Aerotegmina shengenae, a new species of Listroscelidinae (Orthoptera: Tettigoniidae) from the Eastern Arc Mountains of East Africa

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Aerotremina shengenae, a new species of Listroscelidinae (Orthoptera: Tettigoniidae) from the Eastern Arc Mountains of East Africa

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Abstract

Aerotremina shengenae is described from the montane forests of the South Pare Mts of Tanzania. A habitat description is given and co-occurring Saltatoria registered. By the morphology of the acoustical chamber, A. shengenae is more primitive than A. kilimandjarica. Speciation processes are discussed for Aerotremina species.

Key words

Orthoptera, Listroscelidinae, Aerotremina, Euryastes, South Pare Mountains, West Usambara Mountains, new species

Introduction

The genus Aerotremina was erected on A. kilimandjarica Hemp, 2001, from Mt. Kilimanjaro, Tanzania (Hemp 2001a). As is A. kilimandjarica, A. shengenae is a canopy dweller in montane forests of the South Pare Mts. Individuals are well camouflaged in daylight, probably hiding under leaves high up in the canopy. After sunset they descend from the canopy to lower levels to attract partners with their songs. The song is very conspicuous to human ears and that of A. kilimandjarica (Hemp 2001a) easily audible at several hundred meters.

The genus Aerotremina is characterized by highly modified wings and the shape of the pronotum. The tegmina are strongly inflated to form an acoustical chamber, closed by the flap-like alae completing the chamber ventrally. The pronotum is saddle-shaped. Aerotremina probably evolved from Hexitrenini ancestors (Hemp 2001a).

Material and Methods

Collection plots.—Permanent plots were laid in clearings, swamps and closed montane forest area around Mt. Shengena, the highest of the South Pare mountains.

Measurements.—Total body length refers to the body length of the insect, disregarding tegmina but not genitalia: in females the ovipositor is included in body length. Tegminal length is determined as viewed from above.

Song.—The field recording of the songs were made with a Canon 3CCD Digital Video Camcorder XM1 Pal (16 Bit, 48 kHz). The songs of both Aerotremina species were recorded from captive specimens on the same night under the same temperature conditions (22 °C). When recording the songs the video camera was positioned about 2 to 3 m distant from the singing Aerotremina males. A heterodyning bat detector (Laar PX 1, 15-130 kHz) aided in searching for tettigoniids. Using this device, it was apparent that Aerotremina has no frequency output in the ultrasonic range; thus the song was fully recorded by the Canon Video Camcorder.


Results

Aerotremina shengenae n. sp. Figs 1-7

Holotype.—Male: Tanzania, South Pare Mts., Mt. Shengena, 2100 m, UTM zone 37M, 03.80.822E 95.30.035S, canopy of undergrowth tree, March 2001, C. Hemp coll.; depository, NMB.

Paratypes.—All Tanzania; 1 male, same collection data as holotype; depository, NHML. 1 male, same collection data as holotype; depository, EDNMK.

Additional material examined.—all Tanzania, all C. Hemp coll. 4 males, 1 female, 2 nymphs, same data as holotype.

Description.—Color light green.

Head and antennae: Antenna more than twice as long as length of body, whitish with annulate dark markings (Fig. 6). Cuticle of head smooth. Conical and laterally compressed fastigium of vertex situated slightly before antennal sockets (Figs 1, 2). Space between eyes 2.6 × as wide as diameter of eye. Eyes almost circular, prominent, of whitish color (Figs 1, 6).

Thorax: Light green in the preserved insect, rugulose callosities marked darker green in the living insect. Pronotum narrowly emarginate, the margin anteriorly and posteriorly yellow.

Abdomen: Abdomen ventrally milky white.

Tegmina and wings: Acoustical chamber imperfectly closed by blunt alae, leaving a gap posteriorly (Fig. 5). Tympanum (mirror of right tegmen) about 3.5 mm in diameter.

Legs: Fore and middle femora with four pairs of stout spines on the inner and outer side. Apically with a pair of short spurs. Hind femur with six stout outer and three smaller inner spines; distally one spur on each side. Fore and mid tibiae with five pairs of light green predatory spines on each side, apically with a pair of spurs. Base of each spine with small black dot dorsally. Hind tibiae with four rows of minute spines. With well developed tarsal arolium.
Fig. 1. Dorsal view of male head of *Aerotegmina shengenae* (left) and *A. kilimandjarica* (right).

Genitalia: Subgenital plate symmetrical (Fig. 4), of same milky white color as venter of abdomen, with smooth surface, flattened ventrally, lobes with scattered hairs. Cerci robust with rugose surface, on inner basal side a bulge (Fig. 4); in the living specimen stretched out from the body.

**Measurements.** — (mm).

<table>
<thead>
<tr>
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<th>males (n = 7)</th>
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<tbody>
<tr>
<td>Total length of body</td>
<td>13.0 to 15.0 (mean 14.3)</td>
</tr>
<tr>
<td>Length of pronotum</td>
<td>3.5 to 4.0 (mean 3.7)</td>
</tr>
<tr>
<td>Length of hind femur</td>
<td>10.0 to 11.0 (mean 10)</td>
</tr>
<tr>
<td>Length of tegmina</td>
<td>12.0 to 13.0 (mean 12.7)</td>
</tr>
</tbody>
</table>

Only a little general data can be given on the female. It was only possible to collect one female, this in the last instar, which in captivity moulted incompletely to an adult. Therefore some characters could not be determined such as body, femur and wing lengths. But it is obvious from the specimen, that it is very similar to the female of *A. kilimandjarica* and thus typical for the genus *Aerotegmina*.

**Female.** —

General characters: Color pattern similar to the male, of predominantly greenish color.

Fig. 2. Fastigium verticis of *A. shengenae* (left) and *A. kilimandjarica* (right).

Fig. 3. Procoxal spine of *A. shengenae* (left) and *A. kilimandjarica* (right).

Fig. 4. Dorsal view of genitalia (left) and ventral view of subgenital plate (right) of male *A. shengenae*.

**Fig. 3.** Procoxal spine of *A. shengenae* (left) and *A. kilimandjarica* (right).
Abdomen: Ventrally milky white.
Thorax: Median length of pronotum 3.5 mm.
Tegmina: Shortened reticulate lobes with reduced venation, of greenish color; alae lobular with reduced venation, covered by tegmina.
Legs: As in male.
Genitalia: Ovipositor 8.5 mm, of brownish color in the inflated part, proximally greenish.

Nymphs.—Nymphs similar to adults.

Distribution.—A. shengenae n. sp. was collected in montane forest in the South Pare Mts. Here extensive forest cover still exists, starting at about 1900 m on the southern slopes and at about 1700-1800 m on the northern side. Huge areas below this have been burnt and are either partly under cultivation by the local population, or in a regeneration stage with Erica species. A. shengenae was detected only in intact, closed Ocotea forest (see below). It did not occur in smaller forest remnants (e.g., along small rivers where fires could not completely destroy forest cover) or in Erica bushland. Its presence was indicated by its conspicuous song, from the lower borders (south and north slopes) of montane forest, almost to the top of Mt. Shengena. Near its summit at 2400 m, Mt. Shengena is covered by Erica forest, which does not seem to serve as acceptable habitat for A. shengenae. On the northern slopes A. shengenae was noted at about 1600 m.

Habitat.—The forests, in which A. shengenae lives, have an upper tree canopy of 30 to 40 m-height and 80 to 90% coverage. Dominant trees are Ocotea usambarensis, Podocarpus latifolius, Cassipourea malosana, Ocma hostii, Aphloia theiformis, Xymalos monospora, Syzygium guineense, Ilex mitis, Dasyplepis intregra, Melchiora schliebenii and Ficalhoa laurifolia. In the shrub layer at 4 to 5 m-height, with 40 % coverage, in addition to young trees the shrubs Psychotria goetzei, P. pseudoplatyphylla, Lasiandus kilimandscharicus, Pauridiantha paucinervis and Keetia gueinzii are of importance. The herb layer, consisting mainly of ferns of the genus Asplenium and tree seedlings, covered 30 % of the ground. Epiphytes, mainly bryophytes, covered 10 to 30 % of the stems and branches of the trees and shrubs. These diverse forests (with over 70 vascular plant species per plot) receive approximately 1900 mm of mean annual precipitation; mean annual temperature is about 14°C (Hemp, A. unpub. data).

A. shengenae males were located by their singing which starts with nightfall and lasts to the early morning hours. Individuals were collected, perched under broad leaves, at heights from 1.5 to about 2 m. In the montane forest at 2100 m elevation singing males separated themselves from each other by about 20 to 30 m. (Nymphs were obtained by shaking small to medium-height trees.) As occurs for A. kilimandjarica, A. shengenae probably execute a diurnal shift within the habitat: during the day short chirps are occasionally heard from single males high up in the canopy.

A. shengenae occurred syntopically with Anthracites sp., Melidia kenensis Chopard, 1954, Amyta sp., Horatosphaga parensis Hemp, 2002, and Rhainopomma sp. in the montane forest area around Mt. Shengena at 2100 m elevation.

Song.—As appears typical for the genus Aerotegmina, one may observe — because the movement is slow enough — one sound pulse per tegminal movement cycle, this sound made only on tegminal opening. This is the reverse of the situation in most tettigoniids, in which principal sound emissions coincide with tegminal opening (e.g., Heller 1988).
Fig. 7 shows the song patterns of two specimens of A. kilimandjarica (A, C, E) and A. shengenae (B, D, F), recorded under identical temperature conditions. A and B compare the same time scale. While A. kilimandjarica makes three syllables (or pulses), A. shengenae is emitting five, meaning that pulses are generated almost twice as fast in the latter species. Power spectra over the audio range are compared for the two species (Fig. 7 C, D). Both have their sound frequencies confined to the audio range below 10 kHz. A. shengenae is higher in peak carrier frequency than A. kilimandjarica: 5.3 kHz, with a bandwidth (12 dB down from the highest peak) of 4.3 to 7.3 kHz. For A. shengenae the principal peak is 6.8 kHz with a bandwidth 12 dB down of 6.4–9.4 kHz.

E and F (Fig. 7) are short time samples from the pulses at high resolution, showing their waveforms. For both species there is a virtual absence of any pulse structure within the sound emission that accompanies each opening.

Phenological Notes.—The South Pare Mts were visited four times during different months (Dec 2000, March 2001, July and September 2005). The presence of mature A. shengenae was always made apparent by the hearing of its song. As is the case for A. kilimandjarica on Mt. Kilimanjaro, A. shengenae is probably present throughout the year.

Diagnosis.—Only A. kilimandjarica from Mt. Kilimanjaro has been described previously, although additional undescribed species of Aerotegmina have been detected from at least six other regions in East Africa. A. shengenae differs from A. kilimandjarica in body size, the shape and size of the acoustical chamber, song, shape of the alae and some other minor morphological characters. In the same way as A. kilimandjarica is restricted to montane forests on Mt. Kilimanjaro, A. shengenae only occurs in montane forests of the South Pare Mts.

A. shengenae is smaller (mean body size 14.3 mm, mean tegmental length 12.7 mm) than A. kilimandjarica (mean body size 15.5 mm, mean tegmental length 14.5). In A. kilimandjarica the acoustical chamber is inflated and balloon-like while it is more elongated and smaller in A. shengenae (Figs 6, 7). In A. kilimandjarica the alae are elongated and spatulate, perfectly closing the acoustical chamber ventrally in the living specimen; in A. shengenae the alae are shorter and the tips are blunt, leaving a posterior ventral opening (Fig. 5).

The consequences of these morphological differences in generator may be perceptible in the field: the calling song of A. kilimandjarica is very much louder, audible at several hundred metres when approaching the forest on Mt. Kilimanjaro. Males of A. shengenae are heard only at maximum distances of 10 to 20 m. This dramatic difference in intensity is probably related to a smaller-volume chamber and its imperfect ventral completion in A. shengenae.

Further morphological differences between the two species are seen in the shape of the fastigium vertex (Fig. 1, 2). In A. shengenae it is more elongate, while it is broader in A. kilimandjarica. The procoxal spines also differ slightly between species: in A. shengenae the spine has a very swollen base, while in A. kilimandjarica this swelling is much less prominent (Fig. 3). In the male genital complex differences are found in the shape of the cerci, the length of the appendices of the subgenital plates and the penis area. In A. shengenae at the base of the inner side, the cerci show a bulge which is lacking in A. kilimandjarica. In A. kilimandjarica the appendices of the subgenital plate are longer (see Hemp 2001a, Fig. 3).

Discussion

The Eastern Arc mountains of Tanzania and Kenya are well known hotspots of diversity and endemism (e.g., Rodgers and Homewood 1982). Archaeo-endemics (geologically old species) are mostly found in environments evincing long-term stable climatic conditions (e.g., the coastal forests of East Africa). By contrast, mountainous areas of East Africa, including geologically young mountains such as Mt. Kilimanjaro (about 1.5 Mya), harbor many neo-endemics that have evolved (geologically) rather recently (16% endemism in Saltatoria on Mt. Kilimanjaro, Lambrechts et al. 2002, Hemp 2005). Speciation processes here may have been governed by changing climatic conditions that sometimes isolated taxa on higher mountains, but at other times enabled taxa to migrate and spread.

The genus Aerotegmina is restricted to isolated montane forest and its expansion/dispersal could only have happened under a climatic regime which was colder and more humid than today. The South Pare Mts are in a special geographical position: close enough to the coast to receive enough moisture to maintain montane forest cover, but far enough away from the stable coastal climate to become isolated during drier and warmer climatic conditions. Such factors might provide necessary conditions for speciation.

The generator of A. shengenae is apparently the most primitive within the genus Aerotegmina, with a smaller, less rotund acoustical chamber which is not perfectly closed as in other Aerotegmina species (e.g., A. kilimandjarica). It seems possible that Aerotegmina evolved in the South Pare Mts. since no other Aerotegmina has been found with an incompletely closed acoustical chamber (Hemp, unpub. data).

The closest relative from the same area is a member of the genus Hexacentrus, a widespread genus distributed throughout Africa, Asia, Indo-Malaysia, and the Pacific islands (Hemp 2001a). As in Aerotegmina, tegmina in Hexacentrus are often modified into an inflated acoustical chamber in African and Asian Hexacentrus species, indicating perhaps a genetic predisposition for such chambers in Listroscelidinae.

Ecological reasons could also have provided pressure for canopy dwellers to develop highly effective acoustical communication. In regard to climate, similar conditions to those in the South Pare prevail in the adjacent West Usambara Mts. Both mountain ranges are isolated from each other today and probably have been so for a long time. From a plant sociological perspective, the montane Ocotea forests do not differ much between these mountain ranges (Hemp, unpub. data), but in respect to Saltatoria species there are hardly any common to both ranges.

Aerotegmina is missing from the forests of the West Usambaras. Its niche seems to be occupied there by the phaneropterine Euryastes jagoi Ragge (Ragge 1980). Euryastes is a monotypic genus unknown elsewhere (Ragge 1980). Like the Aerotegmina species, E. jagoi starts with its loud calling song at nightfall, singing from medium heights on broadleaf vegetation. Its calling song as heard by human ears, resembles that of Aerotegmina astonishingly.

Acknowledgments

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References


Fig. 7. Oscillograms and spectra of the calling songs of A. kilimandjarica and A. shengenae.