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METALEPTEA

THE NEWSLETTER OF THE ORTHOPTERISTS' SOCIETY

President's Message

By DAVID HUNTER
President
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TABLE OF CONTENTS
(Clicking on an article's title will take you to the desired page)

Dear Society Members,

I bring to your attention the official announcement of the upcoming 14th International Congress of Orthopterology to be held in Mérida, Yucatán, México from October 15-19, 2023, in the Hotel "El Conquistador." Mario Poot, 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 once again we had many applicants for the Theodore J. Cohn Research Grants, there were 21 applications from 9 countries and we were able to fund 10 grants for a total of $15,054. These grants are an important part of our society's support for young scientists and we strongly encourage applications from students and postdocs from around the world that have an interest in Orthoptera and related insects.

As you can see from our Treasurer's Report, our society's investments are still doing well and with the substantial gains over the past few years, we still have about $500,000 more than we had at the end of 2014, the year of the late Ted Cohn's generous gifts to our society. The gains were actually much more than $500,000 because over the past 7 years we have spent

about $300,000 on various projects including moving our *Journal of Orthoptera Research* to open access with Pensoft, with no page charges for Orthopterists' Society members. In addition, there is regular support for Research grants and Young Professionals Awards, for Orthoptera symposia at various meetings, and of course substantial subsidies for travel and expenses for our International Congresses. Over the past few years, we have been setting aside some of the gains into a reserve bond fund that has retained its value well, so that we now have $130,000 in bond and cash reserves that can cover expenses even if there are declines in the stock market investments.

Of course, all of us are continuing our work in ways that work for our circumstances and once again I present another excellent *Metaleptea*, thanks to the tireless efforts of Hojun Song and Derek A. Woller!

The 14th International Congress of Orthopterology: October 2023!

By MARIO A. POOT-PECH
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DAVID HUNTER
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It is with great pleasure that we invite you to join us for the 14th International Congress of Orthopterology in Mérida, Yucatán, México from October 15-19, 2023, in the Hotel "El Conquistador."

This Congress will be organized for the first time in Mexico, under the sub-title "Biodiversity Conservation and Sustainable Management". The Congress will be organized in collaboration with National-International Plant Protection Agencies and teaching-research institutions of Mexico.

As part of the Congress, we will visit and explore aspects of the ancient and wise Mayan culture. The Yucatán Peninsula, located in southeastern Mexico, is a tropical area, full of biodiversity, knowledge, food, and joy. The logo of the 14th Congress features a locust perched on the Mayan symbol of "zaak" (locust), which the Mayans associated with hunger, drought, and death. At the front of the symbol is corn, an important crop for the Mayans, and the Mayan number 14 (four points above two lines). Watch for more information on the Congress website, which will be set up in due course.

14th INTERNATIONAL CONGRESS OF ORTHOPTEROLOGY
Mérida, Yucatán, México

The 2022 Theodore J. Cohn Research Grants Funded

By MICHEL LECOQ
Chair, Theodore J. Cohn Research Fund Committee
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Dear Fellow Orthopterists,

As usual, we received several research proposals this year, mainly from Ph.D. students, but also from undergraduate and Master's students. These proposals came from Algeria, Brazil, Cameroon, India, Israel, New Zealand, South Africa, the United States and Zambia. As usual, the committee's task was not an easy one. Based on their merit and our financial possibilities, we selected 10 research projects for a total amount of $15,054. Below is the list of successful applicants (in alphabetical order by last name) and the title of their research project:

1. **Welliton Carneiro da Silva** (Brazil) - How fire disturbance in the Brazilian Cerrado may affect wood-plant palatability, herbivory rate and grasshopper development.

2. **Mackenzie Farrell** (WI, USA) - Biomechanics of song properties that influence mate choice decisions in *Acheta domesticus.*

3. **Marcos Fianco** (Brazil) - Molecular phylogeny of Phaneropterinae (Orthoptera: Tettigoniidae): including the Neotropical taxa.

4. **Thomas J. Firneno Jr.** (CO, USA) - Effects of temporal variation on the consistency of barrier phenotypes.

5. **Larissa Lima de Queiroz** (Brazil) - Amazonian Proscopiidae (Orthoptera, Caelifera): Biology, behavior and ecology of species along a gradient of topography, soil properties and vegetation in an Amazonian Rain Forest.

6. **Jack McKermitt** (IL, USA) - Operational Sex Ratio and the Evolution of Male Calling Effort in Decorated Crickets.

7. **Jorge Medina-Duran** (TX, USA) - Exploring cophylogenetic patterns between orthopterans and gregarines (Apicomplexa) based on the 18S rDNA marker.

8. **Mari Nakano** (New Zealand) - Location and selection of food plants in sympatric species of endemic New Zealand alpine grasshoppers.

9. **Aarcha Thadi** (MN, USA) - Extreme environments impacting the evolution of reproductive traits in the lava cricket.

10. **Aileen van der Mescht** (South Africa) - Exploring the potential drivers of diel calling patterns of *Acanthoplus discoidalis* (Orthoptera: Tettigoniidae): are emergent activity peaks a result of density dependent competition?

On behalf of all the members of the selection committee, I would like to thank all of our applicants for their participation, congratulate those who have been selected, and wish them good luck in their work. The next call will be in early 2023 and we strongly invite B.S./M.S./Ph.D. students and postdocs from around the world to submit their research proposals. I remind everyone that the only requirement is that the applicant be a member in good standing of the Orthopterists' Society. As usual, upon completion of their research, selected candidates will be asked to provide a brief report, which will be published in our *Metaleptea* newsletter. All information on these grants is available on the website at: http://orthsoc.org/resources/grants-awards/the-theodore-j-cohn-research-fund/

Updates from the Global Locust Initiative

By MIRA WORD[1] & RICK OVERSON[2]
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In February 2022, the Food and Agriculture Organization (FAO) declared the end of the latest desert locust upsurge in the Horn of Africa following a multi-year collaborative effort by organizations and individuals across the region. However, the end of an outbreak is a milestone to cross without losing momentum. Other locust species continue to outbreak, like the brown locust (*Locustana pardalina*) in South Africa and Namibia. The boom and bust nature of locust outbreaks often leads to a loss of vigilance and capacity during recessions. Thus, now is a critical time to continue to engage, build capacity, and share lessons learned. If you haven't yet joined us on HopperLink, our new online community for the Global Locust Initiative Network, we welcome you to do so here! We are 185 members strong and happy to see the lively discussions on topics from anthropology to biocontrol and short films. HopperLink is proving to be a great way to stay abreast of new publications, events, and member projects around the world.

Here at Arizona State University, the Global Locust Initiative is excited to be part of the new Walton Center for Planetary Health, home to the College of Global Futures. The new research building brings together nine institutes and other programs, which aim to bridge disciplines and develop global solutions for the future. The building itself has multiple sustainability features, including a mechanical tree that captures carbon. We look forward to increasing synergistic relationships with other ASU centers and hosting our partners in this new space.

Researchers in the GLI Laboratory are wrapping up a four-year USAID project in West Africa, "Bay Sa Waar" or "Communities for Sustainable Agriculture." The project produced management and identification booklets for farmers in eight languages, initiated an earlier warning system led by women's groups, and introduced a sustainable method for locust management that leveraged the strong soil-plant-locust interactions to reduce crop damage: improving soil fertility. In general, locusts and swarming grasshoppers prefer low protein, high carbohydrate plants growing in poor soils. This project was the first to test the efficacy of soil amendments on a multi-communitywide scale. In areas and years where Senegalese grasshoppers were a problem, fields where farmers applied soil amendments had lower pest abundance and damage, and higher millet yield. Partners from CIRAD will use empirical data collected by Gaston Berger University partners during this project to expand an ecological model that will serve as a community decision-making tool. Bay Sa Waar was made possible through the impressive collaboration of 13 institutions from Senegal, Mali, Niger, the U.S., France, and Canada (Fig. 1).

Figure 1. Final training session in Fass Ngom, Senegal. Photo by Dr. Mamour Toure, Gaston Berger University, Senegal.

Members of the GLI Lab were excited to participate in May's Behavioral Plasticity Research Institute (BPRI) "bootcamp" hosted by Texas A&M University where members across the six institutions met in person for the first time. As part of our ongoing involvement in the BPRI, we are engaging our broad network of stakeholders in community outreach meetings to integrate their research and perspectives into the project.

Updates from the Behavioral Plasticity Research Institute: Bootcamp

By **HOJUN SONG**
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Since the launch in November 2020, the Behavioral Plasticity Research Institute (BPRI) has grown considerably in terms of number of members as well as the scope of research activities. It now consists of nearly 40 researchers and trainees from Texas A&M University, Baylor College of Medicine, Arizona State University, Washington University in St. Louis, Southern Illinois University in Edwardsville, and the USDA ARS. At Texas A&M, we have established a dedicated locust rearing facility housing multiple *Schistocerca* species (including the desert locust and the Central American locust) with a capacity to produce both gregarious and solitarious phases. The BPRI research areas cover genomics, transcriptomics, epigenomics, single cell genomics, genome editing, neurophysiology, collective behavior, nutritional physiology, microbiome, and ecophysiology. It is truly exciting and inspiring to have a group of dedicated people all focusing on understanding locust phase polyphenism in an integrative way!

Because the BPRI launched at the height of the COVID-19 pandemic, most of the originally planned in-person activities and meetings had to transition to a virtual format. While the virtual format did facilitate the interaction among the members across different time zones, we felt that it was not sufficient enough for building a cohesive and integrative team. With the COVID-19 situation becoming under control, we felt the time

was ripe for having the first in-person event for the BPRI. To this end, we organized the "BPRI Bootcamp," which was hosted at Texas A&M University on May 20-21, 2022. A total of 38 participants joined the bootcamp (Fig. 1).

Figure 1. Participants of the BPRI Bootcamp

The aims of the bootcamp were (i) to interact with others in ways that build a better understanding of others' backgrounds, interests, concerns, and priorities related to the BPRI project; (ii) to identify integrative research or collaborative projects ideas and cultivate meaningful relationships; and (iii) to review BPRI progress and identify future directions. On the first day, we started the bootcamp with a visit to the locust rearing facility in the USDA-approved quarantine facility. Then, we had a series of lightning talks by all the PIs associated with the BPRI. Following the lightning talks, we had a series of breakout sessions to develop integrative research questions that can connect various biological subdisciplines to study locust phase polyphenism. On the second day, we had a facilitated discussion on the strengths and weaknesses of the BPRI, followed by the activity on diversity and inclusion, discussion on education and outreach, and trainees' Q&A session. We ended the bootcamp with a "way forward" discussion on how to move forward. Overall, the bootcamp was an excellent opportunity to get to know each other, network and brainstorm ideas, and build an integrative research team.

Regional Reports - What's happening around the world?

India

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Sitting tight
Hiding in plain sight
Entomologists' delight

A good metaphor for how we spent the pandemic years! Unable to travel or interact in person, we as teachers and researchers adapted to the lack of mobility and the solitude. Upgrading tech skills, online lectures and meetings, students as voices and messages, invisible as instructors and teachers. New challenges and new opportunities: one of the biggest being conducting undergraduate biology practicals online. We delved into all our old photographs, videos, data....and built new virtual practical assignments around them. The false leaf katydids and peppered moths (Fig. 1) exemplifying the power of crypsis and of natural selection.....

Even in death, the false leaf katydids came to our rescue. We used the images of their wing and leg remains culled by a bat predator, the lesser false vampire, together with those of other insects, to teach community ecology: predator-prey interactions, diet analysis, and insect identification in one go! (Fig. 2)

For those of us orthopterists in southern India, we did not lose the field seasons, which are in winter, since, luckily for us, the COVID-19 lockdowns and the worst of the pandemic happened in the summer. Also, our field locations are in uncrowded, remote villages and it was considerably more pleasant and safer to be there than in the city! Indeed, we actually managed to carry out a study we had dreamed of for twenty years: tracking radio-tagged male and female false leaf katydids (*Onomarchus uninotatus*) across the landscape to look at the movement patterns of

Figure 1. Photo credits: Rohini Balakrishnan, Mihir Sule

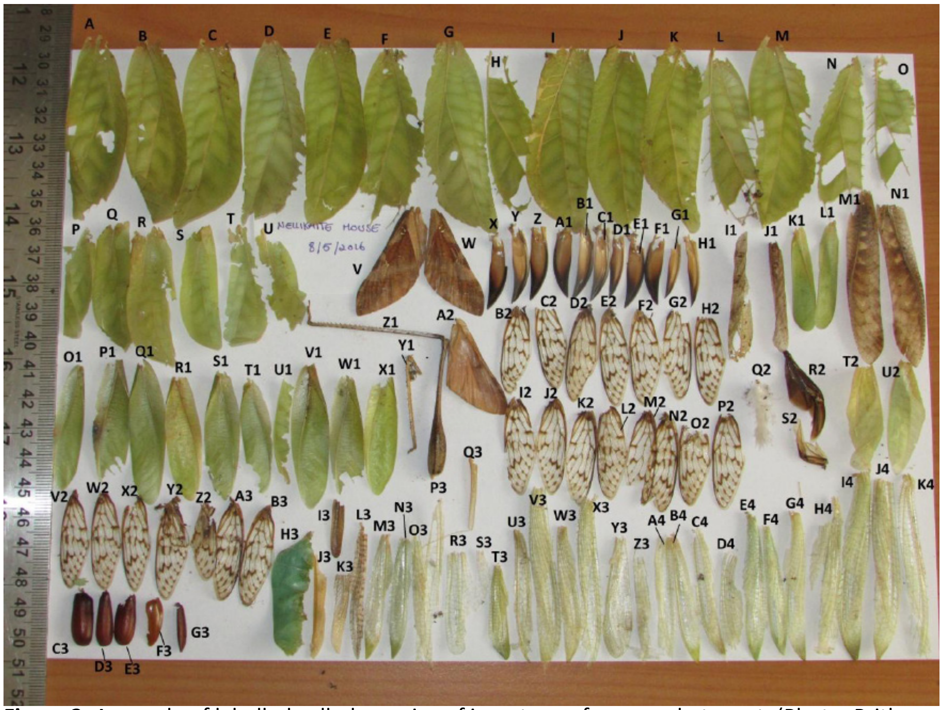

Figure 2. A sample of labelled culled remains of insect prey from one bat roost. (Photo: Pritha Dey)

these canopy insects (Fig. 3).

Many of us used the breather provided by the pandemic to pull out those mounds of unpublished data to analyse, write and publish them! Indeed, the list below of recent publications on Orthoptera from South Asia (even if not exhaustive) reveals this to have been a highly productive period, in spite of the constant threats and challenges posed by COVID-19. Many of us have lost friends, colleagues and relatives to this terrible pandemic, and I dedicate this small write-up to them, and to the fascinating, adaptable false leaf katydids that we have been fortunate to work with, who have taught us so much.

Orthoptera Publications 2021-22

Bioacoustics, ecology and behaviour

Tiwari, C., & Diwakar, S. (2022). The katydid country: bioacoustics and ecology of tettigoniid communities from the Indian subcontinent. *Bioacoustics*, 1-25.

Godthi, V., Balakrishnan, R., & Pratap, R. (2022). The mechanics of acoustic signal evolution in field crickets. *The Journal of Experimental Biology*, 225, jeb243374. doi:10.1242/jeb.243374.

Modak, S., Brown, W. D., & Balakrishnan, R. (2021). Decoupling of female phonotaxis and mating propensity in a tree cricket. *Behavioral Ecology and Sociobiology* 75, 146. https://doi.org/10.1007/s00265-021-03084-3.

Nair, A. & Balakrishnan, R. (2022). Ecological constraints on sexual selection in a human-modified landscape. *Frontiers in Ecology and Evolution*, 9.

Nityananda, V. & Balakrishnan, R. (2021) Synchrony of complex signals in an acoustically communicating katydid. *Journal of Experimental Biology* 224 (9), jeb241877. DOI: https://doi.org/10.1242/jeb.241877.

Prakash, H., Greif, S., Yovel, Y. and Balakrishnan, R. (2021) Acoustically eavesdropping bat predators take longer to capture katydid prey signalling in aggregation. *Journal of Experimental Biology* 224**,** jeb233262. https:**//**doi.org:10.1242/jeb.233262.

Singh, R., & Jain, M. (2021). Variation in call types, calling activity patterns and relationship between call frequency and body size in a field cricket, *Acanthogryllus asiaticus*. *Bioacoustics*, *30*(3), 284-302.

Systematics

Gaikwad, S. M., Koli, Y. J., & Raut, G. A. (2022). First record and description of female *Onomarchus leuconotus* (Serville, 1838)(Insect: Orthoptera: Tettigoniidae) from peninsular India. *Journal of Threatened Taxa*, *14*(2), 20643-20647.

Shah, M. S., & Usmani, M. K. (2022). The Notched-frons Katydids of Kashmir (Jammu and Kashmir) India: new records and a new species of *Euconocephalus* (Tettigoniidae: Conocephalinae: Copiphorini). *Zootaxa*, *5128*(2), 284-294.

Farooqi, M. K., Ahmed, I., & Usmani, M. K. (2021). A New Species of Genus *Duce-*

Figure 3. A false leaf katydid with a VHF radio-transmitter glued to its pronotum. (Photo: Kasturi Saha)

tia Stal, 1874 (Orthoptera: Tettigonioidea: Tettigoniidae) from India. *Transactions of the American Entomological Society*, *147*(1), 11-19.

Hiremath, S. R., & Prathapan, K. D. (2021). Two new species of the genus *Oryctopterus* (Orthoptera: Stenopelmatidae: Oryctopinae) from India, with some notes on biology. *European Journal of Taxonomy*, *748*, 108-137.

Jaiswara, R., Desutter-Grandcolas, L., & Jain, M. (2021). Taxonomic revision of *Teleogryllus mitratus* (Burmeister, 1838) and T. occipitalis (Serville, 1838) in India, with the description of *Teleogryllus rohinae* Jaiswara amp; Jain sp. nov. and a key for *Teleogryllus* species from India (Orthoptera: Gryllidae). *Zootaxa*, *5016*(1), 81-106.

Meena, A. K., Swaminathan, R., & Nagar, R. (2021). Description of a new species of *Gryllotalpa* Latreille, 1802 (Orthoptera: Gryllotalpidae) from India and notes on phenotypic plasticity in the Oriental mole cricket, Gryllotalpa gorkhana Ingrisch, 2006. *Transactions of the American Entomological Society*, *147*(1), 193-202.

Meena, A. K., Swaminathan, R., & Nagar, R. (2022). Occurrence of Three New Species of Crickets (Orthoptera: Gryllidae: Gryllinae) in India. *Transactions of the American Entomological Society*, *148*(1), 113-129.

Meena, A. K., Swaminathan, R., Nagar, R., Chhangani, G., & Kumar, K. (2021). Record of the subgenus, *Gryllitara* Chopard, 1931 (Orthoptera: Gryllidae: Itarinae) and description of a new species from India. *Zootaxa*, *5072*(5), 493-500.

Riffat Sultana, S. S., & Kumar, S. (2021). A review of Gryllidae (Grylloidea) with the description of one new species and four new distribution records from the Sindh Province, Pakistan. *ZooKeys*, *1078*, 1.

Sanam, S., Sultana, R., Bughio, B. A., & Sanam, S. (2021). A Review of the Tettigoniidae Krauss, 1902 (Tettigonioidea: Ensifera: Orthoptera) with a New Species from Pakistan. *Journal of Agricultural Science and Technology A*, *11*, 1-21.

Australia, New Zealand & Pacific Islands

By **MICHAEL KEARNEY**
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In Australia, field work and travel are happening in earnest again. In my last report (October 2021) I mentioned our work, driven by Ph.D. student Hiromi Yagui, translocating wingless “matchstick” grasshoppers (Morabidae) around Melbourne. We translocated ~2,300 individuals of the “Larapuna grasshopper,” *Vandiemenella viatica*, from a remnant to be cleared for housing to 36 new sites, mainly revegetated areas, but also some natural remnants. We are very excited to report that the second generation has emerged at almost all the sites, with quite a range of abundances across sites. We wrote a popular article about the concept of “rewilding” or “renaturing” insects, which you can find here: https://pursuit.unimelb.edu.au/articles/mini-beast-renaturing-a-time-for-local-action

Having developed the proof of concept, we are now undertaking a more extensive translocation program across the state of Victoria with support from the Department of Environment, Land, Water and Planning, and within the City of Melbourne with support from local councils. This is leading to some excellent public engagement about invertebrate conservation as well as helping to secure the future of these low-vagility species. The Victoria-wide surveys have revealed some new populations of the endangered species *Keyacris scurra* and the Department of Transport are providing resources to help manage one of these roadside populations. An honours student, Kimberley Kaufmann, is focusing on understanding the distribution, abundance, and genetics of a poorly known congener known as *Keyacris* P141, which occurs in the north-west of Victoria and was known from only two populations. They occur in a very heavily cleared region (the wheat belt), but, fortunately, we are finding them in remnants of a variety of sizes.

Figure 1. Nullarbor specialist *Austroicetes nullarborensis* (Acrididae) in its yellow form.

Gordon Berg’s Ph.D. thesis was submitted for examination last August. Gordon has now had his degree conferred and the thesis, “The phenology of outbreaks of the Australian plague locust, *Chortoicetes terminifera* (Walker), affecting Victoria,” is now available as an open-access document through the University of Melbourne library “Minerva Access” system. The thesis can be found by searching Minerva (https://minerva-access.unimelb.edu.au/) or by following this direct link: http://hdl.handle.net/11343/297722.

Also, in November last year, I ran the COVID-19-testing gauntlet to cross the border into South Australia to take part in a “Bush Blitz” (https://bushblitz.org.au/) on the Nullarbor Plain. I re-surveyed a number of sites from Ken Key’s Australian National Insect Collection field notes and will report more on what I found in the next issue once the data is collated. A highlight for me, however, was seeing the Nullarbor specialist *Austroicetes nullarborensis* (Acrididae) in its yellow form (Fig. 1).

Kate Umbers, Hojun Song, and colleague’s efforts with the largely alpine genus *Kosciuscola*, mentioned in my previous report, has developed in that *Kosciuscola trists restrictus* has been elevated to a species https://mapress.com/zt/article/view/zootaxa.5071.1.6 and *Kosciuscola restrictus* is now officially listed as CR on the IUCN redlist.

News from our president, David Hunter:

In addition to duties as President of the Society, which have included assessing applications for Theodore J. Cohn Research grants and working with Mario Poot and his team on preparations for the next Congress in the Yucatan, I have been involved in a number of other projects. I am a part-time International Consultant in Integrated Pest Management for an Asian Development Bank project in Pakistan. My work started there during the 2020 desert locust upsurge and during January the work on locusts culminated in an International Webinar that included Keith Cressman (FAO Rome) and Dr. Riffat Sultana (University of Sindh, Jamshoro) who outlined the recent desert locust upsurge and its successful suppression in Pakistan/India. Dr. Chris Adriaansen, Director of the Australian Plague Locust Commission and Heath McRae, APLC officer on secondment to FAO described the APLC system of early intervention and how that system was applied in the Horn of Africa. Heath also introduced the APLC innovations of detecting band infestations from aircraft, treatment of bands by applying a strip of pesticide every 300-500m, and the widespread use of *Metarhizium* biopesticide. We have conducted laboratory and field trials with biopesticides in Pakistan and the results were published recently: Wakil, Ghazanfar, Hunter & Shi 2022: doi.org/10.3390/agronomy12051160.

Recently, I have concentrated on an Asian Development Bank project on the IPM of agricultural pests as part of providing technical support for updating legislation, so that Pakistan can meet World Trade Organization standards for Sanitary and Phytosanitary (SPS) measures for exports, imports, and food safety. An important aspect of ensuring safe products for both local consumption and export is my work with a CABI team who are preparing an App for identification of pests in crops and the uploading of the data into a national database to be used not only by each province to assess the extent of pest outbreaks, but also as a support for assessing pest and pesticide risk for both local and exported products.

My work with locusts in Argentina continues as well: a recently published article analysed aspects of the recent plague of the South American locust that began in 2015 (Trumper et al 2022: doi.org/10.3390/agronomy12010135) that was part of the special issue on Migratory Pests edited by Dr. Michel Lecoq and Dr. Arianne Cease. About once a month, I am asked to review papers for journals or Ph.D. theses, and with our move this month from our house to a 3-bedroom apartment in an over-55 "retirement" village, I have been quite busy recently. One good thing in our new place: we have the latest broadband, so the internet is super-fast!

East Europe - North and Central Asia

By **MICHAEL G. SERGEEV**
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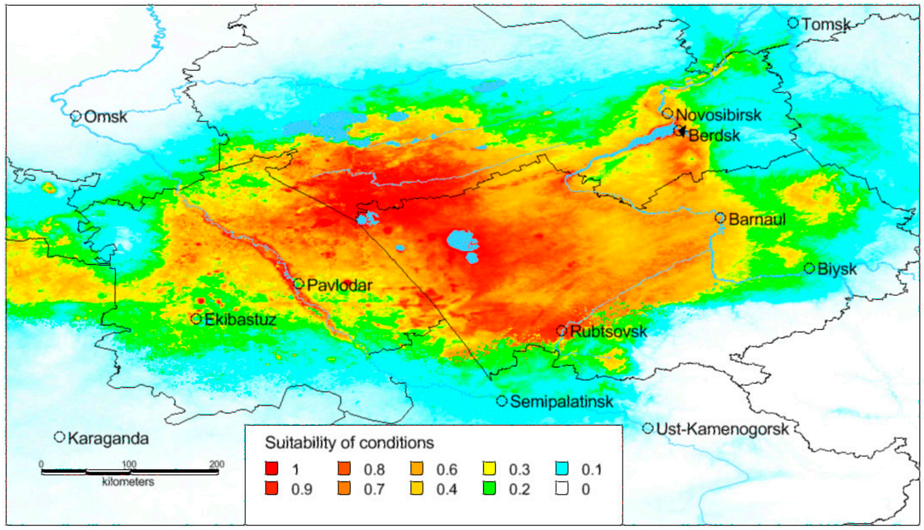
Despite some serious limitations resulting from the COVID-19 pandemic and the complicated political situation our life goes on. In the beginning of January, the FAO published the final version of the book "The Italian Locust *Calliptamus italicus* (Linnaeus, 1758). Morphology, Ecology, Distribution, Population Management" (unfortunately, the version is in Russian only) (https://doi.org/10.4060/cb7921ru). This comprehensive book, written by an international team of orthopterists, consists of ten chapters: **1.** Introduction; **2.** History of the Italian locust studies and population management; **3.** Taxonomic position and morphology of the Italian locust and its relatives; **4.** Intraspecific variability; **5.** Ecological and geographic distribution; **6.** Bionomy and the role in natural and transformed ecosystems; **7.** Outbreaks: main regions and dynamics; **8.** Population monitoring; **9.** Population management; **10.** Conclusion. Additionally, there are two supplements: the first one includes the list of natural enemies of the Italian locust, the second one consists of the set of statistical tables concerning Italian locust population management in Kazakhstan.

The orthopterists from the region attended the European Congress on Orthoptera Conservation (April, 1–2, 2022, Leiden, the Netherlands). The Congress was organized in a hybrid format. This allowed our colleagues from different countries to present their results both offline and online.

In the end of 2021, the group of orthopterists from Novosibirsk State University and Institute of Systematics and Ecology of Animals (Novosibirsk) finished the special project "Ecological and spatial modeling of distribution and dynamics of pest acridid populations in the Novosibirsk Region," financially supported by the joint program of the Russian Foundation for Basic Researches and the Government of Novosibirsk Region (20-416-540004). Quite different patterns of shifts in acridid pest distribution were revealed in the south-eastern part of West Siberian Plain. The range boundaries of several species shifted northward and north-eastward. The distribution patterns of other species didn't change significantly. Some species (e.g., the Siberian grasshop-



Dociostaurus brevicollis (Eversmann): the female in the steppe of Novosibirsk Region and predicted probabilities of suitable conditions for the species in the south-eastern part of the West Siberian Plain (distribution data from 1961 until 2021 and bioclimatic variables for 1970–2000). (Photo by M. G. Sergeev, Map by V. V. Molodtsov & M. G. Sergeev)

per, *Gomophocerus sibiricus* (Linnaeus)) became relatively rare. The Maxent 3.4.4 software was used to model the species distribution over the region for two sets of data: until 1960 and from 1961 until 2021, and for periods between 2021 and 2040, and 2041 and 2060. The ecologo-geographic modeling demonstrated evident opportunities for all pest acridid species to spread northwards (at least up to 58°N) and north-eastwards as well.

Theodore J. Cohn Research Grant Reports

Mantodea diversity of "El Cielo" Biosphere Reserve, Gomez Farías, Tamaulipas, Mexico

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Mantodea is a small order of polyneopterous insects that are characterized by their raptorial first pair of legs and the way females lay a group of eggs inside a protective cover called ootheca (Wieland and Svenson, 2018). Despite their popularity, there are very few works dedicated to summarizing the statal diversity of this very interesting order of insects in Mexico. To date, Reyes-Ibarra (2020), and de Luna & Granados-Corea (in revision) wrote about the fauna of Nuevo Leon, Vázquez-Quintero (2017) on the fauna of Sinaloa, and Núñez-Vázquez et al. (2006) on the fauna of Yucatan. Additionally, the mantid fauna of Chiapas (Hernández-Baltazar et al. 2018b, 2019), Jalisco (Ortega & Márquez, 1987), and Quintana Roo (Hernández-Baltazar et al. 2018a) has been at least partially studied.

The state of Tamaulipas, alongside the states of Nuevo Leon and Coahuila, comprise the region called Northeastern Mexico, which is a very diverse region in terms of biomes, from the extremely xeric "Dunas de Bilbao Natural Reserve" in Coahuila to the mountainous "Parque Nacional Cumbres de Monterrey" in Nuevo Leon to the lush rainforests of "El Cielo Biosphere Reserve" in Tamaulipas. The orthopteroids from this latter locality had been preliminarily listed by Barrientos-Lozano et al. (2008), however, there are issues with this publication: it was not peer-reviewed, no evidence of the specimens exist as no vouchers were cited, and no photographs were published. The authors also largely focused on Orthoptera while the mantises, termites, stoneflies, cockroaches, stick insects and earwigs went almost (or completely) unmentioned. For Mantodea, Barrientos-Lozano et al. (2008) only recorded *Mantis religiosa*, as well as two unidentified species.

Thanks to the Theodore J. Cohn Research Fund, a grant awarded by

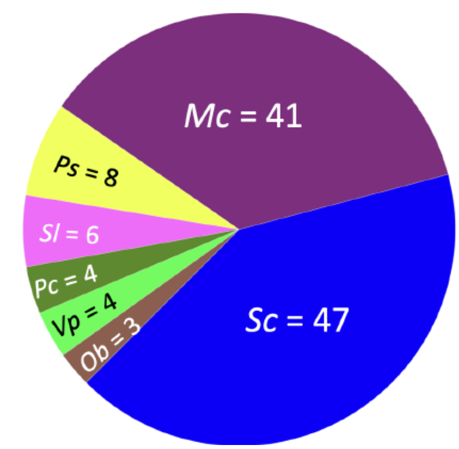

Figure 1. Total of specimens, by species. *Mc = Melliera* cf. *chorotega*. *Ob = Oligonyx bicornis*. *Pc = Pseudovates chlorophaea*. *Ps = Phasmomantis sumichrasti*. *Sc = Stagmomantis* (*Stagmomantis*) *conspurcata*. *Sl = Stagmomantis* (*Auromantis*) *limbata*. *Vp = Vates pectinata*.

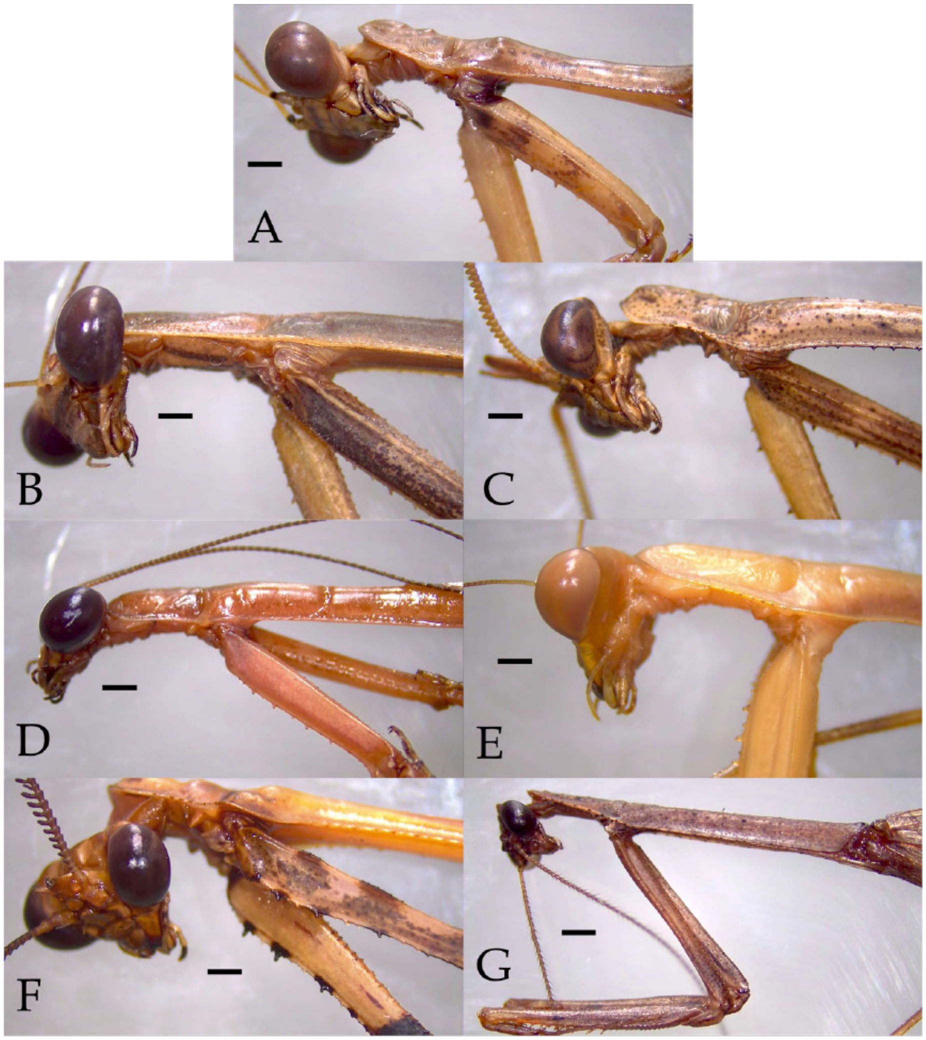

Figure 2. Species found in this study; scale bars = 1 mm. A) *Melliera* cf. *chorotega*, adult male. B) *Phasmomantis sumichrasti*, adult male. C) *Pseudovates chlorophaea*, adult male. D) *Stagmomantis* (*Stagmomantis*) *conspurcata*, adult male. E) *Stagmomantis* (*Auromantis*) *limbata*, adult male. F) *Vates pectinata*, adult male. H) *Oligonyx bicornis*, adult male.

The Orthopterist' Society (to which I am very grateful), I was able to travel, collect, and examine Mantodea from this extraordinary locality and make a more thorough listing. Armed with a light trap, alcohol, and gallons of mosquito repellent, the team, composed of biology undergraduates Roberto García-Barrios and Jorge Madrazo Fanti, as well as myself, a doctoral student, went collecting in four different habitats in the municipality of Gómez Farías. While the collecting trips were thankfully uneventful considering the dangerous situation of the state of Tamaulipas, hardship came when we only obtained mantis specimens from two of the four collecting points. A total of 113 individuals were collected from June 2021 to October 2021 (Fig. 1), in rainforest (79) and thorn forest (34), with no specimens collected in pine-oak forest or mesophyll forest. The following species were collected (arranged alphabetically by family, genus, subgenus, and species):

I. Family **MANTIDAE Latreille, 1802** [5 genera, 6 species]

1. ***Melliera* cf. *chorotega*** (Fig. 2A)
Forty-one specimens were caught, all males [vouchers MANTO020–25, 63–73, 093–096, 101–105, 111–118, 142–151], they were present in all months sampled except September, in both rainforest and thorn forest. The identification to species level is an approximation and was done by comparing them to original descriptions of the species, which are poor by modern standards. This would be the northernmost locality for the genus. *Melliera* cf. *chorotega* accounted for 35.96% of the specimens collected, making it the second most common species in the study.

2. ***Phasmomantis sumichrasti* Saussure, 1861** (Fig. 2B)
Eight specimens were collected: six adult males [vouchers MANTO050–053, 123, and 140] were attracted to the light trap from the months of June and August, in rainforest; one female [voucher MANTO122] was found in the branches of a low bush, in rainforest; and one juvenile [voucher MANTO153] was collected while sifting leaf litter in thorn forest. *Phasmomantis sumichrasti* accounted for 7.01% of the specimens collected, making it the third most common species in the study.

3. ***Pseudovates chlorophaea* (Blanchard, 1836)** (Fig. 2C)
Four male specimens [vouchers MANTO032, 033, 060, 141] were collected, all attracted to the light trap, three in October and one in June, all from rainforest. *Pseudovates chlorophaea* accounted for 3.50% of the specimens collected, being tied with *Vates pectinata* as the third rarest species in the study.

4. ***Stagmomantis* (*Auromantis*) *limbata* (Hahn, 1835)** (Figs. 2D)
Six specimens were collected: one female [MANTO026] was found climbing a tree in thorn forest in July. And five males [vouchers MANTO034, 097–099, 121] were collected in the month of October, also in thorn forest. *Stagmomantis* (*Auromantis*) *limbata* accounted for 5.26% of the specimens collected, making it the fourth rarest species in the study.

5. ***Stagmomantis* (*Stagmomantis*) *conspurcata* Audinet-Serville, 1839** (Figs. 2E)

Fourty-seven specimens were caught, they were present in all months sampled, in rainforest. All were males [vouchers MANTO019, 028, 030, 035–047, 054–056, 061, 062, 089, 090, 100, 106–110, 120, 124–139] with the exception of one female [voucher MANTO027]. *Stagmomantis* (*Stagmomantis*) *conspurcata* accounted for 41.22% of the specimens collected, making it the most common species in the study.

6. ***Vates pectinata*** **Saussure, 1871** (Fig. 2F)
Four male specimens [vouchers MANTO024, 091, 092, 119] were collected, all attracted to the light trap, three in July and one in October, all from rainforest. *Vates pectinata* accounted for 3.50% of the specimens collected, being tied with *Pseudovates chlorophaea* as the third rarest species in the study.

II. Family **THESPIDAE Saussure, 1869** [1 genus, 1 species]

7. ***Oligonyx bicornis*** **Saussure, 1869** (Fig 2G)
Three specimens were collected in the rainforest: a female in July [voucher FCF-MANTO015], a male in October [voucher FCF-MANTO016], and a nymph in June [voucher FCF-MANTO152], were caught. The male was attracted to the light trap and the nymph and female specimens were found while sifting leaf litter in the rainforest. *Oligonyx bicornis* accounted for 2.63% of the specimens collected, making it the second rarest species in the study.

The diversity of mantises found was, as predicted, greater than the one Barrientos-Lozano et al. (2008) recorded (7 vs. 3 species); we did not encounter any specimens of *Mantis religiosa*, nor are there any records for Tamaulipas of this species in the citizen science platform iNaturalist; therefore, as de Luna & Hernández-Baltazar (2020) did previously, I consider the mention of this species in Barrientos-Lozano et al. (2008) a case of misidentification.

Currently, the statistical analyses for this project are ongoing, and a manuscript regarding the mantises of Tamaulipas, Mexico, which includes all the specimens here mentioned, is being prepared to be sent to the Journal of Orthoptera Research. Finally, photographs of the type specimens of the genus *Melliera* Saussure, 1892 have already been requested to properly determine our specimens and hopefully make a full revision of the genus.

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Exploring the mechanism and antipredator function of crepitation in *Acrida cinerea* (Orthoptera: Acrididae)

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Sound production is one of the characteristic behaviors observed in grasshoppers. Several grasshoppers produce sounds while standing on the ground by rubbing one part of their body called a stridulatory file against another one called a scraper (Otte, 1970; Song et al., 2020). The combination of the file and scraper differs among species (Otte, 1970; Song et al., 2020). Some grasshopper species in the Acridinae, Oedipodinae, and Gomphocerinae produce sounds while flying in the air (Song et al., 2020). This behavior is called crepitation.

The function of crepitation is unknown in most grasshoppers. Two functions were suggested based on the crepitation context. First, the crepitation observed during a spontaneous flight may be a signal for pair formation (Otte, 1970). A few Gomphocerinae species exhibit crepitation flight as part of their courtship signal (e.g., Berger, 2008). Second, the crepita-

Figure 1. Male *Acrida cinerea* flying in the sky.

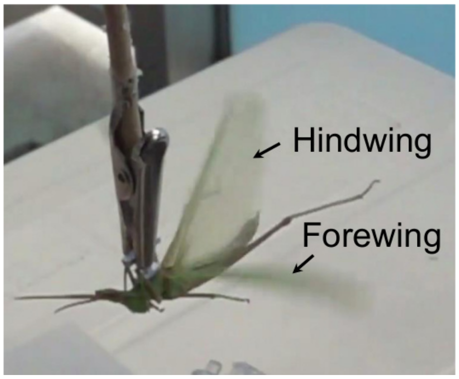

Figure 2. Male *Acrida cinerea* during a tethered flight.

tion observed during a disturbance flight may be an antipredator signal (Edmunds, 1974). The stoppage of conspicuous sounds during flight may mislead the predator, leading to the sudden disappearance of the grasshoppers (Edmunds, 1974). The empirical evidence supporting these hypotheses is still insufficient in most grasshoppers.

It was considered that testing the function of crepitation could be achieved by manipulating sound production during the flight of grasshoppers. This manipulation requires knowledge of the crepitation mechanism. Previous studies proposed that crepitation would occur through wing clapping (Cooter & Baker, 1977) or tautness of the membrane of the hindwings (Otte, 1970). However, the behavior of grasshoppers at the time of sound occurrence had never been observed in the previous studies. Thus, the crepitation mechanism was also unknown.

The focus here was on the Chinese grasshopper, *Acrida cinerea* (Acrididae; Acridinae) (Fig. 1), studying the function and mechanism of its crepitation. This grasshopper is a common species in Japan. The crepitation of male *A. cinerea* is caused by the human approach so frequently that the onomatopoeia of crepitation is the origin of the popular Japanese name for *A. cinerea*. Here, the mechanism and antipredator function of crepitation was tested using two experiments.

The first experiment identified the mechanism of the crepitation by *A. cinerea*. The flight behavior of male *A. cinerea* under tethered conditions (Fig. 2) was recorded using a high-speed digital camera (RX100M5A, Sony, 960 frames/sec.). Sounds were recorded using a linear PCM recorder (LS-P4, Tascam) and synchronized with the high-speed video following the method by Laurijssen et al. (2018). The video indicated that male *A. cinerea* clapped its hindwings at the time of sound occurrence. Sound production under the tethered condition was disturbed when the wing clapping was disturbed by a wire. The wing-clapping was not specific to the tethered condition. Male *A. cinerea* clapped its hindwings while flying in the sky. These results indicate that male *A. cinerea* makes sounds during flights by clapping its hindwings. For further details, refer to the study by Kuga & Kasuya (2021).

This first experiment suggested that crepitation can be inhibited by removing a part of the clapped hindwings at the time of sound production. The first experiment did not identify this body part due to the limits of the frame rate of the high-speed camera. For *A. cinerea*, the crepitation flight was more frequently observed in males than in females. Through the search for morphological differences in the hindwings between the sexes, it was found that more sections between the anterior and posterior medial veins were separated into small ones in females than in males (Fig. 3). An additional experiment indicated that the males whose membranes and veins between the anterior and posterior medial veins were cut (Fig. 4a) produced no sounds during their tethered flight (n = 0/13), whereas the males whose membranes and veins of any area other than the area between the anterior and posterior medial veins were cut (Fig. 4b) produced sounds during their tethered flight (n = 9/15). This result shows that crepitation can be inhibited by removing the membrane and the veins between the anterior and posterior medial veins.

The second experiment tested the antipredator crepitation function in the field. The survival rates of male *A. cinerea* whose crepitation was inhibited and allowed were compared through a capture-recapture experiment. Male *A. cinerea* was searched for and collected in the grassland at Kyushu University (33°35’33.3”N 130°13’07.3”E) for 90 min. The males were randomly assigned to one of the two groups: crepitation-inhibited and crepitation-allowed groups. The veins and membranes between the anterior and posterior medial veins of the hindwings were removed in the crepitation-inhibited group (Fig.

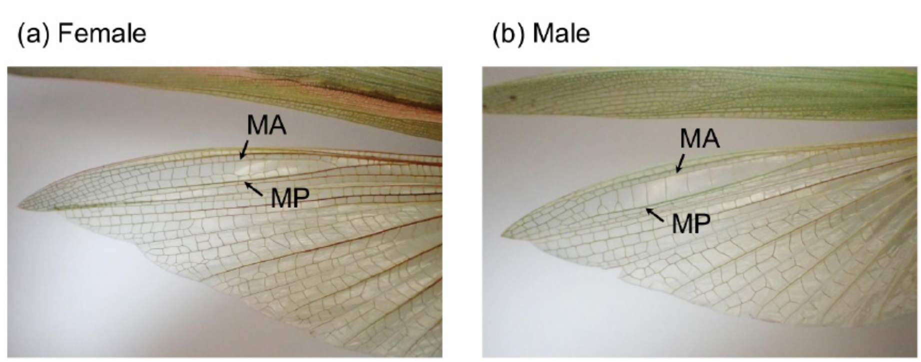

Figure 3. The hindwing of *Acrida cinerea* female (a) and male (b). MA, anterior medial vein; MP, posterior medial vein.

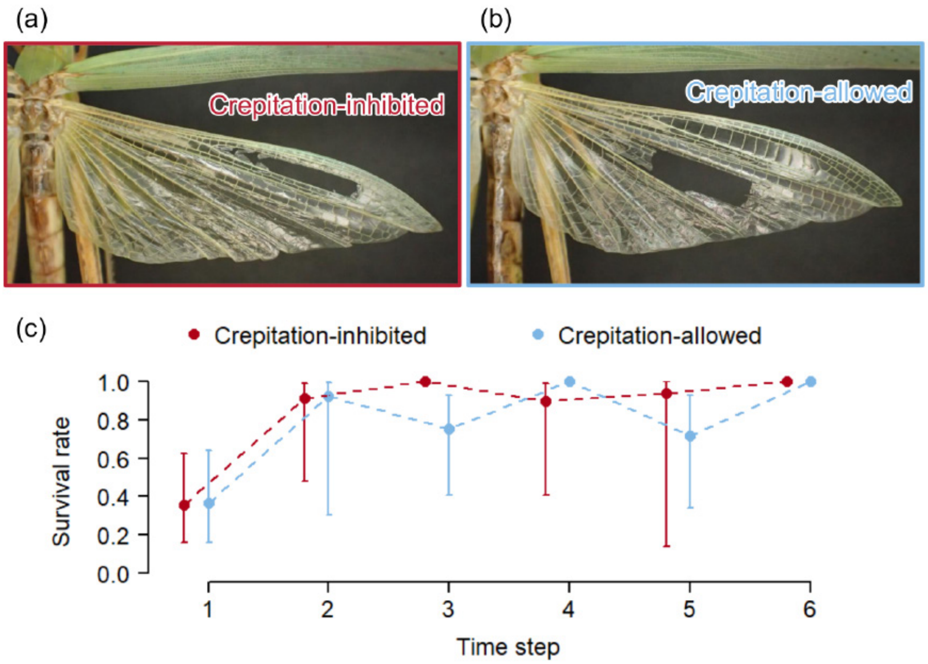

Figure 4. The hindwing of male *Acrida cinerea* in the crepitation-inhibited group (a) and crepitation-allowed group (b), as well as their survival rate, estimated using the Cormack–Jolley–Seber model (c). The error bar represents a 95% confidence interval.

4a), and the veins and membranes of any area other than this area were removed in the crepitation-allowed group (Fig. 4b). These males were marked using a permanent marker pen and released into the grassland. The search, collection, and treatment were continued once in 6–8 days from August 15 to September 27. When the marked individuals were recaptured, their IDs were recorded without reassigning the treatment. In total, each group contained 14 males.

I estimated the survival rate with the Cormack–Jolly–Seber model (Lebreton, Burnham, Clobert, & Anderson, 1992) using the software MARK ver. 9.0 (White, 2020). The difference in the survival rates between the crepitation-inhibited and crepitation-allowed groups was tested with the likelihood ratio test. The result indicated no significant difference in the survival rate between these groups (Fig. 4c; Likelihood ratio test,). Thus, this second experiment did not support the antipredator function of crepitation.

If the crepitation of *A. cinerea* does not increase their survival rate, then what is the function of their crepitation? There are two further hypotheses on the function of crepitation. First, as mentioned earlier, the crepitation of *A. cinerea* may be a courtship song by the males to the females, as in a few Gomphocerinae species (e,g., Berger 2008). Second, the males' crepitation may be a by-product of flight motion without any function. Wing clapping can increase the aerodynamic forces during the flight of insects (Chin & Lentink, 2016). Thus, *A. cinerea* may clap their hindwings to gain an increase in aerodynamic forces, not for sound production. Also note that the males in crepitation-allowed groups did not always escape with crepitation. They sometimes escaped silently and this might make it challenging to detect the effect of crepitation on the survival rate. In addition, the small sample size of the second experiment might also have made the detection of the antipredator crepitation function difficult. Thus, further studies on crepitation in *A. cinerea* are required while considering these problems.

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I am grateful to the Orthopterists' Society for providing the Theodore J. Cohn Research Fund award. I appreciate my supervisor, Dr. Eiiti Kasuya, for support of this study. I thank Kyushu University for allowing me to conduct field experiments in the conservation area of Kyushu University.

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A brief report of the Orthoptera expedition in the Amazon basin and the Andes of southern Ecuador

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Fauna and flora of Ecuador are among the most diverse and magnificent in the New World. Because the Andean Cordillera's rise was relatively recent and complex, a great number of speciation events occurred in this area, most likely as a result of dispersion and vicariance. The Ecuadorian fauna is extremely rich and diversified, which is one of the key repercussions of these events. In this South American region, biological research consistently produces excellent and new data, not just in taxonomy but also in evolutionary biology, speciation studies, biogeography, and other relevant fields.

During March of 2021, and after a long time of being cooped up at home due to the COVID-19 pandemic, I decided to contact Felipe Campos to organize an expedition to Ecuador. Felipe is a passionate biologist from the INABIO (Instituto Nacional de Biodiversidad del Ecuador) who has a lot of field experience. After several virtual meetings, we planned grasshopper collections in 3 localities, which later became more than 20 geographic points around the country. Although this was the first objective of the project, the main goal is to contribute to the knowledge of the Ecuadorean fauna of Orthoptera using a multidisciplinary approach, i.e., taxonomy, cytogenetic, molecular phylogeny, and genomics.

On January 7th of 2022, Felipe and I met in Quito and soon after I arrived we started planning our expedition. Ecuador is smaller than most South American countries, yet it is geographically diverse, with four distinct biogeographical regions: Amazonia, the Andes, the Coastal

Figure 1. Male and female individuals of *Jivarus antisanae* collected in Pintag.

Figure 2. Some ecosystems sampled: A) Montane forest in the eastern foothills of the Andes (Jondachi); B) Amazonian tropical rain forest (Limoncocha).

Figure 3. Male and female Acridoidea specimens collected in montane forest of the eastern foothills of the ecuadorian Andes mountain range.

Plains, and the Galapagos Islands. Moreover, it includes a multitude of microclimates and altitudes that make the fauna and flora extremely diverse and rich (e.g., Páramos). These geographic features are also obstacles to overcome in insect collecting and for other organisms too. Based on that, we were aware that Orthoptera diversity from Ecuador would be far from being "completely" recorded in a month. For this reason, we focused our collection points based on several records from the Orthoptera Species File (OSF) (Cigliano et al., 2022), taxonomic descriptions (Rondero, 1979; Cigliano & Amedegnato, 2010), and the iNaturalist platform of citizen science (https://www.inaturalist.org/observations?place_id=7512&taxon_id=47650).

We planned two itineraries; **the first** would take us from Quito, located in the high Andes, all the way to the Ecuadorian Amazonia, including the eastern foothills of the Andes mountain range, to Limoncocha in low Amazon at 220 meters of altitude. **The second** would take us from Quito to Loja route along the Andes biogeographical region between 2,500 and 4,500 meters altitude; both within the span of 30 days.

The **expedition started** in Pintag where we collected an abundant grasshopper species in that region: *Jivarus antisanae* (Fig. 1). With this finding, Felipe told me about the meaning of the word "Jivaro," a derogatory and rude term that was used decades ago to name the indigenous people from a specific region of the Ecuadorian Amazon, precisely where these insects are not distributed. From Pintag we traveled in a north-east direction to Baeza (precisely along the same path that the Spanish conquerors used to discover the Amazon River). We stopped at Cuyuja, Baeza, Reventador Volcano, and Jondachi (Napo province), on the eastern foothills of the Andes, at altitudes between 4,000 and 1,400 meter, where we stayed searching for specimens during the day and night (Fig. 2A; Fig. 3). From the Andes we traveled to Limoncocha where we spent three days near the Reserva Biológica Limoncocha. This amazing place, a lagoon next to the Napo River, is a humid tropical forest with many flooded areas (Fig. 2B and C). We collected at night and spent more than four hours in places

Figure 4. Male and female specimens of *Jivarus* sp. collected in Huagrahuasi.

around the Reserva. Our preliminary identification noted two species of *Typophyllum* (Tettigoniidae), other katydids, and several species of Acridoidea. The trip continued over the foothills of the mountain range, but this time in the basin of the Pastaza River, up to the town of Río Negro and then Baños, where we expected to find our second species of *Jivarus* (*J. jagoi*). However, we did not succeed since we could not reach the altitude reported in the bibliography. Far from being frustrated, we continued our expedition and moved north via Pillaro and stopped in Huagrahuasi, where we found our second species of *Jivarus*. At first, we only saw potato crops and grass for cows, but after one hour of inspection, a yellowish green insect jumped and we started to scream as we won the lottery "it is *Jivarus*, amigo, it is *Jivarus*" (Fig. 4). On the way back to Quito, we took the road in the direction to Boliche (Cotopaxi) and Machachi (Pichincha), collecting many *J. antisanae*.

After three days in Pintag (our base), we bought some food and provisions (organic coffee, water, "horchata" tea, and "tamales"… definitely not very varied due to the strange eating habits of one of the members of the expedition) and started **the second part of the itinerary** (Fig. 5). We went south, set our brain in *Jivarus* mode and stopped in several places based on the taxonomic revision of the genus (Cigliano & Amedegnato, 2010) and also helped by iNaturalist records. The first stop was Riobamba at 3,660 meters where we found a huge population of *Jivarus* sp. (Fig. 6) The next day we arrived at a place near Laguna de Atillo and stayed in an indigenous house that reminded me of Scotland in the 14th century, a magnificent place. During the next morning, we observed several grasshoppers, but the most amazing finding that day happened in the afternoon when, after several hours, we found a reddish *Jivarus* sp. (Fig. 7).

From that moment on, we collected mostly specimens of *Jivarus*. They were present in nine out of 10 places visited and practically always a different species for each collection site (Fig. 8). Over the next days, we visited several Páramo places located in a range of 3,000 and 3,600 meters: Osogoche and Alausi (3,160 meters), 30 km from Chunchi (2,830 meters), both in Chimborazo province, Jima (3,430 meters), La Ramada (3,185 meters), 17 km Norte Urdaneta, Cruz de Tiura (2,530 meters), until reaching Loja, the southernmost province of Ecuador.

Along the trip, we realized that *Jivarus* was the predominant group on the highlands, but when arriving at the province of Azuay, individuals from the genus Quitus began to be more and more abundant (Fig. 9). The first collecting point was on the road to the town of Jima, where after a long search we found a red individual in a Bromeliaceae (*Puya* sp.) of the same colour. An intensive search within these plants allowed the collection of several specimens and the suspicion of a conspecific relationship between the insect and the plant. In Loja, we

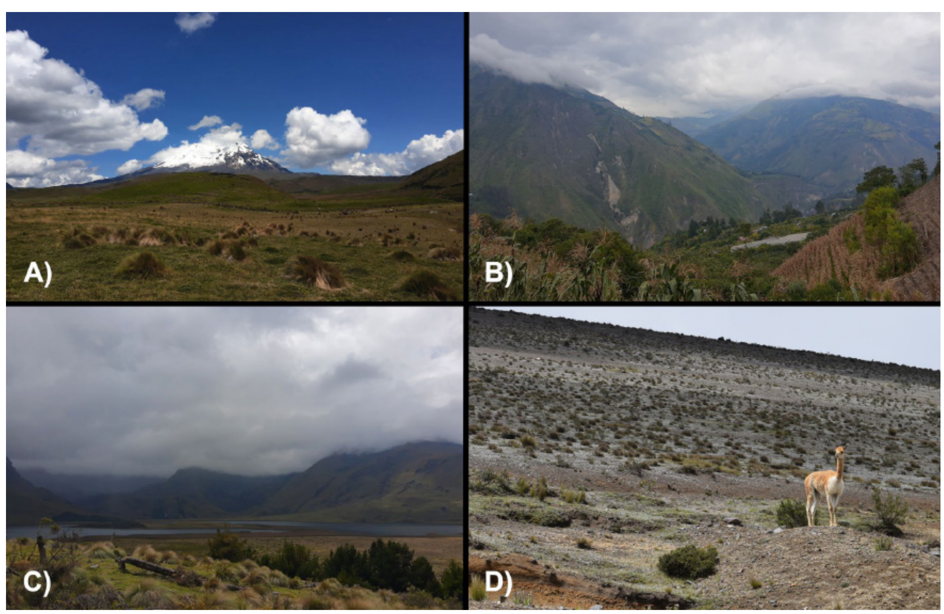

Figure 5. Some ecosystems sampled: A) Napo province; B) and C) Chimboraso province; D) Cotopaxi province.

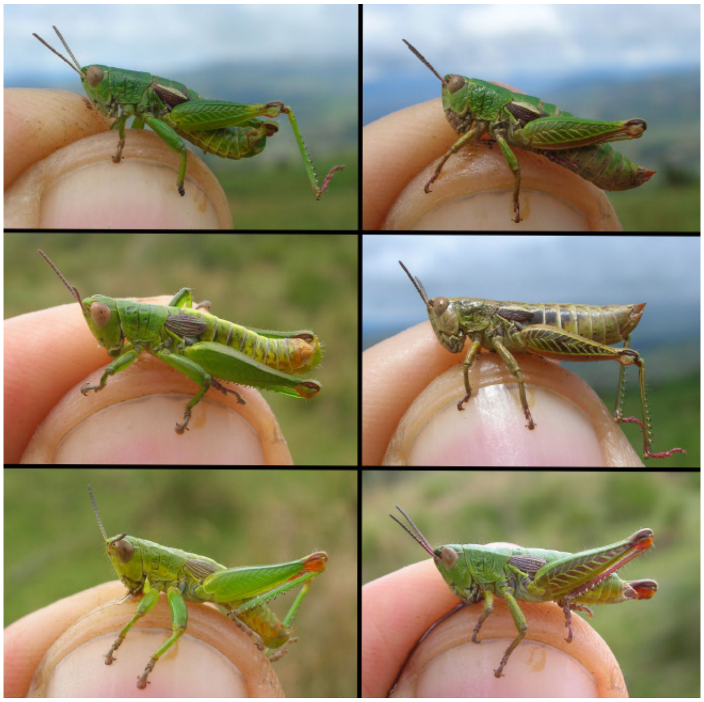

Figure 6. Male and female specimens of *Jivarus* spp. collected in the central and southern Andes of Ecuador.

Figure 7. Male specimens of *Jivarus* sp. collected in the Laguna de Atillo.

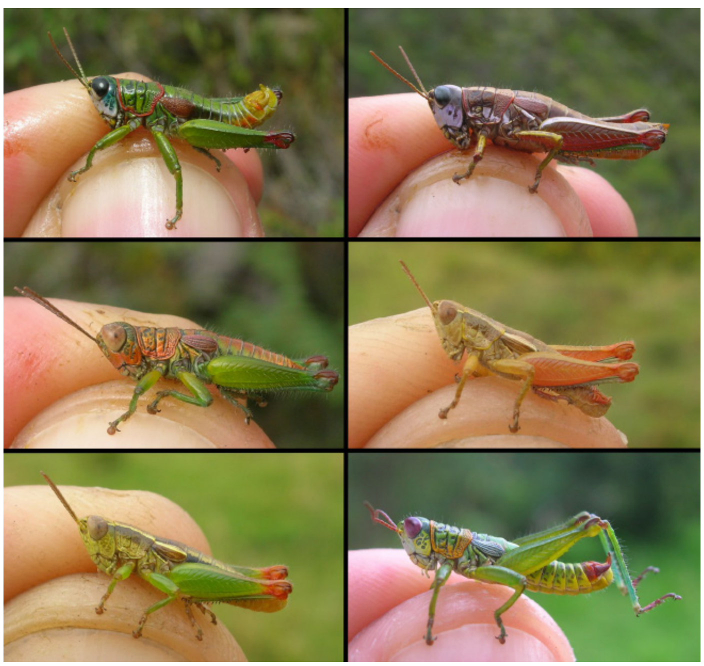

Figure 8. Male and female specimens of *Jivarus* spp. collected in Chimborazo province.

Figure 9. Male specimens of *Quitus* spp. from the paramos of southern Ecuador. Jima, Azuay province.

stayed three days because records in the OSF and Cigliano & Amedegnato's taxonomic revision suggest this site as the center of diversity for *Jivarus*. Therefore, we tried searching in several collecting points, like the Abra de Zamora at different altitudes, Santiago, Saraguro and Podocarpus. Although the acridofauna diversity in that area was low, we had success with *Jivarus* (Fig. 10) and *Quitus* species.

On the way back to Quito we carefully explored other localities in the provinces of Cañar (road Guamote-Macas and Cachapamba), Bolívar (Guaranda), and Azuay (Cajas), in all of which we found several species of *Jivarus* (Fig. 11) and species of *Quitus* as far north as the province of Cañar. We closed out our survey expedition in Santo Domingo in the Pichincha province where we found, once again, *J. antisanae* (Fig. 1).

Across the entire expedition, a total of 840 individuals of Orthoptera were collected. At least half of the

Figure 10. Male and female specimens of *Jivarus* spp. collected in Abra de Zamora, Santiago, Saraguro, and Podocarpus.

Figure 11. Male specimens of *Jivarus* spp. collected in provinces of Cañar, Bolívar, and Azuay.

specimen records correspond to new distributions and some species found will be added to the current list of Ecuadorian Orthoptera. We also believe that some of them correspond to species not yet described. It was a gorgeous expedition and all the observations and material collected exceeded our expectations. This trip was ambitious and also a challenging task because, in that moment, COVID-19 cases in Ecuador were multiplying daily and restriction of physical contact to prevent the spread of the disease was strict. Additionally, the last collections in Ecuador for several grasshopper groups were made more than 15 years ago (e.g., *Jivarus* and *Quitus* species), so we did not know the impact of human activities (or others) in their distribution.

Work on the project with Ecuadorian species is planned to be continued. In this sense, the new taxonomic, cytogenetic, and phylogenetic data will be interpreted with those information available for other related groups. To that end, Sofía Chica Ruiz, a student of the BSc. in Genetics [Universidad Nacional de Misiones (UNaM)] achieved the first results concerning the chromosome morphology and diploid number of several *Jivarus* species; we present here for the first time, the male meiotic metaphase I of *Jivarus antisanae* (Fig. 12). Moreover, we have proposed a scheme of work to be covered in a medium term period. First, continue the taxonomic identification of specimens with emphasis in *Jivarus*, *Quitus*, and katydid species, and publish a complete list of the orthopterans collected in this expedition. Felipe Campos will continue with more collections in other unexplored areas of the country. Second, provide the cytogenetic description of *Jivarus* and *Quitus* species (the same for the other species collected).

We believe that all the activities along the stages of the project will contribute greatly to the knowledge of the Andean orthopterans from Ecuador and will boost the collaborative work between Latin American orthopterists. The new material for taxonomic, cytogenetic, and molecular analyses will enable the ability to conduct a multidisciplinary study and

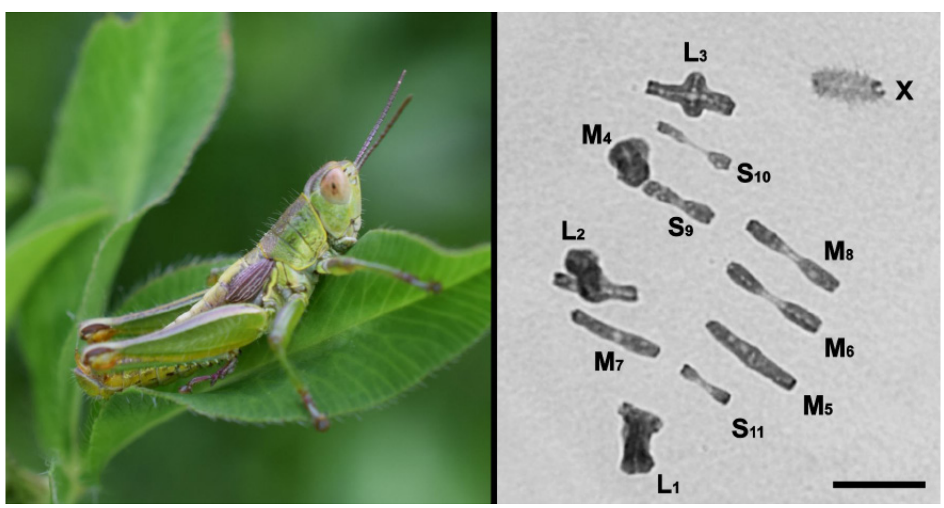

Figure 12. *Jivarus antisanae* male metaphase I, showing eleven autosomal bivalents and the X chromosome (2n=23 and a X0 sex chromosome determination system). Conventional staining. Bar = 10 µm.

in-depth discussion of the evolutionary scenarios previously proposed for several indigenous grasshoppers groups of Ecuador.

Acknowledgements
ERDC is very grateful to the Orthopterist' Society for the financial support through the Theodore J. Cohn Research Fund. ERDC and FCY thank INABIO for field assistance and authorizations. Special thanks to Alex for the support and to Angel Hualpa and his son for their help and company in the city of Loja. ERDC also thanks María José Campos for making our expedition possible. ERDC is grateful to Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET).

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Locust management in Central America in the COVID-19 Period

By MARIO A. POOT-PECH[1*], CARLOS R. URIAS-MORALES[2] & XAVIER I. EUCEDA[2]
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The COVID-19 pandemic continues affecting the world. The governments of almost all countries took strict measures to prevent the contagion of the disease, suspending all activities with massive gatherings, imposing quarantines, limiting citizen movement, and allowing work only on essential activities, closing borders, imposing curfews, amongst other measures.

Simultaneous to the pandemic, swarms of the Central American locust (CAL: *Schistocerca piceifrons piceifrons*) are continuing to threaten agriculture production and pasture in countries of Central America. To face this problem, OIRSA (Regional International Organization for Agricultural Health) developed a series of activities to reduce the risk of CAL and contagion in the official personnel that controlled the current outbreaks. This organization undertakes field assessment missions, strengthens national capacity, and coordinates survey and control operations, as well as emergency assistance during locust outbreaks and upsurges.

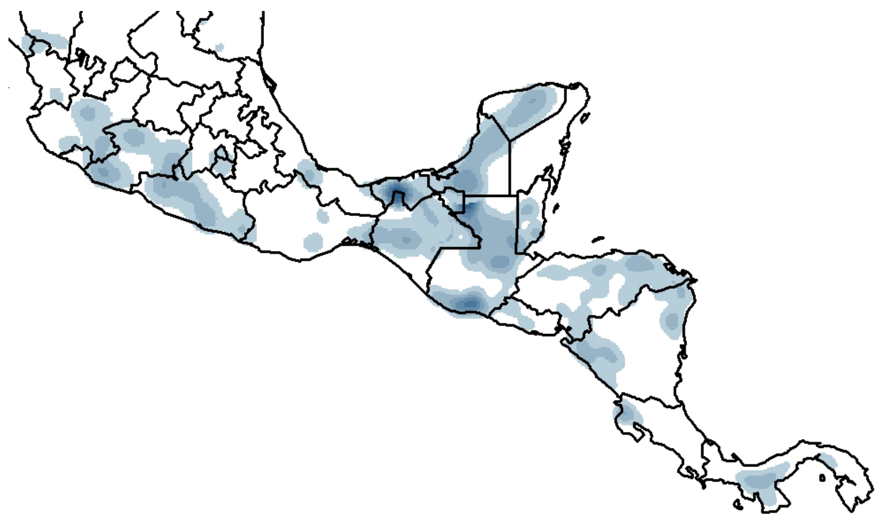

Figure 1. Kernel density of burned sites associated with CAL development areas. From January 1 to March 25, 2020. MODIS. https://firms.modaps.eosdis.nasa.gov/map

Capacity strengthening. From July 13 to August 23, 2020, the first virtual locust workshop was held, Management of CAL towards a preventive approach. 1,037 people from 21 countries signed up: 19 from Latin America, Israel, and Tunisia. It had the support of important institutions such as FAO, GLI, Texas A&M University, Michigan State, INIFAP (Mexico), and OIRSA itself. At the end, the students learned different strategies in the prevention and control of the locust, an event of full satisfaction for the attendees, organizers and institutions that supported it.

OIRSA also developed guidelines and guides to prevent COVID-19 infection among agricultural workers, marketers and exporters: https://www.oirsa.org/contenido/2020/Lineamientos Oirsa-29abril2.pdf.

Regional cooperation. OIRSA is made up of 9 countries from Central America, Mexico and the Caribbean. Locust prevention and management action plans have been reviewed and improved, focusing on ecological alternatives, such as the use of the entomopathogenic fungus Metarhizium acridum, which is already available in the region through a donation of the strain to Mexico. Additionally, OIRSA personnel have visited the countries to analyze the country's situation, recommendations are issued at the end of the mission for the improvement of pest management processes.

Information and forecasting. With the aim of being prevented in the

Figure 2. Control of locust swarms on the treetops with a drone application. Guatemala, January 2021.

event of a possible increase in the CAL population, geospatial and statistical information is analyzed, in addition to field information, to determine the possible areas where locust development would begin. Meetings are held with each country to analyze environmental variables (temperature, precipitation, burned sites, wind direction, and more) and trends for a given time are noted. In Figure 1, we see the sites of influence of agricultural burning, associated with the beginning of locust outbreaks.

Early warning. With forecast information and the opinions of experts (CAL Technical Group), different documents are issued, such as communications, reports, and alerts, among others. This is of great support for the countries to make decisions for an early reaction in the management of the pest.

Preparedness for the locust campaign, including contingency planning. OIRSA has a document on the CAL management action plan: https://www.oirsa.org/contenido/2020/(17 marzo2020) Plan de accion y atencion de brotes corregido2.pdf (Spanish), detailing the processes from identification up to control in the contingency stage.

Research. OIRSA is currently developing research projects with institutions as the Guatemala National Secretary of Science and Technology, Taiwan International Cooperation and Development Fund and other Universities, as well as with farmers organizations of coffee, sugar cane, and banana, among others in Central America.

Current situation. In the 2 years of the pandemic, 2020 was the year with the highest density of CAL, occurring in 7 of the 9 countries. However, all outbreaks were successfully controlled by air with helicopters, aircraft, and drones (Fig. 2), as well as with ground applications. Currently in 2022 there is a calmer situation, but it is expected that in June, after the rains, the first-generation nymphs will appear.

Desert long-horned grasshoppers (Tanaoceridae): hard to find or simply under collected?

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The family Tanaoceridae (Orthoptera: Caelifera) consists of three species (*Tanaocerus koebelei, T. rugosus,* and *Mohavacris timberlakei*) of small, wingless grasshoppers that are unique in having long and filiform antennae that are longer than the entire body. They are an unusual and relict lineage with a very restricted distribution in desert habitats of the southwestern USA (California, Nevada, Arizona) and northwestern Mexico (Baja California). Males possess a stridulatory organ on the third abdominal segment that likely functions in acoustic communication, but their biology is very poorly known (Song et al 2015; Song 2018). Tanaocerids are rare in collections; the insect collections of the University of Michigan Museum of Zoology (UMMZ), The Academy of Natural Sciences of Philadelphia (ANSP) and The California Academy of Sciences (CAS) are the only collections with a good representation of specimens of the three species.

All tanaocerids are considered EDGE (Evolutionarily Distinct

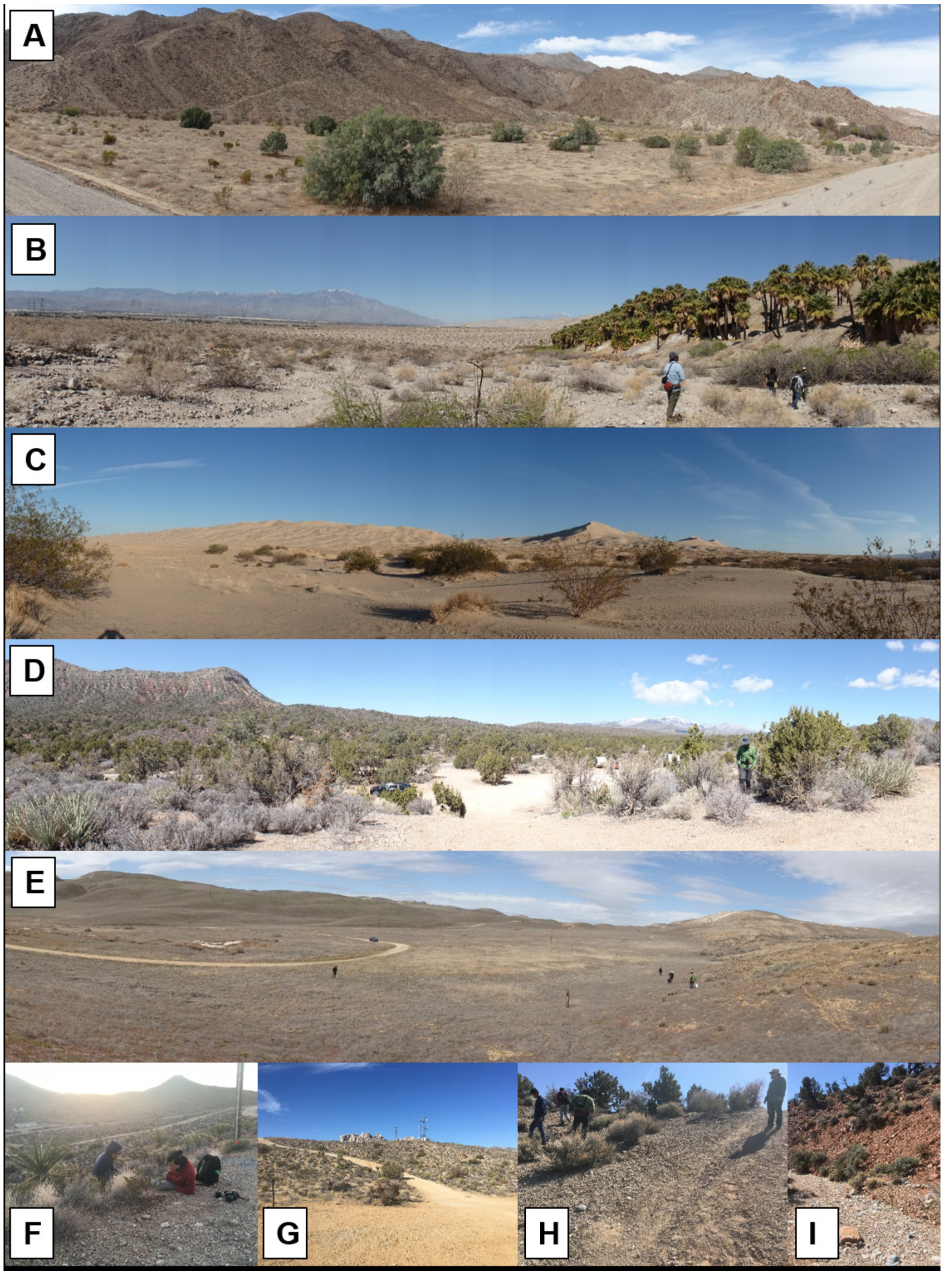

Figure 1. Some localities. A. San Jacinto Mountains National Monument. B. Coachella Valley Preserve. C. Kelso Dunes. D. Lovell Canyon. E. Carrizo Plain National Monument. F-G. Granite Pass. H-I. Lovell Canyon.

and Globally Endangered) species. These groups should have priority in conservation efforts as they are irreplaceable due to their individuality and the lack of close extant relatives. Other Orthoptera EDGE species in North America are the four species of Xyronotidae from Southern Mexico (Mariño-Pérez, 2021). RMP and SSU obtained a SSC EDGE Internal Grant Proposal from the IUCN to conduct fieldwork for both Tanaoceridae and Xyronotidae to obtain new information aiming to provide precise assessments for The IUCN Red List of Threatened Species. In this article, we report on our first field expedition, which targeted the Tanaoceridae distributed in the United States of America.

After reviewing the relevant literature (Grant & Rentz, 1967; Strohecker, Middlekauff & Rentz, 1968), label information from specimens at UMMZ, ANSP, and CAS, iNaturalist and BugGuide records, a previous trip made by BF and KN in 2017, and personal communication with Dave Weissman, we determined that the optimal window for collecting would be late winter and early spring, between February-March and -April. In general, the key information we found was to collect them at night during the late winter and early spring. With all these factors into account, we planned the expedition from March 11th-20th, 2022.

We met in the Ontario Airport (near Los Angeles) and we headed southeast to Santa Rosa and San Jacinto Mountains National Monument (near Palm Desert) where we set our camp and waited until sunset to start collecting (Fig. 1A). We had a difficult start because we spent at least two hours without success. As usual, once we decided to leave the locality and started heading back to the car, they started appearing (*Tanaocerus koebelei* only) so we spent another hour finding many more (Fig. 2A). Interestingly, all of the specimens we collected were females; no males were to be found. Afterwards, we stopped at a nearby spot where BF and KN found them in 2017 and they were there (again only females), relatively close to the road. We found some in a very isolated bush and we decided to return next morning to check if they were still there (Fig. 2B), However, the next morning, they had vanished, as we were unable to find them on the plant, at the base of the plant, or even on the ground around it. We also found many couples of *Timema* sp. (Fig. 4B), a fascinating lineage of walking sticks found only in the western USA.

We continued our expedition towards Mojave National Preserve, first stopping at an oasis at Coachella Valley Preserve (Fig. 1B) and Whitewater Preserve. Although we found other orthopterans, such as the oedipodine *Anconia integra* (Fig. 5A) and the tridactylidae *Ellipes* sp. (fig. 4A), we could not find tanaocerids. Once we reached Mojave National Preserve, we explored the vicinity of Granite Pass (near Granite Peak) (Fig. 1G) and we had a very successful night finding both females and the elusive males in several different types of

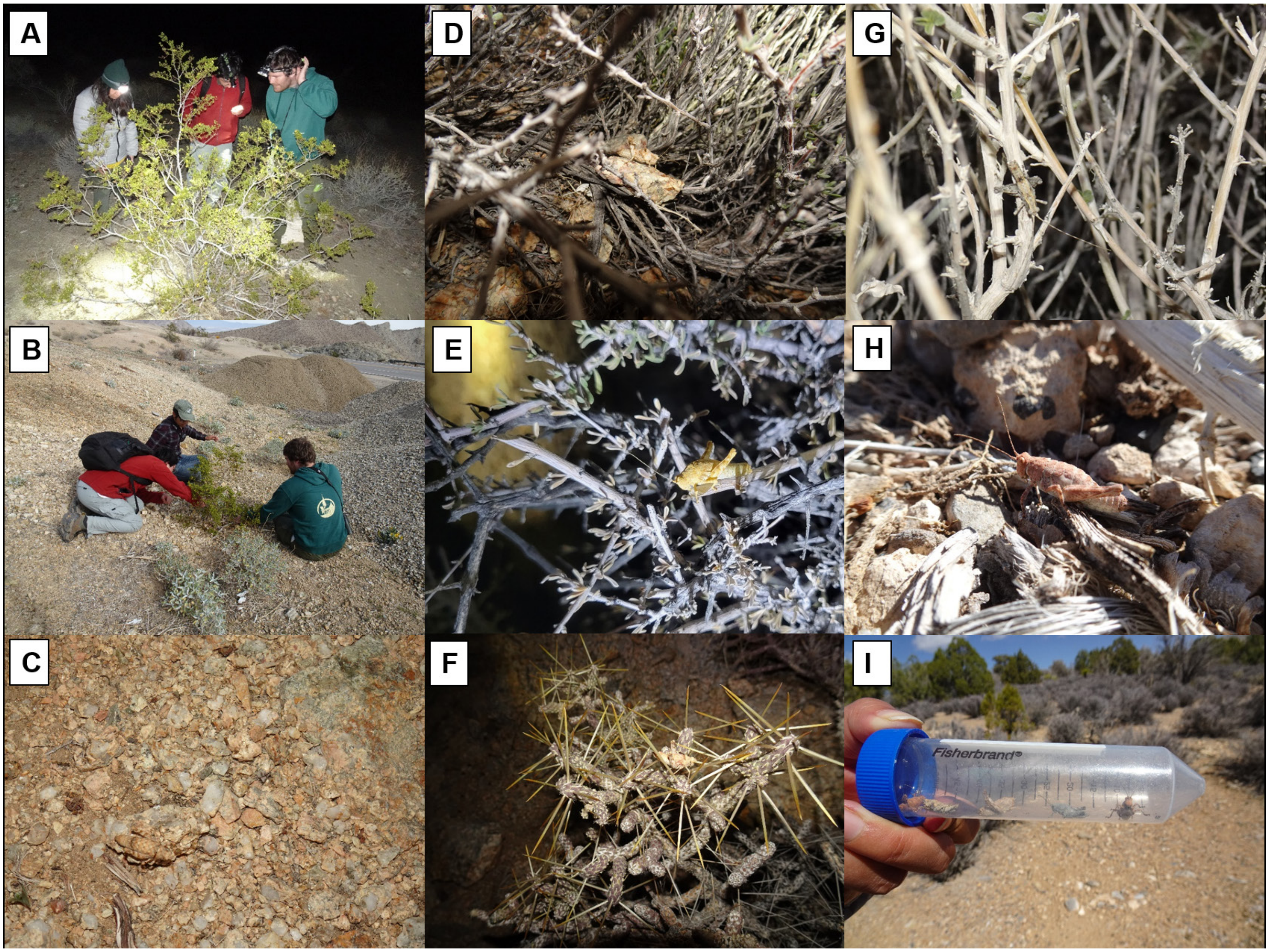

Figure 2. *Tanaocerus koebelei*. A. Night collecting at San Jacinto Mountains National Monument. B. Search the next morning. C-F. Females at Granite Pass in different plants. G. Male at Granite Pass. H. Female at Lovell Canyon. I. Females of different color morphs at Lovell Canyon.

plants (Figs. 2C-G & 7A). We camped close by at the Kelso Dunes (Fig. 1C), finding some interesting nymphs of the Rhaphidophoridae *Ammobaenetes* sp. (Fig. 6A), which may represent an undescribed species. The burning question of "where do tanaocerids go during the day?" still gnawed at our souls, so we staked out several females on a creosote bush and returned before dawn the next day. BW and KN sat down on the hard desert pavement for nearly three hours watching tanaocerids move around almost imperceptibly (Fig. 1F). It turns out that they approach the ground as the sun rises, eventually freezing in place at the bases of shrubs or in grass clumps. Without having been there the entire time, we never would have found them during the day as their camouflage is extraordinary. No wonder they were so hard to find!

It is hard to think of an excuse to collect grasshoppers in Las Vegas, but there were enough records to justify a stop and we headed towards Nevada and camped at Lovell Canyon Campground. We did our best to explore the surroundings at night but we only found one Stenopelmatidae *Ammopelmatus* sp. (Fig. 6B). We spent a very cold night (7°C) and the next day on our way out, we quickly stopped in an early morning sunny spot and to our surprise many females of *Tanaocerus koebelei* were jumping around on a very stony hillside (Figs. 1D, H & 2H). Many male were found in a nearby riverbed (Fig. 1I) The diversity of color morphs was remarkable (Fig. 2I).

At this point, we were satisfied regarding *Tanaocerus koebelei* but we were missing the second USA tanaocerid species, *Mohavacris timberlakei,* which was also supposed to occur in many localities that we already passed. However, in general, this second species is much rarer and less commonly reported. With this in mind, we crossed the Death Valley National Park (Fig. 7B) to explore the eastern slopes of Sequoia National Forest, back in California. We stopped at Walker Pass, where the windy, cold conditions made us wonder if we would find any Orthopterans at all. We eventually found some *Ceuthophilus* sp. (Fig. 6C-D) but after one hour that was all. We scattered across a larger area checking many, many bushes and finally we found

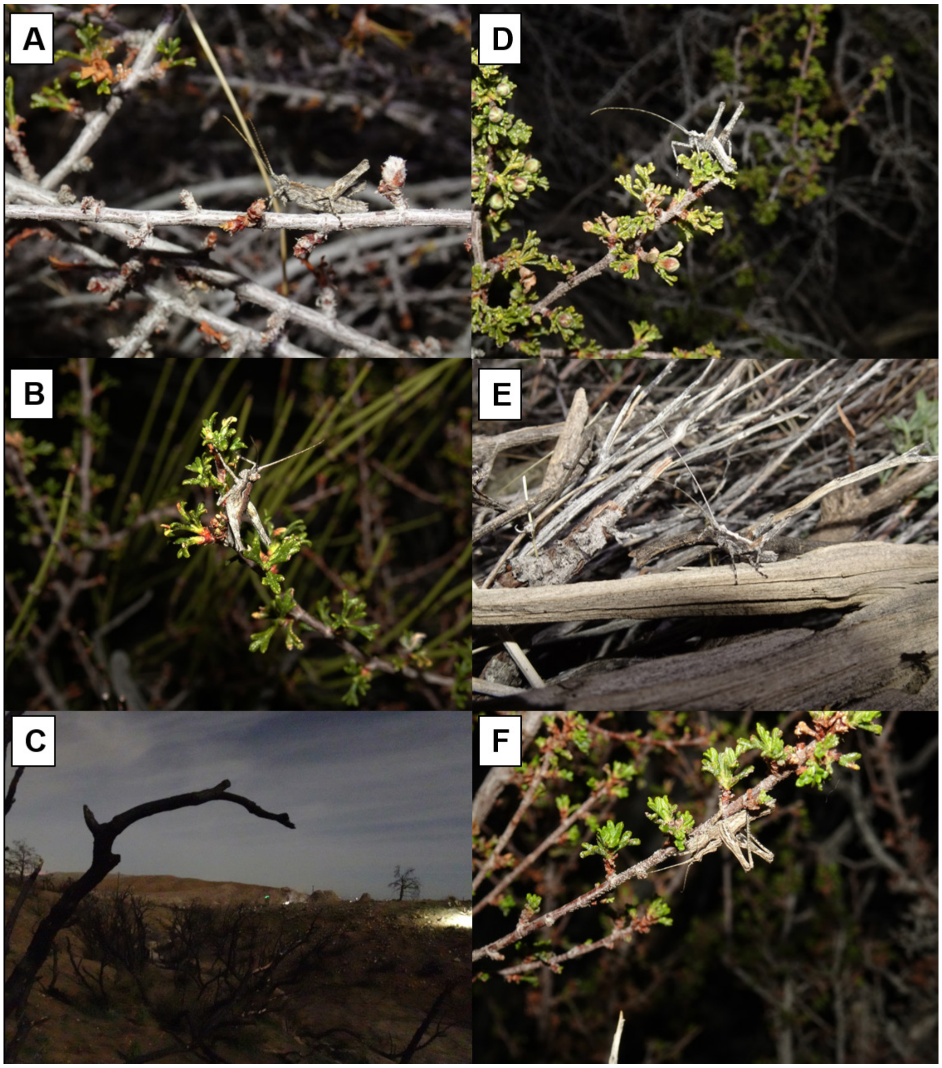

Figure 3. *Mohavacris timberlakei*. A-B. Males at Walker Pass. C. Burnt locality near Palmdale (at night). D-E. Males near Palmdale. F. Female near Palmdale.

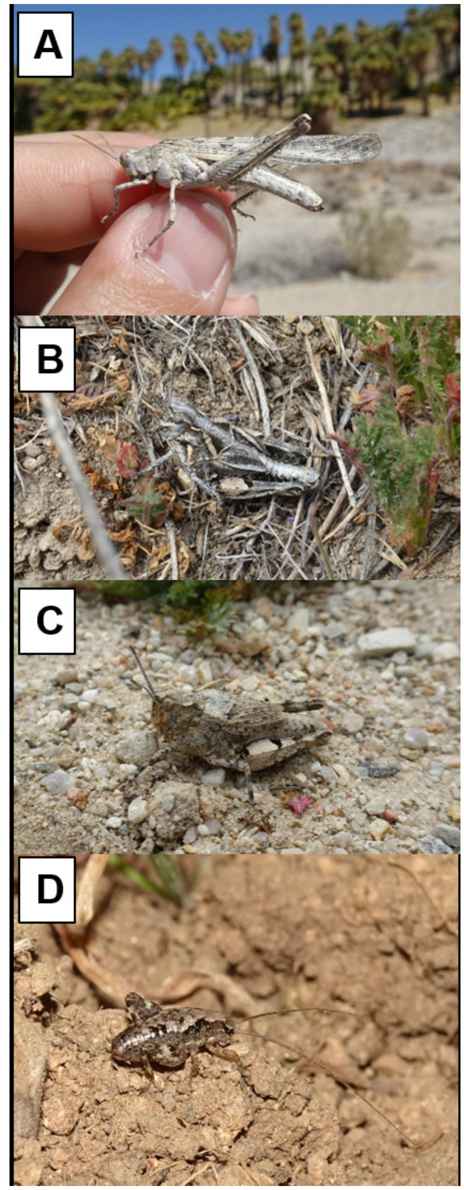

Figure 5. A. *Anconia integra* at Coachella Valley Preserve. B-C. *Esselenia vanduzeei* females at Carrizo Plain National Monument. D. *Gammarotettix genitalis* at Millard Canyon.

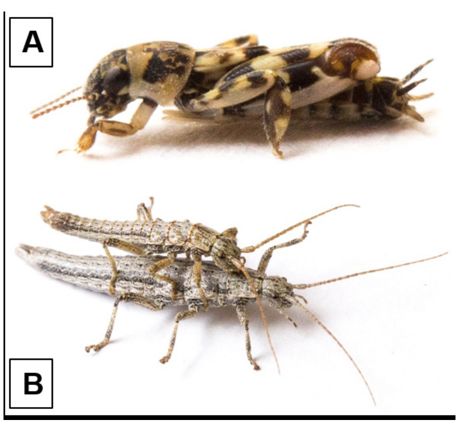

Figure 4. A. *Ellipes* sp. at Whitewater Preserve. B. *Timema* sp. couple at San Jacinto Mountains National Monument.

tanaocerids. They looked different and as it turned out, they were adult males and mostly juvenile females of *Mohavacris timberlakei* (Fig. 3A-B). This species proved easy to distinguish from *Tanaocerus* once we had observed both. *Tanaocerus koebelei* has an absent or nearly absent dorsomedian carina of pronotum and a posterior margin of pronotum undulate. *Mohavacris timberlakei* has a dorsomedian carina of pronotum rising posteriorly forming a clear ridge and the posterior margin of pronotum not undulate (Strohecker, Middlekauff & Rentz, 1968). KN returned to Walker Pass, California, at the beginning of April and found additional specimens of *Mohavacris timberlakei*. This time, all the females were adults.

After a short break to visit the magnificent giant sequoias (Fig. 7C), we headed south towards Palmdale and we found again both males and females of *Mohavacris timberlakei* in three nearby localities (Fig. 3D-F), one of which was next to an area that was destroyed by a recent wildfire (Fig. 3C). Unfortunately, in the burnt areas, we could not find any.

The next day we headed westwards to Carrizo Plain National Monument (Fig. 1E) (Near Taft) to check out the short-winged gomphocerine *Esselenia vanduzeei* (Fig. 5B-C). Finally, we went back to the Los Angeles area to explore Millard Canyon, where we had a splendid night and found three species of Rhaphidophoridae: *Ceuthophilus* sp. (Fig. 6E), *Pristoceuthophilus* sp. (Fig. 6F-G) and *Gammarotettix genitalis* (Fig. 5D). The Anostostomatidae *Cnemotettix bifasciatus* and the Stenopelmatidae *Ammopelmatus* sp. (Fig. 6H) were additional highlights. The final day,

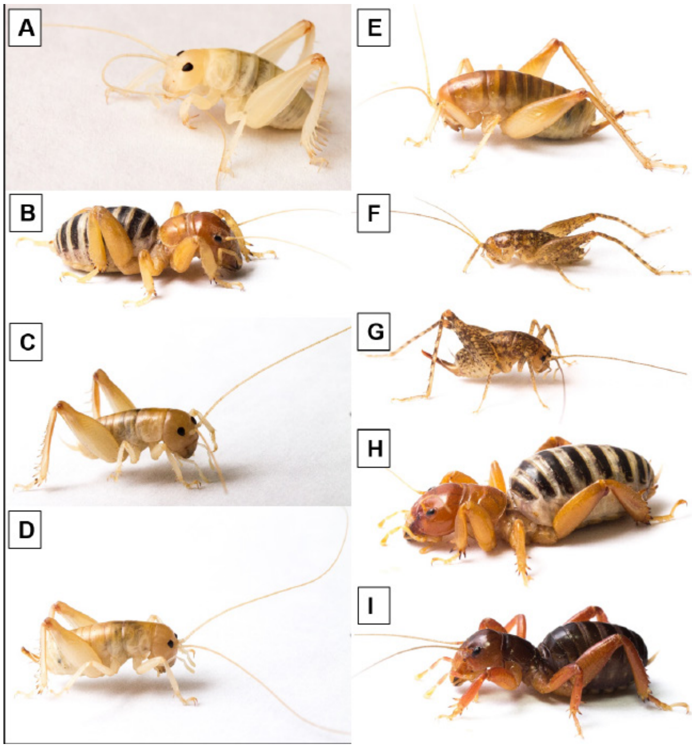

Figure 6. A. *Ammobaenetes* sp. (nymph) at Kelso Dunes. B. *Ammopelmatus* sp. at Lovell Canyon. C-D. *Ceuthophilus* sp. male and female at Walker Pass. E. *Ceuthophilus* sp. at Millard Canyon. F-G. *Pristoceuthophilus* sp. male and female at Millard Canyon. H. *Ammopelmatus* sp. at Millard Canyon. I. *Ammopelmatus* sp. at Mt. Baldy area.

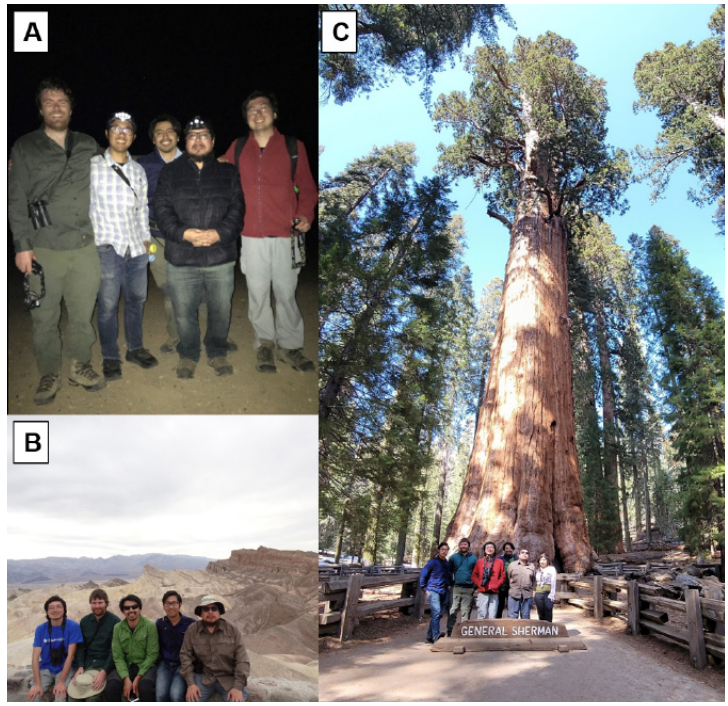

Figure 7. Members of the expedition. A. Night collecting at Granite Pass. B. Death Valley. C. Sequoia National Park.

Figure 8. Localities where we found tanaocerids.

before we all took our flights back home, we briefly explored the Mt. Baldy area and found another, different *Ammopelmatus* sp. (Fig. 6I).

In conclusion, our expedition was a success because we found the two species we were looking for in seven different localities (Fig. 8). Tanaocerids are rarely seen but we believe this is due to their mostly nocturnal habits in an under-collected season (late winter-early spring). Once you find them, they are locally abundant and females are much easier to find due to their chubby and larger size compared to the smaller, much more jumpy and slender males. It is imperative to conduct an expedition to Baja California to check on the third species, *Tanaocerus rugosus,* for which very few localities are reported. Due to logistical reasons, it was not feasible for us to cross the border into Mexico. These observations and records will help us tremendously in the IUCN Assessments.

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 Dave Weissman for his valuable information regarding localities. Isabel C. Velásquez de la Cruz helped us in the field to find specimens and also took photographs. BW thanks Hojun Song for his support through NSF grant (DEB-1937815). We also thank the various contributors to BugGuide and iNaturalist for posting the tanaocerid photos that helped us pinpoint good collecting localities.

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Treasurer's Report

By PAMELA MIHM
Treasurer
p.mihm@regency-multifamily.com

The Statement of Assets as of December 31, 2021 and the 2021 Summary of Cash Receipts and Expenditures are shown below. The Orthoptera Species File, which is funded by an endowment from the University of Illinois, continues to be the largest cash activity. The second largest use of cash was publishing the *Journal of Orthoptera Research* (*JOR*). The Society is able to support the Theodore J. Cohn Research Fund and other worthy endeavors through the generosity of some members. We are pleased to report that the investments grew from $1,754,000 at December 31, 2020 to $1,926,000 at December 31, 2021 even with the economic uncertainty the world has faced. We keep a watchful eye on the investments and in 2021 we exchanged $15,000 of higher risk stock investments for $15,000 in lower risk bonds. If you have any questions, please contact me at p.mihm@regency-multifamily.com.

Orthopterists' Society
Statement of Cash Receipts and Expenditures
(1/1/21 through 12/31/21)

Cash Receipts	
Dues	$4,250.00
Publications	1,785.00
Community Foundation endowment	11,871.18
Royalty and revenue sharing	4,476.77
Book reimbursements	130.00
Transfer cash from Vanguard & Wells Fargo	38,900.00
Proceeds from sale of investments	15,000.00
University of Illinois allocation	154,000.00
Total Cash Receipts	$230,412.95
Cash Expenditures	
Publisher JOR	$5,552.22
Pensoft Publishers	11,983.90
JOR assistance	12,000.00
Research grants (Ted Cohn)	13,702.00
Executive director remuneration	0.00
Ed. Metaleptea remuneration	1,500.00
Assistant Ed. Metaleptea remuneration	1,000.00
Webmaster remuneration	500.00
JOR editor remuneration	3,000.00
Maintenance of Orthoptera Species File	136,500.00
Grants-Orthoptera Species File	16,126.00
Professional fees (income tax preparation and audit)	4,956.00
Webmaster SINA site support	1,200.00
Accounting reimbursement	12,000.00
Other	2,113.98
Total Cash Expenditures	$222,134.10
Cash Receipts over Cash Expenditures	$8,278.85
Beginning Cash Balance	8,190.78
Ending Cash Balance	**$16,469.63**

Orthopterists' Society
Statement of Assets
(As of December 31, 2021)

Cash		
Paypal cash balance	$601.20	
Chase Bank	15,868.43	
	$16,469.63	
Investments at market value		
Vanguard:		
Grants (Note 1)	$511,844.52	
Operating (Note 2)	937,161.11	
	1,449,005.63	
Wells Fargo:		
AAAI (Note 3)	18,607.03	
Endowment (Note 4)	50,708.83	
Operating (Note 2)	307,002.17	
Grants (Note 1)	100,444.77	
	476,762.80	
Total assets	**$1,942,238.06**	

Note 1: This fund is restricted and can only be used for research grants.
Note 2: This fund is nonrestricted.
Note 3: This fund can only be used for the Uvarov Award made at each int'l meeting.
Note 4: The income in this account is available for Society expenses; can extract capital but must have a plan for repaying it within 3 years.

Editorial

By HOJUN SONG
Editor, *Metaleptea*
hsong@tamu.edu

As some of you might know, I have been involved in the NSF-supported research institute called the Behavioral Plasticity Research Institute (BPRI). As part of this institute, we have established an impressive locust rearing facility at Texas A&M University. Although I have always reared locusts since I started my faculty career, the scale and the scope of this particular locust rearing facilitiy is unparalleled to any of my previous efforts. We now have colonies of two locust species (*Schistocerca gregaria* and *S. piceifrons*) and three non-swarming grasshopper species (*S. americana*, *S. serialis cubense*, and *S. nitens*) in the lab. We have built a dedicated room for rearing locusts in high density (500+ individuals in a cage) and another room for solitary rearing (capacity up to 360 isolated cages). We also have dedicated space for collective behavior experiments, RNA extraction, physiology experiments, greenhouse for growing plants. This rearing facility serves as a core resource for the BPRI as well as the scientific communities. While there are other excellent research labs around the world that house locust rearing facilities, I believe that we are the only one that has specific aims at rearing multiple species with different degrees of density-dependent phenotypic plasticity. The last time there was a facility like this was in the 1970's at the height of the Anti-Locust Research Centre activities.


Locust rearing facility at Texas A&M University

To me, the establishment of this rearing facility has been a dream-come-true and what's even more exciting is that we have a large group of researchers and trainees who are pursuing research on locust phase polyphenism using this facility. When I was a graduate student, I was one of very few people in the U.S. interested in locusts. But times have changed and now we have an entire institute dedicated to the study of locusts. Every time I step into the rearing facility, I am excited about all the possibilities of conducting interesting locust research that I could not dream of when I was a graduate student. My hope is that it becomes a long-lasting community resource that will help us move locust research forward.

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 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 September of 2022, so please send me content promptly. I look forward to hearing from you soon!