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An annotated checklist of the bush katydids (Orthoptera: Phaneropteridae: Phaneropterinae) from Singapore, including an illustrated key to species

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Abstract

The Phaneropterinae, or commonly known as the bush katydids, are among the most speciose katydids in the world. The bush katydids have interesting life histories but little is known about species from Southeast Asia. The source of problem may lie in the lack of sampling and revised taxonomic knowledge. The paper reports a species checklist of Phaneropterinae from Singapore. In total, 30 species were recorded from Singapore, eight of which may be locally extinct. Each species was also annotated with known life history information or taxonomic remarks, whenever possible. The female of *Phaulula malayica* was also described for the first time. An illustrated key to species from Singapore was also provided to assist in species identification.

Key words: Orthoptera, Phaneropterinae, Singapore, annotated checklist, illustrated key

Introduction

The Phaneropterinae, or commonly known as the bush katydids, are among the most speciose katydids in the world. The bush katydids have interesting life histories. Nymphs of many species are colourful and some mimic other insects and also change their model organism as they grow through the different instars (Rentz, 2010). Some species are known to be associated to specific plant hosts while others are suspected to be restricted to the canopy (Rentz, 2010). Nymphs are reported to be found feeding on pollen or flower parts and as such, may also play secondary role in pollination (Micheneau et al., 2010; Rentz, 2010). Information on the life history of these katydids needs to be documented with the growing concern of the biodiversity crisis and is now possible through the use of DNA-based methods such as molecular gut analysis (King et al., 2008) and molecular detection of pollinaria (Widmer et al., 2000). These modern techniques however, remain relatively unexplored in the orthopterans, especially for species from Southeast Asia. The source of the problem may lie in the lack of sampling.

The source of the problem may lie in the lack of sampling and revised taxonomic knowledge. The taxonomy for some genera are well studied but many more are poorly known. In the Southeast Asia region, many species were known from very old descriptions (Brunner von Wattenwyl, 1878; Hebard, 1922; Karny, 1923, 1926) and the description may not necessarily always meet the modern criteria of systematics. Moreover, there are also many species known only for one sex, adding to the difficulty for conducting taxonomic revision and thus proper identification. Here, an attempt was made to compile a species checklist of Phaneropterinae from Singapore based on recent collections, museum specimens and old literature. The checklist was also annotated with any known life history information or taxonomic remarks. Additionally, an illustrated key to species from Singapore was provided to assist in species identification. The objective of this paper is to document the Phaneropterinae that exist in Singapore and those which had possibly gone extinct.

20. Male tenth abdominal tergite distinctively bilobous, widely grooved between lobes (Fig. 10E). Male cercus with apical process acute (Fig. 10E). Male subgenital plate less deeply excised with two truncated and dorso-ventrally flattened lateral process, process less than half the length of entire subgenital plate (Fig. 10K). Female ovipositor more elongated, with apex of dorsal valve acute (Fig. 11J) *Holochlora* sp.
20. Male tenth abdominal tergite indistinctively bilobous, feebly grooved between lobes (Fig. 10D). Male cercus with apical flattened lobe, margin dentated (Fig. 10D). Male subgenital plate very deeply excised with two elongated and narrow lateral process, process more than half the length of entire subgenital plate (Fig. 10J) *Holochlora* cf. *signata signata*
21. Tegmen with R with numerous Rs branching diagonally to hind margin (Fig. 9A) *Ducetia japonica*
21. Tegmen with R with one or two Rs (Figs. 9C, 9D) 22
22. Tegmen long, exposing only about 1/5 of hind wing 23
22. Tegmen short, exposing more than 1/4 of hind wing (Fig. 9D) *Phaneroptera brevis*
23. Tegmen with cross veins nearly perpendicular to veins, forming rectangular cells (Figs. 2A, 2B) 24
23. Tegmen with cross veins not perpendicular to veins, not forming rectangular cells (Figs. 6A, 6B, 9C) 27
24. Fastigium verticis forming a right angle with fastigium frontis; tibial tympana covered by conchate fold with anterior slit on both sides or on internal side; never with both open and oval (Figs. 8B–8F) *Elimaea* (25)
24. Fastigium verticis not forming a right angle with fastigium frontis; tibial tympana open and oval for both external and internal sides *Macedna martini*
25. Male tenth abdominal tergite with apical projections long and narrow, forming a three-spined apex *Elimaea* (*Rhaebelima*) *spinigera*
25. Male tenth abdominal tergite without apical projection (Figs. 10A, 10B) 26
26. Male tenth abdominal tergite with apical margin truncated (Fig. 10B). Male epiproct with apical margin subacute (Fig. 10B). Male cercus with apical cone acute (Fig. 10B) *Elimaea* (*Rhaebelima*) *signata*
26. Male tenth abdominal tergite broadly rounded apically, with apical margin obtuse (Fig. 10A). Male epiproct with apical margin truncated (Fig. 10A). Male cercus with apical cone obtuse (Fig. 10A) *Elimaea* (*Elimaea*) *chloris*
27. Pronotum elongated (Fig. 7K). Tegmen very broad, with apex truncated (Fig. 3B) *Leptoderes ornatipennis*
27. Pronotum not elongated (Figs. 7I, 7J). Tegmen more slender, with apex rounded (Figs. 4J–4L, 6M, 6A, 6B) 28
28. Tegmen more broad, basal and apical halves about same width, apex rounded; mostly unicolourous with poorly defined spots or patterns (Figs. 4K, 4L, 6M, 6A, 6B). Male phallic complex with sclerite *Mirollia* (29)
28. Tegmen more slender, widened in basal half, rather narrow in apical half, apex truncated; distinctively multi-coloured, basal area green, dorsal area infumated white, apex brown (Fig. 4J). Male phallic complex without sclerite *Deflorita argentata*
29. Tegmen mostly yellow with few faint dark green variegation; with anterior margin more abruptly convex at basal third, slightly concave near middle (Fig. 6A). Female subgenital plate with lateral lobes diverging outwards; inner process of lateral lobe more angular (Fig. 11E) (only female known) *Mirollia* sp. 1
29. Tegmen red brown basally and within cells near posterior margins, otherwise yellow with tint of green; with anterior margin more smoothly convex at basal third, straight near middle Fig. 6B). Female subgenital plate with lateral lobes more or less parallel; inner process of lateral lobe more bulbous (Fig. 11F) (only female known) *Mirollia* sp. 2

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