

Research articleSubmitted: January 16th, 2017 - Accepted: July 8th, 2017 - Published: December 29th, 2017**Two new African and Madagascan species of the genus *Holochlora* (Orthoptera: Tettigoniidae, Phaneropterinae)**

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bruno.massa@unipa.it**Abstract**

Two new species, *Holochlora mauritiana* and *H. ingrischi* from the island of Mauritius and Zimbabwe, respectively, are described. Along with a third species, *H. biloba* Stål, 1874 from Madagascar, they are the sole African representatives of the mostly Oriental genus *Holochlora* Stål, 1873, including ca. 60 taxa distributed from India to China. Preliminary hypotheses on biogeographical and evolutionary origin of Afro-Madagascan *Holochlora* species are shortly discussed.

Key words: Mauritius Is., Zimbabwe, taxonomy, new species, palaeogeographic connections.

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Introduction

The currently known distribution of the genus *Holochlora* Stål, 1873 (Tettigoniidae, Phaneropterinae) encompasses the Oriental region and the Madagascar, the latter hosting thus far only *H. biloba* Stål, 1874, described from Madagascar. This genus includes other 57 species distributed throughout Eastern Asia, from India to E China (Liu et al. 2008; Cigliano et al. 2016; Swaminathan & Nagar 2016). The presence of *H. biloba* in Madagascar has been even considered as secondary (e.g., by accidentally introduced eggs released on cultivated plants during commercial exchanges between India, Madagascar and Mauritius Is., occurred at least since XVIII century; G. Chelazzi and S. Ingrisch, personal communication, 2016).

I recently had the chance to study two interesting African and Madagascan specimens belonging to the genus *Holochlora*, collected in Zimbabwe and Mauritius Is., respectively. They turned out to represent two clearly distinct species, both being obviously not conspecific with *H. biloba*. This species was described on a female specimen collected in Madagascar, but later it was also reported from India (Bólvivar 1900; Swaminathan & Nagar 2016). Generally speaking, females of species belonging to this genus are difficult to identify without also analyzing their males; in the case of *H. biloba*, the subgenital plate of the female holotype (as figured by Cigliano et al.

2016) matches with the drawings of Swaminathan & Nagar (2016), but males of this taxon from Madagascar are thus far unknown. Thus, we cannot exclude that, when discovered, they will result as not belonging to the same Indian taxon.

Moreover, the new records seem to strengthen the hypothesis that the presence of *Holochlora* species in SE Africa and Madagascar is not due to accidental introduction. On the contrary, these data may rather suggest past biogeographical links between Africa, Indian subcontinent, and E Asia, as demonstrated in several other groups of insects (e.g., Miraldo et al. 2011; Poussereau et al. 2011).

Material and methods

Specimens were photographed with a Nikon Coolpix 4500 digital camera, mounted on a Wild M5 Stereomicroscope, and photos were integrated using the freeware CombineZP (Hadley 2008). Mounted specimens were measured with a digital calliper (precision 0.01 mm). The following measures were taken (all measurements in mm): Body length: dorsal length from the head to the apex of the abdomen, ovipositor excluded in females; Pronotum length: length of the pronotum along dorsal median line; Hind femur: length of hind femur; Tegmina: length and maximum width of tegmina.

Results

***Holochlora mauritiana* new species**

(Figs 1A-1E)

Material examined and depository. Holotype ♂. **Mauritius Island:** Jul 1989, R. Innocenti lgt, without further data (Museo di Zoologia La Specola, University of Florence, Italy).

Diagnosis. Medium sized species, characteristic for the shape of the last tergite, and the long subgenital plate with a deep concavity and stout cerci.

Description. Male (Fig. 1A).

General habitus and colour. Predominantly yellowish, external tympanum of fore tibia dark.

Head and antennae. Eyes oval, fastigium of vertex sulcate. Antennal segments yellowish. Head and legs yellow, face yellow.

Thorax and legs. Fore coxae armed. Tympana on fore tibiae open on outer, closed on inner side. Pronotum yellow, anterior margin straight, posterior margin rounded. Lower margin of pronotal lobes rounded. Tegmina oval, yellow, 3.9 times longer than broad. Stridulatory area of the left tegmen wide and short, stridulatory file straight, consisting of ca. 50 teeth, 1.9 mm long, central wider than external ones (Fig. 1B).

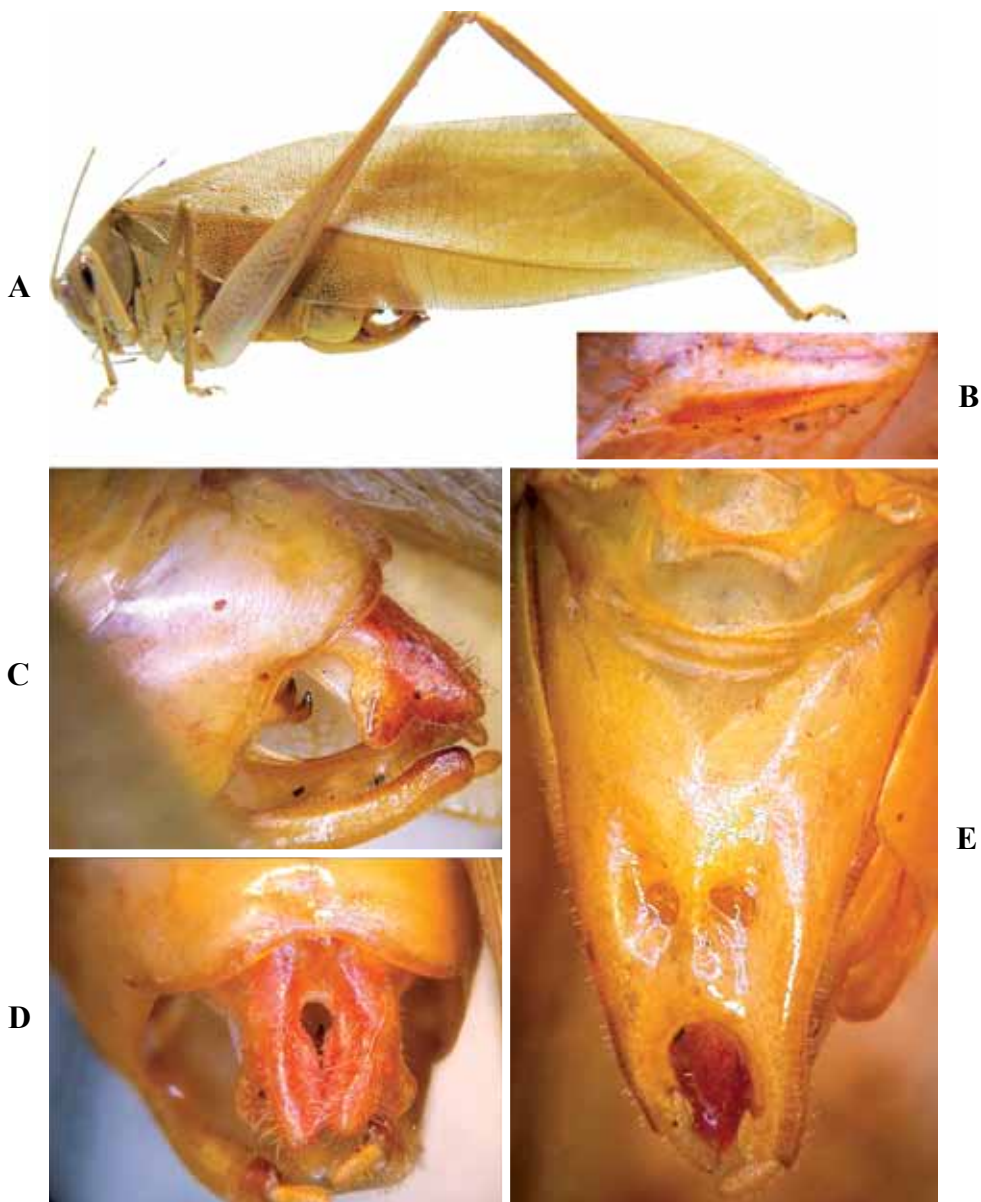


Fig. 1 – *Holochlora mauritiana* n. sp., male: habitus (A), stridulatory file (B), lateral view (C) and dorsal view (D) of last abdominal segments, subgenital plate (E).

Fore femora with 6 inner ventral spines, fore tibiae with 3 inner and 4 outer dorsal spines. Mid femora with 3 outer ventral spines before the tibia joint, mid tibiae dorsally and ventrally with 7 outer and inner ventral spines. Hind femora with 5 outer and inner ventral spines, hind tibiae straight, with many ventral spines.

Abdomen. Last tergite ending with two long appendices with an inferior bulge, cerci stout, in- and up-curved, with an apical spine (Figs 1C, 1D). Subgenital plate triangular, long and narrow, apices in-curved and flat, with a wide, rounded concavity distad; styli stout and incurved (Figs 1D, 1E). Conspicuous yellow pilosity on all genitalia.

Female: unknown.

Measurements (mm). Body length: 26.3; pronotum length: 7.2; pronotum height: 6.1; hind femur: 28.4; hind tibiae: 30.6; tegmina: 48.1; length of hind wings: 49.0; tegmina width: 12.2; ratio tegmina width/pronotum length: 1.7.

Etymology. After the name of the island, where the new species was collected.

Taxonomic remarks. *H. mauritiana* n. sp. is apparently related to *H. spectabilis* (Walker, 1869) from India, however being markedly distinct by its characteristic leg spination, dorsal surface of male last tergite, stouter appendages, relative small size of each lateral hole in male subgenital plate, relative broader lower bulge in relation to

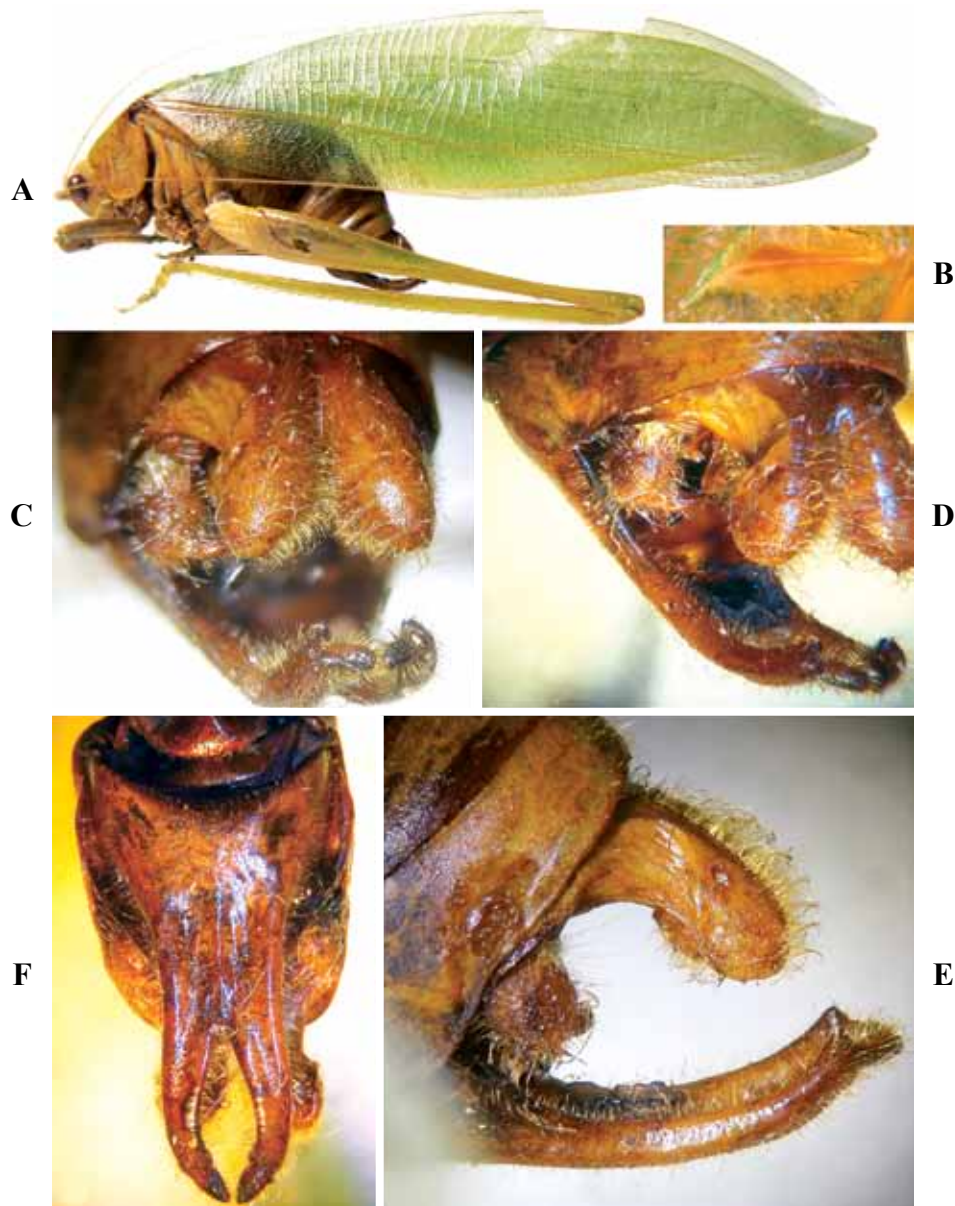


Fig. 2 – *Holochlora ingrischi* n. sp., male: habitus (A), stridulatory file (B), dorsal (C), dorso-lateral view (D) and lateral view (E) of last abdominal segments, subgenital plate (F).

tip length of tergite appendix, and shorter and stouter cerci (cf. Liu et al. 2008; Cigliano et al. 2016; Swaminathan & Nagar 2016).

Distribution. Mauritius Island.

***Holochlora ingrishi* new species**

(Figs 2A-2F)

Material examined and depository. Holotype ♂. **Zimbabwe:** Njanga, Mar 1991, without further data (coll. La Greca, Museo Civico di Storia Naturale, Milan, Italy).

Diagnosis. Large sized species, characteristic for the last tergite modified, the long subgenital plate and the very stout cerci.

Description. Male.

General habitus and colour. Predominantly green, leaf-like; compound eyes dark brown, tegmina with base of R with black marking.

Head and antennae. Eyes oval, fastigium of vertex sulcate. Antennal segments yellowish. Head and legs yellow, face yellow.

Thorax and legs. Fore coxae armed. Tympana on fore tibiae open on outer, closed on inner side. Pronotum green, anterior margin straight, posterior margin rounded. Metazona darker than prozona. Tegmina oval, green, 3.7 times longer than broad. The stridulatory area of the left tegmen is almost straight and elevated above the wing plane, the stridulatory file is angularly arcuate, and consists of ca. 50 teeth, ca. 15 of them, placed in the distal area, being smaller (Fig. 2B).

Fore femora with 4 inner ventral spines, fore tibiae with 5 inner and 3 outer dorsal spines. Mid femora with 1 outer ventral spine near the tibia joint, mid tibiae dorsally and ventrally with 7 outer and inner spines. Hind femora with 5 outer and 4 inner ventral spines, hind tibiae slightly curved, with 14 outer and 10 inner ventral spines.

Abdomen. Last tergite modified, ending with two out- and down-curved inflated appendices, cerci very stout and in-curved, with an apical spine (Figs 2C-2E). Subgenital plate triangular, widest at base, long and narrow, ending into two terminal lobes incurved, before diverging and approaching apically; between them a deep concavity; styli stout (Figs 2E, 2F). Conspicuous yellow pilosity on all genitalia.

Female: unknown.

Measurements (mm). Body length: 31.1; pronotum length: 8.1; pronotum height: 6.7; hind femur: 35.7; hind tibiae: 40.0; tegmina: 56.0; length of hind wings: 58.4; tegmina width: 15.3; ratio tegmina width/pronotum length: 1.9.

Etymology. After the German orthopterologist Sigfrid In-

grisch, who has devoted his entomological work to Oriental region, with many interesting results.

Taxonomic remarks. The appendages of the last tergite and the subgenital plate are similar to those of *H. feuhstorferi* Carl, 1914 from India to China, to *H. lancangensis* Liu, Zheng & Xi, 1991 and to *H. nigrospinulosa* Brunner von Wattenwyl, 1893, both from China, with small differences (see Liu et al. 2008 and Swaminathan & Nagar 2016). Differences lie mainly on the number of teeth and shape of the stridulatory file, in the colour of tibiae and spines on lower margin of hind femora, and in the shape of apical appendages of the last tergite.

Distribution. Only known from the type locality in Zimbabwe. The Njanga province overlaps with North border of Rhodes Inyanga National Park, characterized by primary forests.

Concluding remarks

The genus *Holochlora* is widespread in the Oriental region, with many species in India. Three species have been till now found in Africa and Madagascar. Previously, Jeannel (1961) highlighted the unusual distribution of taxa that cover Madagascar and India, suggesting that the two lands were connected during the Cretaceous period (165–65 Ma). Later, Davis (1979) evidenced that the freshwater snails of the family Potamiopsidae were likely transported to Asia by the Indian plate, and more recently Briggs (1995) reported that India had apparently served as Noah's Ark to transport a variety of animals from Africa to Asia. According to Jeannel (1961), about 90 Ma austral Africa, Madagascar and India were united in a unique territory, that the author named Sudanamie, although this simplified reconstruction has been questioned by further palaeogeographic studies.

It has been known for some time that the Indian plate separated from Madagascar and Africa ca. 90 Ma, but more recent geological and biogeographical evidences suggest that they were still in contact up to the final suturing with the Eurasiatic plate, ca. 50 Ma. India, during its northward journey, remained close to Africa and Madagascar even as it began to contact Eurasia (Briggs 2003). According to Briggs (2003) the main sequence of events that began in the late Jurassic was the following: 1) India–Madagascar rifted from East Africa 158–160 Ma, 2) India–Madagascar from Antarctica ca. 130 Ma, 3) India–Seychelles from Madagascar 84–96 Ma, 4) India from Seychelles 65 Ma, 5) India began collision with Eurasia 55–65 Ma, 6) final suturing ca. 42–55 Ma. Further, there are two critical periods for which adjustments are needed (Briggs 2003): a) by the early part of the late Cretaceous, ca. 94 Ma, the north end of India–Madagascar was either pointed toward the northeast or the continent had undergone a counterclockwise ro-

tation bringing it parallel with Africa; b) at the time of the Cretaceous/Tertiary boundary (65 Ma) India was either situated out in the middle of the Indian Ocean or was lying in close proximity to Africa, Asia and Madagascar. The southern tip of India must have remained close to Madagascar as indicated by the similarity of the vertebrate faunas of the terminal Cretaceous.

According to the above depicted palaeogeographic scenario, the concurrent presence of *Holochlora* in Zimbabwe, Mauritius Island, Madagascar and India could even be dated back to ca. 90-50 Ma (later, the Madagascar-India land undergone a rotation towards North-East, and when finally India left Madagascar and connected with Asia, its fauna was able to disperse through the Oriental region). But other biogeographic reconstructions could take into consideration also possible alternatives, as much more recent colonization routes, common to several other invertebrates, advocating the presence of a stepping-stone system partly linking SW India, Seychelles Islands, Madagascar and circum-Madagascan islands, dating back to the presence of the so-called “Lemurian Stepping-stones” Arc.

Reporting the recent data and discussions by Haq et al. (1988), Schatz (1996) and Poussereau et al. (2011), as India assumed its current position from the Early Eocene onward, global sea levels were dropping, with a marked regression at the Rupellian/Chattian boundary during the Oligocene, i. e., ca. 30 Ma. At that time, significant portions of the Chagos/Laccadive Plateau and the contiguous (at that time) Mascarene Plateau (including the Seychelles Bank) could have been emergent, and served as stepping-stones for dispersal of elements between Laurasia/W Malesia and Africa/Madagascar via India/Sri Lanka.

The African and Mauritian representatives of the genus *Holochlora* may be therefore alternatively considered as true living fossils (even dating back to the late Jurassic, when a wide palaeogeographic connection between Africa, Madagascar and India still existed) or, more likely, as representatives of a more recent Oriental fauna penetrated into Madagascar and neighboring islands during Middle-Late Tertiary. The recent example by Poussereau et al. (2011), dealing with the mostly Indo-Pacific pollen beetle genus *Propetes*, including two markedly distinct and endemic species from Réunion Island and Seychelles, could be paradigmatic for such a model of dispersion and speciation.

Molecular analyses and estimate of interspecific genetic distances on additional fresh material of *Holochlora* spp. from India, SE Africa, Madagascar and neighbor islands could certainly help us to better discriminate be-

tween these two alternative hypotheses, although the observed range of morphological differentiation between Indian and Afro-Madagascan species of *Holochlora* could probably much better support the latter scenario.

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References

- Bolívar I. 1900. Les Orthoptères de St-Joseph’s College à Trichinopoly (Sud de l’Inde). *Annales de la Société Entomologique de France*, 68 [1899]: 761–812, pl. 11–12.
- Briggs J.C. 1995. *Global Biogeography*. Elsevier, Amsterdam.
- Briggs J.C. 2003. The biogeographic and tectonic history of India. *Journal of Biogeography*, 30: 381–388.
- Cigliano M.M., Braun H., Eades D.C., Otte D. 2016. Orthoptera Species File. Version 5.0/5.0. <http://Orthoptera.Species-File.org>.
- Davis G.M. 1979. The origin and evolution of the gastropod family Potamiopsidae, with emphasis on the Mekong River Triculinae. *Academy of Natural Sciences Philadelphia, Monograph*, 20: 1–120.
- Haq B.U., Hardenbol J., Vail P.R. 1988. Mesozoic and Cenozoic chronostratigraphy and eustatic cycles, pp. 71–108. In: Wilgus C.K., Hastings B.S., Kendall C.G.S.C., Posamentier H.W., Ross C.A., Van Wagoner J.C. (eds), *Sea-Level Changes: An Integrated Approach*. Society of Economic Paleontologists and Mineralogists Special Publication, 4, 407 pp.
- Jeannel R. 1961. La Gondwanie et le peuplement de l’Afrique. *Annales du Muséum Royal de l’Afrique centrale*, 102: 7–160.
- Liu C., Liu X., Kang L. 2008. Review of the genus *Holochlora* Stål (Orthoptera, Tettigoniidae, Phaneropterinae) from China. *Deutsche Entomologische Zeitschrift*, 55 (2): 223–240.
- Miraldo A., Wirta H., Hanski I. 2011. Origin and Diversification of Dung Beetles in Madagascar. *Insects*, 2(2): 112–127; doi:10.3390/insects2020112
- Poussereau J., Jelinek J., Audisio P. 2011. A new species of *Propetes* Reitter, 1875 from Réunion (Coleoptera: Nitidulidae: Epuraeinae), and updated checklist of Nitidulidae from Réunion. *Bulletin de la Société entomologique de France*, 116(4): 421–428.
- Schatz G.E. 1996. Malagasy/Indo-Australo-Malesian phylogeographic connections, pp. 73–83. In: Lourenço W.R. (ed.), *Biogeography of Madagascar*. Editions ORSTOM, Paris, 588 pp.
- Swaminathan R., Nagar R. 2016. Some representative species of the tribe Holochlorini (Orthoptera: Tettigoniidae: Phaneropterinae) and the description of two new species from India. *Zootaxa*, 4171 (2): 259–292.