

METALEPTEA

THE NEWSLETTER OF THE



ORTHOPTERISTS' SOCIETY

President's Message

By **DAVID HUNTER**

President

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Dear Society members,

While there has been a levelling off of the effects of COVID-19 in some areas, many of us continue to have limitations on our activities and we are having to learn to adapt, much like the insects we work on that have to adapt when faced with challenges. There has been particular disruption to our work in offices or laboratories, though field work has had less disruption because of COVID-19 being less common in many rural areas. And as I have found, many things can be accomplished with online meetings, not only with work but with catching up with colleagues, friends, and family.

And, of course, COVID-19 has made control of locusts more complex than normal, with an upsurge of *Schistocerca gregaria* from East Africa to the India-Pakistan border region and swarms of *Schistocerca cancellata* in Argentina and neighbouring countries.

We have had some good news in that the journal *Zootaxa* has retained its impact factor. The journal was placed on the list to have its impact factor ended because of over-self-citation; apparently too many papers in the journal cite other *Zootaxa* papers. But it turns out that 45% of taxonomic papers on Orthoptera are published in *Zootaxa*, so it is not surprising there is a "high" 43% rate



of citing other *Zootaxa* papers. Holger Braun sent me a letter supporting the retention of the impact factor for *Zootaxa*, which we circulated to members of our society, and thanks to the many of you who signed the letter, *Zootaxa* has been retained on the list of publications having an impact factor.

The many reports of our activities in this issue of *Metaleptea* demonstrate that in spite of limitations, there is continuing success of our work on Orthoptera and related insects: it is with great pleasure that I present another excellent *Metaleptea*, thanks once again to the tireless efforts of Hojun Song and Derek Woller!

TABLE OF CONTENTS

(Clicking on an article's title will take you to the desired page)

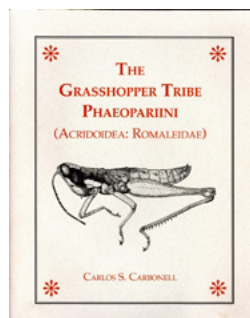
- [1] **PRESIDENT'S MESSAGE**
- [2] **SOCIETY NEWS**
 - [2] *Back Issues of Society Publications Available* by H. SONG
 - [2] *Polyneoptera Symposium at the Virtual ESA 2020* by D.A. WOLLER ET AL.
 - [3] *ICE 2024 will be in Kyoto, Japan* by M.M. CIGLIANO
 - [3] *Behavioral Plasticity Research Institute (BPRI) - a newly funded NSF Biology Integration Institute* by H. SONG
- [4] **REGIONAL REPORTS**
 - [4] *East Europe - North and Central Asia* by M.G. SERGEEV
 - [5] *Australia, New Zealand & Pacific Islands* by M. KEARNEY
 - [5] *Latin America* by M.E. POCCO
 - [6] *China* by L. ZHANG
 - [7] *India* by R. BALAKRISHNAN
- [8] **T.J. COHN GRANT REPORTS**
 - [8] *Behavioral response to multi-channel environmental noise: tracking noise-induced changes in daily locomotor patterns and mate attraction strategies in Acheta domesticus* by N. ABATE
 - [10] *Can Kapton screening minimize the adverse effects of LED light on the behavioral pattern and life history of flower visiting Indian grasshoppers?* by A. GANGULY
 - [13] *Altitudinal variation of Orthoptera species diversity in rice fields of central Nepal* by M. SUBEDI
 - [14] *Acknowledging spatiotemporal hierarchy improves locust outbreak models* by D. LAWTON
- [16] **OSF GRANT REPORTS**
 - [16] *Types of Neotropical Tetrigidae (Orthoptera: Caelifera) in the Collection of Academy of Natural Sciences of Philadelphia (ANSP)* by D.S.M. SILVA
 - [19] *Photographic and distributional data of some Neotropical Orthoptera groups and Colombian Phasmatodea* by O.J. CADENA-CASTAÑEDA
- [24] **CONTRIBUTED ARTICLES**
 - [24] *The altitudinal range of Omocestus viridulus in the United Kingdom* by T. GARNIDER
 - [25] *Agricultural defense of Brazil in alert against the possible entry of locust swarms* by M.G. LHANO
 - [29] *The Orthoptera Collection at MNRJ and the Brazilian Orthopterology* by P.G.B. SOUZA DIAS
 - [32] *Collecting Orthoptera in South Africa and Namibia amid COVID-19* by R. MARIÑO-PÉREZ & D. MATENAAR
- [37] **MEETING REPORTS**
 - [37] *VIII Brazilian Symposium of Orthoptera and I Symposium of Orthopteroid Insects* by P.G.B. SOUZA DIAS
- [41] **EDITORIAL**

Back Issues of Society Publications Available

By **HOJUN SONG**

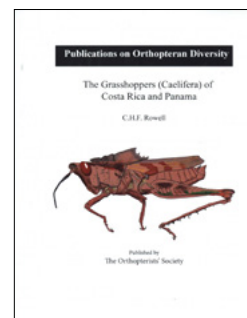
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Our Society has occasionally published the “Publications on Orthopteran Diversity” series, which are available as hard-copy books in limited supply for the members to purchase. Although this information can be found on our Society [website](#), I would like to take this opportunity to advertise in *Metaleptea*. Also, a limited number of hard copies of back issues of the *Journal of Orthoptera Research* are also available. To order, please visit <https://orthsoc.org/publications/books/> or email me at hsong@tamu.edu.



The Grasshopper Tribe Phaeopariini (Acridoidea: Romaleidae) by Carlos S. Carbonell = \$15

Example Publications



The Grasshoppers (Caelifera) of Costa Rica and Panama by C.H.F. Rowell = \$25.

The first comprehensive treatment of grasshoppers (Caelifera) of Costa Rica and Panama.



Katydidids of Costa Rica, Vol. 1. Systematics and bioacoustics of the cone-head katydidids by Piotr Naskrecki = Free (just pay S&H)

Discusses the biology and taxonomy of 3 subfamilies of Costa Rican Tettigoniidae.



Caribbean Crickets by Daniel Otte and Daniel Perez-Gelabert = \$30.

The first comprehensive assessment of the fauna of Caribbean crickets to date. It treats 585 cricket species, of which 458 are described as new species.

Polyneoptera Symposium at the Virtual 2020 Entomological Society of America Meeting: “Small Orders, Big Ideas (Polyneoptera)” - November 11-25

By **DEREK A. WOLLER¹, ABIGAIL HAYES², JOSEPH SWEENEY³, AND HOJUN SONG⁴**

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Polyneopteran 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 and rotating groups of co-organizers have been working diligently to raise their profile at ESA meetings by organizing Organized Meetings and Member Symposia (this year’s event type) to highlight all the fascinating and novel research being undertaken with polyneopterans. Due

to the ongoing worldwide pandemic, this year’s ESA will be entirely virtual, with presentations being a mix of live and pre-recorded (referred to as “On-Demand,” which is what ours will be) that you will be able to access on-line during November 11-25, 2020. In many ways, this will be unfortunate since these meetings are a wonderful chance to catch up with colleagues and make new friends, but this cloud’s silver lining is that anyone in the world will be able to attend. In fact, the nine speakers we have planned represent five countries and come from a variety of research experience levels. This year, there will

be presentations covering an array of Polyneoptera orders and intriguing topics, plus a livestreamed panel discussion (day to be decided) during which you will be able to interact with speakers. Since our symposium is On-Demand, presentations should be available to watch starting November 11, but the meeting schedule is still being finalized, so if you’re interested, please continue to check the online program for updates using the symposium’s title: <https://www.eventscribe.com/2020/entomology2020/index.asp>. We hope you can attend!

ICE 2024 will be in Kyoto, Japan

By **MARIA MARTA CIGLIANO**
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The Council for International Congresses of Entomology, of which I am a member, came to a decision regarding the venue for ICE2024, and they asked us to inform our National Societies and Entomological Societies about it. Kyoto, Japan was chosen as the venue. The Congress is scheduled

for August 25-30, 2024 and more information will become available at <https://ice2024kyoto.jp/>. But, of course, Helsinki ICE2020, which has been postponed to 2021 due to COVID-19 is rescheduled to take place on July 18-23, 2021 and more information is available at <https://ice-2020helsinki.fi/>.



Behavioral Plasticity Research Institute (BPRI) - a newly funded NSF Biology Integration Institute

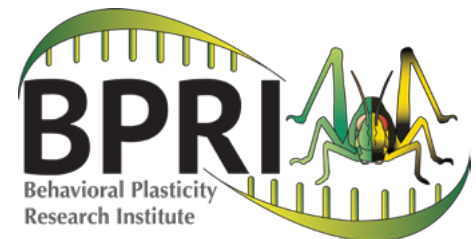
By **HOJUN SONG**
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The Biology Integration Institutes (BII) program is a new program from the U.S. National Science Foundation's Directorate for Biological Sciences that supports collaborative teams of researchers investigating questions that span multiple disciplines within and beyond biology (awards are for 5 years @ \$12.5 million). In February 2020, a group of researchers from 5 U.S. institutions (Baylor College of Medicine [lead], Texas A&M University, Arizona State University, UC Davis, and Washington University in St. Louis) collaborated and submitted a proposal to build a research institute focused on behavioral plasticity; each researcher on this team has expertise in different aspects of locust biology. Locusts, one of the most devastating insect pests in the world, exhibit a form of behavioral plasticity called phase polyphenism. Our submitted proposal focused on understanding locust phase polyphenism by integrating across all scales of biological organization, from molecules to landscape.

On September 1, 2020, we received an official award notification from the

NSF. The title of the funded project is: "Behavioral Plasticity Research Institute (BPRI): Transforming the Study of Phenotypic Plasticity through Biological Integration" with the total funding amount over 5 years being \$12,497,519. The BPRI is one of four awards selected as the inaugural cohort of NSF Biology Integration Institutes (https://www.nsf.gov/news/special_reports/announcements/090120.03.jsp).

Our team consists of [Fabrizio Gabbiani](#) (PI, computational neurobiology), [Herman Dierick](#) (co-PI, genome editing), [Hojun Song](#) (co-PI, transcriptomics, phylogenetics), [Spence Behmer](#) (co-PI, nutritional physiology), [Arianne Cease](#) (co-PI, eco-physiology, Global Locust Initiative), [Barani Raman](#) (Senior Personnel, neuroscience), [Greg Sword](#) (Senior Personnel, collective behavior), [Stephen Richards](#) (Senior Personnel, genomics), [Rick Overson](#) (Senior Personnel, GLI), [Chuck Zong](#) (Senior Personnel, epigenetics, single cell transcriptomics), and [Erez Lieberman Aiden](#) (Senior Personnel, genomics). Other collaborators will soon join our institute as well.



Here is a technical abstract of our project: Phenotypic plasticity – the ability of a genotype to produce different phenotypes in response to different environmental conditions – is ubiquitous in nature, and occurs across all scales of biological organization. To fully understand its mechanisms, maintenance, and evolution, complete biological integration is needed. Locust phase polyphenism represents one of the most striking examples of phenotypic plasticity. It also provides a powerful comparative system for understanding how gene expression patterns and epigenetic regulation are linked to shifts in behavior, physiology, and ecology that result in outbreaks, collective movement, and mass migration. The Behavioral Plasticity Research Institute (BPRI) is established to comprehensively dissect this phenomenon and use it as a model system to transform the study

of phenotypic plasticity. Specifically, the BPRI will carry out ten integrative research activities, using three locust and three non-swarming grasshopper species with varying degrees of plasticity in the genus *Schistocerca*. The BPRI research will provide in-depth understanding of proximate mechanisms of locust phase polyphenism by generating high-quality reference genomes, complemented by tissue-specific and time-resolved transcriptomes and epigenomes, as well as CRISPR/Cas9 and reverse genetics tools to understand functional genetics. These mechanistic approaches will be integrated with organismal biology and ecology to investigate phase-associated nutritional physiology and ecological factors contribut-

ing to swarming under laboratory and field conditions. All research activities will be performed across species in a phylogeny-based comparative framework. The feedback among these activities will create synergies and lay the groundwork for the integrative study of phenotypic plasticity across model organisms from genomes to ecology and sustainability.

The BPRI will provide integrative and comprehensive education and training across academic levels. Members of the BPRI will learn to efficiently navigate across different levels of biological organization through the common thread of phenotypic plasticity. The BPRI will train a total of 30 scholars (3 postdoctoral BPRI Fellows, 11 Ph.D. students,

16 undergraduate students); we will pay particular attention to increasing diversity and inclusion in all aspects of the BPRI, including the training.

Soon, we will advertise these positions. Currently, we plan to hire three postdocs (one at Baylor College of Medicine, one at Texas A&M University, and one at Arizona State University) soon, and we will recruit a total of 11 PhD-level students to start in the Fall 2021 at various institutions. The official launch date for the BPRI is November 1, 2020.

So, please stay tuned and we will provide updates and share exciting new discoveries through this amazing research institute!

Regional Reports - What's happening around the world?

East Europe - North and Central Asia

By **MICHAEL G. SERGEEV**

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The general epidemic situation in almost all countries of our region remains relatively moderate. However, almost all borders

between countries are nearly closed, but now we can travel from one part of a country to another without limitations. In June and July, many of our colleagues could come back to their labs in universities and academic institutes, continue their research, and also organize some field studies, especially within adjacent territories. For instance, in August, a small group of orthopterists visited the so-called Bugotak Hills near Novosibirsk (Fig. 1), small mountains with stony steppes over their southern slopes, tried to estimate local orthopteran diversity for the first time, and

caught several interesting species near the northern boundaries of their actual ranges, e.g., *Phaneroptera falcata* (Poda) and *Stenobothrus nigromaculatus* (H.-S.).

A group of orthopterists from Novosibirsk University and Institute of Systematics and Ecology of Animals finished the huge project “Remote sensing and digital mapping as the basis for forecasts of locust and grasshopper outbreaks in Novosibirsk Region.” This project was financially supported by the joint program of the Russian Foundation for Basic

Researches and the Government of Novosibirsk Region (18-416-540001) and produced a series of digital maps of acridid pest distribution.

We also continue some discussions concerning joint projects, both international (for instance, between Kazakhstan and Russia, mainly in the field of applied acridology, and Russian and Belarusian orthopterists, collaborating on ecology and diversity of Orthoptera) and national (e.g., orthopteran diversity in the mountains of South Siberia and molecular phylogeny of Acrididae).



Figure 1. Bugotak Hills near Novosibirsk — one of the northernmost outpost of the stony steppes in South Siberia (Photo: M.G. Sergeev).

Australia, New Zealand & Pacific Islands

By **MICHAEL KEARNEY**

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In the Australasian region, our president David Hunter reports that, because of the large upsurge in the desert locust for the past year or so he has been kept very busy in the past two months working as a part time consultant for the Asian Development Bank. He is involved in setting up a Technical Assistance Project and an Asian Development Bank Loan for Pakistan not only on locusts, but on sustainable agriculture in the more medium term. Of course, all of the work has been online with Webinars and Team Meetings--half a dozen meetings per week with officials and colleagues in Pakistan are common. He notes that this seems to be the way of the world these days but we have been able to accomplish a lot in spite

of the limitations.

Kate Umbers at Western Sydney University notes that she is officially the IUCN grasshopper group co-chair with Axel Hochrich now.

David Rentz, in the wet tropics of Kuranda, notes the following:

- *Cooloola*- Revision of *Cooloola* with a number of new species (co-authored with GB Monteith).
- New genera and species of short-winged Australian Agraeciine Tettigoniidae. Eight new genera described with biology, ecology, cytology and some acoustics (co-authored with You Ning Su).
- eProject: Tettigoniidae of Australia. A free eBook with line drawings, photographs, maps, sound recordings and details for species identification of many described Australian Tettigoniidae (co-authored with Jessa Thurman).

Also, D Rentz and D. Weissman have been inducted to the "All Eight Club". This is a select group of people who have visited all 8 of the California Channel Islands. This was accomplished in the 1970's

and 80's and resulted in our joint Faunal Affinities, Systematics, and Bionomics of the Orthoptera of the California Channel Islands' University of California Publications in Entomology, Volume 94, 1981.

See:

https://www.islapedia.com/index.php?title=Welcome_to_Islapedia and

https://www.islapedia.com/index.php?title=RENTZ,_David_C for details.

In my group at the University of Melbourne, a number of us have continued to transcribe Ken H. L. Key's field notebooks. One has been fully uploaded to the Atlas of Living Australia (see <https://collections.ala.org.au/public/show/dr15784>), but there are 222 more to come!

During the COVID-19 lockdown here in Melbourne I have also found time to make some web-based apps that can be used to infer past activity and body temperature in grasshoppers (and other ectotherms). See: <https://camel.science.unimelb.edu.au/biological-forecasting-and-hindcasting-tools/>.

Latin America

By **MARTINA E. POCCO**

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Since a few years ago, the south region of South America (Argentina, Bolivia and Paraguay) is under a Phytosanitary Emergency due to the plagues of the South American locust, *Schistocerca gregaria* (Serville, 1838). This is the only swarming locust in southern South America and has been historically considered as the most serious agricultural pest in Argentina, with its maximum known invasion area covering nearly 4,000,000 km² affecting central and northern Argentina, Uruguay, southern Brazil, Paraguay, southeast Bolivia,

and central and northern Chile. After a period of 60 years without major outbreaks of *S. gregaria* (the last major plague was between 1943 and 1955), in late 2015, the north of Argentina was seriously affected by a plague of this locust. Between 2017 and 2019 the swarms were moving in a similar pattern over the north and northwest Argentina, Bolivia, and Paraguay.

Early this year in Argentina swarms of *S. gregaria* were detected in Salta province, limit to Bolivia, and there was a later migration towards the neighboring

countries, Bolivia and Paraguay (SENASA, March 2020). In May, swarms coming from Paraguay entered into Argentina through the east of Formosa province. Unlike the pattern of migration exhibited in recent previous years, in which the swarms moved mostly towards the northwest, the current migration



Figure 1. Maps of the situation of the locust *Schistocerca gregaria*, swarms detected and warning levels in Argentina (A, Report by July 27, 2020; B, Latest report by August 21, 2020). Source: SENASA, Informe Langosta Sudamericana, "Programa Nacional de Langostas y Tucuras (SENASA)". Ing. Héctor Medina. <https://www.argentina.gob.ar/senasa/micros%ADtios/langostas>

was towards the eastern part of the country, and moved in a south direction towards Chaco and Santa Fe, crossed the Paraná River, and entered into the province of Corrientes by mid-June, finally reaching the northeast of Entre Ríos province near the limit to Uruguay and Brazil by July (Fig. 1A). This pattern of migration, which had not been recorded since about 70 years ago, was mostly favored by the winds that enabled the spread of the locusts in a southeast direction (SENASA, July 2020). Due to the high probability

that the swarms would spread towards Brazil and Uruguay, both countries immediately responded through the elaboration of contingency plans and measures in case the plagues enter these countries, and declaration of phytosanitary emergency occurred in two states of South Brazil.

Fortunately, the swarm was successfully controlled in Entre Ríos, avoiding the invasion to Brazil or Uruguay. Simultaneously, other swarms entered again into Argentina from Paraguay and are currently moving over the provinces

of the northwest, Salta, Tucumán, Santiago del Estero, and also Córdoba province, which are currently under “Danger” warning level (Fig. 1B) (SENASA, August 2020). There is a regional coordination and cooperation among the different public and private sectors from the countries in the region. More information is available at the website of the “Programa Nacional de Langostas y Tucuras (SENASA):” <https://www.argentina.gob.ar/senasa/micros%C3%ADdios/langostas>.

China

By **LONG ZHANG**

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Yellow-spined bamboo locust swarms invade Yunan province

Yellow-spined bamboo locust (*Ceracris kiangsu*) is threatening both Laos and Vietnam, as well as the parts of China bordering these two countries. During most of July, adult swarms migrated from Northern Lao and Vietnam into the Yunnan province of China. Three to four big swarms were observed, some of them possibly



containing more than 80 million individuals. The adults landed on and damaged the bamboo trees (~10,000 ha) and corn (~3,000 ha). Since it was first observed in China, the local provincial government established a locust management headquarters and initiated control actions immediately. Drones were the primary machines used to spray pesticides (pyrethroids) because there are mountains and forests. So far, the locust has been controlled and regional cooperation is needed to keep it contained.

A supporting action for desert locust (*Schistocerca gregaria*) plague control in Pakistan

From the 23rd of February to the 5th of March, when the COVID-19 virus epidemic was serious, Long Zhang, as one of the members of a Chinese government delegation team, went to Pakistan, and did surveillance in the field and made some suggestions for management of the desert locust plague in the Sindh, Balochistan, and Punjab provinces. The latter contained the area of most urgent



need for management because of the high density of gregarious locust adult swarms distributed across a large area. The highest density was at more than 1,000 individuals/m². Most adults were mating and laying eggs, with one adult swarm distributed across several km². The number of egg pods in some places was about 228 pods/m², and the average number of eggs in each pod (90.2) indicated that desert locusts were very serious pests and would be even more serious in the future.

After surveillance and discussion with local scientists and officers the team gave suggestions for an integrated management program that included using both fungal and protozoan biological control





agents to manage nymph bands, mechanical control measures to destroy eggs, and chemical pesticides to manage both nymph bands and adult swarms. However, most important was to monitor the exact

locust developmental stages, density, location, and area. For long-term management, Pakistan needs to develop an efficient monitoring and forecasting supporting information system, and biological control

methods, as well as to explore novel control methods. To do this, they might cooperate with neighboring countries, such as Iran, India, China, and international organizations, like FAO.

India

By **ROHINI BALAKRISHNAN**

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We are living through times of historic change and 2020 in particular will not be forgotten, thanks to COVID-19, but,

also, in South Asia, to some of the biggest and furthest-ranging locust swarms in recent history. Whereas Iran, Pakistan, and North-Western India have regularly experienced locust swarms every year, usually restricted to a few districts or states, this summer was unprecedented.

It began in March-April, a little earlier in the summer than usual, and swarms from Iran covered much

of Balochistan, moving into Punjab and Sindh. This year was unusual, in that swarms even penetrated the northern, mountainous province of Khyber Pakhtunkhwa in Pakistan. Indeed, Pakistan declared a national emergency, with food security threatened by the invading hordes of locusts.

Locusts crossed over into the North-Western state of Rajasthan in India in mid-April, a little earlier in the summer, and with many more immatures appearing than usual, and experts on the ground believe that this may be partly why they then ranged much further. There is basically little or no vegetation, and no standing crops at that time in Western Rajasthan, and locusts flew much further east and south than they usually do. There were also multiple waves of swarms coming in from

and buildings covered by a swathe of locusts. Locusts flew further east and south, with the easterly arm reaching the outskirts of the national capital, Delhi, bypassing it and moving further eastwards, where they decimated crops in several districts of India's Uttar Pradesh province in the fertile Gangetic plains.

Another arm of the swarms moved south-eastwards into Central India (Madhya Pradesh), where they caused considerable damage, and even penetrated into the peninsular Indian states of Maharashtra and Telangana. Nothing on this scale has been seen in the last 27 years and certainly not with such a vast geographical spread within India. It is estimated that at least 90,000 hectares of agricultural land have been severely affected.

Although there were dire predictions that the monsoon would worsen the problem, that does not seem to have been the case, at least as of now (August), with the monsoon in full swing. Locust populations are currently restricted, as usual, to breeding grounds in western Rajasthan, though we will have to wait and see whether the more eastern parts where they penetrated serve as additional breeding grounds and foci for swarm formation later in the next season. At least as of now, there appears to be no evidence of that.

Locust invasions have occurred regularly in the Indian subcontinent

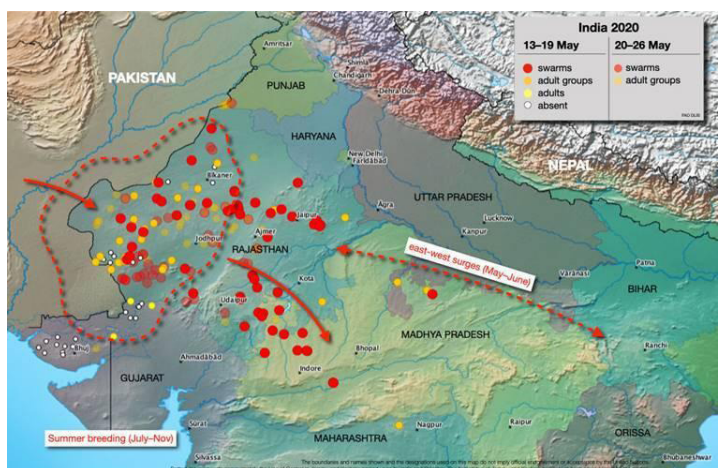


Image source: FAO website <http://www.fao.org/ag/locusts/en/info/info/>



Swarms of locusts in Jaipur, Rajasthan, from The Week, Monday, May 25, 2020
 (Image source: PTI, <https://www.theweek.in/news/india/2020/05/28/explainer-india-worst-locust-plague-and-why-it-needs-to-be-controlled-before-monsoon.html>)



Image: NavbharatTimes.com | Updated: 25 Jun 2020

over historic times and the Locust Warning Organisation (LWO), headquartered in Karachi in then-undivided India, was set up in 1939 by the British after the desert locust plague of 1926-31. Indeed, it is apparently one of the oldest organisations set up for this purpose! In 1946, the LWO came under the Indian Ministry of Agriculture in Delhi, but its operational headquarters is in Jodhpur in Western Rajasthan. In 1945, the first regional conference on the Desert locust was held in Tehran, with India, Saudi Arabia, Iran and Egypt participating, followed by a second conference in 1950, which inducted the newly formed state of Pakistan. LWO continuously monitors locust populations, especially in western Rajasthan and along the

Indo-Pakistan border. In 1964, the FAO Desert Locust Commission was formed with Iran, Afghanistan, Pakistan, and India as members. The mandate was to come together to solve the problem of locust plagues. The LWO of India and its Pakistani counterpart have co-operated in exchanging information, carrying out regular, co-ordinated surveys, meet formally once a year, and have multiple “border” meetings along the Indo-Pak border through the year (this year it moved online, like so much else, due to COVID-19). It is a unique co-operative venture that has survived the worst of the political tensions between the two countries over decades.

With information from the FAO,

and following the locust swarms in East Africa and Arabia, it was clear early in the year that South Asia may witness much higher levels of swarming than before. However, they were unprepared for the scale of the invasion. It was only after the first swarms started that the LWO and Ministry of Agriculture swung into action, with mass spraying of insecticides over the affected areas. For the first time, drones were deployed, both for spraying and for gathering local information on swarm locations for quick action. There is also some thought on developing radar-tracking for large swarms and, possibly, all of this will be increasingly deployed in the future.

The end result of these control measures, however, is still massive damage, both to crops and, perhaps worse, to the ecosystem, from the enormous amounts of pesticides sprayed for quick control. Methods of preventing swarm formation should probably get the highest research priority to minimise such instances in the future.

Theodore J. Cohn Research Grant Reports

Behavioral response to multi-channel environmental noise: tracking noise-induced changes in daily locomotor patterns and mate attraction strategies in *Acheta domesticus*

By **NICOLE ABATE**

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Animals must overcome many factors to survive and pass along their genes to the next generation. They

must be able to find resources, and eventually a mate, while dealing with competition from conspecifics and heterospecifics, and avoiding predation. Prior to mating, animals

must attract a mate, and can do so using visual, acoustic, tactile, and/or chemical signals, alone or in combination. Several factors can attenuate, or otherwise alter, the signal

as it travels through the transmission medium, one of which is noise. Noise is broadly defined as energy or matter that occurs in the same sensory channel as a focal signal, and can interfere with the transmission, detection, and processing of said signals (Zhao et al. 2017).

Isomodal noise interferes with communication in the same modality as the transmitted signal. Noise can also be found in the context of and interacting with other sensory channels. For example, acoustic noise can interfere with visual, chemical, and vibrational signals. This is known as crossmodal noise (Vandersal and Hebets 2007, Halfwerk and Slabbekoorn 2015). Noise can also be multimodal, interacting with multiple sensory channels at once (sound, visual, chemical, vibration). Anthropogenic noise often exhibits this multimodal complexity, and thus holds potential to influence animal behavior as a sensory pollutant (Halfwerk and Slabbekoorn 2015). Noise is considered an environmental stressor and can be equally as detrimental as other forms of pollution (Francis and Barber 2009).

Many studies on the effects of noise in animals have been conducted with vertebrate model species, particularly birds and marine mammals (Shannon et al. 2016, Francis and Barber 2013, Miksis-Olds 2016, 2012, Miksis-Olds et al. 2009, Tyack 1999). Less attention has been paid to invertebrates, which account for 80% of the biomass on the planet (Mora et al. 2011). For my master's thesis, I used house crickets, *Acheta domesticus*, to answer the following questions: **1)** Do different types and durations of noise influence the daily locomotor patterns in animals? **2)** Do different types and durations of noise influence decisions related to male signaling?

Methods

Penultimate instar *A. domesticus* nymphs were obtained from Fluker Farms® (Port Allen, LA) and

separated by sex upon arrival to ensure virginity upon eclosure as adults. Crickets were housed in the Integrative Animal Behavior Laboratory at the University of New Hampshire, Durham in an insectarium space maintained at 23° Celsius and 46% relative humidity, with a 14:10 light/dark cycle (lights on from 06:00-20:00, and lights off 20:00-06:00). Crickets were fed Meow Mix® original choice cat food, ground into a coarse powder, and provided paper towels soaked in bottled drinking water *ad libitum*. They were housed in glass aquaria with mesh screen tops and either egg crate or paper towel/toilet paper rolls for a substrate and refugia. Different individuals were used for each trial.

Cricket locomotion (the first experiment) was recorded with a TriKinetics locomotor activity monitor (LAM; TriKinetics Inc. Waltham, MA) to first establish a daily pattern, and subsequently observe noise effects. The second experiment involved recording crickets using an omnidirectional microphone attached to a Frontier Labs Bioacoustic Recorder to establish a preferred time of day for calling. Crickets were then exposed to isomodal (airborne), crossmodal (substrate borne), and multimodal (air and substrate borne combined) noise intermittently and continuously in both experiments to determine the effects of noise on these two behaviors.

Results and Discussion

In control conditions, crickets were most active between 12:00 and 16:00. I found that noise had an effect on *A. domesticus* locomotion, changing not only the daily pattern of locomotion, but the magnitude as well. This was the case in both intermittent and continuous noise treatments, with intermittent and continuous multimodal noise having the most dramatic effect.

Noise treatments also changed male calling behavior in both the time of

day and magnitude of calling. Males called the most between 2:00 and 6:00 in control trials. With exposure to noise, males called more and for a longer period of time, including increased calling when it was “Day.”

In *Acheta domesticus*, accurate reception of the male's call by females is crucial, and mating opportunities could be missed when males change their calling behavior, as they have done here. In addition, a female will not mount a male unless she has heard him call (Nelson and Nolen 1997). Anthropogenic noise will only increase in the coming years, and further research is needed to understand the impact it may have on organism behavior and fitness.

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I would like to thank The Orthopterists' Society for their generosity in awarding me this Theodore J. Cohn Research Fund Grant, which fully funded this research. Thank you to my advisor, Dr. Daniel Howard, and my thesis committee members, Dr. Carrie Hall and Dr. Donald Chandler. Additional thanks to my husband, parents, and friends for their love and support over the course of my master's research.

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Can Kapton screening minimize the adverse effects of LED light on the behavioral pattern and life history of flower visiting Indian grasshoppers?

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S *pathosternum prasiniferum prasiniferum* (Walker) was selected as the model acridid species to carry out the experiments of the present research. This acridid is an endemic species of the Indian subcontinent having an enormous distribution throughout the country. Arunachal Pradesh, Andhra Pradesh, Bihar, Goa, Himachal Pradesh, Jammu and Kashmir, Kerala, Madhya Pradesh, Maharashtra, Orissa, Rajsthan, Tamil nadu, West Bengal, etc. are the major states



Collection of fledglings in plastic vials for experimental set up

where the presence of this acridid is recorded the most (Dey and Hazra, 2003). It has also been reported from countries like Myanmar, China, Thailand and Vietnam. These are small light brownish to greenish in appearance, and having dark bands behind the lower part of the eyes (Bhowmik, 1986). Males are smaller than females and are about 14.4mm long, while females are about 17.9mm long. The average dry weights are 45mg for males and about 65mg for females. This oligophagous insect species chiefly lives on plants under Poecae family and are considered as a minor pest of these species.

Background

Until very recently some works are emerging on the flower visiting grasshoppers that may act as pollinators (Tan et al., 2017). In this context our personal observation led us to select *S. pr. prasiniferum* for the present study as because these are also frequent visitors in the domestic gardens and parks. Although we don't have any clear proof whether it can help in pollination or not, it is definitely a recurrent flower visitor. Nowadays gardens and parks are being illuminated by light emitting diodes (LEDs) that have a greater intensity of blue wavelength which

is harmful for biota (Eccard et al., 2018). Hori et al. (2014), Wakefield et al. (2017), Hori and Suzuki (2017), and Shibuya et al., (2018) conducted some experiments on impact of white LEDs on nocturnal Dipteran and Coleopteran insects. Their studies revealed that white LED exposure leads to increased reactive oxygen species (ROS) production, suppressed cell growth, and severe mortality in eggs, larvae, pupae and adults. Similar works have been conducted by Mbugua et al. (2020) on the firefly *Lamprigera* sp. They have also reported a dwindling active foraging of this insect in response to artificial lights. Consequently it could be concluded that LEDs can definitely impact on insect life history and physiology. But most of these works have been conducted in nocturnal insects.

Our question was if there is any possibility that LEDs also have some adverse impact on diurnal insects like acridid grasshoppers. To formulate this research question we kept in mind that artificial lightings will increase day length and the grasshoppers may have a prolonged foraging time.

In this project work we did not only concentrate to find out the possible adverse impacts of cool white LEDs on the selected grasshoppers species,



(left) Isolated hopper exuviae, (right) *Sorghum halepense*

but also made an attempt to minimize the impact of the lights using a screen that can significantly cut the blue wavelength light spectrum. For this purpose we have selected a polyimide screen (Kapton). According to a group of Indian scientists in Indian Institute of Science (IISc, Bengalore) kapton screens can filter this harmful blue light of LEDs (Prakash, 2017), and in this work we have attempted to test the efficacy of kapton screen to know whether it can virtually minimize the adverse impact of LEDs on grasshoppers.

Expectations

Surveying the literature, we expected that we would notice some adverse impacts of cool white LEDs on the grasshoppers. As Kapton can significantly cut the blue spectrum, we expected some ameliorative effect on the hoppers if such screen is applied. Thus we anticipated to reach in a conclusion whether these types of screens could be used during artificial lighting that ultimately causes minimal adverse impacts on biota.

Methodology

Procurement of S. pr. prasiniferum

A total of 50 adult males and 50 females were collected from the nearby agricultural field surrounding our institution and bred in captivity in the insect rearing facility of our institution in plastic boxes according to the strategies proposed by Halдар et al. (1999). The experiment was

conducted with same day hatched one day old first instar. Sample individuals were sent to Zoological Survey of India (ZSI), Kolkata for taxonomic identification. *Light source.* Two light sources were selected for the present study. They were 5W cool white

LED, and Kapton screened 5W cool white LED; a control set was also kept having no artificial lighting system.

Food plant. Seeds of *Sorghum halepense* was obtained from the local market and sowed in the Entomology experimental garden in the college premises in a pesticide free environment. When the seedlings emerged their leaves were clipped each day and known amount of fresh leaves were offered to each sets.

Experimental set up. A total of 12 experimental rearing boxes were employed for this study as the experiment was conducted in three sets with quadruplicates with a microcosm set up as described by Halдар (2012).

Each rearing box contained same day hatched 51 fledglings. The rearing boxes measured 38cm×30cm×20cm. All of them were fitted with a nylon mesh on top for air supply. The boxes were filled with sterilized sand with 5cm depth, and each day some water was sprinkled to keep the sand moist so that humidity is

maintained.

The experiment was conducted for a single generation and the following Walbauer (1968) parameters on foraging behavior and life history patterns were estimated:

1. Nymphal and adult duration in days
2. Nymphal mortality in percentage
3. Growth rate (GR)= Wt/TA [Wt = dry weight gained, T = Duration of feeding period in days, A = Mean dry weight of insects during feeding period]
4. Average number of eggs hatched per female (i.e. clutch size)
5. Consumption Index (CI)= F/TA [F = Dry weight of ingested food, T = Duration of feeding period in days, A = Mean dry weight of insects during feeding period], where $F = [1 - (A/2)] [W - L(1+B)]$ [W = Fresh weight of food provided, L = Dry weight of uneaten food, A = Initial dry weight of the aliquot, B = Final dry weight of the aliquot]

The surprise

To our surprise, the obtained results were quite fascinating and nearly opposite to our expectations. In almost all the cases cool white



(top) Cool white LED treated groups, (bottom) Kapton screened LED treated groups

LED treatment was found to be beneficial for the grasshoppers. Average nymphal mortality was much less in LED treated groups (about 16%) compared to the control groups (about 21%) ($p < 0.05$, ANOVA, post hoc test). It was evident from our findings that LED treated sets grew faster (took about 35 days to reach adulthood) than that of control sets (more than 42 days) ($p < 0.05$, ANOVA, post hoc test), while adult life span, clutch size and growth rate were significantly lower in control groups ($p < 0.05$, ANOVA, post hoc test). Nevertheless, we have not observed any significant variation in the foraging behavior, and naturally consumption index had no significant difference.

Although our obtained results did not match our expectations but the findings were crucial. Even though *S. pr. prasiniferum* is not considered as a major pest, but we could conclude that artificial light can definitely increase their annual biomass, as nymphal mortality was found to be less and clutch size was increasing. This finding was alarming because overpopulation may influence the insects to emerge as a major pest. Next it was important to observe if Kapton screen could alter this situation in a positive way.

Can Kapton covering minimize the impact?

In this section we will discuss the impact of Kapton screen on the above mentioned parameters of the selected grasshopper species. It is evident from our findings that control and Kapton screened LED treated groups have similar mortality rate, nymphal duration as well as growth rate (about 21%, 43 days, 0.04 in both control and Kapton screened groups, $p < 0.05$, ANOVA, post hoc test). On the contrary adult duration of Kapton screened groups was similar to white LED treated sets (more than 56 and 59 days respectively). But clutch size was the lowest (about 17 eggs hatched/ female) in kapton

screened LED treated groups, where control groups showed about 29 eggs hatched/female, and LED treated groups had the highest clutch of about 44 eggs hatched/female ($p < 0.05$, ANOVA, post hoc test). However, foraging behavior was again found to be unaffected and consumption index coincided with the previous results (i.e. near about 4; $p < 0.05$, ANOVA, post hoc test).

Conclusion

In conclusion we could state that LED light might impact nocturnal and diurnal insects differently. Although in some other works it was reported that the blue spectrum of cool white LEDs can adversely act upon the physiology of insects, in our experiment we found that grasshoppers responded in a completely different way. In fact, LEDs could be beneficial for them in some cases. From our results it was clear that the nymphal mortality decreases, adult life span and clutch size increases in response to white LED light exposure. But here comes the major concern, because a so-called flower visiting minor pest can easily come into sight as a major pest if its biomass production is increased significantly. Our experiment also showed a light of hope as the impact of LEDs was observed to be diminished by using simple Kapton screens. In case of the latter groups nymphal mortality was similar to control, nymphs grew in a similar fashion as in control groups; even though adults lived longer the clutch size was significantly low. So, it is clear that Kapton screened LEDs can interfere with the population dynamics of grasshoppers leading to a less annual biomass. Thus we could conclude that the impact of cool white LEDs could be minimized by using Kapton screened LEDs, even though further studies are necessary in this regard.

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Altitudinal variation of Orthoptera species diversity in rice fields of central Nepal

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Nepal is a heaven, where each valley has its own species. I always remember my friend, Josip Skejo, quoting these words of Dr. Sigfrid Ingrisch, a pioneer figure in the field of orthoptera of Nepal. I always feel blessed to have been born in this beautiful country with a significant variation in mean altitude above sea level ranging from 58 MSL to 8,848 MSL within a mere breadth of 193 km. This huge variation has contributed significantly to the diversity of flora and fauna found in this country. However, only a few studies have been conducted to assess the diversity of orthoptera fauna in Nepal. In this regard, I was willing to conduct an expedition to explore the orthoptera found at different elevations. I first came to know about the Theodore J Cohn Research Fund from The Orthopterists' Society. I wrote to Dr. Michel Lecoq and Dr. David Hunter who encouraged me to apply for the grant, which I did and was selected.

This selection turned out to be the first page in my story of Orthoptera. Though I was a student of entomology, I had very little knowledge on Orthoptera. This selection encouraged me a lot and I started searching for literature and gathering information on these amazing insects. I, in the month of May 2019, conducted several random field trips to select places located at different elevations (differing by 500 MSL) with the help of an altimeter. I selected four different rice growing places: Rampur, Chitwan (258 MSL), Modibeni, Parbat (758 MSL), Kairimta, Parbat (1258 MSL), and Kalimati, Parbat (1758 MSL) of central Nepal. Each place was visited once a month to collect specimens. I used plastic jars to keep the collected

specimens, fed them with grass on a daily basis, and covered each with mosquito netting for aeration. Unfortunately, the use of mosquito nets allowed ants to enter the jars and kill the specimens, so I shifted towards the use of muslin clothes.

All collected specimens were brought to Agriculture and Forestry University, Rampur, Chitwan by carrying them in cardboard boxes. It was a very challenging job to transport the collected specimens and keep them alive on public transportation (bus) because they are usually too crowded. After taking the specimens to the university, I started observing the different nymphal stages. Students used to come to me, observe me changing grasses, and discuss the insects. In this way, students from other departments were also slowly falling in love with these amazing creatures. I showed them the exuviae, eggs laid, and excreta of the specimens. It took me 2-3 hours daily to change the grass, remove excreta, and record observations. I also took photographs of the specimens. I was slowly learning about them and I started following various literature, keys, and with the help of expert friends, like Dhaneesh Bhaskar, Josip Skejo, and Pattarawich Dawwrueng, I slowly started learning about the ways to move forward in taxonomy.

We have very little advances in the field of taxonomy in our country, so all the basis of identification of the specimens was based on morphology. I spent significant hours in the laboratory with a Leica GZ6 stereozoom microscope, searching for that key diagnostic feature of the species. In total, I was able to collect and identify 18 species of Caelifera from paddy fields, with most species from intermediate altitudes. Ingrisch (2006)

reported the maximum number of Caelifera species to fall in the altitude range of 1,000-1,500 MSL. The species collected were: *Acrida exaltata*, *Atractomorpha crenulata*, *Aulacothrus luteipes*, *Eyprepocnemis alacris*, *Heteropternis respondens*, *Hieroglyphus banian*, *Nepalocaryanda latifrons*, *Oxya fuscovittata*, *O. grandis*, *O. hyla*, *O. japonica*, *O. velox*, *Peripolus nepalensis*, *Phaleoba infumata*, *Spathosternum prassiniferum*, *Stenocatantops splendens*, *Trilophidia annulata*, and *Xenocatantops humilis*. A total of 5 species were reported from Rampur, while Modibeni and Kairimta each had 11 species, and Kalimati had 5 species. For perspective, a total of 26 Caelifera species of grasshoppers have been reported from rice fields of Uttar Pradesh, India, representing 14 genera belonging to 2 families, 8 subfamilies, and 12 tribes (Akhtar, Usmani, Nayeem, & Kumar, 2012). I prepared an identification key of the species I collected, which have been kept as voucher specimens in my university's Entomology laboratory. I am still working on identification of some Ensifera and Tetrigidae.

So, from all these activities and the experiences, I can proudly draw the conclusion that this research fund has paved a strong way in my long journey in the field of Orthoptera.

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Acknowledging spatiotemporal hierarchy improves locust outbreak models

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Ecological phenomena act on various spatial and temporal scales (Wiens 1989, Levin 1992). Acknowledging the spatiotemporal scales of locust swarms from individual gregarization (Simpson and Sword 2009) to the awe-inspiring landscape level migrations that pose significant issues to global food security (Cullen et al. 2017) is important, yet remains understudied. An excellent framework to acknowledge the spatiotemporal hierarchy of locust swarms is the Hierarchical Patch Dynamics paradigm (Wu and Loucks 1995). This paradigm allows for linkages between spatial and temporal scales through a nested model of patches within patches (Kotliar and Wiens 1990, Wu and Loucks 1995). Thus, it can capture the inherent complexity of landscape level analyses which have emergent processes that arise as you move across scales (Newman et al. 2019), like locust outbreaks. I set out to investigate the hierarchical relationship between outbreaks and preceding vegetation by focusing on Australian plague locust (*Chortoicetes terminifera*) and desert locust (*Schistocerca gregaria*) to determine if the spatiotemporal hierarchy remained constant between species.

Precipitation, and the resulting vegetation growth, are thought to be very important factors for locust outbreaks to occur (Joern and Gaines 1990). Due to this, most forecasting models use either soil moisture (Piou et al. 2019) or vegetation growth metrics, such as the normalized difference vegetation index (NDVI; Cressman 2013, Deveson 2013, Piou et al. 2013) to predict outbreaks, with notable success (e.g. Deveson 2011, Millist and Abdalla 2011,

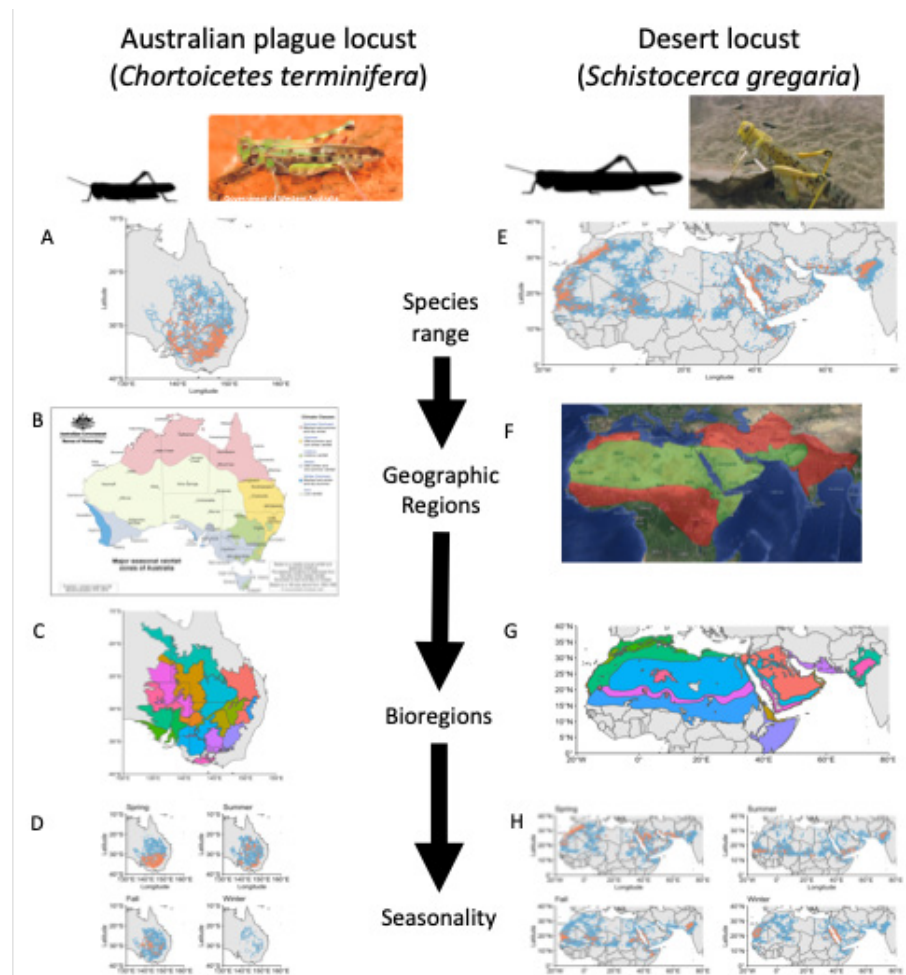


Figure 1. Hierarchical structure of Australian plague locust (A-D) and desert locust (E-H). The hierarchy is as follows: species range (A & E), geographic regions (B & F), bioregions (C&G), and seasonality (D & H).

Adriaansen et al. 2015). Vegetation and, consequently, animals are heterogeneously distributed because abiotic and biotic factors change spatiotemporally (Watt 1947, Greg-Smith 1979, Condit et al. 2000, Ives et al. 2008). Since locusts are widely distributed in highly variable environments, not accounting for spatiotemporal change can lead to inaccurate conclusions about the underlying causes of outbreaks.

The spatiotemporal hierarchy of locust outbreaks can be broken into four biologically relevant levels (Fig. 1). The largest level is

the entire range where outbreaks of each locust species have been observed. At this level, the important factors are migration and large-scale climatic factors (e.g. El Niño Southern Oscillation, Indian Ocean Dipole, etc.). The second level involves large geographic areas that experience similar climatic conditions (e.g., seasonal rainfall zones). The third level includes bioregions or ecoregions that experience similar abiotic and biotic conditions (e.g. soil characteristics, rainfall, vegetation structure, etc.). The final level is season as all higher levels vary

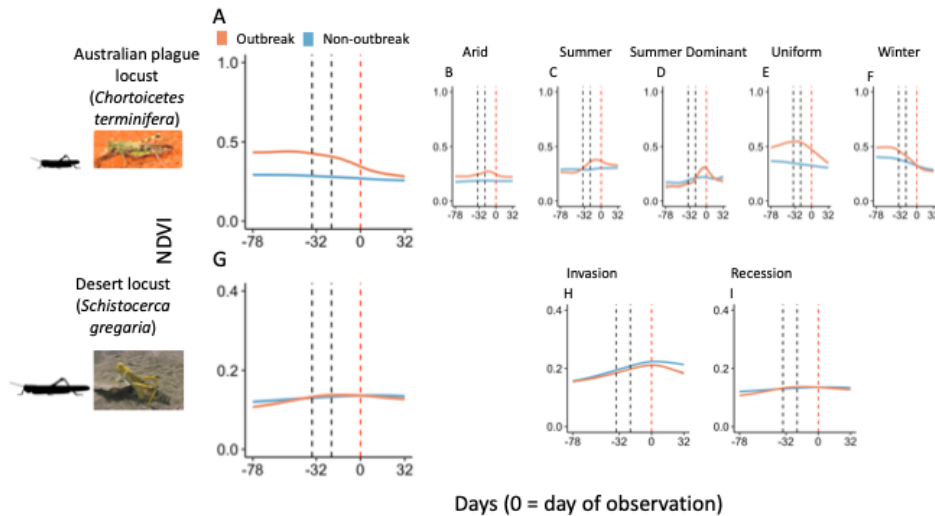


Figure 2. NDVI trends for outbreak and non-outbreak observations over time for the Australian plague locusts (A-F) and desert locust (G-I). The red line is the observation date, black lines represent hypothesized nymph hatching date. Figure A and G are species range level and figures B-F and H-I are geographic region level patterns for the Australian plague locust and desert locust respectively.

based on the time of the year due to changing temperature and rainfall. Each level poses a bottleneck that could restrain locust populations from building. Therefore, to have an outbreak, all four levels must be favorable.

To do this, I used NDVI (a metric to estimate vegetation amount and condition) derived from MODIS imagery and nymph outbreak survey data from the Australian Plague Locust Commission, FAO, and state and country agencies from 2000-2020. To test the hypothesized spatiotemporal hierarchy, I constructed hierarchical generalized additive models with variable spatiotemporal hierarchy following previous protocols (Pedersen et al. 2019). All imagery was downloaded from Google Earth Engine and models built within R.

I am currently drafting the manuscript of this study, but the results suggest that, as expected, preceding vegetation is an important predictor of locust swarms (Fig. 2). However, the actual relationship varied between each hierarchical level and species. Regardless of species, the overall spatiotemporal hierarchy of geographic zone > bioregion > season was overwhelmingly selected in the modeling process.

This suggests several things: first, modeling endeavors that do not include hierarchy may lead to erroneous results. For example, without its inclusion, one would have come to the conclusion that Australian plague locust outbreaks only occur after long preceding vegetation growth, yet, in three of the five geographic regions, outbreaks occur after a shorter resource pulse (Fig. 2 A-F). Second, I was able to dramatically improve model fit by just including this hierarchy without adding additional variables which could introduce concurvity (the non-linear version of collinearity). Lastly, we show that hierarchical structuring of the data is a generalizable feature of Australian plague locust and desert locust outbreaks. We hope that this approach can be applied in studying the many extraordinary Orthoptera with wide-spread ranges.

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Orthoptera Species File Grant Reports

Types of Neotropical Tetrigidae (Orthoptera: Caelifera) in the Collection of Academy of Natural Sciences of Philadelphia (ANSP)

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Tetrigids (pygmy grasshoppers and grouse locusts) are inconspicuous orthopterans characterized mainly by pronotum extended, covering part or the whole abdomen; elytra shortened and laterally arranged in the body with wings developed (there are some species without both characters); tympanal organ absent; fore and middle tarsi with two segments, hind tarsi with three segments and arolia absent (Dirsh, 1961). Tetrigids are distributed all over the world (Hancock, 1907) with some exceptions (Rehn, 1952; Tumbrink, 2014), and their systematics and diversity in the Neotropical region are poorly known (Rowell, 2013). Currently, there are 2,000 valid species (and around 350 synonyms) in seven subfamilies worldwide and 194 species (including 3 fossils) recorded from Central and South America (Cigliano et. al., 2020).

Since Linnæus described the first species, *Tetrix bipunctata* (Linnaeus, 1758) and *Tetrix subulata* (Linnaeus, 1758), numerous new species of Tetrigidae were designated and the majority of tetrigid diversity comes from the tropical regions of the world. Regarding Neotropical tetrigids, most primary types are housed in the collection of the Academy of Natural Sciences of Drexel University (ANSP), Philadelphia. This museum

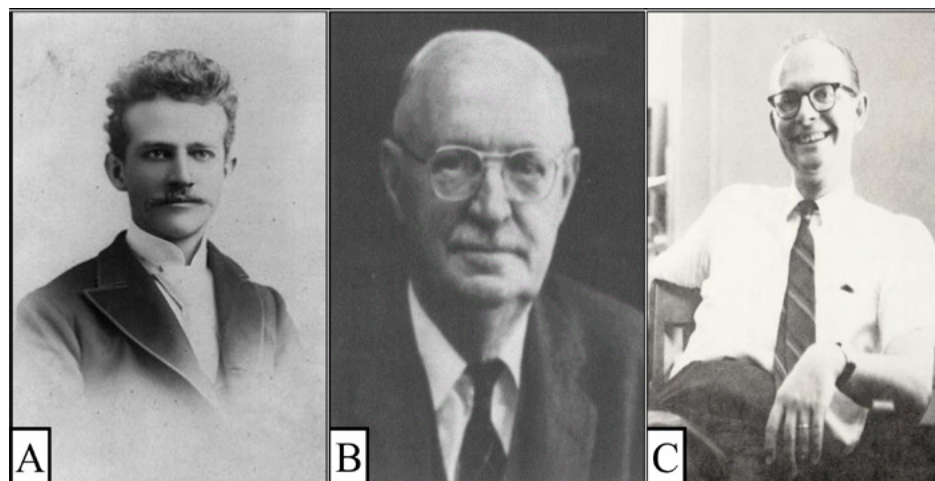


Figure 1. The great researchers of tetrigids of Neotropical regions: (A) Joseph Lane Hancock (from Library of Congress Prints and Photographs Division Washington), (B) James Abram Garfield Rehn (Gurney, 1965), and (C) Harold Johnson Grant Jr. (Phillips, 1966).

has more than 11,000 primary types of insects and most of them comprise Hymenoptera and orthopteroid orders that represent over 70% of the entire collection. Thus, this collection is considered one of the most important for orthopteroid researchers as well as for tetrigid researchers. The great representation of Neotropical species in the ANSP collection is mainly due to the contributions of Joseph Lane Hancock (Fig. 1) and two other great tetrigid researchers in the 20th century: James Abram Garfield Rehn (1881-1965) and Harold Johnson Grant Jr. (1921-1966) (Fig. 1) that, together with other cooperators, made the ANSP collection the biggest collection of this group, containing some hundreds of types from around the world.

During my Ph.D. studies, I started

to become interested in tetrigid studies and I realized that the information available for this group was limited. In tetrigids, many genera have unresolved issues regarding taxa delimitation since species determinations are difficult, in part because, historically, there have been few photographs or drawings of type species available. Thus, the main objective of this proposal was to add data for the Neotropical tetrigids to the Orthoptera Species File by providing high-quality photographs of the type specimens deposited in the Academy of Natural Sciences of Philadelphia (ANSP) collection (Figs. 2, 3) and study some of them taxonomically.

A total of 109 species (holotype, allotype, paratypes, lectotype, lectallotype, and cotype) have been

Table 1. Photographed specimens of Neotropical tetrigids of ANSP Orthoptera collection.

Taxon	Type	Taxon	Type
<i>Acrydium andeanum</i> Hebard, 1923 (<i>Tetrix andeanum</i> (Hebard, 1923))	Holotype, allotype	<i>Paratettix robustus</i> Hancock, 1902 (<i>Paratettix mexicanus</i> (Saussure, 1861))	Holotype
<i>Allotettix americanus</i> Hancock, 1907	Holotype	<i>Paratettix sinuatus</i> Morse, 1900	Holotype
<i>Allotettix bolivianus</i> Bruner, 1913 (<i>Crimisus bolivianus</i> (Bruner, 1913))	Holotype	<i>Paratettix texanus</i> Hancock, 1902 (<i>Paratettix cucullatus</i> (Burmeister, 1838))	Lectotype, paralectotype
<i>Allotettix chapadensis</i> Bruner, 1910	Lectotype	<i>Paratettix totecus arzomus</i> Hancock, 1902 (<i>Paratettix mexicanus</i> (Saussure, 1861))	Lectotype, paralectotype
<i>Allotettix fuscipennis</i> Bruner, 1910	Lectotype	<i>Paratettix totecus extensus</i> Morse, 1899 (<i>Paratettix mexicanus</i> (Saussure, 1861))	Lectotype
<i>Allotettix prolongatus</i> Hancock, 1899	Holotype, paratype	<i>Paratettix totecus sonorensis</i> Hancock, 1902 (<i>Paratettix mexicanus</i> (Saussure, 1861))	Lectotype
<i>Apotettix eurycephalus</i> Hancock, 1902 (<i>Paratettix totecus</i> (Saussure, 1861))	Holotype	<i>Paratettix tuberculatus</i> Hancock, 1902 (<i>Paratettix mexicanus</i> (Saussure, 1861))	Lectotype
<i>Apotettix minutus</i> Rehn & Hebard, 1905 (<i>Neotettix femoratus</i> (Scudder, 1869))	Holotype	<i>Paurotarsus amazonus</i> Hancock, 1900 (<i>Paurotarsus ruficornis</i> (Walker, 1871))	Holotype
<i>Apotettix proximus</i> Hancock, 1907 (<i>Paratettix proximus</i> (Hancock, 1907))	Holotype, allotype	<i>Paurotarsus insolitus insolitus</i> Rehn, 1916	Holotype, allotype
<i>Apteropodon apicale</i> Bruner, 1910 (<i>Halmatettix cristinonius</i> Hancock, 1909)	Lectotype	<i>Paurotarsus insolitus abbreviatus</i> Grant, 1955	Holotype, allotype
<i>Batrachidea cristata</i> Scudder, 1862 (<i>Nomotettix cristatus cristatus</i> (Scudder, 1862))	Holotype	<i>Paurotarsus insolitus extremus</i> Grant, 1955	Holotype
<i>Batrachidea inermis</i> Hebard, 1923 (<i>Batrachidea brevis</i> (Hancock, 1909))	Holotype	<i>Tetrigidea obesa</i> Scudder, 1877 (<i>Paxilla obesa</i> (Scudder, 1877))	Lectotype
<i>Batrachidea macella</i> Grant, 1956	Holotype, allotype	<i>Platyettix arcuatus</i> Bruner, 1920 (<i>Metrodora arcuatus</i> (Bruner, 1920))	Holotype
<i>Batrachidea vesca</i> Grant, 1956	Holotype	<i>Platyettix gibbinotus</i> Bruner, 1910 (<i>Metrodora gibbinotus</i> (Bruner, 1910))	Lectotype, lectallotype
<i>Chiriquia mirifica</i> Hebard, 1924	Holotype	<i>Platyettix harroweri</i> Hebard, 1924 (<i>Metrodora harroweri</i> (Hebard, 1924))	Holotype, allotype
<i>Cranotettix alpha</i> Grant, 1955	Holotype	<i>Platyettix reticulatus</i> Hancock, 1906 (<i>Metrodora reticulata</i> (Hancock, 1906))	Holotype
<i>Crimisoides undulatum</i> Hebard, 1932	Holotype	<i>Platyettix uniformis</i> Bruner, 1910 (<i>Metrodora uniformis</i> (Bruner, 1910))	Lectotype, lectallotype
<i>Cubanotettix narquinensis</i> Perez-Gelabert, Hierro & Otte, 1998	Holotype	<i>Plesiotettix spinosus</i> Hancock, 1907	Holotype
<i>Cubonotus almotatus</i> Perez-Gelabert, Hierro & Otte, 1998	Holotype	<i>Plesiotettix uncinatus</i> Hancock, 1907	Holotype
<i>Eomorphopus granulatus</i> Hancock, 1907	Holotype	<i>Puiggaria antennata</i> Bolívar, 1887	Allotype
<i>Eutettigidea limeata</i> (Bruner, 1910)	Holotype	<i>Rehndium necopinum</i> Grant, 1956	Holotype, allotype
<i>Gladiotettix hancocki</i> Bruner, 1910 (<i>Lophotettix hancocki</i> (Bruner, 1910))	Holotype	<i>Rehndium omnivagum</i> Grant, 1956	Holotype, allotype
<i>Haitianotettix monstruosus</i> Perez-Gelabert, Hierro and Otte, 1998 (<i>Haitianotettix tuberculatus</i> Perez-Gelabert, Hierro & Otte, 1998)	Holotype	<i>Rehndium perexiguum</i> Grant, 1956	Holotype
<i>Halmatettix allardi</i> Grant, 1955	Holotype, allotype	<i>Rehndium verutum</i> Grant, 1956 (<i>Scaria veruta</i> (Grant, 1956))	Holotype, allotype
<i>Halmatettix cristinonius</i> Hancock, 1909	Allotype	<i>Scabrotettix acutilobus</i> Hancock, 1907	Holotype
<i>Halmatettix furcatus</i> Grant, 1955	Holotype	<i>Scabrotettix bolivianus bolivianus</i> Hancock, 1907	Holotype
<i>Halmatettix major</i> Grant, 1955	Holotype	<i>Scabrotettix bolivianus extensus</i> Hancock, 1907	Holotype
<i>Halmatettix sordidus</i> Grant, 1955	Holotype	<i>Scabrotettix scabrosus</i> Hancock, 1907	Holotype
<i>Honetttix haitianus</i> Perez-Gelabert, Hierro & Otte, 1998	Holotype	<i>Scaria fasciata</i> Hancock, 1907	Holotype, allotype
<i>Mucrotettix gibbosus</i> Perez-Gelabert, Hierro & Otte, 1998	Holotype	<i>Scaria producta</i> Hancock, 1907	Holotype
<i>Mucrotettix spinifer</i> Perez-Gelabert, Hierro & Otte, 1998	Holotype	<i>Sclerotettix abbreviatus</i> Bruner, 1910 (<i>Crimisus lobatus</i> Hancock, 1909)	Lectotype, lectallotype
<i>Neotettix hancocki</i> Blatchley, 1903 (<i>Neotettix femoratus</i> (Scudder, 1869))	Holotype	<i>Sclerotettix infuscatus</i> Bruner, 1910 (<i>Crimisus infuscatus</i> (Bruner, 1910))	Lectotype, lectallotype
<i>Neotettix proavus</i> Rehn & Hebard, 1916	Holotype, allotype	<i>Sclerotettix minor</i> Bruner, 1910 (<i>Crimisus minor</i> (Bruner, 1910))	Lectotype, lectallotype
<i>Neotettix roandifrons</i> Hancock, 1898 (<i>Neotettix femoratus</i> (Scudder, 1869))	Lectotype	<i>Sclerotettix steinbachi</i> Bruner, 1913 (<i>Crimisus steinbachi</i> (Bruner, 1913))	Holotype
<i>Nomotettix cristatus floridanus</i> Hancock, 1902	Lectotype	<i>Sclerotettix tibialis</i> Bruner, 1910 (<i>Crimisus tibialis</i> (Bruner, 1910))	Lectotype
<i>Otumba basalis</i> Bruner, 1910	Holotype	<i>Sclerotettix variegatus</i> Bruner, 1910 (<i>Crimisus variegatus</i> (Bruner, 1910))	Lectotype, lectallotype
<i>Otumba dentata</i> Hancock, 1907	Holotype	<i>Sierratettix carinatus</i> Perez-Gelabert, Hierro & Otte, 1998	Holotype
<i>Otumba incompta</i> Hebard, 1924	Holotype, allotype	<i>Stenodorsus extenuatus</i> Hancock, 1906	Holotype
<i>Otumba marcapata</i> Hancock, 1907	Holotype	<i>Telmattettix minutus</i> form <i>rugosus</i> Hancock, 1902 (<i>Paratettix aztecus</i> (Saussure, 1861))	Lectotype
<i>Otumba scapularis</i> Morse, 1900	Holotype	<i>Telmattettix parviverticis</i> Hancock, 1902 (<i>Paratettix aztecus</i> (Saussure, 1861))	Lectotype, paralectotype
<i>Paratettix antennatus</i> Hebard, 1923	Holotype, allotype	<i>Teredorus stenofrons</i> Hancock, 1907	Holotype
<i>Paratettix durus</i> Morse, 1900 (<i>Paratettix totecus</i> (Saussure, 1861))	Holotype		
<i>Paratettix hesperus</i> Morse, 1899 (<i>Paratettix aztecus</i> (Saussure, 1861))	Lectotype		
<i>Paratettix morsei</i> Hancock, 1902 (<i>Paratettix mexicanus</i> (Saussure, 1861))	Lectotype, allotype		

analyzed (see Table 1). For each specimen, approximately four images were obtained: dorsal and lateral habitus, frontal view, and labels. All images were taken with a Canon EOS T3i digital camera equipped with a macro lens EF 100 mm f/2.8 L in a photo lightbox. The images were then treated with image editing software Corel®.

During my stay in Philadelphia, from the images obtained and the studies developed during this time, I already have some publications completed in partnership with several

researchers: (i) The type material of Gryllotalpidae Leach, 1815 (Insecta: Orthoptera: Ensifera) deposited in the ANSP: an updated checklist by Silva et al. (2017); (ii) Review of *Lophotettix*, the sole member of the subfamily Lophotettiginae Hancock, 1909 (Insecta: Orthoptera: Caelifera: Tetrigidae) by Silva et al. (2019); (iii) New tribes, overview and checklist of Neotropical Cladonotinae (Orthoptera: Caelifera: Tetrigidae) by Silva et al. (2019); (iv) Systematics and biogeography of the genus *Scaria* Bolívar, 1887 (Orthoptera:



Figure 2. *Tiburonotus peninsularis* Perez-Gelabert, Hierro & Otte, 1998: (A) right view, (B) left view, and (C) dorsal view. Scale bar = 0.5 cm.

Table 1 (cont'd). Photographed specimens of Neotropical tetrigids of ANSP Orthoptera collection.

Taxon	Type
<i>Tetrigidea gracilicornis</i> Bruner, 1910 (<i>Batrachidea mucronata</i> (Saint-Fargeau & Serville, 1825))	Lectotype, lectallotype
<i>Tetrigidea acuta</i> Morse, 1895	Lectotype
<i>Tetrigidea annulipes</i> Bruner, 1910	Holotype
<i>Tetrigidea arcuata</i> Bruner, 1910	Lectotype, lectallotype
<i>Tetrigidea chapadensis</i> Bruner, 1910	Lectotype, lectallotype
<i>Tetrigidea corrugata</i> Bruner, 1910	Lectotype
<i>Tetrigidea costalis</i> Bruner, 1910	Holotype
<i>Tetrigidea cuspidata</i> Scudder, 1875	Holotype
<i>Tetrigidea glabrata</i> Bruner, 1920	Holotype
<i>Tetrigidea granulosa</i> Bruner, 1913	Holotype
<i>Tetrigidea hancocki</i> Bruner, 1910	Holotype
<i>Tetrigidea intermedia</i> Bruner, 1910	Lectotype, lectallotype
<i>Tetrigidea jalapa</i> Hancock 1900 (<i>Tetrigidea nicaraguae nicaraguae</i> Bruner, 1895)	Holotype
<i>Tetrigidea lateralis</i> variety <i>medialis</i> Hancock, 1902 (<i>Tetrigidea lateralis lateralis</i> (Say, 1824))	Holotype
<i>Tetrigidea nicaraguae</i> Bruner, 1895	Holotype, cotype
<i>Tetrigidea nigra</i> Morse, 1900	Cotype
<i>Tetrigidea paractea</i> Rehn, 1913	Holotype
<i>Tetrigidea parvula</i> Morse, 1900 (<i>Tetrigidea australis</i> Hancock, 1900)	Holotype
<i>Tetrigidea prorsa</i> Scudder, 1877	Holotype
<i>Tetrigidea prorsa</i> variety <i>elongata</i> Morse, 1895 (<i>Tetrigidea prorsa</i> Scudder, 1877)	Paratype
<i>Tetrigidea pulchella</i> Rehn, 1904	Holotype
<i>Tetrigidea spicata</i> Morse, 1895 (<i>Tetrigidea acuta</i> Morse, 1895)	Lectotype
<i>Tetrigidea spicatoides</i> Hebard, 1932	Lectotype
<i>Tetrigidea steinbachi</i> Bruner, 1920	Holotype
<i>Tetrigidea subaptera</i> Bruner, 1910	Lectotype, lectallotype
<i>Tettix rugosa</i> Scudder, 1862 (<i>Paratettix rugosus</i> (Scudder, 1862))	Holotype
<i>Tettix tectus</i> Morse, 1900 (<i>Paratettix toltectus</i> (Saussure, 1861))	Holotype
<i>Tiburonotus peninsularis</i> Perez-Gelabert, Hierro & Otte, 1998	Holotype
<i>Trigonofemora fossilatus</i> Hancock, 1906	Holotype
<i>Truncotettix fronterizus</i> Perez-Gelabert, Hierro & Otte, 1998	Holotype
<i>Truncotettix interruptus</i> Perez-Gelabert, Hierro & Otte, 1998	Holotype
<i>Tylotettix pygmaeus</i> Roberts, 1937 (<i>Metrodora pygmaeus</i> (Roberts, 1937))	Holotype
<i>Tylotettix simplex</i> Hebard, 1924 (<i>Metrodora simplex</i> (Hebard, 1924))	Holotype
<i>Tylotettix sinuata</i> Morse, 1900 (<i>Metrodora sinuata</i> (Morse, 1900))	Holotype

Tetrigidae: Batrachideinae) by Oscar J. Cadena-Castañeda et al. (2019); (v) Review of the tribe Amorphopini (Orthoptera: Tetrigidae: Metrodorinae): Pygmy moss-lichen tetrigids from the Amazon rainforest by Oscar J. Cadena-Castañeda et al. (2020) and (vi) Batrachideinae (Orthoptera: Caelifera: Tetrigidae): an overview of the most diverse tetrigids of Neotropical region (in press). Likewise, some studies are still being done with the data obtained and, so, soon, we will have more results and images uploaded to OSF.

The ANSP is the most important collection of Neotropical tetrigid types from Brazil, but, unfortunately, some types have yet not been located and their whereabouts are currently unknown. Many genera of tetrigids still have unresolved taxonomic issues

and our studies have been continuing to figure out and better understand this peculiar group.

Acknowledgments

I would like to thank the OSF Grant and Orthopterist’s Society for funding this project and giving me the opportunity to visit this amazing museum that houses a lot of Orthoptera types, plus old printed papers and books not available to researchers in some countries. I especially thank Janson Weintraub for his hospitality, support, and allowing access to type material of Orthoptera deposited in the ANSP, and Marcelo Ribeiro Pereira for assistance with photographs.

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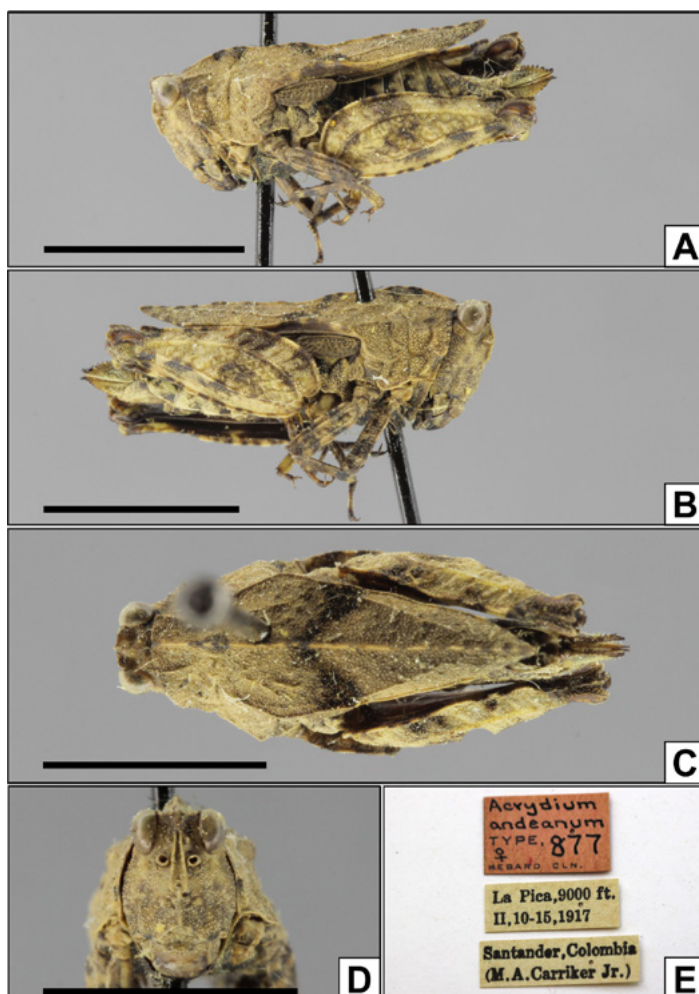


Figure 3. *Tetrix andeanum* (Hebard, 1923): (A) right view, (B) left view, (C) dorsal view, (D) frontal view, and (E) labels. Scale bar = 0.5 cm.

Photographic and distributional data of some Neotropical Orthoptera groups and Colombian Phasmatodea

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In recent years, numerous contributions have been made to the knowledge of the Orthoptera of the Neotropical region, increasing the number of species described for Colombia, Guatemala, Brazil, Peru, Ecuador, Costa Rica, and Mexico, places where researchers have been able to contribute more significantly. However, it is worthwhile to highlight that many colleagues are contributing to the discovery, behavior, and evolution of many groups of orthopteroids in this region of the world. When making these contributions, many specimens have been acquired, for which, historically, there were no photographic records in the Orthoptera Species File (OSF), or only in black and white (mostly

uploaded by Dr. Carlos S. Carbonell), which are still very valuable photos and important for comparisons in identification work, but it is important to add color photos when specimens are available.

Visiting collections in different parts of the world is a titanic task, which not many have the opportunity to perform, mainly due to the lack of funds to pay for trips around the planet. By contributing photographs of the specimens deposited in the collections, we understand that it will not be the same as if you had the type specimen, but it is an important aid for preliminary conclusions on the identity of the specimens we are studying, thus democratizing information for all. For this reason, I decided to contribute

with photographs of the different type and non-type specimens that I had available and in collections that I had the opportunity to visit and add geographic coordinates. In addition, I considered it convenient to photograph the Phasmatodea specimens from Colombia, described by Conle et al., 2011, mostly deposited in Colombian collections, thus contributing data to the Phasmida Species File (PSF) in addition to the OSF. Likewise, specimens were photographed in the field and songs of various species were recorded, with many of these new species still in the process of being described, while several of these remain with a confidentiality code, which will become available as taxa are published.

Table 1. Phasmida photographed and information included in the PSF.

Family	Species	Kind of type	# photos	# specimens
Diapheromeridae	<i>Laciniobethra aculeata</i> Conle, Hennemann & Gutiérrez, 2011	Paratype	3	1
Diapheromeridae	<i>Laciniobethra foliata</i> Conle, Hennemann & Gutiérrez, 2011	Holotype	2	1
Diapheromeridae	<i>Libethra huilaense</i> Conle, Hennemann & Gutiérrez, 2011	Holotype	3	1
Diapheromeridae	<i>Phanoclocrania speciosa</i> Conle, Hennemann & Gutiérrez, 2011	Holotype	6	1
Diapheromeridae	<i>Phanocloidea globocephala</i> Conle, Hennemann & Gutiérrez, 2011	Holotype	3	1
Diapheromeridae	<i>Phanocloidea laevigata</i> Conle, Hennemann & Gutiérrez, 2011	Holotype	3	1
Diapheromeridae	<i>Phanocloidea sagitta</i> Conle, Hennemann & Gutiérrez, 2011	Holotype	4	1
Diapheromeridae	<i>Oncotopasma aurantiaviridiata</i> Murcia, Cadena-Castañeda & Silva, 2020 (submit)	Holotype	7	1
Heteronemiidae	<i>Ceroys (Ceroys) brevicornis</i> Conle, Hennemann & Gutiérrez, 2011	Holotype	3	1
Phasmatidae	<i>Hirtuleius granuliceps</i> Conle, Hennemann & Gutiérrez, 2011	Paratype	5	1
Pseudophasmatidae	<i>Acanthoclonia dilatatum</i> Conle, Hennemann & Gutiérrez, 2011	Holotype / Paratype	6	2
Pseudophasmatidae	<i>Acanthoclonia ferox</i> Conle, Hennemann & Gutiérrez, 2011	Holotype	2	1
Pseudophasmatidae	<i>Acanthoclonia nevadoense</i> Conle, Hennemann & Gutiérrez, 2011	Holotype / Paratype	6	2
Pseudophasmatidae	<i>Atratomorpha bispinosa</i> Conle, Hennemann & Gutiérrez, 2011	Holotype	3	1
Pseudophasmatidae	<i>Atratomorpha colombiana</i> Conle, Hennemann & Gutiérrez, 2011	Holotype / Paratype	6	2
Pseudophasmatidae	<i>Atratomorpha rufolineata</i> Conle, Hennemann & Gutiérrez, 2011	Paratype	6	2
Pseudophasmatidae	<i>Atratomorpha similia</i> Conle, Hennemann & Gutiérrez, 2011	Holotype / Paratype	6	2
Pseudophasmatidae	<i>Decidia kneubuehleri</i> Conle, Hennemann & Gutiérrez, 2011	Holotype / Paratype	6	2
Pseudophasmatidae	<i>Monticomorpha boyaca</i> Conle, Hennemann & Gutiérrez, 2011	Holotype	3	1
Pseudophasmatidae	<i>Parobrimus cervicollis</i> Conle, Hennemann & Gutiérrez, 2011	Holotype	3	1
Pseudophasmatidae	<i>Parobrimus monstrosus</i> Conle, Hennemann & Gutiérrez, 2011	Paratype	3	1
Pseudophasmatidae	<i>Pseudophasma amazonicum</i> Conle, Hennemann & Gutiérrez, 2011	Paratype	3	1
Pseudophasmatidae	<i>Pseudophasma glaber</i> Conle, Hennemann & Gutiérrez, 2011	Holotype / Paratype	6	2
Pseudophasmatidae	<i>Pseudophasma micropterum</i> Conle, Hennemann & Gutiérrez, 2011	Holotype	3	1
Pseudophasmatidae	<i>Xera magdalenae</i> Conle, Hennemann & Gutiérrez, 2011	Holotype	3	1
Pseudophasmatidae	<i>Pachyphloea magnoliae</i> Murcia, Cadena-Castañeda, Noriega & García García, 2019	Holotype / Paratype	10	2

Digitization and upload

During the development of this project, Holger Braun assisted me with digitizing and uploading data to the OSF, which has the same foundation for the other Species File platforms, such as the PSF. However, for the latter, Paul Brock granted me access and data upload abilities. I photographed specimens from 170 species of several families of orthopterans and phasmids, most of these type specimens (Table 1 and 2) totaling 1,122 photos of 208 specimens.

All specimens were photographed in lateral and dorsal view. Additional images were obtained to show diagnostic details, which are useful for comparison in the species identifications (Figs. 1 and 2). The photographs of the specimens were taken with a Nikon D3400 camera, with a Tamron 90 mm macro lens, all attached to a tripod. The photographs were then edited and resized using Adobe Photoshop CS6 to adjust them to the standards of the Species File platforms.

With the knowledge acquired from the upload instructions, I decided to additionally upload my own data from the publications we have made through the years, some of them very large, such as the Caelifera Monograph of Colombia (Cadena-Castañeda & Cardona, 2015) and Grasshoppers of Northwest South America. A Photo Guide. Volume I, II, III (Cardona, 2012; 2015; 2020) among others. I considered it to be an ethical duty to the entomological community and as a deep thanks for the help I have received from different friends and colleagues, Holger Braun, in particular.

Acknowledgments

I especially thank Holger Braun, a great friend and teacher, who had the patience not only to instruct me with the operation of OSF, but to teach me the basics in the studies of Tettigoniidae, to always be willing to listen to my doubts, provide photographs, still have the patience to alleviate my doubts, and help to solve my

8/18/2020 species *Phanoclocrania speciosa* Conle, Hennemann & Gutiérrez, 2011: Phasmida Species File

Phasmida Species File (Version 5.0/5.0)

Home Search Taxa Key Edit Help Wiki

Taxa hierarchy

- subfamily *Diapheromerinae* Kirby, 1904 << TaxonNameID = 1202146
- tribe *Diapheromerini* Kirby, 1904 << TaxonNameID = 1202147
- genus *Phanoclocrania* Hennemann & Conle, 2011 << TaxonNameID = 1202585

species ***Phanoclocrania speciosa* Conle, Hennemann & Gutiérrez, 2011 << TaxonNameID = 1224078**

urn:lsid:Phasmida.speciesfile.org:TaxonName:473073

Images: (6) [See all images](#)

edit:ID=223501	edit:ID=223502	edit:ID=223503	edit:ID=223504	edit:ID=223505	edit:ID=223506
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specimen ID=123441

Distribution: Edit Colombia

Ecology: Terrestrial

Specimen records are available.

Citations:

- Edit Conle, Hennemann & Gutiérrez, 2011. The Stick Insects of Colombia 312, figs >> *Phanoclocrania speciosa*
- urn:lsid:Phasmida.speciesfile.org:TaxonName:473073
- Add new citation.

Scrutiny: Add new scrutiny.

Edit Type specimen information:

- Type locality: Southern America, Western South America, Colombia, Huila, Acevedo, Cueva, Guacharas
- Kind of type: holotype
- Specimen category: Male
- Location of type: ICN Bogotá

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Figure 1. Example of *Phanoclocrania speciosa* Conle, Hennemann & Gutiérrez, 2011 with updated data in the PSF.

difficulties in the advancement of several of my projects. I thank the Orthopterists' Society for its support in this project, which actually became a fundamental support to all my subsequent projects after receiving a Theodore J. Cohn Research Fund grant and the Ted Cohn Award. I was able to greatly improve the quality of my papers in terms of images, and to carry out more diverse and deep studies. For these reasons, I will always be grateful and willing to collaborate in whatever is necessary for enhancing the OSF and I will continue contributing information to the OSF and PSP with the photographs and recordings that I achieve in the future.

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Brock, P.D.; Eades, D.C.; Otte, D.; Baker, E & Büscher; T. (2020) Phasmida Species File. Version 5.0/5.0. Available from: <http://phasmida.speciesfile.org/>

Cadena-Castañeda, O.J. & Cardona, J.M. (2015) Introducción a los Saltamontes de Colombia (Orthoptera: Caelifera: Acrididea:

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Cigliano, M.M., Braun, H., Eades, D.C. & Otte, D. (2020) Orthoptera Species File Online. Version 5 (5.0). Available from: <http://orthoptera.speciesfile.org/>

Conle, O.; Hennemann, F. & Gutiérrez, Y. (2011) The Stick Insects of Colombia. 406 pp.

8/18/2020

species *Markia espinachi* Cadena-Castañeda, 2013: Orthoptera Species File



Orthoptera Species File (Version 5.0/5.0)

[Home](#) [Search](#) [Taxa](#) [Key](#) [Edit](#) [Help](#) [Wiki](#)

Taxa hierarchy

Change items displayed

- [222](#) genus group [Markia](#) Cadena-Castañeda, 2013 << TaxonNameID = 1217258
- [22](#) genus [Markia](#) White, 1862 << TaxonNameID = 1138399
- [1](#) species group [hystrix](#) << TaxonNameID = 1138403

species *Markia espinachi* Cadena-Castañeda, 2013 << TaxonNameID = 1138407

LSID urn:lsid:Orthoptera.speciesfile.org:TaxonName:460247

Images: (10) [See fewer images](#)

 edit:ID=224877 male, labels (paratype)	 edit:ID=224878 male, body lateral view (paratype)	 edit:ID=224879 male, head and pronotum lateral view (paratype)	 edit:ID=224880 male, frons (paratype)	 edit:ID=224881 male, terminalia lateral view (paratype)	specimen ID=141744
 edit:ID=224882 male, labels (paratype)	 edit:ID=224883 male, body lateral view (paratype)	 edit:ID=224884 male, body dorsal view (paratype)	 edit:ID=224885 male, head and pronotum lateral view (paratype)	 edit:ID=224886 male, frons (paratype)	

Distribution:



[Edit](#)

Ecology:

Terrestrial.

[Specimen records](#) are available.

Citations:

[Edit](#) Cadena-Castañeda. 2013. The tribe Dysoniini part II: The genus *Markia* (Orthoptera: Tettigoniidae; Phaneropterinae), new species and some clarifications. *Zootaxa* 3599(6):511 >> *Markia espinachi* **LSID** urn:lsid:Orthoptera.speciesfile.org:TaxonName:76467

[Edit](#) Cadena-Castañeda. 2013. La tribu Dysoniini parte III: Adiciones a los géneros *Apolinaria*, *Lichenodraculus*, *Machimoides* y *Markia* (Orthoptera: Tettigoniidae). *Journal of Orthoptera Research (Jour. Orth. Res.)* 22(2):111 >> *Markia (hystrix) espinachi*

[Add new citation.](#)

Scrutiny:

[Add new scrutiny.](#)

[Edit](#) Type specimen information:

Type locality: Southern America, Central America, Costa Rica, Prov. Alajuela

Kind of type: holotype

Specimen category: male

orthoptera.speciesfile.org/Common/basic/Taxa.aspx?TaxonNameID=1138407

1/2

Figure 2. Example of *Markia espinachi* Cadena-Castañeda, 2013 with updated data in the OSF.

Table 2. Orthoptera photographed and information included in the OSF.

Family	species	Kind of type	# photos	Alive photo	# specimens
Acrididae	<i>Alota carbonelli</i> Cadena-Castañeda & Cardona, 2015	Holotype / Paratype	13	0	2
Acrididae	<i>Arimacris matiottiae</i> Cadena-Castañeda & Cardona, 2015	Holotype / Paratype	17	0	3
Acrididae	<i>Balachowskyacris songi</i> Cadena-Castañeda & Cardona, 2015	Holotype / Paratype	8	0	8
Acrididae	<i>Carbonelliella sciponacrisformis</i> Cadena-Castañeda & Cardona, 2015	Holotype / Paratype	6	0	1
Acrididae	<i>Loepacris septentrionalis</i> Cadena-Castañeda & Cardona, 2015	Holotype	4	0	1
Acrididae	<i>Oedalacris chocoensis</i> Cadena-Castañeda & Cardona, 2015	Holotype / Paratype	11	0	2
Acrididae	<i>Parapiezops robertsi</i> Cadena-Castañeda & Cardona, 2015	Holotype / Paratype	11	0	2
Acrididae	<i>Poecilocoelus portilloi</i> Cadena-Castañeda & Cardona, 2015	Holotype	5	0	1
Acrididae	<i>Silvitettix ottei</i> Cadena-Castañeda & Cardona, 2015	Holotype	6	0	1
Acrididae	<i>Trichopaon hyacinthus</i> Cadena-Castañeda & Cardona, 2015	Holotype / Paratype	18	0	3
Acrididae	<i>Bryophilacris muscicolor</i> Descamps, 1976	Non-type	5	0	1
Acrididae	<i>Coscineuta trochilus</i> (Gerstaecker, 1873)	Non-type	9	0	2
Acrididae	<i>Dicaearchus cribellatus</i> Stål, 1878	Non-type	6	0	2
Acrididae	<i>Eusitalces apolinari</i> (Hebard, 1923)	Non-type	4	0	1
Acrididae	<i>Liebermannacris dorsualis</i> (Giglio-Tos, 1898)	Non-type	10	0	3
Acrididae	<i>Oedalacris antennata</i> (Stål, 1873)	Non-type	4	0	1
Acrididae	<i>Opaon varicolor</i> (Stål, 1878)	Non-type	4	0	1
Acrididae	<i>Psiloscircus splendidus</i> Hebard, 1923	Non-type	4	0	1
Acrididae	<i>Pauracris tenera</i> Descamps & Amédégnato, 1972	Non-type	5	0	1
Acrididae	<i>Rhytidochrota polia</i> Hebard, 1923	Non-type	4	0	1
Acrididae	<i>Sciaphilacris alata</i> Descamps, 1976	Non-type	4	0	1
Acrididae	<i>Silvitettix malasmonotus</i> Otte & Jago, 1979	Non-type	3	0	1
Acrididae	<i>Loepacris merembergensis</i> (Varón, 2001)	Non-type	4	0	1
Acrididae	<i>Vilerna elongata</i> Descamps & Amédégnato, 1989	Non-type	4	0	1
Acrididae	<i>Vilerna polita</i> Descamps & Amédégnato, 1989	Non-type	8	0	1
Acrididae	<i>Peruvia nigromarginata</i> (Scudder, 1875)	Non-type	5	0	1
Acrididae	<i>Leptysmia intermedia</i> Bruner, 1911	Non-type	4	0	1
Acrididae	<i>Cylindrotettix uniformis</i>	Non-type	10	0	2
Acrididae	<i>Agesander ruficornis</i> Stål, 1878	Non-type	0	2	1
Acrididae	<i>Opaonella tenuis</i> Hebard, 1923	Non-type	0	1	0
Anostomatidae	<i>Anabropsis rentzi</i> Cadena-Castañeda & Cortés-Torres, 2013	Paratype	6	0	1
Anostomatidae	<i>Apotetamenus gorochovi</i> Cadena-Castañeda & Cortés-Torres, 2013	Paratype	5	0	1
Episactidae	<i>Episactus schusteri</i> Cadena-Castañeda & Monzón-Sierra, 2014	Holotype / Paratype	6	0	2
Episactidae	<i>Paralethus cerezoi</i> Cadena-Castañeda & Monzón-Sierra, 2014	Holotype / Paratype	8	0	2
Episactidae	<i>Paralethus rowelli</i> Cadena-Castañeda & Monzón-Sierra, 2014	Holotype	3	0	1
Eumastacidae	<i>Paramastax alba</i> Porras, 2011	Holotype / Paratype	13	0	2
Eumastacidae	<i>Paramastax hirsutum</i> Porras, 2011	Holotype / Paratype	11	0	2
Eumastacidae	<i>Paramastax montealegre</i> Porras, 2011	Holotype / Paratype	17	0	3
Eumastacidae	<i>Zeromastax aris</i> Porras, 2010	Holotype / Paratype	9	0	2
Eumastacidae	<i>Zeromastax malavasei</i> Porras, 2010	Holotype	6	0	1
Eumastacidae	<i>Zeromastax selenesii</i> Porras, 2007	Non-type	0	1	0
Eumastacidae	<i>Santanderia caeruleus</i> Cadena-Castañeda & Cardona, 2015	Holotype	3	0	1
Eumastacidae	<i>Santanderia rubris</i> Cadena-Castañeda & Cardona, 2015	Paratype	3	0	1
Eumastacidae	<i>Santanderia lita</i> Hebard, 1923	Non-type	3	0	1
Gryllidae	<i>Faguagryllus luteolus</i> Cadena-Castañeda, 2011	Holotype	5	0	1
Gryllidae	<i>Ectotrypa brachyptera</i> Cadena-Castañeda & Noriega, 2015	Holotype	6	0	1
Gryllidae	<i>Atsigryllus sikiani</i> Cadena-Castañeda & Tijaro, 2020	Holotype	8	0	1
Gryllidae	<i>Perugryllus ranoredius</i> Cadena-Castañeda & Tijaro, 2020	Holotype	8	0	1
Gryllidae	<i>Gigagryllus omayrae</i> Cadena-Castañeda & García García, 2020	Holotype / Paratype	12	0	2
Gryllotalpidae	<i>Scapteriscus headsii</i> Cadena-Castañeda, 2011	Holotype	7	0	1
Gryllotalpidae	<i>Neoscapteriscus rodriguezii</i> (Cadena-Castañeda, 2011)	Holotype	7	0	1
Proscopiidae	<i>Apioscelis araracuensis</i> Bentos-Pereira & Listre, 2005	Holotype	9	0	1
Proscopiidae	<i>Apioscelis laetitiaensis</i> Bentos-Pereira & Listre, 2005	Holotype / Paratype	20	0	3
Proscopiidae	<i>Orienscopia incognita</i> Bentos-Pereira, 2015	Holotype	6	0	1

Table 2 (cont'd). Orthoptera photographed and information included in the OSF.

Family	species	Kind of type	# photos	Alive photo	# specimens
Proscopiidae	<i>Prosarthria annalianae</i> Bentos-Pereira & Cadena-Castañeda, 2015	Holotype / Paratype	11	0	2
Proscopiidae	<i>Pseudoprosopia onca</i> Bentos-Pereira, 2006	Holotype	8	0	1
Proscopiidae	<i>Apioscelis davidcastanedai</i> Cadena-Castañeda, 2015	Holotype	6	0	1
Proscopiidae	<i>Prosarthria alexanderi</i> Cadena-Castañeda, 2015	Holotype	5	0	1
Proscopiidae	<i>Prosarthria chucuriensis</i> Cadena-Castañeda & Cardona, 2015	Holotype	6	0	1
Proscopiidae	<i>Prosarthria llanerensis</i> Cadena-Castañeda & Cardona, 2015	Holotype	6	0	1
Proscopiidae	<i>Prosarthria marlenae</i> Cadena-Castañeda & Cardona, 2015	Holotype / Paratype	8	0	2
Proscopiidae	<i>Wattenwylscopia longiepiproctus</i> Cadena-Castañeda & Cardona, 2015	Holotype	5	0	1
Proscopiidae	<i>Prosarthria jagoi</i> Bentos-Pereira & Cadena-Castañeda, 2015	Holotype	2	0	1
Proscopiidae	<i>Prosarthria caucensis</i> Hebard, 1923	Non-type	5	0	1
Proscopiidae	<i>Pseudoprosopia afroensis</i> Cadena-Castañeda & Cardona, 2015	Holotype	3	0	1
Proscopiidae	<i>Pseudoprosopia caldensis</i> Cadena-Castañeda & Cardona, 2015	Holotype	4	0	1
Romaleidae	<i>Andeomezentia aberrans</i> Cadena-Castañeda & Cardona, 2015	Holotype	7	0	1
Romaleidae	<i>Ampiacris rowelli</i> Cadena-Castañeda & Cardona, 2015	Holotype	4	0	1
Romaleidae	<i>Caenolampis magdalenensis</i> Cadena-Castañeda & Cardona, 2015	Holotype	5	0	1
Romaleidae	<i>Colpolopha origami</i> Cadena-Castañeda & Cardona, 2015	Holotype	6	0	1
Romaleidae	<i>Graciliparia andina</i> Cadena-Castañeda & Cardona, 2015	Holotype	4	0	1
Romaleidae	<i>Nautia santanderensis</i> Cadena-Castañeda & Cardona, 2015	Holotype	9	0	2
Romaleidae	<i>Pararhincoderma eniocanoi</i> Cadena-Castañeda & Monzón-Sierra, 2014	Holotype	5	0	1
Romaleidae	<i>Pouplainiella nigra</i> Cadena-Castañeda & Cardona, 2015	Holotype	5	0	1
Romaleidae	<i>Pseudonautia boyacensis</i> Cadena-Castañeda & Cardona, 2015	Holotype	3	0	1
Romaleidae	<i>Taeniophorella andina</i> Cadena-Castañeda & Cardona, 2015	Holotype	4	0	1
Romaleidae	<i>Megacephalacris pugnax pugnax</i> (Gerstaecker, 1873)	Non-type	11	0	2
Romaleidae	<i>Megacheilacris vallensis</i> (Descamps & Amédégnato, 1971)	Non-type	11	0	2
Romaleidae	<i>Nautia ayapelana</i> Descamps, 1978	Non-type	5	0	1
Romaleidae	<i>Ophthalmolampis truculenta</i> Descamps, 1978	Non-type	5	0	1
Romaleidae	<i>Taeniophora pirrensis</i> Rowell, 2012	Non-type	4	0	1
Romaleidae	<i>Taeniophorella pulchripes</i> (Stål, 1878)	Non-type	8	0	2
Romaleidae	<i>Taeniophora trispinosa sublaevis</i> Descamps & Amédégnato, 1971	Non-type	8	0	2
Tettigoniidae	<i>Anaulacomera alexanderi</i> Cadena-Castañeda, 2012	Paratype	5	0	1
Tettigoniidae	<i>Anaulacomera hernandezi</i> Cadena-Castañeda, 2012	Holotype	7	0	1
Tettigoniidae	<i>Anaulacomera richteri</i> Cadena-Castañeda, 2012	Holotype	7	0	1
Tettigoniidae	<i>Anaulacomera sarmientoi</i> Cadena-Castañeda, 2012	Holotype	6	0	1
Tettigoniidae	<i>Brachyplatyphylloides riosi</i> Cadena-Castañeda & Braun, 2011	Paratype	10	0	1
Tettigoniidae	<i>Montelegrezia amacayacu</i> Cadena-Castañeda, 2012	Holotype / Paratype	11	0	2
Tettigoniidae	<i>Viadana (Arcuadana) arcuata</i> Cadena-Castañeda & Gorochoy, 2015	Holotype	5	0	1
Tettigoniidae	<i>Anaulacomera franciscoi</i> Cadena-Castañeda, 2012	Holotype	5	0	1
Tettigoniidae	<i>Anaulacomera ludivinae</i> Cadena-Castañeda, 2012	Holotype	7	0	1
Tettigoniidae	<i>Viadana (Arcuadana) stephanyae</i> Cadena-Castañeda, 2012	Holotype	5	0	1
Tettigoniidae	<i>Anaphidna gracielae</i> (Cadena-Castañeda, 2012)	Holotype	7	0	1
Tettigoniidae	<i>Anaphidna hernandezi</i> (Cadena-Castañeda, 2012)	Paratype	12	0	2
Tettigoniidae	<i>Anaphidna obrieni</i> Cadena-Castañeda, 2016	Holotype / Paratype	13	0	2
Tettigoniidae	<i>Anaphidna osae osae</i> (Cadena-Castañeda, 2012)	Paratype	8	0	1
Tettigoniidae	<i>Anaphidna quirozi</i> (Cadena-Castañeda, 2012)	Holotype	6	0	1
Tettigoniidae	<i>Anaphidna rhinoceros</i> (Cadena-Castañeda, 2012)	Paratype	6	0	1
Tettigoniidae	<i>Anaphidna silvui</i> (Cadena-Castañeda, 2012)	Holotype	7	0	1
Tettigoniidae	<i>Lichenomorphus montealegrezi</i> Cadena-Castañeda, 2011	Holotype / Paratype	14	1	3
Tettigoniidae	<i>Markia arizae</i> Cadena-Castañeda, 2011	Holotype	6	0	1
Tettigoniidae	<i>Markia espinachi</i> Cadena-Castañeda, 2013	Paratype	10	0	2
Tettigoniidae	<i>Markia nicolasi</i> Cadena-Castañeda, 2013	Paratype	5	0	1
Tettigoniidae	<i>Quiva (Quiva) buhrnheimi</i> Cadena-Castañeda, Mendes & Sovano, 2015	Paratype	10	0	2
Tettigoniidae	<i>Quiva (Quiva) gutjahrae</i> Cadena-Castañeda, Mendes & Sovano, 2015	Paratype	16	0	2
Tettigoniidae	<i>Yungasacris multa</i> Cadena-Castañeda & Gorochoy, 2013	Paratype	14	0	2
Tettigoniidae	<i>Onychopygia brachyptera</i> Cadena-Castañeda & Monzón-Sierra, 2014	Holotype / Paratype	6	0	2

The altitudinal range of *Omocestus viridulus* in the United Kingdom

By TIM GARDINER

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Several articles report observations of the altitude at which the common green grasshopper *Omocestus viridulus* has been found in the UK (Gardiner & Gardiner 2008; Burton 2010; Haes 2010; Horsfield 2010; Gardiner 2011). *Omocestus viridulus* has been observed at a wide range of altitudes in the UK, the highest observation being from Ben Lawers in the Scottish Highlands (Table 1). The highest peak in the Highlands is Ben Nevis at 1,344 m above ordnance datum (AOD), so it appears that this grasshopper occurs at nearly the highest altitude possible in the UK. This is not surprising as in Switzerland it commonly persists at altitudes > 2,400 m (Berner 2005). At these high altitudes (>2,000 m above mean sea level) it appears that egg hatching and adult maturity are reached much later than at lower altitudes (Berner 2005). Hatching and

Table 1. Altitudinal range of *Omocestus viridulus* in the United Kingdom

Country/area	Max altitude observed (m AOD)	Highest altitude possible (m AOD)	Recorder (s)	Year
Scotland				
Highlands	1214	1344	E.C.M. Haes	1978
Wales				
Black Mountains	580	811	J. Burton	1958
Snowdonia	378	1085	T. & M. Gardiner	2008
England				
Peak District	547	636	T. Gardiner	2016
Lake District	480	978	T. & J. Gardiner	2020
Dartmoor	450	621	J. Burton	1973
Exmoor	440	520	J. Burton	1969
Malvern Hills	403	425	T. & M. Gardiner	2010
Northumberland	277	815	T. & J. Gardiner	2020
Southern Pennines	222	517	T. & J. Gardiner	2020
Rutland	126	197	T. & J. Gardiner	2020
Mean ± se	465 ± 85	723 ± 98		

AOD = Above Ordnance Datum, essentially above mean sea level

maturation to adulthood can also be severely affected by cloudy weather (low amount of sunshine) at high altitudes, with poor weather severely affecting reproductive success (Berner et al. 2004). However, high altitude *O. viridulus* nymphs may have a much shorter period from egg hatching to adulthood (quicker nymphal maturation) than their lower altitude counterparts, therefore maximising their chances of survival (in essence, quicker development is necessary due to more unfavourable climate) (Berner et al. 2004).

On Snowdon, the highest mountain in Wales, there was a clear limit to the altitude at which *O. viridulus* was observed; this may be due to heavily grazed habitats (e.g., short grassland with few tussocks for shelter) at higher altitudes leaving no suitable grasshopper refuges, or the particularly unfavourable climate of the north face of the mountain.

A possible altitudinal limit for this



Figure 1. Lower altitude (up to 300 m AOD) slopes of Scafell Pike (summit 978 m) where *Omocestus viridulus* was abundant (photo: Tim Gardiner)

insect was also noted in the Lake District, where it was only observed at 480 m AOD near the summit of Seat How (Whinlatter Forest), despite the highest altitude possible being 978 m AOD (Scafell Pike, England's highest mountain). On Scafell Pike itself, *O. viridulus* was observed up to an altitude of just 313 m AOD in July 2020 (Fig. 1), the rocky upper slopes devoid of the tall, wet vegetation it prefers (Fig. 2). Usefully, these observations may allow future naturalists to make comparisons, particularly if climate change leads to grasshoppers expanding their distribution to the upper slopes of mountains in Snowdonia or the Lake District. In Northumberland, *O. viridulus* was recorded at 277 m AOD on the crag summits along Hadrian's Wall; the maximum possible altitude in the county being The Cheviot (815 m AOD). There is plenty of scope for the insect to be recorded at higher altitudes in the county and it may even be undetected in the Cheviot



Figure 2. Near the summit of Scafell Pike (c. 900 m AOD), suitable habitat absent for *Omocestus viridulus* (photo: Joseph Gardiner)

Hills at loftier elevations.

Generally, apart from the Scottish Highlands, *O. viridulus* was not found at the summits of the hills and mountains surveyed (465 m AOD for mean max reported altitude, 64% of mean max possible of 723 m AOD; Table 1), often only present on the lower slopes where vegetation growth was more luxuriant in stream valleys and woodland clearings. This may be attributed in some cases to unfavourable sheep grazing at

higher altitudes (e.g. in the Malvern Hills) leading to very short grassland (3-4 cm high), which is completely unsuitable for a tall grassland insect like *O. viridulus*.

On smaller hills, there is ample scope to study the factors which determine the abundance of *O. viridulus*, even low summits of less than 100 m are likely to have diverse environmental conditions depending on altitude, aspect and habitat management. The study of zonation from low to high altitudes could be crucial in our understanding of how the insect may respond as our climate warms. It is possible that as the insect declines in drier areas of the UK (e.g. the south-east, Gardiner 2010), the upper altitudes of mountains could be the wetter refuges it requires in the north and west, which receive higher rainfall.

In summary, *O. viridulus* has been observed up to 1,200 m AOD in Britain, suggesting it can persist at very high altitudes if suitable habitats are present. However, in other areas, such as the Lake District and Snowdonia, this grasshopper has only been reported at much lower altitudes than the maximum possible (e.g., highest peak), suggesting that there is a possibility of it colonising the upper

slopes of hills and mountains if the climate becomes more favourable in the future. This could be one of the more interesting results of climate change, an invaluable area of future research.

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Agricultural defense of Brazil in alert against the possible entry of locust swarms

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In recent months, rural producers in Brazil have experienced warnings of a possible entry into the national territory of a locust swarm coming from Argentina. This locust is the species *Schistocerca cancellata*, which has a history of economic damage, but can be prevented and controlled. In Brazil, despite the occurrence of almost 900 species of grasshoppers, only

around 23 can cause damage to plantations, of which only nine can be considered moderate or severe pests: *Rhammatocerus brunneri* (Giglio-Tos, 1895), *R. pictus* (Bruner, 1900), *R. schistocercoides* (Rehn, 1906), *S. cancellata* (Serville, 1838), *S. pallens* (Thunberg, 1815), *Staurorhectus longicornis longicornis* Giglio-Tos, 1897, *Stiphra robusta* Mello-Leitão, 1939, *Tropidacris collaris* (Stoll, 1813), and *T. cristata* (Linnaeus,

1758).

The *Schistocerca* genus has species that are distributed in South America and has historically caused serious economic damage. Among the species in this group, the so-called "South American locust" (*Schistocerca cancellata*) stands out. It is found in Argentina, Bolivia, Paraguay, Brazil, Chile, Peru, and Uruguay, with the largest and most recent population outbreaks occurring in

the first three countries. Although not actually currently listed as one of the main causes of severe damage to crops in Brazil, this locust deserves special attention by producers and agricultural inspectors, because, although they are not constant, the swarms can negatively affect productivity and cause significant economic losses when they arise.

Schistocerca cancellata adults are recognized for being relatively large in size (males can measure approximately 3 to 5 cm and females 4 to 7 cm), with a cylindrical and moderately elongated body, have a short clear band laterally on the wing edge, pigmented wings with brown spots, white/cream colored band that runs all over the body when viewed from above (from the head to the end of the wings), and another white/cream band on the lower half of the outer face of the hind leg that has black spines with white tips. The general color pattern of this species can vary from light brown, to brown, dark brown and even olive green individuals, and, under certain conditions, reddish individuals have been recorded too (possibly occurs when individuals are parasitized). *Schistocerca cancellata* also has two phases: solitary and gregarious. In solitary, individuals thrive on local vegetation and do not migrate. However, with the increase in population density, individuals change their behavior to gregarious in which they change color, and increase food consumption and biotic potential. At this latter stage, adults become migrants and can travel huge distances. However, it is important to highlight that the correct identification of the species is necessary and essential to make decisions regarding its control since most locusts are considered economically neutral, causing no economic damage or losses, and are still beneficial to the field, feeding on weeds and accelerating nutrient cycling and energy flow in the area.

The first records of severe damage

caused by *S. cancellata* in Brazil are from the 1930s, when swarms from Argentina and Paraguay infested the southern region of the country, especially the state of Rio Grande do Sul. In the following decade, the Brazilian Senate passed a law to control and attempt to eradicate this plague (Law 483, established November 12, 1948). This event was so important that even National Agricultural Aviation Day is celebrated in Brazil on the date (August 19, 1947) that a light aircraft was used to combat this *S. cancellata* infestation in Pelotas county by spraying insecticides.

This species has more recurrent records of swarms in Argentina, Bolivia, Brazil and Paraguay. This occurs because in the central region of Argentina, between the departments (states) of Tucumán, Santiago del Estero, Salta, Catamarca, La Rioja, and Córdoba, there is a region called “permanent breeding zone” where this species occurs naturally and with relative abundance. Under certain environmental conditions (mainly high temperatures and long periods of drought), a peak of reproduction of the species occurs, with a high number of individuals, which triggers the formation of the “swarm.” This, in turn, migrates to other countries. This does not mean that the species does not occur naturally in other locations, but the formation of so-called swarms has as its epicenter in this region. These swarms usually travel 10 to 30 km per day, depending on the intensity of the winds, but there are records of up to 150 km of



South American locust nymphs. Image taken from Manual de procedimientos generales para el control de la plaga langosta sudamericana (*Schistocerca cancellata* Serville) (https://www.argentina.gob.ar/sites/default/files/manual_langosta1_0.pdf)

displacement in a single day.

In the most affected regions of Argentina, swarms of more than 30 km long and 2.5 km wide have been recorded, with a density of up to 250 adults per m² (populations of approximately 40 million individuals per km² have also been registered). During flight migration, the swarm tends to be a maximum of 200 m high. With the formation of these swarms, individuals tend to move more, which further increases the voracity of the locusts, being able to devour large crops in a few hours. Generally, a locust of this species consumes an average of 50% of its own weight in fresh vegetable matter every day and, in swarms, this rate reaches 100%. To have an idea of this impact, in Argentina, there was a record of an area 100 km long by 10 km wide containing approximately 50 million locusts (70 to 100 tons of individuals), which resulted in at least 50 tons of vegetation consumed per day.

Several species of grasshoppers are specialists in relation to their food habits, meaning their biology is closely linked to their host plant, but most species are considered

polyphagous, being able to feed on different types of vegetation. This is the case with the South American locust, which has more than 400 plant species on its menu. Both adults and nymphs cause damage, feeding mainly on the aerial parts of the vegetables.

The arrival of these individuals in productive areas can cause considerable losses, from the reduction of leaf area and buds to the totality of the attacked plants. *S. cancellata* has already been recorded causing severe damage to poplar, cotton, peanut, potato, sugar cane, barley, citrus, eucalyptus, beans, sunflower, cassava, corn, mimosa, pasture, soy, sorghum and wheat crops. While soybeans, due to the higher planting density, can tolerate a higher level of damage, crops such as sunflower, corn and sorghum present greater risks.

This past May 30th, a swarm was detected near Asunción, in Paraguay. This population migrated to Argentina and, on June 22nd, the authorities of the Defense of Plant Protection issued a warning to the Brazilian government that the swarm was located at a distance of approximately 100 km from the border with Brazil. If the winds were favorable, the population could enter the country in a matter of hours. This alarm woke up the Brazilian Ministry of Agriculture and the state agricultural defense agencies. With the decrease in the average temperature of the region and the change in the direction of the winds, the population did not enter national territory, but caused a mobilization that had not been seen in the country for a long time, accompanied by great coverage by the national media.

It had been a long time since Brazil had received alerts about possible formations or the entry of swarms in the country. Historical records go back to 1906 when there was a large swarm of *S. cancellata* that reached even the states of São Paulo and Rio de Janeiro, which probably constitutes the record of the longest displacement

of the plague in Brazilian territory. Then, other swarms started to enter the country again in 1915, 1933, and 1936, but it was between 1945 and 1946 that the greatest economic damage ever occurred, affecting mainly crops of wheat, corn, rice, beans and barley. Since then, there are no records of other official warnings. At that time, Brazil was part of a cooperation program with the other South American countries affected by the plague (instituted in 1891), but after the 1960s, with the decrease in the incidence of outbreaks of swarms in border regions, the country reduced its efforts in the prevention and control of locust plagues. From then on, national programs to fight locusts slowly disappeared until their extinction. For other species of grasshoppers that also cause economic damage, such as *R. brunneri* (= *R. conspersus*) and *R. schistocercoides*, Brazil still maintained cooperation agreements in the 1980s, mainly in partnership with EMBRAPA/CIRAD (France). After this period, Brazil no longer maintained any public policy action for the prevention and control of locusts. Interestingly, Brazil also does not have records of swarms originating in the country, despite the occurrence of *S. cancellata* in the solitary phase.

The first (and only) Brazilian legislation related to the fight against locusts was approved in 1948 and, until today, it has not been updated, expanded or modified. With the alert generated this year, the Brazilian Ministry of Agriculture, Livestock and Supply (MAPA) needed to take political and administrative measures in order to enable preventive and control measures, in case the swarm entered Brazil. MAPA initially published Ordinance 201/2020 (1) on June 24, which declared a state of phytosanitary emergency for the states of Rio Grande do Sul and Santa Catarina, regarding the risk of an outbreak of *S. cancellata*. With a 12-month validity, this preventive measure supports the professional

agricultural defense technicians in actions to combat and control the swarms, even allowing the use of pesticides not registered in the country to control this species.

Also on the same day, the Secretariat of Agriculture, Livestock and Rural Development (SEAPDR) of the state of Rio Grande do Sul (the largest border with Argentina) published Normative Instruction 17/2020 (2), which established the “emergency plan for suppression and control of *Schistocerca cancellata* outbreaks in the State of Rio Grande do Sul.” This legislation established the emergency plan to deal with locusts, establishing measures, such as the creation of a state “Phytosanitary Emergency Committee” and also establishing rules for air and land operations against the plague, and mandatory reporting by farmers when detecting the occurrence of individuals of the species. With these emergency legal actions and in a state of alert, the government of Rio Grande do Sul approved about \$100 million USD for actions against the entry of *S. cancellata* in Brazil. Among the measures adopted, the state stationed about 400 planes at the border in a state of readiness in case spraying was needed. In addition, SEAPDR/RS promoted training for agricultural inspectors and technicians, in order to improve the monitoring of swarms and improve action in control operations.

Continuing the actions, MAPA, on June 30th, published Ordinance 208/2020 (3), which established more norms regarding the guidelines for the elaboration of the “Suppression Plan and emergency control measures to be applied in case of ingress of *S. cancellata*” in the states of Rio Grande do Sul and Santa Catarina. Among the measures envisaged there are general recommendations for the use, on an emergency and temporary basis, of biological and agrochemical insecticides (active ingredient per cultivar), as well as mechanisms for controlling the quantities of pesticides

to be distributed, marketed, and used. This ordinance also established recommendations for the use and dosage of biological insecticides based on *Beauveria bassiana* and *Metarhizium anisopliae*, as well as dosages, application intervals, residue limits, and maximum dosages of the active principles to be used to control the plague.

The shock at the possibility of the *S. cancellata* population entering this year was so great that in the same period even the government of the state of Mato Grosso do Sul (border with Bolivia and Paraguay, 1,000 km away from the population center in Argentina and outside the area covered by the health emergency defined by the MAPA), it established a permanent committee to monitor and define possible actions to control locust plagues that may reach the state. Together with Ordinance 208, MAPA also published the “Manual of general procedures for the control of the *Schistocerca cancellata* pest - ‘South American Locust’ (Serville, 1838)”⁽⁴⁾. This manual is the official government document to support the suppression, control and monitoring plans prepared by the agricultural defense agencies of the states of Rio Grande do Sul and Santa Catarina. It determines, for example, that the control of nymphs must be done in the soil, making applications with insecticides by the banding method. As for adults, it establishes that they can be treated by air or by land using cannon-type atomizers (spraying).

But the interesting thing is that for this species it is possible to detect nymphs of the gregarious phase and with that it is also possible to prevent the formation of swarms through the early control of the young forms of the locusts. The control must be carried out mainly by monitoring and treatment, highlighting that it aims to decrease population density and not to eradicate the species. One must remember the beneficial aspect that the occurrence of locusts have, as they are also the food base of several

birds, and thus their presence attracts them, which helps in the control of other insect species that also can cause damage to crops. Regarding agrochemical control, it must also be carried out to decrease population density and using authorized products, with due indication of use for cultivation and with appropriate technology for the application. The legislation implemented by MAPA authorizes the use of a wide range of active ingredients (organophosphates, pyrethroids, etc.) but without evidence of their effectiveness on *S. cancellata* under Brazilian environmental conditions. The effectiveness of the control efforts will always depend on the form of application and the product used, and its emergency use can cause environmental damage (mainly affecting pollinators) since they are not selective insecticides. This is a consequence of the lack of Brazilian public policies for the prevention and monitoring of possible locusts in the country, over the past decades.

For biological control, the use of entomopathogenic fungi such as *Nosema locustae*, *Entomophthora grylli*, and *Beauveria bassiana* has been successful internationally, in addition to the bacteria *Bacillus thurigiensis* and *Coccobacillus acridiorum*. The extracts of leaves and fruits of cinnamon (*Melia azedarach*, family Meliaceae) have also been studied for the control of *S. cancellata*, showing efficiency in terms of mortality and repellency.

Currently, Brazil is part of the Locust Technical Committee of the Vegetable Health Committee (COSAVE⁵⁾), in conjunction with Argentina, Bolivia, Chile, Paraguay, Peru, and Uruguay, which allows for updated monitoring of the outbreaks as well as the adoption of standardized methods to minimize the effects of an eventual outbreak of these locusts in Brazil. Thus, as locusts remain in solitary form when controlled and monitored, causing no economic damage to crops,

prevention is still the most effective form of action. It is important to be aware of this insect that needs a jump to get out of its beneficial condition and become a plague.

In the end, the swarm was controlled by the Argentine authorities (who are now dealing with another 6 swarms, all located a long way from the border) and did not enter Brazil. And what was left of this scare is that, from now on, the agricultural defense agencies in Brazil have awakened to this risk that has always been imminent and the first steps are being taken towards the implementation of public policies, legislation, and training technical personnel for the prevention of locust plagues.

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The Orthoptera Collection at MNRJ and the Brazilian Orthopterology

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In a recent edition of *Metaleptea* 38(3), I wrote about the tragic fire at the Museu Nacional – Universidade Federal do Rio de Janeiro (MNRJ) and my feelings about recently assuming a position in that institution. Now, I would like to share the history of the Orthoptera Collection of MNRJ, and its importance for the recent development of orthopterology in Brazil. The Collection of the Entomology Department of the Museu Nacional contained Orthoptera specimens collected since the early 20th century, including specimens (and some type specimens) collected by important Brazilian naturalists as Ângelo Moreira da Costa Lima (1887-1964) and Cândido Firmino de Mello-Leitão (1886-1948). However, starting in the second half of the 1970s, the Orthoptera Collection began to be recognized as an important collection within the Entomological Collection of MNRJ. An essential event for Brazilian orthopterology was the arrival of the French orthopterist Marius Descamps (1924-1996) who traveled to Brazil to conduct field expeditions in search for grasshoppers in the 70s.

When Descamps came to Brazil, he looked for researchers at the Museu Nacional, in Rio de Janeiro, who might support his work. There, he met Miguel Angel Monné and Carlos Alberto Campos Seabra (1916-2001). Monné had experience with grasshopper curation, having worked with Carlos Salvador Carbonell (1917-2019) in the Facultad de Humanidades y Ciencias - Universidad de la República, in Uruguay, before moving to Brazil. Seabra, who was trained as a physician but never practiced his profession, was a



Figure 1. Miguel Monné, Carlos A. Campos Seabra, and Marius Descamps working on acridids. Rio de Janeiro, 1976.



Figure 2. Olmiro Roppa, Miguel Monné, and Carlos A. Campos Seabra in an expedition in the state of Minas Gerais. Picture taken next to the São Francisco River, municipality of Pirapora, 1975.

wealthy insect collector, with great interest in Coleoptera and with a large private collection. From

the meetings with Descamps, and perhaps also influenced by his friend Monné, Seabra became interested

Dr. Miguel A. Monné, of the Museu Nacional, Rio de Janeiro, informs us that he was able to publish a notice of the foundation of PAAS in the last number of the *Revista brasileira de Entomologia*. We are glad to learn of this extra publicity and acknowledge his kindness in helping us. Dr. Monné also mentions that Dr. Campos Seabra and he are amassing a collection of Brazilian Acridoidea in collaboration with PAAS members C. Carbonell and M. Descamps. Presently it is comprised of numerous species with especial emphasis in its representation of the tree-dwelling Omattolampinae and Ophthalmolampinae. The collection is temporarily housed at Dr. Seabra's residence but, when ready, will be incorporated into the collection at the Museu Nacional.

Figure 3. Excerpt from *Metaleptea* 1 (1) showing the note of Miguel Monné about the Seabra Collection.

in grasshoppers and started to fund several field expeditions, as well as paying for collectors to send insects to him (mainly grasshoppers and beetles) from several regions of Brazil, mainly from the Amazon (Fig. 1). Monné and Seabra were on many expeditions in Northeast and Midwest Brazil, with the support of collectors such as Olmiro Roppa, Bento Silva, and Moacir Alvarenga, among others (Fig. 2). Seabra kept all the material received from collectors and found during expeditions in cabinets, forming a large collection in his house.

In 1976, during an orthopterists meeting in San Martín de Los Andes (Argentina), the Pan American Acridological Society (now The Orthopterists' Society) was created. Later, in **the first volume of *Metaleptea***, Monné published a note saying that he and Seabra, in collaboration with Marius Descamps and Carlos Carbonell, were amassing a collection of Acridoidea, which would be stored in Seabra's house and later sent to MNRJ (Fig. 3). In 1978, Seabra promoted (and funded) the Primeiro Encontro de Acridologia Neotropical (First Meeting on Neotropical Acridology) at the Museu Nacional, bringing together great orthopterists, like Carlos Carbonell, H.R. Roberts (1906-1982), Marius Descamps, Ricardo Ronderos (1928-1995), and Stanley K. Gangwere (Figs. 4, 5). Thus, these

eminent specialists could work in the Orthoptera Collection (at that time, the Seabra Collection), identifying and describing several new species.

Through the 1980s, Seabra continued funding collectors and expeditions in several areas of Brazil and his collection of Acridoidea grew in volume and importance,

receiving several specimens and paratypes from other museums, such as the Muséum national d'Histoire Naturelle (MNHN), Museo de La Plata (MLP), and the Academy of Natural Sciences of Philadelphia (now Academy of Natural Sciences of Drexel University) (ANSP). Between 1981 and 1986, Carbonell worked as a researcher at MNRJ, receiving a scholarship from the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), a Brazilian funding agency. During that period, he actively worked in

the collection and taught courses in entomology (I have some colleagues today who had classes with Carbonell and remember him with great enthusiasm). In 1990, the Seabra Collection was finally moved to the Museu Nacional. Monné says that he took three years to move all the entomological boxes to MNRJ during the weekends, which gave him calluses on the tip of the fingers, as a consequence of the millions of pins he had to move from different boxes. In total, more than 1.5 million insects were transferred to MNRJ (Fig. 6).

The period of around 20 years since the arrival of Marius Descamps to Brazil until the 1990s was the most fruitful period of species descriptions of Acridoidea in South America (Song, 2010). The role of Monné and Seabra was essential for this period of Brazilian orthopterology. The Orthoptera Collection, focused on Acridoidea, had specimens from all Brazilian regions, including material from remote and unexplored areas (at that time), like the north part of the Amazon. Carbonell considered the MNRJ collection of Acrididae one of the greatest collections of this group in the world, together with the



Figure 4. Primeiro Encontro de Acridologia Neotropical (First Meeting on Neotropical Acridology). Museu Nacional, Rio de Janeiro, 1978. In this photograph are Marius Descamps (in the back, in front of the window), H. R. Roberts (in the center, in profile), Carlos Carbonell (after Roberts, also in profile), and Miguel Monné on the right.



Figure 5. Primeiro Encontro de Acridiologia Neotropical (First Meeting on Neotropical Acridiology). Museu Nacional, Rio de Janeiro, 1978. In this photograph are Albina Secondi de Carbonell, Stanley Gangwere, Ricardo Ronderos, Carlos Carbonell, and H. R. Roberts.



Figure 6. Picture of a Brazilian journal about the transference of the Seabra Collection to MNRJ. Rio de Janeiro, 1990.

collections of ANSP and MNHN (Fig. 7). Until September 2nd, 2018, the MNRJ housed the largest and most important collection of Orthoptera in Brazil. The collection had 28,042 pinned specimens and more than 10,000 in backlog. Although it was a small collection, in comparison with European and North American collections (the MNHN, for example,

has around one million Orthoptera specimens), the MNRJ Collection was important because, in addition to the great representativeness of Neotropical Acridoidea, it housed many type specimens.

The collection had 3,129 type specimens, distributed across 215 holotypes, 134 allotypes, and 2,761 paratypes, representing 328 species.

A list of the primary types can be seen in Monné (2018). Over the last few years, the MNRJ joined the SIBBr (Sistema de Informação sobre a Biodiversidade Brasileira), an initiative from the Brazilian government to digitize the Brazilian biodiversity collections. At the MNRJ, the project was headed by prof. Cátia A. de Mello-Patiu, and there was funding for equipment and trainees, with the enormous goal of digitizing the large Entomological Collection, with approximately 12 million specimens. Unfortunately, the fire came before finishing the project. But, luckily, the Orthoptera Collection, almost completely lost in the fire, was digitized, which means that the label data for all 28,042 pinned specimens (22,181 Caelifera) and photographs of all labels are preserved. Thus, the Collection survived, although virtually. Moreover, all the primary types were photographed (two photos per specimen, habitus dorsal and lateral). The more than 10,000 backlog specimens, however, were completely lost. A publication including all the type photographs is being prepared.

Since the Orthoptera Collection was built with the support of eminent orthopterists, who had donated several specimens and paratypes from 49 countries, and had others working there (mainly Carlos Carbonell and Marius Descamps), most of the species determination data are reliable, especially in Acrididae, Eumastacidae, and Romaleidae. In fact, the collection was practically an Acridoidea Collection: of the 22,181 caeliferans, 15,020 were Acrididae and 5,848 were Romaleidae. Ten other Caelifera families were also represented, plus seven in Ensifera. The saved data also allow us to have information on Acridoidea diversity in several areas of Brazil, providing, for example, useful information for scientific studies, field expeditions, and for efforts aimed at the reconstruction of the collection.

Now, two years after the fire, the



Figure 7. Carlos Carbonell and Miguel Monné in Rio de Janeiro, 1993.

Orthoptera Collection is currently divided into a wet (ethanol) and a dry collection, with almost five thousand specimens collected in its first year (2018-2019), and with samples covering all Orthoptera families recorded for

Brazil. When the COVID-19 crisis is over, expectations are good for the forthcoming years: new expeditions will be conducted to increase the Orthoptera Collection's holdings, a new building for the Entomology Department is being constructed, and new buildings specifically designed to house wet and dry collections of the MNRJ are being planned.

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Collecting Orthoptera in South Africa and Namibia amid COVID-19

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This expedition was born in March 2019, during the 13th International Congress of Orthopterology at Agadir, Morocco. There, RMP and DM met in person for the first time, and based on years of DM's experience in Western and Eastern Cape areas in South Africa and RMP's previous short prospective trip to Namibia (Erongo Region) plus similar interests in Southern Africa orthopterofauna, we decided to plan a 4-week expedition in 2020.

After months of endless email exchanging, we finally had the dates: we would be travelling southern Africa from February 28th to March 31st. We decided to rent a 4x4 vehicle and make a circuit, starting and ending in Cape Town, all the way to Etosha National Park (approximately 5,000 km). The basic idea was to spend two weeks in South Africa and two weeks in Namibia. We did not book any lodging in advance to freely decide where to spend more or

less time depending on the weather conditions.

1. Western Cape, South Africa

We travelled the Western Cape in South Africa from March 1st to 8th. We started at Table Mountain, Cape Town. There, we were able to observe *Thericlesiella meridionalis* camouflaging (Fig. 1). In general, we found adult individuals close to the coast as well as in the mountains and hot areas, such as Cederberg

Wilderness Area. During previous field trips in March, DM had mostly only found nymphs in some areas, especially on sites close to the coast. The weather was overall very sunny, similar to the conditions in 2012. It was very hot in the northern reserves (37 °C) and generally dry and hot in the other reserves visited. Concerning water availability, we were able to observe that pools and rivers in Groot Winterhoek Wilderness Area and Cederberg were very dry;



Figure 1. *Thericlesiella meridionalis* habitus at Table Mountain, South Africa.



Figure 2. *Dictyophorus spumans* dead specimens.

the water level was low with only little water left. In general, this is a typical pattern for March as the rainy season is only approaching. Vanessa Couldridge had told us that there had been comparatively more rain last winter (2019) and that summer started late since it had only been warm from January. We found dead adult specimens of *Dictyophorus spumans* (Pyrgomorphidae) sitting on the top of some bushes (Fig. 2). At Cederberg, we found very few individuals as usual, but this time, we only found one species, *Thericlesiella meridionalis*. One study site at Cederberg which used to be highly diverse in plants and rich in vegetation structure (S32 25.704; E19 11.010) was very poor this year. The vegetation was very low, which might be due to differences in water balance or microclimate, it was much drier than usual. However, our general conclusion is that the average grasshopper diversity has not change in recent years. An overview of the observed species and habitats of both South Africa and Namibia are provided in Figures 3 and 4.

2. Northern part of the Western Cape and Northern Cape, South Africa

After leaving Cederberg Wilderness Area, we continued our trip



Figure 3. Selected species, which were found during the field trip through South Africa and Namibia in March 2020:

First row: *Eyprepocnemis calceata* (Serville, 1838) in Kogelberg NR (34°17'45.88"S; 19°7'28.20"E), *Frontifissia elegans* Key, 1937, in Hottentots Holland NR (33°54'20.83"S; 19°9'26.97"E) in Kogelberg NR (34°12'24.43"S; 19°8'55.81"E).
 Second row: *Vitticatantops humeralis* Sjöstedt, 1931 in Limietberg NR (33°37'24.10"S; 19°5'50.63"E), *Betiscoides* sp., *Devylderia* sp. both in Groot Winterhoek Wilderness Area (32°59'35.34"S; 19°3'32.90"E).
 Third row: *Thericlesiella meridionalis* (Sjöstedt, 1923) in Cederberg Wilderness Area (32°25'55.00"S; 19°11'3.09"E), Nymph of *Trachypetrella anderssonii* (Stål, 1875) in BuellsPort (24°8'40.89"S; 16°22'10.44"E), *Punclicornia puncticornis* (Stål, 1876) on the road to Namibgreens (23°53'37.27"S; 16°20'11.92"E).
 Fourth row: *Anacridium* sp. Moonlandscape near Swakopmund, *Euloryma* sp. in the Western Cape, RSA, *Plegmapterus* sp. (24°8'40.89"S; 16°22'10.44"E) in BuellsPort.
 Last row: *Acrotylus cf. patruelis* (Herrich-Schäffer, 1838), Euryphiminae, (21°30'51.81"S; 15°36'53.91"E), *Hemicharilus monomorphus* (Uvarov, 1929) (21°27'51.62"S; 15°45'8.69"E), all close to Omaruru.



Figure 4 (previous page). Different visited habitats ranging from Kogelberg Nature Reserve in the Western Cape, South Africa to Skeleton Coast in Namibia. a) shows a 5-year-old Fynbos site in Kogelberg Nature Reserve (34°21'21.32"S; 18°51'32.55"E), b) RMP is shown while collecting Orthopterans in Rooisand, a typical fynbos wetland habitat belonging to Kogelberg Nature Reserve. c) view from Kliphuis River trail of Groot Winterhoek Wilderness Area; the plateau also features typical wetland habitat which is dominated by Restionaceae. d) shows one collecting site in Cederberg Wilderness Area (32°25'55.00"S; 19°11'3.09"E). This mountain range forms up the northern distribution boundary of Fynbos. e) shows a typical site of Knersvlakte Nature Reserve in mid-March (31°17'53.12"S; 18°28'42.27"E). The vegetation is very dry and low compared to fynbos. f) and g) show environmental conditions in |Ai-|Ais Richtersveld Transfrontier National Park (Namibian site) in mid-March, g) reflects the typical soil and rock structure which usually houses species of Lithidiidae. h) depicts a habitat close to the gravel road between Maltahöhe and BuellsPort (24°43'35.49"S; 16°57'8.89"E). This site featured water and blossoming flowers and housed several specimens of Diptera, Coleoptera and Lepidoptera. However, we observed no Orthoptera there. i) shows the habitat close to BuellsPort where we found specimens of Lithidiidae and *Acocksacris carpi* (24° 8'40.89"S; 16°22'10.44"E). Flowers were also blossoming at the time of our visit and it had rained 10 days before. The soil featured small, reddish pebbles. j) and k) show the habitat of *Puncticornia puncticornis* and *Acanthoplus discoidalis*, it seemed to be rather dry when we visited but the site featured a mixed proportion of high bushes, grasses and open soil with pebbles (23°53'37.27"S; 16°20'11.92"E). l) shows the surveyed habitat in Namibgreens, where also one specimen of Lithidiidae was collected (23°36'36.65"; 16°14'36.80"E). The conditions were similar to those in BuellsPort. m) The plateau close to Gobabeb is pictured. The dry sand only features low, very dry grass. RMP and colleagues were able to collect Lithidiidae there in December 2018, however this time in March we did not find a single grasshopper there. n) shows the typical habitat near Swakopmund close to the beach. The soil features many pebbles. No Orthoptera were found here. o) and p) show the supposed habitat of *Microtmetis kuthyi* along Skeleton Coast. Only few areas featured this habitat of dunes and associated plants. Unfortunately, we were not able to explore this area further since lions were around. q) shows the habitat of *Hemicharilus monomorphus* (21°27'51.62"S; 15°45'8.69"E) while r) was a site featuring comparable many Orthoptera, especially Oedipodinae (21°30'51.81"S; 15°36'53.91"E). This site was wet when we visited and housed different species of Coleoptera, Hemiptera and Lepidoptera.

northwards. It was very dry and people were waiting for the rainy season (pers. comm. accommodation at Nuwerus). We searched a rather wide area, including Knersvlakte Nature Reserve, where we stopped at three sites but only found few juvenile and adult specimens of *Acrotylus*. On the route from Nuwerus to Rietpoort, we only spotted one promising site, which was an artificial pool area, but we were not able to access since it was a Government facility. We continued to search the area around the route from Nuwerus to Strandfontein via Lutzville on gravel road. We found only one suitable area but we were not allowed to stop there again (mining). Due to the drought and poor collecting, we decided to travel to Namibia. According to the literature, the target species should be adult in March whereas the collecting dates of the ones in the Northern Cape ranged between September and November.

We crossed the border to Namibia at Alexander Bay – Oranjemund without a hassle (March 10th). DM did not need a visa but RMP did (obtained in two days at Namibia Consulate, Cape Town). Until then, everything went according to the plan and there were some news regarding COVID-19 in Europe but there were not any travel restrictions.

3. Namibia

In Namibia, we drove zigzag ways along the west coast towards Skeleton Coast. The rainy season should usually end by mid to late March, Windhoek was very green at the end of March 2020, but it rained too little on average in some parts of the country. Windhoek received a comparatively high amount of rain in late January. We visited BuellsPort on March 13th. According to the owner, it had rained 10 days earlier. There, we found the highest grasshopper diversity. It is interesting to note that, although we searched the area three times (March 13th in the afternoon for 3 hours, in the evening around 10 pm for an hour and on March 14th at 10am for an hour), it was only at morning of March 14th that we found an interesting Gomphocerinae on a small patch. The specimens were really hard to catch. In the beginning, we were excited thinking that these specimens belong to a new species but a careful examination of the epiphallus under the microscope revealed the identity of the species. The specimens belong to the species *Acocksacris carpi* (Fig. 5). However, now we have images of live specimens, both male and female, and the specimens are stored in ethanol 100% for future molecular studies.

At Swakopmund, few grasshoppers were collected in total, we only heard

crickets in the dunes, we searched the beach without success and only found moths, flies and some beetles; no typical dune grasshopper species (*Aiolopus*, *Acrotylus*, *Sphingonotus*) were found (along the entire section from Lüderitz Bay, via Swakopmund to Torra Bay).

At Namibgreens, we collected one species of Lithidiidae, which also occurred at BuellsPort. Soil conditions of Namibgreens and BuellsPort seem similar and both sites featured a similar composition of plants. One plant species was flowering on both sites (smell was similar to rosemary).

Regarding the enigmatic genus *Microtmetis* (currently classified as Lithidiidae but most likely (and originally considered) to be a Pamphagidae): we spotted two suitable habitat sites along Skeleton Coast, but detected lion traces (guards are required) at very narrow dunes with scarce vegetation, so we were unable to collect. We generally observed that it only rained very regionally, often in downpours including thunderstorms, plants flowered immediately afterwards but surrounding areas continued to be barren. It really did not matter if we matched dates of previous collecting events. The orthoptero fauna here seems to be very rainy dependent and the most important factor to take into

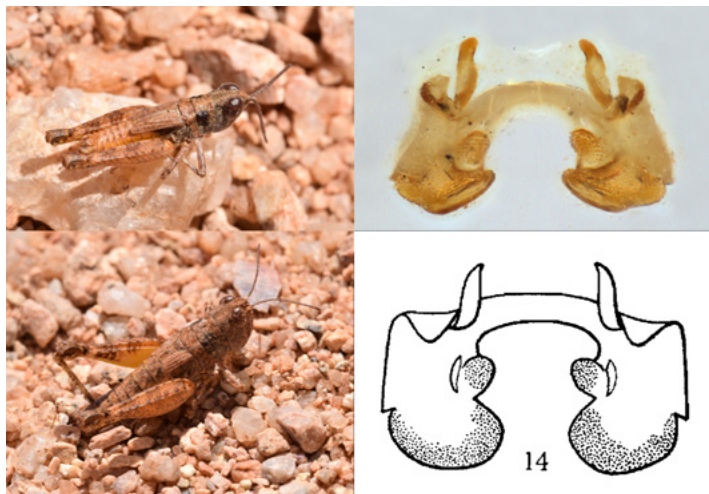


Figure 5. *Acocksacris carpi*. Male and female plus comparison of epiphallus with illustration from Brown, 1962.

account is the local raining. Hojun Song and RMP were able to collect Lithidiidae on two sites in December 2018 (lunar landscape Swakopmund and mountain area around Omaruru), but we did not find Lithidiidae in their season (according to the literature) now despite the extensive search in the described localities. Unfortunately, there is no detailed description of the habitat in the literature. Here, we provide two pictures of the collection sites of Lithidiidae in BuellsPort and Namibgreens together with other habitats in South Africa and Namibia (Fig. 4). We decided to head northeast to Etosha National Park and we found high abundance of one katydid species on March 20th. It was extremely difficult to drive without killing them; these katydids belong to the species *Acanthoplus discoidalis* (Fig. 6).

It makes perfect sense to look for specimens at night in case the species were detected during the day but were difficult to catch due to their behavior (RMP experienced this a year before) such as members of Lithidiidae. Apart from that, we have had no catch successes at night, even if there were few species on the site during the day.

By the time we arrived to Swakopmund (March 16th), travel restrictions started to appear. The South African Government restricted the entrance to people that had been

in USA, UK, Germany, Italy among other countries within the last 20 days. According to that rule, we were on safe grounds because RMP left USA on February 28th and DM left Germany on February 29th. We just needed to wait until at least March 20th to cross back to South Africa.

Namibia did not have any travel restriction yet.

4. Chaos

South Africa – Namibia terrestrial passes started to close and only three remained open thus, on March 23rd, we tried to cross back to South Africa through Noordoewer- Vioolsdrif pass. Migration staff from the Namibian side was very clever and polite and allowed us to check first with the South African migration if we were allowed to enter. If not, we could return to Namibia because we “officially” never left the country. DM did not need a visa to enter South Africa but RMP did (obtained on January at South African Embassy at Mexico City). To our surprise, DM

was denied entry because she was from Germany (even if we argued that DM had not been in Germany since February 29th). RMP was allowed to enter but there was no point to split and the rental vehicle was on DM’s name. Fortunately, RMP did not have an exit stamp from Namibia because he would not be able to reenter with his single entry Namibian visa. We were tired of driving 1,000 km that day and looked for a hotel. The next morning (March 24th) we tried again (hoping another migration officer at South Africa migration understood the situation) but we failed again. We decided to travel to Windhoek (fortunately just 800 km) to try to fly from there to our homes.

The same March 24th, RMP was able to book a flight on March 28th (Windhoek-Johannesburg-Doha-Chicago). The original flight on March 31st (Cape Town-Doha-Chicago-Detroit) was impossible to catch.

On March 26th the Namibian Government decided to close its airspace, meaning all flights were canceled. RMP was stranded. Due to RMP visa, he could legally stay in Namibia until May 2nd. The Namibian authorities stated that international flights will be reinstated in three weeks, but to date (September) there is still no international flight to/from Namibia.

DM was arranging a repatriation



Figure 6. *Acanthoplus discoidalis* at Etosha National Park, Namibia.

flight (Windhoek-Frankfurt) on March 31st through the German Embassy at Windhoek, but DM's permit to stay at Namibia would expire on March 30th, meaning it would be an issue and DM was required to extend her stay. Fortunately, DM was moved to an earlier repatriation flight on March 29th and did not have any issue to leave. DM dropped the rental vehicle at the Windhoek airport instead of the Cape Town airport.

RMP started to arrange accommodation for three weeks at Windhoek. Unfortunately, the lockdown did not allow exiting the city so the alternative plan of at least

collecting nearby was out of question. In a stroke of good luck, one alumnus of University of Michigan was living in Windhoek, she was married with a member of the US Embassy and she suggested RMP to visit the Embassy website and RMP was able to enroll in a repatriation flight program for US citizen and US visa holders. On April 1st RMP flew Windhoek-Lusaka-Addis Ababa-Washington-Chicago-Detroit.

At the end we lost the last week of our month long expedition, but we gathered a lot of ecological information that we will use for future expeditions. It is imperative to report

these field observations findings to ignite future research.

Acknowledgements

We want to thank Vanessa Couldridge for all her logistic support in South Africa. Corey Bazelet provided literature to identify *Acanthopplus discoidalis*. Bruno Massa, Daniel Otte and Hojun Song helped us to identify some specimens. University of Michigan authorities were always attentive and supportive to help RMP to return to USA. We would like to thank CapeNature for providing the permit (No. CN44-59-11619) to work in the Cape Floral Region Protected Areas and the Namibian farmers for providing access to their land and their interest in our work.

VIII Brazilian Symposium of Orthoptera and I Symposium of Orthopteroid Insects

By **PEDRO G.B. SOUZA DIAS**

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In early March of this year, in Águas de Lindoia, a small city in the state of São Paulo, we organized our already traditional meeting on Orthoptera, during the XXXIII Brazilian Congress of Zoology. This time, we went further and organized the first Brazilian meeting on orthopteroid insects, gathering the orthopterists and the small community of colleagues (most of them students) that are studying mantids and phasmids in Brazil. Thus, the VIII Brazilian Symposium of Orthoptera and I Symposium of Orthopteroid Insects occurred on March 4th and 5th.

For this event we increased the participation of students as invited speakers, providing an opportunity for them to present their projects in a congress. We also promoted ten talks, six of them presented by students, and two presented by postdocs. Moreover, 17 studies were presented in the poster session. The presented lectures were: (1) “The Orthoptera Collection at the Museu Nacional/UFRJ and the Brazilian orthopterology” by Dr. Pedro G.B. Souza Dias; (2) “The

resumption of the studies on phasmids (Insecta: Phasmatodea) in Brazil: collections and challenges” by Edgar Blois Crispino and Phillip Watzke Engelking (graduate students); (3) “Brazilian tetrigids: where are they?” by Dra. Daniela Santos Martins Silva; (4) “*Cornops frenatum frenatum* (Orthoptera, Acrididae): bioecology and possibility of damage to heliconia

plantations” by Dr. Marcos Gonçalves Lhano; (5) “Mating behavior and the influence of the courtship sound on the reproductive success of two species of Phalangopsidae crickets (Orthoptera, Grylloidea)” by Riuler Corrêa Acosta (graduate student); (6) “Orthoptera as environmental bioindicators: first attempts in Brazil” by Dr. Neucir Szinwelski and Victor



Participants of VIII Brazilian Symposium of Orthoptera and I Symposium of Orthopteroid

Prasniewski (graduate student); (7) “Dead, but alive: biological collections in the age of “omics”” by Dra. Natallia Vicente; (8) “There is still hope: about the Tettigoniidae (Orthoptera: Ensifera) from the Iguaçú National Park, Brazil” by Marcos Fianco (graduate student); (9) “The mantids as a symbol of conservation” by João Felipe Herculano (graduate student); (10) “Macrophotography in scientific outreach: uniting science and art” by César Favacho (graduate student).

In addition to the talks, we also organized a forum, where we discussed several issues regarding research with orthopteroids in Brazil. Below is a set of some abstracts of the talks.



Participants of VIII Brazilian Symposium of Orthoptera and I Symposium of Orthopteroid

The Resumption of the studies on phasmids (Insecta: Phasmatodea) in Brazil: collections and challenges

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Phasmatodea is one of the few orders in Insecta still lacking a comprehensive phylogeny, and with several unsolved taxonomic questions regarding specially the Neotropical species. In order to explain the major concerns related to stick-insect study in Brazil we focused on basic aspects related to phasmids: taxonomic problems that affect specimen identification; the Areolatae vs Anareolatae situation; species diversity, and general biology. Around 200 species are known for Brazil, with at least twice that number expected to be unknown to science. The history of studies on Brazilian Phasmatodea was also discussed, from the major researchers from the XIX and XX century like Brunner von Wattenwyl, Redtenbacher, Stål, Salvador Toledo de Piza Junior, and others, to their studies describing species, their legacy and problems involved with their work and related Brazilian taxa. Examples, such as brief and vague descriptions

based on external morphology, strong sexual dimorphism resulting in different species described for the same taxa, unknown life cycles, type material deposited in foreign museums and distribution range was exemplified by the taxonomic history of *Canuleius sanguinolentus* (Brunner von Wattenwyl, 1907). Some of the most recent works on Brazilian Phasmatodea were used to exemplify the challenges faced regarding entomological data accessibility and phasmid collections situation in Brazil. We listed depositories and collections with available information (Museu de Zoologia da Universidade de São Paulo with around 1300 specimens, Instituto Biológico with 11, and Escola Superior de Agricultura “Luiz de Queiroz” with important type material) and compare it with the majority of other institutions with their unknown situation regarding the existence of phasmid specimens. A summarization of all problems mentioned and possibilities for the future of Phasmatodea research in Brazil was presented, with focus on research grants, partnerships with other researchers and national/international companies.

Brazilian tetrigids: where are they?

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Members of the family Tetrigidae are distributed all over the world and usually live close to water, decomposing soil, and leaf litter. Tetrigids can be distinguished from other grasshoppers by several characteristics, the most important of which are the pronotum partially or completely covering the abdomen, with variable, ornate shape in certain groups; tegmina, when present, reduced and disposed laterally to the body; absent tympanic organ, and tarsal formula 2-2-3. Currently, the family includes about 280 genera within seven subfamilies: Batrachideinae Bolívar, 1887; Cladonotinae Bolívar, 1887; 1907, Lophotettiginae Hancock, 1909; Metrodorinae Bolívar, 1887; Scelimeninae Bolívar, 1887; Tetriginae Rambur, 1838 and Tripetalocerinae Bolívar, 1887. For taxonomists, the major part of systematic studies requires information that comes from scientific collections. Occasionally it is not possible to visit collections, but the digitization of published material (e.g., papers, books) help with this problem. The digitization of collections is also important because sometimes we do not have access to all the details of the organism in the original publications.

This case is particular to tetrigids, since in this group there are few pictures of the types; simple or short descriptions; drawings with positions that privilege few details and non-morphological information. Hence, the digitization solved one of our biggest problems: the relationship between descriptions/ images/drawings and the absence of specific data. Brazilian tetrigid fauna includes 61 species described and, until 2017, none of them were deposited in Brazilian museums. Among them, 30 type species are housed at the Academy of Natural Sciences of Drexel University (ANSP), Philadelphia. This great representativeness of Brazilian species is mainly due to the contributions of Joseph Lane Hancock and two other great tetrigid researchers in the 20th century: James Abram Garfield Rehn and Harold Johnson Grant Jr. This museum is extremely important to all Orthoptera taxonomists. Thus, this collection is considered one of the most important for orthopteroid researchers as well as for tetrigid researchers.

Cornops frenatum frenatum
(Orthoptera, Acrididae): bioecology and possibility of damage to heliconia plantations

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In this lecture I will present the results of several studies that we conducted at our laboratory (called Laboratory of Insect Ecology and Taxonomy – LETI) to better understand the biology and ecology of *Cornops frenatum frenatum* (Marschall, 1836) (Acrididae, Leptysminae). The Neotropical grasshopper *C. f. frenatum* was first found in 2007 as one of the main pests of *Heliconia* spp. L. (Zingiberales, Heliconiaceae) plantations in Brazil. Significant damages and loss of the quality in the plant cultures can be caused by this species, which generates significant economic losses in the floriculture market. *C. f. frenatum* is a phytophagous grasshopper, which is gregarious in its initial instars of development and commonly found in plantations of *Heliconia* spp., causing

great damage to these ornamental tropical plants. Environmental factors, such as photoperiod, temperature, and food availability, have a direct influence on the development of those insects and the study of their biology is essential to establish adequate programs of pest control. So, we evaluated the influence of the photoperiod on the nymphal development of *C. f. frenatum* in different photophases (L) and scotophases (E) (I = 24 L, II = 12L/12E and III = 24E), under controlled temperature (25 °C) using B.O.D. incubators. Longer development times were observed in individuals undergoing treatment III (24E), where the females needed an average of ± 98 days to complete the nymphal phase, whereas the males needed ± 87 days. Also, we verified that males present 4 to 6 instars and females 5 to 7 instars, depending on the photoperiod. The major survival of the specimens was found in treatment I (24L) and the lowest survival, in treatment III (24E). The circadian rhythm was also studied in grasshopper nymphs under the treatment II (12L/12E). It was found that most ecdyses occurred during the day (79%), and the passage from the last instar to the adult stage was also higher during this period (93%). Regarding mortality, most of them occurred during the night period. Observing these data, we inferred that individuals of *C. f. frenatum* had their development associated with the need of light. After we verified that the photoperiod exerts an important environmental condition (Zeitgeber) for the development of *C. f. frenatum*, we started the studies to describe the phenology of *C. f. frenatum* in culture of *Heliconia* sp. in an anthropized area. Collections were performed during 24 months in a farm producer of tropical flowers, located in Bahia state, where individuals were randomly sampled. For analysis of environmental influence on these population dynamics, climate data were also obtained (temperature, solar radiation and humidity). It was observed that the population of *C. f. frenatum* is multivoltine, featuring monthly variation in frequency of adults and nymphs, associated with the monthly variation of the humidity, temperature and solar radiation. The highest abundances were observed in months of low temperature and direct sunlight and high humidity. *Cornops*

frenatum frenatum lives permanently on plants of *Heliconia* sp., feeding on them and ovipositioning on them. In laboratory, we conducted tests of food preference and acceptability of *C. f. frenatum* to different plant species. In the acceptability test with no chance of choice, were offered 12 different plants for nymphs (*Heliconia*, *Alpinia*, *Brassica*, *Canna*, *Eitinger*, *Lactuca*, *Maranta*, *Strelitzia*, *Zingiber* and three varieties of micropropagated *Musa*). We observed that four species presented high acceptability by the grasshoppers: *H. psittacorum* (host plant, 100% survival of nymphs), *C. indica*, *M. arundinacea* (both 96% survival rate) and *S. reginae* (63% survival). Although it had not been registered, it can be inferred that *C. indica*, *M. arundinacea* and *S. reginae* are susceptible to *C. f. frenatum* attack and may become their alternative host in the absence of a known host. Besides that, we also studied the mandibles type of *C. f. frenatum* and observed that it has a graminivorous type of feeding habit. Besides evaluating *C. f. frenatum* food preference, we studied the presence of its natural enemies in heliconia plantations and evaluated the potential of the fungal pathogen *Metarhizium acridum* (Driver & Milner) J.F. Bisch., Rehner & Humber (2009) (Ascomycota: Hypocreales) (CG423 strain) for its control. We found that *C. f. frenatum* nymphs are more susceptible to *M. acridum* when compared with adults. We concluded that entomopathogenic fungi present promising results in the control of those grasshopper species.

Mating behavior and the influence of the courtship sound on the reproductive success of two species of crickets Phalangopsidae (Orthoptera, Grylloidea)

Riuler Corrêa Acosta

The reproductive behavior of crickets includes a set of events that begin with the attraction of females to males by means of acoustic signals. The sexual recognition occurs through contact among antennae, triggering the court rituals, which simultaneously involve the emission of acoustic signals, vibrations of the antennae, touches of antennae and palps, in addition to

body vibrations. Although these signals have a definition based on elaborate behavior, little is known about their real meaning. Thus, the objective here is to present the functions of the courtship sound in two species of crickets Phalangopsidae. Females of each species were subjected to three types of males: males containing the whole tegmina, males with clipped tegmina (mute males) and mute males with playback. Both experiments with mute males did not have the acoustic production by the males. In the long-legged cricket *Endecous (Notendecous) onthophagus* (Berg, 1891), the courtship sound is directly associated with the mating success, because the males who do not produce sounds do not copulate. The same experiments were carried out with the cricket *Adelosgryllus rubricephalus* Mesa & Zefa, 2004. The results showed that the courtship sound is not necessary for copulation, since in all encounters there was copulation. However, phonotaxis tests have shown that the *A. rubricephalus* courtship sound is effective for attracting females over short distances. Through the results obtained, we provide information that the function of the acoustic signals is associated with the repertoire composition, mainly due to the fact that *E. onthophagus* has a complete repertoire, whereas *A. rubricephalus* does not have a calling sound.

Orthoptera as environmental bioindicators: First attempts in Brazil

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In the last 30 years, Brazil has produced about 37 articles involving the ecology of Orthoptera, eight articles that include Ensifera and 29 with Caelifera. Most of these articles, however, have not achieved significant interest from the scientific community given their low impact factor and the number of citations they have reached, in addition

to other factors that we will not address here. Over these 30 years, several data were collected, both for taxonomy, bioacoustics, cytogenetics, molecular biology, and ecology. The largest research project with Orthoptera ever approved in Brazil, the “SISBIOTA-Orthoptera” had an investment of 1.2 million reais and enabled areas of significant importance in Brazil to be sampled for research in several areas of knowledge. During this project, a large amount of data were produced. Other projects with less financial support were also developed and also produced a series of data that could be used for ecological works. So, if data collection occurs, why is Orthoptera’s ecology work less represented? In this lecture we analyzed some Orthoptera ecological papers and unpublished works in order to identify the reason for the lack of ecological works. We have identified at least seven gaps that make it impossible or fragment the work with Orthoptera ecology: i) no species determination; ii) missing true replicates; iii) lack of specific coordinates; iv) differing sample design; v) missing environmental characteristics; vi) missing functional characters; and vii) there is no sharing of data or a combined database. The first item is unfortunate and in several regions of Brazil where Orthoptera are collected, species determination is practically impossible, either due to the great and unknown biodiversity or the lack of taxonomists in the area. Even with all the excellent taxonomists we have in Brazil, it would be practically impossible for them to be able to identify/describe/publish all the material collected during the SISBIOTA-Orthoptera, for example. And if they did, it would be at the cost of abandoning all the personal work already started. This is the main gap for ecology work, without determining species it is impossible to carry out quality work in the area of ecology. Brazil urgently needs to invest in the training of taxonomists, as it did some time ago. True replicates, specific coordinates, coincident sample design, and environmental characteristics are the basis for ecology work. Before 2010, a series of sample designs were designed, which compromises the comparison of data today. Geographic coordinates did not mark the collection point, but the location/area sampled;

true replicates were scarce, and the characteristics of the environment were not always collected/mentioned. After the SISBIOTA-Orthoptera, a standardization was proposed, allowing comparisons, however we still run into the first problem. The last items are gaps that can be easily resolved, but they represent gaps because the information is not available in databases, so it is not easily accessible. Perhaps the new OSF catalog (Orthoptera Species File) could consider including such information in its database and facilitating access to these data. Although we highlight a series of gaps that hinder ecology work with Orthoptera in Brazil, we are not standing still. We have a group that has started to collaborate (taxonomists, ecologists, cytogeneticists, etc.), seeking to strengthen the knowledge of Orthoptera in our country. The unfolding of Brazilian Orthoptera ecology is near.

There is still hope: about the Tettigoniidae (Orthoptera: Ensifera) from the Iguaçu National Park, Brazil

Marcos Fianco

Tettigoniidae is the most speciose family within Orthoptera, occupying all vegetational strata, from litter to canopy. Most katydids are related to forests, and the production of acoustic signals is paramount to their biology. This work is a presentation of a faunistic inventory of katydids that we have done at the Iguaçu National Park, a large remnant of Atlantic forest in southern Brazil. Additionally, we describe the calling song performed by males. A total of 87 species were collected, 66 of them identified in species level, and 11 of them corresponding to undescribed species (new to science). The most abundant subfamily was Phaneropterinae (56 taxa), followed by Conocephalinae (22), Pseudophyllinae and Meconematinae (4 each), and Pterochrozinae (2). We were also able to record and describe the calling songs of 36 species, 31 not described until then. Sounds were recorded for species of Phaneropterinae (24), Conocephalinae (8), Pseudophyllinae (3), and Pterochrozinae (1).

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The global pandemic still continues on, with no sign of slowing down, at least here in the U.S. We are all eager to get back to our normal lives, but unfortunately, it appears that we are in this for a long haul. These days, most of my time is spent at home. My two children are doing virtual learning and my family still diligently practices social distancing. So, it's been several months since we hung out with our family friends or travelled anywhere. My lab is somewhat functional, but I haven't been to the lab to work for quite some time. Most of my students are also working from home and I only see them through a computer screen when we have a weekly lab meeting via Zoom. The fall semester started in mid-August at my university and I started teaching a graduate course on insect behavior, which I teach virtually. Some days, I have several back-to-back Zoom meetings and I get very tired easily, which I believe is called Zoom fatigue. I know that this pandemic life will go on for many months to come, which is quite depressing.

However, even in the midst of this crisis, something amazing has happened. Back in February, my colleagues and I submitted a proposal to the U.S. National Science Foundation to create a research institute focusing on locusts. We initially thought that it was a long shot, but, to our surprise, it was selected as one of four inaugural Biology Integration Institutes (see [the article about this award](#)). The initial excitement of getting the award news lasted a few days, but now I am working hard to launch this Behavioral Plasticity Research Institute (BPRI) by developing bylaws and planning for recruiting staff and students. It really tickles me to think about all the

amazing discoveries we will make as well as all of the students who will be trained through the BPRI.

This is another fantastic issue of *Metaleptea* featuring how active our society is, even in the midst of the global pandemic. This issue is full of contents and I am thankful to all of the contributors for making this issue possible, including regional representatives and past awardees. I am proud to say with confidence that there is no other entomological society newsletter that is more content-rich than *Metaleptea*. This is a testament to the success of our Society. Of course, I would also like to thank our Associate Editor, Derek A. Woller, for his continued assistance in the editorial process.

To make this newsletter even more interesting, I would like to propose an

idea. For each issue, I would like to invite an established Society member to write a personal essay about how he/she got interested in Orthoptera and built a career as an orthopterist. I think it will serve as a great inspiration for our younger members and an opportunity to get to know more about our members. I will be contacting the first person soon!

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 January of 2021, so please send me content promptly. I look forward to hearing from you soon!

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