasitized host. Parasitoids will generally avoid ovipositing in a host that has already been parasitized either by the same species (superparasitism) or a different species (multiparasitism); and avoidance often increases with the time between the first oviposition and a subsequent encounter, but decreases when there is limited availability of unparasitized hosts. In terms of biological control, an increased diversity of natural enemies can lead to null, additive, antagonistic or synergistic effects and thus, advantages and disadvantages of using single or multiple species against a single target have been long discussed in biological control and more generally in multitrophic interaction studies.
Hymenopteran egg parasitoids have become of considerable interest due to their potential as classical biological control agents of invasive pests, such as the invasive brown marmorated stink bug, *Halyomorpha halys*. The recent adventive establishment of Asian *Trissolcus japonicus* Ashmead (Hymenoptera: Scelionidae) in Europe has resulted in interest in the impact of this parasitoid on the globally invasive pest, but there are also concerns regarding indirect non-target effects due to competitive interactions between *T. japonicus* and native European egg parasitoids. However, interest in competitive interactions among Scelionidae goes beyond an applied biological control context, as the presence or absence of a shared evolutionary history may dictate whether two species have developed mechanisms to co-exist on a shared resource. Here we present examples of competition of *T. japonicus* with native European egg parasitoids or co-evolved species from their native range and the variable outcomes of these interactions.

Tim Haye, CABI, Delémont, Switzerland
t.haye@cabi.org

Behavioural and immunological defense traits of *Lobesia botrana* larvae are affected by host plant phenology and cultivar as well as indirectly by atmospheric CO_2 concentrations

C. Becker, A. Rummel & A. Reineke

The multivoltine European Grapevine Moth (*Lobesia botrana*) is an important insect pest in vineyards worldwide. To avoid falling prey to predatory arthropods and parasitic wasps the larvae employ behavioural and immunological defense mechanisms. Their efficacy can be affected by insect diet. Rising atmospheric carbon dioxide (CO_2) concentrations associated with climate change can alter host plant quality for herbivores. Will this affect larval defenses?
In a combination of field and laboratory experiments, we studied the impact of elevated CO_2 concentrations, larval development, grapevine phenology and cultivar on defense traits of *L. botrana* larvae, i.e. larval silk yarn length, yarn production rate, escape velocity, escape rate, twisting behavior, haemocyte concentration, pro-/phenoloxidase activity and successful development into adults after injury. In the field, larvae were feeding on *Vitis vinifera* 'Riesling' or 'Cabernet Sauvignon' in three different phenological stages (inflorescences, peasized berries, berries changing color) under ambient or elevated CO_2 concentrations in the Geisenheim VineyardFACE (Free-Air Carbon dioxide Enrichment facility in the vineyard). In the lab, larvae were feeding on standard artificial diet under ambient or elevated CO_2 concentrations to study the direct effect of CO_2. To study the indirect effect of CO_2, larvae were feeding on artificial diet containing grapevine reproductive organs harvested in the VineyardFACE. Additionally, we assessed the impact of larval development.
Our field experiments showed a strong impact of plant phenology on traits associated with both behavioural and immunological defense while cultivar and CO_2 concentration rather affected immunological defense. Our lab experiments largely agree with this and additio-

nally show an indirect effect of CO_2 on behavioural defense. No direct effect of CO_2 was observed. Larval development affected some behavioural and immunological traits.
Our experiments suggest that the changes in defense traits observed in the field are largely plant quality-mediated bottom-up effects. Varying larval development may play a role. Projecting approximately 50 years into the future, we may indeed expect some impact of elevated CO_2 concentrations on larval defense against natural enemies and potential consequences for biological pest control. Interestingly, already now, during one season, one generation may defend themselves more successfully than others depending on grapevine phenology. This should be an interesting topic for further studies.

Christine Becker, Hochschule Geisenheim University, Geisenheim, Germany
Christine.Becker@hs-gm.de

Modelling Predator-prey Interactions between the Earwig *Forficula auricularia* and the Woolly Apple Aphid *Eriosoma lanigerum* in Apple Orchards

R. Thomas, B.P. Pokharel, P. Miedtke & G. Petschenka

The Common Earwig (*Forficula auricularia*) is a naturally occurring omnivorous predator in Central-European orchards. A preferred prey of the earwig is the woolly apple aphid (WAA) (*Eriosoma lanigerum*), a colony-forming pest in apple trees. Recently, biocontrol by the earwig received increased attention as the major insecticide for WAA control (Spirotetramat) will be delisted by 2025. However, control of WAA by earwigs frequently yields inconsistent results and it is unclear why WAA control by earwigs often fails. Here, we conducted a field trial to investigate the density dependent relationship of earwigs and WAA. Different densities of earwigs were released on netted branches of apple trees harboring a defined amount of WAA colonies. Control of WAA was determined by predator density and influenced by the complexity of the predation environment. For lower earwig densities, predation of WAA was substantial during the first days of the trial but ceased later resulting in a stable state of coexisting earwig and aphid populations. Earwigs at the highest density eradicated WAA completely. Overall, predation probability on aphid colonies decreased over time. Using a generalized linear mixed modelling approach we found that spatial complexity by a higher number of side branches was correlated with decreased predation in lower earwig densities. This is possibly due to a higher searching time for prey in complex environments. Stable states observed across different earwig densities can be interpreted in the framework of Charnov's Marginal Value Theorem predicting, that if energy gain of predators in a patch falls below the average energy gain in the environment patches will be abandoned. Probably, earwig behaviour shifted from predation to dispersing, as better hidden colonies persisted. Under a biocontrol perspective our data suggest that insecticide-like control of WAA with earwigs requires a higher earwig threshold, than what is commonly found in commercial orchards.

Robert Thomas Bischoff, University of Hohenheim, Stuttgart, Germany
robert.bischoff@uni-hohenheim.de

Temperature modulates via behavioural changes the intraguild predation between the predatory mites *Neoseiulus californicus* and *Euseius stipulatus*

F. Dorn, I. Torres-Campos, M. Montserrat & A. Weinberg

Climate change is affecting the composition and structure of ecological communities. In agricultural communities, most herbivore pests and their natural enemies are arthropods and as ectothermic organisms, many of their physiological functions are temperature dependent. Additionally, their behaviour changes depending on their thermoregulatory strategies to cope with global warming. Both factors indirectly affect the strength by which individuals interact with each other. Therefore, global warming is expected to disrupt the ecological service that natural enemy-pest interactions provide through biocontrol. In this study, the effects of temperature shifts on the behaviour of individuals of a mite community were evaluated to understand the observed trophic changes in the community with increasing temperature. The mite community is present in avocado agro-ecosystems in southeastern Spain and consists of the herbivore pest *Oligonychus perseae* and two species of predatory mites, *Neoseiulus californicus*, and *Euseius stipulatus*, that may engage in intraguild predation. The effects of mild (22°C) and hot (30°C) temperatures on intraguild interactions and individual behaviour were evaluated using different community blocks in laboratory trials. Results revealed that all mite species switched their microhabitats at hot temperatures. Consequently, the shared and intraguild prey changed their availability to their predators at higher temperatures. Therefore, behavioural changes, especially of juvenile predatory mites, were de-

cisive for the observed trophic changes at the community level. Thus, the success of biological pest control will depend on the behavioural plasticity of the biocontrol agents to face heat stress. Further studies exploring the interplay between behaviour and temperature in biocontrol efficiency are needed.

Fabio Dorn, Wageningen University & Research, Paderborn, Germany
fabio_nicolas.dorn@web.de

Can naturally occurring antagonists supported by re-establishment of entomopathogenic nematodes secure sustainable, insecticide-free production of oilseed rape?

R.-U. Ehlers & G. Godina

Future production of oilseed rape (OSR) will have to use non-chemical alternatives to control pest insects. Insecticides are either banned or loose efficacy due to resistance development and novel insecticides have a limited target spectrum. All major OSR pests migrate to the soil for pupation. This is the natural environment for entomopathogenic nematodes (EPN) and spraying of the nematode *Steinernema feltiae* against prepupal stages in field experiments indicated that all of them are potential targets for EPN. However, a survey to trap EPN from soil samples collected at arable crop sites resulted in only 0.2% positive samples out of 11,000 whereas in perennial crops every third to fifth sample is positive. Probably due to agricultural practice (intensive soil tillage and weed control and limited crop rotation) EPN have almost been extinct in arable land. Preliminary results indicate that EPN can successfully re-established in OSR. A concept is discussed whether an insecticide-free or -reduced management of OSR pests is possible. Sustainable measures need to include reduced insecticide applications to protect the activity of naturally occurring predators and parasitoids, measures to promote their potential, the re-establishment of EPN, adapted tillage and inclusion of legumes in the rotation.

Ralf-Udo Ehlers, e-nema GmbH, Schwentinental, Germany
ehlers@e-nema.de

Colour preference and attraction of *Encarsia formosa* (Gahan) towards LED monitoring traps

E. Ekejiuba, R. Meyhöfer & B. Gruppe

The greenhouse whitefly (*Trialeurodes vaporariorum* Westwood, Hemiptera: Aleyrodidae), an important pest of tomatoes in the greenhouse, depends on visual orientation for migration and to find and assess its host plant. Therefore, yellow sticky traps are frequently used to monitor and control this important pest in greenhouses. With the recent integration of light-emitting diodes (LED) into the monitoring system, the attractiveness of the standard yellow sticky traps for *T. vaporariorum* has been significantly improved. However, it remains unclear if this new LED monitoring trap for *T. vaporariorum* also shows higher attractivity for its natural enemies, which might disrupt biological control. For this reason, the visual response of *Encarsia formosa* Gahan (Hymenoptera: Aphelinidae), an essential and cosmopolitan parasitoid of *T. vaporariorum*, was carefully examined.
In the first phase of the experiment, the basic spectral reactivity of *E. formosa* was investigated in multiple-choice arena using six different LED colours. In the arena, forty starved adult *E. formosa* less than 48 h old were released per replicate from a glass vial at a distance of 7 cm to the traps. Colour preference was estimated after 24 h. In the second phase of the experiment, *E. formosa* attractivity was studied between green LED traps designed for whitefly monitoring and the standard yellow sticky trap in the greenhouse environment. In this dual-choice experiment, ten starved adult *E. formosa*, also less than 48 h old, were released from a glass vial at a distance of 25 cm over a period of three hours in the morning, afternoon, and evening to examine daily activity and colour preference. All experiments were replicated at least twenty times in a completely randomized design.
The results show that 61% of the released *E. formosa* responded to the sampled LED trap colours in the multiple-choice setup. Among the recaptured *E. formosa*, 67% of the whole catches were recaptured on the green LED trap, followed by 17% on the UV LED trap, and 3% on the yellow LED trap. Catches on green LED were 25 times higher than catches on yellow LED trap. In the dual-choice test, 94% of the catches were recaptured on the standard yellow sticky traps, while 6% were recaptured on the green LED traps designed for whitefly monitoring. The results so far show that using green LED-enhanced monitoring traps most likely does not interfere with

biological control of *T*. *vaporariorum* using *E*. *formosa*. However, further validation is needed under growing conditions in practice. More so, in light of the present results, further implications of this preference pattern for the monitoring of biological control efficacy of *E*. *formosa* with LED traps will be discussed.

Emeka Ekejiuba, Leibniz University, Hannover, Germany
emeka.ekejiuba@stud.uni-hannover.de

Introduction and establishment of the parasitoid *Trissolcus japonicus* in South Tyrol: A three-year release program

M. Falagiarda, S. Bortolini & S. Schmidt

The samurai-wasp, *Trissolcus japonicus* (Hymenoptera: Scelionidae), is an exotic egg parasitoid that was released in several sites in South Tyrol for the first time in 2020, to naturally regulate populations of the brown marmorated stink bug, *Halyomorpha halys* (Hemiptera: Pentatomidae). More than 40 sites were selected, covering the main valleys of the province, in both urban areas and close to fruit orchards, where the stink bug was present in the year preceding the releases. During summer, parasitoid releases were carried out at all locations on two-three dates, from mid-June to the early August. In order to determine the parasitization rate, egg masses of *H*. *halys* and other stink bug species were collected in all sites both before and after the releases. Through the monitoring activity, the presence of other native and exotic parasitoids was assessed and their efficacy to parasitize *H*. *halys* was compared to that of *T*. *japonicus*. Egg masses of other stink bug species were identified, and their parasitoids were determined to record any parasitism of the samurai-wasp on non-target organisms.
During the three years, almost 2,000 stink bug egg masses were collected, most of them belonging to *H*. *halys*. The released parasitoid was recovered in more than half of the selected sites in all three years, indicating its ability to reproduce under different local conditions. In some locations, parasitization of *H*. *halys* eggs by *T*. *japonicus* reached about 70%. Findings of the exotic parasitoid at the beginning of the season, before the first release, in 2021 and 2022 indicated its ability to overwinter in some of the selected areas. Two other parasitoid species, the native *Anastatus bifasciatus* (Hymenoptera: Eupelmidae) and the exotic *Trissolcus mitsukurii* (Hymenoptera: Scelionidae), were responsible for parasitization of *H*. *halys* eggs at many sites, especially in 2020 and 2021. These species also parasitized several egg masses of other stink bug species. On the contrary, parasitization of *T*. *japonicus* on non-target species was occasionally encountered during the three years. Overall, three years after the first releases, we note a good establishment of this antagonist in the main areas where the pest is present.

Martina Falagiarda, Research Centre Laimburg, Trento, Italy
martina.falagiarda@laimburg.it

Development of a rearing system for the potential biocontrol agent *Pemphredon lethifer*

J. Furtwengler & E. Böckmann

In vegetable and ornamental crops, leftovers of biocontrol agents against aphids, such as droppings or aphid mummies, are generally not accepted by retailers and consumers. Therefore, new methods for leftover-free biological control of aphids are necessary. A promising method might be the use of digger wasps of the genus *Pemphredon* as biocontrol agents. Especially promising is the species *Pemphredon lethifer* (Shuckard, 1837), as it is widespread in Central Europe. *Pemphredon lethifer* females collect and remove aphids from plants completely and transport them to their nests, to provide food for hatching larvae. Nests are dug into pithy twigs like *Sambucus* spp. or *Rubus* spp. However, until now, no rearing system of *P*. *lethifer* is established for research or commercial use. In order to develop a rearing system of *P*. *lethifer* for the use as biocontrol agent, more details on its nesting preferences are needed. Therefore, we firstly evaluated which pith diameter *P*. *lethifer* prefers for nesting.
In 2022, at seven study sites in Braunschweig (Germany) and the surrounding area three trap nests were installed from May to September. Trap nests consisted of 16 twigs of 30 cm length of *Sambucus* spp., with four different pith diameter categories ranging from 2.5 to 10.5 mm. Trap nests were checked weekly for signs of nesting. As soon as signs of nesting were visible, the twig was removed, transferred to the laboratory and replaced with a new twig of the same category. Twigs with nests were stored in individual boxes. Adult wasps, which were present in the nests, as well as wasps and parasitoids emerging from the nests were measured and identified.
In a next step, pith diameter preferences are studied in the laboratory. In this ongoing choice experiment, a newly emerged female and a male *P*. *lethifer* are placed together in a cage with twigs of defined pith diameters and nesting is documented. As soon as signs of nesting are visible, an additional twig of the same diameter category is offered.

Preliminary results from trap nest catches in the field, as well as choice experiments in the laboratory show a preference of *P*. *lethifer* for the largest pith diameter category (8.5 to 10.5 mm). Further field trials and laboratory experiments are planned in 2023. Results will be presented and discussed.
The findings are crucial for development of a rearing system of *P*. *lethifer* for biological control in vegetable and ornamental crops.

Jana Furtwengler, Julius Kühn Institute, Braunschweig, Germany
jana.furtwengler@julius-kuehn.de

Potential of entomopathogenic nematodes to control the oilseed pests *Psylliodes chrysocephala* (Coleoptera: Chrysomilidae)

G. Godina

Can biological control with entomopathogenic nematodes (EPNs) provide a possible, environmentally friendly alternative to manage the cabbage stem flea beetle in oilseed rape? Adult weevils were most susceptible to *Steinernema carpocapsae*, but the LC_{50} was too high to consider use of nematodes against adults. In Petri dish experiments with *Heterorhabditis bacteriophora* at 15°C the LC_{50} ranged from 76 nematodes per insect for L_1 and 12 nematodes for L_3 stages. In pot experiments at 15°C the mortality of L_2/L_3 inside the plant petioles ranged from 29% with *H*. *bacteriophora* to 61% with a cold-activity-selected strain of the same species and 80% with *S*. *feltiae*. In four field trials the mean density of L_2/L_3 larvae in control plots assessed on November 19 and December 3 and 9 ranged from eight to >70 per plant. The majority of the treatments provided no significant reduction, probably due to low temperature between 11 and 14°C during EPN application. The highest significant reduction in the field was 39%, obtained with a mixture of *H*. *bacteriophora* and *S*. *feltiae*. Seed treatments with Cyanthraniliprole (Lumiposa, Corteva) provided no significant reduction, whereas the spraying of lambda-Cyhalothrin (Karate Zeon, Syngenta) against the adults significantly reduced the larvae per plant.

Giulia Godina, E-nema GmbH, Schwentinental, Germany
giuliagodina@gmail.com

Can we combine parasitoids with an entomopathogenic virus to efficiently control *Tuta absoluta*?

J. Gonthier, J. Studer, J. Arnó, J. Romeis, L. Sutter & J. Collatz

New sustainable strategies to control pest insects are required to reduce harmful effects on the environment and the rise of pesticide resistance. *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae), the key pest of tomato crops, is challenging to control due to its high population increase and pesticide resistance. An emerging management strategy consists of biological control using the parasitoids *Necremnus tutae* (Reuter) (Eulophidae) or *Dolichogenidea gelechiidivoris* Marsch (Braconidae), yet with limited efficacy. We assessed wether a baculovirus biopesticide could be combined with the parasitoids to enhance pest control. The *Phthorimaea operculella* granulovirus (PhopGV, Baculoviridae) specifically infects *T*. *absoluta* larvae. However, negative effects could result from overlapping resource requirements of parasitoid immatures and the virus.
First, we assessed whether ovipositing females discriminate against virus-infected hosts and examined the outcome of within-host competition between parasitoids and virus in the laboratory. Second, we evaluated the efficacy of combining the baculovirus with the parasitoid *N*. *tutae* in greenhouse experiments. Finally, we used the data from the greenhouse to parametrize a model on host and parasitoid population dynamics to predict the best release parameters.
Female *D*. *gelichiidivoris* could discriminate against virus-infected hosts, whereas *N*. *tutae* did not. Thus, *D*. *gelichiidivoris* can minimize negative interference and control those hosts that have escaped the virus. Depending on the species and the time after virus infection, we found reduced emergence and longevity, but in general, the virus had a low impact on parasitoid offspring. Compared to *N*. *tutae* and the baculovirus used solely, their combination significantly improved the control of *T*. *absoluta* in the greenhouses. While the parasitoids' efficiency is highly sensitive to the timing and amount of release, our model demonstrated that baculovirus application can reduce the number of required parasitoids by almost 80%. Therefore, both parasitoids seem to be compatible with the baculovirus to control *T*. *absoluta*, and the combined use significantly improves control.

Jérémy Gonthier, Agroscope, Zurich, Switzerland
jeremy.gonthier@agroscope.admin.ch

Wheat undersowing for pest insect regulation in white cabbage

A. Köneke & E. Böckmann

Intercropping is a broadly studied measure for biological control in vegetable crops. Although many studies already confirmed pest regulating effects of different cabbage intercropping systems, especially undersowing with clover species, the system is still not widely transferred into agricultural practice. Therefore, we evaluated the overall suitability of winter wheat (*Triticum aestivum* L.) as undersowing plant for white cabbage (*Brassica oleracea* convar. *capitata* var. *alba*), as it is easy to assess and establish for farmers and unlike clover it does not develop offshoots. Pest regulating effects with focus on flea beetles and aphids, as well as effects on yield and natural enemy abundance were assessed.
Between the years 2017 and 2021, six field trials were conducted in small plots (20–32 m^2), each in randomized complete block design in four to eight repetitions. In each trial, undersown cabbage plots were compared to control plots without undersowing. In undersowing plots, single-rows of winter wheat were sown directly between cabbage rows. Wheat was sown six weeks before transplanting of cabbage in middle of May, to ensure effects on pest insects in early cabbage developmental stages. Numbers of flea beetles and their feeding damage as well as numbers of aphids and their natural enemies were counted weekly on six to ten cabbage plants per plot. In four of the six trials, epigeic predators such as spiders, rove beetles, coccinellids and ground beetles were additionally assessed in pitfall traps. In October, harvested cabbage plants were weighed and remaining quality losses due to feeding of pest insects were assessed on harvested cabbage heads and roots.
Results show reduced numbers of *Phyllotreta* spp. flea beetles and both aphid species, *Brevicoryne brassicae* and *Myzus persicae*, in undersown cabbage in most of the years. However, enhancing effects on natural enemies are not consistent in all trials. Furthermore, there was a slight but significant negative effect on yield in some years, which has to be taken into account when implementing the system to farmer's practice.

Anna Köneke, Julius Kühn Institute, Braunschweig, Germany
anna.koeneke@julius-kuehn.de

Root colonization by fungal entomopathogen systemically primes belowground plant defense against cabbage root fly

C. Posada-Vergara, K. Lohaus, M. Alhussein, S. Vidal & M. Rostás

Entomopathogenic fungi infect insects via spores but also live inside plant tissues as endophytes. Frequently, colonization by entomopathogens provides plants with increased resistance against insects, but the mechanisms are little understood. This study investigated direct, local, and systemic root-mediated interactions between isolates of the fungus *Metarhizium brunneum* and larvae of the cabbage root fly (CRF) *Delia radicum* attacking *Brassica napus* plants. All fungal isolates infected CRF when conidia were present in the soil, leading to 43–93% mortality. Locally, root-associated *M*. *brunneum* isolates reduced herbivore damage by 10–20% and in three out of five isolates caused significant insect mortality due to plant-mediated and/or direct effects. A split-root experiment with isolate Gd12 also demonstrated systemic plant resistance with significantly reduced root collar damage by CRF. LC-MS analyses showed that fungal root colonization did not induce changes in phytohormones, while herbivory increased jasmonic acid (JA) and glucosinolate concentrations. Proteinase inhibitor gene expression was also increased. Fungal colonization, however, primed herbivore-induced JA and the expression of the JA-responsive plant defensin 1.2 (PDF1.2) gene. We conclude that root-associated *M*. *brunneum* benefits plant health through multiple mechanisms, such as the direct infection of insects, as well as the local and systemic priming of the JA pathway.

Catalina Posada-Vergara, Georg August University of Göttingen, Göttingen, Germany
cposadav@gmail.com

Combining banker plants and tailored flower strips: What can flowering plant species provide for optimizing bio-control?

R. Poudel, S. Laurenz & R. Meyhöfer

The cabbage whitefly *Aleyrodes proletella* L. (Hemiptera: Aleyrodidae) is a serious insect pest of *Brassica* crops in Germany and other European countries. A banker plant system with the parasitoid *Encarsia tricolor* Förster (Hymenoptera: Aphelinidae) provided with *Trialeurodes vaporariorum* Westwood (Hemiptera: Aleyrodidae) as alternative host on Hokkaido squash was found promising in biological control of *A*. *proletella*. Flower strips

are another important conservation biological control strategy in the field. They provide additional resources for naturally occurring antagonists. In a recent DBU funded project, a tailored flower strip "Hannover-Mix" consisting of nine flowering plant species, was specifically developed to promote natural enemies against cabbage pests. Combining the tailored flower strip with the banker plant system could be a sustainable strategy to control multiple pests of *Brassica* crops and might also provide supplemental resources for the banker plant system. However, it is not known whether whiteflies, *A. proletella* and the two alternative *E*. *tricolor* hosts, *T*. *vaporariorum* and *Aleyrodes lonicerae* (native host) are able to colonise plant species in the tailored flower strip and if *E*. *tricolor* can find and exploit suitable resources. Therefore, the ability of the three whitefly species to colonise plant species in "Hannover-Mix" was investigated under laboratory conditions. A female of each whitefly species was released per clip cage. The clip cages were then attached to young fully-matured leaf of each plant species and control plants for one week. The control plants were wood avens, broccoli and pumpkin for *A*. *lonicerae*, *A*. *proletella* and *T*. *vaporariorum* respectively. Survival and fecundity of whitefly species was checked and best three plant species were selected for further experiment in which the development of whitefly species from eggs to adults were evaluated. Results show, that many of the tested flowering plant species were potential hosts to the tested whitefly species. But compared to the main host plant reproduction and egg to adult development decreased substantially for *A*. *lonicerae* on all tested host plants. In contrast, reproduction and survival of *A*. *proletella* as well as *T*. *vaporariorum* were similar to the main host plants, and in some cases even increased on flower strip plant species (e.g. *A*. *proletella* on coriander). Positive and negative aspect of whitefly species survival on the flowering strips on banker plant system and biocontrol of the cabbage pests will be discussed in detail with the further investigation on the ability of *E*. *tricolor* to parasitize the whitefly species.

Ritikshya Poudel, Leibniz University, Hannover, Germany
ritikshya.poudel@stud.uni-hannover.de

Can artificial sugar supplements interrupt the mutualism between Argentine ants and vine mealybugs?

M. Schulze-Sylvester & A. Tálamo

In vineyards worldwide, the Argentine ant *Linepithema humile* Mayr engages in a food-for-protection mutualism with the vine mealybug *Planococcus ficus* Signoret. In exchange for honeydew, ants protect mealybugs from natural enemies, which hinders biological mealybug control and can lead to mealybug outbreaks. Control measures against ants in form of toxic baits and pesticide sprays have been recommended, but also eliminate the ants' ecosystem services. In search of more sustainable ways to interrupt this mutualism, we offered two alternative sugar feeders (25% sucrose solution and a commercial sugar mixture "Biogluc®") to ants that actively tended *P*. *ficus*. *Linepithema humile* ants preferred both feeder types over honeydew and reduced mealybug-tending by 70–90% within 120 h. This could open a window for biological control agents, but results need to be confirmed in the field. Sugar feeders could be a sustainable tool to boost the biological control of *P*. *ficus* and other mealybugs while also conserving the ants' ecosystem services.

Maria Schulze-Sylvester, Hochschule Geisenheim University, Geisenheim, Germany
maria.schulzesylvester@hs-gm.de

Thermal stress in an acarine predator-prey relationship: shifts in development, fecundity and predation success induced by heat waves may more harm the predator than its prey

T. Tscholl & A. Walzer

Finely tuned species interactions such as predator-prey relationships can be disrupted by changing environmental conditions. Such a disruptor could be climate change as it will not only lead to an increase in global mean temperatures, but also to an increase in frequency, duration and intensity of heat waves. Heat waves can be a considerable factor, because their abrupt but sporadic appearance makes fast responses by arthropods necessary. This would be of major importance if one of two species in such interactions shows a higher (or lower) capability to cope with thermal changes.
We examined the heat wave effects on various fitness-relevant parameters of an agricultural pest, the two spotted spider mite, *Tetranychus urticae*, and its predator, the predatory mite *Phytoseiulus persimilis*. First, single eggs or adult females of each species were exposed to extreme heat waves with daily maximum temperatures (T_{max}) of 38°C or mild heat waves with T_{max} of 32°C. Juvenile survival, consumption, development, body size and adult survival, consumption, escape behavior, egg number, egg size were evaluated in the first (i.e. single eggs) and second experiment

(i.e. single, adult females), respectively. Second, the interaction between a single female predator and female prey was videotaped at 38°C or 32°C (temperatures corresponded to the T_{max} values during their juvenile development) for 90 min and prey survival and maximum velocity of both predator and prey were evaluated. To separate temperature- from interaction effects, single predator and prey females were exposed to the same conditions, but without the opponent. To exclude heat stress, single predator/prey couples reared under mild or extreme heat waves were exposed to 25°C (optimum temperature for both predator and prey) for 180 min and prey survival was recorded. Additionally, the body sizes of the female predators and prey were measured, when reared under mild or extreme heat waves during juvenile development.

Our results showed that juvenile survival was insensitive to heat waves, while extreme heat waves decreased age at maturity in both species. Sizes at maturity of the female predator were smaller under extreme heat waves, whereas female prey sizes were insensitive shifting the predator-prey body size ratios in favor of the prey. This shift may be an advantage for the prey as large individuals could have a higher longevity, fertility and resistance to predators and heat stress. Second, extreme heat waves led to an increase in food consumption and both species increased the egg production at the expense of smaller egg sizes. Third, survival rates were not different between the two species, but the female predators tried to escape from experimental units under extreme heat waves in contrast to prey. Finally, videotaping of direct interactions showed lower success rates of predator attacks under extreme high temperatures. Independent of temperature and prey presence or not, the maximum velocities of the predator decreased over time. Contrary, maximum velocity of prey was not affected by time. Additionally, predation success was lower under optimum temperatures, when the two adult opponents developed under extreme heat waves to adulthood. These findings were due to the lower predator-prey body size ratios under extreme heat waves compared to mild heat waves.

Hence, our results indicate some advantages for the prey in comparison to the predator when exposed to extreme heat waves. Remaining questions are, whether predators escaping from heat may come back when temperatures cool down and how all the heat wave-sensitive traits may influence population dynamics of predator and prey. Future experiments on heat wave effects in a tritrophic system (plant–spider mite–predatory mite) on population level will give us more precise answers, which species could gain an advantage under heat waves resulting in successful spider mite control or not.

Thomas Tscholl, University of Natural Resources and Life Sciences, Vienna, Austria
thomas.tscholl@boku.ac.at

Sektion Schädlingsbekämpfung im Pflanzen- und Vorratsschutz / Section Insect Control in Plants and Stored Products

Keynote

Neoclassical approaches for species-specific control of agricultural pest insects

M.F. Schetelig, R.A. Aumann & L. Prates

The sterile insect technique (SIT) is a widely used method for controlling insect pest populations. It involves releasing mass-reared, sterilized male insects into the wild, which mate with females but produce no offspring, resulting in a reduction in population size over time. However, not all insect pests can be controlled using this method, as specific requirements must be met for it to be safe, efficient, and cost-effective. One such requirement is the ability to selectively remove females from the rearing population, known as sexing. Genetic sexing strains (GSS) have been developed to improve this process for certain species, with the most successful GSS being created for the Mediterranean fruit fly using classical mutagenesis. Advances in genomics and gene editing have made it possible to understand the genetic basis of this GSS and to recreate its properties in other Tephritid species, allowing for faster and transgene-free development of GSS in new species. The author will compare the 'classic GSS' approach to the newer, 'neo-classical' approach, discussing the differences, advantages, and disadvantages of each.

Marc F. Schetelig, Justus-Liebig-University Giessen, Gießen, Germany
Marc.Schetelig@agrar.uni-giessen.de

Effects of some soft insecticides on the egg parasitoid *Trichogramma cacoeciae* Marchal (Hym. Trichogrammatidae)

H. Abdelgader

Parasitoids of the genus *Trichogramma occur* naturally worldwide and play an important role as natural enemies of lepidopterous pests on a wide range of agricultural crops. Results of augmentative releases of *Trichogramma* can be affected by the use of broad-spectrum insecticides in or near release and consequently affects populations of these beneficial and the biodiversity of the agricultural fields. The search for selective insecticides to be used with *Trichogramma* releases is of great importance. The recent laboratory studies were carried out to investigate the side effects on *Trichogramma cacoeciae* of two formulated products of each of two botanical insecticides: Azadirachtine (Neemazal T/S Blank and Celaflor®) and Quassin (alcoholic or water extracts) to study their possible use with *Trichogramma* releases, since these insecticides are from plant origin and are believed also to have the advantage of having the lease impact on the environment. Two formulations of the botanical active ingredient, azadrichtine (Neemazal T/s Blank and Celaflor) as well as two extracts of Quassin (Alcohlic and Water extracts) were included in the tests. The field recommended concentrations were prepared for the tests. The study included exposing adults (susceptible life stage) of *Trichogramma* to sprayed glass plates. In another experiments adults of *Trichogramma* were exposed to sprayed host eggs. The study also included spraying of parasitized host eggs at different interval after parasitisation ranging from 1–8 days. The results showed that by exposing adults *T. cacoeciae* to residues of Neemazal formulations on glass plates, the preparations were either harmful (Neemazal-Blank) or moderately harmful (Celaflor). The two Quassin formulations tested were harmless. In another set of experiments, where treated host eggs were offered to adults *T. cacoeciae*, all tested chemicals were almost harmless. By exposing adults to treated host eggs both Quassin formulations were harmless. Celaflor was slightly toxic for adults, both when freshly or 6-day old sprayed host eggs were offered to adults of *T. cacoeciae*. Neemazal-Blank formulation was only slightly toxic when 6 day old sprayed host eggs were offered to the adults.

Hayder Abdelgader, Agricultural Research Corporation, Wad Medani, Sudan
abdelgaderh@yahoo.com

Phenotyping of beet moth damage

S. Bänsch & M. Schumann

The beet moth (*Scrobipalpa ocellatella*) as a pest in sugar beet cultivation is becoming increasingly important due to climate change. Long drought periods favour its occurrence and development, so that several generations can be formed per year.
The larvae damage the above-ground biomass and the beet head, so that the growth of new leaves is reduced and secondary infections by other pathogens are possible. Insecticides show only a low efficiency, as the larvae are poorly reached and the adults are very mobile. Breeding insect-resistant varieties is a sustainable approach. However, there is still no protocol to assess beet moth infestation and to select suitable genotypes for breeding.

In a small experiment, we investigated various parameters of beet moth damage on sugar beet from field-collected plants, and the occurrence of larvae. A positive correlation between the blackening of (young) leaves and the occurrence of secondary infections was found. We would like to discuss possible parameters for phenotyping in order to develop a protocol for successful plant breeding in the future.

Svenja Bänsch, KWS SAAT SE & Co. KGaA, Einbeck, Germany
svenja.baensch@kws.com

Identifying thrips resistance in wild accessions of *Chrysanthemum*

M. Bovio, M. Strijker, R. Voorrips, B. Vosman, J. van Loon & L. Caarls

Chrysanthemum is one of the most important ornamental plants and its cultivation is affected by thrips damage. The most relevant thrips species in Europe is *Frankliniella occidentalis*, or western flower thrips (WFT). Genetic variation for sensitivity towards thrips was found among *Chrysanthemum* cultivars, but no effective resistance has been identified. In this paper, we identified wild *Chrysanthemum* accessions with effective levels of resistance to thrips *F. occidentalis*. Forty-eight wild accessions from different *Chrysanthemum* species were screened in whole plant assays for population build-up, and in leaf-disc assays for larval development, larval survival, and adult oviposition. Significant differences were found between resistant and susceptible accessions for thrips population build-up on whole plants, and for larval development and survival on leaf-discs. On resistant accessions, thrips larvae did not develop into prepupae, interrupting the developmental cycle. No significant differences were found for oviposition on leaf-discs. Based on these assays, we identified resistant and susceptible wild accessions, which can be used to elucidate the genetics of the resistance.

Marcella Bovio, Wageningen University and Research, Wageningen, The Netherlands
marcella.bovio@wur.nl

Cydia pomonella (Lepidoptera: Tortricidae) management through female removal in apple crop of Trentino-Alto Adige Region

V. Carnio, M. Preti & S. Angeli

Environmental sustainability in apple crop protection is becoming increasingly important, especially considering the recent resolution on the farm to fork strategy and green deal of the EU Parliament. Despite the widespread use of insecticides and mating disruption, pests, such as *Cydia pomonella*, pose a severe threat in organic and integrated managed orchards. The development of new lures attractive for female moths, based on host plant volatiles, has rekindled interest in mass trapping. In this field study we assessed the effectiveness of the female removal technique on the reduction of *C. pomonella* infestation and fruit damage. In 2022, nine trials were conducted in 1 ha adjacent paired apple plots managed with the same grower spray program in Trentino-Alto Adige Region. The treatment consisted of 60 traps*ha^{-1} lured with the combination of (E,Z)-2,4-ethyl decadienoate (pear ester, PE), (E)-4,8-dimethyl-1,3,7-nonatriene (DMNT), and 6-ethenyl-2,2,6-trimethyloxan-3-ol (pyranoid linalool oxide, LOX), with a colure loaded with acetic acid (AA). Each plot treated with mass trapping was compared with a control plot (without traps) in terms of *C. pomonella* damage recording the fruit injury across the season. In addition, in the treated plots the number of total *C. pomonella* captures, the sex ratio and the mating status of females were recorded to evaluate the performance of the female removal technique. A high trapping efficacy has been demonstrated with an average of 18.66±10 (mean ± SD) captures per trap over the 8-week period, removing an average of flying *C. pomonella* moths of 1,119.6±600 (mean ± SD) per ha. Little or no non-target species were recorded. The level of damage in the two treatments under study was comparable also due to the grower fruit thinning, which impacted the fruit injury level at harvest. Further studies, planned for season 2023, are needed to demonstrate the *C. pomonella* damage reduction using the female removal technique.

Veronica Carnio, Free University of Bozen-Bolzano, Bolzano, Italy
veronica.carnio@natec.unibz.it

Ethanol traps to reduce the damage of the ambrosia beetle *Anisandrus dispar* in apple orchards

R. Favaro, M. Wolf, M. Wilhelm, S. Angeli, E. Endrizzi & A. Gruber

The European shot-hole borer *Anisandrus dispar* has become a problem for apple growers in many parts of South Tyrol (Italy) during the last years. The fertilized female bores into the wood of the apple tree to lay her eggs and simultaneously inoculates the gallery with a symbiotic ambrosia fungus. The beetle has a wide host range and mainly attacks damaged and suffering trees. In apple fields, the damage of these beetles has led to yield losses. Protected by their galleries, the

insects are protected by insecticidal application. The use of ethanol-baited traps for mass trapping is nowadays the most common method to control this pest. This 3 years long study aimed to understand the efficiency of ethanol-baited traps in the damage reduction. Ethanol-soaked apple logs were distributed in two apple orchards to simulate suitable host plants. Ethanol traps were activated alternately in the two orchards during the emergence weeks to intercept the flying beetles. The flight dynamics were recorded by sentinel traps located in the surroundings. The efficacy of ethanol traps was estimated at 50% in 2018 and 2020, whilst almost null in 2019. A spatial analysis of the attacked logs did not reveal a direction of the attack, probably due to the beetles already present in the orchards. The analysis of the flight dynamics and the temperatures in the days prior the flight allows to estimate the days of emergence.

Riccardo Favaro, University Innsbruck, Bolzano, Italy
riccardo.favaro@unibz.it

Toxic effects of the major constituents of thyme and caraway essential oils on stored product pest beetles

B. Fürstenau & P. von Moltke

In view of the growing demand for resilient and sustainable agriculture, chemical pest control is increasingly viewed and discussed critically by society and policy makers. In stored-product protection, integrated pest management also encourages the use of low-risk pesticides and other non-chemical techniques that have no or minimal side effects on human health, non-target organisms, and the environment. The goal is to protect storable plant products from infestation through preventive measures, innovative early detection methods, and environmentally friendly control strategies, thereby reducing post-harvest losses and the use of conventional pesticides. Since a variety of plant extracts, essential oils (EOs), or individual plant volatiles can alter insect behavior and demonstrated to have insecticidal activity, their use in protecting stored products represents an alternative approach to control pest organisms.
Here, we investigated the biological and toxic effects of thyme and caraway solvent extracts as well as the major components thymol, D-limonene and D-carvone on adults of two important stored product pests, the saw-toothed grain beetle *Oryzaephilus surinamensis* (Coleoptera: Silvanidae) and the drugstore beetle *Stegobium paniceum* (Coleoptera: Ptinidae). Extracts and single compounds where chemically analyzed by GC-MS and the impact on behavior and mortality of test beetles was evaluated. In fumigation toxicity bioassays, we tested the influence of exposure time, concentration of extracts and compounds applied and feeding substrate. In addition, we performed an area preference bioassay and Y-tube olfactometer tests to investigate possible repellent/attractant effects of the offered EOs.

Benjamin Fürstenau, Julius Kühn Institute, Berlin, Germany
benjamin.fuerstenau@julius-kuehn.de

Using a Farnesene Isomer Mixture as an Insecticide Alternative for Aphid Control

D. Kuhn, P. Bauer, T. Tolasch,
G. Petschenka & J.L.M. Steidle

(E)-ß-farnesene (EBF) is well-known as an alarm pheromone of many aphid species and occurs as a natural aphid repellent in plants. Upon perception of EBF, aphids exhibit an avoidance behavior by walking away, stopping feeding or dropping from leaves. In addition to acting as a repellent for aphids, EBF is an attractant to natural antagonists. Although the biological functions of EBF are very promising for insecticide free aphid control, studies on the effect of field-applied EBF are scarce. Here, we assessed the activity of exogenously applied EBF on *Myzus persicae* (Sternorrhyncha: Aphidiae) on lettuce (*Lactuca sativa*) in the laboratory and under field conditions. First, we tested if a commercial farnesene isomer mixture (FIM) caused the same reactions described for pure EBF in *M*. *persicae* in the lab. Specifically, we assessed a fast response by observing direct behavioral changes after FIM application. In addition, we investigated aphid reproduction under permanent exposure of FIM. Next, we tested two application methods in the open field crop *Lactuca sativa* by comparing application via dispensers with direct spray application of FIM on the crop. We found that *M*. *persicae* reacts to FIM by walking away and that reproduction tends to be reduced in the presence of FIM. Furthermore, we found lower numbers of aphids on FIM treated lettuce in the field. Here, dispenser application caused higher aphid reduction compared to spray application. In addition, more beneficial insects could be found in dispenser-treated patches. Taken together, these results indicate that the use of EBF is a promising method of insecticide free aphid control in lettuce, but also in other crops.

Denise Kuhn, University of Hohenheim, Germany
denise.kuhn@uni-hohenheim.de

Back to the future–New ways of plant protection against insect pests

T. Meiners & T. Will

The total number of insects in Germany is verifiably declining, while parallel to this a number of already significant insect pests continue to increase in quantity and importance and at the same time neozoa are emerging. Reasons for the increasing pressure from insect pests include their faster development due to climate change, increasing simplification of the landscape and intensified agriculture. The development of resistance to insecticides, such as the group of pyrethroids, also plays a major role. With the increase in insect virus vectors, damage caused by virus infection as an indirect consequence of insect infestation is also on the rise, leading to increasing crop losses.
Parallel to these developments, the use of conventional chemical-synthetic plant protection products is being reduced, as these sometimes do not act specifically only against insect pests in the field, but can also harm beneficial insects and other non-target organisms. In the area of conflict between insect protection on the one hand and the need for increased control of insect pests on the other, new approaches for sustainable plant protection are needed. Research areas such as chemical ecology, plant breeding, biological plant protection, as well as the adaptation of arable farming methods and the development of plant fortifiers and new insecticides provide the basis for this and are presented here exemplarily.
The -omics approaches are promising for the development of new plant protection methods against insects. Non-targeted analytical methods for everything from metabolites to genomes have revolutionised biological research and have been the basis for the introduction of systems-based approaches. These can be used to understand plant-pest interactions and genetic variation between plant genotypes and populations of target invertebrates. They thus form the basis for the development of everything from resistant varieties to bio-based plant protection products. They can also be used to develop more sensitive diagnostic methods for use in the field.
Existing and emerging crop protection methods include areas such as arable farming, mechanical methods, plant breeding, biological control, induced resistance, application of ecological principles in diversified systems, precision agriculture and new crop protection products. In arable farming, these include cultivation methods that contribute to a reduction in pest infestation, such as extended crop rotations, companion crops and undersowing, and the establishment of diversity or flowering strips/areas. There are promising examples of resistance breeding against insect pests in cereals, rape and potatoes. Here, precise knowledge of insect biology is necessary, but often still lacking. In addition, new and high-throughput phenotyping methods are needed. Induced resistance after infestation or immune priming against insects may also play a role in future approaches to controlling insect pests. A better understanding of microbial interactions with plants, e.g. in the rhizosphere, phyllosphere and with endophyte organisms, can help to develop methods and, based on this, products that positively influence tolerance or plant defence against insects. In addition, biological plant protection can also help to control established and new pests (including neozoa). Here, too, understanding the biology of the organisms involved and their interactions plays a decisive role. Finally, making use of chemical ecology approaches together with modern phenotyping and data analysis techniques offers the development of further possibilities beyond synthetic chemical plant protection against insects.

Torsten Meiners, Julius Kühn Institute, Berlin, Germany
torsten.meiners@julius-kuehn.de

Connecting entomologists and plant virologists around the world to tackle vector-borne crop disease[1]

N. Ockendon-Powell, D. Hird, H. Child, G. Foster & A. Bailey

The Community Network for Vector-Borne Plant Viruses (CONNECTED) builds multidisciplinary research capacity to tackle crop diseases spread by insects. CONNECTED is creating a global knowledge network: we connect a multidisciplinary network of 1,500+ members in 87 countries; we link plant pathology and entomology expertise; we enhance technical expertise/knowledge, and increase international collaborations. Our training programmes have improved the skills and knowledge of over 100 early career scientists based in 18 countries who have shared their skills with hundreds of others. We offer training in vector and virus molecular diagnostic techniques, insect sampling and identification, laboratory skills, bioinformatics and much more. CONNECTED has pump-prime funded new interdisciplinary collaborations between the UK and Africa. So far we have enabled 20

[1] Vortrag wurde kurzfristig abgesagt / Lecture cancelled at short notice

research projects that involved 14 countries, 33 institutions, 55 researchers and eleven crops.
To support global plant surveillance and protection, we will soon launch a Virus and Vector Diagnostics online resource which includes expert-led videos and resources providing members with both the theory and the technical knowledge they need to identify which virus and vector is devastating a crop.
Following the success of the first CONNECTED funding award, the UK government awarded the network £500,000 in 2022 through UKRI International, to realise further impact:
- Innovation and translation–Our pump-prime funded research teams can obtain exploitation and dissemination advice and can apply for the funding they need to take their work forward.
- Capacity building–We plan to offer a Train-the-Trainer programme to plant vector-borne disease researchers for delivering our Virus and Vector Diagnostics course in partnership with the BecA-ILRI Hub and IITA, contributing to achieving goals of the OneCGIAR Plant Health Initiative.
- Policy–We will produce targeted policy briefings to engage national and international stakeholders with evidence-based recommendations for detection, management and control of vector-borne plant viruses.
CONNECTED has created countless shareable resources including infographics, films and animations, helping members raise awareness of:
- The impact of plant diseases
- The importance of plant health
...all on a dedicated online resources hub at connectedvirus.net

Nina Ockendon-Powell, University of Bristol, Bristol, United Kingdom
nina.ockendon-powell@bristol.ac.uk

Current research on the biology and management of the planthopper *Pentastiridius leporinus*, a vector of the new sugar beet disease Syndrome "Basses Richesses"

M. Rostás, P. Bruno, R. Pfitzer, J. Detring, O. Shakya & M. Varrelmann

The planthopper *Pentastiridius leporinus* (L.) (Hemiptera: Cixiidae) is the main vector of *Candidatus* Arsenophonus phytopathogenicus, a phloem-restricted γ-proteobacterium associated to the low-sugar content syndrome of sugar beet (*Beta vulgaris* L.) known as "basses richesses" (SBR). This disease was first identified after tremendous yield losses in eastern France in the nineties. In recent years, it has been rapidly expanding east and northward, thus becoming a major problem for sugar beet cultivation in Germany and Switzerland. The planthoppers spend most of their life as root-feeding nymphs, where they are protected from insecticide treatments. After sugar beet harvest, the nymphs are able to complete their life cycle in the subsequent winter wheat crops. Promising sustainable management strategies against SBR and its vector include crop rotation, breeding for tolerant or resistant sugar beet varieties, and biological control of the insect vectors. To develop these, there is urgent need for a deeper understanding of the biology and chemical ecology of *P. leporinus*. Here we present an overview of our current research on the above-mentioned topics by presenting data on inter- and intraspecific host plant use.

Michael Rostás, Georg August University of Göttingen, Göttingen, Germany
michael.rostas@uni-goettingen.de

A novel "attract and kill" control strategy against *Drosophila suzukii* in cherry orchards

S. Schmidt, M. Bjeljac, A. Eben, S. Angeli & U. Spitaler

The invasive insect *Drosophila suzukii* (Matsumura) is an important pest in cherry cultivation. Yeasts, which are associated with *D. suzukii*, strongly attract *D. suzukii* flies and stimulate them to feed on attractive baits. In the present study, a formulation based on *D. suzukii*-associated yeast cultures combined with spinosad insecticide was tested in the field applied only on a stripe of the canopy of cherry trees. The control of *D. suzukii* achieved with the attract and kill application was compared to applying spinosad to the whole plant.
The field trials were performed in a cherry orchard cultivated in South Tyrol, Italy in 2020, 2021, and 2022. Furthermore, an additional trial was performed in Germany in 2022. Application of the yeast-spinosad formulation allowed to reduce the applied amount of spinosad per hectare and reduced the *D. suzukii* field infestation almost at the same rate as applying spinosad to the whole canopy.
Factors influencing the effect of the attract and kill treatments on *D. suzukii* infestation are discussed.

Silvia Schmidt, Institute for Plant Health Laimburg, Auer South Tyrol, Italy
silvia.schmidt@laimburg.it

Erhebungen und Untersuchungen zum Befall durch heimische Borkenkäferarten im Südtiroler Apfelanbau

M. Wolf & A. Gruber

In den Jahren 2016 bis 2020 waren in der Zone Leifers, Branzoll, Auer sowie im Südtiroler Etschtal im Intensivanbau verstärkt Schäden nach Borkenkäferbefall (*Anisandrus dispar*; Coleoptera, Curculionidae) an Apfelbäumen aufgetreten. Es konnten in einem mehrjährigen Fallenmonitoring an ausgewählten Standorten beobachteten Flugverläufe von *A. dispar* Weibchen sowie die Aktivität weiterer Ambrosiakäfer-Arten, vor dem Hintergrund des Befallsgeschehens im Befallsgebiet in der Zone um Auer und Pfatten ermittelt werden. Zusätzlich zum Befallsgeschehen wurden Erhebungen zu „inneren" Schadbildern an Bäumen aus ausgewählten Ertrags-Anlagen durchgeführt indem an Bäumen, nach ihrer Rodung im Spätherbst Brutnester präpariert worden waren. Dabei war es auch möglich an äußerlich unscheinbaren Pflanzen „Altbefall" im Sinne von verlassenen Nestern festzustellen. In einem vergleichbaren Ansatz waren außerdem zwischen 2018 und 2020 Jungbäume (im Pflanzjahr bzw. im ersten Standjahr) ab Befallsbeginn im März entnommen und präpariert worden. Dabei wurde das innere Schadbild inklusive des Brutbaus, das Artenspektrum, das Alter des Nestbaus (verlasssen oder aktiv), die Befallstärke in Einzelbäumen sowie der Entwicklungstatus der *A. dispar*-Stadien bei Neubefall erhoben.
Die Klassifizierung des Entwicklungsstatus von Eiern und Larven von *A. dispar* in Nestern (aus den gesammelten und präparierten Jungbäumen), diente dazu, mit Hilfe der für die Entwicklung benötigten Zeit (lt. Literatur) den ungefähren Zeitpunkt des Neubefalls zu schätzen und diesen mit den in den Jahren 2018 bis 2020 erhobenen Flugverläufen von *A. dispar* abzugleichen.

Manfred Wolf, Institut für Pflanzengesundheit,
Pfatten/Auer, Italien
Manfred.Wolf@laimburg.it

Sektion Wald-/Forstentomologie / Section Forest Entomology

Keynote

The role of fungi in shaping the ecology and behavior of bark and ambrosia beetles

P.H.W. Biedermann

Symbioses between fungal ectosymbionts and wood-boring weevils have emerged repeatedly in the last 100 million years. In the most famous bark and ambrosia beetles (Scolytinae and Platypodinae), fungal symbioses range from facultative to obligate mutualisms and involve fungal services such as direct nutrition, decomposition, the detoxification of host plant tissues and virulence to the tree-hosts. Mutualistic fungi, on the other hand, profit from their host's dispersal and protection and may include the maintenance of beneficial fungal communities through active partner choice and promotion as well as the inhibition of fungal competitors and pathogens.
In this talk I present data on (i) the ecological factors leading to the repeated emergence of fungal symbioses in wood-boring weevils and (ii) the consequences farming has had on the morphology and social systems of the beetles. Furthermore, by presenting exemplary cases from our research, (iii) I highlight the diversity of fungi in bark and ambrosia beetles, what crucial and diverse roles these symbionts play in the majority of species and the techniques these beetles employ to maintain beneficial fungal symbionts. Finally, (iv) I present some major open questions concerning the biology and symbiosis of bark and ambrosia beetles.

Peter H. W. Biedermann, University of Freiburg, Stegen-Wittental, Germany
peter.biedermann@forento.uni-freiburg.de

Detektion und Überwachung des Auftretens invasiver Arten mittels transportabler Ionenmobilitätsspektroskopie (IMS) und neuartigem Monitoringverfahren – Erste Ergebnisse aus dem Projekt DETMON

M. Brunkau

Ziel der Forschungsarbeiten im Verbundvorhabens DETMON ist es, neue technologische Möglichkeiten zu schaffen, um invasive und forstlich bedeutsame Arten in ihrem Auftreten möglichst frühzeitig zu erkennen und deren Ausbreitung identifizieren zu können.
Im Rahmen des Teilprojekts an der Technischen Universität Dresden werden für bereits etablierte invasive Arten wie den Schwarzen Nutzholzborkenkäfer (*Xylosandrus germanus*) und bekannte Verbreitungsvektoren wie den Bäckerbock (*Monochamus galloprovincialis*) ein neuartiges Nachweis- sowie Monitoringverfahren entwickelt.
Hierzu wurden Fangversuche mit bekannten und nicht bekannten verhaltensmodifizierenden Semiochemikalien, deren Abgaberaten, Mischungsverhältnisse und Konfektionierungen sowie mit verschiedenen Fallensystemen durchgeführt.
Im Vortrag werden die vorläufigen Ergebnisse, die gewonnenen Erkenntnisse zu Fangmethoden und das geplante Monitoringsystem vorgestellt.

Moritz Brunkau, Professur für Waldschutz, TU Dresden, Tharandt, Deutschland
moritz.brunkau@tu-dresden.de

Avoiding the masses: Infestation density dependent release of the aggregation inhibitor verbenone from Norway spruce logs infested with the Eurasian spruce bark beetle, *Ips typographus* (L.)

T. Frühbrodt, B. Du, H. Delb,
P.H.W. Biedermann, T. Burzlaff &
J. Kreuzwieser

Ips typographus (L.) is the major forest pest on Norway spruce. During epidemic phases these beetles are able to kill living trees. To achieve this, they release aggregation pheromones to mass-aggregate on a host tree and collectively overcome its defence. But the beetles face a dilemma because a too high brood density on a tree, as a consequence of the attraction of too many mates, will negatively affect the fitness of the parental and following generation. The volatile compound verbenone has been proposed as an anti-aggregation pheromone that the beetles use to reduce intraspecific competition at later stages of host colonisation. However, we still lack a thorough understanding of the release dynamic of verbenone. The few studies on the occurrence of verbenone in *I. typographus* suggest that verbenone already appears relatively early during the colonisation process, contradicting the expectation that verbenone emission coincides with high intraspecific competition at later stages. Also, these studies typically focus on the first week only, but the colonisation of vital or uprooted host trees is a process of rather several weeks under natural conditions. Another question remained so far completely unaddressed, namely, whether the beetles can control the release of verbenone as an active response to high intraspecific competition or whether verbenone is rather a passive indicator of high feeding and microbial activity associated with bark beetle colonisation. Here, we colonised

spruce logs at two defined infestation densities in a greenhouse experiment to analyse the effect of infestation density on the temporal release patterns of verbenone from the begin of host colonisation until the emergence of the next generation. We also included alpha-pinene, the host-borne precursor compound, and verbenol, the intermediate product of the reaction and component of the aggregation pheromone bouquet. To our knowledge, we are the first to show that verbenone is released in significantly higher amounts from logs with high beetle density compared to logs without beetles during the first three weeks of an attack until the end of the larval stage. Our data does not suggest that the beetles actively produce more verbenone in response to high infestation density. Instead, the higher emission compared to a lower beetle density is rather a passive consequence of the greater number of beetles per bark area. We discuss the results regarding their implication for the ecological understanding of the pheromone communication of *I. typographus*, and also in respect of verbenone-based strategies to protect trees from infestation within in the integrated bark beetle management.

Tobias Frühbrodt, Forstliche Versuchs- und Forschungsanstalt Baden-Württemberg, Freiburg, Germany
tobias.fruehbrodt@forst.bwl.de

Towards a holistic risk assessment of Norway spruce dominated forests under climate change

T. Hallas, S. Netherer, J. Pennerstorfer & G. Hoch

The current devastating mass outbreaks of the European spruce bark beetle (*Ips typographus*) (SBB) have led to large-scale dieback of Norway spruce (*Picea abies*) in Central European forests. In the face of progressing climate change the growing conditions of Norway spruce are deteriorating considerably due to rising temperatures and increasing frequency and intensity of droughts and further extreme weather events. At the same time, the SBB benefits from these climatic trends by increased numbers of generations and stressed trees with impaired defenses.
The project RAWLog “Risk assessment of Forests under Climate Change to improve Sanitation Logging Logistics”, funded by the Austrian Waldfonds, is focused on risk assessment of central European conifer forests under climate change by examining important relationships between abiotic, biotic as well as operational factors and SBB infestations. Main goal is to develop the fundamentals of a freely accessible practice-oriented dynamic SBB early warning system for Austria to prevent abrupt climate-mediated forest transformations, which challenge forestry and society likewise.
Important mitigation measures include a controlled conversion of pure spruce stands into climate-stable mixed forests. Yet, Norway spruce will remain a relevant and viable option, particularly within its natural range, such as the mountain forests of the Alps. Therefore, protecting existing forests with a significant share of Norway spruce also by means of effective SBB management remains important, from both ecological and economic points of view. For this purpose, a precise and timely risk assessment is an indispensable basis to enhance and facilitate SBB management.
For such a risk assessment, a more comprehensive view on the whole complex of effects of abiotic disturbance events and the SBB itself is important. Beside storm and snow damages, drought will be considered in the RAWLog model framework, since it has become equally important as a main abiotic driver of SBB infestations in recent years. In addition to environmental parameters, the operational situation within forest areas needs to be evaluated, including for example accessibility and human and machine capabilities to detect and harvest infested trees just-in-time. A holistic and dynamic SBB early warning system combines all these aspects with high temporal and spatial resolution.
In this project, we build on the current developments and advances in remote sensing and innovative modeling approaches, such as aerial and satellite imagery-based analysis techniques that can be used to detect changes in forest structure annually or on an even higher time-scale resolution. Such technical advances allow for an increasingly accurate estimation of actual stand predisposition (= susceptibility) to SBB infestations. In addition, dynamic models of SBB phenology and forest water balance allow for a day-by-day evaluation of the SBB infestation risk. Our work aims to elucidate the relationships between abiotic, biotic and operational factors playing a role in SBB outbreaks and to close the still existing knowledge gaps.

Till Hallas, Institute of Forest Entomology, Forest Pathology and Forest Protection, BOKU Vienna, Vienna, Austria
till.hallas@boku.ac.at

Mass trapping of the large pine weevil *Hylobius abietis*–Challenges and chances

T. Heber

Hylobius abietis is one of the most relevant potential forest pests in Europe. Until insecticides became the preferred management strategy in the 1950s, mass trapping was one of the few ways of controlling *H. abietis* populations. Due to EU policy, certification processes and the public demand to stop the use of insecticides in forest ecosystems close-to-nature regulation and eradication methods increasingly gain attention again. This coincides with a renaissance of *H. abietis* in forest pest management in central Europe as a result of the unlimited availability of fresh stumps due to an ongoing bark beetle outbreak since 2018. With regard to these circumstances the Chair of Forest Protection at Technische Universität Dresden has conducted several field experiments in order to improve existing approaches to mass trapping of *H. abietis* within the ReBek research project. The results of three years of basic research as well as steps towards a practical implementation are going to be presented at the DGaaE 2023 Entomology Congress in Bolzano.

Tobias Heber, Technische Universität Dresden, Chair of Forest Protection, Dresden, Germany
tobias.heber@tu-dresden.de

Biologische Borkenkäferprävention – Ein entomopathogener Pilz als Teil eines nachhaltigen Produktkonzepts

M. Henkel

Stürme, Trockenheit und allem voran der Klimawandel: unser Wald, als einer der wichtigsten Lebensräume ist durch die klimatisch bedingte Borkenkäferproblematik zunehmend aus dem Gleichgewicht geraten. Eine Entwicklung, die in den letzten Jahren dramatische Ausmaße angenommen hat und mehrere Populationen des Borkenkäfers, insbesondere des *Ips typographus*, pro Jahr ermöglicht. Aber nicht nur in Mitteleuropa leidet der Wald unter der extremen Trockenheit und ihren Folgen: die Waldbestände in ihren vielfältigen Funktionen in ganz Europa und Nordamerika sind betroffen. Dabei handelt es sich bei den gefährdeten und bereits befallenen Waldbeständen nicht nur um künstlich angelegte Monokulturen, sondern auch um heimische Mischwälder.
Ziel meiner Arbeit ist es, eine wirkungsvolle und biologische Alternative zu den konventionellen Bekämpfungsmaßnahmen aufzuzeigen und nach den Kriterien der Nachhaltigkeit zu analysieren. Dabei steht die Funktion des entomopathogenen Pilzes *Beauveria bassiana* im Vordergrund: Bei diesem Antagonisten des Borkenkäfers handelt es sich um einen Organismus, der in intakten Waldbeständen auf natürliche Weise im Boden vorkommt und diese vor Schadinsekten schützen kann. Seine Wirkung auf den Borkenkäfer ist unter entsprechenden klimatischen Bedingungen parasitär.
Dieser Pilz ist Teil des von mir entworfenen Produktkonzepts »Vidar – ein Wächter für den Wald« – einem Lösungsansatz, an dessen Entwicklung ich seit 2019 arbeite. Die Ergebnisse dieser Arbeit, in Theorie und Praxis, sollen im Kurzvortrag vorgestellt werden und als Beispiel für biologische und nachhaltige Methoden in der Schädlingsbekämpfung stehen. Das Hauptanliegen meiner Arbeit ist es, den Wald bei der Aufrechterhaltung und Wiederherstellung seines Gleichgewichts zu unterstützen. Neben dem Miteinbeziehen vorangegangener Forschungsergebnisse und Fachliteratur besteht die Konzeption des Produkts aus einem Praxisteil, bei dem ich Feldversuche und Laboruntersuchungen vorgenommen, dokumentiert und ausgewertet habe. Dieser dient dazu, die Wirkungsweise des im Fallensystem integrierten Pilzes zu belegen.
Zudem möchte ich mich der Verträglichkeit des Pilzes gegenüber anderen Organismen widmen. Da die Umweltverträglichkeit ein besonders wichtiger Aspekt ist, werde ich zu den bereits vorhandenen Forschungsergebnissen auch die selbst durchgeführten vorstellen. Dabei soll die Wirkung von *Beauveria bassiana* auf *Thanasimus formicarius*, den wichtigsten Gegenspieler des Borkenkäfers, dargestellt werden. Der Aufbau aller Versuche, sowie ihre Auswertungen erfolgten in Zusammenarbeit mit Dr. Reiner Pospischil und wurden im Rahmen des interdisziplinären Produktdesign mit dem Schwerpunkt Nachhaltigkeit erarbeitet.

Monja Henkel, ecosign / Akademie für Gestaltung, Köln, Hürth, Deutschland
monja.henkel@ecosign.net

Influence of oscillating temperatures on the developmental rate of *Ips typographus*

S. Hofmann, M. Kautz & M. Schebeck

Temperature is known to have a major influence on insects. At the same time fluctuation of the temperature is the prevailing state in most natural habitats. Two prominent examples of responsible effects are seasonal and daily temperature regimes. Both theoretical and experimental analysis suggest, that these temperature fluctuations have a significant influence on development rate, mortality and

morphology of different insect species. However, scientific experiments on the interrelations between insects and temperatures are often only conducted under constant temperatures to reduce complexity, sampling time and resources. We observed the development of the European spruce bark beetle (*Ips typographus*) under constant and daily oscillating temperatures, in order to quantify possible mismatches in development rate induced by natural temperature fluctuations. The offspring in its habitat–the bark of spruce trees–is subjected to extreme temperature fluctuations due to variation in air temperature and global radiation. The knowledge of the interrelations is crucial to correctly predict potential development of *I. typographus*, to provide guidelines for bark beetle management and silviculture under current and future climate scenarios.
The experimental design is inspired by Wermelinger & Seifert's study (1998), which still defines our current understanding of the temperature depended development of *Ips typographus*, and is implemented to calculate daily development rates in all currently available phenology models for this species (e.g., *Phenips*). In order to explore all potential effects, the conducted scenarios cover the entire spectrum of mean temperatures and daily temperature oscillations under which *I. typographus* offspring can survive. Both the so called "sandwich"-method and stem segments were used for brood observation.
The results of this experiment showcase different manners in which oscillating temperatures effect development speed, that are also relevant for other insect species and underline the importance to account for temperature fluctuations in experimental design. Additionally, the obtained data enables us to predict developmental rates under natural conditions more precisely. The resulting development rate models were applied on climate data of current and future climate scenarios to provide clues for the impact and relevance regarding the phenology of *I. typographus*, and bark beetles in general.

Sven Hofmann, Forstliche Versuchs- und Forschungsanstalt Baden-Württemberg, Freiburg, Germany
sven.hofmann@forst.bwl.de

IPSolut – Erforschung von Grundlagen für die Entwicklung eines Verfahrens zur inundativen biologischen Bekämpfung des Buchdruckers (*Ips typographus*)

A. Lawall

Klimatische Veränderungen und sich häufende Schadereignisse wie Stürme, Dürreperioden und Hitzewellen stellen den Wald und dessen Bewirtschafter zunehmend vor Herausforderungen. Besonders die Gemeine Fichte (*Picea abies*) steht auf Grund ihres hohen Waldflächenanteils und der starken Gefährdung durch den Buchdrucker (*Ips typographus*) sowie weitere Borkenkäferarten aktuell besonders im Fokus. Die Vereinbarkeit von wirtschaftlichen, ökologischen und sozialen Ansprüchen an den Wald bedürfen innovativer zukunftsfähiger Lösungsansätze, da aktuell angewandte Verfahrensweisen einer sauberen Waldbewirtschaftung an ihre Grenzen stoßen. Es bedarf der Bereitstellung von naturnahen Regulationsverfahren als Ergänzung zu existierenden Regulierungsverfahren, wie dem Einsatz nichtselektiver Insektizide oder dem Schälen der Stämme.
Dies ist der Punkt, an welchem das Projekt ansetzt. Das perspektivische Ziel der Forschung ist es, die Populationsdichte des Buchdruckers punktuell effektiv durch die Freisetzung von in Massenzucht vermehrten parasitoiden Hymenopteren, d. h. durch inundativen biologischen Pflanzenschutz, zu regulieren. Dabei soll die Parasitierungsrate der Entwicklungsstadien der Borkenkäfer so hoch sein, dass die Population des Buchdruckers unter einen kritischen Schwellenwert fällt. Dieses Ziel ist erreicht, sobald die verbleibende Dichte an Käfern nicht mehr in der Lage ist, neuen Stehendbefall zu verursachen.
Im Zuge dieses Projektes sollen die Grundlagen und Prinzipien für die Entwicklung eines Massenzucht- und -ausbringungsverfahrens geschaffen werden. So soll erforscht werden, welche parasitoide/n Art/en aus der Ordnung Hymenoptera das größte regulatorische Potenzial besitzen und die günstigsten Voraussetzungen für eine erfolgreiche Massenzucht bieten. Dazu gehört neben der Determination natürlich auftretender Parasitoide auch der Aufbau und die Pflege von Zuchten für den Buchdrucker, ausgewählte Zielarten sowie Alternativwirte. Zudem sollen biologisch-ökologische Aspekte wie z. B. die Temperaturtoleranz der Hymenopteren oder die Begleitvegetation in Fichtenbeständen berücksichtigt werden, da diese die Grundlage für eine erfolgreiche Ansiedelung der ausgebrachten Parasitoide bilden. So können ggf. Managementmaßnahmen entwickelt werden, welche die Persistenz der ausgebrachten Parasitoide im Ökosystem fördern und damit einhergehend das Vorkommen weiterer Antagonisten und damit die biologische Diversität erhöhen können.
Die Ausbringung der Parasitoide soll unter anderem zur Bekämpfung an Poltern, an Käferlöchern oder z. B. in Randgebieten von Großschutzgebieten erfolgen, um ein Über-

greifen vorkommender Buchdruckerpopulationen auf den Wirtschaftswald zu verhindern. Der Buchdrucker dient hierbei im Projektvorhaben als Beispielart. Die im Projektzeitraum gewonnenen Erkenntnisse und Prinzipien lassen sich jedoch voraussichtlich direkt oder indirekt auf weitere Schadorganismen (andere Borkenkäferarten, Kieferngroßschädlinge, Eichenschadinsekten) übertragen.

Anna Lawall, Technische Universität Dresden, Dresden, Deutschland
anna.lawall@tu-dresden.de

EIVES – Entwicklung innovativer Verfahren zur naturnahen Regulierung des Großen Buchdruckers (*Ips typographus*) durch Antagonisten

E. Spann

Natürlichen Gegenspielern von Borkenkäfern wird seit Jahrzehnten ein hohes regulatorisches Potential zugesprochen. In Bezug auf die Regulation des Großen Buchdruckers (*Ips typographus*) nehmen Parasitoide durch die starke Wirtspezialisierung einen besonderen Stellenwert ein. Vor allem Arten aus der Ordnung der Hautflügler (Hymenoptera) verursachen vielversprechende Parasitierungsraten und verfügen sowohl über eine gute Mobilität als auch über eine große Vermehrungsrate. Parasitoide Hymenopteren zeigen zudem durch ihr aussichtsreiches Potenzial für eine künstliche Massenzucht eine gute Voraussetzung für die biologische Kontrolle von Schädlingen.
Das Projekt EIVES verfolgt das perspektivische Ziel, bereits beim ersten Auftreten des Großen Buchdruckers ein hohes Vorkommen dieser Antagonisten auf gefährdeten Flächen zu ermöglichen.
Das Projekt hat im ersten Schritt dazu beigetragen, in der Region des Tharandter Waldes häufig vorkommende Zielarten zu ermitteln, welche neben einer nachweisbaren Dichte-Reduzierung von Ips typographus auch Chancen auf eine unkomplizierte und praxistaugliche Vermehrung bieten. Für diese Arten wird nun anhand von Experimenten eine geeignete Vermehrungstechnik entwickelt, welche die Grundlage für die anschließende künstliche Vermehrung darstellt. Dies umfasst sowohl die Ermittlung von geeigneten Alternativwirten als auch Strategien, diese für die Zielarten attraktiver zu machen.

Elisabeth Spann, Technische Universität Dresden, Dresden, Deutschland
elisabethspann@yahoo.de

The role of parasitoids and pathogens in the collapse of a spongy moth, *Lymantria dispar* (Lep., Erebidae), outbreak in Lower Austria

T. Zankl, C. Schafellner & G. Hoch

The spongy moth, *Lymantria dispar* (Lep., Erebidae), is one of the most important pest insects in European oak forests. In 2018, outbreaks were observed in Lower Austria, resulting in total defoliation of an oak forest in the summers of 2018 and 2019. In spring 2020, egg mass numbers were still high, but the population density was expected to decline. The present study investigated the role of natural enemies in the collapse of the outbreak.
In total, 20 egg masses, 680 larvae, and 12 pupae of *L. dispar* were collected in the field between May and July 2020 and reared until emergence of adult moths or death. Mortality rates were calculated based on the detection of parasitoids emerging during both the larval and pupal stages and on microscopic examination of cadavers. Death rates were determined stage-specifically for eggs, caterpillars (instars L_1-L_6), and pupae. Seven parasitoid and three pathogen species were mainly responsible for the excessively high host mortality, leading to the collapse of the spongy moth population in the field.
The egg parasitoid *Anastatus disparis* (Hym., Eupelmidae) emerged from 19% of *L. dispar* eggs. This result differed significantly from previous studies on *L. dispar*, where egg parasitoids were rarely observed in Central Europe. Larval parasitoids caused stage-specific mortality rates of 15% (L_1) to 61 % (L_6). The dominant parasitoid of young and middle-aged larvae was the solitary endoparasitic wasp *Glyptapanteles porthetriae* (Hym., Braconidae) with parasitization rates of 10% in first-instar larvae and 36% in fourth instars. The extraordinarily high parasitization rates in middle-aged larval stages were caused by the second wasp generation in summer, which had also not been observed before. Less abundant species of larval parasitoids were determined as *Hyposoter tricoloripes* (Hym., Ichneumonidae), *Glyptapanteles liparidis* (Hym., Braconidae) and *Cotesia* sp. (Hym., Braconidae). Mature spongy moth larvae were mainly killed by the parasitic flies *Blepharipa pratensis* (Dip., Tachinidae) and *Parasetigena silvestris* (Dip., Tachinidae), each emerged from 26% of the hosts collected as late instars (L_5 and L_6).
Pathogens caused stage-specific mortality rates of 41% in first-instar larvae and 11% in third instars. A nucleopolyhedrovirus was the

dominant pathogen in all instars, resulting in 7% to 34% stage-specific mortality. The entomopathogenic fungus *Entomophaga maimaiga*–detected for the first time in Austria in 2019–was responsible for low mortality in older larvae (4 to 5% stage-specific mortality from L_4 to L_6). The microsporidium *Endoreticulatus schubergi* and other (unidentified) fungal species killed only a small number of host larvae. The results confirm the crucial role of natural enemies in the population cycle of the spongy moth.

Thomas Zankl, Institut für Forstentomologie, Forstpathologie und Forstschutz, Vienna, Austria
thomas.zankl@boku.ac.at

Sektion Insekten-Mikroorganismen Interaktionen / Section Insect-Microorganism Interactions

Keynote

The bioecological traits of spittlebugs and their implications on the epidemiology of *Xylella fastidiosa* in Europe

D. Bosco

The importance of spittlebugs in agriculture has greatly increased following the recent discovery of *Xylella fastidiosa* in Europe. Although only xylem-sap feeder insects can act as vectors, the transmission of *X*. *fastidiosa* has a limited level of specificity, as all xylem-sap feeder insects are potential vectors of all *X*. *fastidiosa* subspecies and sequence types. In Europe, unlike in the America's, spittlebugs are recognized as the most important vectors of *X*. *fastidiosa*, as they are widely distributed, common in natural and cropping systems and locally abundant. Therefore, the spread of the bacterium is mainly driven by the biology and ecology of potential vector insects, rather than by specific pathogen-insect interactions. Bioecological traits of spittlebugs determine the probability of encounter between infected (source) and healthy susceptible (recipient) plants and competent vectors. Population abundance, phenology, spatial dynamics of vectors together with transmission biology (e.g. acquisition and transmission efficiencies under different environmental conditions) are of major importance in the epidemiology of *X*. *fastidiosa* diseases. Also, *X*. *fastidiosa* load in source plants may influence acquisition efficiency and successive transmission. When focusing on the insect vector characteristics, the major drivers of *X*. *fastidiosa* epidemics are:

• the acquisition of the pathogen by the vector from an infected plant and its transmission to healthy plants;
• the vector feeding preference and behavior;
• the vector population dynamics, structure, and abundance at different spatial scales;
• the (active/passive) dispersal capability of the vector/s.

Different subspecies and genotypes of *X*. *fastidiosa* have been identified in several European areas, from Southern and Central Italy to Southern France, Spain mainland and Balearic Islands, Portugal. These multiple introductions led to the emergence of different pathosystems in Europe with peculiar characteristics. However, so far, extensive epidemiological studies have been conducted for the devastating disease of olive trees in the Apulia Region of Italy only. Therefore, in this talk, the paramount vectors' bioecological traits influencing *X*. *fastidiosa* epidemic will be described focusing mainly on the olive quick decline syndrome in Apulia, although bearing in mind their potential outcomes in other European *X*. *fastidiosa* pathosystems.

Several models have been developed to forecast distribution and possible spread of *X*. *fastidiosa* in Apulia, Italy and Europe. However, most of them rely on poor knowledge of key epidemiological parameters, and the traits of insect vectors (transmission biology, dispersal/movements, abundance/density) are rarely explicitly included, despite their key importance. The implementation of knowledge on the traits of the vectors is a prerequisite for the development of reliable epidemiological models and effective control strategies.

Domenico Bosco, DISAFA–Entomologia, Grugliasco (TO), Italy
domenico.bosco@unito.it

Assessing factors influencing the acquisition efficiency of the apple proliferation phytoplasma in *Cacopsylla melanoneura*

E. Corretto, M. Trenti, L. Štarhová Serbina, J.M. Howie, J. Dittmer, C. Kerschbamer, V. Candian, R. Tedeschi, K. Janik & H. Schuler

Phytoplasmas are bacterial pathogens located in the plant's phloem and are responsible for hundreds of plant diseases affecting many important vegetables and fruit crops causing high yield losses worldwide. Their transmission between plants is mainly mediated by phloem-sucking insects such as leafhoppers, planthoppers and psyllids. However, only a small percentage of phloem feeders act as competent vectors by acquiring and transmitting phytoplasmas. Here, we investigate factors influencing the acquisition and transmission of phytoplasmas using apple proliferation (AP) as a study system. AP is an economically important disease in apple production caused by '*Candidatus* Phytoplasma mali'. The psyllid *Cacopsylla melanoneura* is considered the main vector of AP phytoplasma in Northwestern Italy (NW), but not in Northeast Italy (NE) as well as other European countries. At the same time, it is well known that distinct AP phytoplasma are predominant in specific areas (i.e. subtype AT1 in NW, whereas AT2 in NE). Therefore, the study system *C*. *melanoneura*–AP phytoplasma offers the possibility to investigate the factors

influencing its vector efficiency in different geographic areas.
A phytoplasma acquisition experiment using single mating couples of insects was set up to investigate whether the insect haplotype and/or the phytoplasma subtype influence its acquisition in *C*. *melanoneura* populations collected in NW and NE. The offspring were allowed to feed and develop on apple trees infected with different phytoplasma subtypes. While all analyzed populations acquired phytoplasma with different efficiencies, the regional phytoplasma subtype is the main factor driving the phytoplasma uptake by the psyllid vector. Namely, subtype AT1 from NW was the most acquired one. Also, the phytoplasma titer in the leaves of the infected trees had a positive impact on the overall uptake, but not on the phytoplasma titer measured in the insect. Interestingly, *C*. *melanoneura* from NE harbored higher titers of AP phytoplasma with subtype AT1 from NE being the one present in the highest density. Nevertheless, the concentration of phytoplasma was below the established transmission threshold except for a few individuals from NE populations. In its turn, the haplotype of the insect had only a minor, if any, impact on the phytoplasma acquisition efficiency.
Taken together, this is the first study that investigates the role of the insect haplotype and different phytoplasma subtypes in the acquisition process and elucidates the importance of *C*. *melanoneura* as a vector of AP phytoplasma.

Erika Corretto, Free University of Bozen-Bolzano, Bolzano, Italy
erika.corretto@unibz.it

Screening for viruses in natural spotted wing *Drosophila* populations in British Columbia, Canada

J.P. Dudzic, A.E. McPherson, P.K. Abram & S.J. Perlman

The spotted wing drosophila (*Drosophila suzukii*) is an invasive insect pest belonging to the genus *Drosophila* (vinegar flies). Originally from Asia, *D*. *suzukii* invaded North America and Europe in the 2000s. In contrast to other fruit-feeding drosophilids, which lay their eggs in rotten or overripe fruit, *D*. *suzukii* has a specialized ovipositor and can infest intact fruits. The resulting damage can have devastating effects on agriculture. Current control of *D*. *suzukii* relies on labor intensive and expensive preventive measures (e.g. nets), fruit quality and yield reducing measures (e.g. early harvest), and/or the repeated use of chemical pesticides. The negative side effects of these broad-spectrum insecticides on non target insects raises the urgency to develop new methods of *D*. *suzukii* control. Promising alternative strategies currently under research are the use of natural enemies and the use of host specific pathogens like bacteria, fungi and viruses. Already available virus-based insecticides show a narrow host range and they can be effective in systems where insects have developed resistance to chemical insecticides. *Drosophila* species are infected by many viruses in the wild, but little is known about these viruses.
We used next-generation sequencing technologies to survey *D*. *suzukii* from British Columbia (Canada) for viruses. We discovered nine RNA and two DNA viruses, all but one of which are viral lineages that are new for *D*. *suzukii*. We also found that two RNA viruses have a synergistic effect on each other: when a fly is infected with one of the two, it is also likelier that it is infected with the other.
Additionally, about 25% of *D*. *suzukii* in BC harbour an intracellular symbiotic bacterium, called *Wolbachia*. In laboratory experiments we found that *Wolbachia* protects *D*. *suzukii* populations in BC against RNA viruses. By contrast we did not find any evidence of protective effects in wild populations. Furthermore, we observed that Wolbachia frequencies in *D*. *suzukii* can change very rapidly, suggesting that they strongly impact their hosts.
Our results extend the knowledge about the virome of *D*. *suzukii* and also show first indications how *Wolbachia* infections affect *D*. *suzukii*.

Jan Paul Dudzic, Julius Kühn Institute, Dossenheim, Germany
Jan.Dudzic@julius-kuehn.de

Bacterial diversity and distribution of core microbiome in *Scaphoideus titanus* (Hemiptera: Cicadellidae)

J.S. Enciso, A. Moussa, L. Štarhová Serbina, E. Corretto, E. Gonella, A. Alma & H. Schuler.

The Nearctic leafhopper *Scaphoideus titanus* (Hemiptera: Cicadellidae) is the main vector of *Candidatus* Phytoplasma vitis', the causative agent of Flavescence dorée in Europe. The disease negatively affects grapevine production across the biggest viticultural areas of Europe. Despite quarantine control and obligatory management measures, outbreaks of Flavescence dorée are still ongoing in winegrowing communities across Europe. *Scaphoideus titanus* is a highly efficient phytoplasma vector due to its capacity to feed exclusively on *Vitis vinifera*. Leafhoppers as well as other insects harbor different microor-

ganisms, which are crucial for the survival, nutrition and reproduction of its host. Despite the economic importance of this species, only a few studies investigated the role of specific microorganisms in the host diet and their role in the transmission of phytoplasmas. The most common bacteria in *S. titanus* is *Candidatus* Sulcia muelleri (Flavobacteriales), whereas *Cardinium* (Cytophagales) is also highly prevalent in European populations. Here, we present the microbial community of *S. titanus* across various populations in Europe. Using 16S rRNA metabarcoding, we compare several populations across Europe. We present a diverse composition of microbial communities in *S. titanus* across different geographical distribution. This study provides a broader understanding of the interactions between core microbes and the relations between bacteria and their insect hosts. This information ca be used to identify suitable targets for biocontrol.

Juan Enciso, Free University of Bolzano-Bozen, Bolzano-Bozen, Italy
jencisogarcia@unibz.it

Plant-mediated rifampicin treatment of *Bemisia tabaci* disrupts but does not eliminate endosymbionts

M. Milenovic, A. Gouttepifre, M. Eickermann, J. Junk & C. Rapisarda

Whiteflies are among the most important global insect pests in agriculture; their sustainable control has proven challenging and new methods are needed. Bacterial symbionts of whiteflies are poorly understood potential target of novel whitefly control methods. Whiteflies harbour an obligatory bacterium, *Candidatus* Portiera aleyrodidarum, and a diverse set of facultative bacterial endosymbionts. Function of facultative microbial community is poorly understood largely due to the difficulty in their selective elimination without removal of the primary endosymbiont. Since the discovery of secondary endosymbionts, antibiotic rifampicin has emerged as the most used tool for their manipulation. Its effectiveness is however much less clear, with contrasting reports on its effects on the endosymbiont community. The present study builds upon most recent method of rifampicin application in whiteflies and evaluates its ability to eliminate obligatory Portiera and two facultative endosymbionts (*Rickettsia* and *Arsenophnus*). Our results show that rifampicin reduces but does not eliminate any of the three endosymbionts. Additionally, rifampicin causes direct negative effect on whiteflies, likely by disrupting mitochondria. Taken together, results signify the end of a rifampicin era in whitefly endosymbiont studies. Finally, we propose refinement of current quantification and data analysis methods which yields additional insights in cellular metabolic scaling.

Milan Milenovic, Luxembourg Institute of Science and Technology, Belvaux, Luxembourg
milan.milenovic@list.lu

Diversity and evolution of symbionts in psyllids of the genus *Cacopsylla*

H. Schuler, J. Dittmer, E. Corretto, L. Serbina, J. Howie & C. Stauffer

Hemipteran insects have an ancient and intimate associations with beneficial bacterial endosymbionts. These symbionts provide the host with essential nutrients such as amino acids or vitamins lacking in the host's diet. Thereby, they enabled the host to adapt to nutrient-poor food sources such as the plant sap. In Auchenorrhyncha (cicadas, planthoppers, spittlebugs), this host-symbiont collaboration has become even more complex and specialized, as at least two different bacterial endosymbionts jointly produce the complete set of essential amino acids required by the host, resulting in an intricate metabolic interdependence between the three partners. Similar multipartite symbioses may occur in psyllids. Microscopy observations revealed the presence of two types of bacteria in the bacteriomes of various psyllid species. Moreover, 16S rRNA gene sequencing further showed that all investigated psyllid genera harbour the primary endosymbiont *Carsonella*, whereas the second endosymbiont appears to be variable depending on the host species. Here, we present the complete genome sequences of both *Carsonella* and the as yet uncharacterized second endosymbiont of various *Cacopsylla* species from different host plants. While *Carsonella* is widespread among psyllids, the latter likely represents a new, psyllid-associated endosymbiont clade within the family Enterobacteriaceae. Unlike co-occurring endosymbionts in other psyllid species, the small genome size of the second endosymbiont indicates an ancient symbiotic association leading to extreme genome streamlining. We will discuss the evolution and co-divergence with its host and present the complementary metabolic potentials of both endosymbionts in light of the nutritional requirements of their host.

Hannes Schuler, Free University of Bolzano-Bozen, Bolzano-Bozen, Italy
hannes.schuler@unibz.it

Seasonal wild dance of dual-obligate symbionts in the pear psyllid *Cacopsylla pyricola* (Hemiptera: Psylloidea)

L. Štarhová Serbina, J.S.E. Garcia, J. Dittmer, M. Berta, T. Giovanelli, E. Corretto & H. Schuler

Cacopsylla pyricola (Hemiptera: Psylloidea) is a multivoltine pear psyllid that spends its entire life cycle on pear trees, producing several summer generations and one morphologically different overwintering generation. This species is also a vector of '*Candidatus* Phytoplasma pyri', the causative agent of Pear Decline disease. As most sap-feeding insects, *C*. *pyricola* maintains obligate relationships with two endosymbiotic bacteria, *Ca*. Carsonella ruddii and *Ca*. Psyllophila symbiotica, that provide the host with essential nutrients. Using quantitative PCR, we explored the seasonal dynamics of these symbionts in a natural population of *C*. *pyricola*, collected across an entire year, encompassing all generations of this species. Among all tested individuals, immatures harboured the highest titer of both symbionts, while the lowest symbiont density was observed in adult males. The density of *Carsonella* remained high and relatively stable throughout the vegetative period, whereas its density significantly dropped during the non-vegetative period, overlapping with *C*. *pyricola*'s reproductive diapause. In contrast, *Psyllophila* titer was significantly higher than *Carsonella* and exhibited fluctuations throughout the sampling year related to host age. Despite a tightly integrated metabolic complementarity between *Carsonella* and *Psyllophila*, our findings suggest that their density dynamics are regulated by different forces that could be linked to differences in their metabolic roles at different life stages of the host.

Liliya Štarhová Serbina, Free University Bozen-Bolzano, Bolzano, Italy
liliia.serbina@unibz.it

Unidirectional incompatibility in the European cherry fruit fly, *Rhagoletis cerasi*: 50 years of research on a *Wolbachia*-insect relationship

C. Stauffer, T. Wolfe, S. Lecic, M. Schebeck, V. Bakovic, W. Arthofer, M. Riegler & H. Schuler

The European cherry fruit fly, *Rhagoletis cerasi*, is an outstanding system to study the mechanistic background and ecological implications of an insect-microorganism relationship. In the 1970s, crossing experiments by Ernst Boller and colleagues revealed unidirectional incompatibility patterns between various European populations. Twenty-five years later, these findings were explained by (super)infections with the CI-inducing *Wolbachia* strain, wCer2 (in addition to several other *Wolbachia* strains). By conferring reproductive advantages to wCer2-infected female flies, this *Wolbachia* strain is currently invading uninfected *R*. *cerasi* populations. Studying transects with gradients of wCer2 infection frequencies, spanning from completely wCer2-infected populations to entirely wCer2-uninfected populations, informs about the mode of spread of a CI-inducing bacterium and its effects on the life history of its insect host. One of these transects with clinal transitional populations has been monitored for more than ten years and provides a unique insight in *Wolbachia* dynamics under natural conditions.

Invading *Wolbachia* strains are generally linked with co-inherited mitochondria. Rare deviations from a *Wolbachia* strain-mitochondrial haplotype association are observed in these transitional populations of *R*. *cerasi* and inform about potential horizontal transmission of *Wolbachia* among various hosts.

Finally, we present genomic data of both *Wolbachia* strains and *R*. *cerasi*, which helps to infer the evolutionary background of these symbiotic associations, and discuss future research directions.

Christian Stauffer, Boku, University of Natural Resources and Life Sciences, Vienna, Austria
christian.stauffer@boku.ac.at

Sektion Invasive Arthropoden / Section Invasive Arthropods

Keynote

Halyomorpha halys: A tale of intriguing disruptive invaders, from citizen science to classic biocontrol

L. Maistrello

The Brown Marmorated Stink Bug (*Halyomorpha halys* (Stål, 1855), Heteroptera, Pentatomidae), native to Eastern Asia and with invasive populations throughout the European, northern and southern American continents, is one of the most dangerous pests of fruit and seed crops globally.
The incredibly fast spread of *H*. *halys* worldwide is due to the hitchhiking nature of the overwintering adults, which burrow inside inanimate objects (i.e. containers, packaging of any kind, vehicles, luggage) and are carried all over with trade and movements of people. However, overwintering in anthropogenic structures also makes these insects annoying household pests. Indeed, this close association with humans has been exploited in citizen science surveys for early detection and to track their spread in real time, while pursuing public awareness and education.
Halyomorpha halys was officially first detected in Italy in 2012 in the Emilia Romagna region, although according to a model of its spatio-temporal dynamics based on citizen science data, the first entry probably occurred in 2009. Established populations belonging to different haplotypes are currently found in all Italian regions, demonstrating multiple invasions from native and already invaded countries. *H*. *halys* was recognized as a key pest of orchards since 2015, and in 2019 production losses due this pest in northern Italy were estimated at € 588 million.
In an effort to counter *H*. *halys*, the use of broad-spectrum insecticides has increased dramatically in invaded countries, resulting in a major disruption to previous integrated pest management (IPM) programs. *Halyomorpha halys* management is extremely difficult due to high polyphagy, high mobility of all instars, high reproductive potential and overlapping of different instars and generations during summer. Alternative approaches such as exclusion netting and behaviour-based strategies (i.e.“attract and kill”, trap-crop, IPM-Crop Perimeter Restructuring) have been attempted, however, none of them proved fully effective and easily applicable in different contexts.
Long-term and more sustainable management strategies include augmentative and classical biological control. In Asia, *H*. *halys* eggs are attacked by different species of egg parasitoids, among which the Scelionidae *Trissolcus japonicus* (Ashmead) and *T*. *mitsukurii* (Ashmead) have the highest specificity and parasitization efficiency. However, specific regulations in both North America and Europe prohibit/restrict the use of exotic biocontrol agents. In Italy, the devastating economic impact caused by the *H*. *halys* on fruit production had prompted the amendment of the current legislation to grant the authorization for the use of *T*. *japonicus* as a biocontrol agent of the invasive pest, leading to one of the largest biocontrol projects ever attempted in Italy and Europe. The results of the three-year program provide optimistic prospects due to both the successful settlement of the released *T*. *japonicus* and the expansion of adventive populations of both *T*. *japonicus* and *T*. *mitsukurii*, as well as the concrete contribution of the native parasitoid *Anastatus bifasciatus*. Furthermore, the impact of exotic parasitoids on non-target hemipterans was negligible. Further investigations are needed to understand the overall efficacy of parasitoids and the time required to achieve a significant reduction in *H*. *halys* populations, pursuing the goal of implementing sustainable management of this invasive species on affected crops.

Lara Maistrello, Department of Life Sciences, University of Modena and Reggio Emilia, Reggio Emilia, Italy
lara.maistrello@unimore.it

New information on *Halyomorpha halys* from SW-Germany–Data on monitoring, specific fruit damage, and parasitoid presence in orchards

A. Eben, O. Zimmermann, N. Haag,
C. Dieckhoff, P. Katz & J Rademacher

The invasive stink bug, *Halyomorpha halys* (Hemiptera: Pentatomidae), was first described in the year 2011 for Germany. Since then, it quickly spread along the Rhine Valley and across large parts of Germany. The Brown Marmorated Stink Bug is highly polyphagous with over 300 wild and cultivated host plants, especially fruit varieties. From previously invaded countries, important economic losses were reported mainly from pome fruits. In recent years, this pest has become regionally abundant and turned into a threat for fruit growers in Germany, as well. The typical damage caused by the sucking mouthparts on host fruits is similar to damages caused by other known pest insects or nutritional deficiencies. In terms of pest regulation options, currently, the use of insecticide applications is difficult. A sustainable und longterm control of

this pest through natural enemies, especially egg parasitoids, is a promising strategy.
In the frame of a cooperative project, we determined the abundance of *H*. *halys* in various orchards throughout the year. We collected and identified associated egg parasitoids, and we documented induced and naturally occurring bug-specific feeding damages on different host fruits at variable developmental stages.
Using monitoring traps at the same location over two consecutive years, we recorded the population dynamic of adult bugs and nymphal stages. In 2022, probably due to an unusually mild winter and spring, two complete generations of *H*. *halys* developed in southern Germany for the first time. Pest abundance varied strongly between years and field sites. A number of parasitoid species could be identified and were found repeatedly in the study locations. Differences were observed in visual appearance of damage caused by *H*. *halys* between apple and pears, and among apple varieties. Moreover, the damages detected visually differed between developmental stages of the host fruits.
The result of our field monitoring is discussed based on the invasion history and damage potential of *H*. *halys* in Germany. Data on parasitoid abundance and specificity are put into perspective considering the current state of the legal framework for the release of adventive natural enemies in Germany.

Astrid Eben, Julius Kühn Institute, Institut für Pflanzenschutz in Obst- und Weinbau, Dossenheim, Deutschland
astrid.eben@julius-kuehn.de

Quantitative analysis of citizen science data on Heteroptera: Example of the invasive heteropteran *Halyomorpha halys* distribution

V. Hartung & A. Schneider

Citizen science platforms such as iNaturalist.org are getting more and more popular, with tens of thousands of nature aficionados worldwide contributing new photos day by day. Although the users of such platforms often lack taxonomic expertise, the sheer number of their contributions provide a valuable resource for research, since thousands of “amateurs” can access so many regions and habitats with such a regularity that few hundreds taxonomists cannot match. Many professionals already employ citizen science data in their research–however, this research is still mostly qualitative, pertaining to new records of species and distribution shift ranges. Here, we demonstrate that the immense amount of data collected by citizen scientists also has much potential for quantitative approaches. Citizen science data on *Halyomorpha halys* distribution allows us e. g. to test the hypothesis of this subtropical species’ spread in Germany via cities–the so-called “warmth island hopping”. We compare its distribution with that of the local pentatomids *Palomena prasina* and *Rhaphigaster nebulosa*, the results supporting the city-mediated distribution of *H*. *halys*. We hope that this and some additional examples will inspire entomologists to approach more sophisticated questions using citizen-science data.

Viktor Hartung, Senckenberg Forschungsinstitut und Museum, Frankfurt am Main, Germany, Deutschland
viktor.hartung@senckenberg.de

Population genomic analyses and de novo whole genome sequencing of invasive cerambycids in Europe to decipher the invasion patterns

I. Häussermann, B. Lutsch, O. Zimmermann & M. Hasselmann

Anthropogenic activities that cause environmental shifts, as well as translocations are the main causes of the increasing rates of biological invasions. For insects, the most common introduction pathway is the contamination of commodities, or wood-packing materials. Subject of this project are three wood-boring cerambycid species, which all originate from Eastern Asia and were introduced to Europe and North-America. Usually, they attack healthy living plants and cause severe damage over time. The Asian long-horned beetle (ALB), *Anoplophora glabripennis*, has been introduced to Europe in 2004 to Austria. Its life cycle is mainly fulfilled in maples, willows and poplars. The closely related Citrus long-horned beetle (CLB), *Anoplophora chinensis*, was first introduced to Europe into the Netherlands in 1980. Its main hosts are citrus trees, but it is also infecting other broadleaved trees like maples and birches. The Red neck long-horned beetle (RLB), *Aromia bungii*, was first introduced to Europe in Germany in 2011, where it is still present, as well as in Italy. This cerambycid predominantly infests trees of the *Prunus* genus. The most important transport pathway for ALB and RLB are wood packing materials, while CLB is mainly transported by living host plants. In Europe they are classified as quarantine pests (EPPO A2-list), so eradication programs are conducted according to regulations of the European Union. In a previous study, we analysed the invasion patterns of ALB into Europe using genome-wide SNPs discovered by a Genotype-by-sequencing (GBS) approach. The population genomic

study of invasive European ALB populations from Germany, Switzerland and Italy discovered very complex introduction patterns into Europe. The strong founder effects that were observable by low genetic variation within and high population structure between the collection sites, indicate mostly multiple independent introductions into Europe. However, signs of secondary human-mediated translocations in a small spatial scale were also confirmed in Switzerland and Italy. In the follow-up project, the same approach will be applied on RLB and CLB to decipher their introduction pattern into Europe. Given the absence of genome sequences for RLB and CLB, de novo reference genomes will be generated from specimens found in Europe using a combination of a short-read genome survey (Illumina), long-read sequencing (Pacbio HiFi) and Hi-C sequencing for scaffolding up to chromosome level. Additionally, RNAseq data will be used for genome annotation. For an optimal preparation of the sequencing libraries, the so far unknown genome sizes must be estimated in advance. Currently, a protocol for genome size estimation of *Aromia bungii* is established via flow cytometry, using among others *A*. *glabripennis* as size reference. For Cerambycidae genome sizes between 500 Mb and 1,900 Mb have been estimated so far, among which *A*. *glabripennis* has an estimated genome size of 707 Mb. Furthermore, CLB and RLB outbreaks in Germany and Italy will be sampled to be sequenced by GBS approach. Specimens from native ranges will be used to discover source populations. Pioneer studies like these can strongly enhance phytosanitary measures by detailed insights in invasion histories. Control measures can be adapted, and future invasion scenarios can be predicted in more detail.

Iris Häussermann, University of Hohenheim, Stuttgart, Germany
i.haeussermann@uni-hohenheim.de

Halyomorpha halys mass trapping in northern Italy: Preliminary results

M. Preti, G. Vaccari, L. Fagioli & A. Masetti

Halyomorpha halys (Hemiptera: Pentatomidae), known also as brown marmorated stink bug, has been impacting the Italian agricultural systems since almost ten years. To date *H*. *halys* management relies on broad-spectrum insecticides, which are neither fully effective nor environmentally sustainable, sometimes combined with other control methods such as the mechanical barriers provided by multifunctional nets, while everybody is waiting for the significant increase of the biological control with egg parasitoids, both native and exotic. Attract & Kill (AK) and Mass Trapping (MT) are two insect pests control techniques that rely on the attraction of the target species and its subsequent suppression (by killing) or removal (by trapping), respectively. In the last few years, both techniques have been investigated in Emilia-Romagna (northern Italy) to manage *H*. *halys*. In comparison with full block sprays using broad-spectrum insecticides, AK minimizes the contact between pesticides and crops, resulting in many benefits from the standpoints of safety for growers and consumers, reduction of residues on agricultural products and overall impact on the environment. However, unfortunately in our conditions the good results achieved in the ‘attraction’ part matched poor results concerning the ‘killing’ part. Moreover, the use of long lasting insecticide-based nets (LLINs) in Europe is problematic due to regulatory issues. Therefore, the AK approach has been discarded and replaced by the MT approach, which can be realized also without the use of insecticides. MT is safer for the users compared to AK and to date seemed to be very promising to remove *H*. *halys* individuals from the agroecosystem. Different structures for *H*. *halys* MT have been tested over two years in Emilia-Romagna region and in the meanwhile several growers autonomously made some structures to be placed in their farms, confident on the *H*. *halys* captures they recorded inside these handmade MT systems. The developed structure is called ‘sail boat’ and consists of two main components: a ‘boat hull’ represented by a waterproofed fruit bin filled with water plus a ‘black sail’ represented by a black sticky roll (e.g., Tutaroll Back, Serbios) triggered with *H*. *halys* aggregation pheromones (i.e., standard monitoring or high load lures, Trécé Inc.). The MT technique has been refined during 2021–2022 seasons and will be validated in 2023 to reduce the *H*. *halys* population sizes and crops damage. The most relevant preliminary results collected so far using these ‘sail boat’ systems to mass trap *H*. *halys* are presented in this contribution.

Michele Preti, ASTRA Innovazione e Sviluppo Test Facility, Faenza (RA), Italy
michele.preti@astrainnovazione.it

Cimice.Net: An area-wide program to monitor *Halyomorpha halys* in northern Italy

M. Preti, G. Vaccari, E. Gallinucci, C. Forresi, M. Golfarelli & L. Maistrello

Halyomorpha halys (Hemiptera: Pentatomidae), known also as brown marmorated stink bug, is an invasive phytophagous species causing important economic losses in numerous agricultural crops. To date *H*. *halys* is widespread in Italy, where it has become the main key pest of several tree fruit crops. The major challenge of the *H*. *halys* management is mainly related to its great mobility within the agroecosystem, its high polyphagia and its moderate response to the conventional insecticides. To effectively control the damage caused by *H*. *halys* it is therefore crucial to properly monitor this pest occurrence and distribution in a given territory. To help the growers in the *H*. *halys* management, a territorial monitoring project called 'CIMICE.NET' has been activated in Emilia-Romagna region (northern Italy) since 2020. This project provides, in open access, real time and on-line form, useful information on this pest population dynamics, distribution and abundance in the whole regional territory thanks to a network of monitoring traps. In the last three years, 100–140 sites have been weekly monitored using black pyramid traps (Dead-Inn Pyramid Trap™, AgBio®) baited with the *H*. *halys* aggregation pheromones (Pherocon® BMSB Dual lure, Trécé Inc.®). The data collected from this monitoring network, together with other information related to the environment in which each trap is located (presence of arboreal or herbaceous crops, unmanaged areas such as shrubs and woods, presence of buildings, rivers and water channels, weather data, …) have been uploaded in a public platform (https://big.csr.unibo.it/–projects/cimice/–monitoring.php). The platform offers ready to use information and bulletins for the growers and pest control advisors in the different monitored areas of Emilia-Romagna region. In addition, the factors potentially affecting the *H*. *halys* captures have been analysed in order to detect what elements can imply a high risk of pest abundance. Finally, these data (in particular the peaks of *H*. *halys* presence and the dynamics of the various stages of the pest over time) are under elaboration to predict the population dynamics in the next seasons, developing based on 2020–2021–2022 data a forecasting model that still requires a field validation. The most relevant results of this project are presented in this contribution.

Michele Preti, ASTRA Innovazione e Sviluppo Test Facility, Faenza (RA), Italy
michele.preti@astrainnovazione.it

Effect of traps directions on the density of the peach fruit fly, *Bactrocera zonata* (Diptera: Tephritidae) in Gezira State, Sudan

F.E.E. Salah, R.E.H. Fadul, H. Abdelgader, A.A.E. Omer & A.B. Dafaallah

Horticulture production is one of the most important agricultural subsectors in Africa, providing income, creating employment opportunities, and enhancing food and nutritional security. In Sudan the production of Horticultural crops is affected by fruit flies (*Bactrocera* spp.) that may play a major role in reducing production and limiting the exportation capabilities. The objective of the present study was to investigate the effect of directions on the density of the peach fruit fly, *Bactrocera zonata* (Diptera: Tephritidae) in Gezira State, Sudan during season 2016/2017. Three locations were selected in the study area and three sites were selected at each location. One orchard was randomly selected at each site and five directions at each orchard were determined. Methyl Eugenol trap was used to estimate the seasonal abundance of the fly among locations, sites and directions. Data were subjected to descriptive analysis and regression analysis. There were significant ($P \leq 0.05$) differences in the density of the fruit fly (*Bactrocera zonata*) among the directions in Alkamleen. However, there were no significant differences in the density in Wad Medani and Elhagabdallah, Gezira State, Sudan during season 2016/2017. In general, the highest density of the insect (13.14 insects per trap) was recorded in the West direction followed by the East direction (12.74 insects per trap), South direction (10.39 insects per trap) and Center direction (10.11 insects per trap), while the lowest density (8.74 insects per trap) of the insect was recorded in the North direction. These findings could be utilized in a sustainable pest management strategy for fruit flies (*Bactrocera* spp.) in the agro-ecological system of Gezira State, Sudan.

Faiza Elgaili Elhassan Salah, University of Gezira, Wad Medani, Sudan
faizaruba2@gmail.com

Climate change impacts on mealybugs vectoring grapevine leafroll disease

M. Schulze-Sylvester & A. Reineke

Sustainable agriculture and adapting to climate change are major societal challenges of our times. Climate change also impacts plant pathogens and their insect vectors. Grapevine is among the most widely grown fruit crops worldwide and grapevine leafroll disease (GLRD) is probably the most widespread viral infection in vineyards. It is transmitted through infected propagation material and insect vectors, such as the vine mealybug *Planococcus ficus* (Signoret). Knowledge on climate change impacts mealybugs in general or as virus vectors in particular is scarce. Similarly, we lack information on grapevine plant defence against pathogens under climate change conditions. Plant-vector-virus interactions are usually very species-specific hence conclusions cannot be derived from other pathosystems. It is therefore unclear how climate change influences the plant-vector-virus interactions of GLRD. The Hessen Horizon “VineVirus” project at Hochschule Geisenheim University aims to fill this gap. We find that a clear understanding of disease response and transmission to climate change will only emerge from studies that realistically evaluate the effects of combined climate variables on biotic interactions. Current experiments investigate the impacts of elevated temperature (eT) and elevated CO_2 (eCO2) on *P. ficus* and its ability to vector GLRD. At the same time, we also focus on defence-related plant parameters (Gene expression, Phenols, Amino acids). Experiments are carried out in plant growth chambers (Fitotron chambers), sample analysis is ongoing. Preliminary results indicate differences in disease onset and (possibly) transmission. Besides closing basic knowledge gaps on individual species, their interactions, and the disease they cause in current and future climate scenarios, the obtained data will serve to develop a forecasting model for future *P. ficus* and GLRD spread. Enhancing the knowledge and offering tools to predict the impacts of climate change on an economically important plant disease and its insect vector is crucial to strengthen the adaptive capacity of crop production and ensure sustainable viticulture.

Maria Schulze-Sylvester, Hochschule Geisenheim University, Geisenheim, Germany
maria.schulzesylvester@hs-gm.de

Nesting and prey preferences of the neozoic Sphecidae-wasp *Isodontia mexicana*

S. von Adelmannsfelden

Isodontia mexicana is a neozoic wasp of the Sphecidae family. Since it was first found in France in the 1960s, it has spread throughout Europe and is now considered established. It preys on grasshoppers as larval food and seals the nests it builds in cavities with grass leaves. So far, there is little empirical evidence on the composition of prey species in Germany. Likewise, there is a lack of evidence on *I. mexicana*'s preference for nest tube diameters, which could provide information on possible nesting competition with cavity colonising wild bees. Therefore, 12 trap nests with four different hole diameters (5 mm, 7 mm, 9 mm and 11 mm) were deployed in summer 2022 at six sites each in two habitats in Baden-Württemberg (South-West Germany) in Freiburg im Breisgau (city) and at the Kaiserstuhl (vineyard). The control was carried out every four to five days. The collected data were analysed with the statistical software R. A total of 55 completed brood cells with egg were found. All findings came from the vineyard habitat in Ihringen. The results showed that both *Oecanthus pellucens* (n=297) and *Meconema meridionale* (n=110) were recorded as prey. In the case of *O. pellucens*, 80% of the prey found were female, in the case of *M. meridionale* 52%, this is consistent with figures from the literature of the area of origin of *I. mexicana*. The preferred hole diameter was 11 mm, with the lower area of the trap nests being most frequently colonised. Due to the preference for large hole diameters, there seems to be less competition with native bees than previously suspected.

Sarah von Adelmannsfelden, University of Freiburg, Stegen-Wittental, Germany
von.adelmannsfelden@gmail.com

Sektion Landschaftsökologie und Naturschutz / Section Landscape Ecology and Nature Conservation

Keynote

The challenges of the UE 2030 agenda: Lesson from butterflies

S. Bonelli

The ambitious EU Biodiversity Strategy 2030 recognizes the scale and urgency of actions needed to halt and reverse declines in biodiversity, support climate mitigation and adaptation, and improve ecosystem health.
Declines in insect biomass and abundance are well documented. Reports periodically drawn under requirements of Article 17 of the Habitats Directive confirm that many species of European importance, listed in the HD appendixes, are in unfavourable status and many show declining trends. Reversing such trends will be arguably possible only by reducing the use of pesticides, adopting suitable agro-ecological practices, and increasing the extent of protected areas. Incertitude about where, when and how to implement these actions poses a major challenge.
Butterflies are a charismatic insects, easily noticed and generally enjoyed by both adults and children. They are indicators of the conditions of the environments where they thrive and respond relatively quickly to conservation measures.
Butterflies are taxonomically well-known and many of them are reasonably easy to identify in nature, a fact that has stimulated thousands of enthusiastic citizens to co-operate in recording observations of their occurrence. Such Citizen-science activities, run under the co-ordination by the European Butterfly Monitoring Schemes (eBMS), currently active across most of the EU member States, are already obtaining important results as concerns the numerical fluctuations of butterfly species along the tears, which combined with the wealth of knowledge already available on the ecological needs of many of them will allow to draw conservation programs reaching far beyond this specific case. Butterflies in fact include many “umbrella” species, so that acting for butterflies will also benefit other wild insect pollinators, as well as birds and several habitats currently in poor conservation state. The huge amount of work already done on butterflies across the European Countries will be crucial for implementing the Pledge and Review Process in which the member States are called to take part.

Simona Bonelli, Dept Life Sciences and Systems Biology, Turin, Italy
simona.bonelli@unito.it

Attractiveness of different flower strips for beneficial arthropods of agricultural landscapes

S. Blümel, V. Haberlah-Korr & W. H. Kirchner

Flower strips are a prominent agri-environmental scheme (AES) with the potential to counteract the global decline of wild insect populations. The main goal of such AES is to protect biodiversity and maintain ecosystem services such as pollination and pest control. The approach of promoting populations of natural enemies of insect pests by optimizing their habitat is a promising method of integrated pest management.
In a three-year field study (2020–2022) two annual (11 and 13 plant species) and two perennial (30 and 51 plant species), commercially available flower strip mixtures were tested with regard to their attractiveness for beneficial arthropods on three different farms in North Rhine-Westphalia, Germany. The flower strip mixtures as well as a control (four grass species) were organized in a randomized and replicated plot design (n=3) at each study site. In total, we sampled nine beneficial arthropod groups: hoverflies, ladybirds, lacewings, parasitic wasps, plant-dwelling spiders, predatory bugs, ground beetles, rove beetles and ground-dwelling spiders. Arthropods were sampled annually in nine sampling rounds in a ten-day rhythm in summer (June to September) using standardized sweep netting and pitfall traps. Furthermore, to assess the available floral resources in each plot, we estimated the species-specific flower cover on each sampling round.
Our three-year data show that the tested flower strips differ in their attractiveness to beneficial arthropods. Treatment effects on arthropod abundance were most pronounced in the second and third year, when differences in plant species community in flower strips were higher, compared to the first year. For example, perennial flower strips show the highest attractiveness for parasitic wasps and plant-dwelling spiders across all sites. In contrast, annual flower strips show the highest attractiveness for ground beetles, while hoverflies do not differ in abundance between treatments, except for the control. These diffe-

rences are subject to spatial and temporal dynamics and are likely driven by flower composition and structural properties of the flower strip rather than by the number of plant species per se. Due to the variations in treatment effects, it is necessary to formulate precise goals for flower strips and subsequently tailor them for a specific target (e.g. flower strips for the control of aphids in sugar beet).

Simon Blümel, Ruhr University Bochum / Fachhochschule Südwestfalen, Dortmund, Germany
simon.bluemel@rub.de

Multi-taxonomic comparison of arthropod groups between extensive orchard meadows and intensive apple orchards

L. Obwegs, E. Guariento, J. Plunger, A. Rief, P. Fontana, L.E. Vigl, U. Tappeiner & A. Hilpold

Almost 10% of the European apple production comes from South Tyrol, a region in the Central-Alps, which in the valley bottoms is characterized by highly intensive apple monocultures. These are contrasted by the traditional and extensively managed orchard meadows, which historically were planted near farms for various purposes (fruit production in combination with pasture, hay meadow, etc.). Gradually, orchard meadows have been abandoned or converted into intensive apple orchards, promoting a simplified and less biodiversity-friendly landscape. Orchard meadows are known to generally support a high biodiversity portion, while intensive apple orchards are expected to severely limit biodiversity on a metataxonomic scale. Comparing this traditional extensive practice with its intensive counterpart will help to identify the potentially supported biodiversity and serve as a reference for suggesting improvements to reduce the negative impact of intensive orchard systems.
In this study we compared five traditional and extensively managed orchard meadows with five comparable intensive apple orchards. Overall, four arthropod groups (grasshoppers, butterflies, wild bees, and spiders) and four macro-invertebrate communities occupying different strata (soil, ground-dwelling, herb layer, tree layer) were surveyed. Surveys were performed following the protocol of the Biodiversity Monitoring South Tyrol, with the exception of wild bees collected with pan traps.
The overall consistent result was a higher diversity recorded in orchard meadows than in intensive apple orchards. The only exceptions were soil invertebrates and ground-dwelling invertebrates, for which no differences were detected between the studied sites. Community composition was consistently altered for all four groups between the two orchard types.
Generally, more generalist species were found in intensive apple orchards, while in orchard meadows more species with higher sensitivity towards environmental changes were recorded. Grasshoppers bound to forest areas and butterflies typical of extensive grassland occurred in orchard meadows, as did oligolectic wild bees and cuckoo bees. Also, Red List scores consistently mirrored these results with a higher presence of Red List species in orchard meadows.
These results underline the severe erosion of overall biodiversity that happened when most orchard meadows were converted to intensively managed apple orchards. Therefore, this threatened agroecosystem should be more valued and conserved and taken as a reference when aiming to improve the ecological state of intensive orchards towards more sustainable and biodiversity-friendly production systems.

Lisa Obwegs, Eurac Research, Institute for Alpine Environment, Bolzano-Bozen, Italien
lisa.obwegs@eurac.edu

Soil Biodiversity Monitoring as a useful tool on a way to a sustainable, biodiversity-friendly agriculture

J. Plunger, E. Guariento, A. Rief, J. Seeber, M. Steinwandter, U. Tappeiner & A. Hilpold

Soil forms the basis of life for plants, animals, and humans, nevertheless, the general value given to soil and its inhabitants is too little: pollution, land sealing, deforestation, and land-use intensification are still increasing, with negative effects on soil biodiversity. It is a very diverse habitat that is much more than a substrate for growing plants, but a place where numerous reactions take place that controls a wide range of ecosystem services and functions. Sustainable agricultural practices can help to mitigate or even reverse the ongoing loss of soil biodiversity resulting from intensive land use; however, changes over longer time periods have rarely been studied.
For South Tyrol, a biodiversity monitoring system has been set up in 2019 and aims to survey species groups considered highly sensitive to climate and land-use changes. An important part focuses also on soils to improve our understanding of how land use practices influence soil characteristics and soil animal communities over time. Results will help to develop strategies for preserving soil biodiversity in South Tyrol, a challengingly heterogenous mountain region with a wide range of traditional land use types.

We show the results of the soil survey for a total of 73 agricultural sites sampled between 2019–2021, including apple orchards, cereal fields, vineyards, semi-intensively used meadows, extensively used meadows and pastures. We installed two pitfall traps on each site twice a year. Ground-dwelling arthropods were sorted and identified, if possible, to family level, spiders to species level.
Our aim was (1) to understand the effect of land use type and intensity on ground-dwelling arthropods in general, (2) to evaluate whether a soil module within the biodiversity monitoring system could be a useful tool to identify sustainable agriculture practices that support soil biodiversity, and (3) to test whether land use type and intensity effects can be observed already on a coarser taxonomic level or become more distinct only at species level.
The contribution gives insights into the general project design and presents preliminary results of the soil survey, focusing primarily on spiders.

Julia Plunger, Eurac Research, Institute for Alpine Environment, Bozen-Bolzano, Italien
Julia.Plunger@eurac.edu

Museum collections and field monitoring schemes give insight into *Phengaris* butterfly populations and their main distribution in Bavaria

C. Siggelkow

Phengaris butterflies are endangered grassland specialists which are protected under the FFH directive. In Bavaria, four species of the genus *Phengaris* are native: *P. nausithous*, *P. teleius*, *P. alcon*, and *P. arion*. All these species are threatened by habitat loss and fragmentation. Knowledge about the former and recent distribution can help us to understand how populations developed, why they disappeared at some places, and where remaining populations need to be protected.
In this project, records of *Phengaris* butterflies in Bavaria were compiled from museum collections, internet sites and field monitoring. In total 14,364 records were analyzed to evaluate changes over time. We wanted to find out 1) if the number of recorded butterflies declined with time. 2) We analyzed, if the Federal Species Protection Regulation had a negative influence on the number of collected butterflies and if newly established monitoring schemes can compensate for this hypothetical loss of information on species distributions. 3) We determined the five districts in Bavaria with the strongest population records for all species. Doing so, we hope to find focus regions for *Phengaris* monitoring and protection schemes.

Chantal Siggelkow, Würzburg, Germany
chantal.siggelkow@stud-mail.uni-wuerzburg.de

Diversity patterns, community and functional composition of (high) alpine ground-dwelling invertebrates

M. Steinwandter, J. Seeber & J. von Spinn

High alpine landscapes are changing very fast due to climate and land-use change. Further, the responses of soil invertebrates to these changes is still scarce. To fill these knowledge gaps, we conducted a comprehensive pitfall trap survey investigating ground-dwelling invertebrate communities. The habitats were (high) alpine dry pastures that span from 1,500 to 3,000 m along three elevation gradients in the LT(S)ER area ‘Val Mazia/ Matschertal’, South Tyrol, Italy. The aims were (i) to get insights into the structural and functional composition of the fauna communities and their diversity patterns along elevation, and (ii) to investigate influential environmental factors (vegetation, soil properties).
During the growing season in 2021 (early May to late September), we installed each three pitfall traps on each of the 12 plots (three for each 500-m step). The pitfall traps were active for six weeks on each plot. Taxa were mostly identified at family level (and Araneae to species level) and changes in their activity densities, diversity indices and beta diversity were assessed.
The overall activity densities decreased gradually but not significantly along elevation; an exception were Opiliones, whose activity density increased with elevation. These results indicated a highly active ground-dwelling community along the entire mountain ridge, also on the 3,000 m-plots. For each elevation step, the community composition differed and the turnover rates (i.e. the exchange of taxa) increased with elevation. The functional composition changed considerably, with the percentage of carnivores increasing and herbivores decreasing along elevation. Elevation (as proxy for climate warming) was found to be the most important driver for differences in community composition. During this project, we were able to record five new Araneae species: all are new to the area of South Tyrol, and two even new for Italy.
This study gave substantial new insights into still understudied but crucial high alpine ecosystems and their soil and ground-dwelling fauna. However, as global changes are approaching fast, the well-separated communities at each elevation level may struggle to

maintain their functional processes and services when they are disrupted by climate and land-use change.

Michael Steinwandter, Institute for Alpine Environment, Eurac Research, Bozen-Bolzano, Italy
michael.steinwandter@eurac.edu

Sektion Medizinische Entomologie / Section Medical Entomology

Keynote

Monitoring and pathogen-screening of mosquitoes (Diptera: Culicidae) in Germany

H. Kampen & D. Werner

Prompted by the invasion of Europe by non-native, vector-competent mosquito species such as *Aedes albopictus* and *Ae*. *aegypti* and associated outbreaks of dengue and chikungunya fevers, a monitoring programme was launched in Germany in 2011 to map native and invasive mosquito species and provide risk assessments for mosquito-borne diseases. The programme is still running and consists of an active part represented by trapping of adults and dipping/sieving for larvae, and a passive part represented by the citizen science project ‚Mueckenatlas'. The collected mosquitoes are identified to species or species complex/group morphologically and–in the case of damaged individuals or cryptic species–genetically. In parallel to the mosquito monitoring activities, adult mosquito samples additionally collected and immediately deep-frozen to guarantee viral RNA conservation were screened for pathogens during the past few years within the framework of research projects. All monitoring data have been entered into the German mosquito database CulBase which can be used, among others, for preparing mosquito distribution maps. In addition, mosquito voucher specimen and DNA collections are being built up.

To date, close to 800,000 mosquito specimens have been collected and analysed, with some 190,000 alone by the ‚Mueckenatlas' project. Fifty-one mosquito species have been registered, six more than previously described for Germany. After a decade without documentation, one native species (*Culex cyprius*) must be considered extinct, but one species separated from another (*Anopheles daciae*) and five species new for Germany were detected. In addition to the Asian bush mosquitoes *Aedes japonicus* and *Ae*. *koreicus*, which have been shown to be vectors in the laboratory, as well as the non-vectors *An*. *petragnani* and *Culiseta longiareolata*, the Asian tiger mosquito *Ae*. *albopictus*, a most efficient vector of numerous harmful pathogens, have firmly established in Germany. While the climatically well-adapted and highly expansive *Ae*. *japonicus* has succeeded in colonising more than the complete southern part of Germany since its first detection in 2008, the thermophilic and relatively stationary *Ae*. *albopictus*, first observed in Germany in 2007, has built up more than 20 local populations, mainly in the southwestern part of the country. Only one colony of *Ae*. *koreicus*, located in central western Germany, is known to exist.

The pathogen screening demonstrated several viruses (Batai, Sindbis, Usutu and West Nile) and filarial worms (*Cardofilaria pavlovskyi*, *Dirofilaria repens*, *Setaria tundra*) to be endemic in Germany. Potentially life-threatening dengue and chikungunya viruses as vectored by *Ae*. *albopictus* in southern Europe are regularly introduced by travellers but have neither been found in mosquitoes nor have autochthonous cases become known in Germany. By contrast, West Nile virus (WNV) has been circulating in Germany at least since 2018, with numerous cases of infection in birds and horses and several in humans, including a fatal one. WNV hotspots are primarily in northeastern Germany. Major vectors of WNV are certain variants of *Culex pipiens*, the most frequent and widely distributed culicid species in Germany. WNV has been detected in several pools of *Cx*. *pipiens* biotype *pipiens*, including a pool of overwintering specimens, suggesting that WNV will permanently persist in the German mosquito fauna.

Globalisation and climate change are the drivers of vector and pathogen introduction, establishment and spread, with climate warming additionally impacting population growth and seasonal activity of vectors and extrinsic development of pathogens. Both phenomena will lead to increasing risks of mosquito-borne diseases to occur in Germany in the future. Monitoring, risk analyses and information are therefore important public health tasks. Mosquito monitoring has already, at least in part, become institutionalised but routine mosquito-borne pathogen surveillance is still not existent.

Helge Kampen, Friedrich Loeffler Institute, Greifswald, Germany
helge.kampen@fli.de

Doreen Werner, Leibniz Centre for Agricultural Landscape Research, Müncheberg, Germany
doreen.werner@zalf.de

Entomologie der Verwahrlosung und Vernachlässigung in der rechtsmedizinischen Praxis

J. Amendt & L. Lutz

In der rechtsmedizinischen Praxis wird man regelmäßig mit Verstorbenen in „verwahrlostem Zustand" konfrontiert, was oft auch mit einer Insektenbesiedlung des Körpers einher-

geht. In diesen Fällen stellt sich die Frage, ob und wie lange die körperliche Verwahrlosung schon zu Lebzeiten bestand. Auch stellt sich für die Ermittlungsbehörden die Frage nach der Todesursächlichkeit der insektenassoziierten Verwahrlosung. Für den vorliegenden Beitrag wurden 46 Sektionsfälle des Instituts für Rechtsmedizin Frankfurt am Main der Jahre 1994–2021 analysiert, bei denen eine starke körperliche Verwahrlosung der Verstorbenen vorlag. Bei knapp 40% der Verstorbenen wurde zusätzlich eine Besiedlung durch Insekten festgestellt. Diese umfasste teilweise nur wenige kleine Fliegenmaden hin bis zu einem Massenbefall bestehend aus Maden, Puppen und leeren Fliegenpuparien. Anders als bei der typischen Myiasis sind bei der klassischen Verwahrlosung nicht Schmeißfliegen dominierend. Ein Großteil der gefundenen Insekten war der Gruppe der echten Fliegen (Diptera: Muscidae) zuzuordnen. Das vermehrte Auffinden dieser Gruppe in Fällen der körperlichen Verwahrlosung lässt sich durch die typische (Bsp.: „in Exkrementen schwimmend“) Auffindesituation der Verstorbenen erklären. Der Befund der Insektenbesiedlung ist nicht nur ein weiteres körperliches Merkmal der Verwahrlosung, sondern kann auch als ein wichtiges Werkzeug für ihre die zeitliche Einordung fungieren. Durch die Analyse der insektenkundlichen Spuren am Leichnam konnte in allen Fällen nachgewiesen werden, dass der Insektenbefall schon zu Lebzeiten vorlag. Ein ausgewählter Fall illustriert exemplarisch die entomologische Rekonstruktion der Ereignisse. In ca. 70% der Fälle wurde ein Ermittlungsverfahren eingeleitet und Strafanzeigen gegen die Pflegeberechtigten gestellt wegen unterlassener Hilfeleistung, Totschlag oder fahrlässige Tötung durch Unterlassen oder Misshandlung von Schutzbefohlenen.

Jens Amendt, Institute for Forensic Medicine, Frankfurt am Main, Germany
amendt@em.uni-frankfurt.de

Molecular systematics of black flies (Diptera: Simuliidae) in Cameroon, Ethiopia, Tunisia, Nigeria, and Germany

P. Kamtsap, F. Nguemaïm, A. Yilak, R. Schnell, D. Akafi, M. Garbi, A. Paguem & A. Renz

Background: Black flies are present worldwide and are represented by 2,348 species (2,331 living species and 17 fossils), classified under 31 genera. In Africa, 124 species of black flies are described of which 55 are known to occur in Cameroon. However, these identifications were all based on morphology and, for *Simulium damnosum* only, on cytotaxonomic studies. Little has yet been done by modern molecular genetic techniques. This study aims to apply DNA-based techniques to investigate the diversity and evolution of *Simulium* flies to better plan any vector control.
Methodology: *Simulium* larvae and pupae were randomly collected from various *Simulium* breeding sites in rivers from five countries (Cameroon, Ethiopia, Tunisia, Nigeria, and Germany). Adult *Simulium* flies were caught on humans in Cameroon, Nigeria, and Ethiopia. Pupal gills were examined and photographed in a drop of polyvinyl-lactophenol. The genomic DNA was extracted and the CoxI and ITS2 genes targeted by PCR. The amplification products were sequenced and trees were drawn. The sequences were cleaned using Geneious Prime and the evolutionary analyses conducted in Mega-X 10.5.
Results: More than 54 sample collections were included in this study, of which about 1,000 individual larvae, pupae or adult flies from the various sites were studied and 23 species identified on the basis of their morphology and DNA-sequencing: *Simulium damnosum* s.l.; *S. unicornutum*; *S. katangae*; *S. hisurtum*; *S. cervicornutum*; *S. schoutedeni*; *S. alcocki*; *S. dentulosum*; *S. ruficorne*; *S. hargreavesi* v. *medusaeforme*; *S. hargreavesi*; *S. adersi*; *S. pseudequinum*; *S.* (*Eusimulium*) *latipes*; S. (*Odagmia*) *ornatum*; S. (*Wilhelmia*) *equinum*; *S. vorax*; *S. nigritarsis duboisi*; *S. kenyae*; *S. velutinum*; *S. aureum*; *S. angustipes*; *S. bovis*). Sequences of the yet undescribed species will be deposited in the GeneBank
Conclusion: Here we show for the first time the relationship between morphology and molecular data of some black flies from Cameroon, Ethiopia, Nigeria and Germany. Further studies with more samples from a wider range of African countries are needed. These data are important for understanding the transmission and life-cycles of *Simulium*-borne parasites: *Onchocerca* and mermithid worms, microsporidia and apicomplexan parasites (Leucocytozoon) and (yet little known) viruses. Knowledge on the various members of the *S. damnosum* complex in the rain-forest and savannah is also a prerequisite for successful elimination of *O. volvulus* in Africa.

Pierre Kamtsap, University of Tübingen, Germany
kamtsapbuea200@gmail.com

On the influence of environmental factors on the oviposition activity of necrophagous flies

L. Lutz, M.A. Verhoff, T. Rosenbaum & J. Amendt

Locating an optimal oviposition site can be a challenging task for female insects, especially when dealing with a patchy, unpredictable, and ephemeral food source such as carrion. Understanding the biotic and abiotic parameters that influence the oviposition behavior of necrophagous flies is not just of great biological importance, but also essential for their application in legal investigations. In this study, we monitored the oviposition activity of necrophagous flies (Calliphoridae, Sarcophagidae) using mouse carcasses in an urban (city) and a rural (mixed forest) habitat in Frankfurt/Germany over a two-year period. Over 240 sampling days, 220,963 larvae of four blow fly species and one flesh fly were sampled. The most abundant species was the blow fly *Lucilia ampullacea*, followed by its family members *Calliphora vicina* and *L. caesar*, the flesh fly *Sarcophaga caerulescens*, and *L. sericata*. Up to seven environmental parameters were statistically significant predictors for a colonization of the carcasses, leading to unique patterns of seasonal and daily oviposition activity for all five species. Overall, the analysis showed that the seasonal adaption (the phenology of each species), the habitat (rural vs. urban) as well as temperature are the most important factors influencing the oviposition behavior and activity of necrophagous blow flies and flesh flies.

Lena Lutz, Institute for Forensic Medicine Frankfurt am Main, Wiesbaden, Germany
lutz@med.uni-frankfurt.de

Dermestidae–A challenge in pest management

R. Pospischil

From 2010 until now more than 200 biological samples have been submitted each year to the author for identification mostly from localities in Germany and neighboring countries. The samples came from pest management professionals, museums, scientific institutes, botanical and zoological gardens etc. More than 90% were insects found inside or around buildings and one of the most prominent family were Dermestidae. Mostly adults were sent, but also larvae, and sometimes even faecal pellets. Pieces of wood with the typical boreholes of *Dermestes* larvae in soft wood zones were also submitted. Development stages which could not be identified, were cultured until hatching of adults. Identified specimens were included in the reference collection. Photos were taken of the samples (specimens, signs of infestation etc.) to save the entries for further studies. *Attagenus pellio*, a species commonly found in the past, was sent in only a few times from old frame work buildings. It seems to be replaced now particularly in modern buildings by the brown fur beetle *Attagenus smirnovi*, which was first sent to the author in 2007 from Switzerland. Since 2014, this species has been one of the four most common dermestid species found in buildings in Germany, together with *Trogoderma angustum*, the Australian carpet beetle Anthrenocerus australis and the varied carpet beetle *Anthrenus verbasci*. More than 90% of the genus *Dermestes* is represented in buildings by *Dermestes haemorrhoidalis*. One male and one female of the odd beetle *Thylodrias contractus* were sent on the sticky surface of a trap from a museum in Brandenburg (Germany). The larvae of the genera *Trogoderma*, *Anthrenus*, and *Anthrenocerus* are armed with tiny arrow hairs, which can be thrown off when disturbed. They are invisible to the human eye but cause skin reactions in sensitive individuals. Asthmatics are likely to be more affected. In some cases, small punctures are also visible in the skin, which can lead to confusion with a parasite infestation. Almost all of these species found indoors even in winter months were introduced through world trade from other continents. Climate change and the constant temperature conditions in modern buildings have an influence on the further spread and establishment of these exotic species. The prerequisites for the pest management to master these challenges are a profound knowledge of the species and their ecological competence.

Reiner Pospischil, PMP-Biosolutions, Bergheim Erft, Germany
reiner.pospischil@t-online.de

Comparison of the bacteriolytic activity and the pattern of bacteriolytic compounds in the saliva, stomach and small intestine of the haematophagous bug *Triatoma infestans* (Reduviidae)–A review

G. Schaub

Triatomines ingest large amounts of blood, supported by antihemostatic compounds in the saliva. They store it in the strongly distensible stomach, concentrate it and pass small portions to the digestive part, the small intestine. In both parts, blood ingestion induces an acidification of the content, reducing the pH from pH 7.5 (blood) to pH 5.2 and presumably

lower near the intestinal wall. The salivary glands are colonized by a diverse microbiota. The whole intestine is the environment for the development of *Trypanosoma cruzi*, the etiologic agent of Chagas diesease in the New World, mutualistic symbionts and other bacteria and fungi. In the glands and in the intestine, bacteriolytic compounds are present. In the glands, they might regulate the microbiota, but are also ingested with the blood and required during coprophagy, a behavior performed after blood ingestion to obtain the mutualistic symbionts. These Actinomycetales develop stronger in the stomach than in the small intestine. Another interesting interaction is the induction of the synthesis of intestinal antibacterial compounds by *T*. *cruzi*, thereby reducing the number of bacteria. After a knockout of these compounds, more bacteria and less trypanosomes develop. In an attempt to elucidate such interactions, we investigated feeding-induced changes of bacteriolytic activity and the pattern of bacteriolytic compounds in the saliva and extracts of stomach and small intestine of the haematophagous bug *Triatoma infestans*. In the determinations of the activity of the saliva against *Micrococcus luteus* as substrate at different pH values, peaks of activity were detectable at pH 4 and pH 6. At the latter, it increased significantly between three and five days after feeding. Considering the intestine, activity was strongest at pH 4 and pH 7 and was higher in the stomach than in the small intestine. It was reduced 24 hours after feeding by the ingested blood and then increased. Symbiotic *Rhodococcus rhodnii* were not lysed. In zymography, i.e. electrophoretic separation of the proteins in the saliva under non-reducing conditions in gels containing *M*. *luteus*, and summarizing incubations at pH 4 and pH 6, the saliva of unfed nymphs lysed *M*. *luteus* in the gels at seven bands between 15.6 and 31.4 kDa. After prolonged incubation in water, additional bands of lysis appeared at 14.1, 14.7, 21.4 and 38.5 kDa. Using saliva collected at seven days after feeding of nymphs, activity at 17.1 kDa was much stronger than in saliva of unfed nymphs. In zymographs of extracts of stomach and small intestine, the activity against *M*. *luteus* was mainly correlated to proteins of about 16 kDa. At different periods of time after feeding, seven bands of lysis appeared between 15 and 40 kDa and more bands using extracts of the small intestines than those of the stomachs. Lysis bands of 15 to 23 kDa might result from triatox, trialysin, hemolysins, attacins and especially lysozymes. However, antibacterial proteins of 25–40 kDa are unknown for triatomines. Mass spectrometry can identify the respective proteins. Since bacteria in housefly larvae are lysed at a low pH by a combined action of lysozyme and a cathepsin D-like proteinase, an activity of complexes of such compounds might be relevant in triatomines. Since the lysis band at 38.5 kDa appeared after a prolonged incubation in water, a dissociation of a sialocomplex is possible. The lysis of the symbiotic *R*. *rhodnii* might occur by such a complex that is inactive in extracts of the small intestine.

Günter Schaub, Ruhr University Bochum, Bochum, Germany
guenter.schaub@rub.de

Metacercarial infection of edible crab (*Sudanautes*), and crab-eating behavior in transmission of paragonimiasis in Calabar suburbs, Nigeria

E. Uttah & C. Uttah

This study was aimed at investigating the metacercarial infection of edible crab (*Sudanautes*), and crab-eating behavior in two selected coastal communities in Calabar suburb, Nigeria, in transmission of paragonimiasis. *Sudanautes* were caught from their holes, and some bought from local markets and dissected for metacercariae. Crab-eating behaviors of 1,517 randomly selected individuals from the study areas were recorded. Seven sputum examinations per person were made for the presence of *Paragonimus uterobilateralis* eggs/ova on these individuals. The total number edible crabs examined was 3,949, including 2,749 caught from their natural habitats and 1,200 (100 monthly) bought from local markets. The monthly relative abundance showed seasonality and correlated strongly with rainfall. Metacercariae crab infection was 5.3%, with highest and lowest monthly infection rates in August and November. The overall prevalence of metacercariae infection among crabs bought from local market was significantly higher than among those caught in their natural habitats (χ2-test; $p<0.05$). The arithmetic mean of number of crabs caught in the wet season (279) was significantly higher than that (130) caught in the dry season (ANOVA; $p<0.05$). Overall, 42.2% and 43.7% in both populations respectively were crab-eaters. Crab-eating was comparable in both sexes, but highest among the oldest age groups. The risk of being infected was highest among fishermen/women in both populations. Prevalence was highest among weekly crab-eaters followed by the Irregular crab-eaters. The overall risk of being infected with paragonimiasis was (675 times and 44 times in Akp-

abuyo and Calabar South respectively) higher among crab-eaters than among non-crab-eaters. In conclusion, paragonimiasis is endemic in the study areas. Urgent enlightenment against improperly cooked crabs are needed to curb the scourge.

Emmanuel Uttah, University of Agriculture and Environmental Sciences, Umuagwo, Imo State, Umuagwo, Imo State, Nigeria
drecuttah@yahoo.com

Sektion Morphologie, Systematik, Evolution / Section Morphology, Systematic, Evolution

Keynote

Cryptic or flashy: Evolution of defensive strategies in the stick and leaf insects

S. Bradler

Animals are permanently under strong selection to avoid predation, therefore predator-prey interactions are major driving forces of evolution and have given rise to a plethora of effective defensive strategies. Colouration is arguably the most obvious among primary defenses and might enhance crypsis to reduce detection or warn predators of the prey's unpalatability or toxicity. Both strategies can be found in stick and leaf insects (Phasmatodea), a mesodiverse lineage of large terrestrial herbivorous arthropods well known for their remarkable capability to camouflage themselves as plant parts. Most species are nocturnal, remain motionless during the day and exhibit masquerade crypsis by mimicking twigs, leaves and bark. In contrast, a minority of species such as the Peruvian fire stick (*Oreophoetes*) displays striking forms of aposematism (warning colouration) insinuating the use of their efficient prothoracic repellent glands. Chemical spraying from these glands is just one of numerous secondary defense mechanisms in phasmatodeans (i.e., those initiated when a predator attacks), comprising startle display, defensive stridulation, thanatosis or escape by flight, limb autotomy or counterattack via heavily armend legs. Although most species largely rely on cryptic appearance to avoid predator detection, their secondary defense system is quite elaborate, and repugnatorial glands in the prothorax are supposed to be widely present among extant species, in fact constituting a derived ground pattern feature (autapomorphy) of all Phasmatodea.
The chemical substances involved in this powerful defensive mechanism are known only for a dozen species out of the 3,000+ described taxa, so far with no information available for major and pivotal lineages. We currently generate a profound information base for the presence and anatomical diversity of the prothoracic repellent glands across a broad and representative taxon sampling of 100 stick and leaf insect species and identify the chemical substances involved. The goal is to reconstruct the step-wise anatomical and chemical evolution of this elaborate defense system and to detect key innovations in a phylogenetic framework. The obtained information will be correlated with further data on body form and size, armature, colouration and behavioural observations of the examined specimens in order to reveal transformations of crucial traits and to detect key innovations that might have had an effect on diversification rates and shaped the evolution of stick and leaf insects. Since the few hitherto reported repellent substances show an unexpectedly huge diversity between taxa, exhibiting highly specific characteristics such as odor or causing skin irritations (as perceived by humans), and include some previously unreported natural products, we also expect our project to demonstrate the value of stick and leaf insects as sources of new bioactive compounds.

Sven Bradler, Georg August University of Göttingen, Göttingen, Germany
sbradle@gwdg.de

Standing the test of deep time–Cockroach ootheca from the Early Cretaceous to the present day

S V. Jung & M.K. Hörnig

Insect reproductive strategies, which can be observed today, are as diverse as the group itself. However, about the origin and evolution of the individual reproductive strategies is often little known. Hence, fossil remains of insect eggs and reproductive structures as ovipositors are of great interest because they provide important information about ecological adaptations and the evolution of reproductive strategies of insect groups in deep time. Besides the great abundance of adult insects, larvae, and nymphs in the fossil record, there are only rare fossil findings of preserved insect eggs, which makes the comparing investigation of egg morphology and associated structures in fossils challenging.
A distinctive reproductive strategy related to oviposition is the formation of oothecae – egg-packages with a protective case. The ability to produce oothecae is considered as an apomorphy of the group Dictyoptera, which today comprises Blattodea (cockroaches) and Mantodea (praying mantises). Within cockroaches, the oval, slightly convex, sclerotized cases contain 4 to 50 eggs arranged in two parallel rows and exhibit interspecific differences in size, structure, and composition. Cockroaches show different types of strategies concerning the deposition of the oothecae: The oothecae can be e.g. deposited directly, carried around attached to the abdomen or in a brood sack until the nymphs hatch. Oothecae are likely an important as-

pect for the wide distribution of cockroaches and their ability to inhabit different types of habitats that persist to the present day.
Despite their rigidity and the high abundance of cockroaches in fossil records, especially in amber, only about 20 fossil remains of oothecae are known today in the literature in total. The oldest known record is dated to 125 million years ago, suggesting that this type of maternal investment is present since the Early Cretaceous.
To investigate whether the oothecae have altered through time since their presumed first occurrence in the Early Cretaceous, we examined more than 15 fossil oothecae using different techniques including micro-computed tomography (µCT). The fossilized ootheca from Myanmar (100 mya) and Baltic amber (40–50 mya) of different species were analysed with respect to particular morphological characteristics such as the number of egg chambers, surface microstructure and compared to the ootheca of extant cockroaches.

Swane Vivian Jung, University of Rostock, Rostock, Germany
Swane.Jung@web.de

More species than ever thought in the enigmatic mantid genus *Holaptilon* Beier, 1964 (Gonypetidae, Gonypetinae)

Z. Mirzaee, S. Sadeghi, M. Wiemers & T. Schmitt

The mantid genus *Holaptilon* (Gonypetidae, Gonypetinae) is composed of small, runner mantids. Both sexes are apterous, which is rare in the order Mantodea. Due to their clandestine lifestyle, comparatively little is known about this genus, and studies concerning its distribution and taxonomy are scarce. Furthermore, only a few specimens of this genus are available in museum collections. The genus was once established for a single species, *Holaptilon pusillulum* by Beier (1964) based on material collected in Jerusalem. Later, *Holaptilon brevipugilis* Kolnegari, 2018 was described with material from Iran. The systematic placement of this genus was recently changed by moving it from Mantidae to Gonypetidae, and its subfamily changed from Amelinae to Gonypetinae (Schwarz and Roy 2019). Here, we present new data on this genus based on more than 70 *Holaptilon* specimens collected from various provinces of Iran. We conducted extensive morphological analyses, including examination of male and female genitalia and morphological hypervolume PCA. As many of the morphological characters appear to be homoplastic, they cannot be used to define the species within this genus. In addition, we used four molecular markers (mitochondrial and nuclear DNA) to gain a better understanding of species delimitation and phylogenetic relationships. We discovered an important inter- and intra-specific variation. Based on our data, we add four new species to this genus, each of which exhibits a unique distribution within Iran. We provide an identification key plus data regarding this enigmatic genus's distribution, ecology, and biology.

Zohreh Mirzaee, Senckenberg German Entomological Institute, Müncheberg, Germany
zohreh.mirzaee@senckenberg.de

Putting ceraphronoid wasps (Hymenoptera: Ceraphronoidea) back on the map

T. Salden & R.S. Peters

Parasitoid wasps are a megadiverse group of Hymenoptera with ecological and economical importance. The number of currently described species does not reflect the true species diversity. One of the most severely understudied parasitoid wasp groups is Ceraphronoidea. Our studies on ceraphronoid wasps from the biodiversity hotspots in the central-eastern Afromontane regions (Kenya, Tanzania) and the Caucasus (Armenia, Georgia) support this hypothesis. So far, we already described 88 new species, more than doubling the number of Ceraphronoidea species from the Afrotropical mainland (65 vs. 153 Ceraphronoidea). Recently, we made the first ever targeted efforts to collect Ceraphronoidea from the Caucasus, a hotspot virtually unstudied for the superfamily. The collected specimens will be treated in a first integrative species diversity exploration approach, combining morphological examination and DNA-Barcoding. Preliminary results indicate a high diversity in both Ceraphronidae and Megaspilidae, with many species new to science to be expected. In summary, our results highlight that it is necessary and also possible to illuminate the grotesquely understudied parasitoid wasp fauna. We hope that our studies will bring the necessary momentum for the exploration of the diversity of small-bodied and megadiverse insect groups by providing the basic taxonomic knowledge that is much needed for protecting biodiversity and understanding evolution and the networks of life on earth.

Tobias Salden, Leibniz Institute for the Analysis of Biodiversity Change, Leverkusen, Germany
T.Salden@leibniz-lib.de

Simulium vectors of onchocerciasis in different ecological zones of Ethiopia: A paradigm of parasite-vector associations

A. Yilak

Onchocerciasis is an infectious disease caused by *Onchocerca volvulus*, transmitted by *Simulium* species. In Ethiopia, there are complex scenarios of parasite-vector transmissions of *Onchocerca* species of animal and human origin, due to the presence of many non-damnosum black flies coming to bite on man. Little is known about the diversity of vectors, their vectorial role, and their potential to transmit human or animal filariae; hence, the current study is conducted to identify the various anthropophilic *Simulium* species coming to land on man and to know their vectorial status in the transmission of O*nchocerca* parasites.

In the north-western parts of Ethiopia non-*Simulium damnosum* species breed in semi-perennial lowland and perennial mountainous river systems. Early stages were processed from preserved in 96% ethanol alcohol and Carnoy's solution for molecular and cytotaxonomic studies. Adult *Simulium* were caught four times per month by two black fly catchers to determine the annual biting rates (ABRs). At the Universität in Tübingen, morphological identification and molecular genetic analysis is ongoing to know the taxonomic epithet of each species.

In the order of abundance from highest to lowest, *S*. *bovis*, *S*. *dentulosum*, and *S*. *vorax* are confirmed coming to land on man following the dominant *S*. *damnosum* in Central Gondar and West Gondar Zones of Ethiopia. Those adult female flies were identified using morphometrics and molecular genetic analyses.

The breeding situation of those blackflies was seasonal in semi-perennial rivers and year-round in perennial rivers. Mountainous cold rivers were favourable for breeding of *S*. *dentulosum*, whereas the breeding pattern of *S*. *bovis* and *S*. *vorax* was not easily noticeable except little implication for *S*. *bovis* commonly found in lowland warmer areas.

Simulium damnosum complex were caught in onchocerciasis endemic regions and ABRs were calculated ranging from 6 to 24,000 bites per man and year followed by *S*. *bovis* with its highest record of 8,800 bites/man and year. Except *S*. *vorax* with the ABRs of about 500, the other species exceeded a critical number of 1,000 flies per man and year which might potentially contributed to the transmission of *Onchocerca volvulus*.

A pictorial key was developed to distinguish the various anthropophilic female flies in the study of the transmission of *O*. *volvulus* and non- *O*. *volvulus* infective larvae from human or animal origin.

No studies have yet been done on the prevalence of *Simulium*-transmitted *Onchocerca filariae* of animal origin, namely from cattle (*O*. *ochengi* by *S*. *damnsosum* s.l.) and *O*. *dukei*, transmitted by *S*. *bovis*) or filariae of game or other domestic animals, which are frequent in Ethiopia (donkeys, horses, camels). It is highly recommended to compare the vectorial status of each species complex occur in other African countries.

Abebual Yilak, University of Tübingen, Tübingen, Germany
abebual-yilak.belete@student.uni-tuebingen.de

Sektion Molekulare Entomologie / Section Molecular Entomology

Keynote

Adaptations to plant defenses as a driver of insect-plant coevolution

G. Petschenka

While feeding on plants, phytophagous insects are exposed to a tremendous variety of toxic secondary compounds. Remarkably, many insects are not only able to cope with plant toxins but also sequester them into their bodies to defend against predators. Hence, insects exploit plants in at least two ways, - as a dietary resource and as a source of defensive compounds. Our research focuses on cardiac glycosides, potent inhibitors of Na^+/K^+-ATPase that evolved convergently in at least 12 plant families. We study the physiological mechanisms underlying insect resistance to cardiac glycosides and sequestration and found that both traits can be intertwined. Specifically, sequestering cardiac glycosides requires resistance traits different from those needed to simply consume a cardenolide-rich diet. Therefore, predators selecting for sequestration can spur the coevolutionary arms race between insects and plants by driving the evolution of specific resistance adaptations. Moreover, we found that acquisition of plant toxins for defense likely explains specific associations with toxic host plants in insects that are dietary generalists. Besides cardiac glycosides, toxins driving such associations involve colchicum alkaloids and pyrrolizidine alkaloids. Based on our findings, we propose that sequestration is an important mechanism mediating ecological interactions across at least three trophic levels. Despite being common among insects, the mechanisms underlying sequestration and the resulting physiological costs are largely unknown. Using integrative approaches in a comparative, evolutionary framework, we study the toxicokinetics of plant metabolites in insects to understand the functional basis of sequestration. In addition, we investigate the physiological effects of sequestered plant compounds and found that they can shift life history parameters in insects in unexpected ways. Our overall goal is the advancement of coevolutionary theory by integrating insect physiology, analytical chemistry, and ecology. Specifically, we aim on a detailed understanding of how plant toxins function across trophic levels and what mechanisms insects evolved to either disarm plant defenses or to use them for their own benefit.

Georg Petschenka, University of Hohenheim, Institute of Phytomedicine, Stuttgart, Germany
georg.petschenka@uni-hohenheim.de

dsDNA is a potential competitor for dsRNA degrading nucleases in the watery saliva of *Halyomorpha halys*

V.P.S. Amineni, G. Petschenka & A. Koch

Halyomorpha halys (Hemiptera; Pentatomidae), which is native to East Asia, is an invasive pest in Europe and many American countries that causing serious economic damage to both horticulture and agriculture. The fact that chemical pesticides are the sole choice for effective controlling of these pests has led to the development of a strong biological control approach. In our research, we considered RNA-interference (RNAi) as a powerful tool for limiting the *H. halys* population. RNAi is a target-gene silencing method based on double-stranded RNA (dsRNA) and its sequence homology with the targeted endogenous transcript. RNAi has been demonstrated to be a viable method for insect species-specific control. Besides, the varied efficacy of RNAi among insect orders is a significant barrier to its future application in the field. Also, it was observed that hemipteran insects are less sensitive to oral RNAi than that of the highly sensitive Coleopterans. To identify the potential barriers for oral delivery of dsRNA, we tested and observed severe dsRNA degradation rates in *H. halys*' watery saliva, and salivary glands, where dsRNA is entirely degraded within minutes of ex-vivo incubation. It is also discovered that the nuclease activity of *H. halys* at various development stages is similar and high. In contrast, the nuclease activity in hemolymph was found to be rather low, which gives an explanation for the strong RNAi efficacy observed when dsRNA was directly injected into the insect body. The relative expression of five previously reported different dsRNA degrading nucleases; DNA/RNA Non-specific endonuclease (HhNSE), Exoribonuclease-1 (HhEri-1), Small RNA degrading nuclease-1 (HhSDN-1), Argonaute-2 (HhAGO-2), and Dicer-2 (HhDCR-2) in *H. halys* salivary glands reveals that HhNSE is highly expressed compared to the others. Consequently, the HhNSE may have had a substantial role in dsRNA breakdown in saliva. Given that HhNSE has a wide substrate range, dsDNA is considered as a possible competitor for HhNSE in safeguarding dsRNA in saliva. Very interestingly, after 60 minutes of

incubation with the undiluted saliva of *H*. *halys*, the 1:1 ratio of dsDNA and dsRNA maintained the stability of dsRNA for up to 60 minutes. Since dsRNA can be protected by dsDNA from nuclease degradation in saliva, we are examining if this formulation can also enhance the oral RNAi efficiency in *H*. *halys*. In the end, our findings have the potential to boost the efficacy of oral delivery of dsRNA in *H*. *halys* and other insects with similar barriers for dsRNA delivery, so leading to the creation of a novel formulation to develop RNAi as an efficient tool for insect pest control in the field level.

Venkata Partha Sarathi Amineni, University of Hohenheim, Stuttgart, Germany
venkata.amineni@uni-hohenheim.de

Chalcid wasps and their genomic background: Life strategy and its influence on genes

K. Bubeníková, T. Fraňková, J. Böhmová, S. Natarajan, P. Janšta & J. Straka

Chalcid wasps are a megadiverse group of insects which comprises more than 22,000 described species. Larvae of most of the species are parasitoids of other insects though some species are known as secondary phytophagous. Due to these fundamental switches in their life strategies, the chalcid wasps are suitable for the comparison of presence of genes connected with life strategies.
We chose eight representants from the family Torymidae and Megastigmidae for genome and transcriptome evaluation. The sequenced and de novo annotated genomic data were used to produce gene sets representing each species. These datasets were analyzed according to each species' life strategies to determine the common set of genes and specific genes tied to each strategy. As an outgroup, the well annotated genome of *Drosophila melanogaster* was used as an anchor to our dataset. This analysis on the genomic level provides a new insight into the evaluation of differences between life strategies and improves the understanding of the hymenopteran megadiversification.

Kristýna Bubeníková, Faculty of Science, Charles University, Prague, Czech Republic
bubenikk@natur.cuni.cz

Ecdysone starts dorsal closure and is targeted by selection for fast developing beetle eggs

S. Cheng, J. van den Heuvel, E. Mogollon Perez, J. van de Sanden, D. Chen, K.M. Bretscher, F. Verweij, J. Bosman, A. Hackmann, R. Merks, C. Jacobs & M. van der Zee

During current climate change, insect developmental speed can adapt quickly to match shifted host plant or prey availability. However, the genetic basis of such adaptation in developmental timing is hardly studied Here, we show that ecdysone signaling is the main target of long-term artificial selection for fast or slow embryonic development in replicate, outbred populations of the beetle *Tribolium castaneum*. Pooled genomic resequencing data, expression data and an RNAi screen highlight a 222 bp deletion, containing a binding site for Broad and the chromatin architectural protein Tramtrack, that regulates expression of the ecdysone degrading cytochrome CYP18A1. CRISPR/Cas9-mediated recreation of this fast allele in the homogenous genetic background of the Georgia laboratory strain demonstrates that this single deletion advances the ecdysone peak inducing dorsal closure, accelerates development, and trades off with fecundity. Our study demonstrates the relevance of ecdysone during embryonic development, and reveals the presence of large-effect life history alleles in natural populations.

Shixiong Cheng, Institute of Biology, Leiden, The Netherlands
s.cheng@biology.leidenuniv.nl

GBOL III: Two years shining light into the dark taxa: The moth flies project (Diptera: Psychodidae)

S. Jaume-Schinkel

The German barcode of life (GBOL) III: Dark Taxa is a taxonomy and DNA barcoding initiative funded by the German Federal Ministry of education, focusing solely on the highly understudied, highly diverse, and unknown part of biodiversity. Illuminating the "Dark Taxa" through modern integrative taxonomy can be achieved by combining morphology, DNA barcodes, genomes, and new researchers, with the ultimate goal of understanding the organisms, the methods, the evolution and the species concepts. After ten years of the previous phases of GBOL, about half of the animal species occurring in Germany are covered within the DNA Barcode libraries of GBOL, even diverse groups like Coleoptera or Lepi-

doptera, however; only about 25% of Hymenoptera and 33% of Diptera are covered. These abundant and megadiverse insect orders are the main goal of GBOL III: Dark Taxa.
One of the projects focuses on working with moth flies (Diptera: Psychodidae). Some species of moth flies are known vectors of zoonotic diseases, especially human leishmaniasis and, some others are considered possible indicators of habitat quality. However, their very small size and very often scarce numbers in samples make them a neglected and understudied group among the Diptera.
The moth flies are represented in Europe by around 500 extant species, nonetheless, the taxonomic knowledge for moth flies in Europe is uneven, though, with a few countries having high numbers of studies and records and many others lacking systematic collection of specimens. This current situation results in many unknown species' distributions and poor taxonomic treatment in Europe. Furthermore, the classification of the family and the phylogenetic relationships inside it have been poorly understood in the last decades, hence the necessity of up-to-date studies that can bring light to the group.
Now, after two years of the project, we have some interesting preliminary results and we managed to illuminate the psychodids while doing so.

Santiago Jaume-Schinkel, Leibniz Institute for the Analysis of Biodiversity Change, Bonn, Germany
s.jaume@leibniz-lib.de

Characterization and functional analysis of ABCB transporters in the leaf beetle *Chrysochus asclepiadeus*

C. Plate, P. Kowalski & S. Dobler

Some plants produce cardenolides to protect themselves against predators. These toxins act by inhibiting the essential Na,K-ATPase. Nevertheless, a number of insects have adapted to cardenolides in their food and even sequester them. In this process, plant cardenolides are recycled and e.g. transported into defense fluids. In the leaf beetle genus *Chysochus*, there are two cardenolide-adapted species (*C*. *auratus* and *C*. *cobaltinus*) while others feed on plants that do not contain cardenolides (e.g. *C*. *asclepiadeus*). In a previous study, an orally applied radiolabeled cardenolide was detected predominantly in the defense fluid in the adapted species *C*. *auratus*, but was mostly excreted in the feces by *C*. *asclepiadeus*, while not even traces were detected in its defense fluid. We hypothesized that efflux transporters of the ABCB protein family are responsible for this transport and could actually confirm this in *C*. *auratus*.
In this study we investigate how many gene copies of ABCB proteins are present in *C*. *ascepiadeus* and how similar their tissue distribution and substrate specificity is to the situation observed in *C*. *auratus*. Our aim is to elucidate how the change of host plant influences the transport mechanism, which amino acids in the ABCB transporters could coordinate this transport and how the ability to sequester cardenolides develop in the genus *Chrysochus*.
Bioinformatic analyses revealed 45 putative ABC-transporters in a transcriptome of the non-adapted *C*. *asclepiadeus*, of which two were ABCB full transporters (ABCB1 and ABCB2). This contrasts with three ABCB full transporters (ABCB1-3) present in the cardenolide-adapted *C*. *auratus*. Tissue specific expression analyses showed that ABCB1 is most prominent in the nervous tissue but also expressed throughout the body with the exception of the Malpighian tubules. We therefore assume that this transporter has a prominent function in the hemolymph-brain-barrier to protect the sensitive nervous tissue. In contrast the highest expression of ABCB2 was in the Malpighian tubules, suggesting a role in the rapid excretion of toxins. ABCB1 and ABCB2 of *C*. *asclepiadeus* were both heterologously expressed in cell culture and tested for their ability to transport different cardenolides. By measuring the inorganic phosphate released when cleaving ATP the activation of a protein by a specific substrate can be determined. The patterns observed are discussed here and compared with the situation previously described for *C*. *auratus*. The results suggest that the specific adaptations to cardenolides are not present in *C*. *asclepiadeus* but rather only evolved with the host plant switch of *C*. *auratus* and *C*. *cobaltinus* to cardnolide-containing plants.

Cäcilia Plate, University of Hamburg, Hamburg, Germany
caecilia.plate@uni-hamburg.de

Microgels as a novel delivery platform for RNAi-mediated insect pest control

A. Rank, G. Petschenka & A. Koch

The need for more sustainable agriculture increases the demand for research into new alternatives for pest control. With great promise, RNA interference gained prominence as a new mode of action and has been widely used in research, mainly with pests that are difficult to control due to a lack of molecules, resistant to commercial products, or with a particular feeding habit or life cycle. Among these pests,

the Colorado Potato Beetle also stands out for its economic importance in agriculture and was selected as our case study for feeding on leaves coated with large-scale double-stranded RNA synthesized by a company (RNA Greentech) and also making use of a biosurfactant (Trifolio-M). Our results showed high efficiency in pest control, with mortality ranging from 50% (V-ATPase B) to 88% (COPB- coatomer subunit Beta) in selected targets within six days, confirming data already available in the literature. Overall, V-ATPases took longer to reach mortality than COPB and COPI (Coat protein complex) but the moribund effect with a decrease in leaf area consumed and weight gain could also be observed over the days. This study shows preliminary and important results on target screening that can guide us in future research for the development of new sprayable biopesticides.

Aline Rank, University of Hohenheim, Stuttgart, Germany
aline.pereirarank@uni-hohenheim.de

Poster

Sorted by sections and main authors

Sektion Imkerei und Bienengesundheit / Section Apiculture and Bee Health

Poster 01

Climate and land-use influence on the reproductive success of *Osmia* bees: towards an optimal trap-nesting management nearby almond orchards in Southern Europe

C. Polidori, S.R. Gómez, A. Ferrari, F. Ronchetti & D. Gil-Tapetado

Wild bees (Hymenoptera: Apoidea) play an important role as pollinators of many crops, and managed populations of *Osmia* spp. (Megachilidae), through the installation of trap-nests, proved to be efficient in several fruit orchards. In order to optimize the trap-nest protocols, it is necessary to understand which environmental factors play a major role in reproductive success of these bees. Here, we studied how climate, land use and vegetation affect nest occupation rate (OR, i.e. total number of colonized tunnels per trap-nest), brood productivity (BP, i.e. total number of brood cells built per completed nest tunnel) and parasitism rate (PR, i.e. total number of parasitized brood cells per nest tunnel) in *Osmia* bees nearby almond orchards in South-East Spain, a largely understudied Mediterranean area. To determine which environmental variables influence the *Osmia* productivity and mortality we have collected longitude, latitude and altitude (geographical variables) and 24 climatic, 7 land-use and 7 vegetation variables. After having further selected the variables based on their intercorrelations through a hierarchical cluster analysis of similarity, we used to complementary approaches to detect which factors were relevant in explaining variation in the three dependent variables (OR, BP, PR): the Random Forest (RF) classifier algorithm and Generalized linear mixed models (GLMMs). Three *Osmia* species emerged from the installed trap-nests: *Osmia cornuta* (Latreille), *O. tricornis* (Latreille) and *O. latreillei* (Spinola). We found that the summer solar radiation positively influenced all three parameters, while spring solar radiation positively affected OR and BP and negatively PR. Vegetation evenness and diversity of dominant plant species also positively affected OR and BP, while they were unimportant for PR. OR was not affected by climate, but BP increased with maximum temperature in the warmest month and decreased with temperature annual range. PR also increased with high temperature, as well as with precipitation. Aridity limited OR and BP and boosted parasitism. Land use variables (land cover composition and variation) affected the three parameters in a more unclear pattern. Overall, it seems that *Osmia* bees nearby almond field in this area would benefit from trap-nest installation in well solar-radiated, hot and humid sites with a diverse vegetation. Since we have also found a negative association between PR and BP in nests with at least one parasitized cell, environmental conditions which improve productivity will also reduce parasitism in these bees.

Carlo Polidori, Università degli Studi di Milano, Milano, Italy
carlo.polidori@unimi.it

Sektion Chemische Ökologie und Verhalten / Section Chemical Ecology and Behavior

Poster 02

Wireworm responses to CO_2 and plant root volatiles

R. Favaro, M. Brunner, M. Traugott & S. Angeli

Wireworms, the larval stages of the click beetles (Coleoptera: Elateridae), are a major agricultural pest feeding on a broad range of host plant roots. The insects usually establish in non-farmed undisturbed grasslands and repeatedly invade the surrounding crop fields, where they take several years to complete the larval development. Since the removal of the neonicotinoids from the market, the management of the wireworms by means of insecticides has been proven particularly difficult. The development of alternative strategies such as biological and semiochemicals methods is required. While attractive pheromones and plant volatiles are known for the adult stage, little is known about the wireworms. In this study, we combined behavioural and electroantennography trials to address the larval preference of *Agriotes obscurus* towards host plants. We recorded clear neuronal responses to CO_2, confirming its role in the host finding behaviour. In a multiple-choice test, however, the plants releasing the highest amount of CO_2 were not the larvae's main choice, thus suggesting the likely contribution of plant volatiles in the decision.

Riccardo Favaro, University of Innsbruck, Bolzano, Italy
riccardo.favaro@unibz.it

Poster 03

Chemical signalling between flowers and bumble bees

C. Gómez-Ramirez, I. Muktar, T. Schmitt & O. Riabinina

Plant-pollinator interactions are complex processes driven by diverse signals such as floral scents. Bumble bees are important pollinators who are confronted with an enormous diversity of flower odour bouquets, which they process and use to make decisions. Bumble bees are usually considered generalist pollinators, although the specific floral and olfactory preferences of bumble bee species beyond *Bombus terrestris* and *B*. *impatiens* are not well known.
In this project we investigate the floral smell preferences of bumble bees in the Northeast of England. We will study whether bumble bees use smells of flowers to make their foraging decisions and whether flower smell preferences are species-specific. We conducted collections of bumble bees in summer of 2021 and 2022 in Durham, UK, taking note of the flowers where they were found. Next, we collected floral volatiles using standard traps, and analysed them via gas chromatography-mass spectrometry (GC-MS). This approach allowed us to identify key volatiles of the flowers that were visited by seven sympatric bumble bee species. We also started to establish the patterns of floral smell preferences for our species of interest. Next, we aim to evaluate the response to floral blends via electrophysiological recordings such as electroantennography. The behavioural responses of the bumblebees will be ascertained via dual- or multiple-choice assay with artificial flowers.
This work will provide essential information about floral and olfactory preferences of European bumble bee species. This new knowledge may have important implications for bumble bee conservation and their commercial use as pollinators.

C. Gómez-Ramirez, Durham University, Durham, United Kingdom
wendy.c.gomez-ramirez@durham.ac.uk

Poster 04

From red list species to an agriculture threat–The planthopper *Pentastiridius leporinus*, vector for the agent of the sugar beet disease "Syndrome des basses richesse"

J. Köhler, B. Kais, B. Czarnobai de Jorge, C. Gerbert, F. Hergenhahn & J. Gross

The bacterial sugar beet disease "Syndrome des basses richesse" (SBR) is transmitted by the sap sucking activity of the planthopper *Pentastiridius leporinus* (Hemiptera: Cixiidae) and caused by the γ-proteobacterium *Candidatus* Arsenophonus phytopathogenicus. Infected plants show severe symptoms, including necrosis of vascular bundles in the beet, which often lead to a decrease of sugar content, and thus to significant yield losses. In 2020, a sugar beet area of 40,000 ha across Germany was affected by SBR.
Interestingly, *P*. *leporinus* is classified as an endangered species by the German Red List Center. In the past, the main occurrence of *P*. *leporinus* was in reed. Yet a change in host plant towards sugar beet and different cereals has led to an increased occurrence of *P*. *leporinus* in recent years. The planthopper became invasive and currently poses an agricul-

tural threat to sugar beet cultivation in central Europe.
Since variety selection is currently one of the most promising pest management options, one research aim of the joint research project PENTA-Resist is the development of an insect-free transmission technique of *Ca*. A. phytopathogenicus, which would facilitate experiments in variety breeding. In current experiments transmission of the γ-proteobacterium via grafting with infected plant material, as well as a transmission with the holoparasitic plant *Cuscuta* spp. are tested.
Another project aim is to get further insight in the tritrophic interactions between the sugar beet crop, *Ca*. A. phytopathogenicus, and *P*. *leporinus*. Specifically, we explore if host finding and acceptance of *P*. *leporinus* differ between healthy and infected plants, due to possible changes in volatile and/or metabolome composition. As a first step, phloem sap samples are analysed with gas chromatography–mass spectrometry (GC-MS), to investigate if the content of sugars and organic acids are influenced by an SBR infection, which may affect the feeding behaviour of the planthopper.

Jasminka Köhler, Julius Kühn Institute, Dossenheim, Germany,
jasminka.koehler@julius-kuehn.de

Poster 05

First steps of developing a novel push-pull-kill strategy against the brown marmorated stink bug *Halyomorpha halys* in organic fruit and vegetable production

A. Koßmann, B. Czarnobai de Jorge, L.C. Muskat, E. Beizen-Heinecke, A.V. Patel, A. Eben & J. Gross

The brown marmorated stink bug *Halyomorpha halys* (Stål, 1855) (Hemiptera: Pentatomidae) is an invasive and polyphagous pest insect native to Eastern Asia. With a wide host range of about 170 different plants and frequent occurrence in fruit and vegetable crops, *H*. *halys* often causes high economic losses for farmers in the newly invaded regions. Especially fruit growers struggle with this serious pest (Leskey and Nielsen 2018, Moore et al. 2019). In 2019, *H*. *halys* was responsible for an estimated loss of € 588 million in fruit production in Italy (CSO Italy 2020). Repeated applications of synthetic pesticides are usually required for its control. Currently, in Germany no insecticides are available against this invasive pest species. An effective new pest management strategy is needed against this plant-sucking insect for both, organic and integrated farming.
The aim of the joint project BIOBUG is to develop a biotechnical plant protection strategy against *H*. *halys* in organic horticulture. This method will be based on encapsulated volatile attractants and repellents (push-pull strategy) combined with a modified attract-and-kill strategy consisting of a specific suction medium (arrestant) and a biological insecticide or microbial antagonist (kill component). This way, a selective, environmentally friendly, and cost-saving control method for *H*. *halys* will be developed.
During *H*. *halys* monitoring in the experimental field using aggregation pheromone baited traps, high abundance of *H*. *halys* nymphs and adults were observed on specific shrubs. These shrubs seem to be highly attractive despite their proximity to other typical host plants like apple and pear trees. Specific scents are mostly very important for host plant recognition by herbivorous insects. Looking for a volatile, attractive kairomone (pull component) we collected volatiles from leaves and fruit of these shrubs by headspace-sampling. Analysis using thermodesorption followed by gas chromatography coupled with mass spectrometry (GC-MS) gave a first insight into the composition of volatiles emitted by these plants.
Identifying the main compounds of the typical scent of *H*. *halys* attracting shrubs and studying the behavioural reaction of *H*. *halys* is the first step in developing a potential attractant, that can then be used in an innovative capsule based attract and kill strategy. The first results of the chemical analysis and biotests with *H*. *halys* will be presented.

CSO Italy (2020): Estimation of damage from brown marmorated stink bug and plant pathologies related to climate change. http://www.csoservizi.com Cited June 2022
Leskey, T.C. & Nielsen, A.L. (2018): Impact of the invasive brown marmorated stink bug in North America and Europe: History, Biology, Ecology, and Management. Annu. Rev. Entomol. 63, 599–618. https://doi. org/10.1146/annurev-ento-020117-043226
Moore, L., Tirello, P., Scaccini, D., Toews, M.D., Duso, C. & Pozzebon, A. (2019): Characterizing damage potential of the brown marmorated stink bug in cherry orchards in Italy. Entomol. Gen. 39, 271–283. https://doi. org/10.1127/entomologia/2019/0799

Alicia Koßmann, Julius Kühn Institute for Plant Protection in Fruit Crops and Viticulture, Dossenheim, Germany
alicia.kossmann@julius-kuehn.de

Poster 06

No evidence for social closure but highly diverse cuticular-hydrocarbon profiles in an ambrosia beetle

A. Melet, V. Leibold, T. Schmitt & P.H.W. Biedermann

Animal societies have nestmate-recognition to protect against social cheaters. The individu-

als recognize and exclude any non-nestmate. In social insects, the role of cuticular hydrocarbons as recognition cues is well documented.
Some ambrosia beetles live in cooperatively breeding societies, within nests that are almost completely isolated. Their fungus-farming and sib-mating habits within their nest ensure a nearly complete isolation. However, little is known about social closure in ambrosia beetles.
We studied the social closure in *Xyleborus saxesenii*, combining behavioural observations and cuticular hydrocarbons analysis. Laboratory nests of *X*. *saxesenii* were exposed to foreign adult females, from the same population, another population and another species and survival as well as behaviours of receivers and the donor individual were observed. We expected that increasing genetic distance would cause increasing distance in chemical profiles and increasing levels of behavioural exclusion and possibly mortality. Chemical profiles were different between nests and appeared as variable as in other highly social insects. However, we did not find any evidence for behavioural exclusion of foreign individuals. These results suggest that cuticular hydrocarbon profiles might be used for communication, but that kin recognition is absent in *X*. *saxesenii* and probably other species in the inbred ambrosia beetle tribe Xyleborini.

Antoine Melet, University of Freiburg–Chair of Forest Entomology and Protection, Stegen-Wittental, Germany
antoine.melet@forento.uni-freiburg.de

Poster 07
Calcium imaging of ORCO-positive cells in larval malaria mosquitoes

I. Muktar & O. Riabinina

Anopheles gambiae mosquito is a malaria vector in sub-Saharan Africa. Malaria is responsible for thousands of deaths, especially among children under five years of age. Currently there are many strategies to target the adult mosquito, however the increased insecticide resistance and increased malaria incidences require novel interventions. Promising approaches include targeting larvae that reduces the number of mosquitoes emerging into adulthood. Like adults, larvae utilise their olfactory system to locate their food and, potentially, predators. Targeting the larval sense of smell is an effective strategy to attract larvae into traps or interfere with their foraging. Larval mosquitos detect smells via a sensory cone in the antenna, which houses the olfactory receptor neurons (ORNs). ORNs express only 12 different olfactory receptors (ORs). ORs are co-expressed with odorant receptor co-receptor (ORCO) to form OR/ORCO complexes, which are either narrowly or broadly tuned to variety of host-derived odours. Larval olfactory system thus provides a simple olfactory model allowing to interrogate the ORCO-positive cells in response to different concentration of soluble compounds predicted to bind to olfactory receptors (Xia et al. 2008). Recently, an unpublished work from our lab established behavioural valence of these compounds in the larvae by using a novel olfactory assay. The aim of this project is to characterise in-vivo cellular responses to behaviourally relevant compounds via calcium imaging, and to determine the OR-ligand pairings. I will use the new transgenic lines that we developed (Orco-QF2, QUAS-GCamp6s and others) to directly visualise responses of ORCO neurons in the larval antennae. The outcomes of this project will be two-fold. First, we will provide the first comprehensive characterisation of a simple aquatic olfactory system of an insect. Second, understanding of the cellular and molecular basis of odorant perception in *An*. *gambiae* larvae may lead to the development of new olfaction-based methods of larval control.

Iman Muktar, Durham University, Durham, United Kingdom
iman.j.muktar@durham.ac.uk

Sektion Biodiversitätsverlust und Insektenschwund / Section Biodiversity Decline and Loss of Insects

Poster 08

BALIN–Insect conservation at railway stations through insect friendly lighting

F. Bott & C. Ludreschl

Even today, light pollution is still an underrepresented factor in the awareness of the general public and science, but all the more important in national and international nature conservation. Artificial Light At Night (ALAN) has a particularly large impact on insects. According to estimates, approximately 1 billion insects are irritated by ALAN and partially die on artificial light sources every summer night in Germany (Manfrin 2017). The annual worldwide increase of ALAN by about 6 percent (Manfrin et al. 2018) and the resulting steadily growing nighttime illumination probably contributes significantly to the global insect decline in recent decades (e.g. Carrington 2017; Van Klink et al. 2020; Wagner et al. 2021). This highlights the acute need for alternative lighting and illumination concepts.
Rail transport also contributes to light pollution through regular nighttime illumination of around 5,400 railway stations by Deutsche Bahn Station & Service (DB S&S) in Germany. In contrast to the road transport sector, the rail network is not illuminated continuously, but the total length of illuminated platforms in Germany already makes up around 1,900 km of lightened track. Many of the illuminated platforms and station buildings are thereby located in semi-natural areas. Although station lighting is subject to strict requirements to ensure safety of railway operations and waiting passengers, orientation on railway premises, protection against vandalism and maintenance of accessibility, possible effects on insect diversity were disregarded so far. Consequently, there are currently no specifications or recommendations in Germany to prevent the negative impact/impairment of the approved station lighting on insects or other species groups.
Our project “BALIN–Insect conservation at railway stations through insect friendly lighting” (2021–2024; Consortium: German Centre for Rail Traffic Research, Deutsche Bahn S&S, Leibniz Institute for the Analysis of Biodiversity Change (LIB)) is to our knowledge the first study to analyze the effect of nighttime lighting at railway stations on flying insects. By installing three different alternative light sources (LED 4,000 Kelvin, LED 1,800 Kelvin and high-pressure sodium lamps) at six semi-natural railway stations in the Westhavelland Nature Park (dark sky reserve in Brandenburg, Germany), data on the pull effect of platform lighting on insect diversity are collected. Since late summer 2022, 24 semi-automated, self-developed flight-interception traps have been used to determine the number of insects flying at the alternative light sources at night. Additionally, twelve flight-interception traps have been installed on adjacent control poles without any light source and the least possible exposure to direct light irradiation. At each railway station, meteorological data are recorded separately by a weather station installed on-site. The bulk samples of the weekly emptied flight-interception traps are analyzed by modern non-destructive metabarcoding, which is complemented by classical morphological species identification, as well as biomass measurements and count data.
Through multi-year investigations, scientifically robust knowledge will be gained in real operation of rail transport to reduce future light pollution by station lighting. Further, the effects of light dimming and reduced mast reflection through mast blackening will be evaluated in the course of the project.
The poster presented at the conference presents the innovative project and implementation concept and shows first results and possible improvements regarding the attraction of station lighting to insects.

Frederick Bott, German Centre for Rail Traffic Research, Bonn, Germany
bottf@dzsf.bund.de

Carmen Ludreschl, Leibniz Institute for the Analysis of Biodiversity Change, Museum Koenig Bonn, Bonn, Germany
C.Ludreschl@leibniz-lib.de

Poster 09

Grasshopper results from the Biodiversity Monitoring South Tyrol

A. Hilpold, J. Plunger, U. Tappeiner & E. Guariento

“Biodiversity Monitoring South Tyrol” is a long-term project which started in 2019. Amongst others, it contains Grasshoppers as one of its focus groups, thereby assessing crickets (Ensifera), grasshoppers and locusts (Caelifera) and mantids (Mantodea). Grasshoppers can be found in all types of grasslands yet also inhabit various other agricultural habitats and different forest types, especially light and open ones. Their habitat requirements are relatively

specific, which makes them a good indicator group. Overall, the grasshopper and mantid fauna of South Tyrol encompasses 87 species, 6 species went extinct over the last 100 years and about one third of the existing grasshopper fauna is endangered.
For the grasshopper survey plot sizes of 100 m^2 (1000 m^2 for forests and apple orchards) have been used. The survey was started with sweep-netting a 15 m transect along the diagonal of the plot followed by an assessment for exhaustiveness. This includes additional sweep net beats and a detailed hand search. The species are identified by both visual and acoustic assessment within 30 minutes. The survey takes place once a year in late summer.
The presented poster shows the results of the first three years of monitoring. Comparisons of different land-use types of varying management intensity are displayed. Similarly to the butterfly results, apple orchards and settlements resulted very poor in species. Vineyards, semi-intensive meadows, and annual crop fields scored intermediately. Extensive hay meadows and pastures supported the highest grasshopper diversity (up to 14 species per site), with a high share of specialist species. Besides these ecological results, three new records for the area have been made: *Bicolorana bicolor*, *Euchorthippus declivus*, and *Pezotettix giornae* are new species recorded for the province of South Tyrol.

Andreas Hilpold, Eurac Research, Bolzano-Bozen, Italy
andreas.hilpold@eurac.edu

Poster 10
Competition or facilitation? The impact of flowers around pan traps on bee sampling results

A. Krahner, A.C. Dietzsch & F. Klaus

Although pan traps have been used for sampling bees across a wide range of habitats and geographical regions for decades, varying floral resources around pan traps may bias sampling results. This raises questions about the suitability of pan traps for bee monitoring programs that cover sites with varying flower cover. We investigated the effect of floral context around pan traps on sampled bee communities, in a two-year field experiment in the agricultural landscape around Braunschweig, Lower Saxony, Germany. We installed 72 pan traps at 13 sites in 2021 and 2022, with equal proportions of color-context combinations per site (yellow, blue and white; center of flower strip versus adjacent, i.e. at 1 m distance from the edge of the flower strip). We simultaneously assessed the percent flower cover in 2.5 m radii around each trap. We sampled bees for 24 hours three times (March/April, June, August/September) each year. In total, we collected more than 3,000 bee individuals over the course of the experiment. In 2021, traps at the flower strip center were surrounded by a higher proportion of flowers compared to traps adjacent to the flower strip during all three sampling events (Tweedie GLMM, post-hoc Tukey test, $p<0.005$). The number of bee individuals did not differ in pan traps adjacent to the flower strip compared to traps at the center of the flower strip in 2021 (Negative Binomial GLMM, post-hoc Tukey test, $p=0.7659$). However, we found a positive but non-significant correlation between percent flower cover and number of collected bee individuals (Negative Binomial GLMM, $p=0.103$). Based on these initial findings, we encourage bee researchers to assess flower cover around traps when sampling bees in contrasting habitats.

André Krahner, Julius Kühn Institute, Braunschweig, Germany
andre.krahner@julius-kuehn.de

Poster 11
Size matters: Wider pan traps collect more bee individuals than smaller pan traps

A. Krahner, A.C. Dietzsch & F. Klaus

Although pan traps are used as an established method for sampling bees across a wide range of habitats and geographical regions, uncertainty persists as to how pan-trap characteristics influence sampling results. We investigated the effect of pan-trap diameter on sampled bee communities at agricultural sites around Braunschweig, Lower Saxony, Germany. We installed 108 pan traps at six sites, with equal proportions of color-diameter combinations per site (yellow, blue and white; 22 cm versus 12 cm). We sampled bee individuals in three rounds of 24 hours (March/April, June, August/September) in 2021. In total, we collected 1,155 bee individuals that we categorized into the taxa *Apis mellifera*, *Bombus* spp. and other bee species. We observed interacting effects of pan trap color & size, taxon & color, as well as taxon & size on the number of sampled bee individuals. Generally, large pan traps sampled significantly more bee individuals than small pan traps (Negative Binomial GLMM, post-hoc Tukey test, $p<0.05$). Based on these findings, we advocate for the use of large pan traps for

sampling bees, in order to increase trap efficacy.

André Krahner, Julius Kühn Institute, Braunschweig, Germany
andre.krahner@julius-kuehn.de

Poster 12

How precise are size-weight equations for estimating carabid biomass and how could they be improved?

A. Linde & F. Weiß

Insect biomass has been used as an ecological indicator in the past, but in recent years has become a key metric in the study of insect population trends, especially since first reports about the so-called insect decline (e.g. "Krefeld study" of 2017). However, measuring insect biomass can be methodologically challenging, and very labour intensive. For many datasets, weight measurements are not available and the original samples may have already been lost. Size-weight equations provide a straightforward method for estimating insect biomass when the insect's body length is known. If insects have been determined to species level one can also use the average body length given in literature. Based on the correlation between the body length and the weight of an insect, there is a variety of size-weight equations for different groups of insects. They are widely used in insect research, but have rarely been tested with independent data. We evaluated two size-weight models for carabid beetles, by Szyszko (1983) and Booij et al. (1994), drawing on previously published independent data by comparing model predictions with actual measurements of biomass, using relative deviation graphs and observed versus predicted from regression. Moreover, we also tested if the inclusion of additional taxonomic parameters, in this case subfamily, can improve results. We found that both models produced systematically biased results: Szyszko´s model gave more accurate results for larger species, while the model of Booij et al. did so for smaller species. This bias is most likely caused by the different origin of the respective training data. This underlines the restricted applicability of such models. We demonstrate that additional taxonomic parameters have the potential to increase the accuracy of size-weight equations and represent a potential solution to the issue of restricted applicability. As actual biomass measurements for carabids are scarce, data availability is limited to only few subfamilies. Until data on more subfamilies become available, we recommend a combined use of both evaluated models: Szyszko's model for carabids ≥ 11.8 mm, and the model of Booij et al. for carabids < 11.8 mm, respectively.

Weiss, F., Linde, A. (2022) How to estimate carabid biomass?–An evaluation of size-weight models for ground beetles (Coleoptera: Carabidae) and perspectives for further improvement. Journal of Insect Conservation 26, 537–548. https://doi.org/10.1007/s10841-022-00391-6

Andreas Linde, Eberswalde University for Sustainable Development, Eberswalde, Germany
andreas.linde@hnee.de

Poster 13

Local effects of autumn mowing on the abundance and biomass of arthropod communities

H. Melcher & M. Rohlfs

Intensive mowing, as it is widely practiced in urban areas, has a negative impact on arthropod diversity. As plant-layer inhabiting invertebrates, many species are exposed directly to mowing and its lethal consequences. Especially autumn mowing affects arthropods by limiting overwintering and oviposition opportunities. Therefore, it is likely that the different life cycles of arthropods lead to specific responses to mowing. In a field experiment, we tested on a small scale if autumn mowing, being the only management of an urban lawn, can have negative effects on the abundance and biomass of different arthropod taxa, or, conversely, whether the retention of vertical plant structure from the previous year positively influences these important biodiversity parameters. To quantify the effect of mowing, we sampled arthropods on an urban grassland, half of which was mowed in previous autumn and the other half was left untouched. The arthropods were classified into taxonomic groups and their abundance and biomass was measured. The results indicate an overall significantly negative effect of autumn mowing on arthropod abundance and biomass. We also detected specific reactions of the arthropod taxa. These data demonstrate the importance of reduced mowing for arthropod biomass and abundance. Additionally, they indicate individual and long-term effects of mowing on arthropods, which may be related to their different life cycles.

Hannah Melcher, Göttingen, Germany
hannah.melcher@stud.uni-goettingen.de

Poster 14

Developing artificial model flowers for hoverfly monitoring

M. Pink. J. Uhler, P. Kassel & A. Herz

Hoverflies are important pollinators and parts of them are efficient natural enemies of aphids, especially in arable crops. Hoverfly

populations are threatened by habitat loss and agricultural intensification. Within the framework of the project MonViA (National Monitoring of Biodiversity in Agricultural Landscapes[1]), we currently develop, test and evaluate non-invasive methods which may be used in a long-term monitoring of hoverflies in the future. Adult Syrphidae are known to visit flowers frequently for nectar and pollen and can be easily observed here. Therefore, we are exploring the possibility to use artificial model flowers for a standardized observation of hoverflies regardless of flower availability. In greenhouse trials, we tested various flower traits, known to influence flower attractiveness to hoverflies, to create a final model flower combining the most attractive traits. Traits tested included flower colour, flower size, flower composition and arrangement/density, specific floral structures (e.g. fly catcher effect) and floral scent. First results indicate, that a fluorescent yellow colour is particularly attractive. Ultimately, such model flowers shall be used both by entomologists and by citizen scientists to observe and document hoverfly species in a standardized setting in the field. As the observation data from untrained citizen scientists can lack the higher resolution in insect identification, we also plan to collect eDNA samples from the model flowers to gain high quality data on flower visitor identity. Therefore, we are also testing different materials on their capability to retain eDNA, as well as the persistence of eDNA under certain environmental conditions. Based on the results from our laboratory experiments with three hoverfly species, further testing will be conducted in spring under field conditions, with broader range of target organisms and also the comparison of our artificial flowers to natural occurring ones (e.g. wild carrot). In a final step, citizen scientists will utilize the developed flowers in a preliminary survey under realistic field conditions.

[1] On behalf of the Federal Ministry of Food and Agriculture, a total of 12 specialist institutes of the Thuenen Institute and the Julius Kühn Institute as well as the Federal Office for Agriculture and Food are working together in the project MonViA (https://www.agrarmonitoring-monvia.de/en/).

Maximilian Pink, Heidelberg, Germany
maximilian.pink.uni@gmail.com

Sektion Biogeographie und Faunistik / Section Biogeography and Faunistics

Poster 15

Intra-specific weight variability of moth individuals in a rapidly changing post-fire ecosystem

C. Balthasar, T. Schmitt & M. Wiemers

In the first post-wildfire years, succession is leading to strikingly distinct plant communities on the newly emerged open habitats with a much higher plant diversity and biomass in the herb and shrub layer compared to the former pine forests.
This situation provides new habitats and niches for phytophagous insects, which are colonizing from the surrounding landscape. As the larval food availability increases, competition for food resources should temporarily be reduced. This is expected to improve larval development, leading to increased adult weight. Adult weight can therefore be used as an indicator of the quantity and quality of the available larval food resources. So far, only few studies have addressed the aspect of intraspecific variation of insect weight among populations in space and time. Additionally, little is known about the effect of rapidly changing environmental conditions on the weight of moths.
In this study, different forestry treatments were established on former forest sites in southwestern Brandenburg, which burned down three to five years ago. Among others, moths were selected as bioindicator and sampled on each site with standardized automatic light window traps from March to November 2021 and 2022. Fresh and dry weight of the three most common species (i.e. *Lomaspilis marginata* Linnaeus, 1758; *Euxoa tritici* Linnaeus, 1761; *Sphinx pinastri* Linnaeus, 1758) were measured. These three species have diverging caterpillar diets, i.e. pioneer tree species, herbaceous vegetation, and pine needles, respectively. As these differences in resource exploitation should be reflected in different fitness responses, we assess 1) whether different sites vary significantly in moth weight, 2) whether weight variation is related to larval food plant quantity and quality, and 3) whether weight is changing with time. Preliminary results are presented.

Cathrina Balthasar, Senckenberg German Entomological Institute, Müncheberg, Germany
cathrina.balthasar@senckenberg.de

Poster 16

Monitoring of stink bugs and their egg parasitoids in agroforestry ecosystems in South Tyrol

M. Falagiarda, F. Tortorici, S. Bortolini, M. Melchiori, M. Wolf & L. Tavella

During the last years there has been an increase in phytophagous stink bugs (Hemiptera: Pentatomidae), not only in cultivated areas, but also in urban areas. They are potential pests due to their polyphagy, feeding on cultivated, wild and ornamental plants. They are generally highly mobile and can show population outbreaks when the climatic conditions are particularly favorable. Moreover, the exotic species *Halyomorpha halys* has recently invaded several areas of northern Italy, including South Tyrol, making it difficult to control stink bug populations through traditional chemical and mechanical measures. Management strategies based on the use of biocontrol agents are thought to have a great potential, especially the introduction of *Trissolcus japonicus* (Hymenoptera: Scelionidae), an egg parasitoid of *H. halys* that is widespread in its native range. In South Tyrol, a highly mountainous region, rich in forests and where apple production covers the main valleys up to 1,100 m a.s.l., this antagonist was introduced in 2020 through a national biocontrol program. However, the effectiveness of natural parasitization might be influenced by several factors that need to be considered and understood. For this reason, an extensive monitoring program was carried out in 2022 in 27 sites, differing for habitat type and altitude range. Monitoring methods included collection of stink bug egg masses and recording of specimens through beating sheet and visual inspection. Surveys were repeated in each site once a month during the season, starting in April.
Almost 600 stink bugs were recorded through beating sheet and visual inspection, while 164 stink bug egg masses were collected during the surveys. Greater species diversity and abundance were found in forests and urban areas compared to fruit orchards, with up to 10 different stink bug species in one site. Overall, similar numbers of stink bugs were observed at different altitude ranges, but species abundance varied with both altitude and habitat type. The two predominant stink bug species found during the surveys were *Pentatoma rufipes* and *H. halys*. The first one was more present in urban areas and forests at higher altitudes, while the invasive species was more present in urban areas and orchards in the valleys, at lower altitude. Egg

masses were mostly found in urban areas, while only a few egg masses were collected in orchards. Eight different parasitoid species belonging to the families Scelionidae, Eupelmidae and Pteromalidae emerged from the collected stink bug eggs. Parasitization mainly occurred in forests and urban areas, where also stink bug abundance was greater.

Martina Falagiarda, Research Centre Laimburg, Trento, Italy
martina.falagiarda@laimburg.it

Poster 17

Critical thermal maximum of three life stages of the paper wasp *Polistes dominula* (Christ, 1791)

H. Käfer, H. Kovac, A. Amstrup &
A. Stabentheiner

Thermal limits are routinely used to define the boundaries of the viable thermal niche of ectothermic organisms. These data are used to infer the animals' biogeographic distribution and to create models for current and future dispersal under changing environmental conditions. *Polistes dominula* adults show activity (nest and brood care, foraging behavior) from 20°C up, and they strive to keep the maximum nest and therefore brood temperature below about 42°C.

Here we examined the critical thermal maximum (CT_{max}) of a *Polistes dominula* population in Gschwendt (Styria, Austria, Central Europe) at three stages of its life cycle, as (late) larva, pupa, and adult. CT_{max} was determined by means of respiratory measurement via the cessation of controlled respiration. For this purpose, single individuals were placed in a measuring chamber and their CO_2 emission measured via flow through respirometry while driving a temperature ramp from 25°C to 55°C at 0.25°C per minute. The respiratory CO_2 curves characteristic for this type of heat stress were evaluated for a cease in spiracular activity (the onset of respiratory failure) as a metric for CT_{max}.

Larvae, pupae, and adults displayed slightly different responses in their CO_2 release patterns during the experimental procedure, which is also known from other holometabolic insect species. While larvae and adults showed CO_2 spikes during controlled respiration and a pronounced post-mortal peak, pupae lacked these distinct patterns during the entire experiment, and also the post-mortal peak was not so clearly delimited from the previous respiratory events. However, the change in CO_2 release patterns, as a measure for the CT_{max}, was always detectable. Larvae had a higher CT_{max} at 48.8±0.8°C than pupae (47.5±0.6°C) and adults (47.4±1.1°C). A Kruskal-Wallis-test showed a significant effect of life stage on CT_{max} ($p<0.01$). A pairwise comparison with Bonferroni correction indicated a significant difference only between larvae and adults ($p<0.05$).

Adult *P. dominula* have a repertoire of behavioral measures to cope with high ambient temperatures, among which fanning, evaporative cooling with water droplets, and the relocation to an area with a more favorable temperature are most effective. Larvae and pupae lack these possibilities, they depend on the intervention of adults. The limited ability of the larvae to react to detrimental high temperatures, and their dependence on measures of the adults that may not always be timely or fully effective, could explain their increased heat tolerance. Our results show that changing environmental conditions with increased ambient temperature and extreme heat waves could be a challenge for the survival of these paper wasps.

Helmut Käfer, Institute of Biology, Graz, Austria
helmut.kaefer@uni-graz.at

Sektion Biologische Schädlingsbekämpfung / Section Biological Control

Poster 18

Dynamic interactions between trap crops and *Metarhizium brunneum* boost the control performance against a soil-dwelling insect pest

M. Brunner, C. Zeisler, D. Neu, C. Rotondo, O.R. Rubbmark, L. Reinbacher, G. Grabenweger & M. Traugott

Worldwide, soil-dwelling insect pests cause tremendous damage to a broad variety of crops. Their belowground lifestyle makes them durable by nature and protects them from control measurements. Wireworms, the larvae of click beetles (Coleoptera: Elateridae) are one of the most important soil pests in arable farming, because current control measures are insufficient. With our study we discovered a synergistic control mechanism of wireworms and their damage when entomopathogenic fungi (EPF) and trap crops were applied in combination. Entomopathogenic Fungi (EPF) such as *Metarhizium brunneum* are naturally living in soil and have been identified as promising biocontrol agents under laboratory conditions. Certain strains have already been shown to possess high pathogenicity against wireworms, but so far, their establishment and efficacy in the field has been limited by environmental conditions. To improve field efficacy, trap crops and the conidia of *M*. *brunneum* strain ART2825 were tested individually and in combination in a field experiment. Fungal colonized barley kernels (FCBK) were applied plane either in the preceding crop or directly before potato planting. A trap crops mixture was sown in strips on the slopes of potato ridges after planting. Effects on wireworm abundance, feeding preferences, potato damage and potato yield were investigated. Potato damage was significantly reduced by 33% and wireworm abundance by 250% when trap crops and EPF were combined. Since potato yield was not influenced, the combination of trap crops and EPF depicts a promising component for a sustainable and environmentally friendly control strategy of wireworms.

Michael Brunner, University of Innsbruck, Innsbruck, Austria
michael.h.brunner@uibk.ac.at

Poster 19

Compatibility of a micrococcinellid aphidophagous predador with current biocontrol agents in sweet pepper crops

F. Dorn, J. Pérez Rodríguez & G. Messelink

Aphids are one of the main primary pests in sweet pepper crops. Nowadays, its integrated pest management mostly relies on biological control strategies due to the emergence of aphid resistance to insecticides and the prioritization of sustainable strategies. The preventive approach of establishing natural enemies before the arrival of pests has become a key element to the success of biological control strategies. Currently, the biological control program of aphids in sweet pepper crops mainly relies on inundative releases of natural enemies such as *Aphidoletes aphidimyza* (Diptera: Cecidomyiidae) and parasitoids. These natural enemies cannot establish in the crop due to the lack of feeding on alternative food sources when aphids are absent. Furthermore, detrimental trophic interactions occur with other arthopods such as hyperpredation by the generalist phytoseiid mite *Amblyseius swirskii* (Acari: Phytoseiidae) on *A*. *aphidimyza* eggs or hyperparasitism on primary parasitoids. Therefore, new natural enemies are needed to create a more stable biological control system with a “standing army” to anticipate aphid outbreaks in sweet pepper crops. Recently, it had been shown that micrococcinellids belonging to the genus *Scymnus* are among the most efficient aphidophagous predators due to their less voracious feeding habits, long longevity, and ability to survive solely by feeding on floral resources. Here, we propose the aphidophagous micrococcinellid *Scymnus interruptus* (Coleoptera: Coccinellidae) as a novel candidate for preventive biological control on sweet pepper crops in greenhouse cultivation. Through 48h-predation laboratory trials and five-week-long cage trials under greenhouse conditions we evaluated the interactions and compatibility of *S*. *interruptus* in the existing biological control system of sweet pepper with *A*. *swirskii* and *A*. *aphidimyza*. The laboratory trials concluded that *A*. *swirskii* did not act as a predator of *S*. *interruptus* eggs. By contrast, when *A*. *aphidimyza* eggs were offered to *S*. *interruptus* adults, eggs were predated in the absence of aphids as extraguild prey. Our greenhouse trials showed that *S*. *interruptus* exerted an additive effect on aphid control when combined with *A*. *aphidimyza*. However, this additive effect was not found in the presence of *A*. *swirskii*, probably due to the hyperpredation of the phytoseiid on *A*. *aphidimyza*.

Our results demonstrate that *S*. *interruptus* may be employed in combination with the key aphidophagous predator *A*. *aphidimyza* in the presence of aphids in sweet pepper crops. Further research is being carried out on interspecific interactions of *S*. *interruptus* with other commonly employed biological control agents, potential for mass-rear, and establishment potential in the crop.

Fabio Dorn, Wageningen University & Research, Paderborn, Germany
fabio_nicolas.dorn@web.de

Poster 20

Phloem-based plant resistance to aphids: SLI1's involvement in wound responses

F. Dorn & K. Kloth

Phloem feeders, such as aphids, cause huge yield losses to crops worldwide and are challenging to control with conventional resistance breeding. SLI1, a phloem protein in *Arabidopsis*, is a promising candidate for breeding of broad-spectrum resistance to several aphid and whitefly species as it impairs phloem feeding. Wounding, either by mechanical forces, chewing insects, or plasma membrane disruption by aphids can result in the occlusion of the sieve tube and hamper the phloem sap flow. Three suggested modes of sieve tube occlusion are phloem protein (P-protein) agglomeration and dispersion, plastid burst, and callose deposition. Here, we aimed to investigate SLI1's involvement in sieve tube-related wound responses in Arabidopsis and the underlying mechanisms. For these purposes, plant-electrophysiological experiments and expression analyses on callose-related genes were performed on Col-0 and sli1-1 mutants of *Arabidopsis* plants. Firstly, the electrical penetration graph (EPG) recording of sieve element signals indicated that feeding aphids started to salivate longer into the phloem after a neighboring leaf was mechanically wounded. This showed that SLI1 might initiate systemic wound responses. Secondly, RT-qPCR analyses demonstrated that SLI1 expression might be related to plasmodesmata opening. Therefore, we assumed that SLI1 resistance is based on P-protein- and plasmodesmata-mediated defense responses which initiate rapid P-protein response within seconds and a long-term callose sealing lately within minutes. Finally, these results are aimed to help the establishment of SLI1 as an R gene for resistance breeding against phloem-feeding pests.

Fabio Dorn, Wageningen University & Research, Paderborn, Germany
fabio_nicolas.dorn@web.de

Poster 21

First experimental releases of parasitoids for biological control of the spotted wing *Drosophila* in protected berry cultures in Germany

J. Martin, A. Gnewuch, K. Pujner, A. Eben & A. Herz

The spotted wing *Drosophila* (*Drosophila suzukii* Matsumura, Diptera: Drosophilidae) is an invasive pest of stone fruits and berries and has often led to substantial economic loss since its first detection in Germany in 2011. Regulation of *D*. *suzukii* infestation is crucial for farmers, but the current options are narrow. Insecticides are frequently used but have limited efficacy due to the combination of the infestation of ripening fruits, long harvest periods, and negative effects through insecticide residues when applied close to harvest. Exclusion netting was tested successfully in previous projects, but in practice nets sometimes are opened or damaged which allows flies to enter the exclosures. Thus, it is useful to have an additional tool for pest control available. In its area of origin, *D*. *suzukii* is attacked by different larval and pupal parasitoids, such as the cosmopolitan pupal parasitoids *Trichopria drosophilae* Perkins (Hymenoptera: Diapriidae) and *Pachycrepoideus vindemiae* Rondani (Hymenoptera: Pteromalidae). Native populations of both species also parasitize this new host successfully in Germany and are currently explored as biological control agents.
To determine suitable conditions for their application against *D*. *suzukii* in net-protected berry cultures, parasitoids were released weekly in raspberry plantings at the experimental field of the Julius Kühn Institute (JKI) in Dossenheim. The plantings (20 m² each) were protected with a standard net (0.8x0.8 mm) and one additional control planting was left uncovered. At the beginning of the experiments, all plantings were artificially infested with *D*. *suzukii*. In 2021, one netted planting each was subject to weekly releases of five female *T*. *drosophilae*/m² or five *P*. *vindemiae*/m². One additional netted planting and the uncovered planting served as controls. In 2022, two netted plantings each were subject to weekly releases of one female *T*. *drosophilae*/m² or one *P*. *vindemiae*/m². The uncovered planting again served as control. To determine parasitism, fresh *D*. *suzukii*-pupae from laboratory rearing were weekly exposed to parasitoids in the plantings from August to mid-October. After exposure for five days, host pupae were collected and further incu-

bated in the laboratory to determine survival and parasitism rate.
In 2021, of the 6,400 exposed pupae, 4,272 were retrieved in the laboratory, from which 3,435 insects eclosed (2,508 *D*. *suzukii*, 401 *T*. *drosophilae*, 526 *P*. *vindemiae*). In 2022, 8,800 pupae were exposed to parasitoids in the plantings, but the eclosion rate of incubated pupae was much lower for all species. Parasitism rate in both years differed between pupae exposed at different heights in the culture: *T*. *drosophilae* mostly eclosed from pupae near ground level and *P*. *vindemiae* in the upper berry zone. In general, the level of parasitization observed was too low to control populations of *D*. *suzukii*, so further improvements in release strategies (rate of application, provision of food and shelter for parasitoids, timing) are needed and will be subject of subsequent trials.

The project is supported by funds of the Federal Ministry of Food and Agriculture (BMEL) based on a decision of the Parliament of the Federal Republic of Germany via the Federal Office for Agriculture and Food (BLE) under the innovation support programme (FKZ 2818805A19).

Jakob Martin, Julius Kühn Institute, Dossenheim, Germany
jakob.martin@julius-kuehn.de

Poster 22

Parasitoids as biological pest control agents in oak forests

M. Mayrhofer, T. Zankl, C. Schafellner & A. Schopf

In Central European forest ecosystems, drought-tolerant deciduous tree species such as oaks are becoming increasingly important to mitigate the negative impacts of climate change. However, the loss of oak leaf mass caused by insect pests may act as an additional stressor in these forests. In years with high population densities, early spring-feeding larvae of winter moths and leafrollers can cause complete defoliation of the trees. The rates of parasitism and predation are important factors that drive changes in the pest populations over time. The master thesis is part of a bilateral project on oak forest resilience between the University of Natural Resources and Life Sciences, Vienna (Austria) and the Center for Forest and Wood, North Rhine-Westphalia (Germany). The study explores the potential of natural enemies (especially parasitoids) to successfully downregulate population densities of winter moths (e.g., *Operophtera brumata*, *Erannis defoliaria*) and oak leafrollers (e.g., *Tortrix viridana*). In the years 2020 to 2022, the occurrence and abundance of parasitic wasps and parasitic flies (tachinids) were investigated from four oak stands in Münsterland (North Rhine-Westphalia) with different histories of insect outbreaks. To analyze the pupal parasitoids from moth caterpillars pupating in the soil, such as the winter moths, soil samples were taken in autumn and spring, the pupae were sorted out and stored until the moths or parasitoids emerged. To determine the pupal parasitoids of various tortricid moths, leaf rolls with the pupae inside were removed from the crowns and incubated until the insects emerged. Larval-pupal parasitoids, which parasitize host caterpillars but emerge only after the hosts have pupated, were collected from older larvae that drop to the ground to pupate in the soil. Both host and parasitoid species were determined morphologically using different identification keys; unidentifiable individuals were determined with the help of experts. In 2020, a total of 345 moth pupae and 126 parasitoid cocoons were collected from 40 soil samples, 10 each per oak stand. In 2021, the number was about twice as high with 663 moth pupae and 337 parasitoid cocoons. Overall, the parasitization rate of the pupae from the soil was just over 6%, with the parasitization rate in the stand with a low winter moth infestation being only 2% and 10% in the gradation area, respectively. The parasitization rates in the two stands with intermediate moth densities lay between these values. Leaf rolls collected in 2022 contained 880 *T*. *viridana* pupae, 177 of which were parasitized by the ichneumonid wasp *Itoplectis maculator* (Hym., Ichneumonidae). By far the most common parasitic wasp in all populations was the parasitic wasp *Ophion minutus* (Hym., Ichneumonidae), a nocturnal, larval endoparasitoid that develops in a variety of geometrids. The most common parasitic fly was the tachinid species *Cyzenis albicans* (Dip., Tachinidae), which develops in small winter moth caterpillars. In summary, the low parasitization rates of host pupae in all stands suggest that the parasitoids currently have little potential to regulate the oak pest community. Parasitoids with a narrow host range, such as *C*. *albicans* parasitizing *O*. *brumata*, are closely associated with their host's population densities and tend to be subject to high variability. Parasitoids with a broader host range, such as *O*. *minutus*, can switch to alternative hosts and are therefore present in higher densities even during the latency period of their main host. Overall, a crucial requirement for the promotion of parasitoids seems to be the presence of suitable habitats with a high diversity of flowering plants that provide food

and shelter for the adult wasps and allow the occurrence of alternative hosts.

Martin Mayrhofer, University of Natural Resources and Life Sciences, BOKU, Vienna, Austria
m.mayrhofer@boku.ac.at

Poster 23

Einsatz von LED-Fallen zur Thripsbekämpfung: Von verbessertem Monitoring zum Massenfang?

R. Meyhöfer & B. Grupe

Der Kalifornische Blütenthrips (*Frankliniella occidentalis* Pergande, Thysanoptera: Thripidae) spielt durch direkte (Silberschaden) und indirekte (Virusübertragung) Schäden weltweit eine bedeutsame Rolle als Schädling im Gemüse- und Zierpflanzenbau. Um diese Schäden zu vermeiden bzw. zu reduzieren, ist ein effektives und genaues Monitoring des Thrips unabdingbar. Dies wird in der Praxis standardmäßig durch den Einsatz von Gelb- oder Blautafeln versucht. Diese zeigen zwar häufig, wenn der Thrips im Gewächshaus vorhanden ist, lassen jedoch keine zuverlässigen Rückschlüsse auf die Thrips-Dichte im Pflanzenbestand zu. Die Thrips-Dichte im Pflanzenbestand ist allerdings für eine Bekämpfungsmaßnahme im Sinne des integrierten Pflanzenschutzes sowie aus ökonomischer Sicht des Anwenders von großer Bedeutung. Der zusätzliche Einsatz von schmalbandigen, blauen LEDs, die mit einer Blautafel kombiniert werden, bietet daher die Möglichkeit, das Thrips-Monitoring in diesem Punkt zu verbessern. Im Rahmen des BLE-Verbundvorhabens IPMaide, in dem eine Entscheidungshilfe für den integrierten Pflanzenschutz gegen Schadarthropoden in Gewächshauskulturen entwickelt wird, wird daher untersucht, ob durch den Einsatz attraktiver LED-Fallen im Gewächshaus zuverlässiger auf die Thrips-Population im Pflanzenbestand geschlossen werden kann als mit einer herkömmlichen Blautafel. Darüber hinaus wurde in einem Zeltversuch getestet, ob die Attraktivität der blauen LED-Falle durch eine schrittweise Erhöhung der Lichtintensität weiter gesteigert werden kann, um neben dem Monitoring auch als schädlingsreduzierende Maßnahme (Massenfang) eingesetzt werden zu können. Erste Versuche konnten zeigen, dass die LED-Falle im Pflanzenbestand nicht nur mindestens siebenmal mehr Thrips fing als die herkömmliche Blautafel, sondern mithilfe der LED-Falle auch eine zuverlässige Beziehung (R=0,74) zwischen gefangenen Thrips und den im Pflanzenbestand vorhandenen Thrips-Dichte hergestellt werden konnte. Des Weiteren zeigte der Zeltversuch, dass sich eine Erhöhung der Lichtintensität der LED-Falle nicht auf die Attraktivität der Falle gegenüber Thrips auswirkt.
Diese Ergebnisse können zukünftig dazu verwendet werden, über die Anzahl Thrips auf der LED-Falle die Thrips-Dichte im Pflanzenbestand zu schätzen und dadurch die Notwendigkeit einer Bekämpfungsmaßnahme gegen dieses Insekt zu prüfen. Darüber hinaus konnte gezeigt werden, dass signifikant mehr Thrips auf die LED-Falle als auf die Blautafel flogen, sodass dadurch ihre Anzahl mittels LED-Falle deutlich reduziert wurde. Dabei kann beim Einsatz der LED-Falle auf eine Erhöhung der Lichtintensität über ein gewisses Maß verzichtet werden. Die LED-Falle bietet ein großes Potenzial zur Reduzierung von Thrips im Gewächshaus, sollte zukünftig jedoch auch in der Praxis getestet werden, um mögliche Auswirkungen auf andere Schad- und Nutzarthropoden zu untersuchen. Außerdem könnte die Attraktivität der LED-Falle möglicherweise durch weitere Faktoren wie z.B. dem Kontrast zur Umgebung oder ihrer Form und Größe verbessert werden.

Rainer Meyhöfer, Leibniz University Hannover, Hannover, Germany
meyhoefer@ipp.uni-hannover.de

Poster 24

Prüfung von alternativen und natürlichen Stoffen für die Bekämpfung der Marmorierten Baumwanze *Halyomorpha halys*

M. Parth

Die marmorierte Baumwanze *Halyomorpha halys* (Stål, 1855) gilt als invasiver Schädling mit beträchtlichem Schadpotential. In Südtirol treten insbesondere im Apfelanbau regelmäßig Schäden durch diese Pentatomidenart auf. Am Versuchszentrum Laimburg wird daher an der Entwicklung und Prüfung von neuen bzw. alternativen Bekämpfungsmaßnahmen gearbeitet. Seit 2019 werden natürliche Substanzen und Biokontrollagenzien hinsichtlich ihrer Wirkeffizienz gegenüber verschiedenen Entwicklungsstadien der marmorierten Baumwanze geprüft. Die Untersuchungen fokussieren sich insbesondere auf den Einsatz entomopathogener Pilze und auf Stoffe, deren Wirkung auf einer Unterbindung der vertikalen Primär-Symbionten-Transmission über die Eioberfläche beruht. Ziel ist es Stoffe zu identifizieren und charakterisieren, die eine praxisrelevante Wirkung aufweisen und sich als möglicher Ersatz oder als Ergänzung von chemisch-synthetischen Insektiziden eignen. Vorrangig

untersucht werden Stoffe, die sich aufgrund unbedenklicher Eigenschaften explizit für die Nutzung im Bereich landwirtschaftlicher Grenzflächen und im Umfeld von sensiblen Zonen bzw. natürlichen Habitaten eignen.
Anhand eines umfangreichen Laborscreenings wurde die Wirkung verschiedener Stoffe auf Eigelege und Jungstadien der marmorierten Baumwanze überprüft. Beim Screeningverfahren werden Eigelege aus einer Laborzucht mit jeweils einer definierten Menge und Konzentration der Teststoffe besprüht und schließlich unter kontrollierten Bedingungen inkubiert bzw. gehalten. Nach der Applikation wird die Schlupfrate sowie die kumulative Mortalität im Verlauf der Entwicklung erhoben und mit einer H_2O-Kontrollvariante abgeglichen. Bei den Stoffen, die mittels diesem Labortestverfahren geprüft wurden, handelt es sich unter anderem um Pflanzenhilfsstoffe, Biokontrollagenzien (Mykopestizide, Bakterienpräparate), mineralische und biogene Feststoffe (Gesteinsmehle, Diatomeenerden), Grundstoffe, pflanzliche Extrakte sowie ausgewählte Dünge- bzw. Kupferpräparate.
Ausgewählte Stoffe, die im Laborscreening eine Kontrollwirkung zeigten, wurden schließlich einer weiteren Prüfung an Topfpflanzen unterzogen. Dabei wurden verschiedene, mit Eigelegen besetzte Obstgehölze (Pfirsch/ Weinrebe) unter Halbfreilandbedingungen mit den Testsubstanzen behandelt, um die Wirkung auf Eier und daraus schlüpfender Nymphen unter möglichst naturnahen Bedingungen zu erheben.
Bisher konnte bereits eine beachtliche Zahl von Agenzien unter Laborbedingungen an Baumwanzen getestet werden und damit erste Erkenntnisse zum Wirkpotential verschiedener Stoffgruppen gesammelt werden. Eine Wirksamkeit, welche es in weiterführenden und praxisnahen Versuchsanstellungen zu bestätigen gilt, zeigten verschiedene Diatomeenerde-Präparate sowie einige entomopathogene Pilze. Die Anwendung von Diatomeenerde führte in verschiedenen Versuchsansätzen zu einer Mortalitätssteigerung im Vergleich zu einer unbehandelten Kontrollvariante. Durch die Applikation von Diatomeenerde auf Eigelege ergab sich keine wesentliche Beeinträchtigung der Schlupfrate, allerdings manifestierte sich eine erhöhte Sterblichkeit unmittelbar nach dem Schlupf.

Martin Parth, Versuchszentrum Laimburg, Pfatten, Italien
martin.parth@laimburg.it

Poster 25

Increasing plant diversity in organic berry cropping systems for sustainable insect pest control

S. Wenz & A. Reineke

Organic berry production is following an increasing trend in the recent years. Their production is strongly influenced by a range of pathogens and insect pests such as spotted wing drosophila (SWD) *Drosophila suzukii* or the invasive brown marmorated stink bug (BMSB) *Halyomorpha halys*. Therefore, a successful implementation of biological control strategies is important to improve the resilience of berry crops. The aim is to enhance the functional insect biodiversity through increased plant diversity by using companion plants including flower strips to promote important antagonists as well as trap plants to attract and retain pest insects. In order to evaluate the benefit of an implementation of such approaches, classic methods to assess diversity and evenness of insect communities such as net sweeping or suction sampling will be used as well as marking respective insects with fluorescent pigments or foreign DNA e.g. from brine shrimp *Artemia* spp. Marking methods will also serve to better understand dispersal patterns of harmful and beneficial insect communities between crop and companion plants. Furthermore, trophic interactions between complex communities will vary spatially and temporally between habitats of different complexity as well as between predatory and prey insect species. Therefore, the investigation of gut contents of phytophagous or predatory insects will help to analyze those food webs in berry fields more precisely and at the same time provide further conclusions about the effectiveness of the companion plants. The project provides a holistic approach, not only focusing on one special pest insect, and will support recommendations for growers on practical implementation of respective plants in their cropping systems. Accordingly, dependency on external inputs such as plant protection products will be reduced while restoring biodiversity and therefore increasing sustainability.

Sophie Wenz, Hochschule Geisenheim University, Geisenheim, Germany
sophie.wenz@hs-gm.de

Poster 26

Pupal parasitoids of the European oak leafroller, *Tortrix viridana* L. (Lep., Tortricidae), in an outbreak population in Central Hungary

T. Zankl, M. Mayrhofer, C. Schafellner & A. Schopf

Larvae of the European oak leafroller, *Tortrix viridana* (Lep., Tortricidae), can cause significant damage to oak forests in large parts of Europe. As with other forest pests, populations of *T. viridana* typically show large fluctuations in their population density. Natural enemies have an important regulatory impact on these population dynamics. For *T. viridana*, pupal parasitoids play a key role among natural enemies. They comprise the vast majority of the parasitoid species found in populations of *T. viridana*, especially at high host densities.

In May 2022, we observed an outbreak of *T. viridana* in an oak forest near Szolnok in Central Hungary. We collected 1,670 *T. viridana* pupae on May 17, 2022 to determine the parasitization rates and the parasitoid species emerging from the pupae. The pupae were stored at 25°C under long day photoperiods (16 hrs light, 8 hrs dark) and checked daily for emerging parasitoids. The parasitoids were determined morphologically with different identification keys.

Adult moths of *T. viridana* eclosed from 54% of the pupae, parasitoids emerged from 32% and 14% of the pupae did not eclose to adults. The latter may be caused by the host-feeding activity of adult parasitoid wasps, but can also have other reasons. A total of five parasitoid species emerged from the collected pupae. While parasitic flies (Tachinidae) were observed only sporadically, parasitic wasps clearly dominated. Two-thirds of the parasitization was caused by the pimpline wasp *Itoplectis maculator* (Hym., Ichneumonidae), which emerged from 21% of all pupae. Another 2% of the pupae were parasitized by two other members of the subfamily Pimplinae, *Apechthis quadridentata* and *Apechthis rufata* (Hym., Ichneumonidae). The chalcid wasp *Brachymeria tibialis* (Hym., Chalcididae) emerged from 8% of all pupae, which corresponds to 25% of the total parasitization.

Thomas Zankl, University of Natural Resources and Life Sciences, Vienna, Austria
thomas.zankl@boku.ac.at

Sektion Schädlingsbekämpfung im Pflanzen- und Vorratsschutz / Section Insect Control in Plants and Stored Products

Poster 27

The comparison of two different yeasts in an attract-and-kill approach against *Drosophila suzukii* in cherries

M. Bjeljac, A. Sergio & S. Schmidt

Since its first appearance, the invasive insect pest *Drosophila suzukii* is causing severe losses, particularly in stone and soft fruit production. Increased use of insecticides to control *D. suzukii* increased pesticide residues in fruits. Therefore, pest management requires new, more sustainable and eco-friendly control strategies. Yeasts, as an important part of *D. suzukii* nutrition, were known to be a feeding stimulant and attractant. An innovative strategy is the use of yeasts in combination with insecticides to attract *D. suzukii*.
In the present study, we investigated two yeast-based formulations as an attract-and-kill strategy to control *D. suzukii* in sweet cherries. The first formulation was based on the yeast *Hanseniaspora uvarum*, which is known to be suitable as a component of attract-and-kill strategies. The second formulation was based on the yeast *Saccharomycopsis vini*, which has never been tested in attract-and-kill strategies against *D. suzukii*. Both formulations were combined with the insecticide spinosad. The goal was to compare the two yeast formulations based on two different yeast strains, *H. uvarum* and *S. vini*.
The treatments were carried out twice throughout the season using a knapsack sprayer. A band of 80 cm on the canopy at a height of 1 m from the ground was treated with a yeast-based formulation. Analysis of the oviposition rate on sampled cherry fruits showed a lower rate of *D. suzukii* in all treated plots in comparison to the untreated control. There was no significant difference in the performance of the conventional spinosad treatment compared to the yeast-based formulation treatments. Both formulations performed similarly. These results imply that both yeast-based formulations could provide an effective and environmentally friendly approach to cherry production. Further studies are going on to characterize the strain-specific properties.

Marko Bjeljac, Free University of Bozen-Bolzano, Bolzano, Italy
mbjeljac@unibz.it

Poster 28

Creating a universal method for separating male and female insects in pest control programs using the Sterile Insect Technique (SIT)

C. Borghesi, R.A. Aumann, L. Prates & M.F. Schetelig

The Sterile Insect Technique (SIT) is a widely used area-wide pest control strategy that involves releasing sterile males to mate with wild-type females, interrupting the reproductive cycle and suppressing an invasive pest population. This non-polluting, species-specific approach is considered one of the most environmentally-friendly methods for pest control. Essential to the success of SIT programs are the efficient mass rearing of insects, the separation of males and females (also known as sexing), and the sterilization of insects before release. The SIT program for the Mediterranean fruit fly (*Ceratitis capitata* or medfly) has become a role model for other programs due to the development and optimization of genetic sexing strains (GSS) over the past three decades. These GSS allow for the generation of male-only populations through a selectable marker, either the phenotypic marker "white pupae" or the temperature-sensitive lethal (tsl) mutation. Female medflies emerge from white pupae and are sensitive to high temperatures, while males have a wild-type brown pupae phenotype due to a rescue allele linked to the Y chromosome. This allows for sexing through pupal color. A heat shock of GSS embryos leads to female lethality, resulting in the hatching of only male individuals due to a wild-type rescue allele linked to the Y chromosome. In the medfly GSS, heat shock creates a male-only population, and pupal color is a quality control parameter during the pupal stage. While the phenotypes of the medfly GSS are well-known, the genetic background and underlying mechanisms still need to be fully understood. Our recent research has made significant progress in understanding the wp gene responsible for the white pupae phenotype in *Ceratitis capitata* and other Tephritid flies. The current goal is to test the potential for creating a genetic sexing system based on the selectable marker wp by adding rescue alleles to the Y chromosome in different ways, to establish a generic strategy for generating sexing strains in multiple pest species in the future.

Cristina Borghesi, Justus Liebig University, Gießen, Germany
cristina.borghesi@ib.uni-giessen.de

Poster 29

Geomaterial applications on pear crop to control *Halyomorpha halys* damage in northern Italy

M. Preti, L. Fagioli, M. Capriotti, M. Coltorti, M.G. Tommasini & A. Pozzebon

Halyomorpha halys (Hemiptera: Pentatomidae), known also as brown marmorated stink bug, is nowadays one of the main key pests in tree fruit crops in several countries, including Italy. Specifically in Emilia-Romagna region (northern Italy), one of the most damaged crop is pear (*Pyrus communis*), where the fruit injury can reach levels that prejudice the entire orchard yield. The use of geomaterials such as kaolin clays has been investigated for several insect pests, including *H*. *halys*. Specifically, kaolin has been tested in combination with pyrethrin affecting the *H*. *halys* mortality and mobility and has been evaluated in field condition to protect fruiting vegetables from *H*. *halys* injuries, specifically in organic fields. This study collects several field investigations carried out during 2020–2021 in Emilia-Romagna to evaluate the effect of geomaterial sprays on the fruit injury reduction in pear crop. Both small-plot and big-plot trials were realized in pear orchards cultivar Bartlett, either for fresh consumption or for processing. Several geomaterials have been investigated within this study, including two types of kaolin clays, three types of zeolites, a volcanic dust and a talcum based-products. Repeated sprays were carried out across the season from fruit set until harvest, testing the products straight or combining them within strategies, with a spray interval of 7–10 days. In each trial, both the control blocks (unsprayed with geomaterials) and the treated blocks (sprayed with geomaterials) were equally managed by the growers with the same standard spray program, either conventional or organic. Fruit damage assessments were carried out during the season, at harvest and post-harvest, recording the level of *H*. *halys* damage incidence (percentage of injured/deformed fruits) and in some trials, the level of *H*. *halys* damage severity (number of stings per fruit, after cold storage of 6–8 weeks, peeling the fruits). The most relevant results of the geomaterial study on pear crop are reported in this contribution.

Michele Preti, ASTRA Innovazione e Sviluppo Test Facility, Faenza (RA), Italy
michele.preti@astrainnovazione.it

Poster 30

Selektive Detektionswahrscheinlichkeit häufiger Vorratsschädlinge mit dem „Beetle Sound Tube“

M. Schöller, C. Müller-Blenkle, S. Prozell, I. Szallies & C. Adler

Im Sommer 2018 wurden die ersten Versuche im Rahmen des Projektes „Beetle Sound Tube“ zur akustischen Früherkennung vorratsschädlicher Insekten durchgeführt. Dazu wurden drei 3 m lange Edelstahlröhren in ein Silo eingebracht. Die Hauptaufgabe der mit Mikrofonen ausgestatteten Röhren war es, den Bereich, in dem Insektengeräusche gehört werden können, durch Oberflächenvergrößerung zu erweitern. Durch zahlreiche Perforationen haben diese Röhren zusätzlich eine Fallenfunktion, Insekten fielen durch die Röhre und konnten in einem Auffangbehälter am unteren Ende der Röhre eingesammelt werden.

Die Probennahmen erfolgten 2018 über einen Zeitraum von drei Monaten und der Falleninhalt bestand im Wesentlichen aus sechs Käferarten, die 96% der Funde ausmachten. Andere Käfer machten nur 0,2% aus, der Rest bestand aus noch unbestimmten Käferlarven. *Tribolium* spp. (zusammengefasst *T*. *confusum* und *T*. *castaneum*) waren mit etwa 35% aller gefundenen Individuen am häufigsten, gefolgt von *Oryzaephilus surinamensis* (27%), *Sitophilus oryzae* (15%), *Cryptolestes* sp. (11%) und *Rhyzopertha dominica* (8%). Primärschädlinge wie *S*. *oryzae* und *R*. d*ominica* sind die Wegbereiter für sekundäre Schädlingsarten. Sie sind in der Lage unbeschädigte Getreidekörner anzufressen, und sie legen ihre Eier in die Körner, in denen sich die Larven entwickeln und auch verpuppen. Die durch Primärschädlinge beschädigten Körner ermöglichen erst die Entwicklung der sekundären Schädlinge. Daher war zu Beginn des Befalls ein höherer Anteil von primären Schädlingen in den Fallen erwartet worden.

In Laborversuchen wurde untersucht, ob die Arten gleich häufig in die Falle gehen und somit aus der Anzahl gefangener Individuen auf die anteilsmäßige Zusammensetzung der Käferarten im Getreide außerhalb der Falle geschlossen werden kann. Dazu wurden je 100 Exemplare der häufigen Arten in einen mit 17 kg Weizen gefüllten Zylinder mit "Beetle Sound Tube"-Falle gebracht und über einen Zeitraum von jeweils einem Monat die Anzahl der Käfer pro Art in der Falle über die Zeit ausgewertet.

Dabei zeigten sich deutliche Unterschiede zwischen den verschiedenen Arten. Besonders auffällig war der sehr geringe Anteil

der wiedergefangenen Primärschädlinge *R. dominica* (5%) und *S. oryzae* (6%). Mögliche Ursachen für die geringe Anzahl der beiden Arten in den Fallen könnte eine geringere Aktivität der Arten sein, oder diese Arten können sich gut an der Innenwand halten wenn sie in die perforierte Röhre klettern und durch das nächste Loch in der Röhre wieder ins Getreide zurücklaufen. Von den *Tribolium*-Arten hingegen gingen durchschnittlich 71% bzw. 92% in die Falle, von diesen Arten ist bekannt, dass sie sich an senkrechten glatten Flächen schlecht halten können (Cline and Highland, 1976).

Die Laborergebnisse zeigen, dass der Anteil der Primärschädlinge im Silo deutlich höher anzunehmen ist und die zahlenmäßigen Fallenfunde um die selektive Detektionswahrscheinlichkeit korrigiert werden müssen.

Cline, L.D. & Highland, H.A. (1976): Clinging and climbing ability of adults of several stored-product beetles on flexible packaging materials. Journal of Economic Entomology 69, 709–710

Matthias Schöller, Biologische Beratung GmbH, Berlin, Deutschland
bip@biologische-beratung.de

Sektion Wald-/Forstentomologie / Section Forest Entomology

Poster 31

The influence of warmer autumn temperatures on diapause induction in *Ips typographus*

B. Budin, A. Schopf & M. Schebeck

Bark beetles are key forest pests and *Ips typographus* is one of the most destructive species in spruce-dominated forests. Climate change will have a profound impact on population outbreaks of *I. typographus*. Warmer spring and autumn conditions will prolong the breeding season for the beetle, which leads to alterations in voltinism patterns. In recent years, a change from one or two generations per year to two or three generations has been observed. In general, higher temperatures, particularly warmer fall conditions, extend the favourable season. Diapause of *I. typographus* has direct effects on voltinism. Warmer autumns postpone the induction of diapause in *I. typographus*. In Central Europe diapause is induced when the photoperiod (daylength) drops below ~15 hours, which occurs at the end of August. However, higher temperatures counteract the effect of photoperiod on diapause induction, thus postponing the onset of this dormant stage.
This project aims to investigate diapause induction and voltinism of *I. typographus* under warmer autumn conditions. Firstly, this will be done by breeding bark beetles at different temperatures and photoperiods under controlled conditions, and subsequent evaluation of diapause expression. Secondly, detailed analyses on diapause development will be performed, by applying various experimental approaches, to get a comprehensive understanding on the regulation of this alternative developmental pathway. Lastly, an optimum breeding season will be simulated to assess the species' maximum voltinism potential. These experiments will add to the further understanding how climate change affects bark beetles and consequently future forestry.

Bernhard Budin, BOKU, Pfaffstätten, Austria
bernhard.budin@boku.ac.at

Poster 32

Olfactory and behavioural responses of the bark beetle *Ips typographus* to isophorones–insights into a complex olfactory system and new opportunities for bark beetle control?

G. Holighaus, K. Balakrishnan, C. Rachow, H. Löcken, T. Frühbrodt & T. Burzlaff

The discovery of bark beetle pheromones almost 60 years ago lead to an optimistic mood among applied researchers to soon manage these forest pests efficiently without the use of pesticides. Lures containing aggregation pheromones as attractants captured the market, but applications that effectively hamper bark beetle outbreaks are challenging and resource intensive. Recently, declining numbers of certified pesticides during years of escalating bark beetle outbreaks due to climate warming bring foresters in an awkward predicament and call for new actions. Also, looking back is worth trying. Repellent pheromone components have been discovered as early as attractants–but still have not been successfully implemented in integrated pest management (IPM) strategies.
Rather by accident we discovered, and now present two novel volatile chemicals – isophorones–that impact the European Bark Beetle *Ips typographus* on olfactory and behavioural level in the laboratory as well as in the field. Their chemical core structure is quite similar to well-known anti-aggregation pheromone components in primary colonizing bark beetle species and with antennal recordings we could demonstrate an equivalent high sensitivity of the beetle olfactory system. α-Isophorone evokes a repellent behaviour similar as verbenone which is the most promising repellant within the "anti-aggregation-pheromone" context that is under evaluation with regard to its pheromone classification and potential of application in IPM systems (see talk and poster of the project VerbIPS). However, in comparison to the expensive fine chemical verbenone, α-isophorone is produced industrially on a large scale as a polymer precursor, and is thus very cheap and might help to develop a more marketable product.
Our results are not only of interest for application. The recent discovery of an olfactory neuron class (ORN) in Ips typographus that shares verbenone and α-isophorone as best ligands (Kandasamy et al. 2021) corroborates our findings. It is surprising in this respect that the second compound dihydroisophorone–although of high structural similarity–evoked the opposite behaviour in laboratory assays

and attracts the beetles. This might point to a further ORN, not yet discovered. Either way, the olfactory system of *I*. *typographus* and other primary bark beetles are highly evolved with outstanding discriminative capabilities among structurally similar volatile components. These include not only pheromones, but also host volatiles such as terpene resins from where these pheromones derive, as well as microbial volatiles–their roles in bark beetle chemical ecology and behaviour are hardly explored. After 60 years of bark beetle pheromone research we should not resign, but benefit from new discoveries such as the fully annotated *I*. *typographus* genome (Powell et al. 2021) or novel insights into its biology that help to understand mechanisms of mass outbreaks of bark beetles from which European spruce forests suffer so much these days.

Kandasamy, D., et al. (2021): Bark beetles locate fungal symbionts by detecting volatile fungal metabolites of host tree resin monoterpenes. bioRxiv. DOI: 10.1101/2021.07.03.450988

Powell, D., et al. (2021): A highly-contiguous genome assembly of the Eurasian spruce bark beetle, *Ips typographus*, provides insight into a major forest pest. Communications biology, 4(1), 1–9.

Gerrit Holighaus, Nordwestdeutsche Forstliche Versuchsanstalt, Göttingen, Germany
gerrit.holighaus@nw-fva.de

Poster 33

On the importance of site effects in ecological field studies–Where you stand is who you are

H. Löcken

In conducting ecological field studies, we are confronted with numerous complex interactions of various parameters that we cannot control. In order to remove the "noise" resulting from these interactions from our data and to determine the effects of the treatments under study, well-considered study designs and the inclusion of adequate co-factors are essential. Some of these parameters, which can have a large impact on our data, can be summarised as site factors. In order to take into account the effect of site factors, different techniques such as randomised complete block designs or rotating systems are used in data collection, depending on the research question and the respective biology. Here, we would like to show how large the effect of these site factors can be on our data, even at relatively high spatial resolution, using data we collected in 2022 in a field experiment on an anti-aggregation pheromone of the European spruce bark beetle (*Ips typographus*). To determine the effectiveness of the anti-aggregation pheromone verbenone, four replicates each of four application rates were tested in a rotating system for their potential to mask baited traps. The resulting data were used to train a model that takes into account the location factor as a random effect. This model was then used to generate multiple data sets assuming a random distribution of treatments without a rotating system. The resulting data show impressively how difficult it is to interpret the data correctly when essential influencing factors are not properly taken into account due to a poor experimental design.

Helge Löcken, University of Freiburg, Stegen, Germany
Helge.Loecken@forento.uni-freiburg.de

Poster 34

DECIDE for prophylactic forest protection adapted to a changing climate

S. Netherer, F. Knufinke, B, Mattsson & U. Nopp-Mayr

The maintenance of vital forests and important services these ecosystems provide in montane environments is threatened by changes in climate regimes and diverse abiotic and biotic disturbance factors. Forest management strategies aiming at the preservation and promotion of resilient forests and the reduction of damage risks are therefore essential, but often prevented by lacking knowledge about the main factors driving forest vulnerabilities. The Austrian DECIDE project focuses on the development and testing of a decision-support tool to inform stakeholders in forestry about site and stand related susceptibilities to major abiotic disturbance agents (storm, snow, fire), potentially damaging bark beetles, ungulate impacts (peeling of forest trees by red deer, browsing by ruminant ungulates), and wood decaying fungi for conifer-dominated forests (Norway spruce, European larch, European silver fir, and pine species). Existing and new predisposition assessment systems (PAS) are used for modelling and predicting damage susceptibilities of forests in the Austrian model regions of Styria and Lower Austria. DECIDE aims to provide a comprehensible visualization of adaptive capacities for sustainable and preventive forest management within a practical application of the decision-support tool that takes these vulnerabilities and options for action into account.

Sigrid Netherer, University of Natural Resources and Life Sciences, BOKU, Vienna, Austria
sigrid.netherer@boku.ac.at

Poster 35

Temperature-dependent development and host tree preference of the pine bark beetle *Ips acuminatus*

E. Papek, T. Kirisits, A. Schopf, E. Ritzer, P. Baier & M. Schebeck

Bark beetles are among the most destructive forest pests worldwide. Climate change increases the predisposition of coniferous forests to bark beetle infestations. The effects of rising temperatures, unfavourable precipitation patterns and extreme weather events (e.g. droughts, snow breaks, storms) on bark beetle outbreaks have been observed worldwide and will become even more important in the future. Recently, there have been increasing infestations of living pine trees by the pine bark beetle *Ips acuminatus* in Central Europe.

Pines (*Pinus* spp.) are of great relevance in European forests (mostly *Pinus sylvestris* and *Pinus nigra*). In addition, *I*. *acuminatus* can utilize Douglas fir (*Pseudotsuga menziesii*) as a host, a promising tree species for forestry because it is more drought-tolerant than Norway spruce. Knowledge on *I*. *acuminatus* biology, ecology and damage potential is scarce; however, this information is the basis for effective forest protection measures and the prevention of outbreaks.

As *I*. *acuminatus* is ectothermic, many parts of the life cycle (e.g., development and reproduction) are dependent on ambient temperature. One purpose of this project is to determine its upper and lower developmental thresholds and its optimum temperature for development, by performing experiments in climatic cabinets at constant temperatures. By applying linear and non-linear models the duration of generation development, voltinism and phenological patterns of *I*. *acuminatus* can be determined. The other goal of the project is to evaluate the suitability of *P*. *menziesii* as host tree for *I*. *acuminatus* in comparison to *P*. *sylvestris* and *P*. *nigra*.

This project will provide basic data on the biology of *I*. *acuminatus*, which can be used to predict infestations and to control mass outbreaks. This will contribute to an efficient management of *I*. *acuminatus*, which will be of great relevance for European forestry.

Eva Papek, University of Natural Resources and Life Sciences, BOKU, Vienna, Austria
eva.papek@boku.ac.at

Poster 36

Ips acuminatus and its fungal associates with particular emphasis on ophiostomatoid species

E. Ritzer, M. Schebeck & T. Kirisits

Bark beetles are associated with numerous microbial symbionts, e.g., ophiostomatoid fungi. After bark beetle infestation, they grow in the galleries and into the sapwood and cause blue-staining in these tissues. Both partners benefit from this interaction. The fungi deplete the trees' defense and provide supplementary nutrition for the beetles (ambrosia fungi). Inside the galleries, they find a protected environment with a special microhabitat that favors fungal growth. Furthermore, the fungi are transmitted to new habitats by the beetles.

Recently, outbreaks of the pine bark beetle *Ips acuminatus* have been observed in Europe. The females carry a mycetangia, which enables the beetles to transmit beneficial fungi to new habitats. The mycetangia are pairs of invaginations located close to the mandibles. Inside they secrete substances favorable for the most important fungal symbionts. Such organs originated in different bark and woodboring beetles. Previous studies have shown that *I*. *acuminatus* is closely associated with a specific ambrosia fungus (*Ophiostoma macrosporum*). It also transmits several other fungi that may be pathogenic to the host trees and also cause blue-staining of sapwood. Few studies were done all over Europe to determine the fungal community of *I*. *acuminatus*. The composition and frequency of the fungi vary significantly across the continent. In this study, we want to compare the Austrian community with the rest of Europe. Also, the role of the ophiostomatoid fungi in killing the tree remains unclear. As *I*. *acuminatus* also infests Douglas fir and different pine species, we want to test if there are differences among the different tree species. We also want to test the aggressiveness of the most frequent fungi on the various hosts. Another experiment aims to test if beetles prefer certain fungi over others and if they selectively choose beneficial fungi.

Elisabeth Ritzer, University of Natural Resources and Life Sciences, BOKU, Vienna, Austria
elisabeth.ritzer@boku.ac.at

Sektion Insekten-Mikroorganismen Interaktionen / Section Insect-Microorganism Interactions

Poster 37

Transcriptomic responses reveal putative reciprocal adaptations in a non-parasitic insect-fungus antagonism

Z. Abbas, E. Bastakis & M. Rohlfs

Microorganisms engage in numerous beneficial and antagonistic interactions with animals. The net outcomes of these interactions may cascade through species communities and thus influence ecosystem functioning. Changes in species abundance and distribution are the most obvious consequences of animal-microorganism interactions. Additionally, individuals and populations may change their phenotypes in response to animals or microorganisms, respectively. Microorganisms change growth and produce virulence or other factors that allow them to invade an animal host or persist in the presence of animal competitors or predators. Animals in turn launch cellular and humoral immune responses to control microbial pathogens or activate detoxification and excretion pathways that reduce exposure to harmful microbial metabolites. Such altered metabolic and morphological phenotypes manifest via physiological processes regulated by changes in gene expression. Generally, the ability to adjust phenotypes is a naturally selected adaptation that ensures survival and reproduction in non-neutral interspecific interactions.
Fungi are ubiquitous in almost all terrestrial and aquatic habitats and thus share their habitats with multiple animals. As fungi are rich in several essential amino acids, vitamins, etc. they often face attack by animal predators. Their ability to synthesize an extremely rich repertoire of secondary metabolites may serve as an efficient means to fend off predators. Secondary metabolite formation requires energy and the directed allocation of precursor molecules, e.g. acetyl or proteinogenic amino acids. Given these putative costs of synthesising anti-predator metabolites, recent research has asked whether fungi are capable of induced chemical defenses in response to the presence of invertebrate antagonists. Although there is growing evidence that fungi are indeed able to change their chemical and morphological phenotype when attacked, we still barely understand the specificity of these responses, the associated costs, and the (inducible) counter-adaptations of animals. The latter is of particular interest because the mechanisms used to “manage“ fungal growth or deal with their defences may pave the way for antagonistic or mutualistic co-evolution between animals and fungi.
To close this gap in knowledge on the complex phenotypic dynamics in animal-fungus interactions we conducted microcosm experiments in which we confronted *Drosophila melanogaster* fruit fly larvae with the globally distributed and fruit-inhabiting filamentous fungus *Penicillium expansum* in a semi-natural fruit (apple) environment. We ran genome-wide transcriptome analyses on both fungal colonies and the insects interacting with them. The overall goal was to enumerate and identify insect and fungal genes and functional gene networks that exhibit plastic responses in this insect-fungus interaction. We hypothesised that insect-induced changes in fungal gene expression can be related to certain classes of regulatory and biosynthetic genes involved in the formation of secondary metabolites, growth and the repair of hyphae. Specifically, we expected to observe differential regulation of secondary metabolites gene clusters, which may provide a first glimpse of how specific putative anti-predator chemical defence responses are in a globally distributed *Penicillium*. From the insect perspective, we hypothesised that *Drosophila* larvae exhibited changes in expression of genes related to detoxification processes that would allow insects to thrive in the presence of an altered induced mix of fungal secondary metabolites. Moreover, we tested whether signatures of transcriptomic changes in the larval stage can still be observed in adult flies after metamorphosis. In addition to novel insights into the immediate phenotypic reactions as factors influencing ecological processes, our work may shed light on putative mechanisms that exert reciprocal selection pressure and thus affect trait evolution in animal-fungus interactions.

Zaheer Abbas, University of Göttingen, Göttingen, Germany
z.abbas@outlook.com

Poster 38

Crossing the red line: A broken symbiosis can compromise generalist fruit fly’s ecological niche

A. Evlanova & M. Rohlfs

Fruit flies (*Drosophila*) are well adapted to thrive in rotting nutrient-poor substrates. In nature, the main challenge for developing larvae is to ingest enough food to grow into the adult stage before the resource is exploit-

ed. Bacteria, yeast, and fungi, residing in the breeding substrate, can have a deleterious effect on larval development by producing pathogens or competing for the same food source. However, *Drosophila* has the upper hand in this challenge: during egg-laying females pass down to their offspring their own microbial symbionts, which improve the environment by synthesizing nutrients and keeping pathogens in check. This symbiotic relationship can be the “key combination” to success allowing fruit flies spread across many environmental niches. In this context, a common laboratory practice of keeping fruit flies on a standardized diet with high protein content and added anti-microbial agents can hardly reflect the realistic scenario in natural substrates. While microbial communities largely depend on the properties of the substrate (pH, sugar content), it is also hard to disentangle one from another in their effect on *Drosophila* life-history parameters. In our laboratory, we have successfully maintained fruit flies for many generations on a variety of fruit and vegetable substrates in presence of wild-harvested microbial communities. In a series of experiments, we followed the development of *Drosophila* for three generations in natural substrate types with distinct sugar and pH levels, accommodating growth of different microbial communities. Our (preliminary) observations show that *Drosophila melanogaster*, a generalist species, can be pushed to the border of its ecological niche when facing “unsuccessful” microbial composition, resulting in a population crash after only a few generations. By considering the environmental properties at the niche border and comparing microbial communities of “beneficial” and “non-beneficial” substrates, we can have a glimpse into the ecologically relevant scenario of interaction between *Drosophila* and its microbial symbionts. Additionally, *D*. *melanogaster*, much like other fruit fly species, relies on the functions its microbial symbionts provide in their shared environment, rather than on specific taxa. Understanding a pattern in those functions would be a big step for manipulative microbial studies as an alternative to mono-associated fly cultures. With our approach, we argue that from an ecological perspective, *D*. *melanogaster* can yet provide valuable insights into both microbial and host-microbe interactions.

Anna Evlanova, University of Bremen, Bremen, Germany
evlanov@uni-bremen.de

Poster 39

Do *Drosophila* fruit flies form species-specific associations with microorganisms?

S. Krüger & M. Rohlfs

The aggregation model of species coexistence states that independent intraspecific aggregation across fragmented resources mediates coexistence of different species in a shared ecological niche. The model has proven successful to explain coexistence of different *Drosophila* species using the same breeding substrate. However, one main driver in this system has thus far been ignored, namely the potentially species-specific microbiota the insect are associated with in their breeding substrate. During oviposition *Drosophila* females transfer microbes to the egg-laying site by depositing faecal material that contains numerous bacterial and fungal cells. The microbial community composition the females transfer differs depending on the substrate the egg-laying female developed on as larva and has an impact on the developmental success of her own offspring in the new habitat. Different microbial community compositions lead to different development success of the flies’ offspring. It has remained unknown if the microbial communities transmitted by the flies differ in their compositions species specifically. Here, we hypothesize that during their life cycle *Drosophila* fruit flies form species-specific associations with bacterial and fungal microorganisms, which benefit their own but not the development of other species. In other words, in a given plant substrate individuals of each species create their own species-specific microbial niche that is optimal for themselves. If this hypothesis turns out to be an explanation for why fruit flies form intraspecific aggregations, this would speak strongly against the mechanisms proposed by the aggregation model of species coexistence. A novel aspect of our experimental approach is that flies and their microbiota are maintained on different types of fruits which represent a variety of breeding habitats the flies encounter in the field, rather than using nutritious standardized culture medium that does not require the association with dietary or otherwise functional symbionts. In the poster, we will outline the overall setup of the experiment and the specific hypotheses that will be tested to challenge the aggregation model of species coexistence.

Sandra Krüger, University of Bremen, Bremen, Germany
krueger2@uni-bremen.de

Poster 40
Microbiota-by-environment interactions in *Drosophila melanogaster* development

E. Riedel, L. Lender, M. Pollierer & M. Rohlfs

Host-associated microbes (microbiota) and fruit fly host (*Drosophila melanogaster*) are not as highly specialized as other, often eusocial, insect-microbiota partners like bees or termites and their microbiota. In the field, adult fruit flies as well as fly larvae are expected to use (and are often found on) rotting fruit and vegetables as well as other plant material. The larvae rely greatly on microorganisms to fuel the breakdown of the plant tissue and as a resource of its own. Fruit flies may use a plethora of substrates depending on the environmental availability. Their microbiota is influenced by substrate type and colonization may partly be opportunistic. Faecal droplets left by adult flies on the eggs and the oviposition sites serve as microbial primer. Thus, maternally transmitted microbiota may be key to what is called the “generalist” lifestyle of fruit flies and determine the breeding niche. We hypothesized maternal microbiota mismatching with the substrate type of oviposition sites could lead to impaired development of fly offspring. Lab cultures of fruit flies were established from field-exposed plant material and associated microbes. In these microcosms, the flies and the field-acquired microbiota could interact on a given substrate type (e.g. apple or tomato). Faecal droplets of female flies from these microcosms were used to harvest microbiota for experiments. Using an independent fly culture to avoid preadaptation, we tested how matching and mismatching substrate-microbiota combinations would influence fly larval development based on time needed for development and weight gain by one single larvae per experimental unit. A reciprocal inoculation design between the different substrates allowed us to see differences in these fitness indicator traits, concluding that from the fly’s perspective, the microbiota–while universally helpful–lead to gross fitness differences when placed in the wrong environment. Using marker genes for both fungal and bacterial microbes in parallel in a high-resolution metabarcoding study we found differences in diversity down to the strain level between fly microbiota based on the substrate the flies were isolated from. A compound-specific isotopic analysis (CSIA) showed differential incorporation of amino acids during fly development. In conclusion, substrate type-dependent microbiota-dynamics influence the fitness of developing flies which respond by flexibly using sources of amino acids.

Elisabeth Riedel, University of Bremen, Bremen, Germany
eriedel@uni-bremen.de

Poster 41
Impact of climate change on the *Bemisia tabaci* transmitted virus ToLCNDV

M. Ripamonti, M. Eickermann & J. Junk

Whiteflies of the complex *Bemisia tabaci* (Hemiptera: Aleyrodidae) represent one of the most economically and agriculturally important insect pests worldwide. They damage plants both directly, sucking phloem lymph, and indirectly, by producing honeydew and most importantly by transmitting hundreds of viruses of economic relevance. In the early ‘00s, the Tomato Leaf Curl New Delhi Virus (ToLCNDV) arrived in the Mediterranean area, from its original areal in South-East Asia. ToLCNDV is mainly transmitted by whiteflies belonging to the *Bemisia tabaci* complex. In Europe, ToLCNDV presence was reported in Greece, Italy, Spain, and Portugal, and recently in France too. In this area it affects cucurbits, causing severe economic losses in protected and field production. Climate change represents a trivial factor that could increase the spread of *B*. *tabaci*, and consequently its transmitted diseases. Thus, in order to assess how climate change will impact on the overall epidemiology of the ToLCNDV disease in cucurbits, we are testing how ToLCNDV acquisition and inoculation phases in *B*. *tabaci* (MED) will be affected. Moreover, gene expression on a set of target genes will describe how the interaction between climate and virus presence will impact the whitefly vector. Two climatic chambers are being used, able to mimic different climatic conditions: temperature, humidity, CO_2 concentration and light intensity regulations are completely independent and self-regulated. Current climate is being used as control, while future climate was derived from regionally downscaled physically consistent climate change projections for the Greater Region in Europe. Results from these experiments will enlighten a topic so far unexplored, helping address future challenges in plant protection.

Acknowledgments: The work belongs to the H2020 project VIRTIGATION (www.virtigation.eu), funded through EU grant 101000570.

Matteo Ripamonti, Luxembourg Institute of Science and Technology, Belvaux, Luxembourg
matteo.ripamonti@list.lu

Poster 42

Do sweeter and more sour substrates improve fruit fly fitness by changing its microbial composition?

N. Solaiman & M. Rohlfs

The fruit fly *Drosophila melanogaster* utilises a variety of fruits and vegetables as food and breeding resources. Those resources vary among each other in their properties, such as sugar content, pH and water availability. Fruits, like apple or banana, are well-known as suitable substrates concerning larval development and survival. One of the possible reasons that makes those substrates a suitable breeding site could be the high content of sugar. Given that the microbial community (fungi and bacteria) that establishes in the insects' breeding site critically drives larval Drosophila development, sugar-rich environments harbouring different microbial communities than sugar-poor environments, may affect the expression of fruit flies' life history traits differently. Indeed, less favourable vegetable-like substrates that have a relatively low sugar content have been shown to impair developmental success of larvae and survival of adult flies. Moreover, resource acidity is also a main driver of microbial community composition. Our research aims to investigate whether, independent of the plant substrate, the sugar content and pH are global regulators of the microbiota the flies are associated with in their habitat, which have a significant impact on their development and fecundity. We explicitly test if manipulation of sugar content and pH can turn less-favourable breeding substrates for *D. melanogaster* into more suitable resources.

Noran Solaiman, University of Bremen, Bremen, Germany
noran@uni-bremen.de

Sektion Invasive Arthropoden / Section Invasive Arthropods

Poster 43

Diapause termination in the South Tyrolean population of Brown Marmorated Stink Bug in response to photoperiod

G. Bulgarini, S. Fischnaller,
C. Frasconi-Wendt & M. Wolf

The most common diapause in Pentatomidae is the winter adult diapause (Musolin & Saulich 2018), whereas photoperiod and temperature are the main inductive factors (Panizzi & Silva 2009, Musolin & Saulich 2018). Only a few studies evaluated the effect of photoperiod on the termination of reproductive diapause on *Halyomorpha halys* (Stål, 1855), a key factor for further understanding and modeling population dynamics in a certain area. Based on the findings of Nielsen (Nielsen et al. 2017) we supposed that there must be a variability of day-length susceptibility in the South-Tyrolean population of *H*. *halys*. Previous investigations (Schuler et al. 2020) demonstrated clearly a high haplotype diversity with an increasing diversity across the different years in those areas. In our work we focused on studying local overwintering populations collected in fall 2020, maintained under laboratory conditions at 9°C and 08:16 L:D for 5 months. In spring, randomly chosen cohorts, each composed of 25 males and 25 females, were exposed to different day-length qualities (12:12 L:D, 13.5 :10.5 L:D, 14:10, 16:8 L:D and PhInc, a continuous increase of daylength from 12:12 to 16:8 L:D) and constant temperature of 21°C. Mortality and start and maintenance of oviposition activity in each cohort and treatment were recorded for up to 119 days. The preoviposition period (start of experiment till first egg mass in each cohort) was calculated for each treatment (day and DD13). The treatment PhInc was used to estimate the diapause termination data backwards using the calculated value of DD13 from the treatment 16:8 L:D.

Giacomo Bulgarini, Trento, Italy
giacomo.bulgarini@gmail.com

Poster 44

Using a molecular gut analysis to reconstruct the feeding behavior of the brown marmorated stink bug *Halyomorpha halys* in South Tyrol

M. Fluch, E. Corretto, S. Fischnaller,
L. Borruso & H. Schuler

Invasive species are a severe threat to global biodiversity and agricultural production. One example is the brown marmorated stink bug *Halyomorpha halys*, which is native to Northeastern Asia and was introduced to various countries in North America and Europe in the last decades. The polyphagous nature of the species, which includes more than 300 different host plants and among them a broad range of agriculturally important crops, makes it one of the most important pest species worldwide. Host plants are generally defined by visual inspections, meaning that a plant is defined as a host whenever stink bug individuals are found on it. Additionally, the feeding behavior is currently diagnosed by the presence of injured fruits and vegetables, but because the individuals are highly mobile, the question arises whether they also feed on other plants. To get new insights into the feeding behavior of *H*. *halys*, we adopted a molecular approach. Individuals were collected from early summer to late autumn in 2021 and 2022 in and around apple orchards in South Tyrol, Italy. After dissection of the gut, the DNA was extracted and plant DNA was amplified using a plant-specific primer pair targeting at the ITS2 region. Afterwards, the amplicons were sequenced using the Nanopore Flongle device, which resulted in up to 220,000 sequences per individual. The first results showed a preference for plants of the genera *Salix*, *Robinia*, *Malus*, *Carpinus*, and *Prunus*, and by now the method enables to detect up to 10 different host plants per individual. This approach allows to elucidate the feeding behavior of *H*. *halys*. Our study highlights the potential of the developed biomolecular approach to obtain new insights into the ecology of this important insect pest species.

Maja Fluch, Free University of Bozen-Bolzano, Bolzano, Italy
MajaReginaAmalie.Fluch@natec.unibz.it

Poster 45

Across the ‘fireflyverse’: Comparison of niche suitability of an exotic firefly in its colonized and native range

D. Gil-Tapetado & C. Polidori

Photinus signaticollis Blanchard, 1846 (Coleoptera: Lampyridae) is a firefly native to South

America that has been found in Europe in recent years. Since 2016, this firefly has colonized the most northeastern part of the Iberian Peninsula, crossed the Pyrenees, and reached the south of France. The degree of ignorance of the ecology of this species is extensive and the extent of colonization in this foreign area is unknown.
Using species distribution models, we have obtained that the native and alien ranges are similar, making it plausible that the firefly could settle and colonize the new area where the species has arrived when the abiotic conditions of its fundamental niche are fulfilled. *Photinus signaticollis* is potentially distributed in the temperate climate of South America, mainly in La Pampa and Río de La Plata, while in Europe, the most suitable area is in the invaded area, in Girona (Spain). Environmental conditions are similar between the two areas, with the area of origin of the firefly being wetter. Despite these climatic differences, the models indicate that the abiotic climatic conditions in both areas are highly suitable, with only the conditions in South America predicting the area in Europe where the species is currently found.
Thus, the propagule of *P*. *signaticollis* detected in Europe is in the most suitable area where the firefly could be, leaving the question open as to how many species may be spreading indirectly and that we only find those that settle in the right area that it may be able to colonize.

Diego Gil-Tapetado, Università degli Studi di Milano, Madrid, Spain
diego.gil@ucm.es

Poster 46
Climate change as a driver of insect invasions: Dispersal patterns of a dragonfly species colonizing a new region

D. Gil-Tapetado, D. López-Collar, J.F. Gómez, J. Mañani-Pérez, F.J. Cabrero-Sañudo & J. Muñoz

The dragonfly *Trithemis kirbyi* Sélys, 1891 recently colonized Western Europe from North Africa. Since its first record in the Iberian Peninsula in 2007, the species has been spreading northward and has become naturally established in the central and eastern Iberian Peninsula, the Balearic Islands and southern France. Despite its worldwide distribution, its rapid colonization of the western Mediterranean area occurred only very recently.
We found that the dispersal and recent establishment of *T*. *kirbyi* in southwestern Europe strongly depends on increasing temperatures, particularly summer temperature peaks, which has allowed this species to disperse farther and more effectively than during years with average summer temperatures. The most important variable in the suitability models is the minimum temperature of the coldest month, which, in recent decades, has become less of a limiting factor for ectotherms. According to the models, suitable areas for the species are currently found throughout the eastern Mediterranean parts of Europe, and it is likely that it can naturally colonize these areas as it did in the Iberian Peninsula.
Trithemis kirbyi is a model of how climate change and observed rising temperatures have turned previously inhospitable regions into suitable areas for exotic species, which may successfully colonize them naturally if they can reach these promising lands on their own. However, this study serves as a warning that such species can also colonize these new regions with a little help from unsuspecting 'friends', which are often responsible for the increasingly common presence of invasive, noxious taxa in Europe.

Diego Gil-Tapetado, Università degli Studi di Milano, Madrid, Spain
diego.gil@ucm.es

Poster 47
AI-supported early detection of wood boring beetles in plant health control: The development of a smartphone application

B. Lutsch, O. Zimmermann, B. Panti, U. Tillich, I. Häussermann & M. Hasselmann

Wood boring beetles are amongst the most problematic invasive species because of their potential to harm natural and urban wooden habitats severely. To avoid their establishment, trees infected with species that are regulated by law as well as suitable host plants nearby have to be destroyed. Compared to invasive pests in herbal ornamental plants or greenhouse vegetable cultures, this not only leads to economic losses but also builds up social tensions between authorities and citizens because measures taken often impact trees in private gardens or public areas.
Thus, the early detection of potentially dangerous beetle species has a high priority in plant health inspections. On the other hand, there is a lack of experts for identifying this wide range of species that origin from different geographical areas worldwide. Building up a collection of such beetle species (Cerambycidae and Bostrichidae) and developing diagnostic tools with a pictorial key for them has already been accomplished in the previous project PHID-Coleo I. The running succeeding project PHID-Coleo II will expand these identi-

fication tools with a smartphone application based on artificial intelligence for a pre-identification of intercepted beetles during plant health inspections. It will enable the inspection staff to identify problematic beetle species or genera on site.
The algorithms will group the beetle species following specific criteria such as size, elytra pattern and color. The perspective is also to install a geographical and ecological filter for each species in the smartphone application to improve the accuracy of the identification result. For a start, 6.800 photographs of more than 30 cerambycid beetles have been taken in different angles, light conditions and with several smartphones to develop and train the algorithm. Beside quarantine species known for their potential to become invasive pests, common native as well as frequently but harmless non-native species were chosen to cover a broad spectrum. All pictures were taken on a standardized reference scale in order to give the algorithm all the necessary information. Difficult taxonomical groups such as Scolytinae, Bostrichidae or Buprestidae may just be identified to a higher taxonomical level, e.g. genera. This depends on the ongoing development and results of the AI-based smartphone tool.
The application is planned to be freely available and will include endemic and morphologically similar species from Central Europe. The current state can already be tested for free at: https://iap.oculyze.net/beetles
Further information may be found on the project website: https://ltz.landwirtschaft-bw.de/pb/,Lfr/Arbeitsfelder/PHID-Coleo+-+Identifikation+Kaefer+an+Verpackungsholz

Björn Lutsch, Landwirtschaftliche Technologiezentrum Augustenberg, Karlsruhe, Germany
bjoern.lutsch@ltz.bwl.de

Poster 48

Ausbreitung neozoer „südlicher" Heuschrecken in einer „nördlichen" Stadt (Abundanzentwicklung, Habitatanforderungen und Dispersion von *Eumodicogryllus bordigalensis* und *Meconema meridionale* in und um Eberswalde)

U. Schulz & O. Brauner

In diesem englischsprachigen Posterbeitrag wird insbesondere auf die beiden wärmeliebenden Heuschreckenarten Südliche Grille (*Eumodicogryllus bordigalensis*) und Südliche Eichenschrecke (*Meconema meridionale*) eingegangen.
Für die Südliche Grille sind mittlerweile in zwei brandenburgischen Landkreisen (bei und nördlich von Eberswalde) die bis dato nördlichsten bekannt gewordenen Funde in Deutschland und Mitteleuropa nachweisbar – und dies vor allem entlang der Bahngleise, was insbesondere für Eberswalde gut belegt und diskutiert wird. Die Ausbreitung erfolgt offenbar hauptsächlich über Gleisschotter.
Die Südliche Eichenschrecke (*Meconema meridionale*) wurde innerhalb des Eberswalder Stadtgebietes umfangreich und systematisch in ihrer Verbreitung und mit ihren Habitatanforderungen untersucht. Studierendengruppen haben nachts zeitgleich verschiedene Baumstämmegruppierungen nach der allochthonen Südlichen Eichenschrecke und der autochthonen Gemeinen Eichenschrecke (*Meconema thalassinum*) abgesucht. Beim chronologischen Abundanzvergleich der beiden Schwesterarten konnte eine rasante Zunahme der neozoen Schwesterart festgestellt werden. Gehölzbezogene Parameter und unterschiedliche Phänologien werden diskutiert. Die Ausbreitung erfolgt offenbar hauptsächlich über Fahrzeuge.

Ulrich Schulz, Hochschule für nachhaltige Entwicklung Eberswalde, Eberswalde, Deutschland
ulrich.schulz@hnee.de

Poster 49

Invasive apricot aphid (*Myzus mumecola*), a new pest in Europe

U. Spitaler, M. Bjeljac & T. Facchini

Myzus mumecola (Matsumura, 1917) (Hemiptera: Aphididae, Aphidinae), commonly known as apricot aphid, is an invasive insect pest that affects apricots (*Prunus armeniaca* Linnaeus) and Japanese apricots (*Prunus mume* Siebold & Zucc). The secondary summer host of this aphid are not known with certainty.
The species originated from countries of the Far East such as Japan, China, and India. Currently *M*. *mumecola* is spreading in Europe. Up to now, *M*. *mumecola* was found in Italy in 2016 (Panini et al. 2017), in Hungary in 2020 (Borbély et al. 2021), and in Serbia in 2021 (Petrović-Obradović 2021). In South Tyrol (northern Italy) where this study was conducted, *M*. *mumecola* was identified for the first time in 2020. *M*. *mumecola* has spread rapidly and became one of the most important insect pests of apricot trees in Italy (Panini et al. 2017). *Myzus mumecola* damages the crop through sucking on leaves and shoots. Furthermore, *M*. *mumecola* could be a vector of plum pox virus.
In our study we were able to observe the fundatrix and other life stages for the first time. The egg laying of *M*. *mumecola* on apricot trees was observed in South Tyrol and availa-

ble insecticides were tested in the laboratory. The results show that egg laying occurs between November and January. Dose response curve were performed for flupyradifurone, acetamiprid, sulfoxaflor, pirimicarb, deltamethrin, and tau-fluvalinate. The LC50 ranged from 8.12 x 10-5 g/L for flupyradifurone to 6.72 x 10-3 g/L for tau-fluvalinate.

Urban Spitaler, Laimburg Research Centre, Terlan, Italy
urban.spitaler@laimburg.it

Poster 50

The invasion of the Lime Swallowtail in Australasia and its effect on endemic populations in the Lesser Sunda Islands

M. Wiemers & D.J. Lohmann

The original range of the Lime Swallowtail (*Papilio demoleus* L.) consisted of two parts: (1) continental South and SE Asia, including the islands of Sri Lanka, Hainan and Taiwan; and (2) Australia (ssp. *sthenelus*), SE Papua New Guinea (ssp. *novoguineensis*), and the Lesser Sunda Islands (ssp. *sthenelinus*). Populations in the Australian region are well differentiated genetically from Asian ones, in adult phenotype, larval colour pattern and foodplant choice. Whereas larvae of Asian populations are a pest on Citrus (Rutaceae), those in the Australian region only feed on Cullen (Fabaceae).

Since the 1950s, Citrus feeding populations have invaded most of the previous distributional gap, starting from the Philippines through the Greater Sunda Islands, and also reaching the Lesser Sunda Islands (Flores in 1997) and Papua New Guinea (in 2004) with their indigenous Cullen feeding populations.

Molecular analyses of mitochondrial DNA (COI & COII) prove that the indigenous populations in PNG and Flores are well differentiated genetically from invasive ones and closely related to Australian populations while all invasive populations are very similar genetically and originate from Southeast Asia. The most common COI haplotype which spread across most SE Asian islands and which was also introduced into the Caribbean originates from the SE Asian mainland or Hainan (China), a second haplotype spread from Taiwan via the Philippines to the Lesser Sunda Islands, and a third haplotype from the Malaysian Peninsula via Sumatra to the Lesser Sunda Islands and New Guinea.

Despite the invasion into the Lesser Sunda Islands, indigenous populations still exist on the west coast of Flores and the nearby islands of Komodo, Rinca and Padar, where they feed on the endemic *Cullen gaudichaudianum*. Whereas no evidence of mitochondrial introgression was found at Labuanbajo, where indigenous and invasive populations occur in sympatry, genetical admixture could be established at the nuclear locus ef-1α.

Nevertheless, we suspect that the taxon *sthenelinus* constitutes a distinct species, but further studies are needed to clarify the taxonomy of the *Papilio demoleus* complex and the extent of gene flow between indigenous and invasive populations, which might pose a threat to the endemic island taxa.

Martin Wiemers, Senckenberg German Entomological Institute, Müncheberg, Germany
martin.wiemers@senckenberg.de

Sektion Landschaftsökologie und Naturschutz / Section Landscape Ecology and Nature Conservation

Poster 51

Who can pass the urban filter? An investigation concerning abundance, functional diversity and community structure of wild bees in Berlin

A.K. Gathof & A.J. Grossmann

Cities are considered important refuges for insect pollinators such as wild bees and are gaining importance against the backdrop of increasing urbanization. However, our understanding of how urban features affect wild bees and how urban environmental filters shape bee species communities and their traits in particular is still limited. In our research, we investigated the effects of urban environmental variables on (i) diversity and abundance of wild bees and specifically on endangered species, (ii) the composition of wild bee communities within the urban matrix and (iii) species-specific functional traits that address the challenges of urban landscapes. We used variables at two spatial scales (urban matrix & local habitat) to illustrate how wild bee diversity is affected by the urban environment and how environmental filters shape urban species pools. The study was performed on 49 dry grassland sites in the city of Berlin using pan traps for standardized bee sampling. Our analyses revealed that wild bee species diversity and endangered species were only affected by variables at the local scale (patch size & non-native bee-friendly plants). Whereas environmental filtering processes predominantly occurred at the landscape scale as urbanisation significantly structured the taxonomic and functional composition of wild bee (sociality, nesting, diet, body size) communities. We identified urban winners and losers attributed to taxon-specific responses to urban filters. Our results confirm the value of high-quality urban green spaces for diverse bee communities. Further, they highlight the importance of tailor-made conservation measures to support functionally diverse bee communities by giving an insight into how bee communities are shaped in urban environments.

Anika Kristin Gathof, Technische Universität Berlin, Berlin, Germany
a.gathof@tu-berlin.de

Anita Grossmann, Technische Universität Berlin, Berlin, Gemany
anitagrossmann@msn.com

Poster 52

Biodiversity Monitoring South Tyrol: A multi-taxon long-term monitoring scheme with arthropods as a main focus

E. Guariento, A. Hilpold, C. Paniccia, M. Anderle, L. Angelini, R. Bottarin, T. Marsoner, J. Plunger, L. Obwegs, J. Rüdisser, J. Seeber, J. Strobl, A. Scotti, S. Stifter, M. Vanek & U. Tappeiner

The growing need for baseline data for assessing efforts to reduce the rate of biodiversity loss highlights the importance of long-term biological data sets. This is particularly relevant for mountain regions and protected areas, which are considered global biodiversity hotspots and refugia.
In 2019, a long-term biodiversity monitoring scheme was established in South Tyrol. The Biodiversity Monitoring South Tyrol (BMS) uses standardized protocols to survey species groups considered highly sensitive to climate and land-use changes across different spatial scales. Among other taxa (e.g. vascular plants, birds and bats), several arthropod groups including, orthopterans, butterflies, soil fauna, ground-dwelling macro-invertebrates, herb and tree layer arthropods, as well as freshwater macroinvertebrates are sampled according to standard protocols. In addition, data on abiotic factors, landscape structure, and land-use management are collected. The site selection follows a stratified sampling design over the region and includes a representative selection of natural, near-natural habitats, such as grasslands, brooks and forests, as well as habitats that have been strongly influenced by humans, such as meadows, vineyards and residential areas. 320 terrestrial sites and 120 aquatic sites are monitored, covering the entire province of South Tyrol (7,400 km^2). Terrestrial sites are surveyed over a five-year period, while aquatic sites are surveyed over a four years-period before the sampling starts over again.
Our results are and will provide applied solutions on sustainable management practices in agriculture and forestry, as well as on current impacts of global changes, such as extreme events or the spread of invasive alien species. The results are also useful for evaluating and improving conservation efforts for protected species and habitats, within and outside protected areas, and for providing decision support for spatial planning and nature conservation strategies

Elia Guariento, Eurac Research, Bolzano-Bozen, Italy
elia.guariento@eurac.edu

Poster 53

Exploratorium Lebendiges Wittental – Artenschutz auf dem Campus

K. Schweissgut

Ziel dieses 2022 gestarteten Projektes war die ökologische Aufwertung der Flächen des Freigeländes um die Professur für Forstentomologie und Waldschutz der Universität Freiburg. Das Gelände wurde in den letzten 100 Jahren als Park gepflegt und sollte durch Schaffung diverser Kleinbiotope durch Studierende sowohl praktische Aspekte in die Lehre bringen, als auch gewinnbringend für die Natur sein. Ein Kernelement der Methodik war, dass die Studierenden selbst Maßnahmen zur Habitataufwertung überlegen und durchführen sollten, die Lehrpersonen standen lediglich beratend zur Seite. Es wurden ein Sandarium für Eidechsen und Wildbienen, ein Erd-Nisthügel (ebenfalls für Wildbienen), ein Quellbiotop für Feuersalamander, ein Teich für Libellen und als allgemeine Wasserquelle, sowie eine Käferburg für Xylobionten geschaffen. Ferner wurde das Gelände mit diversen heimischen Sträuchern bepflanzt, die das ganze Jahr über blühen und Nektar und Pollen liefern. Die Pflege und Evaluation werden ebenfalls von Studierenden vorgenommen, damit diese einschätzen können, wie hoch der Arbeitsaufwand für artenförderliche Maßnahmen ist und ob diese zum gewünschten Ergebnis führen. Gleichzeitig wird durch die Evaluation die Auseinandersetzung mit der Taxonomie gefordert und Interesse an Artenkenntnis gefördert. Idealerweise hat dieses Projekt Vorbildcharakter und inspiriert andere Universitäten und Lehreinrichtungen gemeinsam mit ihren Lernenden biodiversitätsfördernde Maßnahmen umzusetzen und aktiv dem Lebensraumverlust entgegenzuwirken.

Kristina Schweissgut, Universität Freiburg, Freiburg, Deutschland
K.Schweissgut@gmx.net

Poster 54

Changes in carabid species distribution, body traits and associated microbiota along an elevational gradient

J. Seeber, F. Colla, T. Rzehak, G. Galla, N. Praeg, H.C. Hauffe & P. Illmer

Global warming is affecting alpine habitats through a temperature increase above the global average. Such rapid environmental change can affect biotic interactions, impacting ecosystem stability and functionality; however, these processes in mountain regions are not well understood. We used an elevation gradient ranging from 1,000 to 2,500 m a.s.l. as a proxy for climate change to examine the diversity of carabid beetle species, body traits and their individual microbiota. On 12 grazed pasture sites (3 replicate sites every 500 m of altitude), we installed and checked pitfall traps for 24 hours every two weeks throughout the growing season. Almost 6,000 individuals were morphologically identified to species, and body length, wing development, sex and trophic status were noted. Additionally, 182 carabid beetles were captured by hand, and used for microbial community analysis. Community composition, diversity, and the ratio between winged and wingless species of carabid beetles changed significantly, but non-linearly with elevation. Carabids established individual-specific but still elevation-dependent patterns in prokaryotic and fungal communities. Prokaryotic communities were similar below 2,000 m but changed at higher elevations and fungal diversity was highest at 2,000 m. Such data will help us understand how global warming is affecting biotic interactions in soil

Julia Seeber, Eurac Research, Bolzano-Bozen, Italy
julia.seeber@eurac.edu

Sektion Morphologie, Systematik, Evolution / Section Morphology, Systematic, Evolution

Poster 55

Structure and function of the musculoskeletal ovipositor system of *Leptopilina heterotoma* (Cynipoidea, Figitidae)

M. Csader, B. Sampalla, O. Betz, S. Fischer, T. van de Kamp & B. Eggs

The superfamily Cynipoidea is a diverse and species-rich group of wasps with an estimated total number of 20,000 species (Ronquist 1999) with around 14,000 of them being parasitoids (Nordlander 1984). Cynipoidea can be split into two main groups: the macrocynipoids (Austrocynipidae, Ibaliidae, and Liopteridae) and the microcynipoids (Figitidae and Cynipidae). Figitid wasps develop as endoparasitoids in larvae of Hymenoptera, Neuroptera, and mainly Diptera (Ronquist, 1999). To oviposit concealed living and mobile larvae, which are common in Diptera, a long and flexible terebra is needed. Within the Figitidae, several modifications on the ovipositor have evolved to cope with this task. To investigate these modifications, the musculoskeletal ovipositor system of *Leptopilina heterotoma* (Thomson, 1862) was described in detail in both the resting position and in the active probing position. For this, we combined high-speed video recordings with morphological investigations based on serial sections, SR-µCT and SEM data. The ovipositor consists of the female T9 with a raised anterior part and a flexion point in the posterior section; an L-shaped 2nd valvifer, which becomes extremely thin distally before the transition to the 3rd valvulae; an elongated 1st valvifer and a terebra, consisting of the 1st and 2nd valvulae. In the resting position, the terebra is coiled in the metasoma and twisted around its longitudinal axis. All the ovipositor movements are actuated by a set of ten paired ovipositor muscles and a set of six paired metasomal muscles, which insert at the ovipositor system. The protraction of the terebra from resting to the active probing ovipositing position can be divided into two steps: (1) The contraction of the ovipositor-associated metasomal muscles bends the anterior part of the ovipositor at the flexion point downwards. In consequence, the coiled terebra gets pushed out of the metasoma and protrudes upwards. (2) The simultaneous contraction of the functionally adapted anterior and posterior 2nd valvifer-2nd valvula muscles causes the terebra to untwist around its longitudinal axis, which lets the terebra pointing downward. Such functional modifications of the anterior and posterior 2nd valvifer-2nd valvula muscles, which are antagonists for depressing and elevating the terebra in other Hymenoptera, have not been described before. In this protracted position, *L. heterotoma* is able to reach its mobile hosts, which are *Drosophila* larvae that hide in soft plant substrates.
All these modifications enable figitid wasps to store and manoeuvre a long terebra, and can be considered to be a putative key innovation to exploiting new hosts. This might have contributed to the immense radiation of Cynipoidea (90% of Cynipoidea are microcynipoids).

Michael Csader, State Museum of Natural History Karlsruhe, Karlsruhe, Germany
m.csader@web.de

Poster 56

Terebra movements of a chalcidoid wasp: actuation, mechanisms and eco-evolutionary significance

B. Eggs, S. Fischer, M. Csader, I. Mikó & O. Betz

Chalcidoidea is an extremely diverse hymenopteran group of primarily minute sized wasps with parasitoid lifestyles. Various chalcidoids are able to actively bend their terebra (= ovipositor shaft) in various directions despite the lack of intrinsic musculature. To investigate the mechanisms of these terebra movements, we analysed the mechanics of the musculoskeletal ovipositor system of the pteromalid wasps *Lariophagus distinguendus* (Förster, 1841) and the employment of the terebra during oviposition.
As in all hymenopterans, the chalcidoid ovipositor consists of three pairs of valvulae, two pairs of valvifers and the female T9 (9th abdominal tergum). The paired 1st and the 2nd valvulae are interlocked via the olistheter system, which allows the three parts to slide longitudinally relative to each other, and form the terebra. The various ovipositor movements are actuated by a set of nine paired muscles, four of which (i.e. 2nd valvifer-venom gland reservoir muscle, 2nd valvifer-common oviduct muscle, 1st valvifer-genital membrane muscle, T9-genital membrane muscle) being described for the first time in chalcidoids. The anterior and posterior 2nd valvifer-2nd valvula muscles are adapted in their function: (1) In the active probing position, they enable the wasps to pull the base of each of the longitudinally split and asymmetrically overlapping

halves of the 2nd valvula (which are fused only at the apex) dorsad along its longitudinal axis, thus enabling the terebra to bend to the left or right. This way, the 1st valvulae can be pro- and retracted regardless of the bend. (2) These muscles also enable a rotation of the 2nd valvula and therefore the whole terebra at the basal articulation to a certain degree, thus allowing bending to take effect in different directions.

The manoeuvrability of the hymenopteran metasoma (wasp waist) does not improve the ability to reach hosts hiding in concealed cavities, especially in hard substrates (where drilling is extremely energy and time consuming), since the position of the terebra is anchored at the puncture site. Thus, a freely bendable terebra increases the chance of making contact with the host within a concealed cavity. Similar terebra bending movements were also observed in other species of Pteromalidae but also in species of Eurytomidae, Eupelmidae, Aphelinidae, Torymidae and Agaonidae during the assessment of potential hosts, the ovicide/larvacide of the competitors' eggs and larvae, respectively, and accurate egg placement. The structure of the terebra of the Chalcidoidea, featuring a longitudinally cleft 2nd valvula, is basically similar across families (with the exception of the Mymaridae), but very unique among other superfamilies of parasitoid Hymenoptera. The similar structure of the terebra of chalcidoid taxa might indicate similar underlying mechanisms. The evolution of the ability to actively bend the terebra can be considered a putative key innovation that has largely contributed to the acquisition of new hosts to a parasitoid's host range. Such shifts in host exploitation, each followed by rapid radiations, have likely enabled the enormous evolutionary success of Chalcidoidea (with more than 500,000 species estimated).

Benjamin Eggs, University of Tübingen, Tübingen, Germany
benjamin.eggs@uni-tuebingen.de

Poster 57

Lost but found–In quest of hymenopteran type material from the 18th century

S.V. Jung & F. Geller-Grimm

The determination and description of species is major part of the taxonomy and fundamental for species descriptions are type specimen. In the 18th century, the biological taxonomy was still in its infancy. Scientists had their difficulties with the new binomial system introduced by Carl von Linné in 1753. Older systematics had to be integrated into the current system to achieve validity, and some taxonomic rules we now rely on had not yet been defined. Additionally, there was no conformity in documentation and labelling of specimens as it is today, and many insect collections were in the hands of private collectors. Therefore, the fate of numerous holotypes is still undetermined and considered lost or destroyed.

Inspired by the scientific publications of Linné and his former student Johan Christian Fabricius, who were both working on the systematics of Hymenoptera, the German pastor and naturalist Johann Ludwig Christ (1739–1813) studied this group of insects to compile a comprehensive monograph. Driven by his fascination, passion for nature, and conviction that a comprehensive overview is needed, he examined books and descriptions by other scientists and supplemented them with his own detailed observations of the morphology, behaviour, and ecology of native Hymenoptera species. In his work, Christ reviewed and questioned the partly contradictory species descriptions, made his own suggestions for classifications, and completed the catalogue with new species descriptions as and when required. In 1791, he published the Naturgeschichte, Klassification und Nomenclatur der Insekten vom Bienen, Wespen und Ameisengeschlecht with a supplement of illustrated tables. Despite certain nomenclatural ambiguities and uncertainty about the location of the holotype, some of the taxa he described are still valid today and the author's name "Christ, 1791" is likely well known among hymenopterists.

Johann L. Christ did not have the opportunity to travel the world himself, but he had access to the large insect collection of Johann Gerning in Frankfurt. Based on the Gerning collection, Christ described many Hymenoptera species particularly from the tropics. The Gerning collection is now preserved in the Collection of Natural History at the Museum Wiesbaden and includes approximately 50,000 specimens, with more than 800 Hymenoptera.

Based on a note in Christs Book and on the discovery of a Hymenoptera type specimen by Michael Ohl in 2018, we assumed that there is further type material of this insect group preserved in the Gerning collection. Therefore, we have recorded all Hymenopterans in the Gerning collection and identified their family affiliation and genus as far as possible, since only sparse label data are available. Assignment of this data set to the species described by Christ resulted in more than ten individuals that qualify as type specimens and a broader

data set that provides information on interrogation of synonyms and species associations as well as species descriptions that have not yet been allocated. Subsequently, these specimens were identified and compared with the illustrations and descriptions to find similarities and evidence to provide the type-material presumption.

Swane Vivian Jung, University of Rostock, Rostock, Germany
Swane.Jung@web.de

Poster 58

Full with life: Mantid ootheca are microhabitats for many different arthropods

Z. Mirzaee, T. Schmitt & M. Wiemers

The ootheca is a protein-based structure formed during oviposition by female mantids to contain and protect eggs against harsh climatic conditions, parasitoids, and predators. Multiple arthropods have acquired the advantageous capacity to use both viable and evacuated oothecae as nesting sites or occasional shelters as a result of their protective role. Mantid oothecae appear to be a valuable resource for a variety of arthropods worldwide. It is worth noting that large-sized mantid oothecae (e.g. *Hierodula*, *Tenodera*) are favoured, probably due to their bigger size and volume, which may provide more abundant trophic supplies and better shelter. The repeated discovery of autochthonous beetles in association with alien mantid oothecae indicates that ootheca exploitation is generic rather than species-specific. Investigating these specific associations has many implications for species distribution dynamics and provides further insight into the interaction of various arthropods that use the oothecae of Mantodea as microhabitat to survive the extreme environmental events that occur during winter. Many mantid species, including *H. tenuidentata*, have recently been recorded in non-native areas such as Europe and North America. The spread of these alien mantid species has been documented e.g., by oothecae traveling attached to the merchandise. Presumably, this might go alongside the introduction of alien parasites that may have an impact on native mantid species and other fauna.

Zohreh Mirzaee, Senckenberg German Entomological Institute, Müncheberg, Germany
zohreh.mirzaee@senckenberg.de

Poster 59

Man-made obstacles to insect foraging: Does urbanization select for greater flight ability in bees and wasps?

A. Ferrari & C. Polidori

Urbanization has been considered one of the main drivers of land use change, being associated with both rising in temperatures (Urban Heat Island effect) caused by the increasing proportion of cemented (i.e., impervious) surfaces and with the reduction and fragmentation of green areas. Previous studies revealed that such land use changes affect local wild bees (Hymenoptera: Apoidea) and wasps (Hymenoptera: Vespidae) community composition, with consequent reduction of the ecosystem services they provide (pollination and pest control, respectively). Insects can also respond to urbanization through phenotypic plasticity, though previous studies only focused on body size shifts. However, flight morphology, which includes both size and shape of wings relative to body size, can be relevant in urban, man-made structures filled and fragmented environments, since it correlates with foraging success and dispersal ability. The aim of our study is to analyse wing loading (body mass/wing area) and aspect ratio (wing shape) in the bee *Halictus scabiosae* (Rossi, 1790) (Halictidae) and in the wasp *Polistes dominula* (Christ, 1791) (Vespidae) along an urbanization gradient in the metropolitan city of Milan (Italy). We hypothesized that more fragmented and less green urban areas should filter for better flight ability: i.e., for reduced wing loading (larger wings relative to body size) and higher aspect ratio (more elongated wings). We sampled a total of 180 wasps and 132 bees (all females) and characterized each sampling site in terms of temperature, Normalized Difference Vegetation Index (higher NDVI correspond to higher plant productivity) and edge density of green patches (higher ED correspond to higher fragmentation). For each specimen, we measured intertegular distance (a proxy for body size), fresh body mass, total wing area, and fore wing length, and then calculated wind loading and aspect ratio. We analysed the data through Generalized Linear Mixed Models using the three environmental variables and body size as fixed effects and the sampling site as random effect. Firstly, we found that both bees and wasps show reduced body size in more urbanized landscapes. We found NDVI to positively affect wing loading in *P. dominula*, while temperature affects, less strongly, wing loading and aspect ratio in *H. scabiosae*. Only in *H. scabiosae*, aspect ratio

depends on body size, but not strongly. For *P. dominula*, we found lower wing loading (i.e., better flight ability) in sites with lower NDVI values (i.e., more urbanized sites). Despite body size shrinking–which may negatively affect the range of prey potentially hunted–*P. dominula* could adapt to effectively collect resources in impoverished green areas (low NDVI, urbanized) through reduced wing loading. Conversely, for *H. scabiosae* we found weak changes in flight-related morphological traits. Our environmental variables may be not enough stretched to highlight a possible adaptation, or alternatively, simply changes in wing loading and aspect ratio are driven exclusively by body size and not by environmental features. Our preliminary analysis highlights how phenotypic plasticity in wings size and shape should not be overlooked as urbanization may alter wing morphology in different ways and extent for different species of bees and wasps. In future, we call for more comprehensive frameworks to study phenotypic plasticity in wild bees and wasps in urban habitats. For example, integrating body size and body mass with flight-related traits and with wing fluctuating asymmetry may give a broader view of morphological adaptations to urbanization. Such study should be carried out in a comparative framework, using many species of bees and wasps spanning different lineages and different body sizes. Understanding in detail how urbanization affects flight morphology in insects providing relevant ecosystem services may give important tips to properly manage green areas in heavily urbanized landscapes.

Andrea Ferrari, University of Milan, Milan, Italy
andrea.ferrari@unimi.it

Poster 60

Leptoconops biting midges (Diptera: Ceratopogonidae) from a Mediterranean area: new observations on structures involved in host-searching and host attack

C. Polidori, P. Gabrieli, A. Negri, I. Arnoldi, M. Brilli & S. Epis

Some species of midges in the genus *Leptoconops* (Diptera: Ceratopogonidae) are known to pester humans and domestic animals, and few even transmit harmful diseases. In certain Mediterranean areas, these minute midges occur in large numbers during the summer and limit the use of recreational areas, rising serious health and social concerns. Despite such recognized impacts, the fauna of *Leptoconops* in Maremma is not well known, and no studies to date focused on their molecular relationships and on morphological traits related with their possible adaptations. Here, we present new data on *Leptoconops* in a heavily infested area of Maremma (southern Tuscany, Italy). We sampled females *Leptoconops* in six locations and used Stereomicroscopy and Electron Scanning microscopy (SEM) to identify species and investigate morphology of structures involved in host-searching/recognition (antennae and maxillary palps) and host attack (mouthparts). We performed Energy-dispersive X-ray spectroscopy (EDS) analysis to characterize elemental composition of mouthparts. We used COI sequences to confirm the species identification of the sampled individuals. We recognized two species: *Leptoconops* (*L.*) *irritans* (Noé) and *Leptoconops* (*L.*) *noei* Clastrier & Coluzzi, having been the former more often sampled than the latter during the study, and closer to the sea coast and rivers than the latter, suggesting a certain degree of ecological niche segregation. The antennae have the first three segments respectively annular, cylindrical, and turbinate in both species. The most distal (14^{th}) segment was also similar in shape in the two species. However, the remaining segments seemed slightly more globular in *L. noei* than in *L. irritans*. Five types of sensilla were found on the antennae of both species: sharp trichoid sensilla (StS), blunt trichoid sensilla (StB), long basiconic sensilla (SbL), short basiconic sensilla (SbS) and chaetic sensilla (Sc). SbL were found only on the distal segment in *L. noei*, while one SbL was found on each segment from 13^{th} to 2^{nd} in *L. irritans*. On the other hand, two long StB were found on 13^{th} to 2^{nd} segment only in *L. noei*. Mouthparts are composed by labium (LB), labellum (Lbl), labrum (LR), maxilla (Mx), mandible (Ma) and hypopharynx (Hp). Lbl seemed to differ between the two species, being visibly larger (and covering a greater part of the LR) in *L. noei*. The maxillary palps (MP) possess a palpal pit (PP) filled with bulb-shaped sensilla (Bss), denser in in *L. noei* than in *L. irritans*, and they were covered by in both species by small microtrichoid sensilla (Stm) and sharp trichoid sensilla (StS). Mouthpart cuticle included Calcium (Ca) and Aluminum (Al) at small but detectable concentrations (0.3%–1%) in both species. The presence of Ca and Al in the cuticle of mouthparts may help host skin drilling during bite activity; both metals were reported in the cuticle of few other insects.

Carlo Polidori, Università degli Studi di Milano, Milano, Italy
carlo.polidori@unimi.it

Sektion Molekulare Entomologie / Section Molecular Entomology

Poster 61

Small-scale population genetic structure of the spruce bark beetle *Ips typographus* in the Southern Alps

E. Papek, C. Stauffer, A. Battisti, M. Faccoli, H. Schuler, C. Bertheau & M. Schebeck

Climatic fluctuations during the Pleistocene with cycles of glacial and interglacial periods had a strong impact on the flora and fauna. The last ice ages ended about 12,000 years ago. During the last glacial maximum (LGM) major parts of the Northern hemisphere where uninhabitable, as they were covered by a thick ice shield. Species retracted to refugial areas, where conditions were more favourable, resulting in isolation and limited gene flow among geographically separated refugia. When climatic conditions got more favourable again, recolonization of previously uninhabitable areas occurred and gene flow among separated populations was re-established. These climatic fluctuations, the retraction of species and later recolonization were major evolutionary drivers in many species and shaped their current genetic structure.

The genetic structure of the European spruce bark beetle *Ips typographus* was influenced by these Pleistocene events and its dependency on its main host tree, Norway spruce (*Picea abies*). During glacial periods, *I. typographus* was restricted to certain refugial areas, shared with its host tree. The phylogeography of European *I. typographus* is already well investigated, showing low genetic diversity and a shallow genetic structure. Patterns corresponding to northern and southern phylogenetic *P. abies* ranges, three major haplogroups and at least two refugial areas in the Carpathians have been described. The Apennines are considered as an important glacial refugium for many species, among them *P. abies* and some scolytine species, such as the small spruce bark beetle *Pityogenes chalcographus*. However, the importance of the Apennines as a refugial area for *I. typographus* has not been clearly resolved yet.

Here, we analysed the genetic structure of *I. typographus* of one Apennine location and five populations in the Southern Alps, to study the significance of this potential glacial refugium and its implications for adjacent regions. We analysed a fragment of the mitochondrial cytochrome oxidase I (COI) gene of 132 individuals and compared our results to previous work, studying the population genetics of the beetle on a larger European scale.

In total, four already described mitochondrial haplotypes were found, showing a low genetic diversity and a weak population structure. It is proposed that *I. typographus* high dispersal capacity is the reason for its low genetic diversity and shallow population structure. The question to what extent the Apennine refugial area influenced the genetic structure of *I. typographus* in the Southern Alps remains elusive. However, our study adds additional data on the phylogeography of this widespread bark beetle, contributing to a comprehensive picture of the species' recent evolutionary history.

Eva Papek, University of Natural Resources and Life Sciences, BOKU, Vienna, Austria
eva.papek@boku.ac.at

Weitere Poster / Additional posters

Poster 62

Sublethal effects of insecticides on the chemical orientation of parasitic wasps

J. Ruther & N. Schöfer

The lethal and sublethal effects of pesticides on non-target organisms are considered to be one of the causes of the current decline in insects. In particular, the neurotoxic neonicotinoid insecticides have come under criticism in this regard, but research to date has focused mainly on pollinators, although other beneficial non-target organisms such as parasitic wasps (parasitoids) may also be affected. We studied the sublethal effects of the four insecticides acetamiprid (neonicotinoid), dimethoate (organophosphate), flupyradifuron (butenolide) and sulfoxaflor (sulfoximin) on the pheromone-mediated sexual communication and the olfactory host finding of *Nasonia vitripennis* (Pteromalidae), *Lariophagus distinguendus* (Pteromalidae), and *Leptopilina heterotoma* (Figitidae). All agents target cholinergic neurons, which are involved in, among other things, the perception of chemical information by insects. We applied sublethal doses (survival rate ≥ 70%) of the four insecticides topically to the wasps and tested them the next day in bioassays with respect to their responsiveness to intraspecific sexual signals (sex pheromones), mating rate, and their ability to respond to host-associated chemical cues (kairomones). We found that sublethal doses of all four insecticides impaired sexual communication, mating behavior, and/or olfactory host finding in at least one of the model organisms tested. The susceptibility of the tested species to the different substances varied widely. Considering the reported concentrations of the insecticides in nectar, honeydew and guttation water, all of which are consumed by parasitic wasps as nutritional resources, the doses applied in our study have to be considered as field realistic. Thus, sublethal effects of insecticides from different classes might impair parasitic wasps in their important function as natural enemies of other arthropods.

Joachim Ruther, University of Regensburg, Regensburg, Germany
joachim.ruther@biologie.uni-regensburg.de

Öffentlicher Vortrag / Public lecture

Im öffentlichen Vortrag am Dienstag, den 21. Februar 2023, 19:30–21:00 Uhr, von Prof. Dr. Urs Wyss gezeigte Filme.

Films shown in the public lecture on Tuesday, February, 21, 2023, 7:30-9:00 pm, by Prof. Dr. Urs Wyss.

Highlights aus verborgenen Insektenwelten / Highlights from a hidden insect world

U. Wyss

Männer haben es nicht leicht – Aus der Sicht winziger Milben und Insekten (in SD, 17 Minuten)

Es wird gezeigt, wie sieben Männchen sich bemühen müssen, um ihre Weibchen in Paarungsbereitschaft zu versetzen.

Zuerst wird **Paul,** eine weiße Fliege (*Trialeurodes vaporariorum*) vorgestellt, der sich nach dem Schlupf aus dem Ei auf einem Tomatenblatt saugend über mehrere sessile Nymphenstadium zu einem Puparium entwickelt, aus dem er erwachsen schlüpft. Nachdem er sich aus einer Wachsdrüse am Hinterleib vollständig mit weißem Wachs eingepudert hat, macht er sich auf die Suche nach einem Weibchen. Er stellt sich in gleicher Richtung neben das Weibchen, betrommelt dessen Fühler mit seinem Fühler und vibriert heftig mit dem Hinterleib, so lange und immer wieder, bis das Weibchen endlich ihre Paarungsbereitschaft signalisiert und Paul zum Zuge kommt. Er hat später Pech, als er ein Weibchen in Stimmung bringen will, das, weil bereits begattet, mitten in seinen Bemühungen davonläuft.

Max, eine Spinnmilbe (*Tetranychus urticae*), erkennt das Sexualpheromon eines jungen Weibchens, während es sich als Deutonymphe in einer Ruhephase befindet. Er bewacht und beschützt dieses Weibchen ununterbrochen vor rivalisierenden Männchen, duelliert sich sogar mit ihnen, um nach dessen Häutung zur geschlechtsreifen Milbe der erste zu sein, der ‚sein' Weibchen begatten darf.

Henry, (*Microterys flavus*), das Männchen einer Schlupfwespe, die Napfschildläuse, speziell *Coccus hesperidum,* parasitiert, ist wesentlich kleiner als das Weibchen. Um dieses in Paarungsstimmung zu bringen, muss Henry ihre Fühler mit seinen Fühlern intensiv betrillern, damit sie stillstehend die Paarung zulässt. Im Film wird gezeigt, wie Henry ein Weibchen begatten möchte, das im Begriff ist, mit ihrem langen Legebohrer Eier in *C*. *hesperidum* zu legen. In diesem Fall ist es für Henry nicht möglich, die Geschlechtsöffung des Weibchens zu finden. Deshalb rennt er hin und her, betrillert das Weibchen am Kopf, rennt zum Hinterende, immer wieder. Es ist zum Verzweifeln: Alle Begattungsversuche scheitern der Reihe nach, Henry merkt in seinem Eifer nicht, weshalb die Paarung nicht klappen will. Erst später findet er ein Weibchen das bei der Betrillerung still hält und somit für die Paaarung bereit ist.

Fritz (*Trichogramma brassicae*) ist das Männchen einer parasitischen Wespe, welche ihre Eier in die Eier von Lepidopteren legt. Er hat ein Problem, als aus einem Eigelege ein Weibchen schlüpft, dessen Sexualpheromon derart viele Männchen anlockt, dass Fritz mitten im Gewühl keine Chance hat, sich mit diesem attraktiven Weibchen zu paaren.

Emil, ein Männchen der Haferblattlaus (*Rhopalosiphum padi*) begattet im Spätherbst auf dem Winterwirt, einer Traubenkirsche (*Prunus padus*) lebende ovipare Blattläuse, die, wenn begattet, winterharte Eier produzieren. Emil muss sich im Film enorm anstrengen, bis es ihm endlich gelingt, nach vollbrachter Tat seinen knubbeligen Penis aus dem Weibchen herauszuziehen.

Freddy, ein Männchen des asiatischen Marienkäfers *Harmonia axyridis* hat nach der Paarung ähnliche Probleme wie Emil. Er ruckelt und zuckelt heftig auf dem Weibchen und wird deshalb im Film als „bemerkenswerter Lover" bezeichnet.

Lutz ist das Männchen von *Nasonia vitripennis*, einer Schlupfwespe, welche in Puppen von Stubenfliegen mehrere Eier legt, aus denen sowohl Weibchen als auch Männchen schlüpfen. Lutz schlüpft als erster, beißt sich aus der Puppe heraus und wartet über dem so entstandenen Schlupfloch auf seine Schwester Isolde. Doch es erscheint nicht die Schwester, sondern ein Bruder, Heinz mit Namen. Dieser wird von Lutz rabiat in die Puppe zurückgestoßen. Endlich kommt Isolde. Lutz springt auf ihren Rücken, fällt mir ihr von der Puppe und ist sogleich damit beschäftigt, Isolde in Stimmung zu bringen, indem er, kopfwärts auf ihrem Rücken stehend, sein Sexualpheromon auf ihren Fühlern verteilt. Er ist derart damit beschäftigt, dass sich sein inzwischen aus dem Schlupfloch entwichener Bruder, von Lutz unbemerkt, mit Isolde in aller Ruhe paaren kann.

Zwei trickreiche parasitische Wespen (in SD, 16 Minuten)

Zuerst wird unter dem Titel ‚*Trichogramma brassicae* als Hitch-Hiker'gezeigt, wie *Trichogramma* die von ihr parasitierten Eigelege von Lepidoptern findet. In Versuchen mit *Pieris brasicae* (Kohleißling) wurde nachgewiesen, dass *Trichogramma*-Weibchen begattete *Pieris*-Weibchen anhand der vom Männchen hinterlassenen Duftmarke erkennen, besteigen und somit direkt zum Ort der Eiablage transportiert werden. Bei der Eiablage wird durch eine Eindellung am Hinterleib des Weibchens erkennbar, ob ein befruchtes Ei (daraus schlüpft eine weibliche Larve) oder ein unbefruchtetes Ei (daraus schlüpft eine männliche Larve) in das *Pieris*-Ei hineinlegt wird.

Der zweite Teil des Films mit dem Titel ‚Der Kornkäfer *Sitophilus granarius* und sein natürlicher Feind *Lariophagus distinguendus*' zeigt zuerst, wie das Käfer-Weibchen ein Ei in das Getreidekorn hineinlegt, wie die daraus geschlüpfte Larve im Korn frisst und wie sich nach der Verpuppung der Käfer aus dem Korn herausfrisst. Danach wird gezeigt, wie das *Lariophagus*-Weibchen mit seinem langen Legebohrer die harte Kornschale durchbohrt, wie ein dem Legebohrer entlang fließendes Sekret aus dem Hinterleib zu einem Saugröhrchen (feeding tube) erhärtet, aus dem das *Lariophagus*-Weibchen Hämolymphe aus der *Sitophilus*-Larve für die Reifung ihrer Eier aufsaugt. Der gesamte Vorgang wird mit Hilfe von Beobachtungskammern besser sichtbar gemacht: Für die Eiablage wird der Legebohrer durch das Röhrchen geschoben und ein Ei oder mehrere Eier auf die im Korn fressende *Sitophilus*-Larve gelegt. Nach dem Schlupf aus dem Ei, ernährt sich die *Lariophagus*-Larve ektoparasitisch saugend zum erwachsenen Schlupfwespen-Weibchen, das sich aus dem Korn herausfrisst und daran anschließend sogleich begattet wird.

Sieben Kurzgeschichten (in HD, 21 Minuten)

Geburt einer Blattlaus (hier der Erbsenlaus *Acyrthosiphon pisum*)

Die junge Blattlaus (L_1), von der Embryonalhülle noch vollständig umhüllt, wird mühelos aus der Vagina herausgepresst. Wenn nur noch der Kopf am Hinterende der Blattlaus haftet, streift die L_1 die Hülle ab, beginnt mit den Beinen zu strampeln und wird von der Mutter sorgfältig abgesetzt.

Blattlaus entsorgt überschüssigen Zucker in Form von Honigtakugeln

Junge Blattläuse der Röhrenläuse kicken die Honigtaukugel immer mit einem Hinterbein weg, wie im Film für eine N_2 der Großen Getreideblattlaus *Sitobion avenae* veranschaulicht. Adulte benutzen zum Wegschießen immer ihr Schwänzchen (Cauda). Ein Weibchen der Erbsenlaus (*Acyrthosiphon pisum*) veranschaulicht diesen Vorgang.

Spinnmilben auf Maisblatt ärgern Blattläuse

Die auf einem Maisblatt herumrennenden Milben (*Tetranychus urticae*) irritieren die im Film gezeigten Blattläuse (*Metopolophium dirhodum*, *Rhopalosiphum maidis*), wenn sie deren Beine oder Saugrüssel berühren. Die Blattläuse strampeln heftig, doch nie wurde beobachtet, dass sie weglaufen.

Geschafft! Blattlaus mit verklebten Flügelspitzen kann wieder fliegen

Es wird gezeigt, wie eine geflügelte Lindenzierlaus (*Eucallipterus tiliae*) wegzufliegen versucht, dies aber nicht kann, weil ihre Flügelspitzen mit Honigtau verklebt sind. Sie versucht mehrfach, die Flügel mit ihren Hinterbeinen voneinander zu trennen. Endlich gelingt ihr das und sie fliegt weg. Geschafft!

Stubenfliege (*Musca domestica*) schlüpft aus Puppe

Die zu Beginn des Films gezeigte Tönnchenpuppe entsteht, wenn die Cuticula der verpuppungsreifen L_3-Larve erhärtet. Innerhalb dieses Tönnchens verpuppt sich die Larve. Beim Schlupf sprengt eine ausstülpbare Stirnblase der Fliege Sollbruchlinien am Kopfende des Tönnchens, worauf die Fliege das Tönnchen verlässt. Nach dem Schlupf wird die Stirnblase in den Kopf zurückgezogen und es wird im Detail gezeigt, wie, von vorne frontal zu sehen, die Flieg erstmals Nahrung mit ihrem Saugrüssel aufsaugt. Danach putzt die Fliege Vorderbeine und Kopf und ist flugbereit.

Kleine Teddies (Springschwänze) im Kompost

Zahlreiche Springschwänze (Collembolen) durchwuseln zu Beginn des Films den Kompost. Es ist zu sehen, wie junge Collembolen aus den Eiern schlüpfen und blass violett gefärbt niedlich wie kleine Teddies aussehen. Sie fressen mit ihren winzigen Mundwerkzeugen an totem organischen Abfall. Eine Häutung ist im Detail zu sehen. Die Sprungabel (Furca) ist bei einem seitlichen ruhenden Col-

lembolen deutlich erkennbar. Mit Hilfe dieser Gabel springen Collembolen kreuz und quer durch den Kompost, deshalb werden Collembolen auch Springschwänze genannt.

Pseudoskorpion (*Chthonius* sp.) jagt und vertilgt Springschwänze

Obwohl nur 2 mm groß, erscheint *Chthonius* von vorne gesehen mit seinen paarigen Cheliceren und Palpenscheren gewaltig groß und gefährlich. Um den Beuteerwerb zu dokumentieren, wurden kleine Petrischalen mit Gipsboden verwendet: Herumrennende Collembolen werden von *Chthonius* blitzschnell mit den Palpenscheren ergriffen, zu den Cheliceren geführt und dort geknetet und ausgesaugt. Danach wird der übrig gebliebene feuchte Rest auf den Boden abgelegt.

Die *Cotesia* Story (in HD, 8 Minuten)

Eine weibliche *Cotesia glomerata* Wespe wird vorgestellt, dann ihr Wirt: die am Rand eines Kohlblatts fressende Larve des großen Kohlweißlings (*Pieris brassicae*). Das *Pieris*-Eigelege und daraus schlüpfende Eilarven (L_1) werden gezeigt. Die L_1 fressen nach dem Schlupf die übrig gebliebenen Eihüllen, verteilen sich dann auf dem Blatt und fressen, noch immer gesellig zusammen, Löcher in das Blatt. Die nächste Einstellung zeigt, wie das *Cotesia*-Weibchen in Nähe des *Pieris*-Eigeleges nervös auf den Schlupf der L_1-Larven wartet, um diese mit Eiern zu belegen. Obwohl sich die geschlüpften L_1 gegen den Anstich heftig wehren, gelingt es der Wespe, in einzelne Larven jeweils ca. 40 Eier zu injizieren, auch in ältere, noch stärker sich wehrende Larven. Gleichzeitig mit den Eiern injiziert *Cotesia* ein symbiontisches Virus, ein Polydnavirus, welches das Immunsystem der Wirtslarve inaktiviert. Die im Wirt geschlüpften Larven entwickeln sich mit erhöhter Freßlust ungestört. Nach der letzten Häutung verlassen die L_3 *Cotesia*-Larven, schaurig anzusehen, die *Pieris*-Larve auf beiden Seiten. Dort spinnen sie Puppenkokons in einem lockeren Gespinst. Die noch immer lebende *Pieris*-Larve verfestigt unter dem Einfluss des Virus das Gespinst des Feindes mit ihren eigenen Spinnfäden, erst danach darf sie sterben! Der Film endet mit Aufnahmen, die zeigen, wie ein aus dem Gespinst schlüpfendes *Cotesia*-Weibchen zahlreiche zeitgleich geschlüpfte Männchen anlockt, von denen nur ein Männchen zur Paarung kommt.

Die Schlupfwespe *Aphelinus abdominalis* – Ein hinterlistiger Blattlaus-Killer (in HD, 8 Minuten)

Der Film beginnt mit Getreideblattläusen (*Sitobion avenae*), die auf einem Weizenblatt von *Aphelinus*-Schlupfwespen besucht werden. Die Wespen pirschen sich vorsichtlich von hinten an die saugende Blattlaus heran, schätzen die Distanz für den Anstich, drehen sich um und schieben ihren Legebohrer zur Eiablage in den Bauch der Blattlaus, ohne dass diese, zumindest in den meisten Fällen, auf den Anstich regiert. Die mit einem Ei belegte Blattlaus wird allmählich dunkler, aber auch dann sind in ihrem Innern die Bewegungen der aus dem Ei geschlüpften parasitischen Larve noch gut erkennbar. Die Blattlaus stirbt langsam. Nach ihrem Tod ist sie zu einer schwarzen Mumie erhärtet, in der sich die *Aphelinus*-Larve verpuppt. Die aus der Puppe geschlüpfte Wespe beißt am Hinterende der Mumie ein Loch, aus dem sie entweicht.

Lebensweise und Entwicklung der Tomatenminiermotte *Tuta absoluta* (in HD, 8 Minuten)

Der Film zeigt zu Beginn ein *Tuta*-Weibchen und dessen zahlreich abgelegten Eier auf der Unterseite eines Tomatenblatts. Die aus dem Ei geschlüpfte L_1-Larve wandert noch eine Weile auf dem Blatt, dann dringt sie in das Blatt hinein und frisst direkt unter der Epidemis das Mesophyllgewebe. Es entstehen Blattminen, von denen jede eine Kammer für abgegebenen Kot enthält. Die Häutung zur L_2 wird in einer geöffneten Mine gezeigt. Die L_4-Larve (letztes Stadium) frisst ausgedehnte Minen, aus der das Hinterende der inzwischen groß gewordenen Larve (9 mm) zur Kotabgabe herausbricht. Die L_4 verlässt, wenn voll entwickelt, die Mine. Sie gelangt, an einem Seidenfaden hängend, zur Verpuppung auf die Erde, oder sie spinnt, wie im Film gezeigt, auf dem Tomatenblatt ein Gespinst, in dem sie sich verpuppt. Der Film endet mit dem Schlupf der Imago aus der Puppe.

Lebensweise und Entwicklung der Rübsenblattwespe *Athalia rosae* (in HD, 8 Minuten)

Der Film beginnt mit einem auf dem Rübsenblatt stehenden *Athalia*-Männchen, gefolgt von Aufnahmen, wie ein Weibchen mit seinem Ovipositor einen Schlitz durch den Blattrand sägt und ein Ei in das Blatt hineinschiebt. Um die Eier herum wachsende Taschen werden

seitlich und in Aufsicht gezeigt, dann die Entwicklung der L_1 im Ei und wie sich die L_1 aus der Tasche herausbeißt. Die L_1-Larven fressen oberflächlich Löcher in das Blatt; es entsteht typischer Fensterfraß. Auch die L_2-Larven hinterlassen Festerfraßsymptome. Erst nach dem 3. Stadium beißt die Larve durchgehende Löcher in das Blatt, die bei den nachfolgenden L_4- und L_5-Larven immer größer werden. Die L_6-Larven verursachen Skelettierfraß, nur die Hauptadern und stachelige Trichome bleiben verschont. Voll entwickelt, begibt sich die L_6 in den Boden. Dort verfestigt sie Bodenpartikel mit klebrigem Sekret zu einem Erdkokon, in dem sie sich verpuppt. Zum Schluss des Films wird gezeigt, wie die junge Wespe den Boden verlässt.

Urs Wyss, Universität Kiel, Kiel, Deutschland
uwyss@phytomed.uni-kiel.de

Tagungsleitung und Organisation / Congress management and organisation

Freie Universität Bozen – Bolzano (unibz)
Sergio Angeli, Renate Folie

Senckenberg Deutsches Entomologisches Institut (SDEI)
Stephan M. Blank, Arne Köhler

Leibniz-Zentrum für Agrarlandschaftsforschung (ZALF)
Katja Kramp

zalf

SENCKENBERG
world of biodiversity

unibz