A Rapid Assessment Survey of Katydids and Relatives of the Muller Range (Insecta: Orthoptera: Ensifera)

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Source: Rapid Biological Assessments of the Nakanai Mountains and the upper Strickland Basin: surveying the biodiversity of Papua New Guinea's sublime karst environments: 168

Published By: Conservation International

URL: https://doi.org/10.1896/054.060.0116

Chapter 11

A rapid assessment survey of katydids and relatives of the Muller Range (Insecta: Orthoptera: Ensifera)

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SUMMARY

We report the results of a rapid assessment survey of katydid diversity in the Muller Range of Western and Southern Highlands Provinces, Papua New Guinea. Ninety species of katydids were collected at three different elevations during the survey. At least 56, or 62% of species recorded during the survey represent species new to science. The current survey confirms that the katydid fauna of Papua New Guinea is exceptionally rich, yet still virtually unknown. Although no specific conservation issues have been determined to affect it, habitat loss on Papua New Guinea is the primary threat to the biota of the island.

INTRODUCTION

Katydids (Orthoptera: Tettigonioidea) have long been recognized as organisms with a significant potential for their use in conservation practices. Many katydid species exhibit strong microhabitat fidelity, low dispersal abilities (Rentz 1993a), and high sensitivity to habitat fragmentation (Kindvall and Ahlen 1992) thus making them good indicators of habitat disturbance. These insects also play a major role in many terrestrial ecosystems as herbivores and predators (Rentz 1996). They are themselves a principal prey item for several groups of invertebrates and vertebrates, including birds, bats (Belwood 1990), and primates (Nickle and Heymann 1996). At the same time many species of katydids are threatened and some appear to have already gone extinct (Rentz 1977).

It is critically important that more effort is directed towards basic faunal surveys of katydids across the tropics, thus creating the basis on which a successful conservation strategy for these animals can be built. Such surveys, if conducted in pristine or relatively undisturbed areas, also provide reference data which can later be used in habitat monitoring or restoration efforts that should follow any industrial or agricultural activity.

Katydids of New Guinea and surrounding islands have never been systematically studied, and most of the approximately 325 species recorded from this region of Melanesia were described based on specimens collected during the period of early colonial exploration (primarily from the material collected by Lajos Biro and Otto Schlaginhaufen in the 1890-1900's, and the German Kaiserin-Augusta-River Expedition of 1912-13.) The most significant contributions to the knowledge of the Tettigoniidae of the islands were those by Karny (1907, 1911, 1912, 1920, 1924, 1926) – 58 species described; Bolivar (1890, 1898, 1902, 1903, 1905) – 40 species described; and Willemse (1933, 1940, 1957, 1958, 1959, 1961a, 1961b, 1966 1977, 1979) – 37 species described. More recently, Jin (1992) reviewed the tribe Phisidini, and Ingrisch (2008, 2009) genera *Paramacroxiphus* Willemse and *Pseudonicsara* Karny, and both described a number of Papuan species. The proportion of species from New Guinea that were described as new in these two authors' works was 78% and 81%, respectively, which gives a good indication of the enormous amount of work still needed to fully understand its katydid fauna. Although a recent study by Novotny et al. (2007) significantly tempers the estimates of

plant-associated insect species expected to live in the forests of New Guinea, the results of the Rapid Assessment survey presented below indicate that the katydid fauna of Papua New Guinea may be one of the richest, and least explored, in the world.

METHODS AND STUDY SITES

Field methods

During the survey three collecting methods were employed for collecting katydids: (1) collecting at ultraviolet (UV) and fluorescent lights at night, (2) visual search at night, and (3) acoustic tracking using a heterodyne ultrasound detector and a directional microphone.

The most effective method of collecting, both in terms of the number of species collected and number of collected specimens, was the visual search at night. Most of the collecting was conducted after dark, between the hours of 8 pm and 1 am when the activity of virtually all katydid species was the highest. Day collecting along the roads within the Porgera mining compound yielded one additional, diurnal, grass-feeding species. The UV collecting was done nightly between approximately 8 pm and 11 pm, with the exception of Site 3 where low temperatures at night (10°C and below) resulted in virtually no activity of flying insects. Additionally, katydids were collected from among the leaves of several freshly felled *Pandanus* trees.

In addition to katydids we also collected members of the related orthopteroid groups (Ensifera): Gryllacrididae (raspy crickets), Rhaphidophoridae (camel crickets), and Anostostomatidae (king crickets).

Stridulation of acoustic species was recorded using a Marantz PMD-661 digital recorder and a Sennheiser shotgun microphone ME-66. These recordings are essential to establish the identity of potential cryptic species, in which morphological characters alone are not sufficient for species identification; they were analyzed using a bioacoustics package Raven Pro 1.3 (Cornell Lab of Ornithology). An ultrasound detector Pettersson D 200 was also used to locate species that produce calls in the ultrasonic range that are undetectable to the human ear.

Representatives of all species encountered were collected, and voucher specimens were preserved in 96% ethanol, or dried with silica gel beads between layers of paper tissue. These specimens will be deposited in the collections of the Museum of Comparative Zoology, Harvard University, the Academy of Natural Sciences of Philadelphia, and the Australian National Insect Collection (the last two will also become the official repositories of the holotypes of species new to science encountered during the present survey upon their formal description.) Representatives of all collected morphospecies were photographed, and these photographs will be added to the online database of the Orthoptera (Eades and Otte 2010).

Simpson's Index of Diversity (D_s) was calculated for each site using the formula:

$$D_s = 1 - \sum_1^i [n_i(n_i-1)]/[N(N-1)]$$

where n_i = number of individuals of species i, and
N = number of all collected individuals.

Collecting sites

Western Province

Camp 1: Gugusu (05°43.751'S, 142°15.797'E), 3-10 September 2009

The camp was situated at an elevation of 515 m, and most sampling was conducted within an approximately 50-75 m elevational range of the camp. The site was covered by undisturbed forest, with no apparent signs of logging or hunting, and large emergent trees of DBH over 1 m were common. Katydids were collected from vegetation along trails in the forest, along the more open edge of an escarpment adjacent to the camp, along a small stream near the camp, and along the edges of the helipad clearing. They were also collected from fluorescent lights around the camp, and a UV light situated in the middle of the camp's main area.

Camp 2: Sawetau (05°39.397'S, 142°18.277'E), 11-17 September 2009

The second camp was situated at the elevation of 1,587 m but collecting was done within the range of 1,450 m to nearly 2,000 m. Humidity at this pre-montane site was very high and the surrounding forest, growing on doline karst, was exceptionally rich in mosses and ferns. At lower elevations the largest emergent trees were *Nothofaus,* while at higher elevations they were replaced by *Araucaria*. Large *Pandanus* trees were common, as were several species of tree ferns (*Cyathea*). Katydid collecting was done at night from lower vegetation, but a few additional specimens were collected from felled *Pandanus*, and some were found in mossy tree stumps by members of the ant-collecting team. The UV light was used nightly, and it attracted several species of the Phaneropterinae.

Southern Highlands Province

Camp 3: Apalu Reke (5°20.623'S, 151°18.875'E), 18-27 September 2009

The camp at this montane site was located at 2,875 m, and katydid collecting was conducted up to 2,950 m. The area adjacent to the camp was an open alpine meadow, covered primarily with short ferns *(Blechnum revolutum)* with large clumps of *Rhododendron beyerinckiana* and *Podocarpus brassii*. Surrounding the meadow was mossy forest dominated by *Nothophagus (?starkenborghii)* and *Phyllocladys hypophyllus.* Insect activity and abundance at this site was very low. Only 4 species of katydids were collected, all from large *Pandanus* trees.

Enga Province, Porgera

Site 4: Porgera Joint Venture mining camp (5°29'3.5"S, 143°8'8.8"E), 2-3 & 15 September 2009

This heavily altered site had little vegetation, but nonetheless several species of katydids were collected from plants growing along the roads within the camp, and from flower beds adjacent to buildings.

RESULTS

During the survey 303 individuals representing 90 species of katydids were collected. Simpson's Indexes of Diversity (D_s) for Gugusu, Sawetau, and Apalu Reke were 0.810, 0.858, and 0.992, respectively. At Gugusu and Sawetau these results indicate high species richness, combined with low abundance of individual species, a situation typical of tropical habitats with low levels of disturbance, whereas at Apalu Reke the high Simpson's Index is indicative of exceptionally low population densities of species.

The highest number of species, 65 (165 specimens), was collected at Gugusu. Although the sampling was not conducted in a rigorously structured manner, it is safe to assume that this number does not approach the asymptote of the actual species richness at the site; 26 of the 65 collected species were represented by singletons, and at least 5 additional species were collected on the last night of sampling. Sawetau yielded 26 species (77 specimens), whereas Apalu Reke had only 4 species of katydids (represented by 21 specimens). The low richness and abundance of katydids at the highest site appears to be consistent with the general trend observed in many groups of organisms found in tropical mountains (Ghalambor et al. 2006.)

But the results of this survey exceeded even the most optimistic expectations regarding the proportion of species new to science within the collected samples. Of the 90 species collected, at least 56, or 62% of species belonged to yet undescribed species. Fifteen of these species, and two genera new to science, have already been described (Naskrecki and Rentz 2010), and descriptions of additional species new to science are in preparation. A full list of recorded taxa is given in Table 11.1, and below we comment only on new or particularly interesting taxa.

Subfamily Phaneropterinae

The Phaneropterinae probably comprise the greatest diversity of PNG katydids. Most are cryptic and live not only in the understory, but also in the canopy. As a result, we do not have an extensive collection, and is possible that we have missed the majority of species. Fortunately, many are excellent fliers, and could be collected at night using UV or fluorescent lights. All members of this subfamily are exclusively herbivorous. Our small collection is impressive because it indicates a considerable diversity of this group in PNG. The majority of specimens were from Gugusu, with lesser numbers at the other two sites. Only 42 specimens were collected

Table 11.1. A list of katydids collected during the 2009 Muller Range RAP survey (Orthoptera: Tettigoniidae)

Species	Gugusu	Sawetau	Apalu Reke	Porgera Town
Conocephalinae				
Habetia spada	X			
Microsalomona brachyptera		X		
Microsalomona sawetau		X		
Nicsara sp. *M1*	X			
Nicsara sp. *M14*	X			
Nicsara sp. *M2*	X			
Nicsara sp. *M3*	X			
Pandagraecia armata		X		
Pandagraecia bifurcata			X	
Pandagraecia porgera				X
Pandagraecia stylata	X	X		
Paramacroxiphus maculatus	X			
Philmontis lobatus	X	X		
Philmontis n. nigrofasciatus			X	
Pseudomacroxiphus szentia	X			
Pseudonicsara (P.) fascifrons	X	X		
Pseudonicsara (P.) forceps		X		
Pseudonicsara (P.) gugusu	X			
Salomona aroensia	X			
Secsiva sp. *1*		X		
Spinisternum sp. *6*		X		
Trichophallus cf. *gracilis*	X			
Conocephalus (C.) redtenbacheri				X
Listroscelidinae				
Meiophisis sp. *2*		X		
Meiophisis sp. *n.*	X			
Neophisis sp. *1*	X			
Neophisis sp. *2*	X			
Teuthroides sp. *1*	X			
Mecopodinae				
Eumecopoda cyrtoscelis cyrtoscelis	X			
Eumecopoda sp. *1*	X	X		
Huona variegata	X			
Mossula sp. *1*		X		
Mossula sp. *2*		X		
Mossula sp. *3*	X			
Mossula sp. *4*	X			
Mossula sp. *5*		X		

table continued on next page

Table 11.1. *continued*

Species	Gugusu	Sawetau	Apalu Reke	Porgera Town
Mossula sp. *6*	X			
Phrictaetypus sp. *1*	X			
Segestes cornelii		X		
Segestes sp. *3*			X	
Segestes sp. *4*		X		
Segestes sp. *5*	X			
Segestes stibicki				X
Sexava sp. *1*	X			
Gressittiella sp. *1*		X		
Gressittiella sp. *2*		X		
Gressittiella sp. *3*			X	
Phyllophorinae				
Phyllophorella sp. *2*	X			
Sasima sp. *4*				X
Sasima sp. *5*	X			
Sasima sp. *6*	X			
Pseudophyllinae				
Acauloplacella sp. *10*	X			
Acauloplacella sp. *11*	X			
Acauloplacella sp. *12*	X			
Acauloplacella sp. *13*	X			
Acauloplacella sp. *14*	X			
Acauloplacella sp. *3*	X			
Acauloplacella sp. *4*	X			
Acauloplacella sp. *5*	X			
Acauloplacella sp. *6*	X			
Acauloplacella sp. *7*	X			
Acauloplacella sp. *8*	X			
Acauloplacella sp. *9*	X			
Phaneropterinae				
Kurandoptera sp.	X			
Paracaedicia nigropunctata	X			
Caedicia sp. 1	X			
Caedicia sp. 2		X		
Caedicia sp. 3		X		
Caedicia sp. 4	X			
Caedicia sp. 5	X			
Caedicia sp. 6	X			
Caedicia sp. 7	X			
Caedicia sp. 8		X		
Caedicia sp. 9	X			
Caedicia sp. 10	X	X		
Caedicia sp. 11	X			
Caedicia sp. 12	X			
Caedicia sp. 13	X	X		
Caedicia sp. 14	X			
Caedicia sp. 15	X			
Caedicia sp. 16	X			
Caedicia sp. 17	X			
Caedicia sp. 18	X	X		
Caedicia sp. 19	X			
Caedicia sp. 20	X			
Caedicia sp. 21	X			
Caedicia sp. 22	X			
Caedicia sp. 23	X			
Caedicia sp. 24	X			
Caedicia sp. 25	X	X		
Caedicia sp. 26		X		
Caedicia sp. 27	X			
Total	**65**	**26**	**4**	**4**

in total, representing 27 species. Only two of these could be tentatively identified and the remainder are most likely to be undescribed.

There are great taxonomic problems in the Phaneropterinae. Undoubtedly, the New Guinea fauna is related to that of Australia. The Australian phaneropterine fauna has not been the subject of taxonomic revision in recent years and there are many errors of generic assignment and several "dump-all" genera. *Caedicia* is the largest Australian phaneropterine genus, and several species collected in the Muller Range seem to belong to it, but until the genus *Caedicia* is revised it is difficult to assign many New Guinean species.

It is possible that some of our material is described. Extensive checking with collections and types is necessary to determine this. All of the types are in overseas museums and many are undocumented by illustrations or photos. Almost all lack precise locality data. Our next job is to carefully check, as far as we can, the described New Guinean phaneropterine fauna and attempt to determine if any names are relevant to our collection.

Subfamily Conocephalinae

The Conocephalidae, or the conehead katydids, include a wide range of species found in both open, grassy habitats, and high in the forest canopy. Many species are obligate graminivores (grass feeders), while others are strictly predaceous. A number of species are diurnal, or exhibit both

diurnal and nocturnal patterns of activity. We collected 23 species belonging to this subfamily.

Conocephalus redtenbacheri (Bolivar) was the only representative of the tribe Conocephalini, and is a widely distributed Pacific species, a seed- and grass-feeder, often associated with anthropogenic or disturbed habitats. We found it only on roadside vegetation at the Porgera mining camp.

All remaining conehead katydids collected during this survey belonged to the tribe Agraeciini. Members of this tribe are primarily sylvan species, and many are predaceous. Of the 22 species collected, 16 were new to science; some are already described by Naskrecki and Rentz (2010), others will be included in generic revisions by S. Ingrisch. Of particular interest are 4 species of the newly described genus *Pandanagraecia* Naskrecki & Rentz, which show unusual morphology of the male genitalic structures, and appear to be associated only with *Pandanus* plants; *P. bifurcata* Naskrecki & Rentz was found in water-filled fronds of *Pandanus* (phytotelmata), in association with damselfly naiads, although it was not apparent if the katydids (or the odonate larvae) actually entered the water.

Subfamily Listroscelidinae

The Listroscelidinae are small, predaceous katydids, often found on low vegetation where they feed on small insects captured with long, exceptionally spiny legs. Some species are diurnal, whereas others are nocturnal and can be attracted to a UV light. We collected 5 species of this family, of which at least one, *Meiophisis* cf. *cardiopennis*, is new to science. Unfortunately, the remaining 4 species are represented in our collection only by female specimens, making their identification difficult.

Subfamily Mecopodinae

The Mecopodinae are large, herbivorous katydids, associated primarily with forest habitats. Some species are serious pests of palm trees in PNG, and as such have received a disproportionate attention from entomologists. Yet despite several treatments of the Mecopodinae of PNG, at least 12 out of 19 species we collected are yet undescribed. Three species tentatively assigned to the genus *Gressittiella* Willemse were collected at elevations above 1,500 m at Sawetau and Apalu Reke, and were unusual in being active at relatively very low temperatures; males of *G.* sp. 3 were recorded stridulating when the air temperature was only 12°C. At least five species of the genus *Mossula* Walker and two species of *Segestes* Stål that are new to science were collected at Gugusu and Sawetau camps.

Subfamily Phyllophorinae

The Phyllophorinae, or box katydids, are typical elements of the Papuan fauna, and are one of the few groups of katydids in PNG that has been systematically studied, in a series of papers by C. De Jong (1946, 1947, 1972). They include some of the largest katydids in the world (in fact, some belong to the largest insects in the world), and are easily recognizable by the presence of a large, helmet-like pronotum that covers the base of the wings (and almost the entire body in nymphs). Unlike most katydids, all species in this subfamily lack stridulatory organs on their fore wings, and are thus incapable of producing a typical courtship call. They are still capable of producing sound with the unique coxal stridulatory organs at the base of their hind legs, but the loud sound produced in such a way appears to be employed only as a defensive strategy. The courtship behavior and means by which the opposite sexes of these solitary insects find each other remain a mystery. All species in this group are herbivorous.

We collected 4 species of box katydids (1 species of *Phyllophorella* Karny and 3 species of *Sasima* Bolivar), but as of yet we were not able to identify them to species.

Subfamily Pseudophyllinae

Virtually all members of tropical Pseudophyllinae, or the sylvan katydids, can be found only in forested, undisturbed habitats, and thus have potential as indicators of habitat changes. These katydids are mostly herbivorous, although opportunistic carnivory has been observed in some species. Many are confined to the upper layers of the forest canopy, and rarely come to lights, making it difficult to collect them. Australasian Pseudophyllinae are poorly studied, and most of what is known about them comes from the monographic treatment by Beier (1962) of the world's sylvan katydids. We collected at least 12 species of these katydids, which are tentatively assigned to the genus *Acauloplacella* Karny. Rentz et al. (2010) recently reviewed Australian species of the genus, revealing a hidden diversity of previously unrecognized species, and it is likely that many of the species we collected during the present survey will also be new to science.

Other Ensifera

We also collected the following numbers of species that belong to families related to katydids. At this point it is impossible to identify them to species, but it is likely that some of the species we collected may be new to science:

Gryllacrididae (raspy crickets) – 10 genera, 13 species
Rhaphidophoridae (camel crickets) – 2 genera, 3 species
Anostostomatidae (king crickets) – 2 genera, 3 species.

DISCUSSION AND CONSERVATION RECOMMENDATIONS

The results of this survey confirm that the fauna of katydids of Papua New Guinea is exceptionally rich, even by the standards of lowland tropical forests, and that a large proportion of it remains unknown and unnamed. More sampling surveys, combined with comprehensive taxonomic and phylogenetic reviews are badly needed in order to understand its true magnitude.

As with most groups of tropical insects, the principal threat to the survival of katydids in PNG comes from habitat loss, especially from logging and the development of oil

palm plantations. While species-level conservation recommendations are currently impossible to make, protecting the existing habitats, or at least major, connected fragments of them, are the most effective way of ensuring their survival.

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