ISSN 2372-2517 (Online), ISSN 2372-2479 (Print)

METALEPTEA

THE NEWSLETTER OF THE ORTHOPTERISTS' SOCIETY

President's Message

By **MICHAEL SAMWAYS**
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The Orthoptera *sensu lato* is one of the most prominent of all the terrestrial invertebrate groups. Above all, the many species are important functionally in interaction networks in many terrestrial ecosystems, from tropical rain forest to temperate grasslands, and even in caves. Their diversity of life styles is really amazing, with different species being variously carnivores, omnivores, herbivores, and saprovores. They can be cryptic, whether green in the trees or brown in the litter layer, and some are even aposematic, containing toxic or distasteful compounds that deter potential predators. Indeed, they also play an important role as food for many vertebrate predators. Still others are tunnellers, not only for their protection, but as in the case of mole crickets, also for more efficient sound projection through a horn-shaped tunnel. Inevitably, this means that the orthopteran form has been sculptured over many millennia to give the morphological exuberance that we see today across the world.

Of course, one other feature that makes orthopteran species so interesting is that many are also singers. This means that not only is the physical landscape graced by their presence, but so is the soundscape. The myriad of songs, many of which have components that are well above our hearing range, give a sense of a living,

dynamic planet, of a vitality, honed by evolution. This makes the Orthoptera one of the most exciting animal groups to research. Yet there are still many questions surrounding their biology that are poorly-explored. In the case of some of the katydids, for example, they are amazingly efficient singers and listeners, having wings that have been shaped by natural selection to produce remarkably complex songs that have an astonishing amplitude of 110 db at source. Then they hear using a funnel-like ear. Not only this, but they can also be good fliers. This is a remarkable trade-off between having wings that are both good for singing and for flying. In the case of mole crickets, not only can some sing and fly well, but they also do so apparently un-encumbered by their large spade-like feet used for digging their tunnel!

The Orthopterists' Society (OS) is devoted to this faunistic exuberance and enables all enthusiasts and scientists from around the world to share thoughts and ideas on this remarkable group. There is a meeting of minds

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to explore further the variety of life forms, behaviours, physiologies, and biochemistries. Yet some species have major pest status and have had, and continue to so, an influence on human culture and survival. The OS welcomes those researchers and practitioners who aim to understand and control these pestiferous species.

At the other end of the spectrum are those species which are under threat from human disturbance and require conservation action. This has led to a strong link between the OS and the World Conservation Union (IUCN)/Species Survival Commission's Grasshopper Specialist Group, a global network devoted to assessing threat status of species and developing conservation strategies in the face of global change. In turn, the information gathered by this group, as well as by many other devoted orthopterists, feeds into an amazing facility of the OS: the Orthoptera Species File (OSF). The OSF is a global catalogue of all known Orthoptera species, which continually grows through input of many OS members. This database is a hallmark facility of the OS, and open to all members.

Wishing all Orthopterists around the world a peaceful and prosperous 2015, and many exciting discoveries of the orthopteran world!

2015 Orthoptera Species File Grant Funded

By MARIA MARTA CIGLIANO
Orthoptera Species File Officer
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The OSF grants committee received fourteen grants applications from eleven countries (Algeria, Argentina, Brazil, Colombia, China, France, Germany, Hungary, Mozambique, Spain, and the U.S.A.) and the following seven proposals were funded. These proposals were primarily selected based on the relation to the amount of data expected to be added into the Orthoptera Species File or to a Species File for another group within Polyneoptera. They were also considered if the proposal was related somehow to a taxonomic research project and/or the candidate demonstrated knowledge of the taxa involved.

- **Juliana Chamorro & Rodrigo Romero** (Universidade Federal de Viçosa, Brazil, Universidad de Caldas, Colombia) will contribute photos and distribution records of Brazilian katydids related to the research project on "The wings and phallus of Neotropical katydids (Orthoptera: Tettigonioidea)"
- **Klaus-Gerhard Heller** (Germany) will contribute sound recordings on "Calling songs of West Palearctic Tettigonioidea" .
- **Martin Husemann** (Martin-Luther University, Halle-Wittenberg, Institute of Biology/Zoology, Germany) will contribute photos and distribution records of Oedipodini from Europe, Africa, Asia and North America.
- **Piotr Naskrecki & Ricardo Guta** (E.O. Wilson Biodiversity Laboratory, Museum of Comparative Zoology, Harvard University, USA; Gorongosa National Park, Mozambique) will contribute on "Acoustic and photographic documentation of the Orthoptera of Central Mozambique" (from Gorongosa National Park).
- **Martina Pocco** (División Entomología, Museo de La Plata & CEPAVE, Argentina) will contribute photos of Neotropical grasshopper types and other specimens in the Academy of Natural Sciences of Drexel University, Philadelphia, USA, in particular Romaleinae, along with distribution records, as well as photos of live specimens of Argentine grasshopper species on "Illustrating Neotropical Acridoidea species with emphasis on Romaleinae in OSF".
- **Gellért Puskás** (Hungarian Natural History Museum, Hungary) will contribute on "Photo documentation of types in the Hungarian Natural History Museum as well as the Otto Herman collection and collecting distributional and taxonomical data of Balkan Orthoptera species" (photos of types and live insects, recordings and distribution records).
- **Pedro Guilherme Souza-Dias** (University of São Paulo, Zoology Department, Brazil) will contribute photos of types of Phalangopsinae deposited in Brazilian Museums, photos of live individuals and distribution records of Brazilian Phalangopsinae related to the research project on "The Brazilian fauna of phalangopsid crickets (Grylloidea, Phalangopsidae): distribution, diversity and aspects of natural history."

Procolpia inclarata (Walker, 1870) (Romaleidae), December 11th, 2013
Near Pluma Hidalgo, Oaxaca, Mexico. (Photo Credit: Ricardo Mariño-Pérez)

Orthopteroid Symposium Recap from ESA, 2014

By DEREK A. WOLLER
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During the annual Entomological Society of America (ESA) conference in Portland, Oregon, USA on November 18th, 2014, a 4-hour symposium ("Utilizing orthopteroid insects to overcome grand challenges in an ever-evolving world.") occurred that was focused solely on orthopteroids, organized by myself and my collaborators: Tyler Raszick (Dept. of Entomology/Sword Lab, Texas A&M University, tjraszick@gmail.com), Ricardo Mariño-Pérez (Dept. of Biology/Song Lab, UCF, pselliopus@yahoo.com.mx), and JoVonn Hill (Mississippi Entomological Museum, Mississippi State University, jgh4@entomology.msstate.edu). Overall, I think the symposium was a rousing success because it went off without a hitch, it was entertaining and informative (according to us and audience members who told me so), and there were at least 50 people watching at any given moment, a good crowd for such a large meeting during which there are probably, at minimum, 20 other talks/symposia running simultaneously.

Naturally, the speakers deserve most of the credit for drawing in the crowd since they did the majority of the work in that respect. Tyler kicked off the event with an excellent overview of orthopteropids followed by our 11 invited speakers and Ricardo. We had a good mix of students, post-docs, and seasoned researchers (Fig. 1), including two who came from outside the U.S. (Mexico and Australia): Katy Frederick-Hudson, Oscar Salomon Sanabria-Urban, Dominic Evangelista, Rachel Slatyer, Paul Lenhart, Daniel R. Howard, Gavin J. Svenson, John Barone, Amy Vandergast, Janice S. Edgerly, and our keynote speaker, Johannes Schul. Orthopteroid groups were also diverse and included (in approximate presentation order): Tettigoniidae, Pyrgomorphidae, Blattaria, Gryllidae, Dermaptera, Phasmida, Anostostomatidae, Mantodea, Stenopelmatidae, and Embioptera. Equally impressive were the myriad of topics being studied (in approximate presentation order): acoustics, divergence time estimates, speciation, phylogeography, phylogenetics, thermal tolerance, entomophagy, nutrition, vibrational communication, DNA barcoding, and cryptic diversity. If you'd like to learn more about these subjects and topics, please refer below to the brief abstract and figure provided by each speaker (organized in order of presentation).

Figure 1. Symposium speakers and organizers (from left to right and top to bottom): Dominic Evangelista, Oscar Salomon Sanabria-Urban, Amy Vandergast, Johannes Schul, Paul Lenhart, Gavin J. Svenson, Ricardo Mariño-Pérez, Tyler Raszick, Janice S. Edgerly, Derek A. Woller, Katy Frederick-Hudson, Daniel R. Howard, Rachel Slatyer, and John Barone. Not pictured: JoVonn Hill (sadly for us, he was busy successfully defending his dissertation).

Our primary goal was to bring orthopteroids, particularly Orthoptera, back into the spotlight at ESA, the last time being 2004 when Hojun Song organized an Orthoptera symposium. I think we successfully met that goal, so, following the close of the symposium, the conquering heroes headed to The Green Dragon Bistro and Pub, one of Portland's premiere craft beer establishments. Naturally, a good time was had by all (Fig. 2)! We sincerely hope that someone else in the Society will be inspired by our venture to organize one of their own at ESA or elsewhere now that orthopteroids have gained some momentum once more. Please feel free to contact me or one of the other organizers if you have questions or would like advice.

I'd also like to thank a number of people who contributed significantly to our symposium success: Hojun Song for his support and mental rolodex, Michael S. Engel for suggesting and encouraging the assembly of these abstracts, and, of course, those members of the Orthopterists' Society who graciously gave us the necessary funding to thoroughly enjoy the after-

Figure 2. The after-symposium celebration in full swing.

symposium celebration: David Eades, Michael Samways, Pamm Mihm, and David Hunter.

Know your orthopteroids: An introduction to the subjects of this symposium

Tyler Raszick, Texas A&M University, College Station, TX

Orthopteroid insect orders, those that would have historically been included in the order Orthoptera by Carl Linnaeus in Systema Naturae, are a diverse and speciose group of arthropods that showcase a variety of interesting evolutionary and ecological traits. Modern orders that have been classically considered as orthopteroid include: Blattodea (cockroaches), Dermaptera (earwigs), Grylloblattodea (ice crawlers), Mantodea (praying mantises), Phasmatodea (stick insects), and, of course, the Orthoptera (crickets, grasshoppers, and katydids). Additionally, the newly discovered order Mantophasmatodea (heel-walkers) is also considered to be orthopteroid, and recent phylogenies have illustrated the paraphyly of the orthopteroid orders within the remainder of the Polyneoptera (Zoraptera, Plecoptera, Embioptera), and have also placed Isoptera within the Blattodea.

Despite the large number of orders considered to be orthopteroid, either classically or as the Polyneoptera, orthopteroid insects have been greatly underrepresented at the annual meetings of the Entomological Society of America for a number of years (Fig. 3). Furthermore, a disturbing trend is revealed when comparing the representation of orthopteroid insects to other orders of insects; although the number of talks has increased by roughly 200 over the past 4 years, the number of talks discussing orthopteroid insects has remained stagnant. To bring attention to this issue, the stunning diversity, and research possibilities provided by the orthopteroids, we organized a symposium at the 2014 annual meeting of the ESA, and attempted to both sound a call-to-arms for orthopteroid insect researchers to present their research, as well as highlight these magnificent insects.

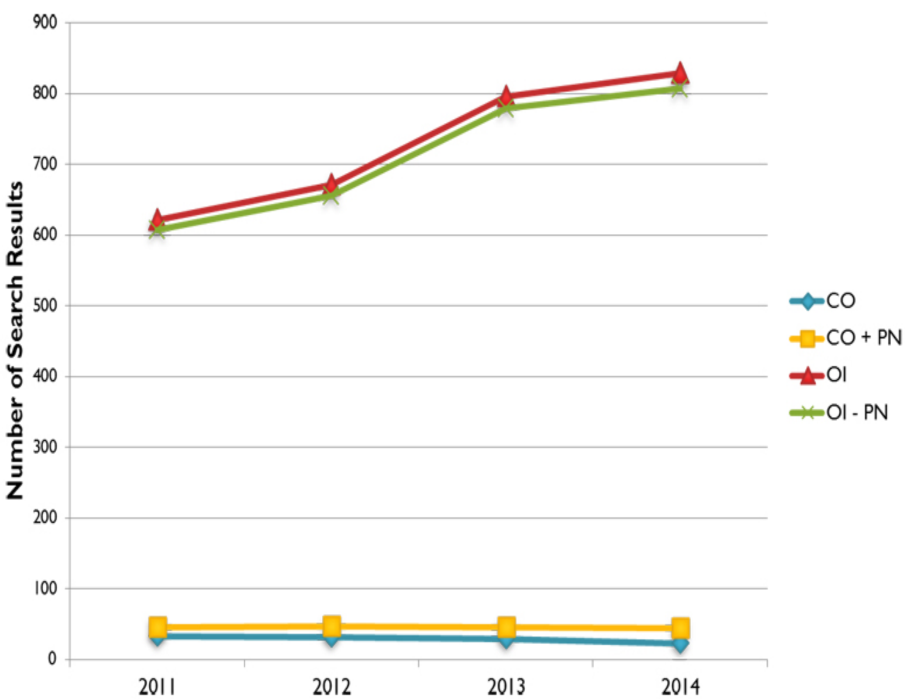

Figure 3. Underrepresentation of orthopteroid orders at ESA annual meetings: y-axis represents the number of times that groups of orders of insects appear in the program during the past 4 meetings (x-axis). (CO = classical orthopteroids, PN = Polyneoptera, & OI = other insect orders)

Faster than cichlids? Rapid diversification in *Neoconocephalus*

Katy Frederick-Hudson, University of Missouri, Columbia, MO, USA.

Evolution of communication systems is inherently complex, requiring coevolution between sender and receiver mechanisms. Males of the katydid genus *Neoconocephalus* have four common signal phenotypes. This study used comparative methods to investigate the relationship of signal diversity and biogeography and applied an Orthopteran mutation rate to determine clade age and better explain *Neoconocephalus* evolutionary history.

Ancestral state reconstructions revealed three derived call traits with independent evolutionary histories. These call traits each have multiple independent origins and subsequent

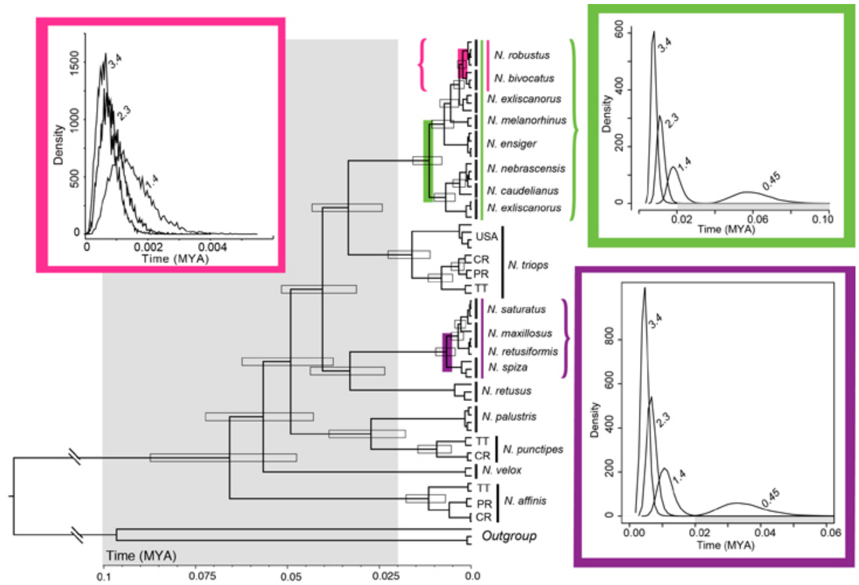

Figure 4. Phylogenetic reconstruction of *Neoconocephalus*. Colored boxes = estimates of speciation events for corresponding tree regions.

losses, indicating plasticity of signal evolution in this system. *Neoconocephalus* occur ancestrally in tropical grasslands. Most temperate species are found in a single monophyletic clade with few additional migrations (Fig. 4). This clade recapitulates the total signal diversity of the genus. The temperate clade contains at least one species with each derived call trait, as well as species with entirely ancestral call characters. Conversely, the sister clade to this temperate clade contains one species (*N. triops*), which phylogenetic analysis has shown to have greater genetic diversity with less signal variation than among all species in the temperate clade. Additionally, mitochondrial ultrametric (relative-time) analysis indicates that the *N. triops* clade, like all tropical clades, is older than its sister temperate clade.

We conducted molecular clock analysis, calibrating the ultrametric time tree with several mutation rates found in invertebrate and orthopteran literature. These mutation rates all dated the speciation within the temperate clade to less than 50,000 years ago (Fig. 4- Green box).

To accurately date the age of the temperate clade we built an Orthopera phylogeny from mitochondrial DNA (mitogenomes and COI genes). Using 14 fossil calibrations, we calculated a mutation rate specific to Orthopterans across the phylogeny, as well as a mutation rate specific to the Copiphorini tribe (cone-headed katydids). Calibrating a molecular clock using mutation rates specific to the ingroup of interest is preferable to using rates borrowed from other taxonomic groups. However, these mutations rates largely supported rates from the literature.

Temperate *Neoconocephalus* diversification is young; even by conservative estimates it occurred during the last glacial cycle and likely in the last 12,000 years, coinciding with the end of the Last Glacial Maxima (LGM) and subsequent fluctuations in temperature for thousands of years. Instead of species diversifying in refugia between glaciations, *Neoconocephalus* species simply moved North with the receding glaciers traveling out of South and Central America. As the species migrated North there was a period of rapid signal diversification due to drift along the migration front resulting in reproductive isolation. *Neoconocephalus* expansion occurred much faster than it did in other well-known island radiations (i.e. Hawaiian *Laupala* crickets), which radiated over millions of years. Our findings are consistent with Cichlid radiations within lakes of the African Rift Valley, due to temperature fluctuations and glacial cycles. These rapid diversifications are similar in both the amount of phenotypic diversity and the timescale of thousands of years. Finally, our results highlight how rapidly acoustic communication systems can diversify and has important implications for our understanding of the underlying evolutionary mechanisms.

Systematics of Sphenariina (Orthoptera; Pyrgomorphidae)

Oscar Salomon Sanabria-Urban[1], Hojun Song[2], Ken Oyama[3], Antonio González-Rodríguez[3], and Raúl Cueva del Castillo Mendoza[1]. [1]Facultad de Estudios Superiores Iztacala, Universidad Nacional Autónoma de México, Tlalnepantla, 54090 México, México; [2]University of Central Florida, Orlando, FL, USA; [3]Centro de Investigaciones en Ecosistemas, UNAM, Morelia, 58190 Michoacán, México.

Multiple studies on vertebrate and plant taxa propose that the formation of the Mexican Volcanic Belt, the inundation of the Isthmus of Tehuantepec, and the Quaternary climatic fluctuations (QCF) are primarily drivers of biotic diversification in Central and Southern Mexico. The spatial and temporal occurrence of these three events suggests a model of diversification for Neotropical biotas in Mexico, in which phylogenetic relationships and interspecific divergence among taxa might reflect the occurrence of past geologic and climatic events.

Comparatively, the knowledge about patterns of diversification of Neotropical insects is sparse. However, the grasshoppers in the genus *Sphenarium* (Fig. 5) represent a good system to further explore the effects of patterns of geologic and climatic events on the diversification of animal species, given the biology, ecology,

Figure 5. Representative species of the genus: *Sphenarium mexicanum histrio*.

and biogeography of these grasshoppers. Towards this end, we used the genetic variation of sequences of five mitochondrial and nuclear loci in combination with a wide in-group and out-group taxonomic sampling to reconstruct the phylogenetic relationships of *Sphenarium* and estimate divergence time among its species. We obtained the first phylogenetic reconstruction of the genus *Sphenarium* to date and observed that monophyly of the genus as well as some internal monophyletic groups were strongly supported.

Our results also indicated that taxonomy of the genus needs a more detailed revision, although we observed a strong geographic association of the monophyletic groups found. Phylogenetic relationships and divergence time estimations among principal lineages were congruent with the proposed model of diversification. Our results also suggested that considerable lineage diversification in the group occurred during the last 3 million years before the present, probably associated with QCF.

Overall, this work contributed to knowledge about the impact of past geologic and climatic events on diversification of Neotropical fauna in Mexico, particularly insects. Additionally, we propose *Sphenarium* grasshoppers as a system to more deeply study the genetic and demographic effects of QCF and the role of other evolutionary forces on the diversification of Neotropical insects.

What we could learn from a phylogeny of Blaberoidea

Dominic Evangelista and Jessica L. Ware, Rutgers, The State University of New Jersey, Newark, NJ, USA.

The Blaberoidea are a diverse group of cockroaches that contains over 3,600 described species. In this rich group are examples of the evolution of many novel niches, diets, social structures, parental care strategies, and other behaviors. We believe that a phylogeny of this group is important because it would map the course of evolution of this great diversity. To this end, we provide a phylogeny of this superfamily synthesized from multiple studies as well as the number of species known in each major clade (Fig. 6). We also believe that understanding the evolution of nitrogen physiology in Blaberoidea would give insight into explaining the drivers of diversification in this group. We show this in a broader phylogenetic context by looking at how possible shifts in nitrogen pathways correlate with gains and losses of the endocellular symbiotic bacteria, *Blattabacterium*.

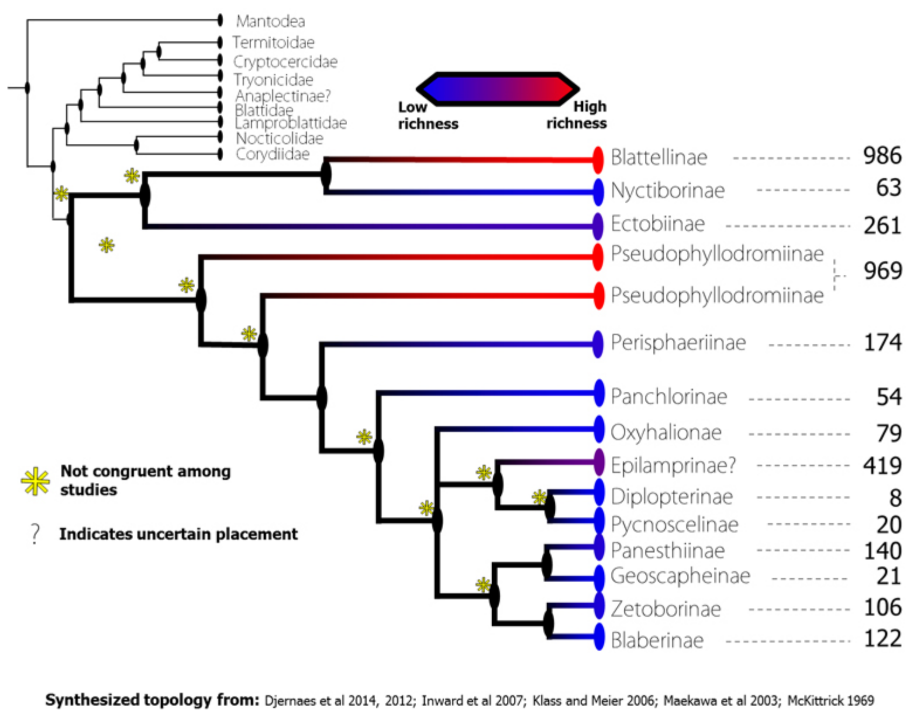

Figure 6. Reconstructed phylogeny of Blaberoidea.

Some like it hot, some like it cold: Thermal tolerance in Australian alpine grasshoppers

Rachel Slatyer, Michael Nash, and Ary Hoffmann, University of Melbourne, Parkville, Australia.

Alpine species are distributed across steep environmental gradients and turnover of closely-related species along these clines is common. Thermal tolerance is frequently inferred as a proximal driver of both high- and low-elevation range limits across a wide range of species, as temperature decreases rapidly with elevation. Furthermore, locally adaptive variation within species can be maintained where populations exist along an environmental gradient. Three species of mountain-endemic grasshoppers (*Kosciuscola* genus) occupy overlapping elevation zones in the mountains of southeastern Australia. We explored the role of thermal tolerance in shaping distribution patterns of *Kosciuscola* in the Kosciuszko alpine region, and the potential for local adaptation in thermal limits. First, we tested whether the two high-elevation

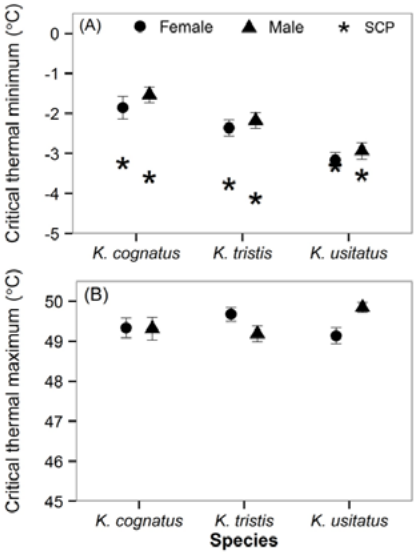

Figure 7. Thermal tolerance of 3 species of *Kosciuscola*: A.Cold tolerance. B. Heat tolerance. *SCP = Supercooling point

species have greater cold tolerance and/or poorer heat tolerance than their lower-elevation counterpart by measuring both heat and cold tolerance for each species from a site where all three species co-occur. Second, we tested for an altitudinal cline in thermal tolerance among populations of each species by measuring thermal limits at high- and low-elevation sites.

All species showed remarkable thermal tolerance ranges of over 50°C. Higher-elevation species were more cold-tolerant (Fig. 7A) and all species occupied thermal environments close to (or exceeding) their cold tolerance limits, suggesting a role for thermal adaptation in shaping patterns of species turnover. Heat tolerance is considered to be a more conserved trait across lineages than cold tolerance, and we found no variation in heat tolerance among the three species (Fig. 7B). However, exposed dark soils in the Australian alps exceed 45°C during the summer, and high heat tolerance could thus be an adaptive, rather than conserved trait.

Within species, there was no detectable variation in cold tolerance but a generally greater heat tolerance in higher-elevation populations. Whether this variation reflects local adaptation or plasticity is unclear, but is correlated with a greater incidence of high-temperature extremes at the higher-elevation sites of each species. Tree and shrub cover (and, hence, available shade) also decrease with elevation, increasing the potential for exposure to temperature extremes. Clear differences in patterns of physiological variation among and within species emphasise that understanding species distributions in the context of physiological traits requires both species- and population-level measurements.

Edible orthopteroids: The Mexican case

Ricardo Mariño-Pérez, University of Central Florida, Orlando, FL, USA.

In Mexico, 78 unique species from 42 genera of Orthoptera are/were historically consumed by humans. The great majority belong to 6 families: Ensifera: Gryllidae, Phaneropteridae, and Tettigoniidae, and Caelifera: Pyrgomorphidae, Acrididae, and Romaleidae. Due to the fact that entomophagy was a common practice among the pre-Hispanic civilizations that were distributed in Central and Southern Mexico, those areas are the richest in insect consumption and the order Orthoptera is not the exception. The states of Chiapas, Oaxaca and Veracruz report 25, 24, and 23 species, respectively. Concerning the indigenous groups, Orthoptera consumption is highest among Nahuas (53 spp.), Zapotecos (52 spp.) Otomíes (44 spp.), Mixtecos (41 spp.), and Mayas (28 spp.).

The modern descendants of Aztecs are known as Nahuas and they still eat orthopterans belonging to genera *Schistocerca* and *Melanoplus* (Acrididae), *Taeniopoda* (Romaleidae), *Sphenarium* (Pyrgomorphidae), and *Neoconocephalus* (Tettigoniidae). In Oaxaca, some of the species eaten belong to the genera *Schistocerca*, *Melanoplus*, *Arphia*, *Boopedon*, *Encoptolophus*, and *Sphenarium*. In the State of Mexico some Ensifera consumed are from the genera *Petaloptera* and *Stilpnochlora* and some Caelifera belong to the genera *Schistocerca*, *Melanoplus*, *Opeia*, *Trimerotropis*, *Rhammatocerus*, *Xanthippus*, *Boopedon*, and *Sphenarium*. In the area of Zongolica in Veracruz state several genera of Phaneropteridae and Tettigoniidae are eaten, such as *Stilpnochlora*, *Conocephalus*, *Neoconocephalus*, *Scudderia*, and *Microcentrum*, as well as crickets of the genus

Figure 8. A typical and common vendor in the streets of Oaxaca City, Oaxaca, Mexico selling nymphs and adults of *Sphenarium purpurascens purpurascens*.

Gryllus. Also, other orthopteroids, such as cockroaches (*Periplaneta* sp. and *Blaberus* sp.) and phasmids (*Bacteria* sp.) are consumed. In the great majority of the cases both nymphs and adults are considered edible.

The species *Sphenarium purpurascens purpurascens* deserves particular attention because it is one of the most abundant species of grasshoppers in Mexico. In fact, this species is considered a plague in certain areas (mainly northern areas of central Mexico) whereas in central and southern Mexico it is, by far, the most consumed species of insect in Mexico. Known locally as "chapulines", they are harvested in cornfields mainly in the states of Tlaxcala, Puebla and Oaxaca. The typical recipe once collected is leaving them one or two days without food to clean the digestive tract. In some cases pieces of paper or cardboard are provided with the same purpose. After that the chapulines are boiled, sun-dried, and seasoned with salt, lemon, and garlic juice. Finally, they can be fried or grilled and are sold in fresh markets, especially in Oaxaca state (Fig. 8).

Some uses for orthopteroids beyond nutrition in Mexico are, for example: rub an entire cockroach (*Blatta orientalis*) to cure Tetanus and cook an entire earwig (*Forficula auricularia*) and eat it for ear pain and cough. Also, eat a locust (*Schistocerca piceifrons*) to cure hiccups, boil in water some legs of *Sphenarium p. purpurascens* in case of constipation or the whole animal if there is urination pain, and toast a cricket (*Gryllus* sp.) and eat it for stuttering.

Combining nutrition and community ecology of grasshoppers to benefit ecosystems and people

Paul Lenhart, University of Kentucky, Lexington, KY, USA.

Rangeland grasshoppers often compete with livestock for forage in grasslands around the world. Better predictive models of grasshopper outbreaks could improve rangeland management practices and allow more targeted application of insecticides. Advances in nutritional ecology, namely nutritional geometry, have capitalized on acridids as model organisms and could provide a better understanding of plant-mediated changes in grasshopper populations and communities. These studies have found that plant nutrient content is an important parameter to consider because animals actively regulate for specific ratios of protein:carbohydrate (p:c) through foraging decision-making.

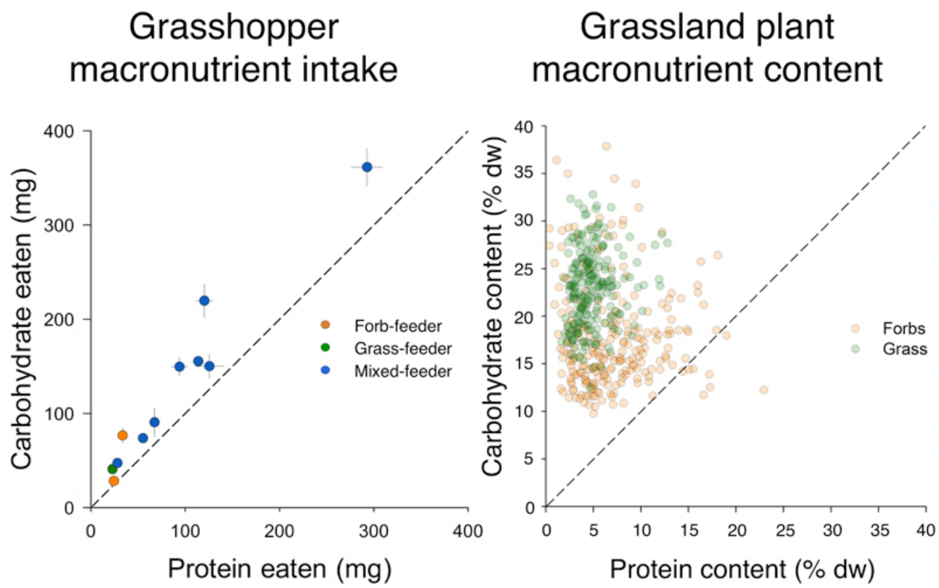

Figure 9. Grasshopper macronutrient intake and grassland plant macronutrient content.

I determined host plant use and preferred macronutrient intake among dominant grasshopper species in Central Texas using microscopic analysis of gut contents and artificial diet experiments, respectively. I found that grasshoppers had broadly overlapping diets despite significantly different nutritional requirements. The grasshoppers' preferred p:c ratios were all carbohydrate-biased (Fig. 9) and differences were associated with diet and not taxonomic groupings. I also documented temporal and spatial variation in the digestible protein and nonstructural carbohydrate content of forbs and grasses in the same grassland during the summer of 2009 and 2010. This study provided a view of the 'nutrient landscape' available to generalist grassland herbivores (Fig. 9). The ratio of plant p:c was carbohydrate-biased with significant differences between forbs and grasses, between sampling times, and between sites.

Using a model selection approach I found that grasshopper densities were correlated with different nutritional metrics based on year. During a severe drought in 2009 the variation in plant protein and carbohydrate shrank over the course of the summer, which was correlated to a decline in both total and grass-feeding grasshopper densities. During the wet summer of 2010 spatial variation in all grasshopper densities were negatively correlated with plant protein and protein:carbohydrate ratio, challenging the nitrogen limitation hypothesis. More work is required before predictive models of grasshopper community responses can be formulated. There appears to be a mismatch between the quantified protein:non-structural carbohydrates of specific host plants and the preferred p:c intake of associated grasshopper species determined by laboratory choice experiments. Differences could be related to how efficiently different grasshoppers extract nutrients from plant tissue. Interactions between host plant nutrient quality and plant defense traits also need to be understood. Nevertheless, this nutritional approach could be a critical component of future grasshopper population management. In the near future, it may be possible to remotely sense for plant nutrient quality in real time across broad swathes of rangeland, identify areas with conditions indicative of a potential outbreak, and apply targeted control measures if necessary.

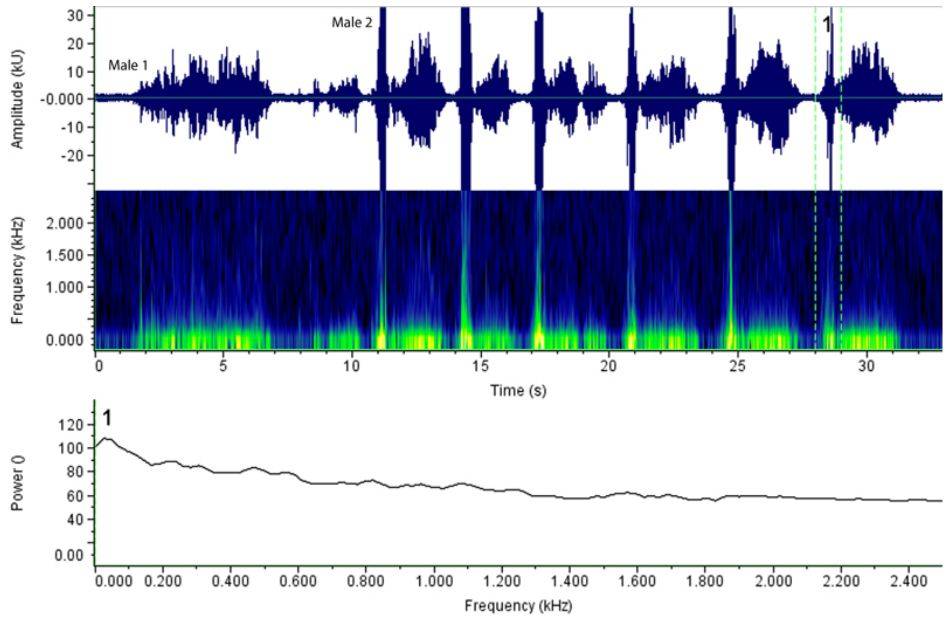

Figure 10. Oscillogram (top), spectrogram (center) and FFT (bottom) of a vibrational duetting bout in a pair of Cook Strait giant weta males. Males were observed to produce a low frequency (DF=36.73±6.34 Hz) signal of variable pulse length (0.56–3.45s). Substrate-borne vibrational duetting would only occur when two males were in the presence of a female, and generally concluded with one male abandoning courtship efforts and the winning male remaining in possession of the female.

Talking back to the night: Vibrational communication in the New Zealand Giant Weta (Anostostomatidae: Deinacrida)

Ashley P. Schmidt[1], Claire E. Bestul[1], Courtney L. Moore[1], Andrew C. Mason[2], and **Daniel R. Howard**[1,3].
[1]Augustana College Department of Biology, 2001 S. Summit Ave., Sioux Falls, South Dakota 57197 USA;
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Communication via substrate-borne vibration is common in many insect groups, with vibration often serving as a secondary or tertiary channel of a multimodal signal. The Cook Strait giant weta, *Deinacrida rugosa* (Insecta: Orthoptera: Anostostomatidae), is an endangered New Zealand orthopteran insect belonging to an endemic genera whose communication systems remains poorly understood. Our field observations of intraspecific interactions in *D. rugosa* provided us with preliminary evidence that individuals produce some form of substrate-borne vibrational signal in unknown contexts. In this study we conducted laboratory behavioral assays to identify the following with respect to vibrational communication in *D. rugosa*: 1) the acoustic structure of vibrational signals, 2) the biomechanics of signal production, 3) if signals are produced by box sexes and are structurally differentiated, 4) if substrate-borne signals transmit information regarding sender morphology, 5) the primary social context in which vibrational signals are produced, and 6) the function of vibrational signaling in *D. rugosa*.

We tested the model observed in other insects that use substrate-borne communication that in *D. rugosa* vibration functions in both intra- and intersexual signaling, associated with courtship and inter-male aggression. Using giant weta collected at our Matiu-Somes Island Scientific and Historic Reserve field site, we used laser Doppler vibrometry to show that *D. rugosa* produce low frequency (36.73±6.34 Hz) substrate-borne vibration for intraspecific communication, with males producing an alternating duet through dorso-ventral tremulation (Fig. 10). Males were observed signaling while in the presence of a female and another male, most commonly engaging in inter-male vibrational duets. Vibrational responses to playback signals were only solicited from males in male-male-female social contexts, and both sexes exhibited negative walking taxes to playback signals, indicating that substrate-borne vibrational signals are not likely produced by males for purposed of courtship. Male vibrational duetting bouts resulted in one male abandoning the trio, leaving the winning male with sole possession of the female. While we found that vibrational signal structure was not closely related to signaler size, larger males that initiated duetting bouts held a significant advantage in winning competitive encounters. We infer from our findings that substrate-borne vibrational signaling in *D. rugosa* serves to lower costs associated with inter-male competition for mates, with contests settled without escalation into costly fights.

Project Mantodea: An update on the phylogeny and revision of two praying mantis clades (Earless Neotropicals and the Hymenopodidae)

Gavin Svenson, Cleveland Museum of Natural History, OH, USA, Julio Rivera, University of Toronto, Canada, Nate Hardy, Auburn University, AL, USA, Frank Wieland, Pfalzmuseum für Naturkunde, Germany, and Haley Wightman, Brigham Young University, UT, USA.

We performed a suprageneric revision of the plant-mimicking mantis families Empusidae and Hymenopodidae as well as an heterogeneous assemblage comprising ca. 55% of mantodean diversity in the New World called the "polymorphic earless praying mantises". The phylogenetic revision of the Hymenopodidae and Empusidae was based on 124 morphological characters and a DNA dataset comprised of ten gene fragments for an aligned matrix with 7,511 nucleic acid sites. We recovered largely congruent topologies across molecular, morphology, and total evidence analyses. Empusidae and its assigned subfamilies were recovered as monophyletic. Hymenopodidae was recovered as paraphyletic with respect to Sibyllidae and Phyllotheliinae (Mantidae) while a small assemblage of hymenopodid taxa (*Galinthias*, *Congoharpax*, *Pseudoharpax*, and *Harpagomantis*) were recovered among outgroup taxa. The Caribbean genus *Epaphrodita* fell outside ingroup taxa, far from the rest of the hymenopodid subfamily Epaphroditinae, in which it is classified. The non-monophyly of Acromantinae was recovered with some species within Oxypilinae and others recovered within Hymenopodinae.

We presented a new classification scheme that includes a newly-elevated family and subfamily, a reinstated tribe, a demoted family to subfamily, a newly-assigned subfamily to Hymenopodidae transferred from Mantidae, and a new tribe. We used our morphology characters to produce extensive re-descriptions of all suprageneric groups as well as best character diagnoses. The phylogenetic revision of the neotropical mantises was based on a DNA dataset of 9,949 aligned nucleic acid characters comprising ten mitochondrial and nuclear genes. Our analyses largely resolved congruent relationships with high levels of support for higher-level taxonomic groups, while revealing multiple inconsistencies between the resolved topology and morphology-based classification systems. The polymorphic earless praying mantises, now granted superfamily status as the Acanthopoidea stat. n., comprises eight families including new subfamilies and tribes. Our new system resulted in the reassignment of various genera to new and existing higher-level taxa, the exclusion of old world genera otherwise traditionally classified among the Thespidae, Liturgusidae and Angelidae, the confirmation of *Stenophylla* Westwood, 1845 as a member of this clade, and the revalidation of *Paradiabantia* Piza, 1973 stat. rev. We provided preliminary diagnoses for all suprageneric taxa using a combination of both external morphological characters and/or male genital features, all summarized in dichotomous keys. We also incorporated egg case structural variation as a novel character for taxon delineation.

DNA barcoding to determine the diets of prairie grasshoppers

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DNA barcoding is a molecular technique that allows for the identification of taxa from small tissue samples. Gene regions that are variable across species but relatively uniform within a species are used. These regions include CO1 from the mitochondrial genome of animals and rbcL and matK from the chloroplast genome of plants. DNA barcoding has been used to examine the diets of several species of herbivorous mammals by barcoding plant material found in their feces and comparing recovered sequences to a DNA barcode "library." More recently, a study confirmed the host plants of leaf beetles by grinding up the beetles and extracting and identifying the plant DNA from the samples.

Here, we describe a non-destructive approach in which the diets of grasshoppers were determined by collecting the frass from live individuals. First, a plant DNA barcode library was produced from herbarium specimens that had recently been collected from the Black Belt prairie region of Mississippi and Alabama. The library included 475 specimens from 205 species. For each sample, both the rbcL and matK gene regions were sequenced. For these plants, rbcL was recovered at a higher rate than matK (91% vs. 68%). The rbcL barcode had a modestly higher rate of identification success than matK for monotypic plant genera (80.2% vs. 72.0%), but similar rates for polytypic plant genera (28.2% vs. 32.1%, respectively). Based on these results, rbcL was the preferred barcode region for this flora.

Second, frass samples were taken from a prairie site in eastern Mississippi. Grasshoppers were caught and held in test tubes until they released a frass pellet. They were then identified and released, unharmed. The frass was kept in a dessicator to prevent mold growth until DNA extraction was done using Fast DNA® SPIN Kits. After extraction, the DNA was amplified using primers for the rbcL gene region. The amplified product was sequenced using the same primers for PCR. From 78 samples, 38 (48.7%) yielded high quality PCR

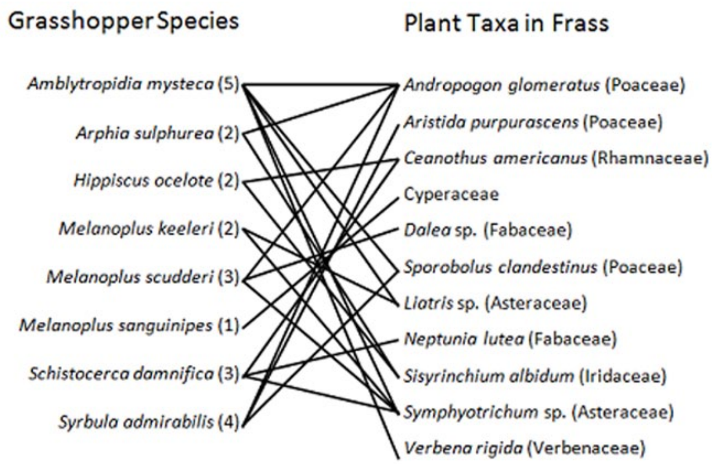

Figure 11. Tentative food web for grasshoppers in Black Belt prairies based on the results of DNA barcoding. Numbers in parentheses indicate the number of samples from that grasshopper species.

products. Thirty of these samples were sequenced, yielding 23 high quality bidirectional sequences. Sixteen were homozygous, meaning that a single plant species was present in the frass pellet. Based on comparisons with the barcode library, 11 samples could be identified as having come from a particular plant species, and four more from a particular plant genus (Fig. 11). Data for eight grasshopper species show that most are fairly generalist in diet, but some, such as *Schistocerca damnifica*, appear to consume only forbs. Thus, DNA barcoding holds considerable promise for non-destructively determining the diets of grasshoppers and other insects, providing a valuable complement to fieldwork.

Cryptic diversity within the North and Central American Jerusalem Crickets (Orthoptera Stenopelmatidae): Influences of acoustic signaling and habitat heterogeneity

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The American Jerusalem crickets (Orthoptera: Stenopelmatidae: Stenopelmatinae) are one of the most conspicuous and large-bodied orthopteran lineages found throughout western North and Central America. In the western U.S., stenopelmatids are reportedly the insects most often brought to entomologists for identification and have been known by several descriptive common names in different languages including niñas de la tierra (children of the earth), wo se c'ini (skull insects; Navajo), potato bugs and Jerusalem crickets (Stoffolano and Wright 2005; Weissman 2005). Although there are 39 species named in the literature, comprehensive collection, rearing, and analysis of acoustic mating calls (produced by abdominal drumming) have revealed substantial cryptic diversity, with as many as 150 putative species (Weissman 2001a,b). Many of these species have specific habitat affinities and small ranges with the most species found in Mexico and California.

We are further examining patterns of acoustic signaling and geographic patterns of diversification within the context of a molecular phylogeny within this group. First, a broad phylogenetic analysis of nuclear and mtDNA gene regions from Stenopelmatidae and six other closely-related orthopteran families supports a monophyletic American Stenopelmatinae. Further phylogenetic analysis within the Stenopelmatinae supports clades with distinctive song characteristics and geographic affinities (Fig. 12). For example, species producing trilled drums, distributed from central California through western Washington, comprise a well-supported monophyletic clade as do species producing single drums throughout the North American desert basins and into British Columbia (east of the Sierra Nevada and Cascade mountain ranges). These clades further group with species distributed from Baja California, Mexico, through southern California

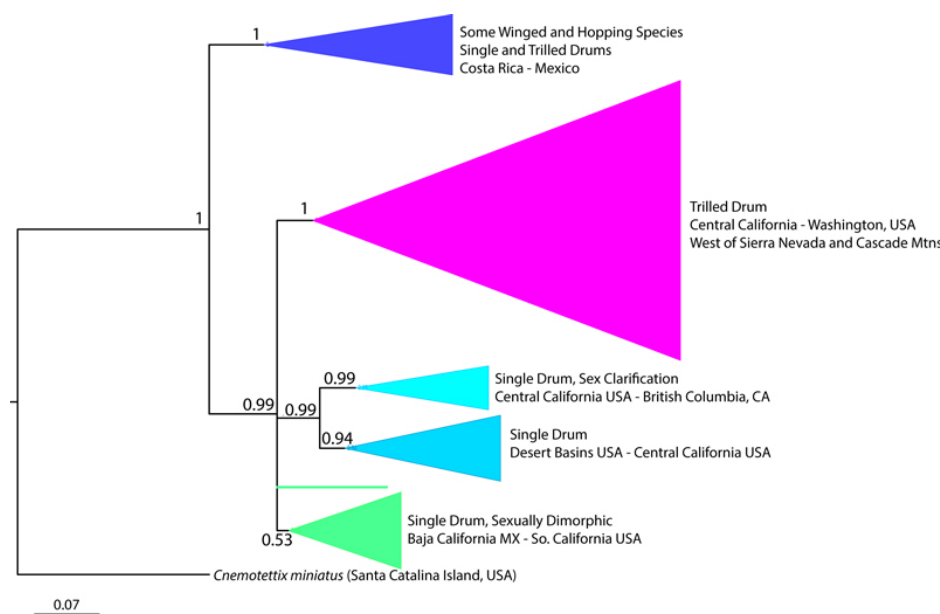

Figure 12. Bayesian consensus tree with posterior probabilities mapped at nodes. A Bayesian likelihood analysis of 1200 bp of the mtDNA COI gene sequenced from 103 individuals representing 55 song species and one outgroup was performed in Mr. Bayes using the GTR+I+Γ model. 10 million generations were run with trees saved every 1000 generations, and the first 10% of the data discarded as burn in.

with sexually dimorphic drums. Sister to this entirely wingless clade are the sometimes winged or hopping species distributed from Costa Rica to northern Mexico. Overall, these patterns suggest that both shifts in calling song and geographic barriers are associated with diversification in this group and warrant further study.

Finer scale examination of population genetic structure with two southern California species showed that populations can become genetically isolated with both natural and anthropogenic habitat fragmentation (Vandergast et al. 2007, 2009). Low vagility coupled with habitat specificity within a diverse landscape may have led to allopatric speciation over evolutionary time, but may also increase extinction risks in fragmented landscapes. We predict that many stenopelmatid species will be sensitive to habitat loss and fragmentation and those with restricted ranges and threatened habitats may require protection. Continued efforts to describe species and define their habitat affinities and ranges are paramount to such conservation efforts.

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Lessons from the embiopteran silk road

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The primitively social insect order Embioptera (approximately 2,000 species) shows little morphological variability and all exhibit maternal care of eggs and nymphs. Recent research has investigated how their use of silk (Fig. 13), social tendencies, or silk proteins might allow these otherwise similar insects to live in different habitats. Adult females (neotenous, flexible) run backwards and forwards in tubes they construct by stepping with front tarsi swollen with silk glands. They release silk with each foot-fall. Males, usually winged, also spin but die soon after mating. Habitats range from litter, underground, or on trees in humid regions (Fig. 13). As shown in Figure 13, they use silk to stitch leaves together, line burrows, or create elaborate coverings where they gain protection from the elements.

Field studies on *Antipaluria urichi*, a tropical rainforest species (Fig. 13) revealed that they gain protection by sharing expansive silk coverings. The risk of predation is more diffuse for individuals living in larger groups and may select for the colonial tendency for these tropical females. Silk is also important for nymphal development. Mothers spin copious amounts after egg hatch; when nymphs are alone in the field, they grow more slowly. A lab study demonstrated that nymphs reach smaller adult size if their silk is regularly torn and they repeatedly need to replace it. A comparative lab study also showed that *A. urichi* is highly gregarious, perhaps because they rely more on silk and sharing is an advantage. The opposite is true for the less social Australian detritivore, *Metoligotoma incompta* who spin little silk, relying more on leaves for cover (Fig. 13: Leaf litter). A species of intermediate silk usage, *Notoli-*

Figure 13. Visual overview of Embioptera, its habitat preferences, and its myriad uses for its silk. All photographs taken by J.S. Edgerly.

gotoma hardyi, showed intermediate tendencies to group-up. Thus, reliance on silk appears to relate to the colonial tendency of females.

Recent investigations of the chemistry of embiopteran silk have revealed features typical for this type of biopolymer: repeat motifs and beta-sheets aligned along the fiber axis. Their silk has the smallest diameter of any silks studied and is relatively rigid, reflecting the highest beta-sheet content observed to date. In addition, silk of *A. urichi* has a super-hydrophobic lipid coating. Water sits on the silk in high-relief droplets and sticks, as in the so-called rose-petal effect. When the lipid layer is chemically removed, droplets spread out, wetting the silk. Waterproofing appears adaptive for rainforest species, whose colonies are exposed to torrential rains. Embiopterans cut holes in the silk to drink in the adhered droplets when needed. Such behavior was featured in the silk spinner segment of the BBC's film *Life in the Undergrowth*. In that film, a female cut a hole beneath a droplet sitting on her silk, sucked in the water, and stitched the hole closed after taking the drink. In sum, the use of silk appears to promote group living, especially in species who rely heavily on silk for protection. Recent studies of silk proteins are revealing intriguing adaptations at the nano- and micro-structure level.

Acoustic communication in *Neoconocephalus*: From ion channels to phylogenetics

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During the last thirteen years we studied the diversity of the acoustic communication system of the katydid genus *Neoconocephalus*. This new world genus includes about 25 species in North and Central America and the Caribbean. The ancestral call pattern is an extremely fast pulse rate (>200 Hz) produced as a continuous trill. Three derived call patterns occur in this group: 1) pulses are produced as pairs (double pulses), 2) slower pulse rates below 50 Hz, and 3) discontinuous calls with pulses grouped to regularly-repeated chirps. Each one of these derived call traits has evolved several times independently.

We tested female call recognition for pulse and chirp patterns. We found at least 5 different recognition mechanisms for the pulse pattern and three mechanisms for the chirp patterns of male calls (Fig. 14). In addition, we found some species where male calls have derived characters but female call recognition remained in the ancestral state.

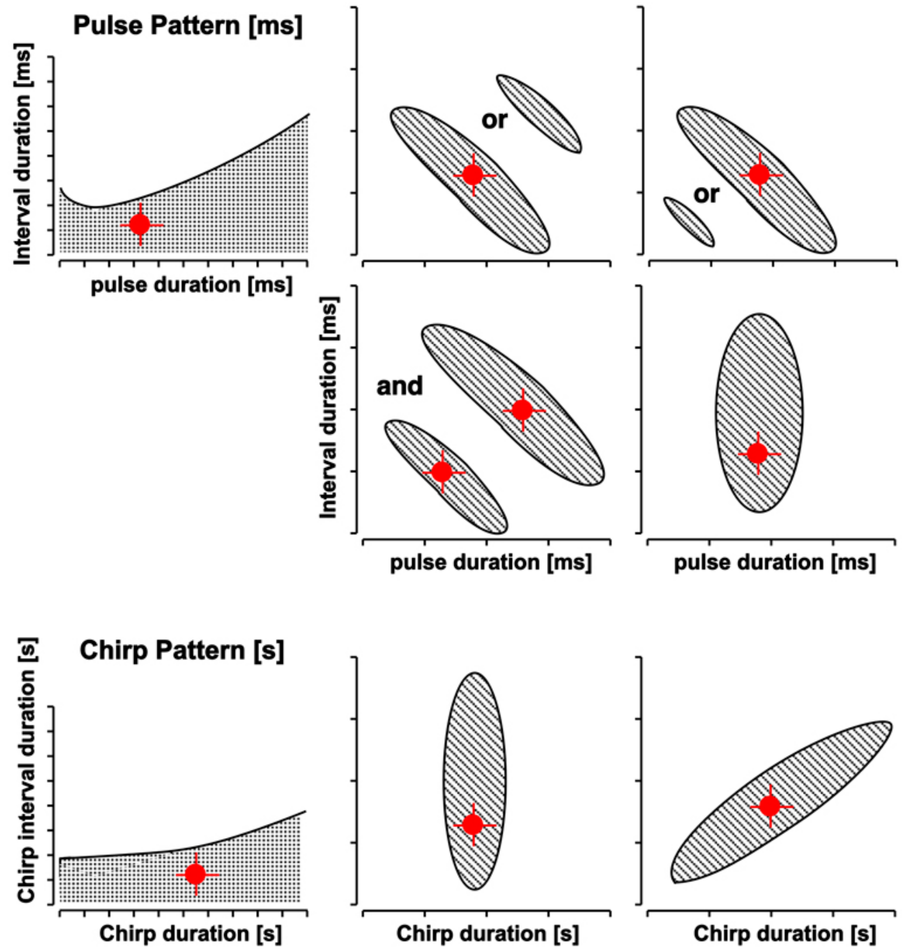

Figure 14. Sketches of attractive parameter spaces for female call recognition among *Neoconocephalus* species: Top: pulse pattern, Bottom: chirp pattern.

In species with discontinuous calls, neighboring males synchronize their calls. At least two types of synchrony occur. First, males settle into stable leader follower relationships, seemingly cooperating to preserve the chirp pattern. Second, males compete for the leading position of the duets. This competition is the outcome of female preferences for leading calls. Phylogenetic analyses indicate that competitive synchrony, as well as leader preference, has evolved at least twice in this genus. The phylogenetic pattern indicates that leader preferences are not the result of a preexisting sensory bias.

Comparative analyses of the processing of the temporal call patterns and their timing relationships in the ascending sensory pathway provide additional evidence on the evolutionary mechanisms shaping the communication system. Furthermore, molecular clock approaches reveal that the diversity of communication in this genus evolved extremely rapidly, with divergence times orders of magnitude less than found in comparable systems. For this talk, we attempted to integrate the various data sets into a comprehensive view of the evolutionary history and the mechanisms generating the diversity of this communication system.

*This work supported by several grants from the National Science Foundation to J. Schul and S.L. Bush.

Report on "CURSO-TALLER DE MANEJO DE LANGOSTA Y CHAPULÍN"

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In Mexico, there are approximately 600 described species of Caelifera (Orthoptera) distributed throughout diverse habitats within the country. Of these, some species are serious agricultural pests and there is a major ongoing effort to control pest grasshoppers and locusts. Primary pest species in Mexico include several species of *Sphenarium* (mostly *S. purpurascens*), *Brachystola*, *Taeniopoda*, and *Melanoplus*, and, of course, the Central American locust, *Schistocerca piceifrons*. In Northern provinces (Chihuahua and Zacatecas), *Brachystola* is the main pest species, damaging beans. In Central provinces (Guanajuato, Puebla, Querétaro, and Tlaxcala), *Sphenarium* is a chief pest, causing significant damages to maize. Querétaro is also affected by *Melanoplus* spp. *Schistocerca piceifrons* affects large areas in Northeastern provinces as well as the Yucatan peninsula.

In October 15-17, 2014, a workshop etitled, "CURSO-TALLER DE MANEJO DE LANGOSTA Y CHAPULÍN," was held in Merida in Yucatan peninsula, Mexico. The workshop was sponsored by various governmental organizations including Secretaria de Agricultura, Ganaderia, Desarrollo Rural, Pesca y Alimentacion (SAGARPA), and Servicio Nacional de Sanidad Inocuidad y Calidad Agroalimentaria (SENASICA). Local organization of the workshop was arranged by Mario Poot Pech, a locust control coordinator in Yucatan from Comite Estatal de Sanidad Vegetal de Yucatan (CESVY). The workshop was organized to provide the officers who fight to control grasshoppers and locusts in the field with the latest information.

Mario Poot Pech demonstrating how to manage locusts in the field

This three-day workshop consisted of two days of presentations at a beautiful hotel in Merida called "Los Aluxes" followed by a field trip to a locust-infested area in Municipio de Yobain. The workshop was attended by about 50 participants, mostly from different provincial locust control offices and universities. The presentations covered various topics including biological, microbial, and chemical control of grasshoppers and locusts, IPM methods, remote sensing, and locust phase polyphenism, as well as regional reports on the status of pest control efforts. Alex Latchininsky and Hojun Song were also invited to give

Participants of the locust workshop in Merida, Yucatan, Mexico several presentations. Mario provided translation for Latchininsky's presentations and Ricardo Mariño-Pérez provided translation for Song's presentations.

On the third day of the workshop, the participants visited an area infested with nymphal bands of *S. piceifrons*. According to Poot, the size of the bands in this area was small, but it was impressive to those who were not familiar with the locusts. During the site visit, there was also a demonstration of survey and management practices, led by the organizer Poot. Overall, this workshop was a very informative event for those who participated and it was also an excellent opportunity to make new collaborative networks among the participants.

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Report from the Annual Meeting of the National Grasshopper Management Board

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The annual meeting of the U.S. National Grasshopper Management Board (NGMB) took place January 21-22, 2015 in Denver, Colorado, U.S.A.. The meeting was attended by 44 participants from 15 western U.S. states along with Canada and Mexico. In addition, 19 people from 11 states attended the meeting remotely, through a webinar.

The NGMB was created in 1995 when federal subsidies for grasshopper monitoring and control dwindled to zero. The purpose of NGMB was to bring together pest managers and researchers across the West in order to develop and propose to end-users efficient, economical, and environmentally-friendly strategies and methods of grasshopper control. Grasshoppers are an intrinsic component of healthy rangeland ecosystems around the world. They are also major herbivores, which compete with wildlife and livestock for available rangeland forage. In the 17 U.S. states west of Mississippi, grasshoppers annually destroy 20 to 25% of above-ground rangeland vegetation at an estimated damage of $1 Billion. Out of about 450 species of grasshoppers in N. America north of Mexico about a dozen are recurrent economic pests. During outbreaks, chemical control has to be applied to millions of grasshopper-infested hectares. For example, in 2010, over 2 million hectares were protected from grasshoppers in western U.S. states with synthetic pesticides.

During the 2015 NGMB meeting, 17 states delivered reports on the grasshopper and Mormon cricket situation and control in 2014. In general, the densities were rather low across the western U.S. and chemical control was required only on very limited areas. Research reports by federal and state scientists dealt with efficacy of new pesticide formulations, non-target effects of chemical treatments, microbiological means of grasshopper control, and methods of grasshopper outbreak forecasting. The attendance gave a standing ovation to Professor Don W. Roberts from Utah State University, acknowledging decades of his tireless fruitful work in the domain of grasshopper fungal pathogens. There were two invited speakers: Mr. Mario Poot Pech from Yucatan, Mexico, and Dr. Hojun Song from Texas A&M University. Mr. Poot Pech presented on biology, ecology, and control of the Central American locust *Schistocerca piceifrons piceifrons* in Mexico. Dr. Song summarized the latest findings in locust phase polyphenism and also gave a fascinating presentation on the evolution of swarming behavior within the genus *Schistocerca*.

The next annual meeting of NGMB will take place in Denver on January 20-21, 2016. For more information, please vist: https://sites.google.com/site/ngmborg/.

The Orthopterists' Society Grant Reports

To be "Pavarotti" in a crowded concert hall? Song competition between bushcricket males in natural choruses: first field season and laboratory recordings

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The decision to study one of the most important theoretical issues of animal behavior, such as male competition and sexual selection, using one Orthopteran species, is well-justified. In fact, within the genus *Poecilimon* (Tettigoniidae: Phaneropterinae), *Poecilimon ampliatus* (Brunner von Wattenwy, 1878) presents several advantages: males compete by singing (intrasexual selection) and also produce a nuptial gift (spermatophore), which is extremely important to mating success. Females then choose (intersexual selection) the best singer and, consequently, the best quality male, reaching him by positive phonotaxis in this unidirectional communication system (Heller & von Helversen 1993). Moreover, this species is well-distributed in southeastern Europe, is easy to rear in the laboratory, and previous studies are also available. In another co-generic species with a unidirectional communication system, *P. zimmeri*, this mechanism of intra/intersexual selection, has been already proved: females prefer the heavier male of two singing competitors (Lehmann & Lehmann 2008) and these males transfer heavier nuptial gifts (spermatophores) (Lehmann & Lehmann 2008, 2009). Moreover, heavier males produce songs with higher duty cycles during song contests (Lehmann; pers. comm). Singing is fundamental to attract females for a successful mating. With my research, I will test how individual fitness and population density affects the singing performance of *P. ampliatus* males.

Figure 1. photo sequence showing the collection activity in the field of a male nymph of *P. ampliatus*.

This scholarship supported the preliminary work during my first Ph.D. year, in which I combined field work in Slovenia, where *P. ampliatus* occurs, with laboratory experiments at the Humboldt University of Berlin, Department of Biology, Behavioural Physiology. At the beginning of the field season (May 2014), I travelled to Slovenia in order to find an appropriate study area for the coming field seasons and in order to collect nymphal individuals. Over the course of five days, I was able to collect 154 male individuals of *P. ampliatus* (Fig.1) at Mount Slavnik, which is 1,028 m ASL. Nymphs were divided into two different feeding regimes, caged individually, and transferred to Berlin for subsequent acoustic experiments.

In the laboratory, specimens were kept under monitored temperature and light conditions. In order to investigate the male competition process, experiments were run using age- and weight-controlled male-male pairs. During 14 days of Lab recording, 30 couples were studied, resulting in a total in 548 recordings. The experiments were conducted within a sound chamber using two microphones simultaneously in order to record, digitize, and store the songs. I included into the analysis only those recordings in which both males were singing

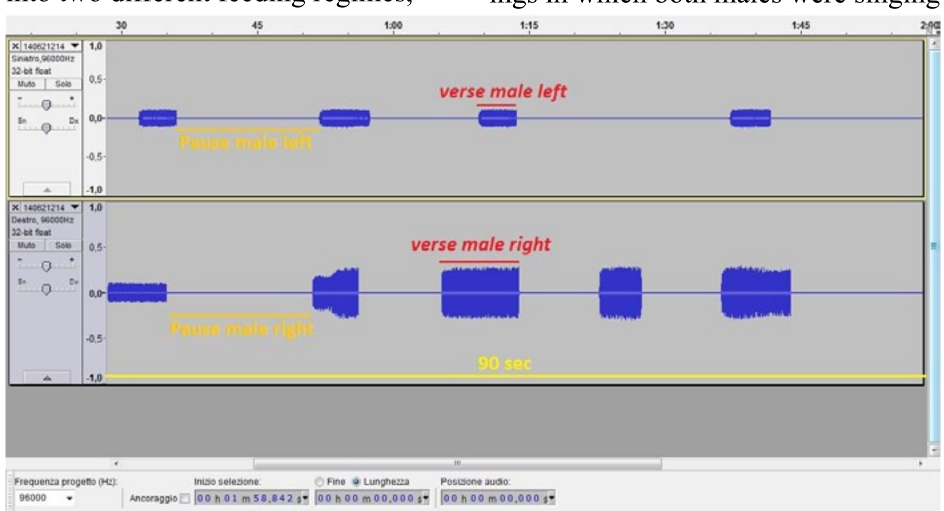

Figure 2. Spectrogram sample (90sec) of two males recorded in competition showing the song's verses spaced by pauses.

simultaneously during the competition trial.

The male songs of *P. ampliatus* consist of stereotyped subunits: the syllables, which are separated by silent pauses. Since the song parameters are decisive for recognition and acceptance by females in other bushcrickets species, I am expecting that it will be the same also in *P. ampliatus*. Along the same lines, I am now extracting several acoustic features, like verse and pause duration (Fig. 2). I expect that the heavier male will sing more (higher duty cycle, longer verse duration) than the lighter one. Moreover, the competition distance and diet treatments might affect singing capacity or efficiency of the males during song competition. In accordance with the hearing threshold there will be a "critical" distance between males, at which singers ignore each other.

My field season and preliminary laboratory experiments were made possible thanks to the incredibly useful support of my supervisor, PD Dr. Gerlind U.C. Lehmann and her family, who kindly helped me in the field to find, recognize, and collect the animals as well as to set up the experiments in the lab. I wish to also thank Dr. Karl-Heinz Frommolt from the Animal Sound Archive at the Museum für Naturkunde, Berlin, who provided me with all necessary acoustic equipment, and to M.Sc. Sara Garau who assisted during my field work in Slovenia. Financial support was provided by a research grant from the Orthopterists' Society.

Rare Color Form of *Atlanticus* Katydid Observed

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In June of 2005, while working on a book project (The Songs of Insects, Lang Elliott and Wil Hershberger, 2007, Houghton-Mifflin, Co.), I was looking for and recording the songs of *Atlanticus monticola* at the Big Meadows location within Shenandoah National Park, VA. After acquiring suitable recordings I began to focus on acquiring some interesting photographs of these singers in their native vegetation. Upon inspection, one of the first few observed individuals showed a striking green dorsum from head to posterior. The tegmina were of the typical brown color for this species. This individual was resting on the leaf of common milkweed (Fig. 1A). For visual impact, this male was moved to a nearby butterfly weed for more photographs (Fig. 1B). Further searching did not reveal any more green form *A. monticola*. Conversations with Dr. Tom Walker of the University of Florida indicated that no one had ever seen an *Atlanticus* of any species with green coloration. Dr. Walker directed me to contact Dr. T. Forrest of the University of North Carolina, Asheville. He, too, indicated that he had never observed or heard of green coloration on any *Atlanticus* species. His examination of photos and sound recordings from the 2005 specimen concurred with the *A. monticola* identification.

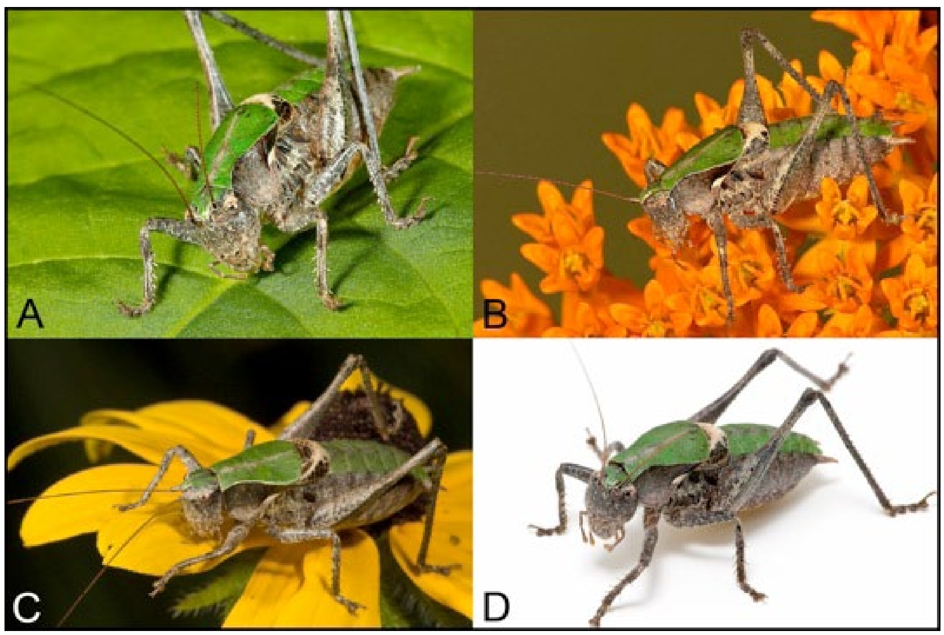

Figure 1. A. Green form of *Atlanticus monticola* on common milkweed leaf. B. Green form of *Atlanticus monticola* on butterfly weed flowers. C. 2008 individual on Black-eyed Susan. D. Original green form of *Atlanticus monticola* on white. All images copyright Wil Hershberger.

A repeat visit in July of 2008 revealed another male with a green dorsum as in the specimen from 2005 (Fig. 1C). This individual was found on foxtail grass. All of the brown form singing male *A. monticola* in this area were found on blueberry bushes. One female of the nominate brown color form was also observed. At this location in 2008, a two-hour search revealed 11 singing male *A. monticola*, one of which was the green form. Further research of this area needs to be performed to establish an accurate proportion of the green—striped form within the *A. monticola* population. While the song and the genitalia appear to be consistent with *A. monticola*, perhaps further examination of specimens could reveal a new species or sub-species of *Atlanticus* or *A. monticola* that has not been previously encountered.

How a non-sound-producing grasshopper can inspire a musical piece

- This contribution deals with a musical piece called "Purpurascens", created ad hoc to commemorate the 50th anniversary of the 2nd Section of the Urban Park "Chapultepec" in Mexico City

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As many of you know, the word for grasshopper in Spanish is "saltamonte", but, in Mexico, we often refer to grasshoppers as "chapulines". The word "chapulín" comes from Náhuatl (the language spoken by Aztecs): chapa(nia) = "bounce" and ulli = "rubber". Literally, it means the "insect that jumps like a rubber ball". The Florentine Codex (1540-1585 AD), written by the Franciscan missionary Bernardino de Sahagún, contains the first record of the word. In Book 11, "Earthly Things: About properties of animals, birds, fishes, trees, herbs, flowers, metals, stones and colors", Sahagún introduced different types of grasshoppers that share the same root (chapoli), such as "Acachapoli" (= arrow grasshopper = *Schistocerca* spp.), "Tiectli chapoli" (probably *Melanoplus* spp.) and "Xopanchapoli" (= summer grasshopper = *Sphenarium purpurascens purpurascens*) among others.

The Boturini Codex (1530-1541 AD) narrates the journey of the seven Nahuatlaca tribes from Aztlán to the Valley of Mexico. Their first place of arrival is depicted by a glyph comprised of a hill with a grasshopper at the top. This place is known as "Chapultepec", which means "at the grasshoppers' hill" (Fig. 1). The king of the Tepanecas of Azcapotzalco (owner of the entire basin, including the Valley of Mexico) allowed the Mexicas (ie. Aztecs) to establish themselves upon this hill, which was rich with grasshoppers. Nowadays, this hill and its surroundings are part of the urban park in Mexico City called "Chapultepec", which has three sections. Even the icon of the nearest subway station is a grasshopper (Fig. 2). The 2nd section was established in 1964 and, in order to celebrate its 50th anniversary in 2014, the Government of Mexico City asked the composer Felipe Pérez Santiago to write a musical piece.

Figure 1. Page 18 of the Boturini Codex.

Figure 2. Icon of the subway station "Chapultepec".

To do so, Felipe contacted Orthopterists' Society member Charles Bomar in order to obtain information about the species of grasshoppers and crickets that inhabit the Park, in particular, and Mexico City, in general. This, then, is the point at which I entered the story because Charles kindly put Felipe in contact with me, and, after some emails, he was very enthusiastic about the names of the common species from Mexico City, both in Latin and Náhuatl. He decided

Figure 3. Adults and nymphs of *Sphenarium purpurascens purpurascens*, Tecomatlán, Hidalgo, 29-IX-2012.

to name the musical piece "Purpurascens" because the most common species of grasshopper (both in Mexico City and around Mexico overall), *Sphenarium purpurascens purpurascens* (Pyrgomorphidae) (Fig. 3), is an iconic species due to its abundance and importance. For example, in certain areas of Mexico this species is a plague, whereas in others it is a delicacy and is sold for human consumption. Assisting with this endeavor was also a great pleasure because my dissertation is focused on the family Pyrgomorphidae.

The musical piece is written to be played by an entire symphonic orchestra, plus an ensemble composed of an electric guitar (played by Felipe himself), electric drums (Octapad) (Juan Antonio Arévalo), bass guitar (Jaime Vargas), soprano saxophone (Sofía Zumbado), sitar (Sidartha Siliceo), electronic keyboard (Camilo Froideval), and two singers (Catalina Pereda and Leika Mochán). The name of this Ensemble is "Mal'Akh" and was founded in 2010 by Felipe and Juan. The musical piece lasts approximately 20 minutes and was played by the Philharmonic Orchestra of Mexico City and the Mal'Akh Ensemble during the festivities of the 50th Anniversary of the 2nd section of Chapultepec Park on the days of October 25th and 26th in Ollin Yoliztli Hall and in Cárcamo de Dolores Hall inside the park (Fig. 4).

During the musical piece both singers (Fig. 5: S1 and S2) sing different taxonomic categories, such as: Animalia, Arthropoda, Insecta, Orthoptera, Caelifera, Pyrgomorphoidea, Acrididae and Pyrgomorphidae. Also, scientific species names of common orthopterans are included, like: *Gryllus assimilis*, *Acheta domesticus*, *Sphenarium purpurascens*, *Schistocerca pallens*, and *Melanoplus gladstoni*. Finally, other words that include the root "chapoli" were included in the lyrics, such as Lecti chapolin and Cuica chapolin. Something that I found interesting is the way that both singers play with the words. It is not only that words related to Orthoptera appear in the lyrics but the fusion of words, the elongation of syllables and that certain words require both singers to be completed are very pleasant to the ear. In Fig. 5, some sample lyrics are included; note that they are arranged always in pairs (S1 and S2) because of the two singers.

It was an honor to contribute names for the lyrics of this musical piece and a privilege to listen it for the very first time this past October in Mexico City. I am not sure if this is the first musical piece to incorporate so many taxonomic categories and species names of Orthoptera, but I hope that you will feel as excited as I do that our group of study appears in such a great musical piece. Please follow this link, so you can hear it too: https://www.youtube.com/watch?v=utHYPK3SHAw

Acknowledgments

I'd like to give thanks to Charles Bomar for his excellent management of the Facebook Group of the Orthopterists' Society and for thinking of me for this opportunity, to Derek A. Woller for English improvement, and, last, but not least, to Felipe Pérez Santiago for providing a photograph of the concert and allowing me to assist.

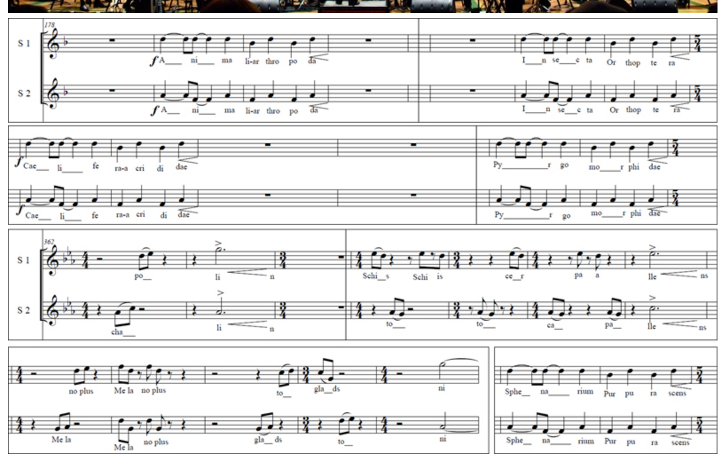

Figure 4 (top). Philharmonic Orchestra of Mexico City and the Mal'Akh Ensemble playing "Purpurascens", 25-X-2014. Picture sent by Felipe Pérez Santiago.

Figure 5 (bottom). Sample from the musical piece "Purpurascens" showing the lyrics of both singers (S1 and S2).

Treasurer's Report

By PAMELA MIHM
Treasurer

The Statement of Assets, as of December 31, 2014 and Cash Summary, are shown below. The largest cash activity was in support of the Orthoptera Species File. 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*. This activity operated at a $2,600 deficit in 2014. The Orthopterists' Society received a very generous gift from the Estate of Dr. Theodore Cohn. The Society received an additional $840,000 in 2014 for a total of $1,240,000. The money has been invested so that the income from the investments can be used to fund research grants and help with operating expenses. Dr. Cohn's generosity will enable the Society to have financial stability for years to come. If you have any questions, you can contact me at p.mihm@regencyapartments.com.

Orthopterists' Society
Statement of Cash Receipts and Expenditures
(1/1/14 through 12/31/14)

Cash Receipts	
Dues	$5,285.00
Publications	4,948.00
Page charges	3,097.25
Royalty and revenue sharing	16,940.82
Book reimbursements	737.60
Donations	527.00
University of Illinois allocation	78,060.00
Proceeds from T. Cohn's Estate	840,000.00
Interest income certificate of deposit	41.43
Total Cash Receipts	$949,637.10
Cash Expenditures	
Publisher JOR	$5,590.31
JOR assistance	21,000.00
Research grants	4,692.00
Executive director-remuneration	1,500.00
Ed. Metaleptea remuneration	500.00
Webmaster remuneration	300.00
JOR editor remuneration	1,000.00
Maintenance of Orthoptera Species File	77,046.11
Professional fees (income tax preparation and audit)	7,200.00
Investments in Vanguard	950,000.00
Investments through Wells Fargo	275,000.00
Other	1,886.67
Total Cash Expenditures	$1,345,715.09
Excess of Cash Receipts over Cash Expenditures	$(396,077.99)
Beginning Cash Balance	411,178.83
Ending Cash Balance	**$15,100.84**
Investment income not included above:	
Interest income and dividends reinvested	$14,188.00

Orthopterists' Society
Statement of Assets
(As of December 31, 2014)

Cash		
Paypal cash balance	$111.17	
Midland States Bank	14,989.67	
	$15,100.84	
Investments at market value		
Vanguard:		
Grants (Note 1)		$372,447.16
Operating (Note 2)		688,054.98
		1,060,502.14
Wells Fargo:		
AAAI (Note 3)		12,185.63
Endowment (Note 4)		24,547.34
Operating (Note 2)		216,103.79
Grants (Note 1)		67,660.00
		320,496.76
Total assets		**$1,396,099.74**

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
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This year is bound to be an important year for me. I have recently moved from the Biology Department at the University of Central Florida, where I started my faculty career, to the Department of Entomology at Texas A&M University. In fact, I made the decision to transfer last June, but there were quite a few things to wrap up before the move. Shutting down an active lab (to restart again) was an interesting experience. Knowing that I won't have a functional lab up and running anytime soon, I tried to be as productive as possible until the very end. Then came December and I abruptly started packing my lab. It was amazing to realize how much stuff I had accumulated over four and a half years. The assorted odds and ends from my lab managed to fill up a 22-foot truck that I rented for transporting all of my precious cargo. I could not trust a moving company with my specimens, so I decided to drive the truck myself the 1,055 miles (1,697.86 kilometers) from Florida to Texas, packed full of lab equipment and supplies, thousands of pinned and alcohol-preserved specimens, as well as my live grasshopper colonies. Derek and Ricardo, my Ph.D. students who I brought with me to Texas, helped out with my move. Now, I am sitting in my new office (finally with a window!), trying to rebuild my lab. It's going to take some time to generate momentum, but I am very excited about what I can do in this new place. I emailed Dan Otte about my move and this is what he replied: "NOW you are in the middle of Orthoptera heaven. So much going on there with shortwing grasshoppers. And you're close to Mexico. Absolutely wonderful place to be." I guess I am in the right place!

As usual, this issue is full of interesting articles. We have interesting meeting reports and member-contributed articles. I would like to thank all those who have contributed to this issue. I would also like to thank our associate editor, Derek A. Woller, for his continued assistance in the editorial process. I apologize for a slight delay with the publication, which was due to my relocation.

Metaleptea is an excellent outlet to communicate to our members around the world. There is no limit on what we can publish: articles, stories, photos, artwork, etc. However, specifically, I would like to solicit the following types of contributions for all future issues:

-Collecting travelogues
-Museum visit travelogues
-Highlights of your peer-reviewed publications
-Photography/collecting techniques
-Collecting techniques
-Personal stories

To publish in *Metaleptea*, please send articles, photographs, or anything related to orthopteroid insects to hsong@tamu.edu [please note that this is my new email] 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 2015, so please send me content promptly. I look forward to hearing from you soon!