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METALEPTEA

THE NEWSLETTER OF THE ORTHOPTERISTS' SOCIETY

President's Message

By DAVID HUNTER
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Dear Society Members,

A very happy New Year to everyone!

Without doubt, 2020 was a very challenging year. Limitations on our activities have meant we have had to adapt to a very different environment for both work and leisure. COVID-19 has affected all of us and, as has occurred with so many other international meetings, has led the Board to decide to delay our next Congress (see next article). Let's hope for a better 2021 and a gradual return to normal - whatever the "new normal" turns out to be and however long it takes.

A special thanks to both Corey Bazelet and Tony Robillard for a smooth transition of the editorship of our Journal. After an overlapping period with Corey, Tony has now taken over as Editor of our *Journal of Orthoptera Research*. Corey's tireless efforts over the past five years have brought our journal to open access through Pensoft which means a substantially increased readership of our journal. Remember that as members of our society, you can publish your work in the journal free of charge (except for coloured images), so send your articles to Tony, our new Editor!

I draw your attention to the Report by our Treasurer, Pamm Mihm: even though the many economic uncertainties led to a decline in the Society's investments early this year, there has

been a full recovery in recent months. This puts us in a good position to fund the upcoming Theodore J. Cohn Research Fund projects and our many other endeavours that support you as members of our society while increasing the profile of Orthoptera and related groups.

The many reports in the current issue of *Metaleptea* demonstrate the continuing success of the work of our members: it is with great pleasure that I present another excellent *Metaleptea*, thanks once again to the tireless efforts of Hojun Song and Derek Woller!

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14th Congress delayed due to COVID-19

By DAVID HUNTER
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With a great deal of reluctance, the Orthopterists' Society Board has decided to delay our 14th International Congress of Orthopterology (ICO) that was planned for 2022.

Similar delays have been made for other congresses, including, most importantly, the International Congress of Entomology (ICE) in Finland, which was originally scheduled for July 2020, then postponed until 2021, and now postponed again until 2022. This means that our 14th ICO, originally scheduled for late 2022 would be only a few months after ICE, and the last time this happened, in 2016 with the 12th ICO in Brazil, it was clear that some of our members were unable to find funds for both ICE and our event, so we had fewer people at the Brazil ICO than expected. The Board then made the decision to avoid ICE years by having our Congress every three years instead of four. Consequently, ICE moving to the same year as our Congress, combined with the uncertainties of the ongoing SARS-CoV-2 pandemic, led the Board to decide to delay the Congress until 2023. We hope this delay is sufficient because who knows when things will be back to normal.

SARS-CoV-2 has placed substantial difficulties on any international meeting. The substantial health issues caused by the associated disease, COVID-19, especially for older members, mean that holding international meetings will be extremely difficult until there is a dramatic decline in the number of cases. Vaccinations will be important, but there are still many uncertainties as to how effective they will actually be in reducing cases and how long such reductions will take. And because international air travel is much reduced currently, travel costs will most likely be much higher than normal in the immediate future. In addition, COVID-19 has placed severe limitations on the organisation of ICO in Paris, including organisers being unable to get definite commitments as to availability of venues, making congress organisation nearly impossible. Consequently, we are looking at the option of a smaller city venue, as we often have had in the past, which is likely to be much safer and easier to organise in the current situation: the Yucatán of Mexico had been offered as a potential venue for our 2025 congress, and organisers of that venue have indicated that it could be brought forward. Regardless, the delay will allow us to look carefully at what others have had to do in organising their congresses, allowing us to have as near normal a congress as possible. In this time of pandemic uncertainty, please stay tuned for updates on the timing and location of the next ICO!

Call for OSF Grant Applications

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The Orthopterists' Society, in cooperation with the Illinois Natural History Survey, provides funding for work in support of the Orthoptera Species File. Members of the Orthopterists' Society are invited to apply. Applications should be sent to María Marta Cigliano (cigliano@fcnym.unlp.edu.ar).

Grants are available for a project as defined by the applicant. The project must involve benefit to the Orthoptera Species File. The usual benefit is the addition of images (photographs of the habitus and diagnostic details of type specimens, other reliably identified museum specimens, living individuals in natural habitats), sound recordings, and/or geo-referenced specimen records. Any proposal that solely focuses on fieldwork or other systematic research without direct benefits to OSF will not be considered. Projects may be proposed for periods of one to three years.

Due to the Covid-19 situation, there has been a reduction in the funds available for grants. For 2021, $20,000 USD will be available. All the requested information must be submitted by February 28, 2021 to receive full consideration. The committee will complete its assessment and announce the results in March, 2021.

The proposals should include:

1. Project description (not more than five pages):
   - Title
   - Significance (highlighting the new data that will be added to OSF, preferably to taxa currently lacking images, sound recordings, distribution records, etc.)
   - Objectives, methods and activities
   - Timetable
2. If applicable, provide summary of the research project related to the proposal
3. Curriculum vitae
4. Budget (including justification of trips to museums, fieldwork, equipment, etc.)
5. If applicable, provide letter of agreement/acknowledgement to work with the collection from the corresponding institution/curator including permission to add the

images to OSF.

Proposals from graduate students should include a simple recommendation from their professor or advisor.

Preference will be given in relation to the amount of data added into OSF, i.e., the expected contribution to the considered taxa (dependent on already existing data). A detailed list of the species that are poorly illustrated in OSF and the data that is expected to be added as a result of the grant is highly recommended to be included in the proposal. Proposals involving images and sound recordings taken in the field will be funded depending on the "biogeographical value," i.e., surveys in undercollected areas will be preferred over similar activities in well-worked terrain. Preference will be also given to applicants who demonstrate knowledge of the taxa involved. The methods, e.g., techniques for capturing images, will be likewise considered in the evaluation. Also, priority will be given to applicants planning to document and photograph the types of Orthoptera species not yet documented by images in OSF, or who are planning to document the types from museums or other collections not easily accessible to researchers. Applications of curators for support of a qualified student to do this under their supervision will also be considered.

Important: A short financial and tasks report will be required from each grantee once the funding period is finished. The report should be in a format suitable for publication in *Metaleptea*.

If the candidate has received an OSF grant in a previous year, the tasks from the previous grant have to be finished and the report approved by the OSF Committee before applying for a new grant.

Current Status of the *Journal of Orthoptera Research*

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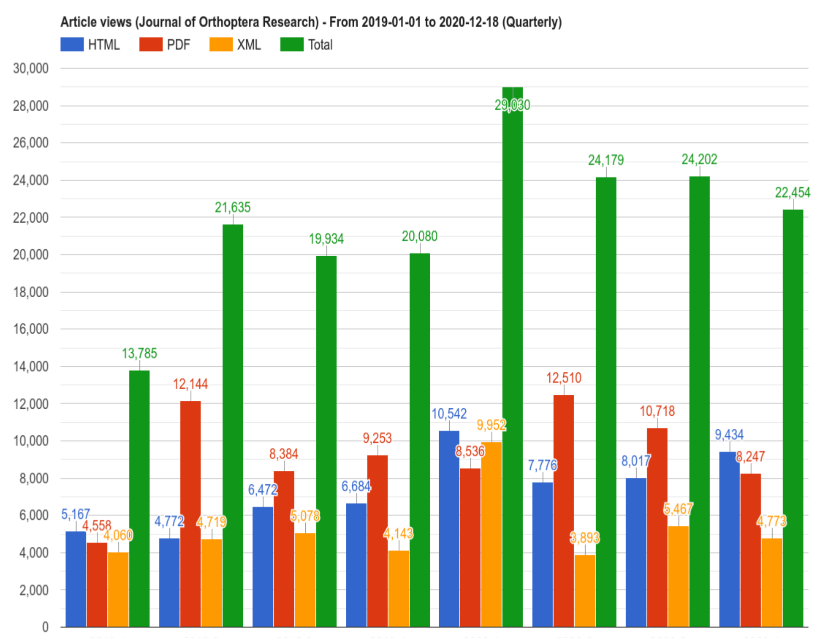
Dear orthopterist colleagues,

As announced in a previous issue of *Metaleptea* (Volume 40(2)), as of January 2021, I, Tony, am the new Managing Editor of the *Journal of Orthoptera Research* (JOR). After a short period of transition, during which Corey taught me the processes involved in being the *JOR* editor, I am now fully in charge. First of all, I want to thank the Orthopterists' Society for giving me this opportunity, and then Corey and the rest of the editorial team for the excellent work done to place the journal on the ascending slope it has recently taken. This is due to their continued efforts, to the support of the Orthopterists' Society, and to you, the authors, who entrust your manuscripts to JOR.

As a reminder, *JOR* is now complete open access on the Pensoft platform and articles are free of article processing charge for society members. This has led to a significant increase in citations of the articles and has given us more visibility outside of our community. Although we were expecting to receive the outcome of the Impact Factor evaluation during 2020, unexpected delays at Clarivate Analytics have delayed this process, so we continue to wait.

To end this transition period, Corey and I would like to share with you some interesting reports from Pensoft about JOR's stats over the past 2 years. Of particular interest:

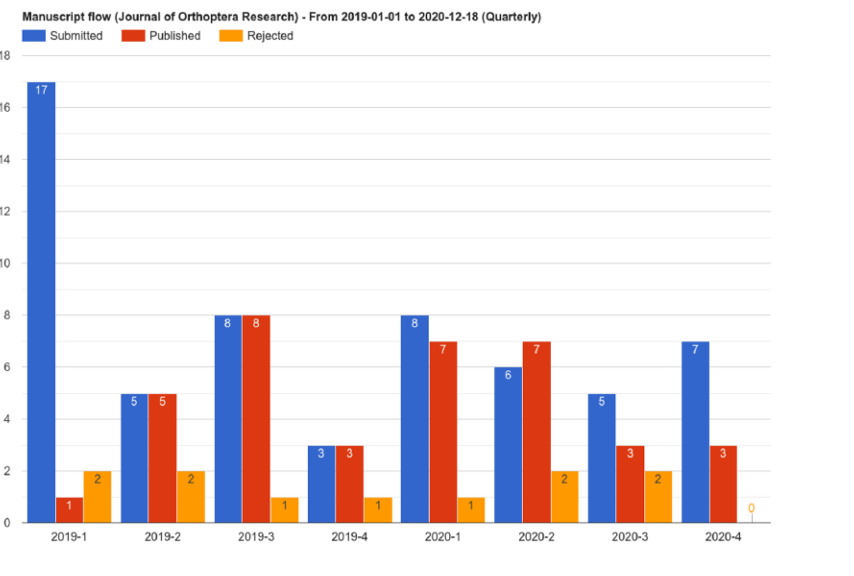
- The journal receives about 22,000 views on average per quarter. This

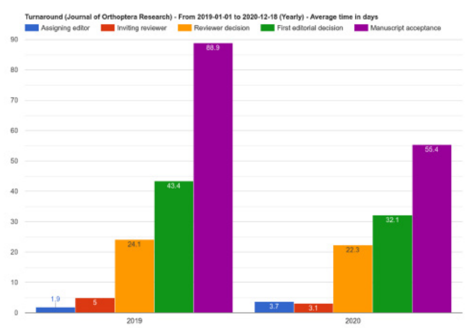


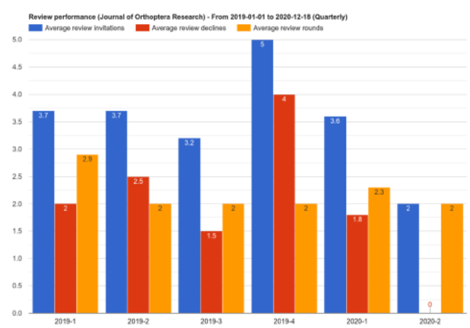
seems to have been higher during 2020 than it was in 2019, which may indicate that the move to Pensoft and open access was beneficial for journal accessibility to readers, as we had hoped.

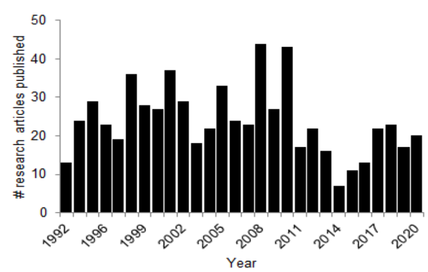
- The journal seems to receive about 7 new submissions per quarter. This is good but should be ameliorated.
- In 2020, it took about 2 months from manuscript submission to acceptance - down from 3 months in 2019.

Overall it shows that *JOR* is a stable, healthy, and dynamic journal, but that we also still need to receive more (good) submissions from the community. As an editor, I will do my best to continue on the same path in order to publish the best quality papers out of our research on these fascinating insects.









The Theodore J. Cohn Research Fund: A new call for applications for 2021

(Application Deadline: March 31, 2021)

By MICHEL LECOQ
Chair, Theodore J. Cohn Research Fund Committee
mlecoq34@gmail.com

This research grant is primarily to fund research projects in Orthoptera (*sensu lato*) by young researchers often as part of a Master's or Ph.D., though Postdoctorates may also be funded. A total amount of $15K per year is available and it is possible to fund research grants for up to $1,500 per grantee.

Full detailed information can be found on the Orthopterists' Society website, on the "Grants & Awards" page: http://orthsoc.org/resources/grants-awards/the-theodore-j-cohn-research-fund/

As usual, proposals should be submitted at the following address: Michel Lecoq, Manager, The Ted Cohn Research Fund
e-mail: mlecoq34@gmail.com

Regional Reports - What's happening around the world?

North, Sahelian, & West Africa

By AMINA IDRISSI
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Regarding the news from Agadir in Morocco, Mathias Kayalto defended his PhD thesis on September 19, 2020 concerning the delimitation and characterization of the biotopes of the desert locust breeding and gregarization areas in Chad (see abstract below). This thesis was funded by the CLCPRO and supervised by Dr. Cyril Piou (CBGP Cirad Montpellier) and Pr. Mina Idrissi Hassani (IBN ZOHR Agadir University). Due to difficulties in traveling these days, it was presented with part of the jury being online, including Dr. Piou, Dr. Lecoq, and Dr. Lemine of the CLCPRO. The nominee received the highest honor and congratulations from the jury.

Regarding the locust situation in Morocco, according to the National Locust Control Center, no threat of an invasion has been reported.

General Thesis Abstract

Despite the many improvements in the preventive control system; the use of new techniques and technologies (GPS, elocust, remote sensing etc.) allowing the management of locust crises, upsurges and invasions through resurgences continue to threaten the livelihoods of more than 1.5 billion people.

The work of this thesis aims to study, map and characterize the biotopes of the breeding and gregarization areas of the desert locust in its environment in Chad. We evaluated the spatial distribution of the desert locust and the factors (biological or geomorphological) which are likely to influence the ecological potential of the desert locust and constitute a risk of gregarization.

First, we studied and mapped desert locust distribution in Chad based on 7,014 reports of survey teams for a period of more than 38 years. A spatial smoothing method calculating the density of observations has identified three geographic areas (Kanem/Lake Chad, Batha, and Ennedi) which are added to the Tibesti area (old) as new breeding and gregarization areas.

Second, we proceeded to the floristic characterization of the reproduction and gregarization biotopes on the basis of 186 floristic surveys including 112 plant species. The operational objective of this study was to improve knowledge of the nature and distribution of vegetation in the breeding and gregarization areas of the desert locust. Multivariate statistical methods were applied: Principal Component Analysis (PCA), Hill & Smith Analysis, and Co-inertia. The results of these analyzes have highlighted five groups of plant species of importance for the desert locust. These species groups can help in identifying favorable habitats during surveys.

Third, we evaluated whether the geomorphological variables of the terrain could be related to the risks of desert locust gregarization. A total of 128 sites corresponding to 1,555 sampled points were analyzed. The results revealed that two geomorphological variables (soil texture and facies) significantly influence the gregarogenic range of the desert locust.

This thesis, which is the first of its kind in Chad and the western region of Africa, is of capital importance for the preventive management of upsurges and invasions. The results can be used by surveyors to easily identify plant species of major importance whose presence in the environment is an indicator of the probability of observing the desert locust. The results also highlight the variability of geomorphological and granulometric indicators within a gregarogenic site. The ambition of all this data and these findings is to improve the strategy of preventive control.

Keywords: floristic and geomorphological characterization, cartography, biotopes, gregarogenous areas, desert locust, spatial smoothing, PCA, Hill & Smith, Co-inertia, Logistic regression.

Theodore J. Cohn Research Grant Reports

The kool katydid: acoustic response of a South African-endemic bush cricket, *Thoracistus thyraeus*, to a transformed landscape

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Bush crickets, or katydids, (Orthoptera: Tettigoniidae) are the most speciose orthopteran family and, for many an Orthoptera enthusiast, are arguably the most charismatic orthopteran group. Like most Orthoptera, male bush crickets have a lot to say through production of species-specific songs, while also stimulating curious humans to tune into the fascinating world of bush cricket sound transmission.

Species-specific calls are essential for mate attraction in bush crickets. But if the calls are interrupted or altered in any way, female bush crickets are unable to locate potential mates. Both biotic and abiotic factors can alter the calls of bush crickets. Acoustic competition between species can cause one species to alter its calls as a direct result of interspecific competition. When calling in close proximity to one another, calls of the European bush cricket, *Platycleis intermedia,* are either completely inhibited by calls of *P. affinis* and *P. falx,* or *P. intermedia* is forced to produce corrupted chirps following acoustic inhibition [1].

Physical barriers within the landscape also interact with and attenuate songs as they are propagated across the landscape [2]. Higher frequencies more-so than lower frequencies, so, as well as competing with each other, bush crickets have to overcome barriers to communication within the landscape itself. *Tettigonia viridissima* has been used to illustrate the tradeoffs between call propagation and an individual's predation risk. When calling from atop vegetation (>1 m), calls travel farther, potentially reaching more females, yet the individual is more exposed, so the greater the likelihood of it becoming someone else's supper increases. To avoid predators, males may call from inside clumps of vegetation, but here calls are highly attenuated and instead of carrying tens of meters the calls propagate over only a few meters, reaching fewer potential mates [3].

South Africa is a mega-diverse country and home to three global biodiversity hotspots. The country has a diverse array of bush cricket species, two thirds of which are thought to be national endemics [4], largely associated with these biodiversity hotspots [5]. All members of the genus *Thoracistus* are endemic to South Africa, occurring in grasslands and some disturbed habitats. *Thoracistus thyraeus* (Figure 1), the inflated seedpod shieldback (affectionately known as the kool katydid) is the most charismatic of all and a distinctive member of this genus. The pronotum forms a large extension that covers its abdomen and aids in the amplification of its characteristic call [6].

Historically, *T. thyraeus* was known from only three localities and thought to be restricted to grasslands and pasturelands. Beyond this, not much is known about the species or what drives its distribution in a landscape. The species is currently red-listed as Endangered [7], but during fieldwork in KwaZulu-Natal, I found the species to be widely distributed in a transformed landscape mosaic consisting of natural grasslands, indigenous forests, and exotic *Eucalyptus* plantations (Figures 2 and 3). Since plantation forestry was highlighted as a threat to *T. thyraeus*, I became interested in trying to determine where exactly in this landscape *T. thyraeus* could be found and how it, and other bush cricket species, are able to maintain effective communication in this transformed landscape mosaic. To do this, over the course of three months, I recorded the nocturnal bush cricket soundscape at sixty sites distributed across a variety of biotope types – indigenous forests, grasslands, mature and young *Eucalyptus* plantations, and the ecotones between them. Five-minute recordings were made at 19h00, 21h00, 23h00, 01h00, 03h00 and 05h00 for four consecutive nights at every site.

Figure 1. *Thoracistus thyraeus* (Photograph property of Dr. Claudia Hemp and used with permission)

From these recordings, 11 bush cricket species were identified, which was surprisingly low, as the study site was located in the Maputaland-Pondoland-Albany hotspot. Even so, I recorded almost 90,000 bush cricket calls and choruses, making the night air full of song. I found *T. thyraeus* to be present at 41 out of the sixty sampled sites, and it occurred in all the sampled biotopes, both natural and transformed. *Thoracistus thyraeus* is the most widely distributed species in the landscape, as no other species was found in all seven biotopes.

The natural forest-grassland ecotone appears to be the firm favorite for the species (Figure 4), as the total call time of *T. thyraeus* in this biotope is significantly higher here than in any other sampled biotope. As the natural ecotones are characterized by increasing woody vegetation, as one moves from the grasslands to the indigenous forest, this increasing habitat complexity likely provides a wide variety of resources for *T. thyraeus*, allowing for a higher number of individuals to cohabit in this natural ecotone. With more individuals, more males will be calling, resulting in the higher call times observed. Since I recorded *T. thyraeus* in the *Eucalyptus* plantations, and past observations of the species have shown it to prefer weedy roadside verges, this species is likely not a habitat specialist, but rather a generalist species that responds to the amount of woody vegetation present, and not to plant species composition. As singing populations of *T. thyraeus* are well-maintained across this transformed landscape, it is likely that its

Figure 2. A view of the sampled landscape showing a patch of indigenous forest in the foreground and exotic *Eucalyptus* plantations and indigenous grasslands in the distance.

Figure 3. An additional view of the landscape showing conservation corridors composed of remnant grasslands among Eucalyptus plantations.

current Red List assessment [7] is overly cautious.

Of the 11 bush crickets identified in the landscape, I found *T. thyraeus* to sympatric with eight of the 11identified species. Of these eight species, I selected the four most abundant species after *T. thyraeus* in the landscape when they were present at more than 8 sites. These species belonged to *Plangia, Ruspolia*, and *Conocephalus*, as well as another member of the *Thoracistus* genus, *T. viridifer*. I compared the central frequencies of the calls and the presence of these species to those of *T. thyraeus* to determine whether inter-specific competition exists between these species and *T. thyraeus*. Surprisingly, there appears to be no direct acoustic competition between these species and *T. thyraeus*, as the species' calls all have different central frequencies, allowing for simultaneous calling with *T. thyraeus*, without any species' calls interfering or masking each other (Figure 5). Each species appears to occupy a distinct acoustic niche [8]. Although the *Conocephalus* and *Plangia* species here were found to occupy the same central frequency band, their call structure differed significantly, allowing *Plangia* to produce its short chirps in-between the long choruses of *Conocephalus*.

Species biotope preference also plays a role in limiting the competition between the bush crickets identified in this landscape. I found some species to prefer the more open habitats, such as grasslands (*T. viridifer*), while others preferred the woodier environments (*Plangia* sp.1 and *Conocephalus* sp.1). By existing in separate biotopes, the species are seldom in direct contact, or in acoustic competition, with each other.

It is remarkable that the bush cricket assemblage is able to maintain acoustic integrity in this transformed landscape. The natural areas within this landscape are invaluable for the conservation of the natural bush cricket assemblage, yet the bush cricket assemblage, and especially *T. thyraeus*, are resilient enough to persist within this human-modified landscape. *Thoracistus thyraeus* truly is a kool katydid.

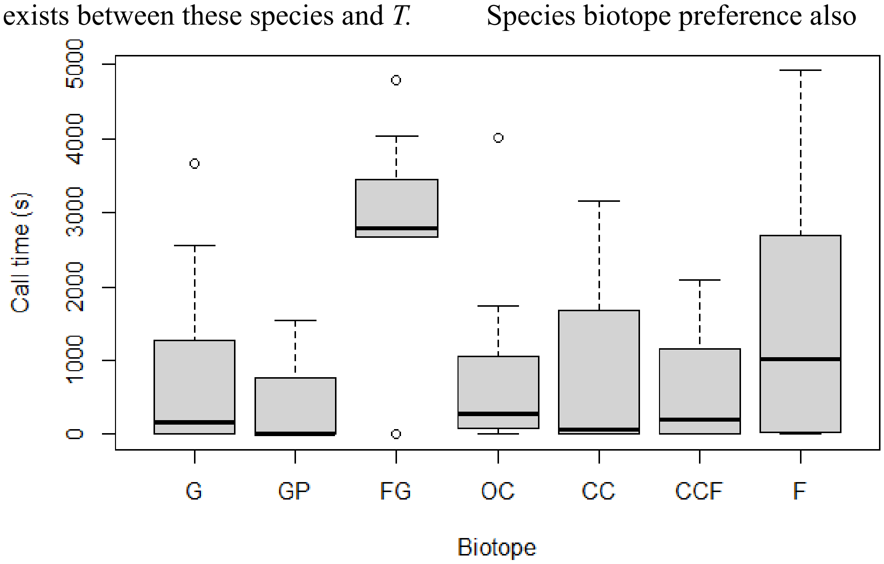

Figure 4. Call times of *Thoracistus thyraeus* in the seven sampled biotopes. The greatest activity of the species was found in the forest-grassland ecotones. (Abbreviations used- G: Grassland, GP: Grassland-plantation ecotone, FG: Forest grassland ecotone, OC: Open canopy/immature plantations, CC: Closed canopy/mature plantations, CCF: Indigenous forest-closed canopy plantations ecotone, F: Indigenous forests).

Acknowledgments

Thanks indeed to the Orthopterists' Society for providing funding for this study through the Theodore J. Cohn Research Fund. Funding for this study and for my PhD was also provided by Mondi Group.

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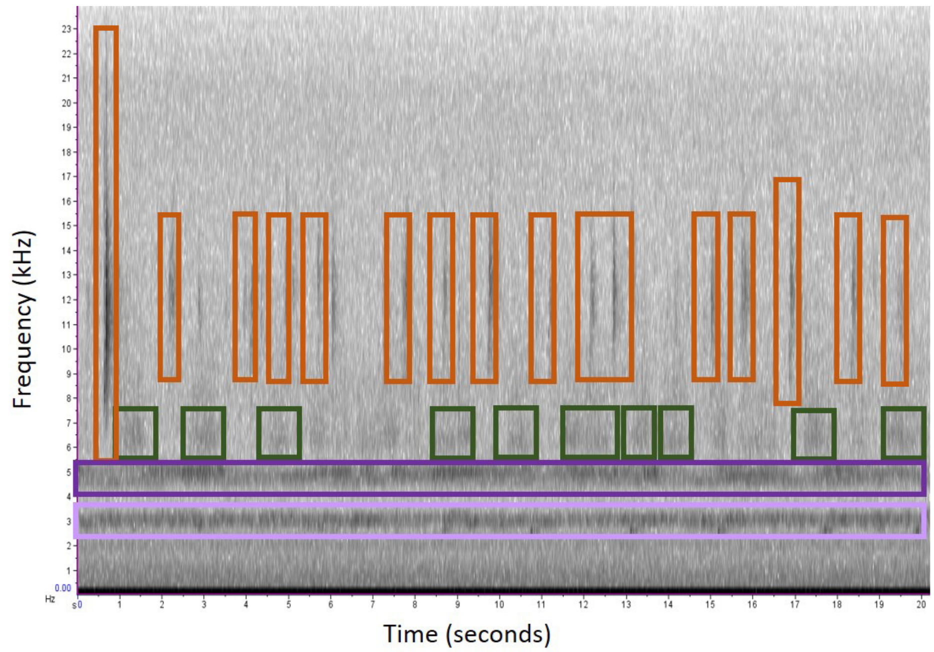

Figure 5. Spectrogram of a simple soundscape, highlighting how the species call at different frequencies to avoid acoustic competition with each other. Green squares show *Thorasistus thyraeus* calls, orange squares show *Plangia* sp. 1 calls, and the two purple boxes show cricket choruses, which were not analysed here.

Oh, you shouldn't have: investigating the role of nuptial gift proteins in decorated cricket sexual conflict

By IAN RINES
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Although sexual reproduction is inherently cooperative, it is frequently beset with conflicts of interest between the sexes (Arnqvist and Rowe 2005). Conflicts over female mating frequency and the paternity of a female's offspring are common: a male's interests are best served when a female utilizes only his sperm to fertilize her eggs, whereas females often benefit by seeking further matings with different males (Arnqvist and Rowe 2005). This disagreement between the sexes favors male adaptations to protect their paternity, such as mate guarding and ejaculatory substances that serve to decrease female remating. Female counter-adaptations to regain control of mating can lead to an arms race known as sexually antagonistic coevolution (Arnqvist and Rowe 2005).

Male manipulation of female remating frequency can be detrimental to female fitness. This has been well-documented in *Drosophila*, where male accessory gland proteins are known to decrease female lifespan and sexual receptivity, while increasing egg-laying (Chapman et al. 1995; Wolfner 2002). In some insect species, the sexual conflict between males and females may be further mediated via the provisioning of nuptial food gifts by males (Lewis et al. 2014). These food items, given by males to females at mating, function primarily to increase sperm transfer (Lewis et al. 2014), but they may further manipulate female physiology and behavior to the benefit of the gift-giving male.

Figure 1. A male decorated cricket (bottom) attaching his spermatophore to a female (top). Photograph by D. Funk.

In decorated crickets, *Gryllodes sigillatus,* the food gift consumed by females is known as the spermatophylax, a gelatinous mass forming part of the male's spermatophore that is transferred to females at mating (Sakaluk 1984; Sakaluk et al. 2006) (Figure 1). Feeding on the spermato-

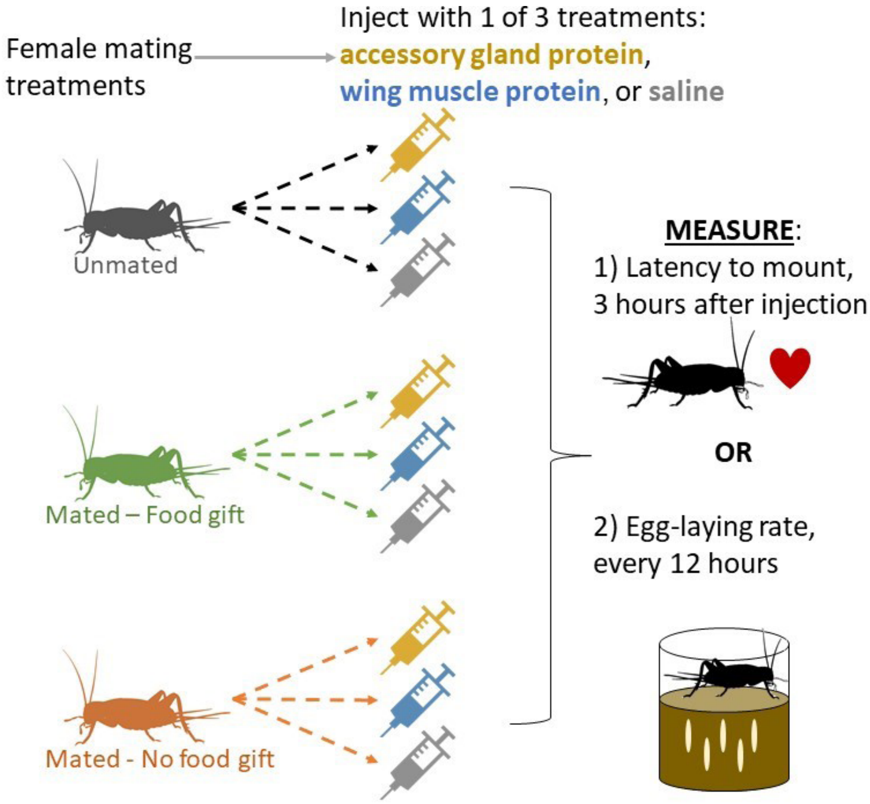

Figure 2. Experimental design showing female mating and injection treatments.

phylax prevents the female from removing the sperm-containing portion of the spermatophore (ampulla) and terminating sperm transfer, thus enticing females into relinquishing some control over insemination (Sakaluk et al. 2006). Interestingly, consumption of decorated cricket food gifts decreases sexual receptivity in females of a non-gift-giving cricket species (*Acheta domesticus)* (Sakaluk et al. 2006), demonstrating the potential for males to manipulate females via spermatophylax compounds. A recent study of the decorated cricket spermatophylax revealed the presence of 30 different proteins, the majority of which are encoded by genes expressed in the male accessory glands (Pauchet et al. 2015). Unsurprisingly, for proteins involved in a potential arms race between males and females, most of those identified were not similar to any proteins of known biological function. However, where putative functions could be ascribed, the assignments hint at functions to protect other active components from digestion and the physiological manipulation of females (Pauchet et al. 2015).

As a first step in a series of experiments designed to uncover the role of spermatophylax proteins in mediating the sexual conflict between male and female decorated crickets, we tested the hypothesis that accessory gland proteins mediate female remating and egg laying rate. To avoid potential confounding effects of differential female consumption of gifts and digestion, females were injected with a solution of accessory gland proteins or, to control for the injection of protein or an injection *per se*, with a solution of stridulatory muscle protein or a saline solution (Figure 2). We also varied female mating status, using unmated females, females mated normally and allowed to consume the food gift, or females mated but experimentally prevented from consuming the gift. We predicted that with increased receipt of accessory gland proteins by females, either through injection, prior mating, or both, the less likely they would be to engage in future mating and the more eggs they would lay.

We did not find that accessory gland extract injection influenced the subsequent mating behavior of female decorated crickets. However, previously mated females took longer to mount a subsequent courting male compared with unmated females. Surprisingly, females that had previously mated, but were prevented from consuming the food gift, fed on the spermatophylax for a longer time after remating than previously unmated females did. As time spent feeding on the food gift is tightly correlated with sperm transfer, this would lead to these females receiving more sperm. Previously mated females that were allowed to normally consume the food gift did not differ from previously unmated females in their subsequent gift consumption. Additionally, neither injection, nor mating treatment, affected subsequent egg laying by females.

The effect of mating treatment suggests that female behavior is altered by mating experience. The receipt of accessory gland proteins may account for this, but we found no effect of injection of accessory gland proteins. The lack of a direct effect could be due to an inadequate injection dosage or the unnatural route of administration by injection. In light of these results, the role of accessory gland proteins on female remating behavior remains unclear. Regardless, the effect of prior mating on latency of females to remate could be beneficial to males, potentially reducing competition with future males by decreasing the receptivity of females to remate. It is possible that females themselves could be directly responding to mating, but the fitness benefits that would be gained by mating with multiple males (Ivy & Sakaluk 2005) suggests that females should not delay future matings. In addition, effects of mating treatment on food gift consumption and, thus, sperm transfer time, suggests that food gift consumption influences female re-mating behavior. The direction of this effect of prior food gift consumption would be to reduce sperm transfer in subsequent matings, which would align with the interests of the first-mating male.

Overall, this study contributes to our understanding of the effects of mating on female behavior and sets the stage for further work on mechanisms of sexual conflict, specifically compounds that are transferred from males to females at mating.

Acknowledgments
We graciously thank the Orthopterists' Society's Theodore J. Cohn Research Fund for supporting this research. Thanks also to Audrey Harrod for help with counting eggs and measuring females. This work was done in collaboration with my co-advisors, Drs. Ben Sadd and Scott Sakaluk at Illinois State University.

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Integrative taxonomic revision of the tribe Bryodemini Bey-Bienko, 1930 (Orthoptera: Acrididae: Oedipodinae)

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In 1773, Pallas first described the grasshopper species *Gryllus (Locusta) barabensis,* a relatively large species with colorful wings, a robust body and a buzzing flight, from his journeys through the Russian counties (Pallas, 1773). Shortly after, Fabricius (1775) described *Gryllus tuberculatus,* the only central and northern European species of the tribe from Sweden. This represented the starting point for the establishment of a whole tribe, the Bryodemini Bey-Bienko, 1930 (Acrididae: Oedipodinae). Several additional species distributed in the steppe habitats, mountains, and semi-deserts from India to Russia, were subsequently discovered and described, especially by several Russian and Chinese entomologists. Today, the tribe comprises 7 genera and more than 44 species with a distribution hotspot in North Asia (Siberia and Mongolia). The tribe is quite diverse in color patterns (Fig. 1), but most taxa share several morphological features, e.g., the colorful hindwings are shorter than the elytra, and all species have a rather slender but robust body shape. Additionally, the pronotum is cut by two or three transversal sulci and the internal carina of the posterior tibiae are not greatly unequal (Bey-Bienko, 1930).

While the tribe has long been neglected taxonomically, it has received more attention in recent years; e.g., the genus *Angaracris* was revised by Storozhenko et al. in 2017. Based on morphological investigations of more than 1,000 specimens of the genus, Storozhenko et al. (2017) synonymized all valid, described species of the genus *Angaracris* with *Angaracris barabensis* (Pallas, 1773) and considered all variation in the genus to be intraspecific (Storozhenko et al. 2017). This study indicated the complex relationships that can be found in the tribe and, hence, the necessity of a revision of the whole tribe.

Therefore, in our study, we used integrative taxonomic and phylogenetic methods to understand the systematics of the species-rich Bryodemini gen-

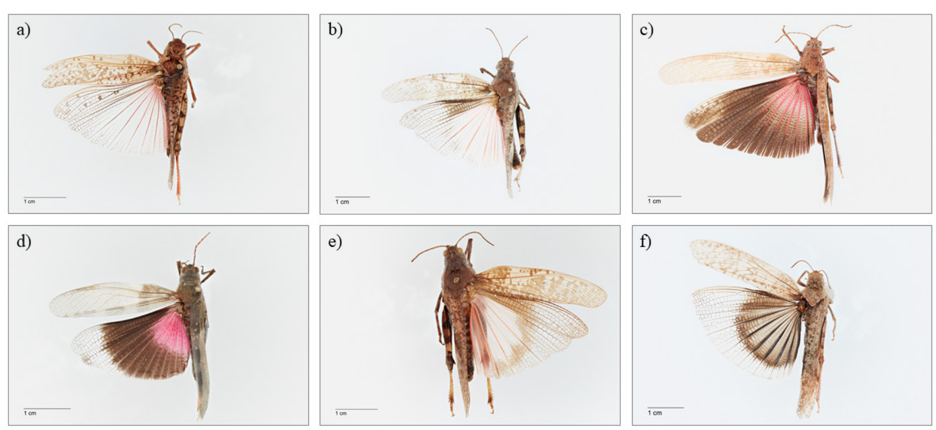

Figure 1. Dorsal view of six Bryodemini species from Mongolia: a) *Angaracris barabensis* (Pallas, 1773); b) *Bryodemella holdereri* (Kraus, 1901); c) *Bryodema gebleri* (Fischer von Waldheim, 1836); d) *Compsorhipis bryodemoides* Bey-Bienko, 1932; e) *Bryodemella tuberculata* (Fabricius, 1775); f) *Bryodema luctuosum* (Stoll, 1813).

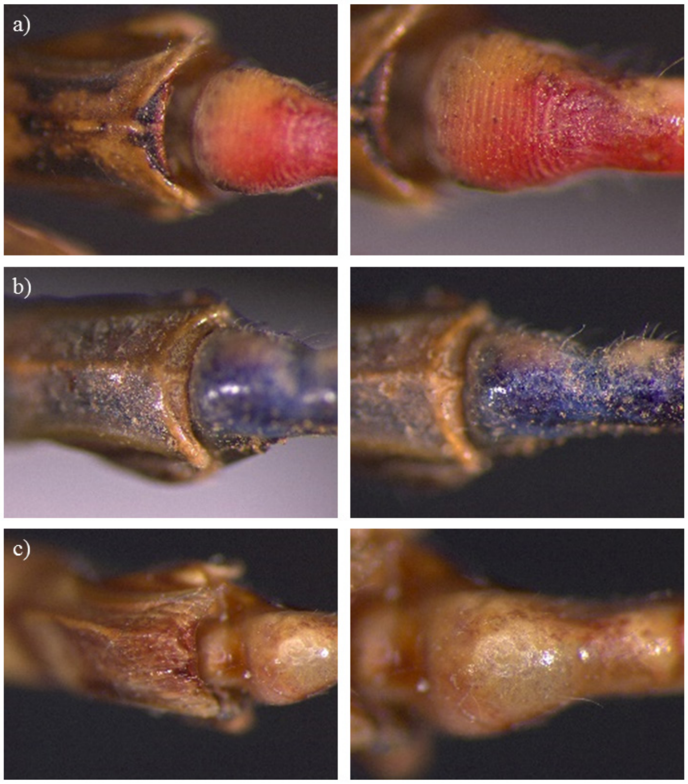

Figure 2. Hind femur and hind tibia structures of a) *Angaracris* (base of hind tibia dorsally with shallow transverse furrows), b) *Bryodema* (base of hind tibia dorsally smooth or weakly pointed) and c) *Bryodemella* (hind femur in dorsal view with longitudinal furrows).

era: *Angaracris* Bey-Bienko, 1930, *Bryodema* Fieber, 1853, *Bryodemella* Yin, 1982, and *Compsorhipis* Saussure, 1889. Three of these genera are the easiest to distinguish: *Angaracris* is characterized by shallow transverse furrows at the dorsal part of the hind tibia; *Bryodema*, in contrast, has a smooth or weakly pointed dorsal part of the hind tibia, whereas *Bryodemella* has longitudinal furrows in the dorsal part of the femur (Storozhenko et al. 2017; Fig. 2). In contrast to the three aforementioned genera, *Compsorhipis* has a smoother body surface with dense long hairs and lacks thickened hind wing venation. All genera share similar distributions and ecological requirements. The identification of species within these genera is much more complicated because good identification keys with clear characteristics are lacking.

We performed morphological and molecular analysis of the four genera using classic molecular methods (single gene, multi gene, mitogenomes). Our first results show that the four genera are readily distinguishable morphologically by combinations of their hind wing, hind femora, and hind tibia structure (Fig. 2). Identification at genus level was done using the traits described by Bey-Bienko (1930) and Storozhenko et al. (2017). Unfortunately, identification at species level was not as clear, as diagnostic characters are overlapping between species. However, we were able to identify most specimens used in this study, but our analyses revealed synonymy of subspecies of *Bryodema gebleri* (Fischer von Waldheim, 1836) and showed large similarity between *Bryodemella tuberculata* and *Bryodemella holdereri* (Krauss, 1901) (Dey et al. In press).

Based on our morphological identification, we used DNA barcoding as a first attempt to molecularly distinguish species of the tribe. Although the species and genera we included in the study were morphologically clearly identifiable, no resolution was obtained by using barcoding sequences. All species, and even genera, of the tribe were admixed throughout the tree (Fig. 3). Similarly, the use of multiple genes (COI, H3, 12S) did not improve the tree's resolution. Hence, we sequenced entire mitochondrial genomes of several species belonging to the four target genera. We used next generation sequencing and assembled the short reads into full mitochondrial sequences. All species share a relatively similar mitochondrial genome size of around 16,000 bp. The phylogenetic analyses based on these sequences are still ongoing. However, preliminary results, as well as those of another study, already suggest that the genera cannot be resolved even based on whole mitogenomes (Chang et al. 2020).

As single- and multigene, as well as whole mitogenome data did not resolve the phylogenetic relationships, we decided to employ a large number random genomic markers generated with next-generation sequencing (ddRAD) and target capture methods. This data is not available yet, but we hope that such massive data will be able to distinguish all taxa and hence can solve the mystery of the tribe.

Acknowledgements

We thank the Orthopterists' society for financial support by the Theodore J. Cohn Research Fund, Heinrich-Böll-Stiftung, DAAD, DFG, and Hamburg University. Moreover, we thank the German-Mongolian expeditions for the possibility to obtain samples from many locations in Mongolia. All sampling was performed under government permit #200008 (02.01.2020). We would also like to thank S.-Q. Xu and M. Sergeev for providing us material from Asia and fruitful discussions.

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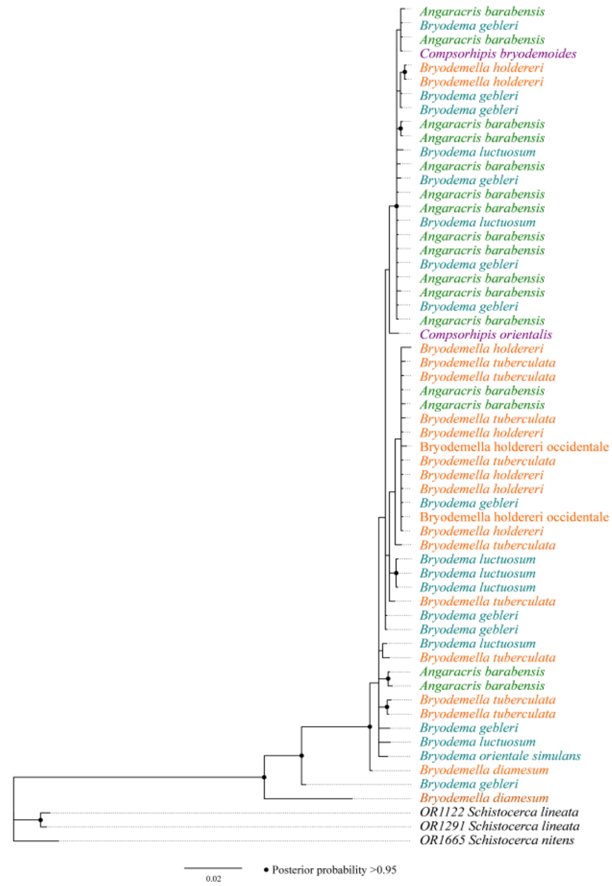

Figure 3. Phylogenetic tree based on the barcoding gene (COI, Cytochrome Oxidase I) showing the relationships between the genera of the tribe Bryodemini and some outgroup species. The Bayesian Inference tree was calculated with MrBayes for 100,000,000 generations. Posterior probability scores higher than 0.95 are shown as dots at nodes. Colors highlight the different genera (green = *Angaracris*; blue = *Bryodema*; orange = *Bryodemella,* purple = *Compsorhipis,* black = outgroup).

Egg morphology among the genus *Pseudosermyle* Caudell, 1903 (Phasmatodea)

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Stick insects (Phasmatodea) are a fascinating order of orthopteoids that exhibit crypsis, meaning they look like twigs or leaves. They have carried crypsis to every level of their life cycle, with eggs resembling plant seeds. Also, they are among the largest insects in the world, having the longest insect: *Sadyattes chani*.

Therefore, stick insect eggs are usually big and exhibit great variability in shape. In 1871, Kaup proposed the hypothesis that eggs are a very important feature in the taxonomy of Phasmatodea. Von Brunn (1898) ascribed to Brunner the following sentence about phasmid's eggs "für die Genera charakteristisch ist" meaning "it is characteristic of the genera."

Unfortunately, in Mexico, phasmids have been very poorly studied due to the difficulty of being collected because of crypsis and nocturnal habits. During my bachelor's degree, I was able to find them on nocturnal hikes during many field expeditions. But most of the time, I was only able to collect one or two per hike due to my untrained eye back then.

Caudell (1903) described *Pseudosermyle* from some USA southern species, and then other authors included several more species, resulting in a wide distribution from the southern USA to Central America. This is why I initially determined that the stick insects I collected in many Mexican states were *Pseudosermyle*, suggesting the genus is one of the most common in the country. However, the eggs and genitalia looked a little different among them, so I decided to figure out what *Pseudosermyle* eggs look like in detail.

In the past, I have been able to undertake some expeditions across central Mexico to collect stick insects, which includes the states of Oaxaca, Puebla, and Mexico, plus Mexico city. With the Theodore J. Cohn Research Fund, I was able to visit many other states, such as Veracruz, Jalisco, Guanajuato, and Morelos (Fig. 1). In total, I was able to collect 12 different *Pseudosermyle* species: *P.* aff. *tridens, P. carinulata, P.* aff. *striatus, P. phalangiphora, P. procera*, and seven new species (Figs. 2-4). To obtain the eggs I kept all the stick insects alive in separate cages with healthy conditions, and then waited for eggs to be laid. During this time, I hypothesized which males match up with which females because they exhibit sexual dimorphism. Fortunately, sometimes I found them mating in the feld, so the matching was easier, other times they began mating when they were in cages. After I incubated the eggs, I then bred nymphs to get adults. In this way, I completed the life cycle for all 12 species and compared the morphology of all reared and wild specimens, and found them to be similar. Therefore, I was able to associate males, females, and eggs for every species.

We noticed that each species has a unique egg shape (Fig. 5). Furthermore, there appear to be three different oviposition techniques: drop, glued, and ootheca-like (Fig. 6). I measured 255 eggs (about 11 eggs per female and a total of 22 females) using the basic measurements of each egg structure: capsule length (L), width (W), height (H); micropylar plate length (mpl), width (mpw), and operculum length (opl) and height (oph) (Sellick, 1997). With these measurements, we performed a principal component analysis (PCA) and found four groups (Fig. 7) corresponding with the genital morphology of males and females, as well as a general pattern among the eggs. The first three components explained 96.76% of the observed variance (Fig 8 A). The vari-

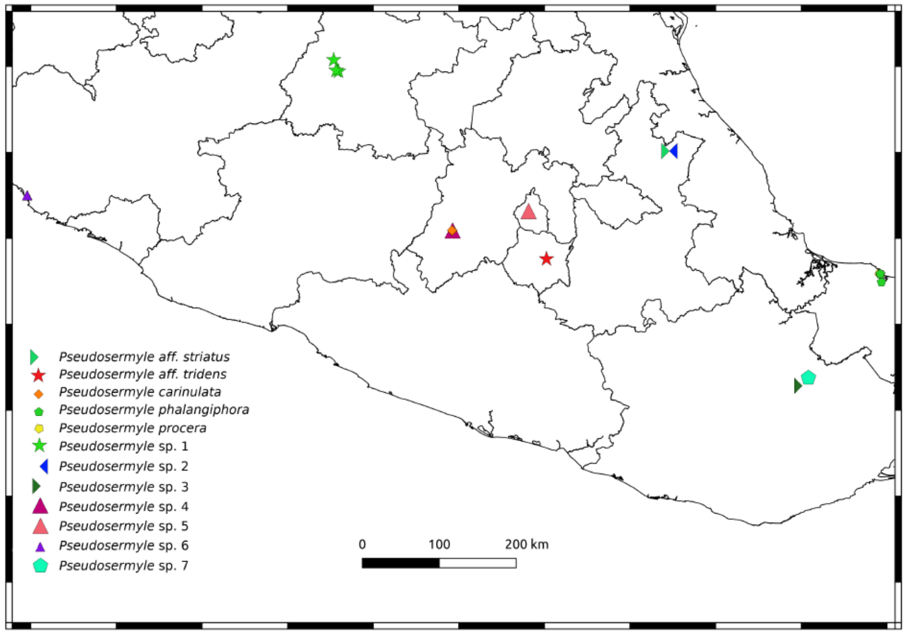

Figure 1. Map of sampled localities of *Pseudosermyle* spp.

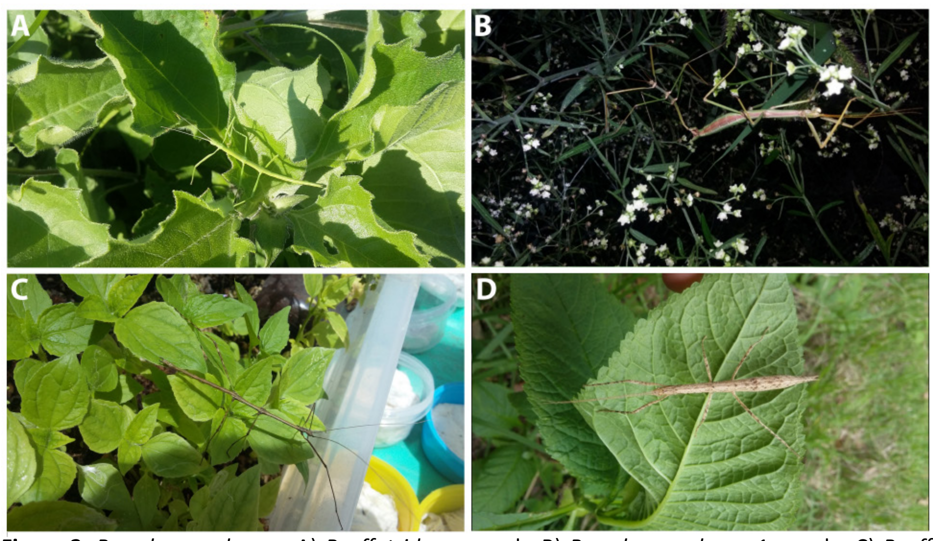

Figure 2. *Pseudosermyle* spp. A) *P. aff. tridens* nymph; B) *Pseudosermyle* sp. 1 couple; C) *P. aff. striatus* male; D) *P. aff. carinulata* female.

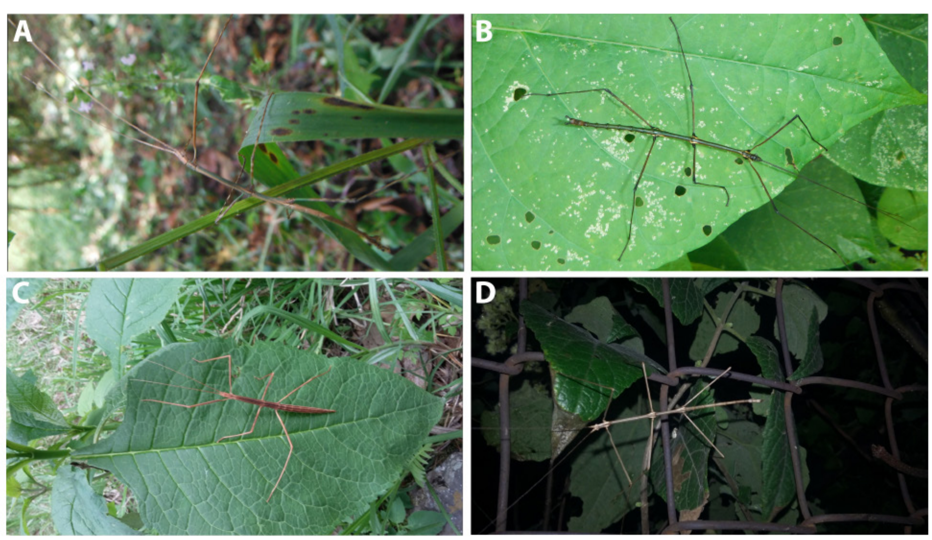

Figure 3. *Pseudosermyle* spp. A) *Pseudosermyle* sp. 2 male; B) *Pseudosermyle* sp. 3 male; C) *Pseudosermyle* sp. 4 female; D) *Pseudosermyle* sp. 5 male.

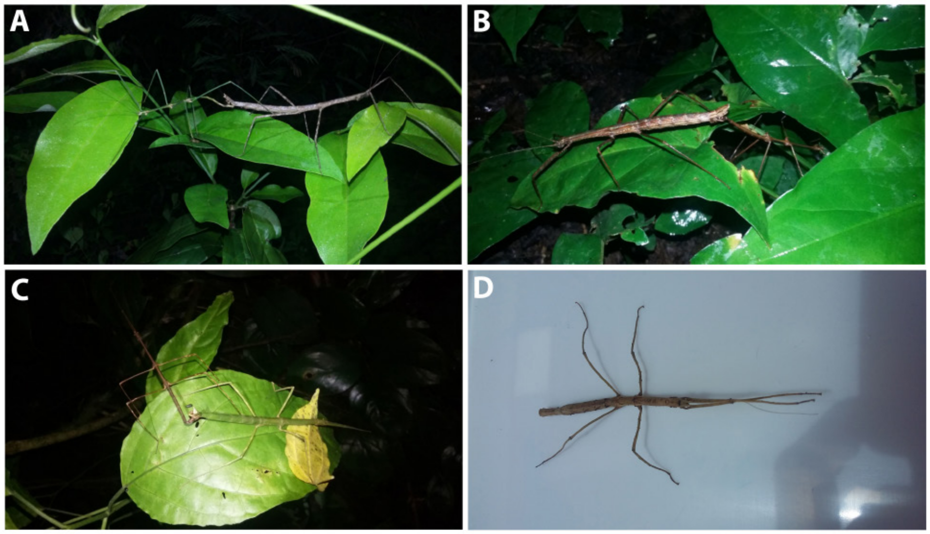

Figure 4. *Pseudosermyle* spp. A) *Pseudosermyle* sp. 6 couple; B) *P. phalangiphora* couple; C) *P. procera* couple; D) *Pseudosermyle* sp. 7 female.

ables with the biggest contributions towards each component were L, mpl, and oph for components 1, 2, and 3 respectively (Fig 8 B-C).

In conclusion, we found that *Pseudosermyle* seems to actually be divided into at least four genera based on egg morphology, male and female morphology, and oviposition technique. Also, each egg structure (capsule, micropylar plate and operculum) gave us much information about the egg pattern. To propose a proper division of *Pseudosermyle* we must work next on a phylogeny-based approach, using morphological features and genes, such as COI, COII, as well as including more already-described species beyond the five found here. And last, but not least, this project was a great reminder that field expeditions are always the best way to find new species and to clarify many taxonomic troubles within taxa.

Acknowledgments

To the Orthopterists' Society for financial support to conduct my field expedition trip to Veracruz, Jalisco, Morelos, and Guanajuato through the Theodore J. Cohn Research Fund. To CONACYT for the scholarship (CVU, 599426, No. becario: 628666, No. apoyo: 477560) that provided materials and tools used in the trips. To DGAPA PAPIIT IN202415 for the trip to Oaxaca. To SEREPSA for the 462 project to collect in REPSA, Mexico City. To EBTLT and EBCH, IB, UNAM

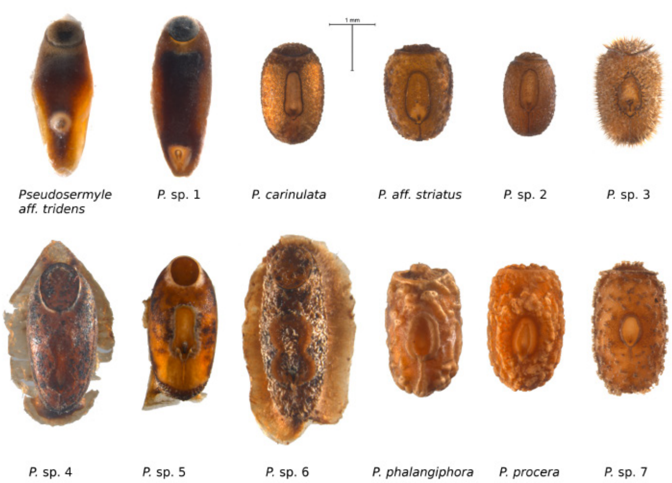

Figure 5. Eggs of the 12 species of *Pseudosermyle.*

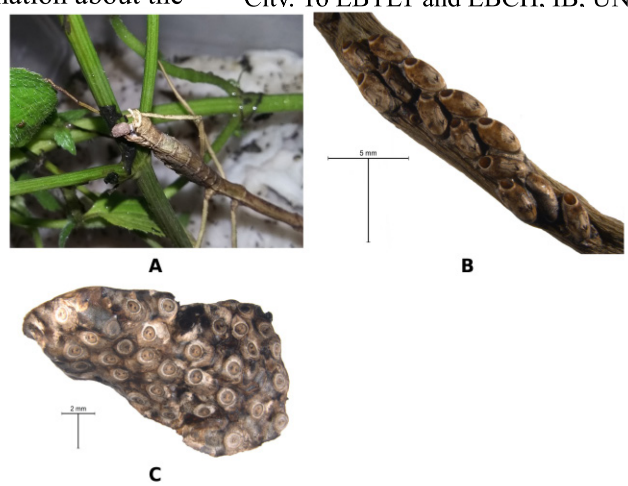

Figure 6. Oviposition techniques among *Pseudosermyle,* A) drop *Pseudosermyle* sp. 7; B) glued *Pseudosermyle* sp. 5; and C) ootheca-like *P. aff. tridens*.

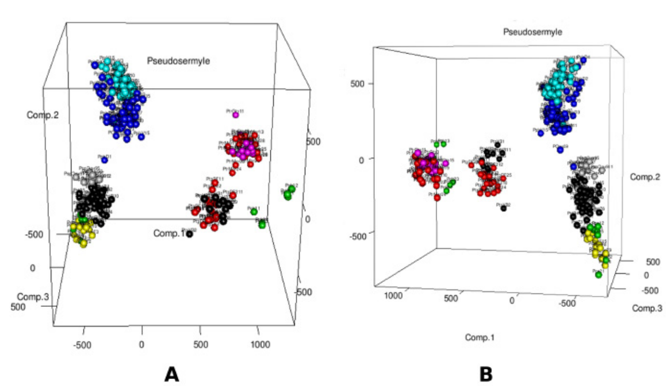

Figure 7. 3D graphic of PCA with 96.76% of explained variance represented; A) axis X rotated; B) axis Y rotated.

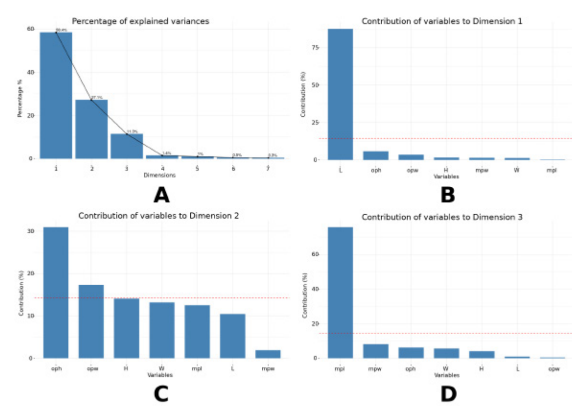

Figure 8. Graphics of PCA: A) percentage of explained variance; B) contribution of variables to dimension 1; C) contribution of variables to dimension 2; D) contribution of variables to dimension 3.

for facilities and access to the biological stations. To Dr. Jorge Enrique Llorente Bousquets for aid in access to a microscope to observe and measure the eggs in Museo de Zoología Alfonso L. Herrera. To Biól. Susana Guzmán Gómez for technical assistance using a focal-stacking microscope in Laboratorio de Microscopia y Fotografía de la Biodiversidad II, IB, UNAM.

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Orthoptera Species File Grant Reports

Oecanthines of high interest in the United States

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I am very grateful for the Orthoptera Species File Grant awarded to me for the purpose of searching for tree crickets of high interest in 2019. The grant was mainly intended to allow me to travel to a remote part of California to investigate a potential new species, and to re-find two species along the southern border of Texas. *Oecanthus leptogrammus* (T Walker, 1962) was last documented in Brownsville, Cameron county, Texas, in 1962 (http://orthoptera.speciesfile.org/Common/basic/Taxa.aspx?TaxonNameID=1128131). *Neoxabea formosa* (T Walker, 1967) was last documented in Brownsville in 1912 (http://orthoptera.speciesfile.org/Common/basic/Taxa.aspx?TaxonNameID=1128172).

While *O. leptogrammus* is well-documented in Mexico and Central America, very little is known about *N. formosa*, and there are no known recordings of the male's song. Given the destruction occurring along the southern Texas border, I felt it was important to search for these two species in 2019. So, in early May, I traveled to Brownsville and stayed two nights in the Robb House in the Sabal Palm Sanctuary. The sanctuary sits on the U.S. side of the Rio Grande and south of the border wall. I spent the majority of daylight hours looking on and under vegetation that tree crickets tend to prefer. I was also able to walk safely on the grounds two nights to look and listen for two target species, *Oecanthus leptogrammus* and *Neoxabea formosa*. Unfortunately, despite an extensive search of the grounds near the Robb House and along several trails, I was not able to locate them. Several baited traps attracted only *O. varicornis* (Walker, 1869). A collecting permit granted by the sanctuary allowed me to collect specimens, which were helpful in the investigation of two potentially new Mexican species.

On the third day in the Brownsville area, with assistance from Melissa Jones from the Texas Parks and Wildlife Department, I searched in Resaca de La Palma State Park. There, too, I found only *O. varicornis*. I did find and photograph two individuals in the genus of *Obolopteryx* (Cohn, Swanson & Fontana, 2014), however the photos were not sufficient for identification to species. I was able to locate *O. celerinictus* (Walker, 1963) in a weedy field across from my hotel in Brownsville.

The following week, I traveled to Laredo to again search for *O. leptogrammus* and *N. formosa*, but found none. I did locate a healthy population of *O. walkeri* (Collins & Symes,

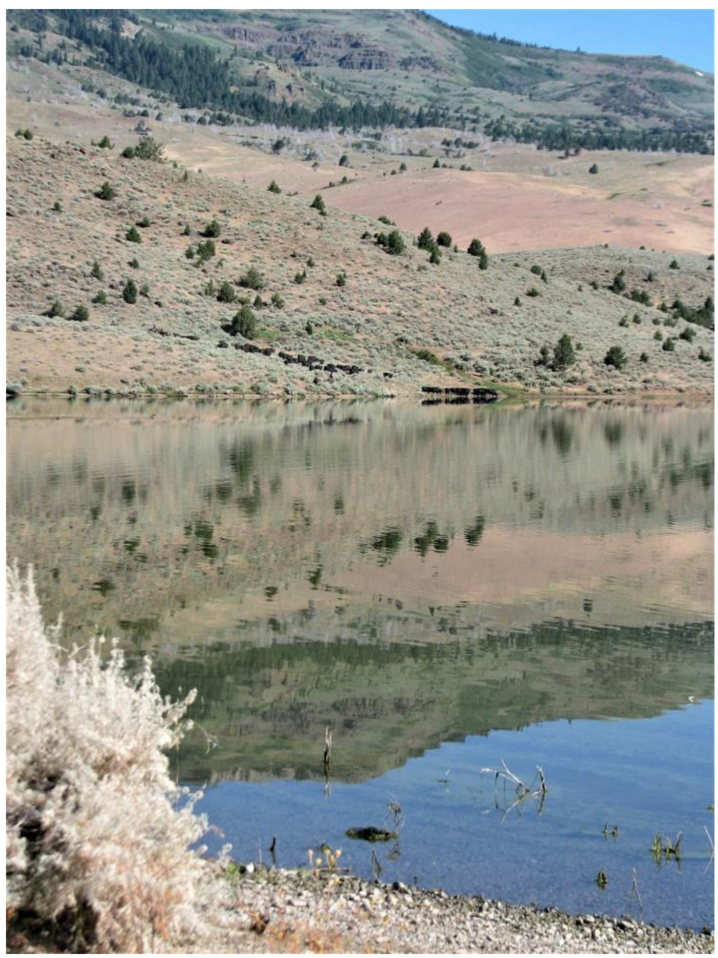

Figure 1. Lake Annie, Modoc County

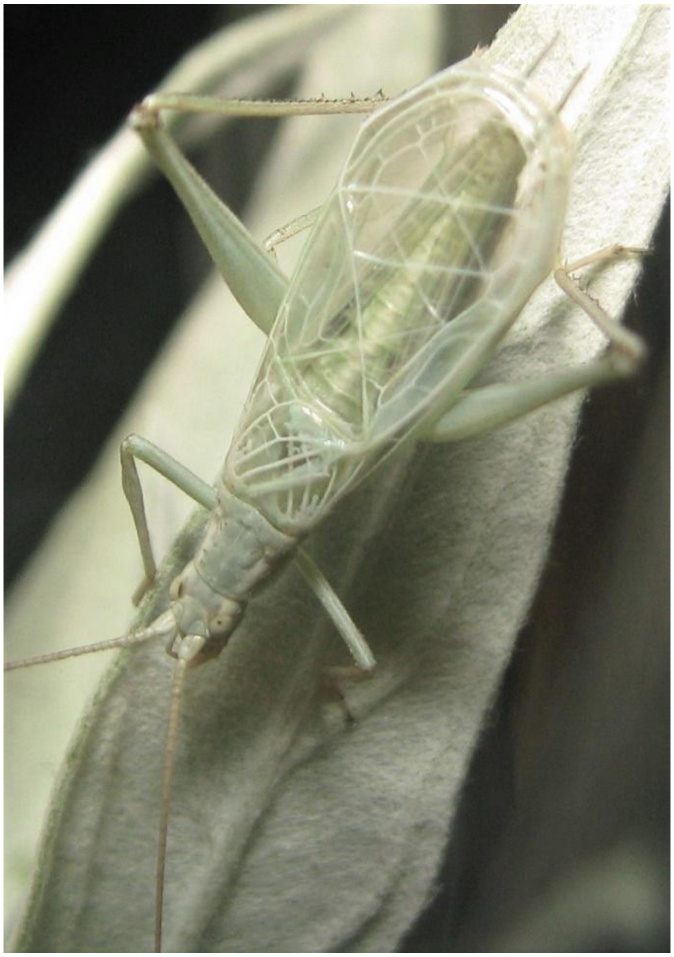

Figure 2. *Oecanthus salvii*

2012) on the campus grounds of the Texas A&M International University.

Ken R. Schneider posted photos on BugGuide.net of a tree cricket from Lake Annie, Modoc county, California in 2017 and 2018. Although they had characters similar to both *O. argentinus* (Saussure, 1874) and *O. quadripunctatus* (Beutenmüller, 1894), the coloring was an unusual milky pastel green color and the upper outer mark on the first antennal segment had an unusual shape.

In late July, I traveled to Lake Annie (Fig. 1) in Modoc County in far northeast California, to search for the third species of high interest. Some of the grant money was used to hire a guide as the location is rather remote. I was able to locate several individuals of this now newly described species - *Oecanthus salvii* (Collins, 2020) (Fig. 2) (http://orthoptera.speciesfile.org/Common/basic/Taxa.aspx?TaxonNameID=1240251). The various sagebrush and rabbitbrush species in the Lake Annie area also had good numbers of the snakeweed grasshopper, *Hesperotettix viridis* (Thomas, 1872).

Oecanthus major was described from Mexico in 1967 by Thomas J. Walker. In 2010, Lon Brehmer and Enriqueta Flores-Guevara posted photos on BugGuide.net of a brown-form female Oecanthine with a very long ovipositor from Dudleyville, Pinal County, Arizona. In 2018, Walker confirmed it as *O. major*. This was the first reported occurrence of that species in the U.S.

In October, I traveled to Pinal County in southeast Arizona to join Lon Brehmer and Enriqueta Flores-Guevara to search for *O. major* (http://orthoptera.speciesfile.org/Common/basic/Taxa.aspx?TaxonNameID=1128096). The spot where they had found a female in 2010 was just as remote as the site of *O. salvii*, but with a much more rugged drive that required some minor road repairs to get there (Fig. 3). An extensive search of the vegetation in the area of Grants Wash was carried out, but no tree crickets were encountered. Unfortunately, vigorous sweeping of shrubs and plants were hampered by a large number of wasps intent on protecting their neighborhood. Additionally, the road conditions made an after-dark visit unsafe. In the areas surrounding Dudleyville, however, I did encounter good numbers of *O. texensis* (Symes & Collins, 2013) and several *O. argentinus*.

At Boyce Thompson Arboretum near Superior, AZ, I was able to photograph and record the song of *Ligurotettix coquilletti* (McNeill, 1897) (http://orthoptera.speciesfile.org/Common/basic/Taxa.aspx?TaxonNameID=1105498). Further north, in Mayer, I encountered *Eremopedes bilineatus* (Thomas, 1875) (http://orthoptera.speciesfile.org/Common/basic/Taxa.aspx?TaxonNameID=1142204).

I will continue to monitor both BugGuide.net and iNaturalist.org on a daily basis for submissions of tree crickets, in the hopes of one day finding *O. leptogrammus* and *N. formosa* in Texas, *O. major* in Arizona, and *O. salvii* in additional sites. Additionally, as of November, 2020, the female holotype of *N. formosa* has been located in the Natural History Museum in South Kensington, London (UNMUK). The morphology and song of the male of remains unknown.

Figure 3. Road to Grants Wash near Dudleyville, AZ

Field observations on the feeding habits of the European Schmidt's marbled bush cricket

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Eupholidoptera schmidti (also known as Schmidt's marbled bush-cricket, http://orthoptera.speciesfile.org/Common/basic/Taxa.aspx?TaxonNameID=1142968) is currently the only known species of *Eupholidoptera* to reside in Albania, although there is a shortage of information available on the flora and fauna of the country (Lemonnier et al. 2015). This species is most commonly found in shrubland, open forest, or at forest edges (Lemonnier-Darcemont et al 2018) where it feeds on other insects and plants (Charpentier 1825). It is described as a "medium-sized species" with long, upcurved titillators (Allegrucci et al. 2013). *E. schmidti* is considered to be "of least concern" in terms of conservation status (Hochkirk et al. 2016).

Figure 1. *Eupholidoptera schmidti* feeding on the seed of a branched asphodel while a defensive snail interrupts its meal.

Observations

The male *E. schmidti* (Fieber 1861) pictured in Figure 1 was observed at a woodland edge at Karavasta Lagoon, Divjakë-Karavasta National Park, Albania. The interaction was documented in a high quality video (available at https://www.youtube.com/watch?v=h40N5TTYCWE). The footage was filmed on June 1, 2018 using a Nikon D3200 in combination with a Tamron 70-300mm f/4.5-5.6 lens. This male was observed feeding on the perennial herb *Asphodelus ramosus* (branched asphodel), but, interestingly, there was a snail, *Monacha cartusiana* (White-McLean 2011), also present on the plant, which appeared to be acting defensively regarding its territory. As seen in Figure 1, the snail was extending its mouth and lower tentacles over the body of the cricket, interfering with its feeding and causing the cricket to lose its footing.

Acknowledgments
Fernando Montealegre-Z and Klaus-G Heller helped with species identification.

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Interview with Futaro Okuyama

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It was a pleasure to receive as a gift the book "図鑑 日本の鳴く虫 コオロギ類 キリギリス類 捕り方から飼い方まで" "Japanese crickets and katydids: from how to catch them to how to rear them" by Futaro Okuyama (2018; ISBN 978-4-904837-67-2, 160 pp.) (Fig. 1). Although written in Japanese, it was delightful to enjoy each page because there is not a single page without an illustration. This book contains information of more than 170 species from Hokkaido to Okinawa. Only photographs of live specimens are included in order to properly portray the dynamics of these singing orthopterans. Features, such as general morphology, habitat, phenology, distribution, and abundance are provided (Fig. 2). There are also sections about collecting methods and a deep section devoted to breeding methods that includes different common food types and specific types of cages and microhabitats suggestions (soil types, light exposition, ideal cage size and densities) for successfully rearing specimens. Additionally, a cultural section about cricket fights and all the related paraphernalia closes this book (Fig. 3).

After carefully reviewing each page of this book, I decided to interview the author, in order to have a better sense of his reasons and background that made him pursue the endeavor of publishing this book.

Q1: How do you become interested in crickets and katydids?
FO: I have always loved insects since I was a kid. I was particularly interested in katydids because of their cool appearance but I do not know exactly why; I just love their beautiful appearance.

Q2: Do you collect alone or with someone else?
FO: I collected almost everything; perhaps friends collected about 10%.

Q3: How long did it take you to write your book?
FO: The writing itself was just about a year but I spent 5-6 years taking the pictures.

Q4: What sources did you use to identify the crickets and katydids?
FO: There are only two scholarly books on Orthoptera in Japan. 1. *Orthoptera of the Japanese Archipelago in Color* (2006; ISBN: 978-4-8329-8161-4) and 2. *The Standard of Polyneoptera in Japan* (2016; ISBN: 978-4-05-406447-8). The two books are the main sources of information, and the rest is my own observation.

Figure 1. Cover of *"Japanese crickets and katydids: from how to catch them to how to rear them"* by Futaro Okuyama

Q5: Do you know any orthopterologist (person that study crickets, katydids and grasshoppers)?
FO: Unfortunately, I do not have such an acquaintance. I know that there is only one Orthoptera researcher in Japan; Ricardo was very kind in helping me to identify a grasshopper from Malaysia.

Q6: What is your favorite cricket or katydid?
FO: This is a very difficult question. I like both as much. Today's feeling is cricket but I do not know how I will feel tomorrow.

Q7: What was the easiest and hardest cricket and katydid to find and to rear?
FO: The easiest crickets to find in Japan are *Loxoblemmus campestris* and *Ornebius kanetataki*, and *Gampsocleis buergeri* for katydids. The most difficult to collect, for me, is *Parasongella japonica*. For katydids, it's *Gibbomeconema odoriko*. However, there are many undescribed species in Japan, especially in the Ogasawara Islands, there seem to be many unknown and rare orthopterans.

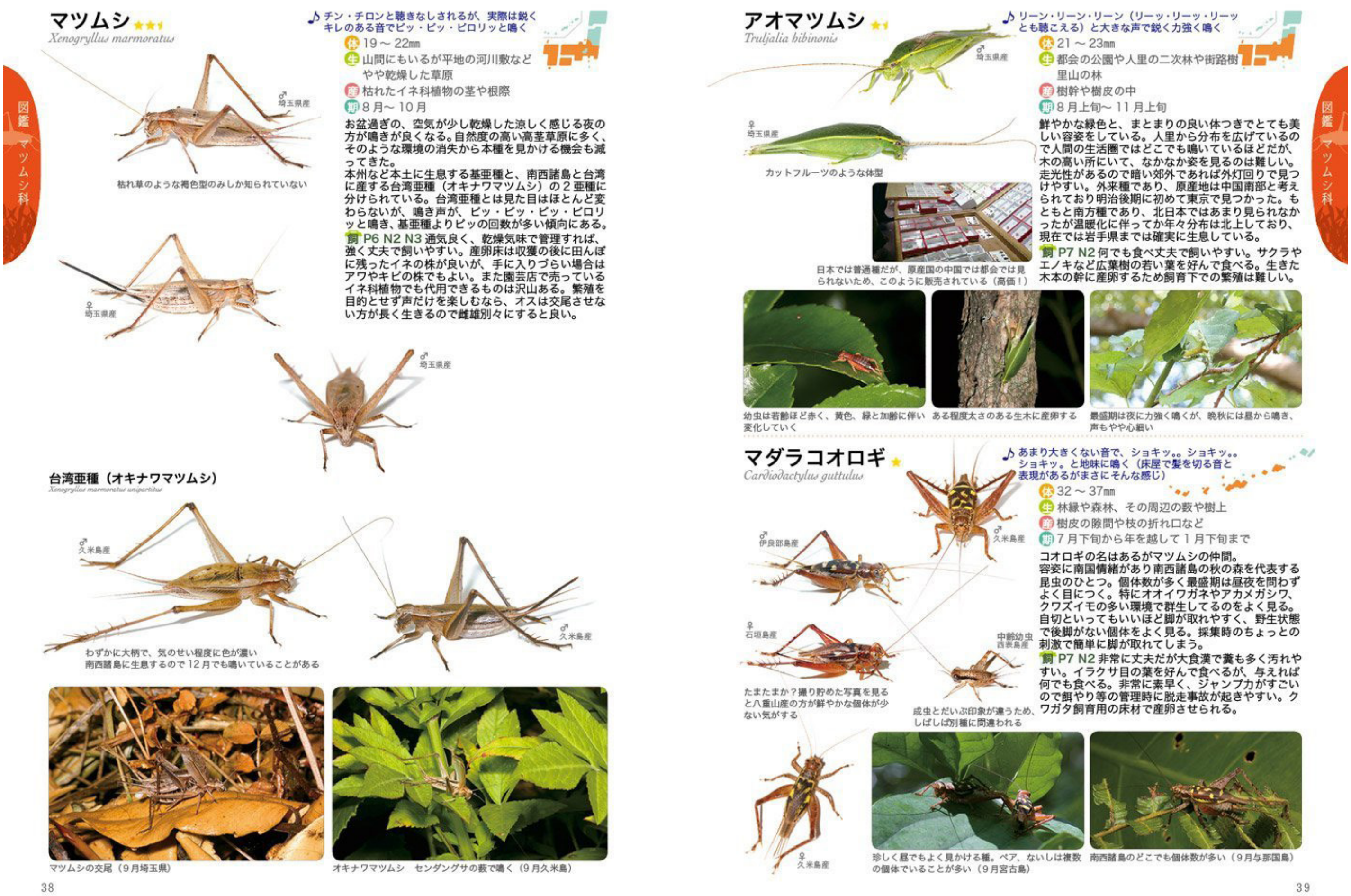

Figure 2. Example of the book content

Figure 3. A section describing cultural aspects of cricket fights.

Q8: What is your favorite technique to collect them?
FO: Sometimes I use a light trap, but it is best to just walk in the middle of the night and look for them.

Q9: What is the place in Japan where you have collected the most species of crickets and katydids?
FO: The Ryukyu Islands, such as Okinawa, are the most species-rich. Nearly half of the total was collected in Okinawa.

Q10: What is the best season of the year to collect them?
FO: Orthoptera in Japan are active since the end of summer. In Honshu (around Tokyo), there are many from mid-August to early October. The best season in Okinawa is from August to November.

Q11: Have you collected in other countries?
FO: I collected only a few in China.

However, many were purchased at the market. The insects on pages 152 and 153 of my book were collected in China.

Q12: What is your dream country to collect after Japan?
FO: I traveled the World when I was young. After all, the farther away from Japan, the more exciting and interesting insects there are. Especially Suriname and Venezuela are dream destinations to me. I would also want to travel to Madagascar. However, I still have to spend a lot of time in Japan and Asia. It seems that it will be many years before I can collect as much as I want in other countries.

Q13: Are you interested in writing a book about grasshoppers?
FO: Yes! I want to make a grasshopper book. I am taking pictures of grasshoppers little by little. However, Japanese publishers do not seem to be very interested in grasshoppers

Q14: Who is the target audience for your book?
FO: It is difficult to express in English, but this book was created for nature lovers and amateur insect researchers.

Q15: Where can we buy your book?
FO: In Japan, bookstores sell it everywhere, but I think it is realistic for people outside Japan to buy it on Amazon. I am thinking of ways to make it easier for foreigners to buy.

You can email Futaro at info@akimushi.com.

Commission for Controlling the Desert Locust in the Western Region (CLCPRO) - A Success Story

By MOHAMED LEMINE HAMOUNY
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The Desert Locust is the most formidable of the locust pests of agro-sylvo-pastoral resources. It poses a threat to agriculture in a very large area of the world stretching from the Atlantic coast of Africa to the Indo-Pakistan border through the Middle East. Its ability to migrate hundreds, if not thousands, of kilometers makes it an international problem with major economic, social, and environmental effects. This pest therefore constitutes a food security issue for major economic, social, public health, and environmental systems.

To deal with the problem of the Desert Locust in the Western Region, which includes West and North-West Africa, the Commission for the Control of the Desert Locust in the Western Region (CLCPRO) was created under the aegis of the United Nations Food and Agriculture Organization (FAO), bringing together 10 member countries (Algeria, Burkina Faso, Libya, Mali, Morocco, Mauritania, Niger, Senegal, Chad, and Tunisia). Its role is to promote the preventive

control strategy, that is to say the regular monitoring of the desert locust biotopes, the early warning and the rapid response as well as to coordinate its control between its member countries. More specifically, the purpose of the Commission is to promote at national, regional and international level all actions, in particular research and training with a view to ensuring a rational and sustainable management of preventive control and to cope with Desert Locust invasions.

The Western Region, already weakened by severe droughts, is regularly confronted by many desert locust invasions, the last of which, from 2003 to 2005, resulted in the treatment of more than 12 million hectares requiring a financial amount of nearly $570 million USD. However, thanks to the strengthening of the preventive control strategy, six locust outbreaks have been contained since the 2003-2005 invasion, including the locust menace in the Sahel in 2012-2013, which could have evolved into an upsurge.

This control is the result of a whole policy implemented by the Commission and its member countries which is based on very efficient financing and intervention mechanisms to deal with any change in the locust situation. Thus, the annual contributions of member countries to the Trust Fund of the Commission increased from $227,000 to $639,000 USD in 2011 and a Regional Locust Risk Management Fund (FRGRA) was created in 2014 to manage exclusively all locust situations of resurgence and early upsurge.

The CLCPRO was also reinforced by a Western Region Intervention Force (FIRO), positioned at the level of the main base in Nouakchott (Mauritania) and at the level of the secondary base in N'Djamena (Chad). Its objective is to implement an operational regional cooperation tool that ensures and strengthens prospecting and preventive control activities in four frontline countries (Mali, Mauritania, Niger, and Chad) during major resurgences and early Desert Locust upsurge.

All these advances have been made concrete thanks to the involvement of the FAO and the solid commitment of the member countries of the Commission as well as technical and financial partners (Agence Française de Developpment-AFD, African Development Bank-ADB and the Agency of United States for International Development-USAID).

In light of the above, the CLCPRO Secretariat has produced a short documentary entitled: **Commission for Controlling the Desert Locust in the Western Region (CLCPRO) - A Success Story**. The objective of its achievement is to highlight all the efforts implemented by the Commission that led to the success of the preventive control strategy in the Western Region and also the mechanisms developed for the management of possible locust crises.

The film is produced in three versions: French, English, and Arabic, accessible through the links below:

1. French Version: https://youtu.be/pmkqiyReayM
2. English Version: https://youtu.be/g4jDZ6tR1mg
3. Arabic Version: https://youtu.be/quTK-f9X8Ik

Proceedings of the 2020 ESA Symposium: "Small Orders, Big Ideas (Polyneoptera)"

By DEREK A. WOLLER[1], ABIGAIL HAYES[2], JOSEPH SWEENEY[3], & HOJUN SONG[4]
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Since 2014, a symposium focused on Polyneoptera has been part of the annual Entomological Society of America (ESA) conference, containing presentations by a balanced ratio of younger researchers (often students) and seasoned ones, and covering interesting topics that focus on one or more of the 10 extant polyneopteran orders: Blattodea (+Isoptera), Dermaptera, Embiodea, Grylloblattodea, Mantodea, Mantophasmatodea, Orthoptera, Phasmatodea, Plecoptera, and Zoraptera. This symposium (or "organized meeting," depending on the whim of the conference organizers) quickly became an annual tradition (2020 marks its 7th time so far!) and will hopefully continue to be a mainstay at ESA conferences for years to come. Over time, one of the event's goals has been to have the symposium co-organized with the assistance of a student, which has occurred successfully the last 3 times. Thus, Derek and Hojun's two main roles these days are to apply for the meeting and assist the student as needed when they are selecting and inviting speakers, as well as moderating the meeting, all of which gives students invaluable experience in organizing symposia. For 2020's event, we were lucky enough to have two student co-organizers who did a great job overall despite the switch to a virtual format (due to the ongoing SARS-CoV-2 pandemic) and several unfortunate cancellations by speakers.

This year, we had six speakers from three countries (U.S.A., Canada, Italy) and, as always, we attribute a majority of the event's success to the wonderful speakers and their engaging presentations. Plus, we had another excellent keynote speaker, the one-and-only Janice S. Edgerly (who has now entertained the audience 6 of the 7 years we've done this). As always, she presented on her endlessly fascinating Embiodea, this time regarding their bulky genomes and silky genes. The other five speakers were Aaron J. Mullins, Federico Marangoni, Amy M. Worthington, Alexandre Caouette, and Stav Talal. Together, these talks covered three of the Polyneopteran orders: Orthoptera (always!), Blattodea: Isoptera, and Embiodea. Moreover, a diverse array of topics were discussed, ranging from biomimicry to monitoring via bioacoustics to diet preferences.

If you would like to learn more about the presentations, a brief abstract and figure for all are provided below. Sadly, we had to break with tradition this year and skip the unofficial Orthopterists' Society communal meal at a local restaurant to celebrate the success of the event, so here's hoping we can do it twice in 2021 to make up for it!

Finally, we have a request for students working on polyneopteran insects. Assuming the symposia is approved yet again for the November 2021 ESA meeting, we'll need someone new to co-organize it with us. Not only is this a unique opportunity to learn about the organization of symposia, and even conferences, it also brings you in contact with some of the most interesting researchers out there who are focusing on Polyneoptera. Ideally, the student will have been a past presenter in the symposia, but it's not required. If you don't feel like you want to take up this responsibility in 2021 or beyond, but still want to present in our symposia next year or in the future, feel free to also contact Derek and Hojun. Either way, we're looking forward to your response!!

From construction to decomposition: Termite contributions to novel biomimicry innovations and elusive goals

Aaron J. Mullins (amull81@ufl.edu), University of Florida, U.S.A., Paul Bardunias, and Nan-Yao Su

A termite mound represents many levels of complex interactions and symbioses. Starting with the self-organized behavior, which designs and constructs them, all the way down to the termite gut made up of hundreds of different symbiotic microorganisms that all contribute to the final product. As a whole, termites tend to specialize in both construction and decomposition. They have thus been a source of inspiration for many types of human technology. As the consummate builders of the animal world, humans have mimicked both the form of their towering mounds and the manner in which a distributed force of minute workers coordinate their labor to construct them. Architects have turned to the manner in which termites ventilate their mounds to produce more energy efficient solutions. Swarm intelligence in termites led to the discovery of one of the earliest and most robust self-organizational algorithms, stigmergy, which has been adapted to diverse applications, including quorum sensing for internet search engines, maximization of subterranean resource discovery, and even autonomous construction using multiple robots working on the same task with decentralized control (swarm robotics).

Workers and soldiers of *Syntermes nanus* Constantino initiating construction of a protective staging area prior to above-ground foraging. Structures constructed by termites represent extended phenotypes made of self-organized systems with emergent properties.

Termites are also a force of decomposition in nature. The termite gut represents one of nature's most impressive bioreactors, breaking down cellulose and lignin present in sound wood, freeing carbon for a variety of uses. In some cases, termites even extract carbon from mineral soil with very little organic matter via extreme alkaline digestion chambers present in the gut. They are also adept at fixing nitrogen when their diet is poor in the essential nutrient. From teeming multitudes within, to soaring mounds without, termites are a model representation of the superorganism.

Preliminary assessment of the genetic population structure of *Pholidoptera aptera aptera* (Fabricius, 1793) (Orthoptera, Tettigoniidae) in the north–east Italy

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In recent years, changes in population density have been observed for some orthopteran species in northeastern Italy. Such variations can be attributable to outbreaks and are of considerable interest as they have important impacts on agriculture and forestry. For example, in the hilly Euganean Hills area of this region, unexpected outbreaks of the bushcricket *Pholidoptera aptera aptera* have recently been recorded, whereas no demographic increase has been observed in their typical areas across the pre-alpine and alpine areas. Therefore, through the analysis of genetic variability, this preliminary study was aimed at elucidating whether outbreak populations from the Euganean Hills are genetically distinct from latent (non-outbreak) populations from the pre-alpine and alpine areas.

A total of 150 samples were collected in seven sites across the pre-alpine and alpine areas, as well as the Euganean and Berici Hills areas. To avoid collecting relatives, samples were collected by sweeping an area at least

Pholidoptera aptera aptera in natural environment.

100 m^2 at each sampling site. DNA was extracted using the salting out method from the metafemoral muscle and a mitochondrial fragment corresponding to the Cytochrome Oxidase Subunit 1 (COI) was then amplified and sequenced.

Preliminary results showed the presence of 21 haplotypes; 14 exclusive to the alpine populations and 8 exclusive to the Berici and Euganean populations. ANOVA revealed the presence of significant geographic structure among the studied populations ($p < 0.05$). Outbreak populations from the Euganean Hills were genetically different from pre-alpine and alpine populations, but they were not genetically distinct from the latent populations of Berici Hills. SAMOVA analysis showed 4 genetically distinct groups corresponding to populations from: i) Euganean and Berici Hills, ii) alpine areas (Siusi allo Sciliar), iii) western pre-alpine areas, and iv) eastern pre-alpine areas.

This preliminary genetic study on *P. aptera* shows a high geographical structure among populations of the different distribution areas. The Berici and Euganean populations do not share any haplotypes with the pre-alpine and alpine populations, suggesting limited gene flow, probably due to limited dispersal ability of the flightless species. Further studies are necessary to understand whether the outbreak events are affected by genetic characteristics of local populations, environmental conditions, or both of these combined.

The host with the most: Field crickets alter their physiology and behavior for their parasites

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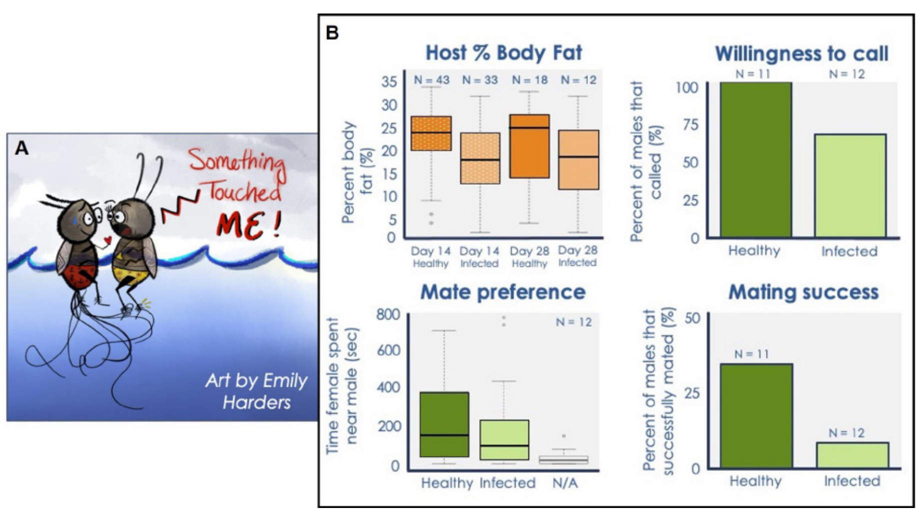
Parasites often manipulate their host's behavior and physiology, resulting in detrimental effects on host fitness. The horsehair worm (*Paragordius varius*) is a long-lived parasite that infects arthropods, including the sand field cricket, *Gryllus firmus*. This parasite lives inside its host for upwards of 28 days and can grow as long as 30 cm, presenting a significant challenge for its host's own growth and survival. Interestingly, infection by and emergence of the horsehair worm parasite does not always immediately kill its host, yet may drastically impair its host's reproduction due to altered host physiology and behavior. Here, we tested the ability of infected male crickets to properly invest in sexual reproductive structures and energetically expensive courtship behaviors, as well as quantified whether infection negatively affects female mate preference. We compared courtship behaviors, calling abilities, and mating success rates between infected and healthy males to identify how host reproductive fitness is affected by this large, long-lived parasite. Interestingly, we found that while the physical size of somatic and reproductive structures was unaffected, host cricket mass was reduced by nearly 30% upon parasite emergence. This can likely be attributed to infected crickets having significantly fewer fat reserves, which in turn reduces the energetic resources available for costly courtship activities in reproductively mature male crickets. Our preliminary results suggest that infected males do, in fact, produce fewer spermatophores, are less likely to call in the presence of a female, are less attractive to females, and have drastically reduced mating success relative to healthy males. We are currently working to increase our sample sizes, but our preliminary results indicate a significant reproductive burden on infected males, where even if host male crickets are able to survive horsehair worm infection, they will likely suffer from significantly reduced lifetime reproductive fitness.



A) An original cartoon illustrating the study system; **B)** Graphical summary of major findings.

Using large-scale bioacoustics monitoring and audio recognition software to investigate the distribution of orthopterans in Alberta, Canada

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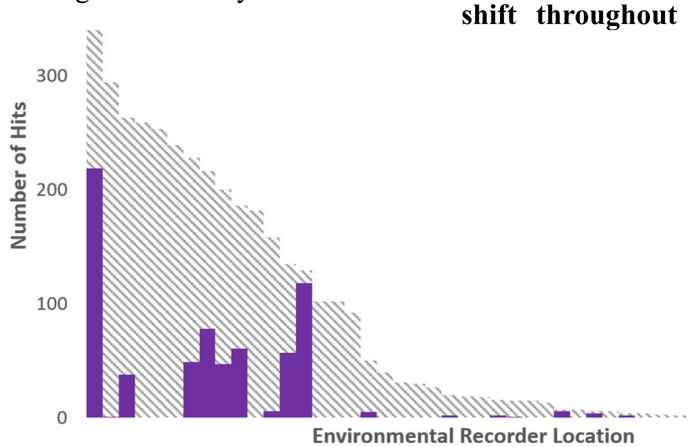
Global climate change is causing species' ranges to shift. As a result, finding tools to monitor species range changes is essential for understanding how species are responding to climate change. For species that produce audible vocalization, using passive acoustic monitoring (PAM) is a useful tool for monitoring changes in species distribution. Orthoptera is a group of insects that produce audible vocalizations, called stridulations, where males produce species-specific sounds to attract females. These stridulations can be searched for via PAM and used for monitoring pests, as well as for conservation. Roesel's katydid, *Roeseliana roeselii* (Orthoptera, Tettigoniidae), is a species that is successfully expanding its global range in response to various factors, including climate change.

In 2017, a population of Roesel's katydid was discovered in Alberta, far outside its naturalized North American range. We used field collections and PAM, in environmental recordings collected by the Alberta Biodiversity Monitoring Institute (ABMI), to search for new populations of Roesel's katydid in Alberta. We sampled 20 sites using active sampling techniques in central and eastern Alberta and found four unreported populations of Roesel's katydid. Using PAM, we analyzed 74 environmental recording sites, equaling 10,242 hours of audio, but failed to detect any *Roesel's katydid* in any of the recordings. However, 21 of the environmental recording sites did contain species within Acrididae, Tettigoniidae, and Gryllidae, identified from stridulations.

Despite not finding Roesel's katydid in the environmental recordings, we were able to find specimens using field sampling methods. There are two possibilities for why we did not find Roesel's katydid stridulations, either because it is not yet present outside of its current distribution or it is undetectable in audio recordings under specific scenarios. Regardless, this project does show that PAM can be used for monitoring Orthoptera species. We are currently using PAM and the ABMI environmental recorders for *Cyphoderris monstrosa* (Prophalangopsidae), the great grig, to monitor their eastern and northern range limits in the Canadian Rocky Mountains and to collect temporal mating information.



Histogram of the number of identified calls binned into groups (Roesel's katydid, Orthoptera, and Other) by environmental recorder location.

Diet preference and requirements shift throughout ontogeny in the South American Locust (*Schistocerca cancellata*)

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Extensive research using the Geometric Framework for Nutrition have shown that generalist feeders often behaviorally regulate their food choices so that they consume protein:carbohydrate at a ratio that supports maximal growth, survival, and/or reproduction. Studies of the consumption of locusts given choices of food differing in protein and carbohydrate content have generally found that, given a choice, locusts consume roughly equal amounts of protein and carbohydrate, or slightly more carbohydrate than protein. However, the vast majority of past studies on this topic have examined only the last juvenile stage (instar) or adults. Early instars must prioritize growth, while the last instar and adults must prioritize preparation for dispersal and reproduction, so it seems plausible that protein:carbohydrate needs vary during ontogeny.

To test this possibility, we measured protein and carbohydrate consumption from two artificial diets differing strongly in protein:carbohydrate content for the six juvenile instars and adults of the South American locust, *Schistocerca cancellata*. In addition, we measured growth and survival of locusts reared on single artificial diets varying in protein:carbohydrate ratio for their entire developmental period. Nutritional requirements changed dramatically during development. The first four instars consumed more protein than carbohydrate; whereas, later instars and adults consumed more carbohydrate than protein. When confined to a single diet throughout all instars, survival and rate of development were highest on the protein-biased diets preferred by the early instars.

Body mass was also greater when locusts were confined to protein-biased diets relative to balanced or carbohydrate-biased diets, especially when measured 25 days after hatching, approximately when our locusts

Two *Schistocerca cancellata* locust males, each 45 days old. The adult on the left was reared on a diet with 28% protein and 14% carbohydrate, while the 4^{th} instar nymph on the left was fed a diet with 7% protein and 35% carbohydrate.

molted to the 5^{th} instar and shifted to preferring to consume more carbohydrate. Locusts confined to carbohydrate-biased diets did gain weight more quickly during later developmental stages, but not enough to attain the same body mass as those confined to protein-biased diets. These data suggest that matching nutrition requirements during early development critically determines developmental performance later in ontogeny. Also, our research demonstrates that studies based solely on the final instar are inadequate to predict nutritional needs of locusts throughout development. Supported by NSF IOS-1826848 and BARD FI-575-2018.

Exploring Embiodea: Bulky genomes & silky genes

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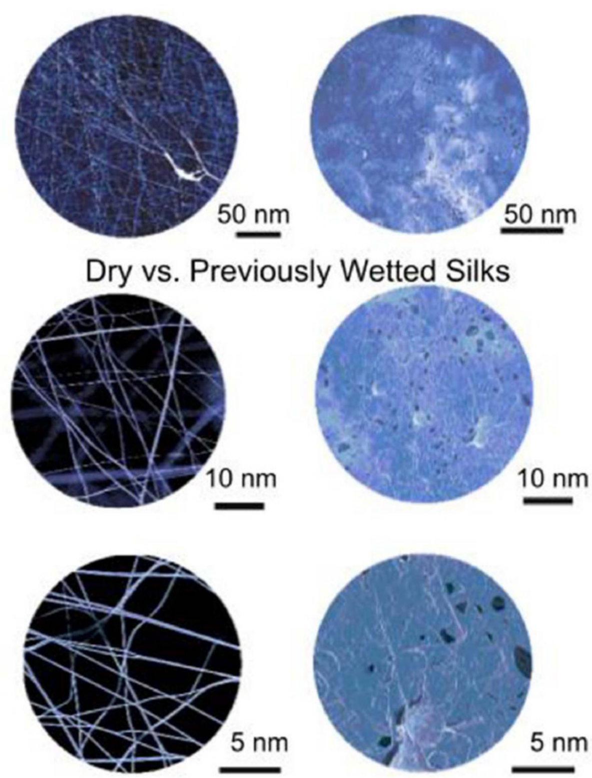
Webspinners in the Order Embiodea (AKA Embioptera or Embiidina) display behavior, body form, and lifestyles that have evolved under the constraints imposed by their need to spin silk with their front feet. Furthermore, they dwell in tightly constructed galleries, on tree bark, in leaf litter, or underground. As a consequence of these snug abodes, their bodies are flexible and soft. Their locomotion, egg-clustering and guarding, colonial life, and a suite of other traits align with the web of adaptation associated with their silk-dwelling habit. Because silk is so critical to their existence, we have worked to untangle its underlying molecular basis as we seek to understand its protective function. An analysis of cDNAs based on mRNA from silk glands of two Trinidadian species revealed repetitive motifs that typify arthropod silks, especially glycine and serine, which repeat in long series in the core of the protein fiber. Interesting characteristics also appeared that might explain an unusual feature of their silks: their tendency to transform from fiber to film when exposed to rain. The SEM images tinted blue, herein, show dry fibers versus previously wetted, dried, and transformed silks for one of the Trinidadian species. The continuous film resulted after tiny droplets of water were left to sit on the silk samples. The same effect is seen in natural field colonies, which shine like plastic after rainwater has transformed the outer surface of the silk gallery. Characterization of silk genes and amino acids of Efibroins (the name for their silk proteins) showed surprisingly high levels of hydrophilic amino acids, which might facilitate invasion by water of the silks, which are initially hydrophobic (water actually beads up!). Once the silk becomes film-like, water slips off, apparently protecting the vulnerable insects from the heavy rainfall of their tropical habitat.

Another trait we analyzed is genome size variation within the order to compare to other insects, which have been characterized as of late. Of particular interest are those of the large assemblage, the Polyneoptera, to which Embiodea belongs. Our genome size analysis, relying on flow cytometry, revealed that some webspinner species sport some of the largest genomes found in insects, rivaling many other polyneopterans (famous for having bulky genomes). For the webspinners, perhaps not surprisingly, larger-bodied species house larger genomes. Despite this pattern, phylogenetic signal is not apparent within the order. A general pattern for insects is that hemimetabolous insects have large genomes while those of the holometabola have a constraint that limits their genome size; thus, webspinners fit the pattern so far described in the literature.



SEM comparisons at different scales of dry (left) vs. previously wetted, dried, and transformed silks (right) of an Embiodea species from Trinidad.

Treasurer's Report

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Treasurer
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The Statement of Assets as of December 31, 2020 and the 2020 Summary of Cash Receipts and Expenditures are shown below. The Orthoptera Species File continues to be the largest cash activity. This is funded by an allocation of endowment income from the University of Illinois. The second largest use of cash was publishing the *Journal of Orthoptera Research* (*JOR*). The Society is able to support the Theodore J. Cohn Research Fund and other worthy endeavors through the generosity of some members. In particular, Ted Cohn's bequest of $1.3M USD is now valued at $1.7M despite withdrawing $300,000 to support the Society. We keep a watchful eye on the investments and in 2020 we exchanged $55,000 of higher risk stock investments for $55,000 in lower risk bonds. We are pleased to report that the investments grew from $1,631,000 on December 31, 2019 to $1,754,000 on December 31, 2020 even with the economic uncertainty throughout the world. If you have any questions, please contact me at p.mihm@regency-multifamily.com.

Orthopterists' Society
Statement of Cash Receipts and Expenditures
(1/1/20 through 12/31/20)

Cash Receipts	
Dues	$1,660.00
Publications	1,295.00
Community Foundation endowment	11,646.91
Royalty and revenue sharing	4,431.58
Book reimbursements	171.12
Donations	10.00
Transfer cash from Vanguard & Wells Fargo	48,200.00
Proceeds from sale of investments	10,000.00
Sales of Vanguard stock to invest in bonds	55,000.00
University of Illinois allocation	194,000.00
Total Cash Receipts	$326,414.61
Cash Expenditures	
Publisher JOR	$5,165.05
Pensoft Publishers	11,741.00
JOR assistance	12,000.00
Research grants (Ted Cohn)	14,879.00
Executive director remuneration	0.00
Ed. Metaleptea remuneration	1,500.00
Assistant Ed. Metaleptea remuneration	1,000.00
Webmaster remuneration	500.00
JOR editor remuneration	3,000.00
Maintenance of Orthoptera Species File	146,000.00
Grants-Orthoptera Species File	40,356.00
JSTOR content sharing	1,500.00
Publishing support-Bushcrickets	18,587.36
Professional fees (income tax preparation and audit)	4,866.75
Accounting reimbursement	12,000.00
Purchase of bonds with proceeds from sale of stock	55,000.00
Other	1,948.12
Total Cash Expenditures	$330,043.28
Cash Receipts over Cash Expenditures	$(3,628.67)
Beginning Cash Balance	11,819.45
Ending Cash Balance	**$8,190.78**

Orthopterists' Society
Statement of Assets
(As of December 31, 2020)

Cash	
Paypal cash balance	$155.82
Chase Bank	8,034.96
	$8,190.78
Investments at market value	
Vanguard:	
Grants (Note 1)	$471,960.46
Operating (Note 2)	868,610.00
	1,340,570.46
Wells Fargo:	
AAAI (Note 3)	16,596.43
Endowment (Note 4)	42,536.12
Operating (Note 2)	268,475.31
Grants (Note 1)	85,496.31
	413,104.17
Total assets	**$1,761,865.41**

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

Editorial

By HOJUN SONG
Editor, *Metaleptea*
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What a year it has been! I am glad that the year 2020 is behind us, but it appears that the year 2021 is not going to be particularly better in terms of how we deal with COVID-19. While the rollout of vaccines is hopeful, it will likely take another year until the entire world gets vaccinated and reach some level of herd immunity enough for us to get back to normalcy. We will just have to continue to be more patient, I guess.

In December, I had to submit an annual report to the National Science Foundation for my grant on the phylogenomics of Ensifera. It was a painful experience because I realized that I was not able to accomplish much during 2020. My lab was shut down for more than 6 months, so data generation that had to be done in the lab was not accomplished at all. Due to travel restrictions, both domestically and internationally, I could not collect key taxa that I needed. And my international colleagues could not send me specimens because international carrier services were suspended. Basically, my annual report was a long list of activities that could not be done. It was depressing to write, but it was also a reminder that I will somehow have to catch up on all of the research activities in 2021.

I have many plans for this year. I will likely do some fieldwork to collect katydids and crickets from Texas and Florida in the summer. The NSF-supported Behavioral Plasticity Research Institute has launched and my lab will soon have colonies of six species of *Schistocerca,* including all three locust species, *S. gregaria, S. cancellata, and S. piceifrons*, which will be used for some exciting research. For the first time, I will have a postdoc, and I am expecting a large cohort of graduate students in the fall. Hopefully, when I look back on 2021 at the end of this year, it will not be as depressing as how I felt about 2020. I am sure many of our members feel the same way, so I wish my very best to every member of our society!

This is another great issue of *Metaleptea* featuring how active our society is, even in the midst of the contiuing global pandemic. This issue is full of contents and I am thankful to all of the contributors for making this issue possible. I would also like to thank our Associate Editor, Derek A. Woller, for his continued assistance in the editorial process.

In the last issue, I made a proposal for a new section in *Metaleptea*, but this did not actually pan out as I hoped. So, here is a reminder. 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 May of 2021, so please send me content promptly. I look forward to hearing from you soon!