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METALEPTEA

THE NEWSLETTER OF THE ORTHOPTERISTS' SOCIETY

President's Message

By DAVID HUNTER
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What a wonderful Congress we have just had at Agadir! Sincerest thanks to Amina Idrissi and Michel Lecoq and all those on the Organising and Scientific Committees that made the 13th International Congress of Orthopterology such a success. We had one of the largest Congresses ever with 240 participants including accompanying persons. The theme of the Congress "Challenges in Front of Climate and Environmental Changes" led to a variety of types of presentation on a wide variety of topics. And the Locust Opera presented the effects of environmental change on the Rocky Mountain Grasshopper extinction in a most entertaining and novel way. There were over 250 presentations including posters at the Congress, which meant that there were plenty of opportunities to see and discuss the latest research and developments in Othopterology not only at the time of presentations but also afterward during lunches and at coffee breaks where some very delicious "petit fours" were served. And the Gala Dinner was a real highlight that helped us all to appreciate Moroccan food and culture through the many forms of entertainment - who can forget the skill and artistry of the Moroccan horsemen, the dancers, and the entertainers?

I write these remarks from Cameroon, where my son and his family live and work, and here I have a much fuller appreciation of Africa and all of its opportunities. I am glad the Orthopterists' Society has been able to play a small part in helping Africa realize its potential first of all by having our first ever Congress in Africa and also by welcoming our new Executive Director Mohamed Abdellahi Ould Babah EBBE, who has worked on locusts in Mauritania for many years and who now is the Director General of the Institut du Sahel (INSAH/CLISS) in Bamako Mali.

Let me say one of the aspects I like most about our society is how a number of endowments and gifts allow us to fund so many worthy endeavours in Orthopterology. It gave me great pleasure that the Orthopterists' Society was able to fund 12 students and young professionals to come to the

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Congress and for many it was a first opportunity to expand their horizons in ways they could not otherwise afford. The many awards presented at the Congress and the recent allocation of research grants to support students and young professionals throughout the world as part of the Theodore Cohn Research Fund emphasize the advantages of being a member of our Society. Equally important is the mentoring of students both locally and internationally by members of our Society which provides guidance and networking opportunities for young Orthopterists. A full report on the Congress and the Awards presented follows my opening remarks (see my report on the congress and the separate report on the Research Grants by Michel Lecoq in this issue).

During the Board meeting, the current state and future directions of the Society were discussed. The financial situation of the Society is quite robust, thanks to the generous bequest of its former President, Ted Cohn, and the diverse and sophisticated assets management by the Treasurer, Pamm Mihm. The substantial earnings of these investments has not only allowed us to present many awards and travel grants but it has also been instrumental in allowing us to move our *Journal of Orthoptera Research (JOR)* to Pensoft, as part of it becoming open access and making it an impact-factor publication. The *JOR* Editor, Dr. Corey Bazelet, with able assistance from Nancy Morris and the editorial team, are to be congratulated in the rapid progress made. Articles published in *JOR* are being viewed often as the switch to Pensoft has helped boost the profile of our journal: so I urge Society members to publish in *JOR*, which offers a fast and competent peer-review of Orthoptera-related manuscripts.

At this time I would like to thank all the members of the Board for their diligent work: Derek A. Woller for his continuing revisions and updating of the website (and assistance with *Metaleptea*), Maria Marta Cigliano for her tireless efforts on the updating the Orthoptera Species File onto a new platform, TaxonWorks, Hojun Song who amazingly provides a better and better *Metaleptea* in each issue, and I would like to very much welcome to the Board our new President Elect, Axel Hochkirch. And to our regional representatives - many thanks for your support in our regions, both the continuing representatives: Gerlind Lehmann, Battal Çiplak, Michael Sergeev, Haruki Tatsuta, Long Zhang, Rohini Balakrishnan, Claudia Hemp and Vanessa Couldridge as well as our new representatives Kathleen King, Michael Kearney, Amina Idrissi, and Martina Pocco.

One final thanks to Amina Idrissi with able assistance from Michel Lecoq and the rest of the 13th International Congress of Orthopterology team. And thanks to all of you who came to the Congress - your participation is what made it such a success. As for the 14th Congress, the congress committee is considering Paris! More information on the next Congress will be made available as it comes to hand.

RECAP of the 13th International Congress of Orthopterology:

"*Challenges in Front of Environmental and Climate Changes*"

(March 24-28, 2019, Agadir, Morocco)

By **DAVID HUNTER**
President
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What an amazing Congress it was! From my first entry into the Palais des Roses I was impressed with the choice of venue with its large open area perfect for gathering together for discussions, and when Amina showed me the Conference rooms and facilities – excellent! Amina and her team are to be congratulated on their organization at such a venue. With 240 participants, including delegates, presenters, and accompanying persons in about 30 separate events, there was plenty of opportunity to learn about and discuss the latest in orthopterology. And those discussions continued at such a pace over the delicious offerings during coffee breaks that at times it was difficult to return to the sessions!

The Congress had a very full program of nearly 250 presentations in 4 Plenaries, 11 Symposia, 5 Oral and 5 Poster Sessions, and 3 Workshops, and, of course, the most entertaining Locust Opera under the overall theme of "Challenges in Front of Climate and Environmental Changes." These many presentations meant there were often 2 or 3 simultaneous events - many thanks to the chairs of these events in ensuring that they ran smoothly and on time.

The opening Plenary Lecture by Thami Ben Halima (Morocco) on "Desert Locust Management: A Success Story" was a most appropriate opening presentation that outlined the successful implementation of the preventive management strategy of this important pest problem in the region. In keeping with the African theme, Claudia Hemp (Germany) presented the latest work on “Speciation Mechanisms of East African Orthoptera” and the speciation theme was continued by Kerry Shaw (U.S.A.), who elaborated on the evidence for the various mechanisms of speciation in Orthoptera. And Tony Robillard (France) presented a multidisciplinary exploration of the evolution of systems of communication in crickets.

There were 11 symposia of invited papers covering a wide range of subjects on a number of general themes. Closely related to the overall Congress theme “Challenges in Front of Climate and Environmental Changes” were symposia on the “Effects of Climate and Environment Change on Orthoptera” and “Orthoptera Conservation.” There were symposia on aspects of locust and grasshopper management: “Forecasting Locust Risks” and “Locust and Grasshopper Management and Control.” There were a number of symposia on various aspects of the biology of Orthoptera including “Bioecology of North African Orthoptera,” “Sexual Selection in the Orthoptera,” “Communication and Behaviour of Orthopteran Insects,” “Orthopteran Physiology,” and “Evolution, Diversification and Biology of Orthoptera.” The latter symposium had much in common with symposia on the latest directions in taxonomy including “Speciation and Adaptation in Polyneoptera” and “Population and Landscape Genomics of Orthopterans”.


Audience listening to a lecture at ICO 2019 in Agadir, Morocco (photo credit: ICO2019)

This wide variety of symposium topics was complemented by the 5 sessions of oral and 5 sessions of poster presentations. Topics for these included Systematics and Molecular Biology, Development and Physiology, Population Biology and Management, Biodiversity, Biogeography and Ecology, and Behaviour and Communication.

Of great value were the workshops that gave delegates the opportunity to learn about and discuss several practical aspects of Orthopterology. There was a Workshop on the Orthoptera Species File which has been recently updated to TaxonWorks - a valuable taxonomic resource supported by the Orthopterists’ Society. The Global Locust Initiative Workshop discussed locust and grasshopper data management in this age of rapidly increasing information from a huge variety of sources. And the workshop on the CLCPRO Regional Research Plan discussed the research on desert locust ecology and management, a complementary follow-up to the opening plenary on the success of preventive management of this important species. And many thanks to three of our


Group photo at ICO 2019 in Agadir, Morocco (photo credit: ICO2019)

Premier of Locust Opera at ICO 2019 in Agadir, Morocco (photo credit: ICO2019)

Participants of ICO 2019 visited the Centre National de Lutte AntiAcridienne (CNLAA). (photo credit: ICO2019)

Participants in the bus for the post-congress tour (photo credit: ICO2019)

Past President Alex Latchininsky (left), Incoming President David Hunter (middle), Executive Director Mohamed Abdellahi Ould Babah EBBE (right) during the Gala Dinner, continuing on the traditional hat ceremony. (photo credit: Hojun Song)

sponsors: Micron Sprayers Ltd that showed us Micron-Air application equipment, Groupe Eléphant Vert that provided information on the Novacrid biopesticide both as a display and in one of the symposia and the Centre National de Lutte AntiAcridienne (CNLAA) for their most interesting display covering both historical and current aspects of desert locusts.

On the Friday morning after the official Congress close, many delegates visited the CNLAA facilities and were impressed with the ample supply of equipment and vehicles prepared for the next upsurge of the desert locust. Special thanks to Dr. Abdelghani Bouaichi, Director of CNLAA for showing us these facilities and for all of the help given before and during the Congress itself.

Not only were there many opportunities for exchanges and discussions at the Congress, there were many forms of entertainment. In this regard, we must congratulate Jeff Lockwood and the group of performers and musicians that presented to us in quite a different way one effect of human activity: the extinction of the Rocky Mountain Locust in North America, apparently due to the expansion of agriculture into its region. And we all enjoyed the Gala Dinner with its wonderful variety of typical Moroccan dishes, along with constant and varied entertainment both during the dinner and afterwards. And many of us took advantage of the many tours available to see the sights of the beautiful city of Agadir and the Moroccan scenery in the surrounding region. And, of course, the post-Congress tour gave the opportunity to immerse oneself in the culture of Morocco through seeing first-hand the cities, mountains, and deserts of Morocco.

All and all, a most enjoyable and profitable congress, and we are looking forward to the next congress in 2022.

Acceptance Speech

2019 D.C.F. Rentz Award in recognition of a lifetime dedicated to the study of Orthoptera

By DANIEL OTTE
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When I was five years old in South Africa there was a little brown grasshopper, *Morphacris fasciata*, that shared my home at Untunjambili. I captured it with my bare hands so that I could stretch its wings to admire its beautiful red color. This was my inauspicious introduction to a world which was to consume 65 years of my life and which would ultimately lead to this occasion in which I am being honored for a purely selfish devotion to a group of insects that I love. Now, near the end of my life, and at the opposite end of this great continent I am being honored to receive this award - bestowed by the Orthopterists' Society in the name of Dr. David Rentz, one of the most remarkable Orthopterists in our field of science. I appreciate this honor beyond measure.

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By pure chance, perhaps luck, I ended up at the University of Michigan Museum of Zoology where there were four specialists in orthopteran taxonomy. As a student, I was invited to join expeditions to collect insects all across the United States. And when I asked Richard Alexander whether he would serve as my doctoral chairman, he was quick to answer: "Sure! What do you want to work on?" After a pause I answered: "Mmmm? I'm not sure . . . maybe camel crickets?" He thought that was a bad idea because there were already two experts in that group in the department. "How about grasshoppers?," he said. "Okay," I said. What else was I to say?

I was not much interested in grasshopper taxonomy. I wanted to study their behavior - how they signal to one another. My doctoral thesis ended up being a comparison of communicative behavior, and in the course of the next three years I compared the communication of 110 species belonging to four subfamilies.

But right from the beginning I was stymied by what is now called the taxonomic impediment. There were lots of species that were very difficult to identify and no keys to help me out. So, I started to construct my own keys and soon became much more interested in taxonomy than in behavior. I decided then that, someday, I would straighten things out.

After receiving my Ph.D. in 1968 I was invited to join Alexander on a year-long expedition to work on the taxonomy of Australian crickets. With our families in tow, we moved to Australia, bought a new Land Rover, and began to criss-cross the continent. In 15 months we had travelled 46,000 miles (74,000 kilometers) and the number of species for the continent rose from about 130 to 492.

Back in the United States, I joined the faculty at the University of Texas. After 6 years I was invited to join the staff at the Academy of Natural Sciences, in Philadelphia, where I am today. The Australian cricket work took 15 years to complete, longer than anticipated, but forgivable because I was hired in Philadelphia principally to work on grasshoppers. I still have two allegiances…to crickets and to grasshoppers, and I still switch back and forth between the two groups. My other big endeavors were two volumes of North American grasshoppers, a monograph each on Hawaiian and Caribbean crickets, and initiating the Orthoptera Species File, which was designed to overcome another


Richard Alexander and Daniel Otte in New Caledonia in 1983 (photo credit: Bill Cade, downloaded from Dan Otte Symposium website)

truly massive taxonomic impediment.

I am currently working on three large projects - more or less simultaneously. These are a continuation of North American grasshopper handbooks, a handbook on South African grasshoppers, and a study of Amazonian crickets collected by David Nickle.

At the present time, the most exciting project is a study of speciation in the African genus *Eremidium*, a small member of Lentulidae that inhabits Afromontane forests. This biome stretches along the eastern slopes of Africa, from the tip of the continent up to Ethiopia. The focus is on a small stretch of the range, from Eastern Cape to KwaZulu-Natal. This is an extraordinary biome consisting of Afromontane forest islands in an ocean of grassland. There are 31,000 forest patches in KwaZulu-Natal alone, varying in size from thousands of hectares to less than one hectare, all of ancient origin. These are not remnants of forests, but ancient patches whose boundaries have always been maintained by fires (natural and man-made).

So . . . here I am in my 80th year. It is as if I'm on a mountain top where I can look back (and down) upon the landscape molded by the diversity of our favorite group of insects. From this vantage point one is able to make some interesting comparisons about orthopteran diversity. Here are few that I have found especially interesting.

When one speaks of diversity, two measures are relevant: alpha diversity (the number of species found at one place) and beta diversity (the replacement of species as one moves from point A to point B).

In the 1960s, community ecologists told their students that ecological conditions determine community structure. So, they predicted (among other things) that similar habitats will produce similar insect diversities and community structure. That is what I expected to find. But that turns out to be a naive view of the world.

At a certain level of generalization natural selection does produce similar looking biomes: rain in winter between the latitudes of 30 and 40 degrees north or south of the equator produces a very similar vegetational structure and a high floral diversity. Contrary to ecological prediction, though, the similarity has had no bearing on the diversity of Orthoptera. Among the five winter rain biomes in the world only the Cape region in southern Africa has a rich grasshopper fauna, and it is very rich. Is this related to the ages of these regions?

Here are a few other comparisons:

In crickets, the highest alpha diversity occurs in Southeast Asia, but the highest beta diversity is found in Hawaii.

The noisiest places on earth to the human ear (and orthopterologically speaking) are the Malaysian rainforests. But Central American forests, perhaps even richer in species, appear to be largely silent.

The Australian rainforests have a very high diversity of crickets, and I expected, on the basis of ecological theory, that African forests would be similar, but with a different taxonomic makeup, of course. But African forests are very species-poor.

This same pattern pertains to the deserts as well, with Australian deserts having a high diversity and the African deserts being depauperate.

Grasslands of temperate Africa are exceedingly similar, structurally, to the temperate grasslands of North America. But alpha diversity patterns are very different - much higher in North America, noticeably lower in Southern Africa. The beta diversity of the two regions is just the opposite.

What about grasshopper diversities in rainforests? The highest diversity is in New World forests. Both African and Australian forests are species-


Daniel Otte in Malaysia in 1990 (photo credit: Bill Cade, downloaded from Dan Otte Symposium website)

poor. The forest canopy radiation took place only in Central and South America. Australia's rainforests have no grasshoppers at all.

Africa has the oldest grasshopper fauna and temperate North America the youngest. This has resulted in an interesting difference. The United States saw a burst of speciation following Pleistocene glaciation, resulting in many close relatives coexisting at one place. In Africa it is rare to find more than two congeners living in one place. One can speculate that the difference is somehow also related to the ages of the two faunas.

The smallest Acridoidea in the world are in Africa, especially in Southern Africa. Smallness was selected independently in a number of groups. But what were the selective agents?

Africa has, by far, the highest morphological diversity of any continent - there, many more species resemble grasses, or twigs, or stones, or burned vegetation, or bird droppings. Is this also related to the much greater age of the fauna: more time, more divergence? I suspect that behavioral and ecological diversity will follow the same pattern.

Daniel Otte trying to catch a flying grasshopper in Namibia (photo credit: Bill Cade, downloaded from Dan Otte Symposium website)

The most difficult grasshoppers to collect, in open country, are the African species (but I don't have enough experience with Australia). United States species are much easier to get into your net. Is this because African grasshoppers have coexisted with primates for such a long time, with monkeys and baboons in particular, but with humans as well?

Daniel Otte and a pamphagid in South Africa (photo credit: Piotr Naskrecki, downloaded from Dan Otte Symposium website)

I have many enjoyable and many not-so-nice recollections from expeditions around the world. Here are a few of them: being arrested in Botswana by the defense forces for getting too close to the Angola war; being threatened by lions in the Okavango Swamp, and again in Kruger National Park, and on the Serengeti plain in Tanzania; jumping up in the middle of the night in the Australian outback and seeking refuge in the Land Rover because our camp cots were in the middle of the only path used by wild cattle to reach a water hole; falling off a cliff while collecting Hawaiian crickets; being smashed by an Argentinian bus on the way to Cordoba; getting lost at night while collecting crickets in Botswana and in the Australian outback; getting stuck in deep sand for three days in Mali after a rain storm; chasing after jackals that had stolen our oryx biltong in bright Namibian moonlight; running for cover in Texas when a rancher threatened to shoot me; running down a mountain in Malaysia when surrounded by hordes of leeches; stumbling down a mountain and losing my glasses when attacked by wasps in New Caledonia; hiding behind the truck at night in Mali when hordes of grasshoppers and crickets were flying south to avoid the coming harmattan.

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What is the future of our science? Over the years, I have witnessed the steady decline in the number of systematists working on Orthoptera. When I received my degree in 1968 there were at least 10 taxonomists in United States museums: two in Philadelphia, two in Washington, three at the University of Michigan, one in Florida, two in California, and a few more working on and off at various other places. In Europe the situation is much worse. Institutions that contributed so much over more than a 100 years have no experts now: London, Leiden, Berlin, Vienna, Stockholm, Geneva, and Madrid. Australia did not replace David Rentz and Philadelphia has not replaced me.

The situation is dire, principally because of modern trends at universities not to hire taxonomists - it is not fashionable. Taxonomy is derogatively viewed as a "descriptive science" and it is devalued for that reason. "Mere stamp collecting," James Watson of DNA fame called it. But most of modern molecular systematics is equally descriptive and so is much of physics, chemistry, and all of astronomy. With the invention of fantastic technological breakthroughs in microscopy, now is a great time to return to morphology, the foundation of all of organismic diversity. Illustrating morphology is no longer an impediment.

In conclusion, I have been thinking

about the great venue of this conference, in relation to one of the most striking geological events in world history. I think it is not commonly realized that Pennsylvania and Morocco have something important in common. Here it is: the Anti-Atlas Mountains, quite nearby to Agadir, are part of the same geological formation as the Appalachian Mountain Range in the United States, more than 3,000 miles away. Will humans still be around when Morocco and Pennsylvania collide again? I don't think so. Will raphidophorids still be around? They have demonstrated their capacity for longevity, so why not?

Acceptance Speech

2019 D.C.F. Rentz Award in recognition of a lifetime dedicated to the study of Orthoptera

By MICHEL LECOQ
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Dear fellow Orthopterists,

At our recent congress in Agadir, I had the honor of receiving the D.C.F. Rentz award, "in recognition of a life dedicated to the study of Orthoptera." I would like, on this occasion, to share with you some memories and thoughts. At the moment that I received the award, I was filled with emotion and with joy, but I also looked back with nostalgia at the various stages of my career for which our Society was kind enough to give me this award. How many years ago was it that I had my first encounter with Orthoptera - as a young child of 4 years scared by locusts in the French Pyrenees, through my studies at the University of Orleans, then at the University of Paris-Orsay, through many and varied types of work to the "young" retiree that I currently am. I look back on my first work in Madagascar where I lived several years; my thesis on the migrations of the solitary phase of the migratory locust; my recruitment to GERDAT[1] (later CIRAD[2]) in 1975 and my research on locusts in the Sahel at a time when I was posted to Burkina Faso; followed by many study trips, consultations, and assignments in various countries of the world, starting with Brazil where I lived twice, first in the Northeast then in the state of São Paulo.

The world was for me a rich, wonderful, and fantastic field for research! My work on Orthoptera was carried out on areas as varied as the extreme south of Madagascar, the sandy tracks of the Sahara, the Australian outback, the llanos of Colombia, the forests of Borneo and Sumatra, the islands of the Cape Verde archipelago, and in Brazil, including the caatinga of the Northeast as well as pioneering work in Mato Grosso ... and many other places even more exciting than the others.

My research focused on the population dynamics and ecology of various locust and grasshopper species, such as the migratory locust (*Locusta migratoria*), the red locust (*Nomadacris septemfasciata*), the Italian locust (*Calliptamus italicus*), the Senegalese grasshopper (*Oedaleus senegalensis*), the Mato Grosso locust in Brazil (*Rhammatocerus schistocercoides*), and, of course, the desert locust (*Schistocerca gregaria*) in Africa. This variety of work led me, from time to time, to experiment with various new insecticides, but by the end of the 1990s I was moving towards the mycopesticides, in particular in Brazil with colleagues at Cenargen[3]. The growing importance that these organic products are beginning to have, especially in Asia, shows me

1982, Cape Verde islands – Study on the local grasshoppers. (photo credit: Michel Lecoq)

that this orientation was undoubtedly the right one. In addition to working on pest locusts, I also conducted ecological research on harmless species, such as many grasshoppers from West Africa, some European species, such as the Mediterranean grasshopper *Arcyptera brevipennis vicheti*, some species of the *Calliptamus* genus, and even rare and protected species such as the stone grasshopper *Prionotropis hystrix rhodanica*, listed on the IUCN[4] World Red List. I can also cite *Poekilocerus bufonius*

[1] Groupement d'étude et de recherche pour le développement de l'agronomie tropicale
[2] The French agricultural research and international cooperation organization working for the sustainable development of tropical and Mediterranean regions
[3] Embrapa Genetic Resources and Biotechnology
[4] International Union for Conservation of Nature

1971, Madagascar – In the far South, trying to work on the migratory locust. (photo credit: Michel Lecoq)

1983, Senegal – Working in Dakar with the staff of the local Desert Locust Control Organization (OCLALAV). (photo credit: Michel Lecoq)

1984, Australia - In the outback to learn a little more about the local locust. (photo credit: Michel Lecoq)

1987, Chad - Near Mao, north of Lake Chad, conducting some experiments on new pesticides for desert locust control. (photo credit: Michel Lecoq)

hieroglyphicus (Klug, 1832), a common species in the Sahel, without economic interest, but for which I had the opportunity to make some original observations on its life cycle in the Saharan environment. These research activities resulted in 95 publications in scientific peer-reviewed journals, 56 books or book chapters, and 99 conference papers. And since there is always a need for projects, I am still working with many colleagues on an Encyclopaedia of Pest Orthoptera of the World, which is expected to be published soon.

Based on the results of this diverse research, I undertook substantial work on applied research and have contributed to the development of preventive control strategies, in particular against the Mato Grosso locust in Brazil (in cooperation with Embrapa, the Brazilian Agricultural Research Corporation), the desert locust in Africa in cooperation with the Food and Agriculture Organization of the United Nations (FAO), and the migratory locust in Madagascar (with FAO, the National Center for Applied Research on Rural Development FOFIFA, and the Malagasy Center for Locust Control). For the desert locust, from 1997 to 2011, I have been involved in FAO's EMPRES program to strengthen preventive control: from program formulation missions, support for fundraising from international donors, research on sustainability of funding, to participation in the planning of program activities (including research activities), and monitoring of implementation as a member of the Consultative Committee. I also contributed, for FAO and the French Ministry of Foreign Affairs, to various studies and expert missions that led to a major overhaul of the institutions in charge of preventive control of this species in West and North Africa. I continue to be interested in such preventive strategies to better understand the obstacles (sociological, financial, legal) to the implementation of effective control. These activities on the applied aspects of locust and grasshopper control resulted in numerous technical and consultation reports as well as many popularization papers. I often become a little apprehensive by the thousands of pages that I have written; sometimes they are useful, but sometimes they are purely administrative.

Along with these various aspects of research, I conducted many training and teaching activities in France and abroad, ranging from the technician to

1991, Niger - Working on the desert locust biotopes in the Saharan area. (photo credit: Michel Lecoq)

1997, Brazil - Studying the behavior of *Rhammatocerus schistocercoides* hopper bands in the cerrado of Mato Grosso. (photo credit: Michel Lecoq)

engineer level, and it's always a pleasure for me to meet former students on one or the other of my various trips. I also supervised many Master's and Ph.D. students for Montpellier University and at various foreign universities. I assumed the responsibility of ESAT's Crop Protection Department[5] in Montpellier from 1982 to 1984, and I created and ran for several years (from 1983 to 1988) the training in acridology at the plant protection training department (DFPV) of the AGRHYMET[6] Center in Niamey, Niger. Finally, in recent years, I had the pleasure to teach courses in the field of acridology at the Institute Hassan 2, Agadir from 2008 to 2010. And, of course, I must not forget the multiple occasions when I engaged in "on the job" training, provided throughout my career during my many missions abroad.

All of this research work and training has been carried out, for the most part, within the framework of CIRAD's mandate for scientific research for agricultural development, training, and knowledge shared for the benefit of developing countries. From 1997 and for almost 15 years, until the end of my career in 2011, the management of a research unit entitled "Locust and grasshopper ecology and control" allowed me (with the team I had the privilege to lead) to face even more concretely the challenges posed by the control of pest locusts and grasshoppers, issues so important for food security in many countries of the world, especially in Africa. Cooperation with our partners in developing countries has been fundamental to me and I have always tried to respond as relevantly as possible to their concerns. I remember with fondness the many bonds of friendship and trust built up over the years, with fellow entomologists in these developing countries, as well as with many local populations, rich or poor.

At this point, I realize how lucky I was not to be confined to a lab, even though I was able to undertake various interesting studies there, but to be able to travel the planet, to compare species, their ecology, to feel, smell, breathe entomological problems each time anew; to be confronted with new landscapes, colleagues, populations ... and never to start from an a priori position, but to think about the novelty of a problem and the means of solving it, a position not so obvious as it can appear. But what exciting investigations! At our recent congress in Agadir, Jeffrey A. Lockwood revived, through the opera he created, the search for the "murderer" of the rocky mountain locust in the United States. For my part, I also had to solve many puzzles. One of the last, and not least, was the mysterious outbreaks of the Mato Grosso locust in Brazil that suddenly appeared in the early 1980s. I cannot resist the pleasure of sharing with you some of my many displacements and my joys from that time when I was trying to understand the origin of this plague.

I arrived in Campinas in the state of São Paolo at the end of the summer of 1991 to work in Embrapa's satellite remote sensing center (NMA), which was developing applications in the field of remote sensing. With LANDSAT satellite images, we hoped to map the habitats of the locusts concerned (identified as belonging to the species *Rhammatocerus schistocercoides*) and to analyze the relations with the development of agriculture in these regions of the states of Mato Grosso and Rondonia at the southern limit of the Amazon rainforest. Indeed, in these regions, from the 1970s, new farmlands were developed and planted with rice, sugar cane, soybeans, but, very quickly, outbreaks of locusts appeared and affected the harvest. The prevailing hypothesis at the time was that the extension of mechanized crops had altered the natural balance, leading to locust

[5] Higher School of Tropical Agronomy
[6] Specialized Institution of the Permanent Inter-State Committee for Drought Control in the Sahel (CILSS)

1991, Niger – In the Tamesna area, working on the desert locust. (photo credit: Michel Lecoq)

1991, in the Sahara, trying to get the coordinates from a primitive GPS: just wait for a few minutes and data from the satellites arrive. (photo credit: Michel Lecoq)

outbreaks. The new farmers had only received what they deserved!

With my Brazilian colleagues, I would show that this was not the case; far from it, in fact. Relentlessly exploring the regions concerned, especially on the Chapada dos Parecis, an isolated area of Mato Grosso from where the outbreaks seemed to come, I interviewed many people who were in the region during the first half of the 20th century: former missionaries: Jesuits and Salesians, Indians: Parecis and Nambiquaras, gold diggers, old farmers and tradesmen, latex collectors (the "seringueros"), breeders, all pioneers of the colonization of Mato Grosso. I was also looking in the literature for stories about Brazil's explorations. I thus discovered, through their writings, the anthropologist Edgar Roquette Pinto and the famous Marshal Cândido Mariano da Silva Rondon known for his explorations of Mato Grosso and Western Amazonia. I accumulated a set of facts showing that the outbreaks of this locust in the states of Mato Grosso and Rondonia had always existed. The locusts of *R. schistocercoides* have been there since the dawn of time. The evidence, obtained orally or in ancient works, clearly indicated that their outbreaks were a very old phenomenon. The Nambiquaras Indians were also very fond of them, as reported by Claude Levi-Strauss in his famous book "Tristes Tropiques." Among the Parecis Indians, locusts are an integral part of their myths of the creation of the world, thus showing the recurrent importance of these insects in the region. Evidence accumulated little by little. The prevailing theories of the origin of the outbreaks had to be completely revised, especially those involving the accelerated development of agriculture since the 1980s. In reality, the new farmers had settled in the territory of the locusts and reaped the consequences!

Little by little, and while the knowledge was almost non-existent at my arrival, I managed to understand the biology of this insect, its ecology, and what were its preferred habitats, especially for laying. It is naturally in these laying areas that this insect reproduced and swarmed. The new farmers had, of course, planted their crops on the richest soils, leaving the most sandy and least fertile areas as natural vegetation and as wildlife reserves. It was precisely on these sandy soils that the locust multiplied...and then invaded the crops in the immediate vicinity. We had simply created a juxtaposition of cultivated areas and breeding areas of the locust. Agriculture had in no way favored the insect, but, rather, had settled on its territory and kept the breeding habitats of the insect relatively untouched. The problem was then inevitable and occurred from the first harvests. Farmers already had many problems, no need to add to them by accusing them of an ecological imbalance, probably real, but which had nothing to do with the outbreaks of locusts. Forgive me for a moment's lack of modesty: at the time I was more than a little proud of my research and its results.

Another anecdote I like to report is that of my first contact with Africa and the tropical world. In 1969, after a year spent at the University of Paris-Orsay specializing in entomology (and especially on locusts), I flew to Madagascar where I had to carry out research on the migratory locust. Arriving in Antananarivo, a car took me to the "Great South." After 2 days of road and track, I finally arrived in the extreme south, in Betioky, headquarters of the National Center for locust control. But that was not my final destination! Another track day took me to a rather isolated place called Bepeha, located on the Horombe plateau, about 30 km from a small town called Betroka. My local manager who had accompanied me until then, left me on the spot with an old Hotchkiss jeep, a Renault 4, 4 laborers and some cans of gasoline. My field base to conduct the work that I had to undertake on the solitary phase of the Malagasy migratory locust, was reduced to a few tents near occasional trees. A small "comfortable" house was then built with mud and cow dung. The water was pumped from a spring a hundred meters away. The nearest

1992, Campinas, Brazil – Studying nymphs of the Mato Grosso locust with Ivo Pierozzi Jr., a Brazilian colleague from Embrapa. (photo credit: Michel Lecoq)

native village was about a kilometer away, and everywhere around was the grassy, flat, and empty expanses of the Horombe Plateau. Having arrived at the end of the dry season, I barely had time to create a firewall around my camp, before a bushfire would burn all the surrounding vegetation. I managed to save the camp...and my thesis work! I suppose that the purpose of such a site was also to test the resilience to field work, in somewhat spartan conditions, of a young student fresh out of Paris University and who had no preparations for work in the bush. I passed the test successfully and my tropical career was launched!

These are of course only two anecdotes. I was fortunate to be able to get excited about many other issues around the world. Unfortunately, all this work was inevitably strewn with moments of anguish and emotion: the attack of my camp by brigands in the Sahara in 1991 where a colleague was unfortunately killed, a helicopter crash the same year also in the Sahara in the middle of nowhere, a peasant revolt in Madagascar in 1971 and the attack on the small town of Betioky, headquarters of the national center for locust control...but also intense moments, such as a dinner with the emir of Kanem in Chad on the terrace of his palace, a meeting with the President of Senegal on the occasion of the Desert locust invasion in 2005, the discovery of a dinosaur skeleton in the Saharan Tamesna, a head-to-head encounter with a deer and the discovery of recent traces of the passage of a panther while I was alone in the heart of the Brazilian Cerrado. Many moments of emotion where I happened to recall my reading as a youth the "Strange Safari" by Margaret Ruthin, or "The Mighty Orinoco" by Jules Verne. The enthusiasm of youth is a driving force to be cultivated throughout one's life. That's all that I wish my younger colleagues.

I will not finish this brief article of memories without thanking the Orthopterists' Society for the confidence it has given me over the years in various positions of responsibility, for the wealth of scientific exchanges, for friendship developed with many colleagues, for the good times spent together in all corners of the world. Our society is a source of richness in the scientific world. Let's continue to live life and support our Society with dedication, enthusiasm, pleasure, and love.

The 2019 Theodore J. Cohn Research Grants Funded

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

From the many research proposals submitted this year to the Theodore J. Cohn Research Fund Committee, 11 projects have been selected for a total of $14,309 USD. Below is the list of the successful candidates (by alphabetical order of surname) and the title of their research project:

- **Nicole Abate (U.S.A.)** - Behavioral response to multi-channel environmental noise: tracking noise-induced changes in daily activity patterns and mate attraction strategies in *Acheta domesticus*.
- **Lara-Sophie Day (Germany)** - Integrative taxonomical revision of the tribe Bryodemini Bey-Bienko, 1930.
- **Arijit Ganguly (India)** - Can kapton tape covering minimise the adverse effects of LED light on the behavioural pattern and life history of flower visiting Indian grasshoppers?
- **Abigail Hayes (U.S.A.)** - Morph formation, environmental cues, and transduction mechanisms underpinning development in the wing dimorphic sand cricket, *Gryllus firmus*.
- **Douglas Lawton (U.S.A.)** - How does landscape structure degradation impact locust population dynamics?
- **Ulises López-Mora (Mexico)** - Egg morphology among the genus *Pseudosermyle* Caudell, 1903 (Insecta: Phasmatodea).
- **Aileen Van der Mescht (South Africa)** - Acoustic response of a threatened katydid species (Tettigoniidae: *Thoracistus thyraeus*) to a fragmented landscape mosaic.
- **Ian Rines (U.S.A.)** - Accessory-gland proteins as purveyors of reproductive manipulation: using RNAi to explore sexual conflict in decorated crickets.
- **Madan Subedi (Nepal)** - Altitudinal

variation of Orthoptera species richness and diversity in rice based farming system in western Nepal.

- **Brooke Washburn (U.S.A.) -** Genomic basis of a novel sexual signal.
- **Timo Wehrt (Germany)** - An evaluation of the Mediterranean species of the band-winged grasshopper genus *Acrotylus* (Fieber, 1853) using DNA barcoding.

The committee warmly congratulate all the candidates for the quality of their projects and wish them every success in their research work.

The next call will be in early 2020 and we strongly invite MSc/PhD students, and post-docs from around the world to submit their research proposals. The only requirement is that the applicant be a member of the Orthopterists' Society in good standing.

Seeking Speakers for the 2020 International Congress of Entomology Symposium: "*Polyneoptera for our Planet*"

By DEREK A. WOLLER[1], BERT FOQUET[2], AND HOJUN SONG[3]
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Fellow Society members, we are currently seeking speakers for our symposium "*Polyneoptera for our Planet*," which will be part of the 2020 International Congress of Entomology (ICE). The congress will be July 19-24 in Helsinki, Finland and the symposium is currently scheduled for Friday, July 24, from 8 AM-10 AM. Presentations are limited to 15 minutes (8 speakers total) and submission is currently available to the public by going to this site (where more general information on the meeting and symposia can be found): https://ice2020helsinki.fi/call-for-symposia/. Then, click on the "Submit presentation abstract" icon on the upper graphic, find the scientific section "Ecology, Evolution and Behaviour, Track 2" and click on our symposium's name, and then follow the subsequent directions. All are welcome – students, postdocs, seasoned researchers, etc.! Our goal is to have a good mix of polyneopterans represented that demonstrate all the interesting work being undertaken with the group, so please spread the word to your colleagues that work on taxa beyond Orthoptera. Please also note that while you can only give a single presentation at ICE you can be a coauthor on as many presentations as you like.

Here is the general description for the symposium:
"Polyneoptera (AKA "orthopteroids") comprise 10 relatively small, but diverse insect orders (Orthoptera, Blattodea (+Isoptera), Dermaptera, Grylloblattodea, Mantodea, Phasmatodea, Mantophasmatodea, Zoraptera, Plecoptera, and Embiidina), which include some of the most recognizable insects on our Planet (e.g., everyone knows what grasshoppers are!), as well as endangered species and important economic pests. In addition, polyneopterans represent some of the most ancient extant insects and are crucial to our understanding of insect morphology and evolution. Yet they are often overlooked by researchers in favor of other insects, especially at entomological meetings. Therefore, communicating the research potential of polyneopterans to a greater scientific audience is crucial. The primary goal for this symposium is to enthrall an audience with fascinating presentations covering multiple facets of polyneopteran ecology, evolution, and behavior.

Across our Planet, there are multiple on-going projects that are utilizing polyneopterans to gain deeper knowledge about life on Earth. In fact, polyneopteran insect orders often intersect with some of the most cutting-edge entomological research. Examples include terrestrial robotics, unmanned aircraft systems, remote sensing, genomic-based systematics, novel methods of detection and tracking, biopesticides, and molecular insecticides. These intriguing research avenues are still in their relative infancy and further development is needed, which is why demonstrating the utility of orthopteroids as research subjects is crucial, and why this symposium is quite timely."

Regional Reports - What's happening around the world?

Western Europe

By GERLIND U.C. LEHMANN
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Last year, two important conferences took place, the first one in Potsdam, Germany, and the second one in Slovakia.

The first conference in Potsdam was the Annual Meeting of the German Society of Orthopterology, in March 2018, organized in cooperation with the Natural History Museum of Potsdam, the Humboldt University Berlin, and the Orthoptera Working-group of Brandenburg and Berlin. During this meeting we celebrated the 30th anniversary of our German Society of Orthopterists. Despite being the congress of the German Society, Orthoptera enthusiasts from Germany, Switzerland, Austria, and the Netherlands attended this event.

We had an intensive meeting with key note talks, regular talks, and posters. The topics ranged from taxonomy to evolution and showed a diversity of aspects in working with grasshoppers and bushcrickets. For those interested, the abstracts can be accessed online (http://dgfo-articulata.de/downloads/tagungen/2018_15_jahrestgaung_dgfo_potsdam_tagungsband.pdf).

The second large meeting, the II European Congress on Orthoptera Conservation took place from September 19-21, 2018 in Smolenice, Slovakia. The conference was organized by the IUCN SSC Grasshopper Specialist Group (GSG), namely Prof. Axel Hochkirch, and the host institution, the Institute of Forest Ecology of the Slovak Academy of Sciences (SAS), namely Dr. Anton Kristin. Almost 48 delegates from 20 countries attended the congress. Talks and discussions spanned the range from taxonomy, distribution, ecology, population trends, and threats of Orthoptera species. There were many interesting sessions, discussions and a great exchange of ideas, see the program online (http://www.orthoptera.sk/2ndECOC/programme.pdf). The conference was very well-organized and successful.

Naturkundemuseum Potsdam
23. – 25. März 2018

A strong discussion has developed over the last months between scientists and the media about insect decline. Shortly after the Krefeld-study was published in PLOS one (Hallmann et al. 2017) and featured in many journals including Science, the debate reached the political agenda. A key finding of the study was that over the past 20 years we saw a decline of around 75 percent in insect biomass in Germany. How much Orthoptera are affected is unclear so far, as the results were based on Malaise sampling, which covers the flying insects.

Participants of the II European Congress on Orthoptera Conservation (photo credit: Gerlind Lehmann)

Different projects are now being financially powered by the German authorities targeting this topic with different approaches. Meanwhile, insect conservationists claim that a more "nature-friendly land-use might be necessary to re-establish Europe's insect diversity." For example, see the 2019 article by Habel, Samways and Schmitt: "Mitigating the precipitous decline of terrestrial European insects: Requirements for a new strategy" in Biodiversity and Conservation, 28(6): 1343-1360, https://doi.org/10.1007/s10531-019-01741-8).

We are seeing Citizen Science tools introduced to broaden the general interest in insects and to add resources into existing monitoring schemes. In fact, we hopefully will increase the conservation efforts for insects. Even the agricultural industry is partly interested, as they fear a decrease in all pollinator-related food sources. It should be noted that in contrast to many other regions in the world, pest control is not an issue in Central Europe.

On two favorite Citizen Science webpages everybody can upload her/his observations: observado.org from the Netherlands and Naturgucker.de, from Germany. Data from the latter are automatically integrated into GBIF (Global biodiversity information facility), the central data source for biodiversity information worldwide. We also are in the middle of developing additional tools for insect monitoring and databank support, sponsored by the German Government.

South Asia

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Most papers were from India, but three were from Pakistan (distribution/diversity). New species descriptions from the region were evenly divided between tettigoniids and acridids.

Taxonomic publications were from the following research groups: the Swaminathans from Jodhpur in Rajasthan, M. K. Usmani from Aligarh Muslim University, the Zoological Survey of India, and by Ranjana Jaiswara, currently in Punjab University.

Behaviour/acoustics publications were mostly from the research group of Rohini Balakrishnan from Indian Institute of Science, Bangalore, but new research groups on Orthoptera have been set up by Dr. Swati Diwakar, University of Delhi, Dr. Manjari Jain, Indian Institute of Science Education and Research, Mohali (Punjab), Dr. Kaveri Rajaraman at Ashoka University, Sonepat (near Delhi), and Dr. Ranjana Jaiswara (Punjab University). This bodes well for greater expansion and diversification of work on Orthoptera, particularly in the context of exploring regions in North India. Swati Diwakar has also started a project in the North-East of India in Assam, which may yield some interesting results.

Table. Publications summary (2015-2018)

	2015	2016	2017	2018	Total
Total	6	8	10	14	38
Distribution/Diversity	1	3	6	3	13
New Species descriptions	1	4	1	7	13
Behaviour/Acoustics	3	1	3	2	9
Orthoptera as Food	1			2	3

The University of Agricultural Sciences at Bangalore holds workshops on insect taxonomy, including Orthoptera, twice a year for about 25 graduate students and researchers. I have regularly contributed to these workshops with lectures on the use of acoustics in identification of Orthoptera at the species level. The Swaminathans conducted a week-long workshop on higher level taxonomy of Orthoptera using morphology. Insect Museum: The Centre for Ecological Sciences at the Indian Institute of Science has consolidated the insect collections of its faculty into an integrated Insect Museum. This includes collections of hundreds of individuals of Orthoptern insects, with a song associated with each specimen. We plan to digitize our insect collection and also upload songs over the next 2-3 years and are actively seeking funding to do the same.

Finally, I would like to draw your attention to an interesting article in the Economic Times of India on locust invasions and their decline in North-West India entitled "The Missing Phenomenon of Locust Attacks" (https://economictimes.indiatimes.com/news/science/the-missing-phenomenon-of-locust-attacks/articleshow/61498777.cms) and how locusts have promoted cross-border cooperation between India and Pakistan.

List of South Asia publications (2018)

1. Chakravorty, J., Jugli, S., Boria, M., & Meyer-Rochow, V. B. (2018). Arunachal's Adi and Apatani tribes' traditional knowledge of harvesting and using edible insects. Journal of Insects as Food and Feed, 1-12.
2. Chakravorty, J., Gogoi, M., Jugli, S., & Boria, M. (2018). *Ducetia japonica* and *Phyllozelus* Sp.: Two Tettigoniid Species of Orthopteran Insects Appreciated by Tribal People of Arunachal Pradesh (North-East India) May Serve as Future Alternative Food Source. Food Nutr J: FDNJ-180. DOI, 10, 2575-7091.
3. Dutta, R., Balakrishnan, R. and Tregenza, T., 2018. Divergence in potential contact pheromones and genital morphology among sympatric song types of the bush cricket *Mecopoda elongata*. Frontiers in Ecology and Evolution, 6, p.158.
4. Farooqi, M. K., & Usmani, M. K. (2018). A new species and a new record of genus *Hexacentrus* Serville, 1831 (Orthoptera: Tettigoniidae: Hexacentrinae) from India. Zootaxa, 4526(4), 547-560.
5. Farooqi, M. K., & Usmani, M. K. (2018). Record of genus *Xestophrys* Redten-

bacher, 1891 (Orthoptera: Tettigoniidae: Conocephalinae; Copiphorini) and description of one new species from India. Zootaxa, 4388(3), 431-436.
6. Gupta, S. K., Chandra, K., & Dang, Y. (2018). *Brachyxenia subtruncata* sp. nov. (Orthoptera: Acrididae: Calliptaminae), a new short-horned grasshopper species from India. Zootaxa, 4433(2), 397-400.
7. Gupta, S. K., & Chandra, K. (2018). Two new species of the genus *Criotettix* Bolivar, 1887 (Orthoptera: Tetrigidae: Scelimeninae) from India. Zootaxa, 4375(1), 143-150.
8. Gupta, S. K., Shi, J. P., & Chandra, K. A. I. L. A. S. H. (2018). A new species of genus *Thoradonta* Hancock, 1908 (Orthoptera: Tetrigoidea: Tetrigidae) from India. Zootaxa, 4455(3), 585-588.
9. Kumar, H., & Chandra, K. (2018). Review of the Indian species of *Anaptygus* Mistshenko, 1951 (Orthoptera: Acrididae) with description of a new species from the Himalayas. Oriental Insects, 1-13.
10. Rajaraman, K., Nair, A., Dey, A. and Balakrishnan, R., 2018. Response mode choice in a multimodally duetting paleotropical pseudophylline bushcricket. Frontiers in Ecology and Evolution, 6, 172 (1-12).
11. Swaminathan, R., Nagar, R., & Swaminathan, T. (2018). Representative Species of the Tribe Catantopini (Orthoptera: Acrididae) from India. Transactions of the American Entomological Society, 144(2), 239-261.
12. Usmani, M. K., Usmani, S., & Naz, H. (2018). Taxonomic studies on the gaudy grasshoppers (Orthoptera: Pyrgomorphoidea: Pyrgomorphidae) from the northeastern states of India. Journal of Threatened Taxa, 10(15), 12953-12968.
13. Usmani, M. K., & Usmani, S. (2018). Locusts. In Pests and Their Management (pp. 825-869). Springer, Singapore.
14. Tiwari, C., & Diwakar, S. (2018). Singers in the grass: call description of conehead katydids (family: Tettigoniidae) and observations on avoidance of acoustic overlap. Bioacoustics, 1-17.

Latin America

By MARCOS LHANO
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After many years representing our Society as Regional Representative for Latin America, I understand that it's necessary to refresh ideas and establish new goals and resolutions. During the wonderful ICO in Agadir, I declined from my position to the board of the Society. After many years representing the Society, I think that I gave my contribution, promoting the OS and orthopterology in the region (as an example, I had the privilege to host and organize the 12th International Congress of Orthopterology in 2016).

For me, was a great pleasure to serve as OS's representative during all this years. I´m leaving this position, however I will be always available to contribute to the Orthopterists' Society in other occasions and needs. I have a great affection for OS and I really like to be part of it.

With the agreement of the OS Board, I invited Martina Pocco, from Argentina (CEPAVE, CONICET-UNLP, Museo de La Plata, Argentina), to assume this position. I think that she is the right person in this moment to assume the regional representation of the OS and I don´t have doubts that she will do a marvelous job.

I would like to thank all persons who helped me during this years, specially the past OS presidents, executive directors, and board members. As Ted Cohn used to say "The Orthopterists Society is a society of friends," and in this manner, the regional representative plays an important role to stay in touch with the people and know their needs. Every time that I transmitted those needs to the board, they always tried to gave the best solution or solve the problem.
My sincere gratitude to the OS! Thank you to all members of Latin America for these years of fellowship and mutual help!

My best wishes to Martina and to all the OS Board!

East Africa

By CLAUDIA HEMP
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An interdisciplinary research unit focusing on ecosystems of Mt. Kilimanjaro since 2010 came to an end in October, 2018. The major research findings were summarized in a booklet that can be downloaded at: https://www.kilimanjaro.biozentrum.uni-wuerzburg.de/Publication/KiLi-Booklet.aspx.

Besides a summary in English and Swahili, the booklet presents findings from the seven subunits comprising research on climate, soil, botany, and zoology. Also, Orthoptera were intensively investigated and results summarized.

All papers published in the frame of the Kili research unit are listed at the end of the booklet, thus offering an overview of the latest scientific outputs of the area.

Synthesis of the results are published in Nature Communications (2016) and Nature (2019):

Peters, M. K., Hemp, A., Appelhans, T., Behler, C., Classen. A., Ensslin, A., Ferger, S. W., Helbig-Bonitz, M., Hemp, C., Kindeketa, W.J., Mwangomo, E., Ngereza, C., Röder, J., Rutten, G., Schellenberger-Costa, D., Zancolli, G., Eardley, C. D., Peters, R., Ssymank, A., Kakengi, V., Zhang, J., Böhning-Gaese, K., Brandl, R., Kalko, E., Kleyer, M., Nauss, T., Tschapka, M., Fischer, M., Steffan-Dewenter, I. (2016): Predictors of elevational biodiversity gradients change from single taxa to the multi-taxa community level. Nature Communications 7: 13736. DOI: 10.1038/ncomms13736.
Peters, M. Hemp A., Appelhans T., Becker J. N., Behler C., Classen A., Detsch F., Ensslin A., Ferger S. W. Frederiksen S. B., Gebert F., Gerschlauer F., Gütlein A., Helbig-Bonitz M., Hemp C., Kindeketa W. J.,Kühnel A., Mayr A. V., Mwangomo E., Ngereza C., Njovu H. K., Otte I., Pabst H., Renner M., Röder J. Rutten G., Schellenberger Costa D., Sierra-Cornejo N., Vollstädt M. G. R., Dulle H. I., Eardley C. D., Howell K. M., Keller A., Peters R. S., Ssymank A., Kakengi V., Zhang J., Bogner C., Böhning-Gaese K., Brandl R., Hertel D., Huwe B., Kiese R., Kleyer M., Kuzyakov Y., Nauss T., Schleuning M., Tschapka M., Fischer M., Steffan-Dewenter, I. (2019): Climate–land-use interactions shape tropical mountain biodiversity and ecosystem functions. Nature 568: 88-92. https://doi.org/10.1038/s41586-019-1048-z

Theodore J. Cohn Research Grant Reports

Response of grasshoppers' communities to forest destruction and habitat conversion in the savanna-forest transition zone in the center region of Cameroon

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Orthoptera is a diversified group of insects, which consists of about 27,500 described species nowadays, a number that is steadily increasing (Eades et al., 2016). The majority of these species are found in the tropics, especially in Africa. Most people associate grasshoppers with locust swarms, but about only 500 grasshopper species among the whole group are considered pest species (NRI, 1990; Oueld-El Hadj, 2004). The majority of grasshoppers do not cause any significant damage to crops. In fact, grasshoppers are insects highly sensitive to changes in environmental conditions (Fabriciusová et al., 2011; Weiss et al., 2013) or land conversion. Thus, their relative abundance can be a sensitive indicator of land use intensity (Alignan et al., 2014). For this reason, grasshoppers have become one of the most important invertebrate groups for environmental monitoring and assessment (Andersen et al., 2001; Maas et al., 2002). Being mostly herbivorous insects, they are also particularly important for ecosystem functioning (Soliveres et al., 2016). They are an important source of proteins to many vertebrate species, including several threatened insectivorous bird species (Valera et al., 2001). Grasshoppers play a huge role in transporting and generating nutrients and are major players in energy flow. Some species are even regarded as ecosystem keystone species (Samways, 1997).

Many grasshopper species are flightless while many others are often adapted to a special microclimate and vegetation structure. This is one of the main reasons for their high species diversity with many species being endemic to small ranges, such as single islands or mountains (Hochkirch, 1998). Despite their ecological importance, few data are available on grasshopper status in Cameroon. According to Mestre & Chiffaud (2006), knowledge of grasshoppers in Cameroon results mostly from the German colonial era. Given the scanty data on this insect group, it would difficult to elaborate a strong conservation action on this important taxon without detailed knowledge of their spatiotemporal distribution, their abundance, and their ecological requirements.

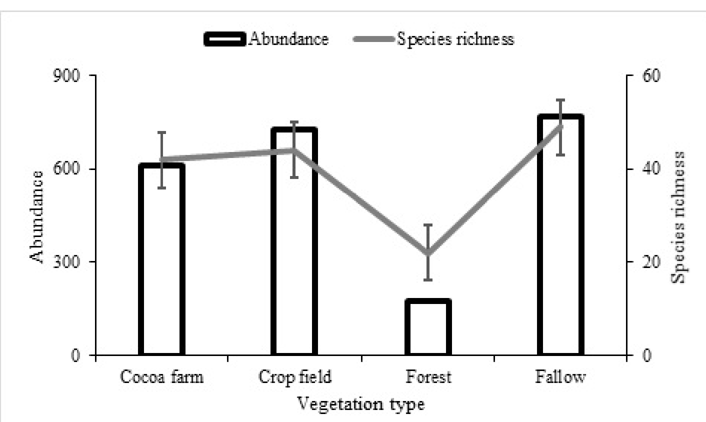

Figure 1. Variation of abundances and species richness in different types of vegetation.

In fact, to date, habitat loss caused by anthropogenic activities and climate changes are obvious threats to grasshoppers (Hochkirch et al., 2016). Consequently, many grasshopper species have never been indexed before, with restricted distribution areas and specific habitats seriously threatened (Barataud, 2005). Therefore, immediate measures should be taken in order to improve their status and tackle, in particular, the degradation of their habitats. That is why it is important to study actual grasshopper fauna before it becomes more impoverished and lost forever. The general aim of this study was to evaluate the effects of habitat conversion on grasshopper population in the center region of Cameroon in order to predict future trends in the distribution and abundance of this taxa.

Material and Methods

Study site

The study was conducted in two localities of the forest-savanna transition zone of the Center region of Cameroon: the locality of Mfou (N3 48.364, E11 40.496 and 718m) and Balamba (N4 24.796, E11 14.866 and 442m). In each locality, four vegetation types (forests, cocoa farm, fallows, and crop fields) were investigated. The Center region is situated within the humid forest, which is characterized by a bimodal rainfall pattern, but this forest is highly degraded with semi-forest savannah that spreads more and more under the pressure of anthropogenic activities. The Central region is dominated by an Equatorial climate of Guinean type with four seasons: a long dry season

Table 1. Species abundances in different types of vegetation

Family	Subfamily	Species	Cocoa farm	*Vegetation type* Crop field	Forest	Fallow	Total
Acrididae	**Acridinae**	*Acrida turrita*	5	3	-	7	15
		Amphicrema scalata	2	5	-	11	18
		Cannula gracilis	3	1	-	30	34
		Chirista compta	8	62	-	27	97
		Coryphosima stenoptera	8	108	-	5	121
		Gymnobothrus temporalis	-	33	-	23	56
		Holopercna gerstaeckeri	7	-	22	-	29
		Machaeridia bilineata	-	-	-	5	5
		Odontomelus kamerunensis	32	6	5	14	57
		Paralobopoma bugoiensis	-	1	-	86	87
		Sherifuria haningtoni	-	-	-	13	13
	Catantopinae	*Abisares viridipennis*	-	-	1	-	1
		Apoboleus degener	2	1	-	-	3
		Catantops stramineus	11	7	-	11	29
		Eupropacris coerulea	4	3	1	18	26
		Exopropacris mellita	1	10	1	19	31
		Exopropacris modica	-	1	-	-	1
		Exopropacris rehni	10	9	3	11	33
		Hadrolecocatantops quadratus	3	17	1	19	40
		Hadrolecocatantops sp.	12	10	-	19	41
		Mazaea granulosa	15	4	47	3	69
		Oxycatantops imperator	9	14	2	13	38
		Oxycatantops spissus	38	16	1	15	70
		Parapropacris notata	3	40	1	38	82
		Pteropera sp.1	39	2	15	15	71
		Serpusia opacula	73	20	19	50	162
		Stenocrobylus festivus	-	3	-	9	12
	Coptacridinae	*Cyphocerastis laeta*	3	-	7	-	10
		Cyphocerastis sp.	17	5	-	15	37
		Cyphocerastis stipatus	24	-	-	3	27
		Epistaurus succineus	43	13	-	2	58
		Eucoptacra anguliflava	44	16	4	16	80
	Cyrtacanthacridinae	*Acanthacris ruficornis*	5	5	1	9	20
		Cyrtacantacris aeruginosa	1	1	-	2	4
	Eyprepocnemidinae	*Cataloipus fuscocoeruleipes*	-	-	-	1	1
		Eyprepocnemis plorans	31	47	-	20	98
		Heteracris annulosa	5	4	-	5	14
		Metaxymecus gracilipes	20	4	-	5	29
	Gomphocerinae	*Anableipia granulata*	-	-	-	6	6
		Mesopsis laticornis	-	-	-	7	7
	Hemiacridinae	*Leptacris kraussii*	-	-	-	2	2
		Leptacris monteiroi	-	-	-	1	1
		Spathosternum pygmaeum	-	1	-	-	1
	Oedipodinae	*Gastrimargus africanus*	-	2	-	-	2
		Heteropternis thoracica	-	61	1	29	91
		Morphacris fasciata	-	9	-	-	9
		Oedaleus nigeriensis	-	-	-	1	1
		Trilophidia conturbata	1	2	-	2	5
	Oxynae	*Dibastica modesta*	-	-	2	-	2
		Digentia fasciata	-	-	3	-	3
		Oxya hyla	-	1	-	-	1
		Pterotiltus sp.1	9	-	25	-	34
		Pterotiltus sp.2	2	1	7	-	10
	Tropidopolinae	*Homoxyrrhepes punctipennis*	1	-	-	1	2
		Tristria discoidalis	2	-	-	31	33
Pyrgomorphidae	**Pyrgomorphinae**	*Atractomorpha acutipennis*	11	18	-	4	33
		Chrotogonus senegalensis	1	7	-	-	8
		Pyrgomorpha vignaudii	4	13	-	4	21
		Taphronota ferruginea	5	-	-	4	9
		Zonocerus variegatus	87	129	-	130	346
Thericleidae	**Thericleinae**	*Afromastax zebra*	3	1	-	4	8
		Bunkeya congoensis	6	11	4	2	23
		Thericles sp.	-	-	-	1	1
Total			**610**	**727**	**173**	**768**	**2278**

(November to March), a short rainy season (March to June), a short dry season (July to August), and a long rainy season (September to November) (Olivry 1986).

Grasshopper sampling and morphological identification

Two sampling methods were used for collecting specimens: sweep net and pitfall trapping. The sweep net method consists of moving everywhere in the forests, cocoa farm, fallows, and crop fields of each study site and to capture all grasshoppers found for thirty minutes time. After this, a linear transect of 100m was made for the pitfalls. In each vegetation type, 10 pitfalls were placed along each transect, separated from one another by a 10m distance. In each study site, sampling took place once a month during a period of 12 months. All collected specimens were transported to the Zoology Laboratory of the University of Yaoundé I where grasshoppers were counted, codified, and grouped by morphospecies in collection boxes for later identification. Given that identification keys of grasshoppers are generally based on the morphological characters of adults, nymphs collected by sweep net were placed in labeled breeding boxes where they were reared until they became adults. The identifications were made under a binocular microscope (Heerbrugg brand) with identification keys of Descamps (1977), Dirsh (1965, 1975), Grunshaw (1991, 1995), Jago (1982, 1984, 1989, 1994), Launois-Luong & Lecoq (1989), Lecoq (1980, 2010), Mestre (1988), Popov (1988), and Stuart (1998). The reference collections of the Zoology Laboratory of the University of Yaoundé I and the Orthoptera Species File Online were also consulted.

Data analysis

The PAST 3.20 software was used to calculate observed species richness (S) and diversity index. Normality of the variation in abundance and average species richness was tested using the SHAPIRO-WILK test. The means per grouping factors (vegetation) of each variable were compared using the KRUSKALL-WALLIS test (H) associated with the MANN-WHITNEY pairwise comparison test when the distribution was not normal. When the distribution was normal, the ANOVA test (F) associated with the TUKEY pairwise comparison test was used. The results were appreciated at the 5% threshold. The contribution of each species for the evaluation of the bio-indicator status was calculated by the IndVal (Indicator Value) method of Dufrêne and Legendre (1997). The indicator value of the species has been performed thanks to the indicspecies package (De Caceres & Legendre, 2009) of the R software (R Core Team 2015). In this package, the "multipatt" function was used to perform the analysis.

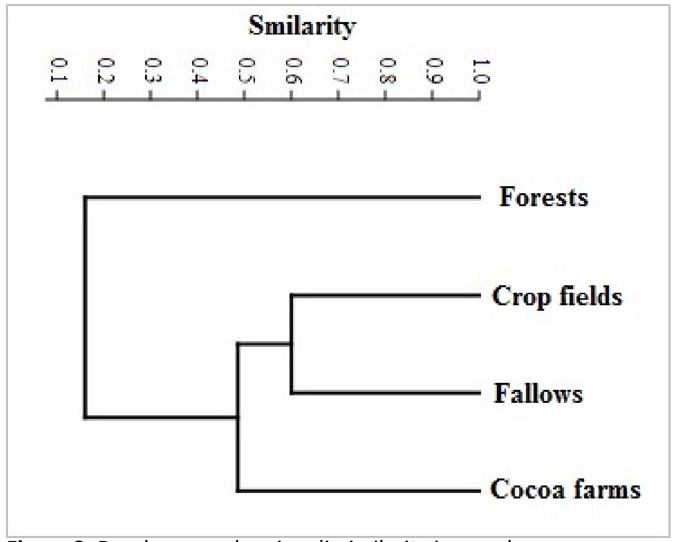

Figure 2. Dendrogram showing dissimilarity in grasshopper community structure between vegetation types, based on paired grouped algorithm and Bray-Curtis similarity index.

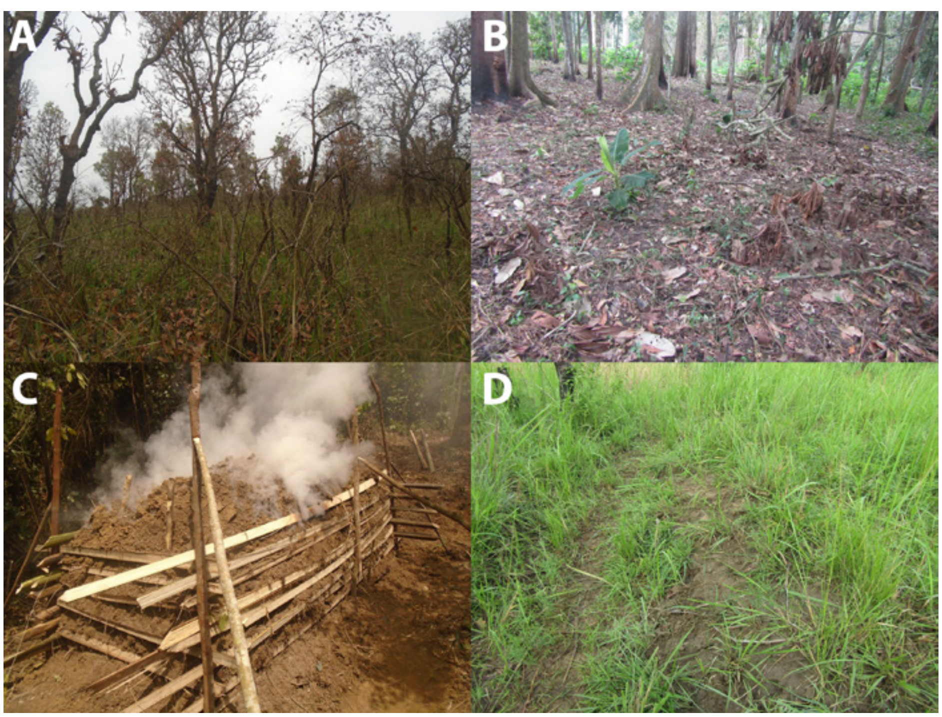

Figure 3. Anthropogenic activities: (a) vegetation after bush fires, (b) deforestation and extension of a cocoa farm, (c) coal kiln, (d) signs of grazing.

Results and Discussion

Overall, we collected 2,278 specimens from the two localities in the Center region of Cameroon and a total of 63 grasshopper species were identified. These species belonged to 3 families, 12 subfamilies, and 55 genera. Among the 55 genera, 49 genera (8.09%) were monospecific.

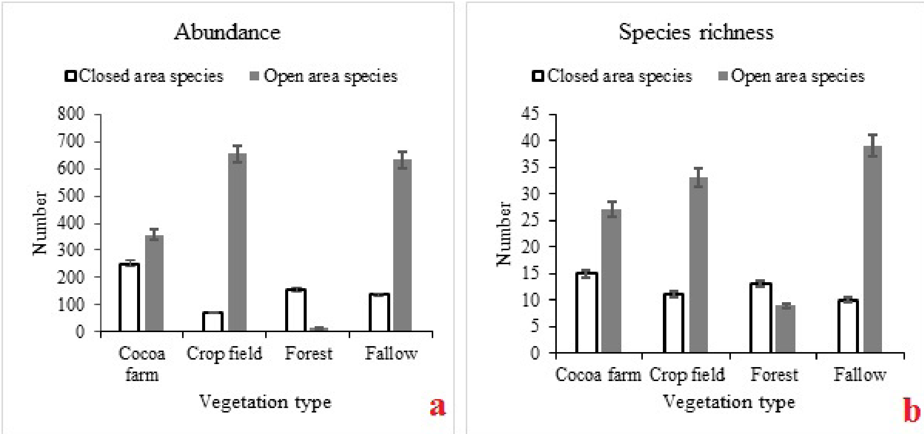

Figure 4. Abundance (a) and species richness (b) of closed area species and open area species in the vegetation types.

The Acrididae family was the most represented with 55 species (87.30%), followed by the family of Pyrgomorphidae with 5 species (7.94%), and then Thericleidae with 3 species (4.76%). Thus, respectively, 42, 44, 22, and 49 species were identified from the cocoa farm, crop fields, forests, and fallows. *Mazaea granulosa* was the most abundant species in forests with 47 individuals (27.17%), while *Zonocerus variegatus* was the most dominant in the cocoa farm (87 individuals, or 14.26%), crop fields (129 individuals, 17.74%) and fallows (130 individuals, 16.93%) (Table 1).

Influence of vegetation type on the species diversity of grasshopper fauna

From a total of 2,278 individuals collected from the four vegetation types, 610 (51 ± 7), 727 (59 ± 8), 173 (16 ± 2), and 768 (64 ± 9) individuals were respectively captured in the cocoa farm, crop fields, forests, and fallows (Fig. 1). The comparison of the average number of individuals between the different types of vegetation revealed a significant difference (F = 9.25; df = 3; P <0.0001). The highest species richness was recorded in fallows (49 species, averaging 19 ± 2 species), followed by crop fields with 44 species (17 ± 1), and cocoa farm with 42 species (16 ± 1). The forests were the least rich with 22 species (6 ± 1) (Fig.1). The variation of the average species richness between the vegetation types was significant (H = 24.27; df = 3; P <0.0001). In addition, the Shannon index confirms the strong grasshopper diversity in fallow (H'= 3.27) and the very low diversity in forests (H' = 2.37). The Pielou equitability index is close to 1 in all vegetation types, but remains higher in fallows (J = 0.84) and the cocoa farm (J = 0.83). As for the dominance index of Berger-Parker, it reflects a very weak dominance of the most frequent species. Indeed, this index was 0.14, 0.16, 0.17 and 0.27, respectively in the cocoa farm, fallow, crop fields and forests.

Composition and similarity of grasshopper communities

The greatest similarity was noted between the grasshopper communities of the crop fields and the fallows (Cn = 0.601). The forest and fallow grasshopper communities were the most dissimilar (Cn = 0.128) (Fig. 2).

Impacts of human activities on grasshopper fauna

Figure 3 shows the impacts of human activities in the Center region of Cameroon. As a result of these activities, of the 22 species captured in the forests, 9 species (40.91 %) were typical species of the open area. In contrast, closed area species were collected in open areas (25% in the crop fields and 41% in the fallows). In the cocoa farm, only 35.71 % of closed area species were captured (Fig. 4).

Bioindicator species

On the 63 species identified in this study, 24 species were identified as bioindicator species. Respectively, three and nine species are presented as indicator species for forests and fallows. No bioindicator species have been identified in crop fields and cocoa farms. Moreover, when the species of the closed and open area were grouped together, two species against 10 were identified as indicator species for the closed and open area (Table 2).

Table 2. List of indicator species of some vegetation types

Species	Specificity (%)	Fidelity (%)	IndVal (%)	p-value
		Forest		
Apoboleus degener	87	31	52	0,001***
Digentia fasciata	100	7	26	0,003**
Pterotiltus sp.1	66	9	25	0,020*
		Fallow		
Spathosternum pygmaeum	91	29	51,6	0,001***
Paralobopoma bugoiensis	98	20	44,3	0,001***
Cannula gracilis	87	20	41,7	0,001***
Tristria discoidalis	95	15	37,2	0,001***
Mesopsis laticornis	100	11	32,7	0,001***
Leptacris kraussii	96	11	32	0,001***
Machaeridia bilineata	96	8	27,7	0,001***
Anableipia granulata	100	7	25,8	0,004**
Sherifuria haningtoni	100	5	23,1	0,012*
		Closed area (cocoa farm and forest)		
Holopercna gerstaeckeri	91	62	75,4	0,001***
Mazaea granulosa	91	37	58,1	0,001***
		Open area (crop field and fallow)		
Heteropternis thoracica	86	60	71,6	0,001***
Acrida turrita	86	37	56,7	0,001***
Parapropacris notata	88	34	54,8	0,001***
Chrotogonus senegalensis	96	31	54,2	0,001***
Trilophidia conturbata	88	33	54,1	0,001***
Amphicrema scalata	94	22	45,4	0,001***
Oxya hyla	87	21	42,5	0,001***
Morphacris fasciata	93	17	40,2	0,001***
Exopropacris mellita	85	17	38,3	0,002**
Gastrimargus africanus	94	8	27,4	0,008**

Discussion

The grasshopper communities in the study areas were relatively rich. However, these numbers are all lower than the 240 grasshopper species identified by Mestre & Chiffaud (2009). Fallows harbored higher species richness than field crops, cocoa farms, and forest. The Shannon index confirms the strong grasshopper diversity in fallow and the very low diversity in forests. This variation in grasshopper diversity may be explained by many factors, including natural intra-site variations due to environmental heterogeneity, natural inter-site variation of environmental factors between landscapes and differences in past and current anthropogenic disturbances. Grasshopper communities at the crop fields and the fallows were more similar to each other when the forest and fallow grasshopper communities were the most dissimilar. This may be explained either by the vegetation structure or by the environmental conditions. Almost all wingless species, micropterous and brachypterous, were species of the closed area except *Odontomelus kamerunensis*, *Paralobopoma bugoiensis*, and *Cyphocerastis* sp. In contrast, all macropterous species, one brachypterous species, and two micropterous species were species of the open area. According to Hochkirch (1998), there is a correlation between habitat and wing development in grasshoppers. Indeed, the species of the closed area generally have reduced or absent wings whereas the species of the open area have wings that are very well-developed. The fallows represent the most diversified habitats, but also contain the largest number of bioindicator species. Therefore, it is clear that while biodiversity conservation cannot be achieved without protecting natural habitats such as forests, it will not be achieved without recognizing the contribution of landscapes already modified by humans, like fallows.

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How heavy transmitters can be used on small ground-dwelling Orthoptera species

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Radio telemetry tracking is one of the methods used to study animal movement, dispersal and space use. It's based on attachment of active transmitter on the animal's body. Each single transmitter emits a unique frequency signal that is detectable with a radio receiver and antenna system.

Since the size and weight of transmitters is decreasing, the method has been applied in many insect ecology studies (movement, migration, habitat use, behaviour and evolution). The size and weight of a transmitter is dependent on battery life, so it is trade-off in selection for a particular study. A heavy transmitter lasts longer but can be used only on bigger animals. On the other hand, lighter transmitters have battery life of only a few days (less than a week). For more information about using radiotelemetry in insect studies, please see the review by Kissling et. al 2014. In the case of orthopterans it has successfully been used only on relatively large species. Before every telemetry experiment several things need to be taken into account, both regarding model species and the aim of experiment (see also Selking 2018).

Materials and Methods

We designed an experiment to determine how the weight of the transmitters affects movement ability of the cricket *Gryllus assimilis* (Fabricius, 1775), with the use of video recording analysis. We observed if the effect changed within first three days of continual attachment and also how the movement with transmitters changed in different temperatures.

We prepared 3D-printed dummy transmitters based on parameters of the three lightest commercially available transmitters (0.2 g, 0.55 g, 0.75 g). *G. assimilis* was chosen because it is flightless species, easy to obtain, and has sufficient size - weight of individuals was 0.5–1.3 g (transmitter/animal weight ratio was 20–150%); only adult females were used. Dummy transmitters were glued on the pronotum and each individual within one group was tagged by a unique mark with a UV active color (Fig. 1). Video records were taken by a 4K camera in 1.2 x 0.8 m arena in a dark room under UV light (Fig. 2).

In total, 180 females were divided into 9 groups of 20 individuals. Each group was recorded in the arena for 10 minutes, and consisted of 5 control individuals and 5 individuals for each transmitter weight category (0 - control, 1 - light, 2 - medium, 3 - heavy). Each group was recorded repeatedly for three consecutive days. Different temperature conditions were simulated for every three groups (low 19.5°C; medium 24°C; high 28.3 °C averages) (see the design diagram in Fig. 3).

Trajectories for each individual were retrieved from all records with our original F-transform based tracking algorithm, which was faster and more precise for our use case than other existing tracking algorithms (Hurtik et al. 2018). Extracted spatiotemporal data and other factors (transmitter weight, temperature, attachment duration, …) were analysed with regression analysis using R software. Sample of record can be seen as trajectories in Fig. 4 or in a short YouTube video: youtu.be/PYy-dVG6gjE0.

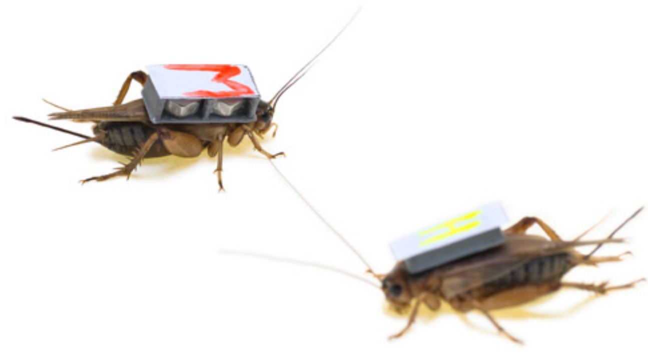

Figure 1. Females of *G. assimilis* with attached 3D-printed dummy transmitters marked with a UV active color.

Figure 2. Construction of arena with 4K camera and UV light.

Results and Conclusions

Dummy transmitters decreased the walking distance and speed with dependence on temperature. Both movement speed and travelled distances showed similar patterns in results. The influence of transmitter attachment did not change during the first three days of attachment. The negative effect of the lightest transmitter (<30% of crickets weight) was found only in cold temperature. Overall, the negative effect was higher with heavier transmitters (Fig. 5), as with the colder environment (Fig. 6). We roughly estimate that every milligram of a transmitter weight decreased travelled distance approximately 7 mm on average with all temperatures mixed together. We also did a basic analysis of spatial interactions, which showed that travelled distance of crickets is longer if their distribution is more separated. The time of closeness of another single cricket has a small positive ef-

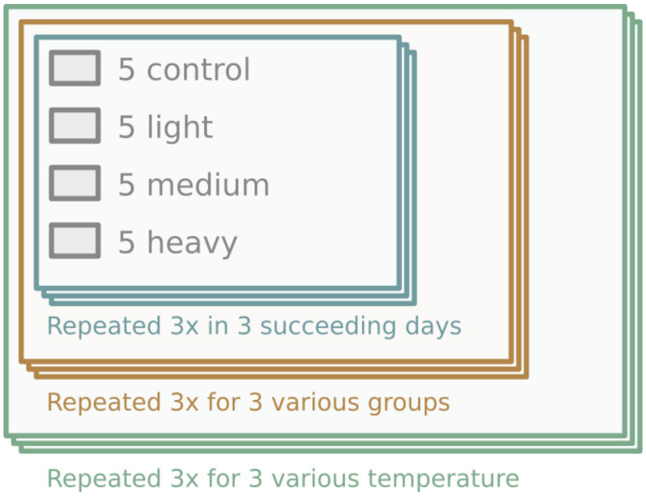

Figure 3. Schema of experimental design.

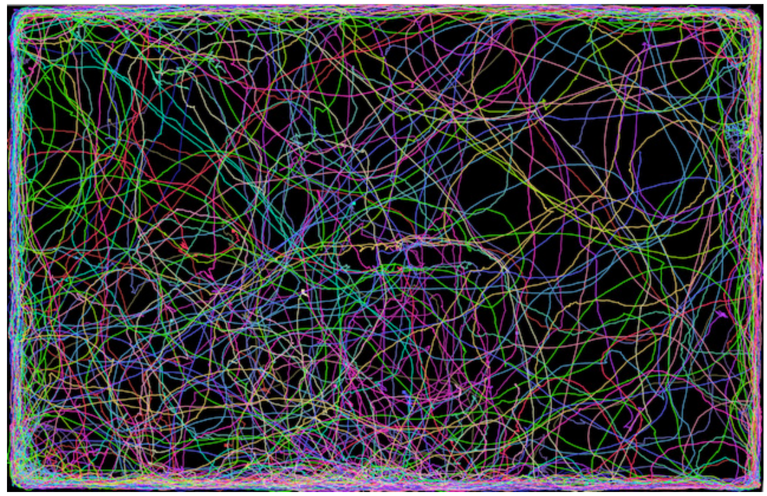

Figure 4. Visualisation of all trajectories from one record. Each color is for a particular individual.

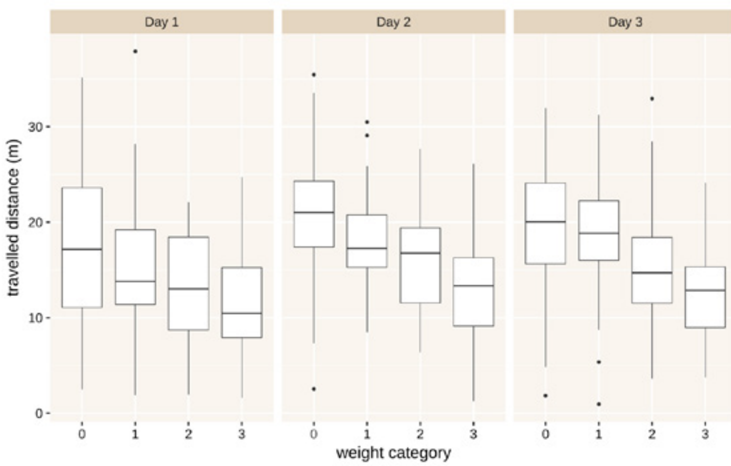

Figure 5. Negative effect of attachment on travelled distance with dependence on weight category of transmitter (0 – control; 1 - 0.2 g; 2 - 0.55 g; 3 - 0.75 g) separately on first three days of attachment.

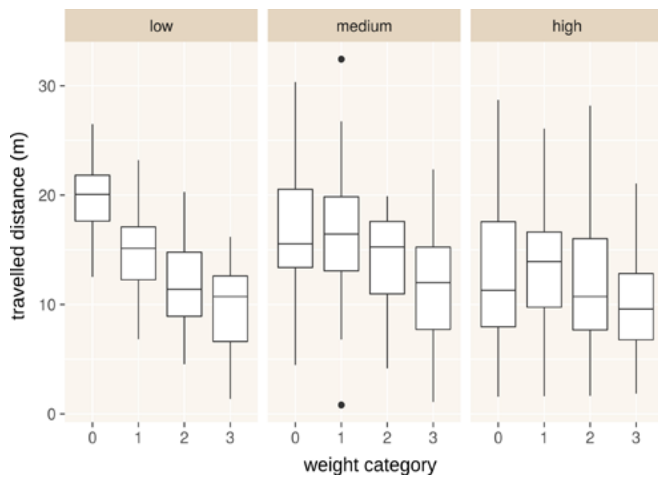

Figure 6. Negative effect of attachment on travelled distance with dependence on weight category of transmitter (0 - control; 1 - 0.2 g; 2 - 0.55 g; 3 - 0.75 g) separately for three temperature conditions (averages: low - 19.5°C; medium - 24°C; high - 28.3°C)

fect on travelled distance of a cricket, but if an individual is approached by two or more other crickets the effect is opposite.

Generally, we highly recommend considering the effect of transmitter attachment before using radio telemetry in research. The use of radio telemetry and selection of proper transmitter size should depend on species of interest, the aim of study, and also the environmental conditions. For the selection of species, the main rules for biomonitoring can be applied: species should be of sufficient abundance and easy to obtain. Additionally, possible mortality (predation and other environment threats) have to be taken into account. The attachment of a transmitter can also affect the behaviour of the species, e.g., burrowing or flying.

If the study aims to investigate animal movement directly (e.g., absolute distances in time) and heavy transmitters are used, the bias has to be considered. On the other hand, some long-term observation of habitat use could be, in some cases, less affected by the lowered movement ability of the species.

In the time of writing this report, we further analysed the data (movement types, resting, movement areas, spatial interactions, body mass loss, etc.), and are preparing a scientific paper for a peer-reviewed journal. Preliminary results were presented in international conferences: II. European Congress on Orthoptera Conservation, Smolenice in 2018 and the 13th International Congress of the Orthopterists´ Society, Agadir in 2019.

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I would like to sincerely thank the Orthopterists' Society for their financial support opportunity, which the Theodore J. Cohn Research Grant gives to young orthopterists around the world. I am very grateful that my project has been funded by this grant, it help me conduct the experiments and present the preliminary results at international conferences. I also acknowledge my colleagues that work on the project with me, and support from a University of Ostrava students grant (SGS14/PřF/2018).

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Orthoptera Species File Grant Reports

Photographic database of Tafaliscinae *sensu* Desutter, 1987, Podoscirtinae and Phalangopsidae (Ensifera, Grylloidea) type specimens deposited in the Academy of Natural Sciences of Philadelphia (ANSP)

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The entomology type collection of the Academy of Natural Sciences of Philadelphia is an historical collection, which has more than 11,000 primary types of insects. Part of the Entomology Department, this set of insects is mainly composed of Hymenoptera and orthopteroid orders that represent over 70% of the entire collection. The Orthoptera collection in the ANSP is considered one of the largest in the world and is an important place for orthopterists. If you are an Orthoptera taxonomist and/or systematist, you will probably one day need to visit this museum.

According to OSF (Cigliano et al., 2019), the entomology collection contains more than 4,000 type specimens of Orthoptera, of which 3,717 are primary types. This great and historical collection of Orthoptera was built mainly by famous Orthopterists, such as Samuel H. Scudder, Lawrence Bruner, James A.G. Rehn, Morgan Hebard, and, more recently, Daniel Otte. In addition, a great part of the specimens are from the Neotropical region, which is one of the most diverse regions of the world concerning orthopterans.

Knowing the importance and amount of specimens of Orthoptera in the ANSP, I proposed a project to OSF, and received a grant, to photograph all the Tafaliscinae sensu Desutter (1987), Podoscirtinae, and Phalangopsidae in its type collection. These are groups of crickets that are important for my Ph.D. project and interest other colleagues here in Brazil. Plus, they will improve the data of these crickets for the OSF online database. Arriving in Philadelphia, I was very well-received by Jason Weintraub (Collection Manager), Greg Cowper (Curatorial Assistant), the staff of the entomology department, and from other departments of the Academy. They helped me a lot, providing everything that I needed during my stay, making my stay pleasant and easier.

During my stay in Philadelphia I photographed 53 Podoscirtinae species (including Tafaliscinae) and 46 Phalangopsidae species, totalizing 99

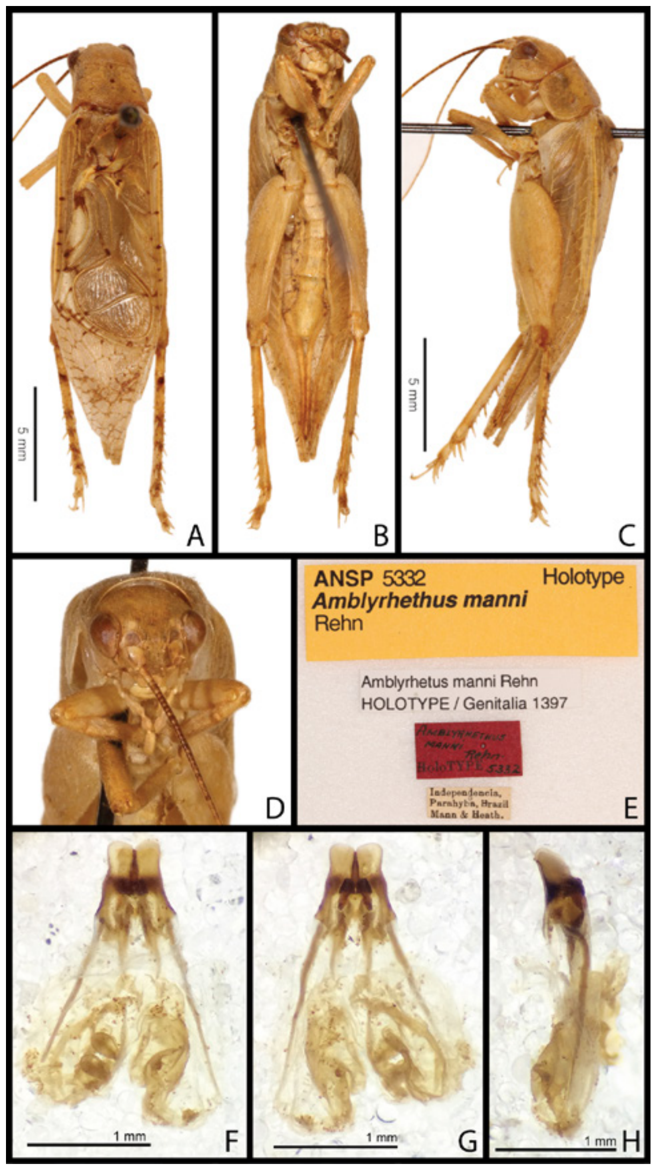

Figure 1. *Amblyrhethus manni* Rehn, 1917 holotype male: **A.** dorsal view; **B.** ventral view; **C.** lateral view; **D.** frontal view; **E.** labels. Phallic complex: **F.** dorsal view; **G.** ventral view; **H.** lateral view.

Table 1. Photographed specimens of Tafaliscinae and Podoscirtinae of ANSP Orthoptera collection.

Tafaliscinae/Podoscirtinae	
Taxon	Type
Adenophallusia naiguatana	Holotype male, allotype female, paratype
Adenopterus caledonicus	Holotype male
Adenopterus sylvaticus	Holotype male, female paratype
Adenopterus tchambicus	Holotype male
Amblyrhethus manni	Holotype male, allotype female
Amblyrhethus natalensis	Holotype male, allotype female
Angustitrella hespera	Holotype male
Angustitrella mataraku	non type male
Angustitrella picipes	Holotype male
Angustitrella roosevelti	Holotype male, allotype female
Aphemogryllus gracilis	Holotype male
Aphonomorphus pusillus	Holotype male
Aphonomorphus surdus	Holotype male
Aphonomorphus tenebrosus	Holotype female
Bofana mirifica	non type male, non type female
Brazitrypa paulista	Holotype female
Calscirtus amoa	Holotype male
Calscirtus paniensis	Holotype male
Cearacesa cearensis	Holotype male
Cearacesa nova	Holotype male, allotype female
Diatrypa colombiana	Holotype male
Diatrypa univittata	Holotype female
Ectotrypa brevis	Holotype female
Ectotrypa repentina	Holotype male, allotype female
Eneopteroides bicolor	Holotype male
Hapithus (Antillicharis) latifrons	Holotype female
Hapithus (Hapithus) agitator	Syntypes
Hapitus vagus	Syntypes
Hemiphonus (Mundeicus) trimaculatus	Holotype female
Madasumma melanonotum	Holotype male
Paraphonus cophus	Holotype male, allotype female
Paroecanthus aff. mexicanus	non type males
Paroecanthus annutalus	non type specimens
Paroecanthus aztecus	non type specimens
Paroecanthus mexicanus	non type specimens
Paroecanthus oaxaca	non type male, non type female
Paroecanthus olmecus	non type specimens
Paroecanthus podagrosus	non type female
Paroecanthus simplex	non type male
Podoscirtodes orocharoides	Holotype male
Selvagryllus sp.	non type male, non type female
Siccotrella guatemalae	non type specimen
Siccotrella managua	non type male, non type female
Siccotrella modesta	non type male, non type female
Sicotrella sp.	non type male, non type female
Sonotrella (Sonotrella) crumbi	Holotype male
Stenoecanthus gracillimus	not type male, non type female
Tafalisca bahiensis	non type specimen
Tafalisca furfurosa	non type male, non type female
Tafalisca lineatipes	Holotype female
Tafalisca lurida	non types specimens
Tafalisca periplanes	non type male, non type female

Table 2. Photographed specimens of Phalangospsidae of ANSP Orthoptera collection.

Phalangopsidae	
Taxon	Type
Aclodes cryptos	Holotype male, paratype female
Aclodes nicuesa	Holotype male, allotype female
Amusodes albifrons	Holotype male
Amusodes estrellae	Holotype female
Anacusta micans	Holotype female
Arachnomimus lepidus	Holotype male
Cantrallia fusca	Holotype male
Cophella formosa	Holotype male
Cophella picta	Holotype female
Cophella rehni	Holotype male, allotype female
Dambachia eritheles	Holotype male, paratype female
Dyscophogryllus castaneus	Type male
Eidmanacris marmorata	Holotype male
Endecous ferruginosus	Type male
Endecous itatibensis	Holotype male
Endecous lizeri	Holotype male, allotype female
Escondacla thymodes	Holotype male
Eugryllina acanthoptera	Holotype male, allotype female
Eugryllina veraguae	Holotype female
Gryllosoma choco	Holotype female
Gryllosoma esau	Holotype male, allotype female
Lerneca funebris	Holotype male, allotype female
Lernecella trinitatis	Holotype male
Luzara minor	Holotype male, allotype female
Luzarida annuliger	Holotype male
Luzarida gracilior	Holotype female
Luzarida pulla	Holotype male
Luzarida recondita	Holotype male, paratype male and female
Megalamusus casenare	Holotype female
Miogryllodes panamae	Holotype female
Neoacla clandestina	Holotype male, paratypes male and female
Niquirana polita	Holotype male
Palpigera boliviana	Unspecified type
Palpigera fratercula	Holotype male
Paragryllus (Aclogryllus) crybelos	Holotype male
Prosthama tessellata	Holotype male
Pseudotrigonidium (Pseudotrigonidium) alpha	Holotype male
Pseudotrigonidium (Pseudotrigonidium) beta	Holotype male
Pseudotrigonidium (Pseudotrigonidium) caledonica	Holotype male
Pseudotrigonidium (Pseudotrigonidium) tiwaka	Holotype male
Rehniella glaphyra	Holotype male, allotype female
Silvastella epiplatys	Holotype male
Tairona pulchella	Holotype male, allotype female
Uvaroviella (Euacla) chamocoru	Holotype male, paratype male
Uvaroviella (Euacla) mocochoru	Holotype male, paratype female

species photographed (Tables 1 and 2) between non-types, types, and primary types (Fig. 1). All the specimens were photographed in dorsal, lateral, ventral, and frontal views; when available, male genitalia were photographed in dorsal, lateral, and ventral views; labels were also photographed (Fig. 2). The photographs of the specimens were taken with a camera Canon T5i with 100mm macro lens and macro flash Yongnuo Twin. All this equipment coupled in a tripod (Fig. 3A). The photographs of male genitalia were taken using a cell phone camera attached to the stereomicroscope (Fig. 3B). The images were taken at different focal lengths and then stacked with the software Helicon Focus. The stacked images were then edited in Adobe Photoshop CS6.

More than 7,000 photographs were taken, totalizing 82.7 Gb of obtained data! The final images were uploaded to OSF: 385 images of Tafaliscinae and Podoscirtinae, and 306 images of phalangopsid crickets, totaling 691 photographs!

Besides helping me with my Ph.D. project and my colleagues in Brazil, I hope that these images will help more people with their research and questions. Even being one of the largest

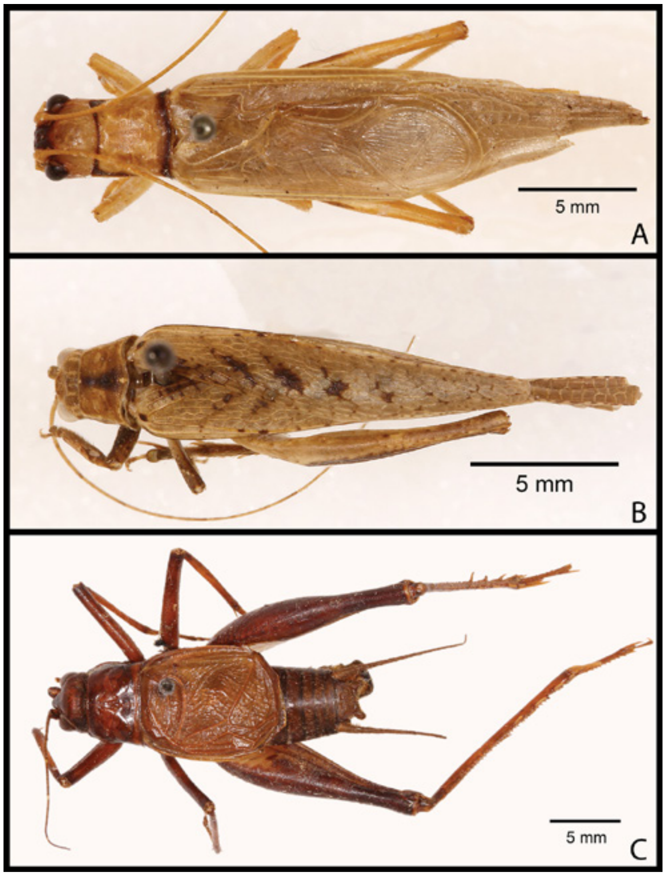

Figure 2. Holotypes: **A.** *Ectotrypa repentina* (Rehn); **B.** *Cearacesa cearensis* (Rehn); **C.** *Palpigera boliviana* (Bruner).

Figure 3. Photographic equipment: **A.** To photograph specimens; **B.** To photograph male genitalia.

collections of Orthoptera in the world, it is far from being totally digitalized, mainly the crickets. This means that, we, the orthopterists, still have a long way to go to provide all this historical information to the scientific and nonscientific community. I hope that this can happen as soon as possible.

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A photographic safari to Southern and Central Tanzania

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Many African Orthoptera, including eastern Africa and Tanzania, are sometimes known from single individuals, often only from the holotypes. Various types are in bad condition and/or discoloured. Additionally, in many cases no information on the exact locality is available since labels just read "British East Africa" (Kenya) or "German East Africa" (Tanzania) referring to the former colonies at that time. Therefore, we applied for a travel grant to search for Orthoptera species in southern and central Tanzania for which no recent information is available and to take photos for Orthoptera Species File Online (OSF). Specimens were also collected and preserved, and, for many species, the acoustics were recorded. The tour also resulted in several species new to science. All in all, more than 1,100 photos of bushcrickets were made available for OSF coming from over 60 genera and over 200 species depicting males, females, often nymphs, and morphological details (Table 1).

Acridoidea species were also collected and photographed during our trips through Central and Southern Tanzania. The images were incorporated into the handbook series of Jago's Grasshoppers of East and North East Africa. Three volumes are already published and the photos uploaded to the OSF comprising Lentulidae, Pamphagidae, Pneumoridae, Pyrgomorphidae, Coptacrinae, Hemiacridinae, Oxyinae, Eyprepocnemidae, and Catantopinae.

Central Tanzanian areas were screened intensively, especially the East Chenene Forest Reserve (Fig. 1), type locality of many Orthoptera. This reserve, a mountainous ridge, is located about 80 kilometers north of Dodoma and covered by Miombo woodlands. Miombo woodlands,

Figure 1. Miombo woodland, East Chenene, 1550 m

Figure 2. Miombo Antennenhügel, 1550 m

formerly one of the most widespread vegetation units in Tanzania throughout Zambia and parts of southern Africa, are currently vanishing rapidly due to due to anthropogenic clearing and settlement. Also, the East Chenene Forest Reserve, although officially protected, is under heavy pressure by illegal charcoalers (Fig. 2). During our surveys the air was filled with a veil of smoke from the many kilns in the area. Almost the whole area is already affected, most larger trees already vicitims of this illegal activity.

The Hetrodinae species *Spalacomimus magnus* (Fig. 3) has one of its few known localities in this forest reserve and the large Phaneropterine species *Arantia tanzanica* (Fig. 4), newly described in 2017, has one of its two known localities in East Chenene (the other in Puge Simbo Forest Reserve near Tabora). Also the lentulid *Usambilla chlorophrygana* has one of its few known localities here. Furthermore, the Lentulidae species *Chromousambilla robertsoni* and the Phaneropterinae *Odonturoides insolitus* are only known from this forest area. During our surveys a couple of new species were found and partly described. These are the Acrometopini *Altihoratosphaga chenene*, *Lamecosoma miombo* and *Peronurella centralis* (Fig. 5). The latter was also found in the Mpwapwa District of Tanzania while the first two species are currently only known from East Chenene. Further new species (a *Eulioptera* (Phaneropterinae), two *Amytta* species (Meconematinae), a species similar to *Ivensia* or *Pronomapyga* (Phaneropterinae), a *Fulvoscirtes* (Conocephalinae, Conocephalini, Karniellina), an *Odonotomelus* (Acridinae), and a *Horatosphaga* species similar to *H. magna* Ragge, 1960 or *H. leggei* (Kirby, 1909)) were found and will be described soon (Table 2).

Figure 3. *Spalacomimus magnus* male, Rubeho Gulva Milowe, 1090 m

Figure 4. *Arantia tanzanica* male, Tabora Puge Simbo FR, Holotype

Data obtained from the surveys were partly incorporated in a red list assessment conducted as the diploma thesis by Michael Boetzel (supervisor Axel Hochkirch) (Boetzel 2018) and by Axel Hochkirch (IUCN red list (https://www.iucnredlist.org/). Thus, *Usambilla chlorophrygana* (B1ab) and *Chromousambilla robertsoni* (B1a) are listed as endangered species from this forest reserve.

A second area of emphasis was the Mpwapwa District of Central Tanzania, one of the earliest collection sites during German colonial times. The so-called Mpwapwa Plateau is well-known as type locality for several species. On our tour we first surveyed the Kiboriani Hills (Fig. 6) with the district town Mpwapwa at its southern

Table 1. List of Species with photos uploaded to OSF

Tettigoniidae	*Afroanthracites usambaricus*	*Amytta kilimandjarica*	*Euryastes jagoi*	*Parapyrrhicia litipo*
Conocephalinae	*Afroanthracites viridis*	*Amytta kilomeni*	*Eurycorypha annexata*	*Parapyrrhicia niloensis*
Conocephalini	*Dendrobia amaniensis*	*Amytta meruensis*	*Eurycorypha binasuta*	*Parapyrrhicia zanzibarica*
Acanthoscirtes albostriatus	*Dendrobia octopunctata*	*Amytta merumontana*	*Eurycorypha combrtoides*	*Peronura clavigera*
Chortoscirtes masaicus	**Copiphorini**	*Amytta mramba*	*Eurycorypha conclusa*	*Peronura hildebrandtiana*
Chortoscirtes pseudomeruensis	*Lanista varelai*	*Amytta olindo*	*Eurycorypha curviflava*	*Peronura uguenoensis*
Chortoscirtes puguensis	*Pseudorhynchus pungens pungens*	*Amytta pellucida*	*Eurycorypha divertata*	*Peronura usambarica*
Conocephalus phasma	*Ruspolia differens*	*Amytta savannae*	*Eurycorypha elongata*	*Peronurella centralis*
Fulvoscirtes fulvotaitensis	*Ruspolia exigua*	*Amytta taitensis*	*Eurycorypha flexata*	*Phaneroptera sparsa*
Fulvoscirtes fulvus fulvus	**Hetrodinae**	*Phlugidia ampendiculata*	*Eurycorypha ligata*	*Plangia amaniensis*
Fulvoscirtes kilimandjaricus	*Enyaliopsis bloyeti*	*Phlugidia kisarawe*	*Eurycorypha meruensis*	*Plangia multimaculata*
Fulvoscirtes laticercus	*Enyaliopsis bloyeti*	*Phlugidia obtusicercus*	*Eurycorypha pianofortis*	*Plangia satiscaerulea*
Fulvoscirtes legumishera	*Enyaliopsis carolinus*	*Phlugidia plancicercus*	*Eurycorypha pseudomeruensis*	*Plangia variacantans*
Fulvoscirtes sylvaticus	*Enyaliopsis ephippiatus*	*Phlugidia usambarica*	*Eurycorypha pseudovaria*	*Poecilogramma striatifemus*
Melanoscirtes kibonotensis	*Enyaliopsis ephippiatus*	**Mecopodinae**	*Eurycorypha punctipennis*	*Pseudopreussia flavifolia*
Melanoscirtes taitensis	*Enyaliopsis jennae*	*Anoedopoda lamellata*	*Eurycorypha resonans*	*Tenerasphaga chyuluensis*
Melanoscirtes usambarensis	*Enyaliopsis jennae*	*Apteroscirtus planidorsatus*	*Eurycorypha varia*	*Tenerasphaga mbulu*
Phlesirtes elgonensis	*Eugasteroides loricatus*	*Apterosicrtus cristatus*	*Eurycorypha victoriae*	*Tenerasphaga meruensis*
Phlesirtes githunguri	*Spalacomimus magnus*	*Gymnoscirtus uniguiculatus*	*Gonatoxia furcata*	*Tenerasphaga nuda*
Phlesirtes hanangensis	*Spalacomimus magnus*	*Philoscirtus cordipennis*	*Gonatoxia helleri*	*Terpnistria zebrata*
Phlesirtes keniensis	*Spalacomimus stettinensis*	*Philoscirtus viridulus*	*Gonatoxia immaculata*	*Tropidonotacris grandis*
Phlesirtes kilimontanus	*Spalacomimus stettinensis*	**Phaneropterinae**	*Gonatoxia maculata*	*Tylopsis continua*
Phlesirtes kinangopa	*Spalacomimus talpa*	*Altihoratosphaga basalis*	*Horatosphaga heteromorpha*	*Tylopsis dispar*
Phlesirtes latifrons	*Spalacomimus verruciferus*	*Altihoratosphaga chenene*	*Horatosphaga parensis*	*Tylopsis rubrescens*
Phlesirtes limuru	**Hexacentrinae**	*Altihoratosphaga hanangensis*	*Horatosphaga regularis*	**Pseudophyllinae**
Phlesirtes melanocercus	*Aerotegmina kilimandjarica*	*Altihoratosphaga helleri*	*Horatosphaga sabuk*	*Acauloplax exigua*
Phlesirtes ngongensis	*Aerotegmina magaloptera*	*Altihoratosphaga montivaga*	*Lamecosoma inermis*	*Cymatomera denticollis*
Phlesirtes ngorongoroensis	*Aerotegmina shengenae*	*Altihoratosphaga nomima*	*Lamecosoma miombo*	*Cymatomera viridimaculata*
Phlesirtes nou	*Aerotegmina taitensis*	*Altihoratosphaga nou*	*Lunidia acuticercata*	*Cymatomerella muta*
Agraeciini	*Aerotegmina vociferator*	*Altihoratosphaga simbo*	*Lunidia bicercata*	*Cymatomerella pardopunctata*
Afroagraecia brachyptera	**Meconematinae**	*Arantia fasciata*	*Materuana eriki*	*Cymatomerella spilophora*
Afroagraecia kisarawe	*Afrophisis flagellata*	*Arantia tanzanica*	*Melidia laminata*	*Pseudotomias kisarawe*
Afroagraecia mangula	*Afrophisis kisarawe*	*Catoptropteryx aurita*	*Meruterrana elegans*	*Pseudotomias usambaricus*
Afroagraecia panteli	*Afrophisis mazumbaiensis*	*Debrona cervina*	*Monticolaria kilimandjarica*	*Zabalius ophthalmicus*
Afroagraecia pwania	*Afrophisis mazumbaiensis*	*Diogena fausta*	*Monticolaria manyara*	**Saginae**
Afroagraecia sansibara	*Afrophisis pseudoflagellata*	*Dioncomena jagoi*	*Monticolaria meruensis*	*Clonia jagoi*
Afroanthracites discolor	*Afrophisis undosa*	*Dioncomena ornata*	*Odonturoides hanangensis*	
Afroanthracites jagoi	*Afrophisis undosa*	*Dioncomena scutellata*	*Odonturoides insolitus*	**Anostostomatidae**
Afroanthracites lutindi	*Amytta digitata*	*Dioncomena tanneri*	*Oxyecous apertus*	*Libanasa brachyura*
Afroanthracites montium	*Amytta digitata*	*Dioncomena zernyi*	*Oxyecous undulatus*	*Libanasa kilomeni*
Afroanthracites ngologolo	*Amytta hanangensis*	*Ducetia biramosa*	*Parapyrrhicia abdita*	
Afroanthracites nguru	*Amytta hanangensis*	*Ducetia punctipennis*	*Parapyrrhicia acutilobata*	
Afroanthracites pseudodiscolor	*Amytta judithae*	*Ectomoptera nepicauda*	*Parapyrrhicia diamantina*	
Afroanthracites uluguruensis	*Amytta judithae*	*Eulioptera monticola*	*Parapyrrhicia globulata*	

foothills and then climbed up the only road to the Mpwapwa Plateau from Kibakwe. The plateau is situated at an average elevation of 1,800 m with single peaks rising to over 2200 m. However, when exploring the Kiboriani Hills, as well as the plateau, we mostly encountered maize fields and other transformed or heavily degraded areas, and natural vegetation was sparse (Fig. 7). Orthoptera were mainly collected from roadside vegetation, e.g., *Altihoratosphaga nomina* (Fig. 8). On the Mpwapwa Plateau only one patch of almost-destroyed forest, officially protected as the Wotta Forest Reserve, was seen at the eastern side of the plateau (Fig. 9). The “forests” consisted of low bushes with a few larger trees at unaccessible slopes and on top of the summits, and was full of lifestock, mostly cattle (Fig. 10). Species described from the Mpwapwa District of Tanzania are *Acrophymus cuspidatus*, *Acrothericles viridithorax* Descamps, 1977 (not found), *Altihoratosphaga nomina*, *Chromousambilla burtti* (Fig. 11), the subspecies of *Gastrimargus verticalis*, *G. v. mpwapwae* Ritchie, 1982 (not found), *Eyprepocnemis burtti* Dirsh, 1981 (not found), *Mecostibus rubripes* (not found here, but in Chenene), *Physocrobylus burtti* Dirsh, 1951, *Physophorina livingstonii* Westwood, 1874 (not found), *Pseudoberengue-*

Figure 5. *Peronurella centralis* male, Rubeho Gulwe, 1000 m, Grassland

ria burtti (Dirsh, 1951), *Spalacomimus magnus*, *Stenoscepa fusiformis* (Kevan, 1956) (not found), *Usambilla chlorophrygana*, *Vitticatantops burtti* (Dirsh, 1965) (not found), and *Xiphoceriana atrox* (not found here, but in East Chenene).

Near Gulwe, a hill covered by Miombo woodlands was visited (Fig. 12). Along forest edges and in clearings a diverse herb and grass flora were present. Numerous rare Orthoptera species and species new to science were collected and photographed. Especially interesting was the distribution of *Altihoratosphaga* species (Acrometopini) in the Mpwapwa District. Only one female was known for *A. nomima* described by Karsch 1896, the label indicating only "Mpwapwa" as the locality. During our surveys at least three different Altihoratosphaga species were collected and analysed for their songs in the Mpwapwa District. Very likely, *A. nomima* was described in proxmity to the District Town Mpwapwa since this place was one of the first German posts in the area. It was found by us in herbal vegetation fringing the road side at the eastern side of the Kiboriani Hills (Figs. 7 & 8). A few kilometers further south on the Miombo woodland hill near Gulwe a species (morphologically very similar to *A. nomina*) occurred, but with a different song (not yet described). And, finally, during another survey at the furthest western part of the Mpwapwa District near the tarred road A 104, another *Altihoratosphaga* species was collected, subsequently described as *A. basalis* since it was the most basal species of *Altihoratosphaga* encountered so far in the genus (with developed hind wings while all other species have reduced tiny scales) (Hemp et al. 2017) (for localities, see Fig. 12). On the Miombo woodlands hill near Gulwe at least 8 new species were collected, among them a new genus aleady known from the East Chenene Forest Reserve that is morphological similar to *Ivensia/Pronomapyga* (Fig. 13) and a second new Phaneropterinae genus (Fig. 14).

Although heavily degraded in the Wotta Forest Reserve species new to science were found from the genera *Chromothericles*, *Usambilla*, *Fulvoscirtes*, *Ivensia/Pronomapyga* and *Peronura* (Table 3).

A third target area was the Udzungwa Mountains in southern Tanzania. The Udzungwa Mountains belong to the so-called Eastern Arc Mountains,

Table 2. Species recorded and photographed from East Chenene Forest Reserve

Eumastacoidea	**Catantopinae**	**Meconematinae**
Plagiotriptus sp.	*Allotriusia luteipennis* Ramme, 1929	*Amytta* sp. 1
Plagiotriptus hippiscus Gerstäcker, 1869	*Diabolocatantops axillaris* (Burmeister, 1838)	*Amytta* sp. 2
Pseudoschulthessiella sp.	*Oxycatantops spissus uranius* (Kirby, 1902)	**Phaneropterinae**
Pseudothericles jallae griffinii Bolívar, 1896	*Phaeocatantops decoratus* (Gerstäcker, 1869)	*Altihoratosphaga chenene* Hemp, 2017
Acridoidea	**Cyrtacanthacridinae**	*Arantia (Euarantia) fasciata* (Walker, 1869)
Pamphagidae	*Rhytidacris punctata* (Kirby, 1902)	*Arantia (Euarantia) tanzanica* Hemp & Massa, 2018
Xiphocerinana atrox (Gerstäcker, 1869)	*Kraussaria dius* (Karsch, 1896)	*Eulioptera* sp.
Lentulidae	**Oedipodinae**	*Eurycorypha punctipennis* Chopard, 1938
Chromousambilla verseyi Jago, 1981	*Acrotylus trifasciatus trifasciatus* Kevan, 1961	*Horatosphaga* sp.
Chromousambilla robertsoni Jago, 1980	*Oedaleus senegalensis* (Kraus, 1877)	*Ivensia/Pronomapyga* sp.
Mecostibus rubripes Dirsh, 1957	**Acridinae**	*Lamecosoma miombo* Hemp, 2017
Mecostibus sp.	*Odontomelus* sp.	*Odonturoides insolitus* Ragge, 1980
Usambilla leptophrygana Jago, 1981	**Gomphocerinae**	*Oxyecous undulatus* Ragge, 1956
Tropidopolinae	**Pnorisa squalus (Stål, 1860)**	*Peronurella centralis* Hemp, 2017
Afroxyrrhepes sp.	**Tettigoniidae**	*Plangia multimaculata* Hemp, 2015
Euryphyminae	**Conocephalinae**	*Plangia satiscaerulea* Hemp, 2015
Acrophymus cuspidatus (Karsch, 1900)	*Fulvoscirtes* sp.	*Poecilogramma striatifemur* Karsch, 1887
Calliptaminae	**Hetrodinae**	*Terpnistria zebrata* (Serville, 1839)
Acorypha nigrovariegata tibialis (Kirby, 1902)	*Enyaliopsis* sp.	*Tylopsis continua* (Walker, 1869)
Eyprepocnemidinae	*Gymnoproctus* sp.	*Tylopsis rubrescens* Kirby, 1900
Heteracris coerulescens (Stål, 1876)	*Spalacomimus magnus* (La Baume, 1911)	**Pseudophyllinae**
Paraprocticus forchhammeri (Johnsen, 1974)		*Cymatomera denticollis* Schaum, 1853
		Cymatomerella muta Beier, 1954

Figure 6. Mpwapwa Rundfahrt

Figure 7. Mpwapwa Rundfahrt

Figure 8. *Altihoratosphaga nomima* male, Ostseite Kiboriani Hills, 870 m

Figure 9. Lugunga Forest Reserve, 1840 m, Mpwapwa Plateau

Table 3. Species recorded and photographed from the Mpwapwa District and Wotta Forest Reserve

Acridoidea	**Catantopinae**	**Phaneropterinae**
Eumastacoidea	*Abisares depressus* Uvarov, 1938	*Altihoratosphaga basalis* Hemp, 2017
Chromothericles sp. (Wotta)	*Epacrocatantops curvicercus* (Miller, 1929)	*Altihoratosphaga nomima* (Karsch, 1896)
Plagiotriptus sp.	**Cyrtacanthacridinae**	*Altihoratosphaga* sp.
Pseudothericles jallae griffinii Bolívar, 1914	*Kraussaria dius* (Karsch, 1896)	*Ducetia biramosa* (Karsch, 1888)
Pyrgomorphidae	**Oedipodinae**	*Eulioptera* sp.
Chrotogonus hemipterus Schaum, 1853	*Acrotylus elgonensis* Sjöstedt, 1933	*Eurycorypha conclusa* Hemp, 2013
Pamphagidae	*Acrotylus trifasciatus trifasciatus* Kevan, 1961	*Eurycorypha pseudomeruensis* Hemp, 2017
Xiphocerinana atrox (Gerstäcker, 1869)	*Heteropternis couloniana* (Saussure, 1884) (Wotta)	*Horatosphaga* sp.
Lentulidae	**Acridinae**	*Ivensia/Pronomapyga* (Wotta)
Chromousambilla burtti Jago, 1981	*Duronia chloronota* (Stål, 1976)	*Melidia laminata* Chopard, 1954
Mecostibus sp.	**Gomphocerinae**	*Melidia* sp.
Usambilla chlorophrygana Jago, 1981	*Pseudoberengueria burtti* (Dirsh, 1951)	N. gen n sp.
Usambilla sp. (Wotta)	**Tettigoniidae**	*Oxyecous undulatus* Ragge, 1956
Coptacrinae	**Conocephalinae**	*Peronura* sp. 1 (Wotta)
Parepistaurus lobicercus Uvarov, 1953 (Wotta)	*Fulvoscirtes* sp. (Wotta)	*Peronura* sp. 2
Euryphyminae	**Hetrodinae**	*Peronurella centralis* Hemp, 2017
Acrophymus cuspidatus (Karsch, 1900)	*Enyaliopsis inflatus* Weidner, 1941 (Wotta)	*Poecilogramma striatifemur* Karsch, 1887
Eyprepocnemidinae	*Spalacomimus magnus* (La Baume, 1911)	*Tenerasphaga* sp.
Heteracris coerulescens (Stål, 1876)	**Meconematinae**	*Terpnistria zebrata* (Serville, 1839)
Hemiacridinae	*Amytta* sp. 1	*Tropidonotacris grandis* Ragge, 1957
Mesopsera sp.	*Amytta* sp. 2	*Tylopsis continua* (Walker, 1869)
		Pseudophyllinae
		Acauloplax exigua Karsch, 1891 (Wotta)
		Cymatomerella spilophora (Walker, 1870)

Figure 10. Lugunga Forest Reserve, 1840 m, Mpwapwa Plateau

Figure 11. *Chromousambilla* female, Gulwe Rubeho

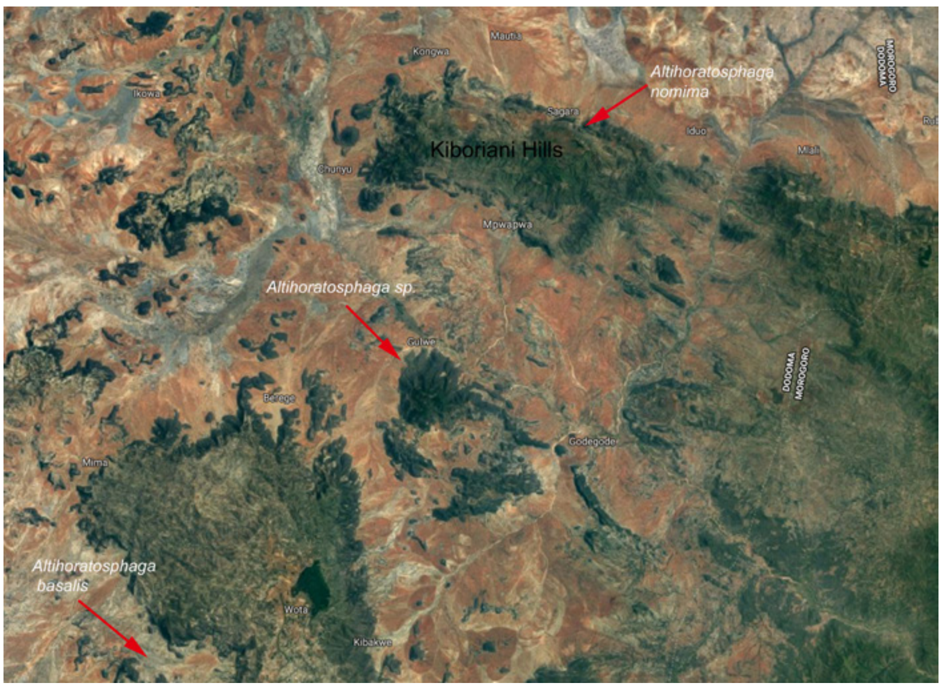

Figure 12. Mpwapwa District Kopie

Figure 13. *Pronomapyga* male, Wotta FR, 1840 m, Waldlichtungen Mpwapwa Plateau Rubeho Mts

Figure 14. Gen. nov. female, Rubeho foothills, 1000 m, beingen Gulwe Baobab Commiphora Wald

Figure 15. Irongo 1000 m, Lager 1, Mpwapwa District

well-known hotspots of high biodiversity and degree of endemism, and of a very high geological age. These mountains were visited several times during the course of the project, with species collected and photographed. First results are published in Hemp (2017), which also gives a species list of the Orthoptera species found so far. The surveys supported by the OSF grant through the Orthopterists' Society show very clearly that although natural habitats are vanishing at an unprecedented pace, numerous new Orthoptera species and even genera are still present in Central Tanzania. Field work (Fig. 15) and knowledge of species are still necessary to learn about the biodiversity and biogeographical patterns on our planet. Still, there is time to find species described over 100 years ago and for which no further data or images are available.

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Orthopteran Physiology

Symposium Presented at the 13th International Congress of Orthopterology, Agadir, Morocco, March 24-28, 2019

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Orthopteran insects have made a major contribution to our knowledge in the field of integrative physiology of insects in particular and animals in general. Offering large size and distinct ecological importance (e.g. Ingrisch and Rentz, 2009), together with relative ease of maintaining and rearing in laboratory conditions, orthopteran insects have served for many decades as models in the study of the muscular, nervous, endocrine, and neuro-endocrine systems (e.g. Burrows, 1996). Locusts have remained prominent model organisms, being for example, in the forefront of research into rhythmic patterns of neuronal activity and the neural control of rhythmic behaviour (Ayali and Lange, 2010). Pioneering studies using locusts range from the very first demonstration of a central pattern generating circuit-producing fictive flight behaviour in a deafferented thoracic ganglia preparation (Wilson, 1961), to studies of the role of brain oscillations in odour perception (e.g. Laurent and Naraghi, 1994; Laurent, 1996). Locusts were, again, leading the way in the identification of neuronal structures dedicated to the processing of polarized light signals (Homberg et al., 2011). One of the most thoroughly studied cases of endocrine regulation by way of neuropeptides in animals is the control of fuel transport by the adipokinetic hormones (AKHs) in the locust (Van der Horst and Rodenburg, 2010), and this example led to the study of many other neuropeptides and peptide hormones in orthopterans and beyond (Claeys et al., 2005). Crickets have been widely utilized in the study of aggression, male courtship, and social hierarchies, from the behavioural to the physiological and endocrinological levels (e.g. Stevenson and Schildberger, 2013; Horch et al., 2017; Stevenson and Rillich, 2019). The phonotactic behaviour of female crickets towards calling males remains a prominent model in auditory physiology and pattern recognition (Schöneich et al., 2015; Hedwig and Stumpner, 2016). They have also served in the study of neurogenesis in the adult insect brain (e.g. Cayre et al., 2013).

While the fruit fly, *Drosophila melanogaster*, is considered the leading model insect for developmental, molecular biological, and genetic studies, this species still has its limitations when it comes to neuroethology and integrative physiology (though these limitations are diminishing as technology advances). Nevertheless, increasingly, benefits from the knowledge specifically gained from *Drosophila* are applied to studies using other insects, including orthopterans (Watanabe et al., 2018). Advances in genetic tools (RNAi, CRISPR, etc.) are expected to be applied to more diverse insect species, orthopterans included, if not leading.

The symposium titled: "**Orthopteran Physiology**," presented at the 13th International Congress of Orthopterology, was aimed at providing a panorama of cutting-edge research, demonstrating that even today, when research tends to focus increasingly on a few selected so-called model organisms, orthopterans have not lost their appeal as an outstanding preparation for physiological studies. The innovative research presented in the symposium represented diverse research fields and directions, and emphasized the importance of a comparative approach in the study of insect physiology. Contributions to the symposium included the following:

- **Uwe Homberg, et al.**, Philipps Universität Marburg , Germany: *The central complex - an internal sky compass in the locust brain*
- **Paul A. Stevenson and Jan Rillich**, University of Leipzig, Germany: *Neurotransmitters and the decision to fight or flee - novel insights on aggression from crickets*
- **Jozef Vanden Broeck, et al.**, University of Leuven (KU Leuven), Belgium: *Recent advances in the study of neuropeptides and their receptors in locust physiology*
- **Stephen Rogers**, University of Cambridge, United Kingdom: *Mechanisms of behavioural phase change in the Australian plague locust, Chortoicetes terminifera*
- **Amir Ayali, et al.**, Tel Aviv University, Israel: *Locusts and grasshoppers as models in the study of respiration and discontinuous gas exchange*

Below we briefly summarize these different contributions:

Homberg and colleagues have pioneered and led the way with considerable recent research into the structure and functional role of the insect central complex (CX) in sensory processing and the control of behaviour (reviewed by Pfeiffer and Homberg, 2014). While early work showed that a small dorsal area of the locust compound eye is specialized for the detection of the angle of polarized light in the sky (Mappes and Homberg, 2004), further research revealed that polarization vision pathways from both eyes converge in the CX (Pfeiffer et al., 2005). Homberg et al. showed that the CX is organized like an internal sky compass with neurons signalling the orientation of the animal relative to sky polarization and solar azimuth (Heinze and Homberg, 2007; Pegel et al., 2018). Neural activity of CX neurons is, furthermore, modulated by visual flow fields and sensory feedback during walking and flight suggesting that this brain area plays a key role in sky compass mediated spatial orientation and navigation. Homberg et al. highlighted the intriguing functional parallels of the CX with parts of the mammalian hippocampal formation and entorhinal cortex discussing the CX in the context of navigation-related directional information, similar to vertebrate head direction cells.

The presentation by **Stevenson and Rillich** highlighted the key role of neurotransmitters in aggression-related decision making. In all animals, the decision whether to fight or flee from a competitor depends both on previous experiences, and an assessment of momentary win chances, but it is unclear how this is implemented. Work on crickets has shown that potentially rewarding experiences, such as previous wins, or possession of a key resource, increases the tendency to fight by raising the threshold to flee due to the action of octopamine, the invertebrate analogue of noradrenaline. On the other hand, aversive experiences, such as the offensive actions of the opponent, induces the release of the gaseous neuromodulator nitric oxide (NO), which lowers the threshold to flee. In turn, NO release in losers recruits the amine serotonin (5HT), which establishes a state of suppressed aggression characteristic for subordinates. Finally, the action of yet another amine, dopamine, is then necessary for recovery of aggression. These studies are now revealing how experiencing excessive aggression (e.g., chronic social defeat stress) can lead to life-long changes in behavioural responsiveness and even cognitive capacity. Hence, the cricket has emerged as a superb model for understanding how brain chemicals mediate the effects of social experience to shape an individual's total behavioural profile.

Keeping with the theme of chemical messenger molecules in insect nervous systems, **Vanden Broeck and colleagues** have been studying for many years the role of neuropeptides and their receptors in the physiology of orthopteran (and other) insects (Claeys et al., 2005; Dillen et al., 2013; Lenaerts et al., 2017; Lismont et al., 2015; Marchal et al., 2018; Vanden Broeck, 2001). Neuropeptides form the most diverse class of signalling molecules in metazoan nervous and endocrine systems. Data presented in the symposium focused on a few neuropeptide-mediated signalling pathways that are implicated in the regulation of developmental-physiological processes in insects, and in locusts in particular. Based on their importance as signalling molecules, interfering with the normal function of neuropeptides or their receptors by way of peptido-mimetic analogues or downregulation by way of RNA interference could affect key physiological processes in insects, and provide a useful means of dealing with agricultural pests, such as the locust. The general aim of the work is to contribute to a better understanding of the regulation of postembryonic processes, as well as of the functional interactions between different regulatory pathways in an integrative (organismal/systemic) physiological context.

No discussion of Orthopteran physiology is complete without a mention of the remarkable density-dependent plasticity demonstrated by locusts (Cullen et al., 2017). A density-dependent transition in behaviour brings about an array of phase-specific characteristics, culminating in the two extreme phases: solitarious and gregarious. While the different locust species may demonstrate somewhat similar phase-specific behaviour and even physiology, they seem to differ in the mechanisms underlying the phase change (Buhl and Rogers, 2016). This is very evident from comparison of the two most studied locust species: *Schistocerca gregaria* and *Locusta migratoria*. The presentation by **Steve Rogers** focused on the mechanism and the time course of behavioural phase transformation in the Australian plague locust, *Chortoicetes terminifera*. Unlike in other species studied, both gregarisation and solitarisation followed similar time-courses in this species. Rogers also identified an initial period of rapid behavioural change lasting a few hours, followed by a longer period of slower change lasting 2-3 days, after which the locusts behaviourally fully resembled those of the opposite phase. Regarding the much studied roles for biogenic amines in locust phase transformation (e.g., Rogers et al., 2004), in the Australian plague locust changes in the amount of dopamine and octopamine were associated with gregarisation but not solitarisation. Comparative physiology of different locust species is instrumental for our growing understanding of the phase phenomenon and its multitude facets.

Finally, recent years have seen a growing interest in the control of gas exchange and respiration in actively ventilating insects. Locusts and grasshoppers (together with cockroaches) have been instrumental in the efforts to revisit the best-studied among insect gas exchange patterns: discontinuous gas exchange (DGE, Grieshaber and Terblanche, 2015; Huang et al., 2015; Talal et al., 2015; 2016; 2018; Matthews, 2018). Our ample knowledge of pattern generation and the control of rhythmic behaviors in locusts (e.g. Ayali, 2004; Ayali and Lange, 2010), promotes research into the complexity of locust respiratory motor activity and its neural control. In the locust, as in all actively ventilating insects, respiration involves, in addition to spiracular activity, abdominal pumping movements. In the symposium, **Ayali and colleagues** presented recent findings based on simultaneous respirometry and muscle electrophysiological recordings (Talal et al., 2018). Strong coupling between abdominal constrictor muscles and spiracle closure muscle activity throughout the DGE cycles was reported. The tight yet intricate coupling was also evident in isolated thoracic ganglia preparations where modulation by different gas concentration could also be demonstrated. The work calls for further research into the details of the peripheral and the central sensing of respiratory gases and possible interactions in their effects on the respiratory output from the CNS.

Acknowledgments

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Workshop Recap

First Training in Systematics and Identification of Orthoptera at Universidade Federal de Viçosa, campus Rio Paranaíba, Minas Gerais, Brazil

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During January 14-30, 2019, in the city of Rio Paranaíba (which is the smallest Brazilian city with a university), the First Training in Systematics and Identification of Orthoptera occurred for undergraduate students. I created this initiative because my country is the largest Neotropical nation with the world's most biodiverse region and several groups of Orthoptera are poorly known or practically unknown. Thus, it is always necessary to foster the interest of young students for these insects.

The training was divided into two parts: in the first part, I showed the students the current classification, the OSF database, and the morphological aspects of Neotropical Orthoptera subfamilies (Fig. 1). For the study of the external morphology, I used classic studies, like Snodgrass (1935) materials and the most recent version of the Insects of Brazil (2012) book. The emphasis of the course was given to the grasshoppers and I used Carbonell's studies and "The

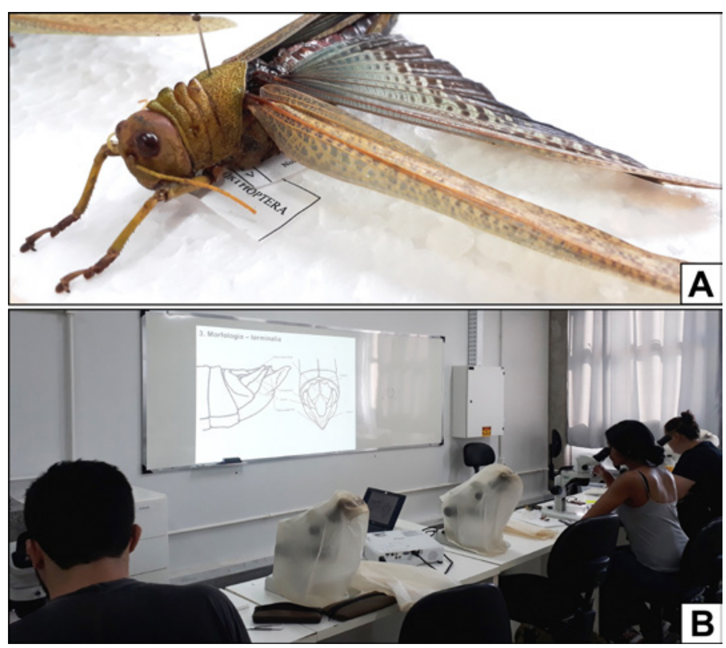

Figure 1. *Tropidacris* sp. as a model for morphological studies during our training (A) and undergraduate students in a classroom (B).

Figure 2. Platô Azul farm area: yellow circle is the farm administrative office and white circles are the points at which we sampled in the preserved area.

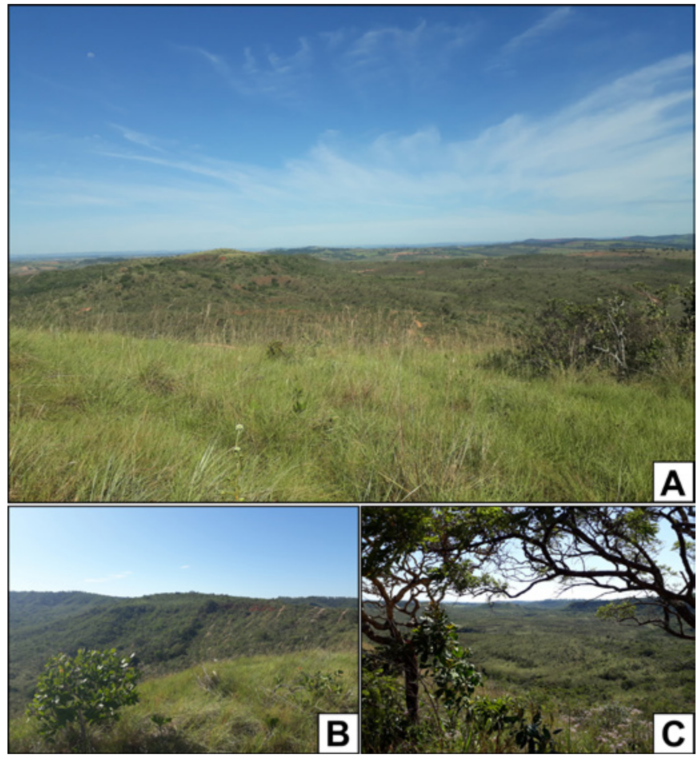

Figure 3. Habitats of grasshoppers observed in herbaceous and shrubby vegetation.

Grasshoppers (Caelifera) of Costa Rica and Panama" book by C.H.F. Rowell (2013) to show the diversity of this group. In the discussion about the phallic complex aspects, the study of Woller & Song (2017) served as a basis for the understanding of each structure.

The second part of the training was the field sampling. Whereas the field activities are essential for the preparation of a good taxonomist, we sampled Orthoptera insects in a natural environment. This activity was performed at the Platô Azul farm, found in the biome Cerrado (Brazilian Savanna) (Fig. 2). On this farm, a percentage of the total area is designated by Brazilian law for the preservation of the original vegetation cover of the biome, named in Brazil as "reserva legal." We sampled in this place on a sunny day and scanned shrubby vegetation for grasshopper activity (Fig.3), which were collected with sweep net.

During our activity, we identified several species of Caelifera, with the ones that attracted the attention of the students the most being the astonishing *Chromacris* sp. (Fig.4A), *Zoniopoda* sp. (Fig. 4B), and *Parascopas* sp. (Fig. 4C). Since field sampling is a practice that optimizes students' abilities to understand taxonomic characters, my first experience of training undergraduate students was very rewarding. Also, several new species of Caeifera are in the process of being described. Now, new students here are interesting in working with Orthoptera and this is very happy news, especially in the current political and environmental context in which Brazil is unfortunately immersed.

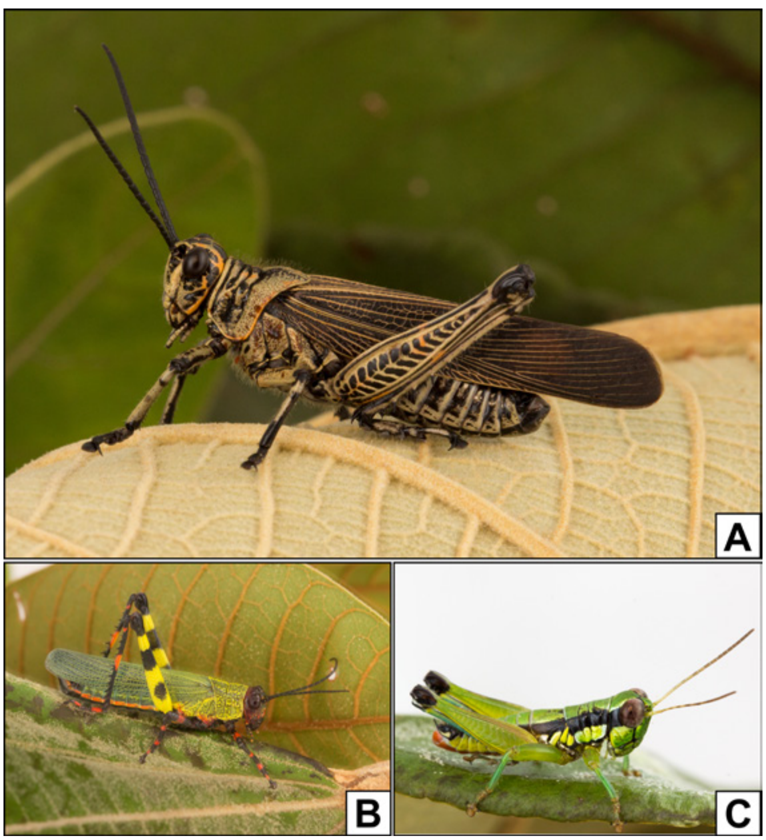

Figure 4. Some species of Caelifera observed in Platô Azul farm: (A) *Chromacris* sp., (B) *Zoniopoda* sp., and (C) *Parascopas* sp.

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I would like to thank the Platô Azul farm administration for their invaluable attention and availability to meet us, and Dr. Marcelo Ribeiro Pereira for the grasshopper pictures.

Editorial

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Of many scientific meetings that I regularly attend, the International Congress of Orthopterology (ICO) is by far my most favorite not only because it is solely focused on the insect group that I love, but also because it gives me a chance to catch up with old friends and to meet new faces. The 13th ICO in Agadir, Morocco was my sixth ICO, after the meetings held in Montpellier, France (2002), Canmore, Canada (2005), Antalya, Turkey (2009), Kunming, China (2013), and Ilheus, Brazil (2016), and again it was a wonderful meeting. Unfortunately, because the meeting was scheduled in the middle of my teaching semester, I was not able to fully experience Morocco, but nevertheless I enjoyed meeting friends and new colleagues, and learned many new things about Orthoptera.

Although catching up with old friends and discussing new collaborative projects with colleagues are always interesting and enjoyable, what I am excited about the most is meeting new students who are just beginning their journeys to become orthopterists. Their enthusiasm about research is infectious and it makes me feel assured that this society has a bright future ahead. For many of these students, the ICO meeting can be both inspiring and intimidating at the same time. They get to meet with the people that they only know from the literature, and have the opportunity to build their networks. They get to share their ideas and get instant feedbacks from the experts, and even go out and have drinks with them!

But, not everyone is naturally gregarious, and it is entirely possible for the young students (especially if their native language is not English) to feel that it is too daunting to strike up a conversation with others (and thus stay quiet or even feel lonely) and that their projects do not measure up to the quality of research being presented at the meeting. If any young student has felt this way at the last ICO meeting, I would like to say that it is okay and natural to feel that way, and that this society is a society of friends and mentors who are extremely interested in nurturing the next generation of orthopterists. I have personally benefitted greatly from the friends and colleagues who I have met at the ICO meetings over the years, and I feel a sense of responsibility to help as many young orthopterists as possible, so that they can mature into the next generation of leaders for our society.

This is another fine issue of *Metaleptea*. I am especially thankful to Dr. Dan Otte and Dr. Michel Lecoq for sharing their journeys and thoughts. The special conference issue of *Metaleptea* has already been uploaded to the Society's website, where you can download it to read all the abstracts. I would also like to thank our Associate Editor, Derek A. Woller, for his continued assistance in the editorial process, especially during his busy field season.

To publish in *Metaleptea*, please send your contribution to **hsong@tamu.edu** with a subject line starting with [Metaleptea]. As for the format, a MS Word document is preferred and images should be in JPEG or TIFF format with a resolution of at least 144 DPI. The next issue of *Metaleptea* will be published in September of 2019, so please send me content promptly. I look forward to hearing from you soon!

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