

# METALEPTEA

THE NEWSLETTER OF THE



ORTHOPTERISTS' SOCIETY

## President's Message

By **DAVID HUNTER**

President

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**D**ear Society members:  
With the effects of COVID-19 gradually easing, we are gradually getting back to some

level of normality, including meetings in person and not Zoom! The case in point is the recent International Congress of Entomology (ICE) in Helsinki, Finland that a number of you participated in, meaning that further easing of restrictions is likely, which bodes well for our 14<sup>th</sup> Congress to be held in Mérida, Yucatán in October next year. Mario Poot-Pech, President of the Organizing Committee, has been organizing the Congress in collaboration with National and International Plant Protection Agencies who are planning to send substantial numbers of delegates to the Congress to give us a good basis for a successful Congress. And the Yucatán is a wonderful place, with the stunning beaches of the Riviera Maya, biosphere reserve, and the pyramids of the ancient Mayan civilization all on display. It will be a real opportunity for all of us to get together once again. ¡Todos son bienvenidos en Yucatán!

In this regard. It is time for all of us to consider our contributions to the Congress, such as thinking about symposium proposals and presentations. On the preliminary [Congress website](#), you can see that the deadline for symposium proposals is the end of January with abstracts due 3 months later, so consider your part in making



our Congress a success.

No doubt you have heard of the devastating floods in Pakistan. My contacts there say that in addition to the record monsoon rains, glacial melt from the very hot weather earlier this year is making matters worse. One in 100-year floods two years in a row in Australia and now in Pakistan at the time of record heatwaves and droughts in the western U.S.A. and China: the very essence of climate change.

As I write this, my wife and I are preparing for a holiday in the south of France with my son and his family. Then in October, I will attend the Entomology Congress in La Plata, Argentina for a bit of a catch-up on the locust situation there. It is good to finally be able to travel in a somewhat normal manner. This has meant a resumption of “more” normal work as well, which is what all of us have really wanted to do. Once again, enjoy another excellent *Metaleptea* thanks to Hojun Song, Derek A. Woller, and everyone who has contributed!

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# The 14<sup>th</sup> International Congress of Orthopterology: October 2023!

By **MARIO A. POOT-PECH**  
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**T**he International Congress of Orthopterology draws near, and the history and flavor of the Mayan culture is already in the air.

We are hosting events that will be a mix of flavors: symposia, meetings, forums, cultural, and archaeological events. For now, it is important to keep in mind two important dates:

**31 January, 2023:** Deadline for symposia submissions or other academic proposals, such as workshops, meetings, forums, etc.

**30 April, 2023:** Deadline for abstract submissions.

Please send proposals to:  
[orthoptera@ico2023mexico.com](mailto:orthoptera@ico2023mexico.com).  
Please contact us with any questions.

You can check the proposal requirements here: <https://ico2023mexico.com/symposium-requirements/>

The Congress will be in the Hotel “El Conquistador” in Mérida City, Yucatán State, México.



# Polyneoptera Symposium Planned for the 2022 Entomological Society of America Meeting in Vancouver, Canada on November 16th: “Small Orders, Big Ideas (Polyneoptera)”

By **CARLA DE LOERA<sup>1</sup>, DEREK A. WOLLER<sup>2</sup>, AND HOJUN SONG<sup>3</sup>**

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**P**olyneopteran insects (Orthoptera and nine other insect orders) are very common and include some of the most recognizable creatures on Earth, but are rarely represented at Entomological Society of America (ESA) meetings. Since 2014, Derek A. Woller, Hojun Song, and rotating groups of co-organizers have been working diligently to raise their profile at ESA

meetings by organizing Organized Meetings (this year’s event type) and Member Symposia to highlight all the fascinating and novel research being undertaken with polyneopterans. This year, ESA will be held in Vancouver, Canada from November 13-16 and the 10 speakers of varying experience levels will represent four countries. Presentations will be a mix of live and pre-recorded (referred to by ESA as “On-Demand”) that you will be able

to access on-line from November 28, 2022-October 31, 2023. There will be presentations covering an array of Polyneoptera orders and intriguing topics. If you’d like to attend in person, the event will happen November 16 from 9-11 AM in Meeting Room 206 and you can register for in-person or virtual attendance [here](#) and you can see the speaker line-up by searching the [program](#) for “polyneoptera.” We hope you can attend!

## Regional Reports - What’s happening around the world?

### North America

By **KATHLEEN KING**  
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**F**rom June 9<sup>th</sup> to July 6<sup>th</sup>, the USDA-APHIS-PPQ-Science & Technology Rangeland Grasshopper and Mormon Cricket Management Team conducted field and lab research on Mormon crickets (*Anabrus simplex*) (Fig. 1) in 10 western states, primarily in the Boise, Idaho region, all for the

purpose of improving pest management methods on behalf of the APHIS Rangeland Grasshopper and Mormon Cricket Suppression Program and its myriad stakeholders. Thirty-one outbreaking and non-outbreaking populations (Fig. 2) were collected in nine of the western states visited. These specimens will be the backbone of a planned genomic comparison study to determine if there is a genetic explanation for why some populations outbreak in the billions why others remain tiny and unnoticed, which could potentially enable novel molecular management methods. The field and

lab experiments in Idaho included: 1) determining preference between two common baits in support of an ongoing project with cooperators to develop a nanoparticle-based molecular insecticide that will be deployed using the bait as a carrier, 2) assessing the efficacy of a fungal pathogen-coated bait applied directly on a public road-crossing horde, 3) collecting specimens from highly stressed populations (that often die prematurely) (Fig. 1) for a cooperator project to identify and quantify the culprit pathogen, 4) identifying a local mite species that seems to use Mormon crickets



**Figure 1.** A Mormon cricket (*Anabrus simplex*) horde alongside a creek in Idaho desperately trying to escape the rapidly moving water by grabbing anything available to pull themselves out. Photo by Derek A. Woller.

as primary hosts. Mormon cricket outbreaks are a remarkable natural phenomenon and were the focus of a June news article about an outbreak in Oregon: <https://www.natureworld-news.com/articles/51646/20220630/swarms-of-biblical-proportions-ravaged-crops-in-the-american-west.htm>.

After being in the role since 2017, Derek A. Woller has stepped down as the Team Leader of the aforementioned Rangeland Grasshopper and Mormon Cricket Management Team. On September 11<sup>th</sup>, Derek embarked on a new phase of his USDA career as an Agriculturist (Regulatory Policy Specialist) with PPQ's Regulatory Coordination and Compliance (RCC) unit. Derek was also the lead PPQ scientist for the APHIS Rangeland Grasshopper and Mormon Cricket (GH-MC) Suppression Program. The Team supports the GH-MC program's mission of protecting the health of rangeland habitats in the U.S.A. against economically and ecologically damaging cyclical outbreaks of native grasshoppers and Mormon crickets by finding, testing, and developing better, cheaper, and greener methods of integrated pest management (IPM). During his tenure with the Team, Derek led research, often with cooperators, into novel IPM methods that could be

potential alternatives to traditional insecticides, which are strongly desired by program customers, such as sonic weaponry to repel and/or shift the diets of grasshoppers and a smart molecular insecticide that silences genes in Mormon crickets. Other research

Derek led was integrated into the GH-MC program, like determining which spray nozzles are the best to use on contractor airplanes for the program's insecticide treatments, and determining the efficacy and optimal application rate for an insecticide new to the program. Derek was also instrumental in updating critical program documents and being available to program customers to answer technical questions and assist in resolving critical issues.

The National Grasshopper Management Board (NGMB) held its annual meeting in Salt Lake City, Utah on September 20<sup>th</sup> & 21<sup>st</sup>. This meeting provides an opportunity for private, State, Federal, and Tribal stakeholders interested in grasshopper and Mormon cricket management to come

together for discussions, to learn from each other, and continue best management practices. This meeting is always very informative for me and I enjoy attending. Stay tuned for a summary of the meeting in the next newsletter.

The Entomological Society of America is joining up with the Entomological Society of Canada and the Entomological Society of British Columbia for an exciting 2022 Joint Annual Meeting taking place this November 13-16 at the Vancouver Convention Centre in Vancouver, British Columbia. The theme for the meeting is "Entomology as inspiration: Insects through art, science and culture." There will be wonderful plenary speakers, presentations, posters, exhibits and social engagements, including two Polyneoptera events: an Orthoptera Networking Event November 14 hosted by the **Global Locust Initiative** and oral presentations during the Organized Meeting, "Small Orders, Big Ideas (Polyneoptera)" (see promotion article on page 3 in this issue) on November 16. For more information about this meeting visit [here](#). Hope to see you there!



**Figure 2.** A) 1st instar Mormon cricket (*Anabrus simplex*) from a non-outbreaking population in Colorado; B) Derek A. Woller hunting for specimens of said population at ~3,600 m. Photo by Derek A. Woller.

# Australia, New Zealand & Pacific Islands

By **MICHAEL KEARNEY**

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In news from Australia, a group of us published a paper on the parthenogenetic matchstick grasshopper *Warramaba virgo* (<https://www.science.org/doi/abs/10.1126/science.abm1072>) showing that it had a single hybrid origin, has extremely low diversity, and shows no evidence for hybrid vigor or hybrid breakdown. We conclude that there has been no apparent cost to getting rid of sex and males in this species, and we suggest that the reason we rarely see parthenogenesis evolve is because of constraints on its origin. We also wrote a popular article on this study: <https://pursuit.unimelb.edu.au/articles/the-australian-grasshopper-that-s-given-up-sex>.

This winter, the Kearney and Hoffmann lab groups have continued with our translocations of the matchstick grasshopper *Vandiemenella viatica* across Victoria, including releases into Royal Park in the city of Melbourne. The Lord Mayor of Melbourne took part in the release which was publicised on local TV news (Fig. 1). We also had the Mayor of the Bayside City Council take part in a release of these grasshoppers into a remnant of coastal heath in the south of Melbourne. It is encouraging to see so much interest and enthusiasm from the public about invertebrate conservation.

Other news from the Kearney lab is that Anwar Hossain handed in his thesis entitled “Understanding the patterns of distribution and environmental responses in Australian grasshoppers based on historic field survey notebooks.” He digitised Ken H. L. Key’s field notebooks and geocoded ~9000 survey sites for ~500 species of



**Figure 1.** Lord Mayor of Melbourne Sally Capp (right) with Michael Kearney (left) and 50 *Vandiemenella viatica* specimens ready to release into a city park.

Australian grasshopper and undertook some sophisticated spatial modelling with the data. We are in the process of uploading all the notebooks to the Biodiversity Heritage Library.

News from Kate Umbers’ group is that *Kosciuscola restrictus* is being formally nominated for an EPBC Act conservation advice and that their phylogenetic work on museum specimens of the spectacular mountain katydid *Acripeza reticulata* is moving ahead quickly and successfully with the final bout of DNA extractions having begun this month.

Finally, from Dave Rentz, the Peppermint Stick Insect Study Team from the University of New South Wales, Sydney recently visited the Daintree region of Queensland to observe the biology, physiology, and ecology of several populations of the Peppermint Stick Insect, *Megacrania batesii*. They are a truly international group of scientists (Fig. 2).



**Figure 2.** The Peppermint Stick Insect Study Team (left to right). Soleille Miller, U.S.A.; B. Rentz (host), Australia; Daniela Miller, Peru; Jigmidmaa Boldbaatur, Mongolia; Russell Bonduriansky (leader), Ukraine.

# West Europe

By **GERLIND U.C. LEHMANN**  
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In May of this year, a BioBlitz in Armenia and Georgia took place aiming to collect as many insect species as possible within a short time. The overall goal is to sample insects in the Caucasian region suitable for barcoding and establish a huge database. This project is a joint initiative of the Caucasian countries, called CABOL (Caucasian Barcoding of Life), building on the existing knowledge of GBOL (German Barcoding of Life), which has been running successfully for several years. The project is financed by the German Federal

Ministry of Education and Research, and managed by the Zoological Research Museum Alexander Koenig (ZMFK) in Bonn, Germany in cooperation with many local partners. The group this year consisted of invited scientists from Georgia, Armenia, Germany, Poland, Czechia, and Russia, bringing different views and knowledge together. We (Fig. 1) joined the trip as experts for Orthoptera and enjoyed the tour very much, discussing insect topics with our colleagues.

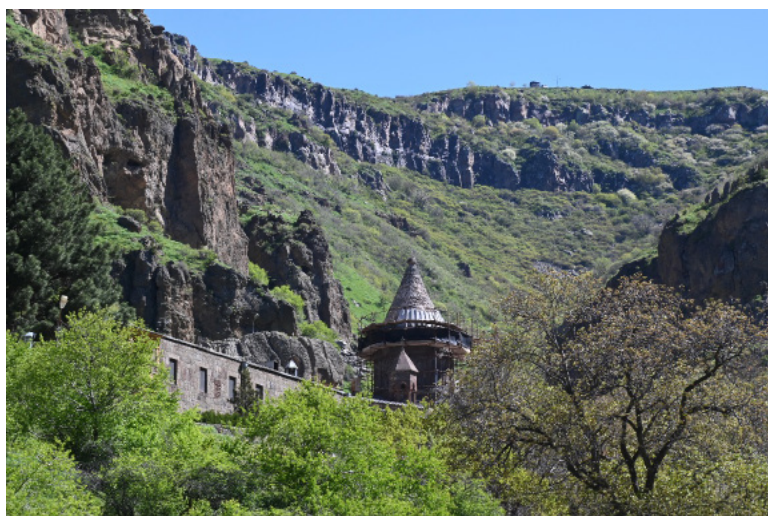


**Figure 1:** The author with her husband, another orthopteran expert close to the monastery Khor Virap, Armenia.

To gain more public visibility, a Citizen Science event took place in Erivan, the capital of Armenia. A BioBlitz was organized in the Botanical Garden. During one intensive day, the insect experts for different groups,



**Figures 2 (left) and 3 (right).** Interested locals, together with experts, identify Orthoptera in a meadow in the botanical garden of Erevan, Armenia.



**Figure 4.** Monastery of Geghard and the Upper Azat Valley



**Figure 5.** Last sampling of the day in the evening before it starts to rain.

as well as specialists for vertebrates, offered walks and talks for the public, supported by broad media coverage. People visiting the botanical garden were asked to participate and invited to join in, which a lot of them did with great enthusiasm (Figs. 2 and 3). All specimens collected during the BioBlitz were brought to Germany, where Barcoding is underway for

many of them. Organized by the ZFMK, CABOL has its own [website](#) to inform interested persons about the participating experts, as well as the results of the sampling tours and much more.

Another stop on our collection trip were the surroundings of the monastery Geghard (Figs. 4 and 5), an UNESCO world heritage site, in order

to cover habitats of different altitudes because it is an awesome settlement at an elevation of around 1900m.

Some more intensive sampling days followed before we took our flights home. The tour continued in Georgia for a further BioBlitz attracting more people and collecting even more specimens.

## Latin America

By **MARTINA E. POCCO**

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It is my pleasure to share news on the upcoming scientific meetings and events related to Orthoptera studies. Two symposia will take place in this region before the end of this year.

A symposium on South American Orthoptera (“Ortópteros sudamericanos: Estudios ecológicos, evolutivos, filogenéticos y de manejo”) will be held in Argentina to discuss the most recent studies focused on Orthoptera from South America from an interdisciplinary perspective, integrating several topics (systematics, evolution, ecology, and management, among others). This symposium is organized by Dr. Yanina Mariottini (UNICEN) and Dr. M. Celeste Scatolini (CEPAVE), and there will be 12 presentations. One of these talks will be given by our OS president, Dr. David Hunter. This event will be part of the XI Argentinean and XII Latin American Congress of Entomology (“XI Congreso Argentino (CAE) y XII Congreso Latinoamericano de Entomología (CLE)”) that will be held from October 24th to 28th, 2022 in a hybrid way (in-person and virtual) at La Plata National University, in the city of La Plata, Buenos Aires. This congress is organized by entomologists from La Plata Museum (MLP-UNLP), CEPAVE (CONICET-UNLP), and members of the “Sociedad

Entomológica Argentina (SEA).” In this edition, there will be seven plenary talks given by outstanding entomologists from U.S.A., Mexico and Germany. One of the plenary speakers will be Dr. Hojun Song, who will give a talk on the evolution of locust swarms and phenotypic plasticity in grasshoppers. I am happy that orthopteroLOGY will have excellent representation in this entomological meeting! For more information you can visit the [website of the congress](#).

The other upcoming symposium from our region is the “IX Orthoptera Symposium and II Orthopteroid Insects Symposium,” coordinated by Dr. Daniela Santos Martins Silva and Dr. Natália Maria de Freitas Vicente, that will be held in Brazil at Universidade Federal de Viçosa, in the city of Viçosa, Minas Gerais state, from December 5<sup>th</sup> to 9<sup>th</sup>, 2022. This symposium is free of charge and is organized as a hybrid meeting, allowing for both in-person and online presentations. The program for this meeting includes talks, mini-courses, and posters within seven thematic areas. Since 2006, the Orthoptera Symposium integrates researchers, professors, and students interested in topics related to orthopterans. In this new edition, in addition to the bioacoustics, systematics, ecology, and evolution of Orthoptera and orthopteroid insects, there will be a space to discuss the challenges of promoting an inclusive academic environment for women, black men and women, and the LGBTQIA+ population. For more information, you can send an email to: [simposioortho@gmail.com](mailto:simposioortho@gmail.com)

Another academic event related to

Orthoptera topics held in our region since few years ago, is the OrthopteroLOGY course that Dr. Pedro G. B. Souza Dias teaches as part of the Graduate Program on Zoology at the Federal University of Rio de Janeiro (UFRJ). The course is divided into a theoretical part and field work. In the 2021 course offering, the theoretical classes were online during December (13th-17th), and had seven graduate students from two universities and two invited undergraduate students. The topics covered not only the diversity of the order, with classes about Caelifera (Tetragoidea, Tridactyloidea, Eumastacoidea, Pyrgomorfoidea, and Acridomorpha), and Ensifera (Grylloidea, Gryllotalpoidea, Tettigonioidae), but also about methods of collecting orthopterans, biology, behavior, and bioacoustics of Orthoptera. The invited speakers were: Dr. Daniela Santos Silva, talking about Tettigidae; Dr. Maria Marta Cigliano, talking about Acrididae; Dr. Edison Zefa and Riuler Correa Acosta, talking about bioacoustics.

Finally, on February, 2022, there was a one-week field trip to the Reserva Biológica União, a conservation unit at Rio das Ostras municipality, near Rio de Janeiro, Brazil. During the field trip, the students learned different techniques of collecting orthopterans: active sampling, light collecting, light traps, pitfall traps, moericke traps. They were able to collect an amazing diversity of Orthoptera, including new species, and all the material collected was deposited at the new MNRJ Orthoptera Collection.

# Theodore J. Cohn Research Grant Reports

## Delineation of notoriously difficult species complexes: testing of novel genetic approaches on the example of two sibling species in Central Europe

By SOŇA NUHLÍČKOVÁ<sup>1</sup> & OLIVER HAWLITSCHKE<sup>2</sup>

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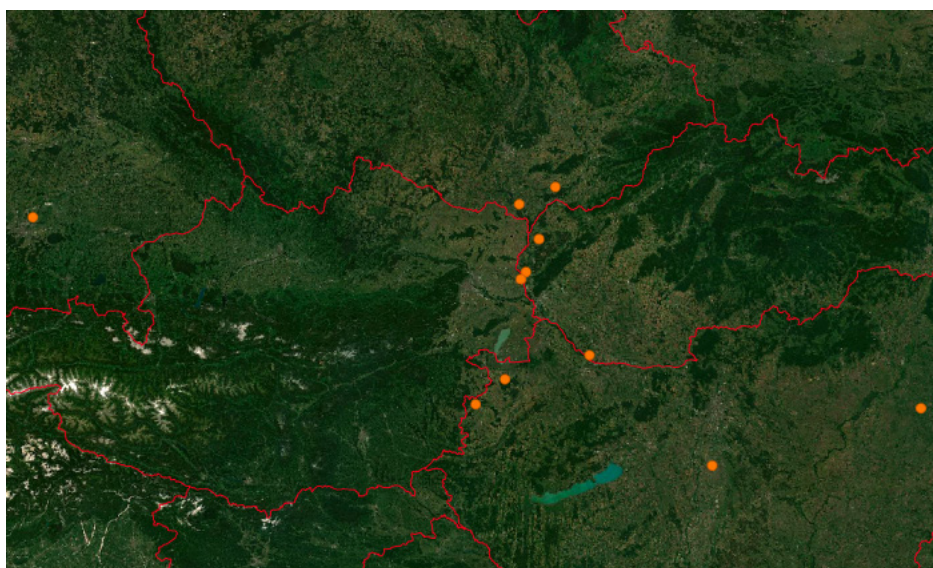
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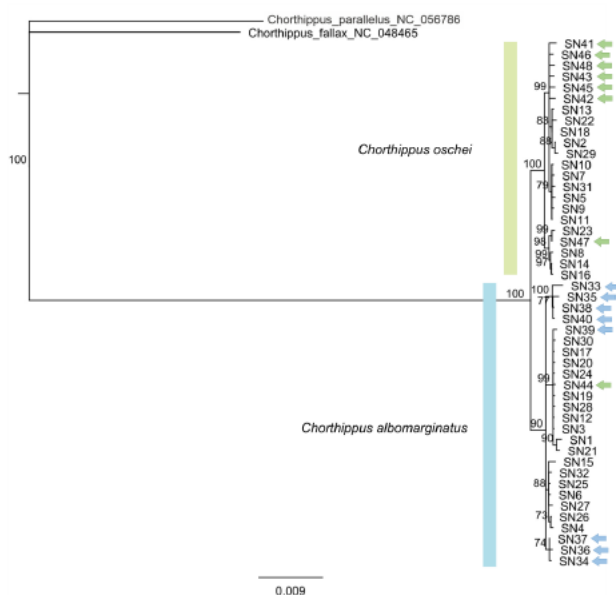
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The Carpathian dancing grasshopper (*Chorthippus oschei*) and the lesser marsh grasshopper (*Ch. albomarginatus*) are two sibling species that are widespread across Europe (Hochkirch et al. 2016), meeting in a hybrid zone in Central Europe. They exhibit distinct courtship behaviour (Vedenina & Helversen 2003, 2009a), but are morphologically nearly indistinguishable, making the identification of the parent species and their hybrids very difficult. Despite numerous field observations (e.g., Vedenina et al. 2009b, Kenyeres et al. 2017, Vlk et al. 2017, Zuna-Kratky et al. 2017), much of the data collected from the Central European region simply refers to *Ch. albomarginatus/oschei* (Kenyeres et al. 2017; Krištín et al. 2020) and if any species were identified, this was often done only tentatively, without systematic evidence (Zuna-Kratky et al. 2017).

Via this project, we were able to collect and provide, for the first-time, novel information about the genetic structure of the two sibling species and their hybrids. Genetic data of 48 males collected along the gradient from the western-most population in Germany (assumed to be pure *Ch. albomarginatus*), through the trans-border area of Czechia, Austria, and Slovakia to the eastern-most populations in Hungary (assumed to be pure *Ch. oschei*) were examined (Fig. 1 and Table 1). As earlier studies based on only a few genetic markers have been uninformative (Vedenina et al. 2007), we used a transcriptomics ap-



**Figure 1.** Selection of model sites along the gradient from Germany to eastern Hungary: five males were selected from each site to examine the level of differentiation between the two sibling species and their possible hybrids.



**Figure 2.** A preliminary tree of all mitochondrial sequences of the dataset, generated via the Neighbor-Joining method in MEGA7. Mitochondrial data is inherited via the maternal lineage only, which is why hybrid specimens cannot be shown as such. Samples of “pure” parental species are indicated with green (*Ch. oschei*) or blue (*Ch. albomarginatus*) arrows. With one exception, all parental samples form part of distinct clusters, to which the samples from the hybrid zone are assigned.



**Table 1.** Genetic data of 48 males collected along the gradient from Germany to Hungary. Explanations: green - parental population assumed to be *Ch. albomarginatus*, red - parental population assumed to be *Ch. oschei*. SN49 and 50: back up samples. NA = not available.

Code	Taxon	Country	Locality	Sex	Pegs
SN1	ChorAlb_complex	Slovakia	Kľúčovec	M	158
SN2	ChorAlb_complex	Slovakia	Kľúčovec	M	170
SN3	ChorAlb_complex	Slovakia	Kľúčovec	F	NA
SN4	ChorAlb_complex	Slovakia	Kľúčovec	M	173
SN5	ChorAlb_complex	Slovakia	Kľúčovec	M	177
SN6	ChorAlb_complex	Austria	Marchegg	M	105
SN7	ChorAlb_complex	Austria	Marchegg	M	127
SN8	ChorAlb_complex	Austria	Marchegg	M	140
SN9	ChorAlb_complex	Austria	Marchegg	M	148
SN10	ChorAlb_complex	Slovakia	Láb	M	122
SN11	ChorAlb_complex	Slovakia	Láb	M	125
SN12	ChorAlb_complex	Slovakia	Láb	M	133
SN13	ChorAlb_complex	Slovakia	Láb	M	147
SN14	ChorAlb_complex	Slovakia	Húšky	M	113
SN15	ChorAlb_complex	Slovakia	Húšky	M	121
SN16	ChorAlb_complex	Slovakia	Húšky	M	124
SN17	ChorAlb_complex	Slovakia	Húšky	M	128
SN18	ChorAlb_complex	Slovakia	Húšky	M	133
SN19	ChorAlb_complex	Czech Republic	Lednice	M	115
SN20	ChorAlb_complex	Czech Republic	Lednice	M	127
SN21	ChorAlb_complex	Czech Republic	Lednice	M	141
SN22	ChorAlb_complex	Czech Republic	Lednice	M	143
SN23	ChorAlb_complex	Czech Republic	Vacenovice	M	117
SN24	ChorAlb_complex	Czech Republic	Vacenovice	M	119
SN25	ChorAlb_complex	Czech Republic	Vacenovice	M	123
SN26	ChorAlb_complex	Czech Republic	Vacenovice	M	133
SN27	ChorAlb_complex	Czech Republic	Vacenovice	M	138
SN28	ChorAlb_complex	Hungary	Sopron	M	132
SN29	ChorAlb_complex	Hungary	Sopron	M	185
SN30	ChorAlb_complex	Hungary	Sopron	M	163
SN31	ChorAlb_complex	Hungary	Sopron	M	165
SN32	ChorAlb_complex	Hungary	Sopron	M	117
SN33	ChorAlb_complex	Germany	München	M	106
SN34	ChorAlb_complex	Germany	München	M	112
SN35	ChorAlb_complex	Germany	München	M	120
SN36	ChorAlb_complex	Germany	München	F	NA
SN37	ChorAlb_complex	Germany	München	F	NA
SN38	ChorAlb_complex	Germany	München	F	NA
SN39	ChorAlb_complex	Germany	München	F	NA
SN40	ChorAlb_complex	Germany	München	F	NA
SN41	ChorAlb_complex	Hungary	Hortobágy	M	185
SN42	ChorAlb_complex	Hungary	Hortobágy	M	190
SN43	ChorAlb_complex	Hungary	Hortobágy	M	177
SN44	ChorAlb_complex	Hungary	Hortobágy	M	166
SN45	ChorAlb_complex	Hungary	Hortobágy	M	166
SN46	ChorAlb_complex	Hungary	Hortobágy	M	203
SN47	ChorAlb_complex	Hungary	Apaj	M	189
SN48	ChorAlb_complex	Hungary	Apaj	M	169
SN49	ChorAlb_complex	Slovakia	Láb	M	121
SN50	ChorAlb_complex	Slovakia	Strážne	M	192

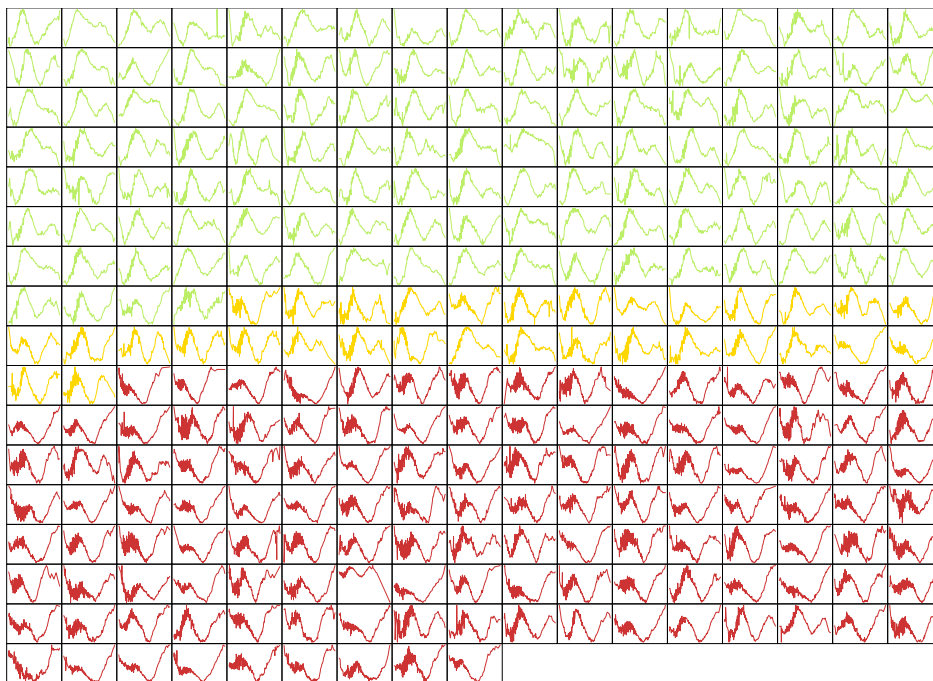
proach with the goal of sequencing as many genes as possible, up to several thousand base pairs vs. the few hundreds included in earlier analyses. In order to generate transcriptomic data, we extracted RNA from samples stored in RNAlater using the protocol described in Hawlitschek et al. (2022). Sequencing of transcriptomes and filtering of raw data was conducted by a commercial provider (BGI, Hong Kong). The transcriptomes were then assembled using Trinity 2.13.2 (Grabherr et al. 2011). To search the transcriptomes for orthologs, we used Orthograph version 0.7.1 (Petersen et al. 2017).

Further analyses of nuclear genes, which have the potential to reflect admixture and distinguish hybrids from parent populations, are still ongoing. Therefore, as a first step, we analysed a set of 13 mitochondrial protein-coding genes. The mitochondrial sequences were aligned using the Muscle (Edgar 2004) algorithm implemented in MEGA7 (Kumar et al. 2016) and concatenated with FASconCAT v1.11 (Kück & Meusemann 2010), resulting in a 11,139 bp mitochondrial dataset. A preliminary Neighbor-Joining consensus tree was computed using the GTR+G+I substitution model with 100 bootstrap replications and otherwise default settings in MEGA7 (Fig. 2). The tree shows two major clusters, probably representing the mitogenomes

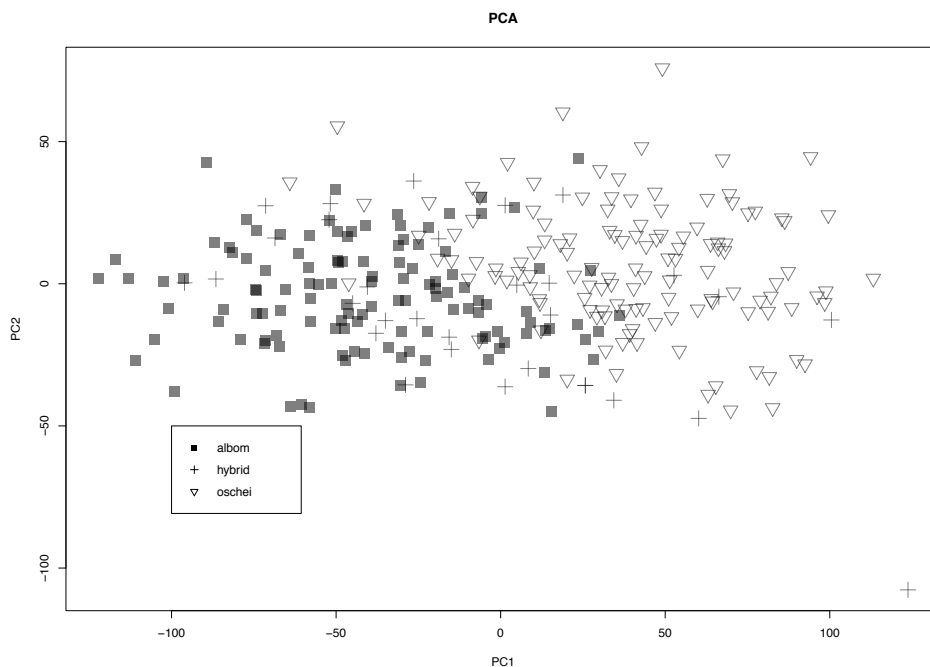
of the two parental species *Ch. albomarginatus* and *Ch. oschei*. As mitochondria are inherited via the maternal lineage only, there is no potential of showing admixture. The tree shows that all samples assigned to pure *Ch. albomarginatus* (SN33 to SN40) and *Ch. oschei* (SN41 to SN48) form part of distinct clusters (for comparison with sampling sites and peg numbers, see Table 1). SN44 (Hortobágy, eastern Hungary) is an exception, due to erroneous assignment to a parental lineage. The remaining samples from the hybrid zone form a part of either of the parental clusters, although several samples indicate a striking intra-population variability (note the ordination of individuals collected in different localities, Fig. 2 and Table 1). Overall, the most important result is that we confirm the existence of distinct mitochondrial lineages of both parental species in the Central European region.

These expectations were also supported by the preliminary morphometric analysis, which was performed on a set of 281 males (including the same males used in the genetic approach) collected in the same sites of Germany, Slovakia, Czechia, Austria and Hungary. Examination of shapes of the stridulatory files have shown a significant difference between all three phenotypes. Our preliminary results indicate two distinct clusters representing the two parental phenotypes. Their putative hybrids (in crosses) exhibit high variability in shape of stridulatory file, from specimens resembling *Ch. albomarginatus* to specimens resembling “pure” *Ch. oschei* (Figs. 3 and 4).

In the next steps of our genetic analysis, we will filter for orthologous sequences of the 1,367 nuclear markers from the insect odb10.2020-09-10 set of the BUSCO v5.3.0 (Manni et al. 2021a, 2021b) marker set from OrthoDB v10.1 (Kriventseva et al. 2019), which is used as a standard in the detection of informative genes from genomic data (Fig. 5). As nuclear markers are inherited by both



**Figure 3.** Rotated and centered configurations of all stridulatory files ( $n = 281$ ). This approach is based on *Procrustes superimposition* – a morphometric procedure that aims to extract shape variables based on an identical number of geometric landmarks for each specimen configuration and their homology. Explanations: green = *Ch. albomarginatus*, yellow = hybrid, and red = *Ch. oschei* morphological phenotypes.



**Figure 4.** PCA plot of two parental phenotypes and their hybrids performed on shape variables. PC1 accounted for 67.5%, PC2 accounted for 12.1% of total variability.

parental lineages, we expect to see possible signs of admixture (hybridization).

Parallel with the genetic and morphometric analyses, our results will also be supported by courtship song analysis. We will describe changes of the courtship song from parental

phenotypes collected in Germany and Hungary through the possible hybrid zone in Central Europe. In total, 301 males will be examined to provide a complex of information based on courtship song, combined with the morphometric analysis of all stridulatory file shapes. We note that the

same individuals were used in all three approaches. Finally, we are convinced that novel genetic approaches employed in this study, together with morphometric and courtship song analyses, will provide comprehensive results that will contribute to delineation of notoriously difficult species complexes like the *Ch. albomarginatus* group.

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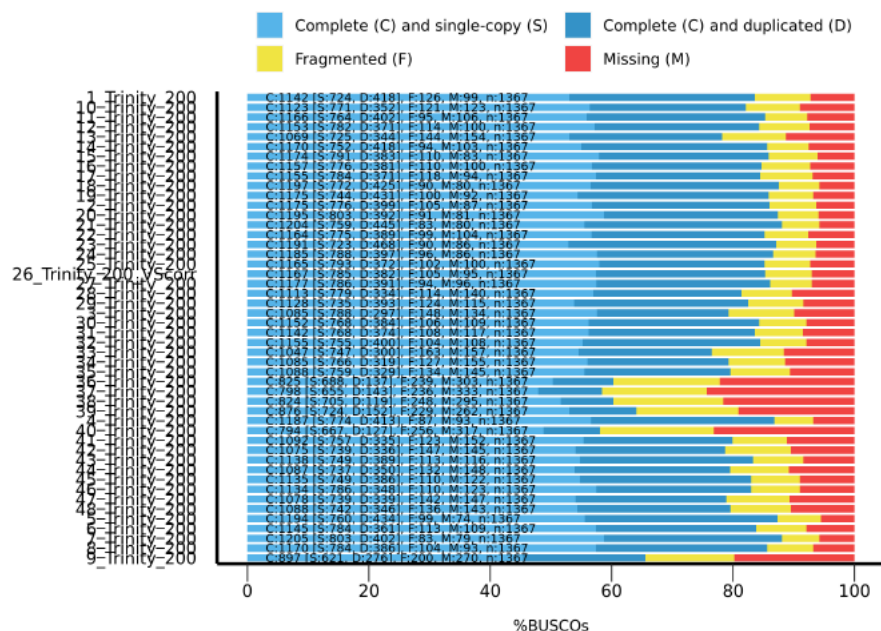
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BUSCO Assessment Results



**Figure 5.** The results of the BUSCO assessment of the transcriptomic dataset show overall good quality. Around 50% of the loci are assigned to complete single-copy genes, resulting in several hundreds of genes available for the further analyses.

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Effects of traffic noise on cricket fitness

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**U**rbanization is expanding each and every day, making anthropogenic influences on local ecosystems important areas of investigation [1]. While adaptive evolution sometimes allows organisms to survive

and persist in changing environments, evolution cannot always keep up with the rate of human-induced change. Phenotypic plasticity, the ability of a single genotype to produce multiple phenotypes, is another mechanism that may help to ameliorate any negative impacts of urbanization and allow

time for evolution to catch up. Developmental plasticity, in particular, where adult traits are influenced by experience during development, may prepare animals for living in urbanized habitats. My recent work has focused on one particular anthropogenic influ-



**Figure 1.** Photo of the Pacific Field Cricket (*Teleogryllus oceanicus*), the cricket species used in this study

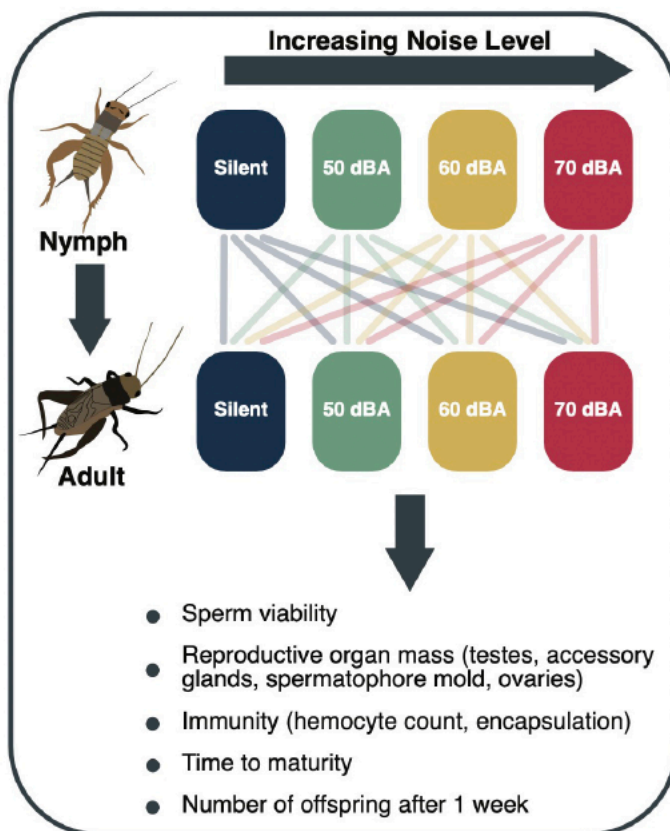
ence, traffic noise, that impacts numerous behavioral, physiological and reproductive traits of a variety of organisms [2]. Human-generated noise causes vocal shifts in various bird [3,4], insect [5, 6], and anuran species [7,8], raises stress hormones in birds and fish [9,10], and reduces clutch sizes of female great tits, for instance [11]. However, most noise pollution research has been conducted in vertebrates, and only 4% of it addresses impacts on invertebrates [12]. Declines in arthropod population sizes have been correlated with noise pollution, which could have drastic impacts on entire communities of interacting organisms [13]. Acoustically communicating insects may be particularly impacted by noise pollution, making them prime subjects for expanding this research area into invertebrates.

I am investigating the impacts of anthropogenic noise in the Pacific field cricket (*Teleogryllus oceanicus*, Fig. 1). In this species, males use calling and courtship songs to attract female mates, and traffic noise overlaps in frequency (pitch) with their range of hearing [14]. This masking effect could have negative impacts on various fitness-related traits (discussed in [15]). Previous work in this study system found that crickets reared in masking traffic noise took 23% longer to reach adulthood, had 13% shorter adult lifespans, and take 80% longer to reach singing males [16,15,17].

I sought to address three questions: 1) What level(s) of noise impact cricket fitness? 2) Are there further immune or reproductive costs of exposure to traffic noise?, and 3) Are there transgenerational impacts of noise on fitness? I used a multigenerational rearing experiment in the lab

in which I exposed animals to one of four treatments: three identical traffic noise tracks played at different amplitudes (50 dBA, 60 dBA, and 70 dBA) or silence. I compiled the traffic tracks by combining 30 second clips from areas around Denver into a 5 min track and adjusting it so the average amplitude was leveled at 70 dBA, 60 dBA, and 50 dBA. I reared crickets (starting at 0-2 weeks old) in the four different noise experiences (Fig. 2). Once these crickets reached adulthood, I randomly assigned them to a new noise treatment for two weeks. This facet of the experimental design allowed me to test whether adult noise exposure could override nymph experience or vice versa, and mimics the animals moving to more desirable (less noisy) environments as highly mobile adults. I then subjected adults to a suite of assays including mating trials, sperm viability assessments, immune assays, and measurements of their reproductive organs. Finally, I reared their offspring in silence and repeated the same assays to assess transgenerational impacts of the noise exposures.

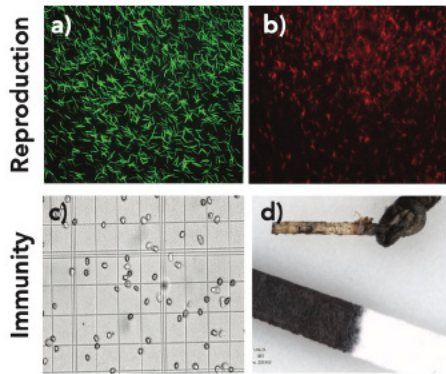
My assays involved collecting large amounts of data (N=412 For F1 and N=684 For F2) in the form of photos such as images of live and dead sperm, hemocytes in a standardized grid area, and melanized encapsulated filaments (Fig. 3). While searching for ways to process these huge datasets, I was introduced to a community science platform called Zooniverse.



**Figure 2.** Fully factorial experimental design for experimental treatments. We reared cricket nymphs in one of the 4 randomly assigned noise treatments and randomly reassigned them to a new treatment at adulthood. We then measured a suite of reproductive and immune traits. This allowed us to investigate whether adult noise experience can override effects from nymph experience.

This platform allows scientists to create projects for their research and connects them with over one million people from around the world who help to process large amounts of data. I collaborated with colleagues Sophia Anner and Mary Westwood to create a Zooniverse project called The Cricket Wing (<https://www.zooniverse.org/projects/marywestwood/the-cricket-wing>) with workflows for counting sperm and hemocyte images (Fig. 4a). Volunteers complete a tutorial that we designed and then count items on the images using a pointer tool built into Zooniverse. Each photo is processed by six volunteers, ensuring reliable counts.

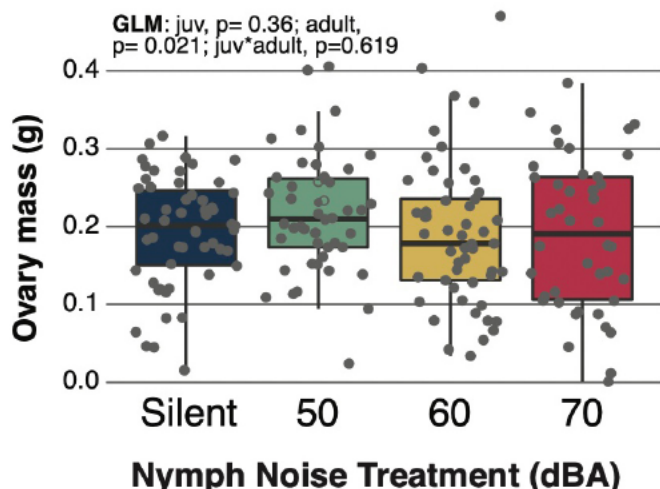
Data processing is still underway, but already we have engaged 895 volunteers in the process and retired 7,825 images (Fig. 4b). Through this platform's Talk Board, we can engage with students and volunteers around the world (Fig. 4c). We have con-



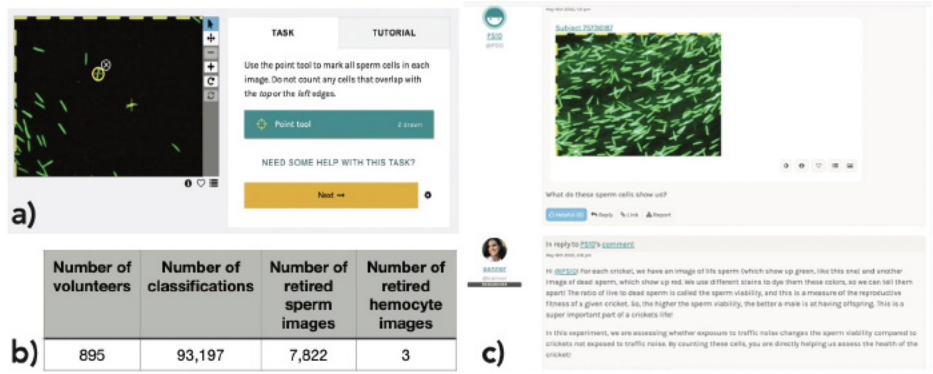
**Figure 3.** Sample images of a) live sperm, b) dead sperm, c) immune cells (hemocytes), and d) encapsulation assay.

nected, for instance, with a group of AP Biology students who processed some of the data for class presentations and are mentoring a high school student who is interested in gaining research experience before college. She is now reading relevant literature and even beginning to learn R so she can conduct preliminary analyses on some of our data. Lastly, we are currently designing a Mini Course to keep volunteers engaged while also teaching them more about the biology of these crickets. Every time they complete processing of 10 images, a little informational blurb will pop up with photos and details about how we performed various methods, why we are studying this, etc.

While we are still in the process of collecting and analyzing the data for this project, we do have some preliminary results showing that noise level does not impact female ovary mass in



**Figure 5.** Preliminary data showing the effect of the noise treatment experienced during the cricket's nymph stage on its ovary mass. Nymph treatment had no significant effect on female ovary mass.



**Figure 4.** Screenshots from the Zooniverse platform for The Cricket Wing. a) Screenshot of platform for counting sperm. Volunteers complete the tutorial and use the point tool to click on all sperm cells in an image. b) Table of count numbers for different measurements of the project's progress on Zooniverse. c) Screenshot of Talk Board where my collaborators and I can respond to questions from volunteers about the research or tricky images.

these crickets (Fig. 5). Stay tuned for further results!

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# Orthoptera Species File Grant Reports

## Contribution to the Orthoptera from eastern Sabah in Borneo, East Malaysia

By **MING KAI TAN**

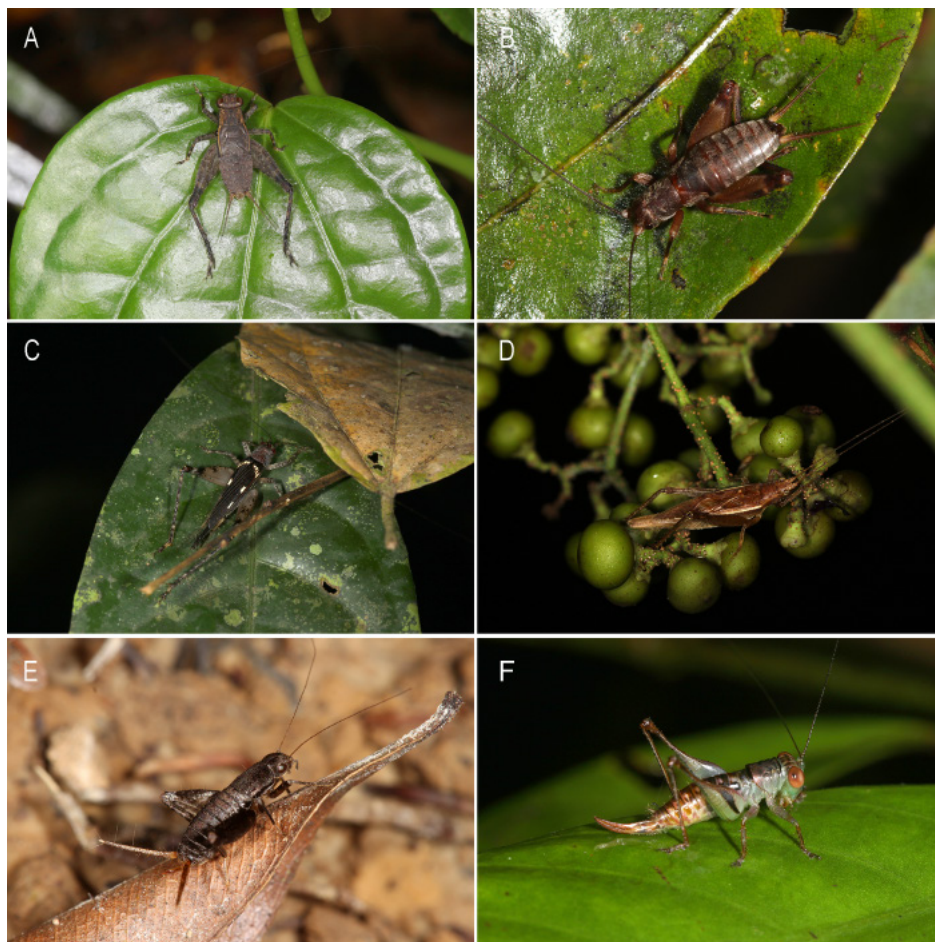
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**B**orneo is known as a biodiversity hotspot. At least 780 species of orthopterans were described from this island, with many more species coexisting there (Cigliano et al., 2022). Nevertheless, owing to the vast area and inadequate sampling, not every part of Borneo is equally well-studied, even when they are accessible to researchers. This can be illustrated in the state of Sabah (East Malaysia): the orthopterans from the western parts, which include the famous Mount Kinabalu and Mount Trus Madi, are comparatively better studied than the counterparts from the eastern parts (Tan et al., 2017). To answer overarching question about the biodiversity of Borneo, specifically, how many species there are, disproportionately more effort is needed to sample eastern Sabah. This is essential to “level the playing field” in terms of our knowledge of Sabah’s rich biodiversity.

To address this gap, a project was funded by a 2019 Orthoptera Species File (OSF) grant aimed at documenting the diversity of orthopterans in and around Sandakan in eastern Sabah. Despite the COVID-19 pandemic disrupting international travel for fieldwork, I managed to collect, examine, and image the orthopterans from eastern Sabah in 2019 and 2022. I was also able to examine specimens deposited in the Forest Research Centre (Sepilok), Sabah Forestry Department, East Malaysia.

### Methods

After obtaining research permit from the Sabah Biodiversity Center District Forestry Officer of Lahad



**Figure 1.** Some new species discovered during the project: **A)** *Falceminthus sandakan* (Tan, Japir, Chung & Robillard 2019), **B)** *Odontogrylodes spinifer* Tan, Japir, Chung & Robillard, 2022, **C)** *Brevimunda trilineata* Tan, Japir, Chung & Robillard, 2022, **D)** *Varitrella (Cantotrella) suikei* Tan, Japir & Chung, 2020, **E)** *Cycloptiloides bimaculata* Tan, Japir & Chung, 2021, and **F)** *Lipotactes kabili* Tan, Japir and Chung, 2020.

Datu, I sampled different parts of eastern Sabah in 2019 and 2022: Kabili Sepilok Forest Reserve, Mount Silam, Kawag Forest Reserve and Tabin Wildlife Reserve. Specimens were collected by sight during day and night. Whenever possible, I photographed the orthopterans in-situ using a Canon EOS 500D digital SLR camera with a compact-macro lens EF 100 mm f/2.8 Macro USM and Canon Macro Twin Lite MT-24EX was used for lighting and flash. Additionally,

specimens already deposited in Forest Research Centre (Sepilok), Sabah Forestry Department, East Malaysia were examined (Tan et al., 2019).

I also recorded the calling songs of crickets and katydids, either in the field or in captivity. Methods for acoustic recording and analyses follow that of Tan et al. (2020, 2022). For species that produce high frequency calls (>25 kHz), a Wildlife Acoustics Echo Meter Touch Pro (sampling frequency of 256 kilo-samples per

**Table 1.** List of species for which images were made available to the OSF during the project.

No.	Subfamily	Species	1st photo	1st live photo	Songs	Named
		<b>Family Acrididae</b>				
1	Catantopinae	<i>Traulia bimaculata</i>	Y	Y		
		<b>Family Chorotypidae</b>				
2	Mnesicleinae	<i>Uvarovia gracilipes</i>	Y	Y		
		<b>Family Gryllacrididae</b>				
3	Gryllacridinae	<i>Monseremus appendiculatus</i>	Y	Y		
4	Gryllacridinae	<i>Phlebogryllacris venosa</i>	Y	Y		
		<b>Family Gryllidae</b>				
5	Eneopterinae	<i>Cardiodactylus borneoe</i>	Y	Y		
6	Eneopterinae	<i>Falcernithus sandakan</i>	Y	Y	Y	Y
7	Eneopterinae	<i>Nisitrus musicus</i>				
8	Eneopterinae	<i>Nisitrus vittatus</i>				
9	Gryllinae	<i>Gryllus (Gryllus) bimaculatus</i>				
10	Gryllinae	<i>Gymnogryllus unexpectus trusmadi</i>	Y			
11	Landrevinae	<i>Duolandrevus (Bejorama) lambir</i>	Y		Y	
12	Podoscirtinae	<i>Varitrella (Cantotrella) suikei</i>	Y	Y	Y	Y
		<b>Family Mogoplistidae</b>				
13	Mogoplistinae	<i>Cycloptiloides bimaculata</i>	Y	Y	Y	
		<b>Family Phalangopsidae</b>				
14	Phalangopsinae	<i>Luzonogryllus (Squamizacla) palawanensis</i>	Y	Y		
15	Phalorinae	<i>Vescelia sepiokensis</i>	Y	Y	Y	Y
		<b>Family Tetrigidae</b>				
16	Metrodorinae	<i>Rostella processus</i>				
17	Scelimeninae	<i>Discotettix belzebuth</i>		Y		
18	Scelimeninae	<i>Scelimena hexodon</i>				
		<b>Family Tettigoniidae</b>				
19	Conocephalinae	<i>Conocephalus (Anisoptera) maculatus</i>				
20	Conocephalinae	<i>Eumacroxiphus (Hyperxiphus) brachyurus</i>		Y		
21	Conocephalinae	<i>Lesina (Ellatodon) blanchardi</i>				
22	Conocephalinae	<i>Sacculiphallus dyaka</i>		Y		
23	Conocephalinae	<i>Salomona borneensis</i>				
24	Conocephalinae	<i>Scytocera (Bornecera) borneensis sandakani</i>	Y	Y		
25	Hexacentrinae	<i>Hexacentrus unicolor</i>				
26	Lipotactinae	<i>Lipotactes (Lipotactes) kabili</i>	Y	Y	Y	Y
27	Lipotactinae	<i>Lipotactes (Mortoniellus) karryi</i>				
28	Meconematinae	<i>Asiophlugis legitima manukan</i>	Y	Y		
29	Meconematinae	<i>Asiophlugis trusmadi</i>	Y	Y	Y	
30	Mecopodinae	<i>Arachnacris tenuipes</i>				
31	Mecopodinae	<i>Mecopoda (Mecopoda) elongata elongata</i>				
32	Phaneropterinae	<i>Ancylecha fenestrata</i>				
33	Phaneropterinae	<i>Baryprostha bellua</i>				
34	Phaneropterinae	<i>Casigneta bisinuata</i>				
35	Phaneropterinae	<i>Dysmorpha obesa</i>				
36	Phaneropterinae	<i>Leptoderes ornatipennis</i>				
37	Phaneropterinae	<i>Phaneroptera (Phaneroptera) brevis</i>				
38	Phaneropterinae	<i>Rectimarginalis ensis</i>				
39	Phaneropterinae	<i>Rectimarginalis fuscospinosa</i>	Y			
40	Phaneropterinae	<i>Scambophyllum sandakanae</i>				
41	Phaneropterinae	<i>Stictophaula elzbietae</i>				
42	Phaneropterinae	<i>Sympaestria acutelobata</i>				
43	Phaneropterinae	<i>Sympaestria lampra</i>				
44	Phaneropterinae	<i>Tapiena incisa</i>				
45	Phaneropterinae	<i>Xantia borneensis</i>	Y			
46	Phaneropterinae	<i>Zulpha perlaria</i>	Y			
47	Pseudophyllinae	<i>Chloracris brunneri</i>	Y			
48	Pseudophyllinae	<i>Cratioma oculatum</i>				
49	Pseudophyllinae	<i>Gonyatopus gemmiculus</i>	Y			
50	Pseudophyllinae	<i>Morsimus quadratus quadratus</i>				
51	Pseudophyllinae	<i>Olcimia dentata</i>	Y			
52	Pseudophyllinae	<i>Onomarchus uninotatus</i>				
53	Pseudophyllinae	<i>Phyllomimus (Phyllomimus) zebra</i>				
54	Pseudophyllinae	<i>Promeca borneana</i>				
55	Pseudophyllinae	<i>Pseudophyllus hercules</i>				
56	Pseudophyllinae	<i>Rhomboptera honorabilis</i>				
57	Pseudophyllinae	<i>Sathrophylliopsis truncatipennis</i>				
		<b>Family Trigonidiidae</b>				
58	Trigonidiinae	<i>Rhincogryllus bipunctatus</i>	Y	Y		

second) attached to a smart phone was used. Otherwise, a Wildlife Acoustics Song Meter (SM) Mini acoustic recorder (sampling frequency of 96 kilo-samples per second) was used.

Methods for processing and curating specimens follow that of Tan et al. (2022). The specimens were preserved in absolute analytical-grade ethanol and later pinned and dry-preserved. I dissected male genitalia and cleaned them using aqueous KOH before preserving them in glycerin or hand sanitizer. The specimens were eventually deposited in: **1)** Forest Research Centre (Sepilok), Sabah Forestry Department, East Malaysia, **2)** Muséum national d’Histoire naturelle, Paris, France, and **3)** Zoological Reference Collection, Lee Kong Chian Natural History Museum, Singapore.

Imaging of specimens follow that of Tan et al. (2019). Close-up images of morphological features (including male genitalia) were done using a macro photo lens MP-E 65 mm 1:2.8 USM (1–5×). Canon Macro Twin Lite MT24EX was used for lighting and flash. All image editing was accomplished using Adobe Photoshop CC 2014.

### Results and Discussion

So far, 248 images of 58 species of orthopterans were deposited in the OSF (Table 1). These include 39 species of katydids, 14 species of crickets, and five species of grasshoppers. This project contributed the first photograph(s) to the OSF for 23 species (40%), and the first in-situ photograph(s) of living specimens in their natural environment for 18 species (31%) (Table 1). Sound files of the calling songs of seven species of crickets and katydids were also deposited in the OSF online. These represents the first documentation of the calling songs for these species.

In total, 13 papers were published based on the material collected in Sabah (Appendix 1), and these include the discovery and description of nine species new to science (six Gryllidae, one Phalangopsidae, one Mogoplisti-

dae, and one Tettigoniidae): *Falcerminthus sandakan* (Tan, Japir, Chung & Robillard 2019), *Duolandrevus* (*Duolandrevus*) *nobilis* Tan, Japir, Chung & Robillard, 2022, *Odontogrylloides spinifer* Tan, Japir, Chung & Robillard, 2022, *Brevimunda trilineata* Tan, Japir, Chung & Robillard, 2022; *Varitrella* (*Cantotrella*) *suikei* Tan, Japir & Chung, 2020, *Varitrella* (*Cantotrella*) *tabin* Tan, Japir, Chung & Robillard, 2022, *Vescelia sepilokensis* Tan, Gorochoy, Japir & Chung, 2019; *Cycloptiloides bimaculata* Tan, Japir & Chung, 2021; and *Lipotactes kabili* Tan, Japir and Chung, 2020 (Fig. 1).

The data collected from the field trips in 2019 and 2022 are still being processed, analyzed, and written into manuscripts. Many more specimens still need to be identified (and verified), as well as to be named and described. In fact, I am in the process of describing at least six more species from Sabah. Images of these species will eventually also be made available in the OSF. Likewise, sound files of more species of crickets and katydids are expected to be deposited in the OSF after the manuscripts submitted for review have been published. As such, the results presented here are merely preliminary and do not reflect the true diversity of orthopterans in eastern Sabah. This is also particularly true owing to the limited sampling sites and the vast forest areas in the region.

#### Acknowledgments

I thank the Orthopterists' Species File for funding this project. I am most grateful of Arthur Y.C. Chung and Razy Japir from the Forest Research Centre (Sepilok), Sabah Forestry Department for supporting my research in Sabah and offering assistance in every possible way during the trips. The permission for research in Sabah was granted by the Sabah Biodiversity Centre (JKM/MBS.1000-2/3 JLD.3 (99) and JKM/MBS.1000-2/2 JLD.10 (179)); Osman Bangkong [the District Forestry Officer (DFO) of Lahad Datu]; Geungnong Ah Jing (the assistant DFO of Lahad Datu); and Jackly Ambrose (the DFO of Ulu Segama-Malua). I am thank-

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#### Appendix 1: List of publications from the project

Tan, M. K., Japir, R., Chung, A. Y. C. & Robillard, T. (2022) New taxa and notes on bark and bush crickets (Orthoptera, Grylloidea, Gryllidae, Landrevinae and Podoscirtinae) from Sabah. *Zootaxa*, 5178(3), 201–228. <https://doi.org/10.11646/zootaxa.5178.3.1>

Tan, M. K., Japir, R., Chung, A. Y. C. & Robillard, T. (2022) A review of the genus *Monseremus* Ingrisch, 2018 (Orthoptera, Stenopelmatoidea, Gryllacrididae) from Borneo. *Zootaxa*, 5165(1), 107–114. <https://doi.org/10.11646/zootaxa.5165.1.5>

Tan, M. K., Japir, R. & Chung, A. Y. C. (2022) Contribution to the taxonomy of *Uvarovia* (Orthoptera: Chorotypi-

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Tan, M. K., Ingrisch, S., Wahab, R. A., Japir, R. & Chung, A. Y. C. (2020) Ultrasonic bioacoustics and stridulum morphology reveal cryptic species among *Lipotactes* big-eyed katydids (Orthoptera: Tettigoniidae: Lipotactinae) from Borneo. *Systematics and Biodiversity*, 18(5), 510–524.

Tan, M. K., Baroga-Barbecho, J. B., Japir, R., Chung, A. Y. C., Wahab, R. A. & Yap, S. A. (2020) A taxonomic study on the Bornean and Philippines sword-tailed crickets in the genus *Rhincogryllus* Chopard, 1925 (Orthoptera: Trigonidiidae; Trigonidiinae). *Zootaxa*, 4763(2), 217–230. <https://doi.org/10.11646/zootaxa.4763.2.5>

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# Razor-backed bush-hoppers (Xyronotidae): diurnal or nocturnal?

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**F**amily Xyronotidae (Orthoptera: Caelifera) consists of four species in two genera (*Xyronotus aztecus*, *X. cohni*, *X. hubbelli* and *Axyronotus cantralli*). This family represents a unique and relict lineage (its closer relative is endemic to Southeast Asia) found in cloud forest in the states of Veracruz, Oaxaca and Chiapas, Mexico. These species are characterized by a laterally compressed body, lack of wings and tympana, and the presence of a crescent-shaped row of stridulatory ridges on the abdomen (Song et al, 2015; Song, 2018).

Xyronotids are rare in collections; the insect collections of the University of Michigan Museum of Zoology (UMMZ) and the Academy of Natural Sciences of Drexel University (ANSP) are the only collections with a good representation of specimens. The UMMZ collection holds the primary type material of three species and UMO at Oxford, UK and Museum d'Histoire Naturelle, Geneva, Switzerland Insect Collections hold type material of *X. aztecus*.

All xyronotids are considered EDGE (Evolutionarily Distinct and Globally Endangered) species. The EDGE species should have a priority in conservation efforts, as they are irreplaceable due to their individuality and the lack of close extant relatives (Mariño-Pérez, 2021). RMP and SSU received a SSC EDGE Internal Grant



Figure 1. Team members and live specimen of *Axyronotus cantralli* from Chiapas, Mexico.

Proposal from the IUCN to conduct fieldwork for two EDGE families: Tanaoceridae and Xyronotidae, in order to obtain new information aiming at providing precise assessments for the IUCN Red List of Threatened Species. In this article, we report on our second field expedition, which targeted the Xyronotidae distributed in Southern Mexico, in the states of Veracruz, Oaxaca and Chiapas.

As usual, we gathered information from specimens deposited at UMMZ, records from iNaturalist and from previous trips we conducted. While our past trips did not specifically target xyronotids, we did have some information, and thus we decided to conduct an expedition on July. We decided to focus in the less common species in the genus *Xyronotus* (*X. cohni* and *X. hubbelli*) because the widely distributed *Xyronotus aztecus* had been previously collected by us

in many localities. Also, we finally, for the first time in our careers, were able to visit the Chiapas region where *Axyronotus cantralli* was collected 60 years ago.

Two weeks before our expedition, SSU visit the region of Agua Pescadito and San Martín Caballero in Oaxaca and successfully collected specimens of the common *Xyronotus aztecus* and of *X. hubbelli*. These records are very important because they extend the range of both species and provide records from lower elevations. We gathered in Mexico City and decided to visit the furthest locality first, so we headed out to El Ocote region in Chiapas State to look for *Axyronotus cantralli*. First, we visited the Parque Laguna Bélgica and after some hours we were frustrated because we could not see any xyronotid despite well preserved vegetations. Then, we encountered



Figure 2. Habitats and different morphs of *Axyronotus cantralli* from Chiapas, Mexico.



Figure 3. Habitat and different morphs of *Xyronotus hubbelli* from La Esperanza, Oaxaca, Mexico.

some local people who gave tour guides there, and when we mentioned what we were looking for, they immediately reply that they have seen them quite frequently. Just to be sure, we showed them some pictures and they confirm its identity. They offered us to take us to a nearby locality where they have recently observed them. We arrived to the locality at

dusk and in less than five minutes, we started to find them. As the night started, it also started to rain, and we were delighted to find even more and to observe how active xyronotids are in dark, humid, and cool conditions in a well-conserved forest. This behavior is quite different to the typical grasshopper that we are used to. We even remembered how tanaocerids

were also quite nocturnal but in a dry environment. The next day, we decided to return but during daytime in order to check as with tanaocerids, their presence. We stopped at the very same place and they were there, during daytime with no rain and with warmer conditions. In Figures 1 and 2, we present members of the team, habitat and live specimens of



Figure 4. Some conservation signs from roads and trails in Santiago Comaltepec County.

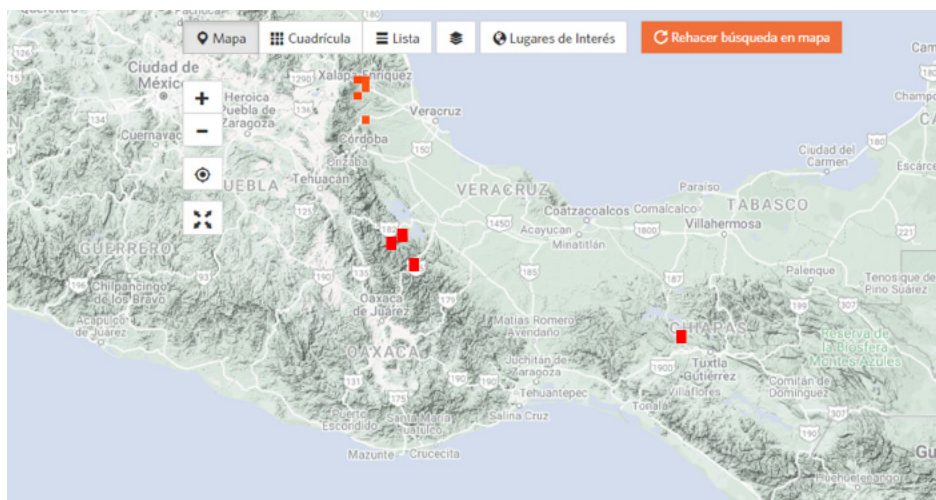


Figure 5. Localities where xyronotids have been recorded.

*Axyronotus cantralli* both at night and day. It was quite impressive to find different morphs; some were brownish while other blackish and some with white pronotum. They were active, eating, copulating and as abundant as the night before. Now we have more evidence to state that xyronotids are diurnal and nocturnal.

We started our way back and we visit the community La Esperanza in Oaxaca State. This community belongs to Santiago Comaltepec County. It was impressive how well preserved and managed this region was, and after a meeting with the authorities, we were allowed to explore the vicinities. Very similar to the *Axyronotus cantralli* locality, we found many specimens during a rainy night and also we were impressed by the very similar morphs, but this time the species was *Xyronotus hubbelli*. Although the females were harder to distinguish between species, the male cerci in males were quite different. In Figure 3, we show the habitat and

specimens of *X. hubbelli* and in Figure 4, we show some of the signs about conservation efforts present in the roads and trails. For both species, we were able to record some videos as well that RMP presented in the International Conference of Entomology in Helsinki, Finland this past July and he will present the same data at the Entomological Society of America Congress in Vancouver, Canada this coming November as well. The local people were very interested in our research and we have established contact for future projects. It is rewarding to share our knowledge to communities that will use it for their conservation action. They already knew about the xyronotids and shared with us many aspects, but now they are aware of their evolutionary uniqueness. They were quite surprised to know that their closest relatives are endemic to Southeast Asia.

Now, in addition to the new material for the UMMZ, the specimens of

the four species of xyronotids from different localities (Fig. 5) have been deposited in at the Arthropod Collection of the Facultad de Estudios Superiores Iztacala (CAFESI), UNAM, Mexico. Without a doubt, there is still a lot to know about xyronotids, but we are in the right direction, and this expedition has provided us valuable information because we were able to revisit the type localities during the same season as well as a different season. Also, we found some new localities and we were able to photograph and record videos of live xyronotids for the first time. Now as part of the SSC EDGE grant final products, we are working on the assessments for the IUCN Red List.

#### Acknowledgments

This expedition was sponsored by the SSC EDGE Internal Grant Proposal “IUCN assessment of two Orthoptera EDGE families” to RMP and SSU. RMP also thanks the Insect Division at the University of Michigan Museum of Zoology for providing additional resources. We also thank Isabel C. Velásquez de la Cruz and Aline A. Pingarroni Martín del Campo for their help in the field to find specimens and taking photographs. Special gratitude to all the people of Agua Pescadito, San Martín Caballero and Santiago Comaltepec, Ixtlán de Juárez communities in Oaxaca and people of Parque Laguna Bélgica in Chiapas for showed us allowed us to visit different localities in their vicinities.

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# *Aspergillus oryzae*, an effective fungal agent against adult locusts

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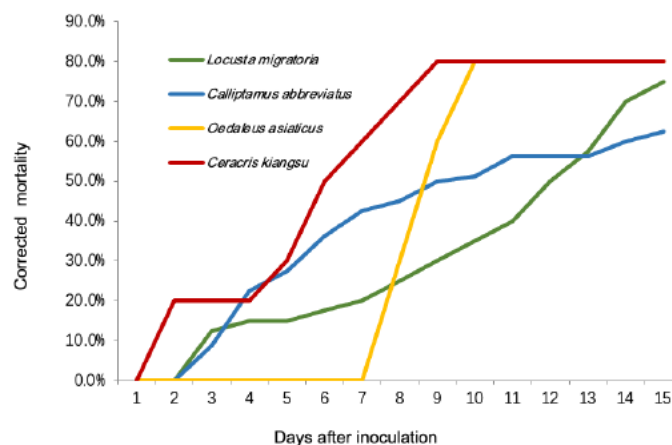
**B**iological control of locusts and grasshoppers are currently primarily dependent on two microbial agents, *Metarhizium* spp. (fungus) and *Paranosema locustae* (Protozoa) (Zhang et al., 2019; Zhang and Lecoq, 2021). These two agents perform well against the early developmental stages (early instars) of locusts and grasshoppers, but are less effective against adults. As we know, locust plagues are mainly caused by swarms of adult locusts because of their ferocious appetites and strong migration ability. Often, because of a lack of an effective biological control method for locust adults, chemical pesticides are used instead, but have known negative side-effects. Therefore, developing a powerful biological control agent for use against locust adults is imperative for managing plagues.

Recently, our group isolated a fungal pathogen from dead locusts identified as *Aspergillus oryzae* (Zhang et al., 2015). Further study indicated that this pathogen caused high mortality of four species of locust adults in the laboratory (Fig. 1): *Locusta migratoria*, *Calliptamus abbreviatus*, *Oedaleus asiaticus*, and *Ceracris kiangsu*.

As shown in Figure 1, *C. kiangsu* and *O. asiaticus* were the most susceptible to *A. oryzae*. They reached a peak mortality of 80% on the 8<sup>th</sup>-10<sup>th</sup> day after inoculation. Following these was *L. migratoria*, its mortality increasing gradually and approaching 80% on the 15<sup>th</sup> day after inoculation. *C. abbreviatus* was the least susceptible, its mortality gradually increasing and finally reaching 60% on the 15<sup>th</sup> day after inoculation. Besides these

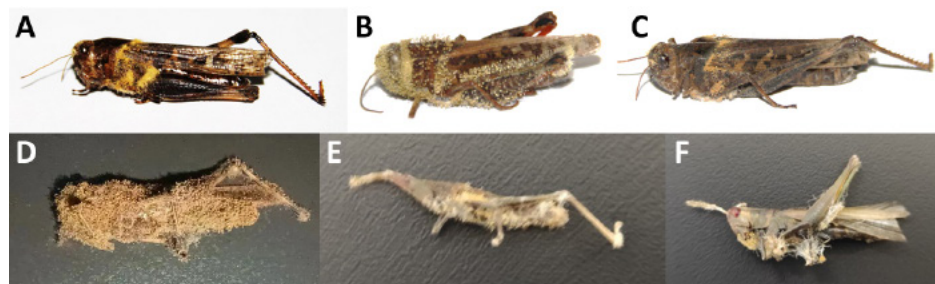
four species, four other orthopteran species have been observed to be infected by this pathogen at the adult stage, two in the genus *Epacromius*, *Atractomorpha* sp., and *Oxya* sp.

To determine if this pathogen is effective for managing adults of grasshoppers and locusts in the field, we conducted field trials in Kenli county, Shandong province, China during 20<sup>th</sup> of June to 23<sup>rd</sup> of July, 2022. The mixture population of locusts consisted of *L. migratoria*, *Epacromius* sp., *Atractomorpha* sp., and *Oxya* sp. in the region. At the time of treatment, all species were almost at adulthood. The *A. oryzae* spores were in a water-based suspension and applied by drones at an application rate of 15 L/ha. Total treated area was 666.6 ha in two plots, one was 120 ha (plot 1) and the other was 546.6 ha (plot 2), separated by more than 2,000 m. An untreated control

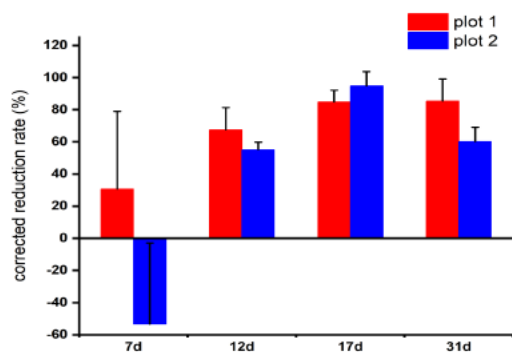


**Figure 1.** Locust adults of four species were susceptible to *Aspergillus oryzae*. The four locust species were: *Locusta migratoria*, *Calliptamus abbreviatus*, *Oedaleus asiaticus*, and *Ceracris kiangsu*. The inoculation of the *A. oryzae* spores was at a concentration of  $10^8$  spores/ml.

plot was located 100 m away from plot 2. The densities of locusts were estimated on the day before treatment, and on the 7<sup>th</sup> day, 12<sup>th</sup> day, 17<sup>th</sup> day, and 31<sup>st</sup> day after treatment. The corrected reduction rates of population density of locusts increased since the 7<sup>th</sup> day after treatment and reached the highest (96.84%) on the 17<sup>th</sup> day after treatment in plot 2, while plot 1's highest (85.15%) came on the 31<sup>st</sup> day after treatment (Fig. 3). These results indicate that *A. oryzae* is quite powerful for managing locust adults in the field and the effect can last more than one month.



**Figure 2.** Locust species adults infected by *A. oryzae*: A) *L. migratoria*, B) *C. abbreviatus*, C) *O. asiaticus*, D) *Epacromius* sp., E) *Atractomorpha* sp., F) *Oxya* sp.



**Figure 3.** The corrected reduction rates of locusts in field trials in Shandong Province, China, 2022. Red box is plot 1, blue box is plot 2.

#### Acknowledgements

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# Proceedings of the 2022 ICE Symposium in Helsinki, Finland: “Polyneoptera for Our Planet”

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**W**e organized a Symposium (“Polyneoptera for the Planet”) at the International Congress of Entomology (ICE), which occurred in Helsinki, Finland from July 17-22. This event was supposed to happen in 2020, but, as we’re all aware, a global pandemic decided it had to wait until 2022. We had eight speakers of varying experience levels participate in the symposium, representing seven countries (Argentina, Australia, Canada, France, Germany, Japan, U.S.A.) and three polyneopteran orders (Blattodea, Orthoptera, Phasmida). As always, we attribute the majority of the event’s success to the wonderful speakers and their engaging presentations, which covered a diverse array of topics. If you would like to learn more about the presentations, a brief abstract and figure for each are provided below in

the order they were presented in the symposium.

#### *Gryllus veletis*: A model for insect freeze tolerance

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Many insects can survive low sub-zero temperatures by withstanding internal ice formation: they are freeze tolerant. A range of Orthoptera are freeze tolerant, most famously the New Zealand alpine wētā, *Hemideina maori*. However, although we know a lot about the physiological correlates of freeze tolerance from work on field-collected animals, progress on understanding the underlying mechanisms has been hampered by a lack of a tractable laboratory model. Laura Ferguson, a Ph.D. student in my lab

at the time (now faculty at Acadia University), accidentally discovered that *Gryllus veletis* (Fig. 1) was freeze tolerant when she brought animals in from an outdoor field overwintering cage as part of an ecoimmunology experiment. Zander McKinnon spent his MSc developing an acclimation regime of shortening photoperiod and declining, fluctuating temperatures that induces freeze tolerance (survival of -8.5°C for a week and -12°C for 1.5 hours), and Ph.D. student (now faculty at St Francis Xavier University) Jantina Toxopeus identified the genes and cryoprotectants associated with this acquisition of freeze tolerance. We have been able to move beyond these descriptions to use *G. veletis* to test some long-standing hypotheses. For example, Jantina showed that the three components of the cryoprotectant system provide different kinds of protection, while students Adam Smith and Kurtis



Figure 1. *Gryllus veletis*.

Turnbull showed that there is a significant metabolic cost to thawing out after freezing. My lab is now working to develop *G. veletis* as a model for freeze tolerance, including assembling a genome, developing tools such as RNAi, tissue-specific tools to study gut, renal, and neural function, and to explore the role of metabolism and oxidative stress in freeze tolerance.

### The implications of chemical defence on animal decision

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Decisions made by prey during a predator attack have direct impact on fitness. Flight initiation is a decision made by prey to deploy defensive tactics during a predator attack. As this predator-prey interaction affects the survival of the prey, there is strong evolution for these defensive strategies. When considering the importance of such a strategy, the timing of when this defence is used in a predator attack is also critical. Accordingly, the “flight-initiation hypothesis” describes the ability for prey to choose optimal times to “fight or flight” based on the costs and benefits of either option. This decision-making process relies on the defence strategy being used, where the prey is in relation to its refuge, the relative location of the predator, and the speed at which a predator attacks. Whilst this concept is extensively researched among defence strategies, there is no understanding for where chemical de-

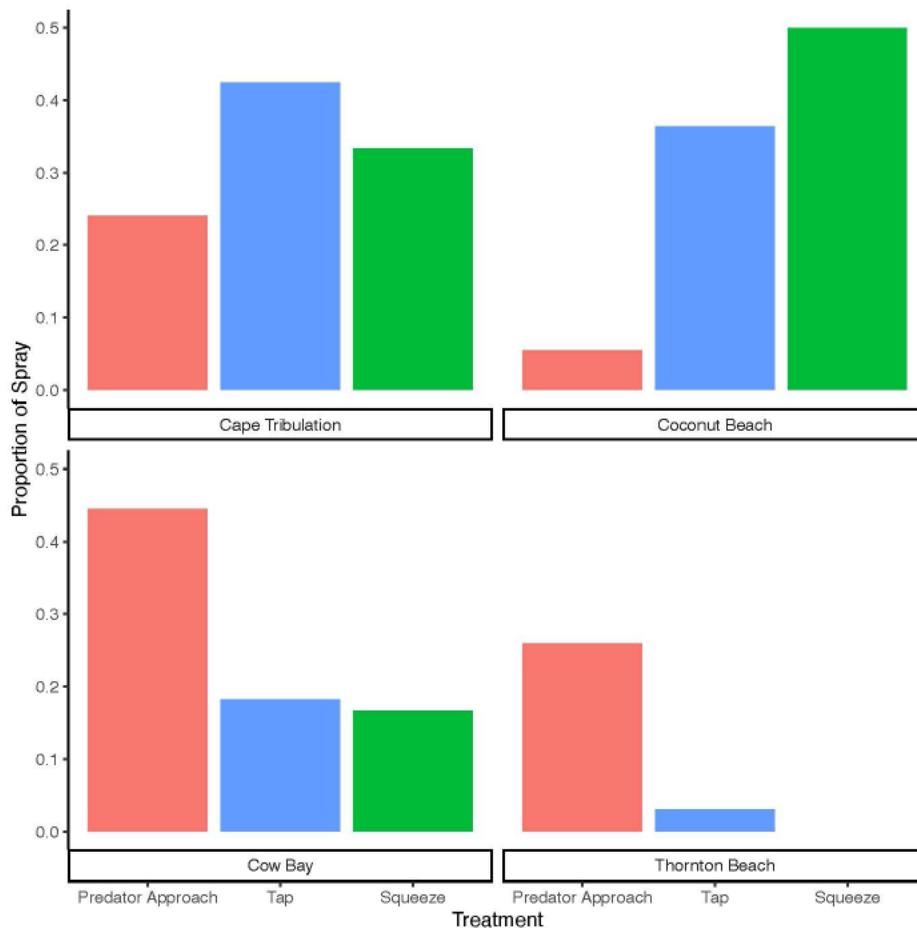


Figure 2. The proportion of sprays across all mixed and single sex populations. The percentage of spray is listed for each population, Cape Tribulation and Coconut Beach (mixed populations), and Cow Bay and Thornton Beach (single sex populations).

fence fits in this hypothesis.

By looking into the chemical defence of the Peppermint stick insect (*Megacrania batesii*), we used this insect as a model to bring chemical defences into light with flight initiation. Experiments on wild individuals were conducted to examine the relationship between likelihood of spraying relative to distance and slope to refuge. A simulated predator sequence was used to elicit spray response, being predator approach, tap, and squeeze in that order. The predator approach was pre-contact, tap was simply a tap with the handle of a paint brush, and the squeeze was a finger pinch. We further considered sex differences and variation in reproductive preferences of multiple populations (Population 1: sexual, Population 2: asexual).

We found, unexpectedly, that spraying and refuge retreat were coupled in a way not unlike that used by squids.

In general, though, in mixed-sex populations the subjects as predicted were more likely to spray and retreat pre-contact the further they were from the refuge (Fig. 2). Their strategy transitioned to delaying spray and retreat upon contact the closer the prey were to the retreat. This observation though was only upheld in mixed sexed populations, in female only populations however, the subjects were more likely to spray and retreat pre-contact and at any distance.

### Edge lineages in Orthoptera (Xyronotidae and Tanaoceridae): current status and challenges

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The Orthoptera family Xyronotidae (Fig. 3, left) consists of four



**Figure 3.** Orthoptera EDGE lineages. **Left.** *Xyronotus hubbelli* (male) (Xyronotidae) from Oaxaca, Mexico. **Right.** *Tanaocerus koebelei* (female) (Tanaoceridae) from California, USA. Photos by RMP.

species and they are a unique and relict lineage (their closest relative is endemic to Southeast Asia) found in cloud forest in the states of Veracruz, Oaxaca, and Chiapas, Mexico. The family Tanaoceridae (Fig. 3, right) consists of three species, and they are an unusual and relict lineage with very restricted distribution in desert habitats in the southwestern U.S.A. (California and Nevada) and northern Mexico (Baja California). They are small, wingless and are unique in all grasshoppers in having long and fili-form antennae (longer than the entire body itself). Both families are relict lineages, evolutionary distinct from their closest relatives, possess unique stridulatory structures, and have very narrow distributions threatened by land conversion. Both taxa are priorities (targets) of the Grasshopper Specialist Group and here we discuss new and valuable information from recent expeditions sponsored by an SSC EDGE Internal Grant. Now, we will be able to provide precise IUCN assessments that will help stakeholders to make decisions to protect their habitats. People from Mexico and the U.S.A. will benefit, as well as humanity, in general, because these two EDGE lineages will be better understood.

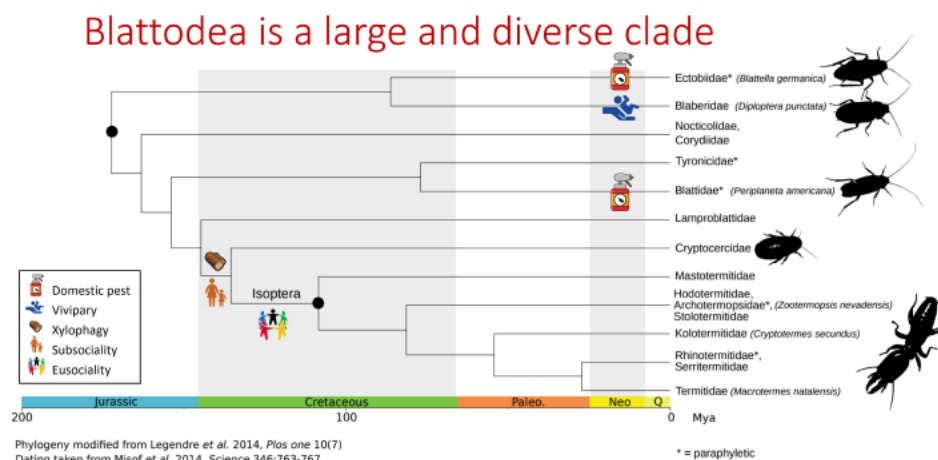
### Social and Anti-Social Cockroaches

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Blattodea is a large and diverse clade (Fig. 4) comprising over 4,600 cockroaches and around 3,000 termite species. Innovations in the order of Blattodea include various reproductive strategies, such as viviparity (*Diploptera punctata*) and eusociality (Isoptera), as well as a wide range of feeding behaviours, like omnivory (e.g., the pest species, *Blattella germanica* and *Periplaneta americana*) and xylophagy (e.g., Crypocercidae & lower termites). Blattodea, therefore, represents an attractive clade for studying the evolution of complex traits with comparative genomics. However, to-date, only two cockroach

and five termite genomes have been published, which is likely related to the difficulty of sequencing and assembling these large (cockroaches: >2Gb; termites: >1Gb) and highly repetitive (most >50%) genomes. A more recent (currently in review as Fouks et al., 2022) genome assembly of the live-bearing *D. punctata* is the first available Blattodea genome produced with long-read technology, leading to a considerably higher contiguity (contig N50: 1.4Mb) than the previously published short-read genomes (12.1-61.8Kb).

In our group, we use comparative genomics to investigate the evolution of complex traits in Blattodea. Here, I concentrated on two publications. In a further study, which is currently in review, we investigated the evolutionary mechanisms linked to viviparity in insects. This study was not covered in my conference talk, but I invite readers to consult the [preprint \(Fouks et al. 2022\)](#). In 2018, we sequenced and assembled the third termite and the first cockroach genome, in order to investigate the molecular evolution of eusociality in Blattodea. We found major gene family expansions in the cockroach, but large reductions at the root of termites. Interestingly, gene family expansions that did occur within termites were likely assisted by transposable elements (TEs) in flanking regions caused by unequal crossing-over. Furthermore, we presented evidence for changes in



**Figure 4.** Blattodea phylogeny.

transcriptional regulation along with the evolution of eusociality, such as shifts in DNA methylation patterns and expansions of zinc finger transcription factors. An adaptive evolution of chemical communication was supported by expansions of Ionotropic Receptors with significant positive selection within ligand binding lobes, especially within the higher termite, *Macrotermes natalensis*, for which a more sophisticated colony communication can be expected.

We were also **interested** in understanding how the German cockroach, *B. germanica*, an absolute omnivore and domestic pest, adapted to such a challenging, inhospitable environment, developing efficient defence against pathogens and resistance to pesticides. Accordingly, we found major expansions in gene families with important functions related to defence, digestion and perception. Many of these expansions in gene families arose via tandem duplications that were promoted by transposable elements in flanking regions. Gene duplications likely led to a divergence in enzyme specificity, supported by variation in expression of selected, expanded gene families across developmental stages.

### Knockdown of an accessory gland protein gift in male nuptial gifts influences female feeding behavior and sperm receipt in decorated crickets

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Sexual reproduction is a cooperative endeavor, but the interests of the sexes frequently diverge, leading to sexual conflict. Such conflict is common among insects, and is often characterized by males that attempt to manipulate female behavior and physiology to increase their share of paternity. One hypothesis posits that males of some species achieve this

by using a nuptial food gift, comprised of materials other than sperm, and offered to females at copulation. In the decorated cricket, *Gryllobates sigillatus*, nuptial food gifts take the form of a spermatophylax, a gelatinous mass forming part of the male spermatophore. The spermatophylax is consumed by the female after mating (Fig. 5), but prior to her removing the sperm-containing ampulla. Feeding on the spermatophylax deters females from prematurely terminating sperm transfer, thereby enhancing the paternity share of the male. In addition, the spermatophylax allows males a direct access to female physiology, and males might thus use this route to even further manipulate females to their own fitness benefit.

In this study, we focused on the effect of spermatophylax protein 1 (SPX1), which is the most abundant protein in the spermatophylax of male decorated crickets. We used RNA interference (RNAi) to generate a knockdown of SPX1 expression and tested its effect on spermatophylax feeding duration and the latency to remate in females. We found that females fed for a shorter time on spermatophylaxes generated by SPX1-knockdown males, and that these same females fed longer on the spermatophylax offered to them during a second mating with a control male. Additionally, we found that the knockdown of the SPX1 gene also influences the overall mating success of male crickets. As such, SPX1 seems to play an important role in mediating sexual conflict in this species, enhancing paternity by increasing a male's sperm transfer time, while decreasing that of a competitor in the next mating.



**Figure 5.** Female *Gryllobates sigillatus* bending down to grab a spermatophylax that was just attached by a male. The sperm-containing ampulla will remain attached until spermatophylax feeding is finished.

### TaxonWorks-powered Orthoptera Species File (OSF): an integrated web-based workbench for orthopterists

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The **Orthoptera Species File** (OSF) (Fig. 6) is the most up-to-date and complete taxonomic database of the world's Orthoptera (grasshoppers, locusts, katydids, crickets, etc.), both living and fossil. Nowadays, the classification of Orthoptera shown in OSF is used worldwide as the general reference for the group. The field of cybertaxonomy represents the confluence of traditional taxonomic goals with new ones, powered by the full potential of digital technology, information science, and computer engineering. An introduction to **TaxonWorks**, the new platform that integrates the best features of Species File software with new ones was presented. TaxonWorks is an integrated web-based workbench for taxonomists and biodiversity scientists. It is designed to capture, organize, and enrich data, share and refine it with collaborators, and package it for analysis and publication. This new platform, constituted by a collection of open-source tools and services that cover all aspects of





Orthoptera Species File (Version 5.0/5.0)

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## Orthoptera Species File Online

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Figure 6. Homepage of the Orthoptera Species File.

the taxonomic workflow will help to maximize the efficiency of taxonomic work allowing the exchange of data among the orthopterists' community and helping to expand and enhance our knowledge of Orthoptera. The potential of using OSF for integrating many of the most recent cyber-taxonomic tools was discussed. The presentation explored the status of OSF within TaxonWorks as it stands now, and gave an overview of the new features developed that will be used to add, explore, retrieve, and download data from OSF.

## Evolution of symbiosis, colony organization and mandibular defense in termites

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Termites are the oldest social insect lineage, one of the few animal groups able to feed on lignocellulose, and amongst the most abundant animal groups in tropical ecosystems. To understand the key evolutionary transitions during the ~ 140 Ma of extant

termite evolution a robust molecular phylogenetic tree is required. To this end, we used datasets based on transcriptome sequences, ultraconserved element sequences, and mitochondrial genome sequences. Our analyses revise previous molecular phylogenies of Termitidae, a termite family that shares its last common ancestor 50

MYA and represents ~80% of termite diversity. The sister relationships between the Macrotermitinae and the Sphaerotermitinae termite lineages that externally cultivate microbial symbionts indicates that “farming” is possibly a derived trait within Termitidae and that externalization of some of the digestion to fungal or bacterial “gardens” may not have driven the loss of protozoa from ancestral termitids, as previously hypothesized.

Our phylogeny of the second largest termite family, dry wood termites (Kalotermitidae, uncovered their trans-oceanic dispersal capabilities and hinted at their ancestral potential to forage between separate wood pieces. The major remaining challenge is the resolution of relationships within the crown group of Termitidae that rapidly diversified ~35 Ma. Within this group, soldiers independently evolved multiple times a mandibular defensive adaptation, so-called snapping, which allows them to store energy in the form of mandibular elastic deformation that can be rapidly released in a powerful mandibular defensive strike (Fig. 7). Our latest ultraconserved element-based phylogenies and recovery of robust phyloge-

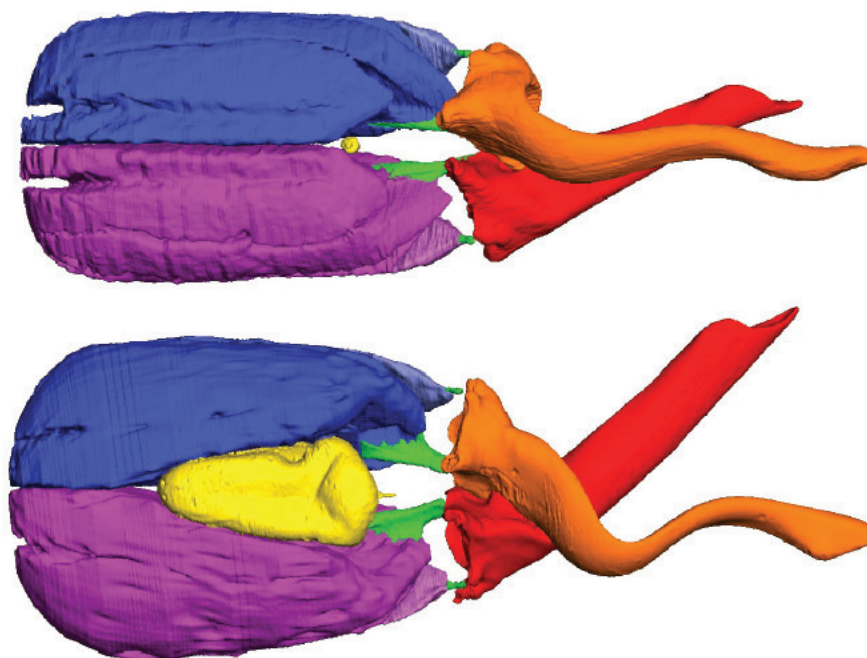


Figure 7. X-ray microtomographic reconstruction of termite soldier heads from two example termite genera (top: *Neocapritermes*; bottom: *Dicuspiditermes*) where soldiers evolved mandibular snapping convergently.

netic relationships are enabling ancestral state reconstruction of mandibular anatomy in termite soldiers hinting at more than five likely independent convergent origins of mandibular snapping (unpublished results). This next iteration of phylogenetic hypothesis will also facilitate understanding of other traits that led to the global ecological success of termites.

**The prevalence of Orthoptera in Late Carboniferous faunas**  
(<https://elifesciences.org/articles/71006>)

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At the end of the 20<sup>th</sup> century, a large proportion of Late Carboniferous insects were classified as “Protorthoptera,” best-understood when considering “Proto-” as the equivalent of our modern “stem-” and “-orthoptera” in its widest sense; i.e., more or less equivalent to our modern “Polyneoptera.” Indeed, the Protorthoptera proved to be a mixture of stem-groups of various polyneopteran lineages and, possibly, including genuine stem-Polyneoptera (besides groups of yet unknown affinities). In the last 20 years, systematic revisions and descriptions of new material from various localities led to tentative identifications of genuine stem-Orthoptera (e.g., Fig. 8) among the protorthoptera, essentially based on wing venation. The idea of a prevalence of relatives of Orthoptera in early insect faunas emerged, although the actual affinities of the corresponding fossil taxa, and, notably, the “lobeattids,” remained debated. Discoveries made

in the Xiaheyan locality provided decisive inputs, in two respects. Firstly, the abundant, exhaustive sample made it possible to provide, for the first time, reliable quantitative data on the abundance of the various insect species occurring in a Late Carboniferous locality. Secondly, it has been possible to observe, in superbly preserved female specimens of a lobeattid species, the occurrence of an ovipositor with two valve-interlocking mechanisms, a unique apomorphy of Orthoptera. The available data depict early relatives of Orthoptera as both abundant and highly diversified as early as 315 million years ago.



Figure 8. Reconstruction of a Carboniferous female stem-Orthoptera laying eggs (from Chen et al. 2021, courtesy of Xiaoran Zuo).

# Editorial

By **HOJUN SONG**

Editor, *Metaleptea*  
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**A**t the end of the spring semester, I developed a long list of things to accomplish during the summer. The list included several manuscripts to finish, two federal grant proposals to submit, several field trips within Texas, data generation and analyses, as well as spending time with my family, etc. I was determined to be productive!

Well, now that I am a month into the fall semester and busy teaching, I realize that I did not really accomplish much over the summer. I managed to publish just one paper, gave up on writing the grant proposals, and did not really do much fieldwork. I made some progress in generating data, but mostly done through my students and postdocs. I honestly don't know how the summer went by. Did I spend time with my family? Yes, I did that, but because we were mostly stuck at home together. The COVID-19 wave did reach our family, and we tried to avoid crowded places as much as possible.

I did do an international trip, though. I usually teach a summer study abroad course on tropical entomology at the Soltis Center in Costa Rica, but this course had been cancelled twice due to the pandemic. This year, we were able to offer it, so we recruited 12 students and spent 16 days in Costa Rica, visiting various habitats near Soltis Center, as well as Monteverde Cloud Forest Reserve and La Selva Biological Station. It was great to be able to go back to the tropics for the first time since 2019. The time in Costa Rica flew by so quickly, and it almost feels like a dream now.

These days, I spend most of my time attending meetings. I have never had so many meetings in my life.

Although we are now meeting folks in person, Zoom meetings still happen everyday. Zoom meetings are great for virtually meeting people across time zones, but having three or four of these meetings back-to-back certainly drains my energy.

I wanted to write a positive note, but I also feel like many of us are feeling the same way, so maybe it's not a bad thing to reflect this sort of sentiment. What is exciting, though, is that the field of orthopterology is vibrant and exciting, as you can read in this issue! We have new students getting interested in Orthoptera and many of the studies published on Orthoptera these days are outstanding. I am hopeful that the field of orthopterology will grow even more, and I am so excited to meet new people and old friends in

upcoming meetings.

This issue of *Metaleptea* is filled with interesting reports and stories contributed by our members. I would also like to thank our Associate Editor, Derek A. Woller, for his continued assistance in the editorial process.

To publish in *Metaleptea*, please send your contribution to [hsong@tamu.edu](mailto:hsong@tamu.edu) with a subject line starting with [**Metaleptea**]. As for the format, a MS Word document is preferred and images should be in JPEG or TIFF format with a resolution of at least 144 DPI. The next issue of *Metaleptea* will be published in January of 2023, so please send me content promptly. I look forward to hearing from you soon!

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