

## THE ORTHOPTERA OF SEMAKAU LANDFILL, SINGAPORE: A PROJECT SEMAKAU CHECKLIST

Ming Kai Tan<sup>1\*</sup> and Luan Keng Wang<sup>2</sup>

<sup>1</sup>Department of Biological Sciences, National University of Singapore  
14 Science Drive 4, Singapore 117543, Republic of Singapore

<sup>2</sup>Raffles Museum of Biodiversity Research, Department of Biological Sciences, National University of Singapore  
6 Science Drive 2, Singapore 117546, Republic of Singapore

(\*Corresponding author: [mk1990@hotmail.com](mailto:mk1990@hotmail.com))

**ABSTRACT.** — The list of Orthoptera at the Semakau Landfill was compiled. At least 20 species were recorded from terrestrial surveys conducted during Project Semakau from Nov.2009 to Feb.2012. In Singapore, *Gonista* cf. *bicolor* (de Haan) is postulated to be restricted to the Semakau Landfill and appears to be the first published record for Singapore.

**KEY WORDS.** — Orthoptera, inventory, Semakau Landfill, Project Semakau, Singapore

### INTRODUCTION

This paper contains an inventory of Orthoptera (Insecta) at the Semakau Landfill. Located in the Straits of Singapore, the Semakau Landfill is made from the merging of two offshore islands, Pulau [= Island] Semakau and Pulau Sakeng, by land reclamation (Fig. 1). As part of an attempt to assess the biodiversity found on this offshore landfill, Project Semakau was initiated by the Raffles Museum of Biodiversity Research to collect data through scientific surveys with the aid of the community and volunteers.

The landfill consists of cells filled with incinerated waste as well as construction debris that could not be incinerated. After each cell has been filled, 30 cm of top soil will be used to cover the cell. Natural succession will then take place, resulting in open country habitats with tall grasses, shrubs, and some trees, from seeds brought in by the wind or by birds. As the grassland matures, many animals that thrive in such open country habitats colonise the area. Several terrestrial surveys were made in these landfill cells.

Based on the specimens collected during the terrestrial surveys, a preliminary inventory of the orthopteran fauna in the Semakau Landfill is presented. Colour images of some noteworthy species (some of which are yet to be conclusively identified) are also presented for future comparisons. Among the several publications on Semakau's biodiversity (Tan & Yeo, 2010; Chua, 2011; Teo et al., 2011; Wang & Yeo, 2011), this is the first on the landfill's insect fauna. It is also the first checklist of Orthoptera from the southern islands of Singapore, adding to a number of publications on the orthopteran fauna of Singapore (Tan, 2010a, 2010b, 2012; Tan et al., 2012).

### METHODS

Sweep-netting collections were conducted during terrestrial surveys. Specimens were collected by sweep-nets in the filled cells as well as the secondary forests (Fig. 2). In total, 12 surveys were conducted from Nov.2009 to Feb.2012: 7–8 Nov.2009, 5 Dec.2009, 23–24 Oct.2010, 7–8 May 2011, 18 Jun.2011, 13 Aug.2011, 26–27 Nov.2011, and 18 Feb.2012. As it is not possible to accurately identify nymphs to species level, only adult specimens were included in the inventory. Specimens were collected, pinned, and examined. Photographic images were obtained with a digital SLR with compact-macro lens, and measurements were made using a vernier caliper with precision of 0.05 mm. Specimens were subsequently deposited in the Zoological Reference Collection (ZRC) of the Raffles Museum of Biodiversity Research (RMBR), National University of Singapore, and catalogued under ZRC.ORT.369–398. Classification was based on the Orthoptera Species File Online Version 2.0/4.1 (Eades et al., 2012). The families, subfamilies, and genera are arranged alphabetically for ease of reference. Measurement given in the figures indicates the body length of dry-pinned specimens.



Fig. 1. A satellite image of the Semakau Landfill. (Photograph by: CRISP).

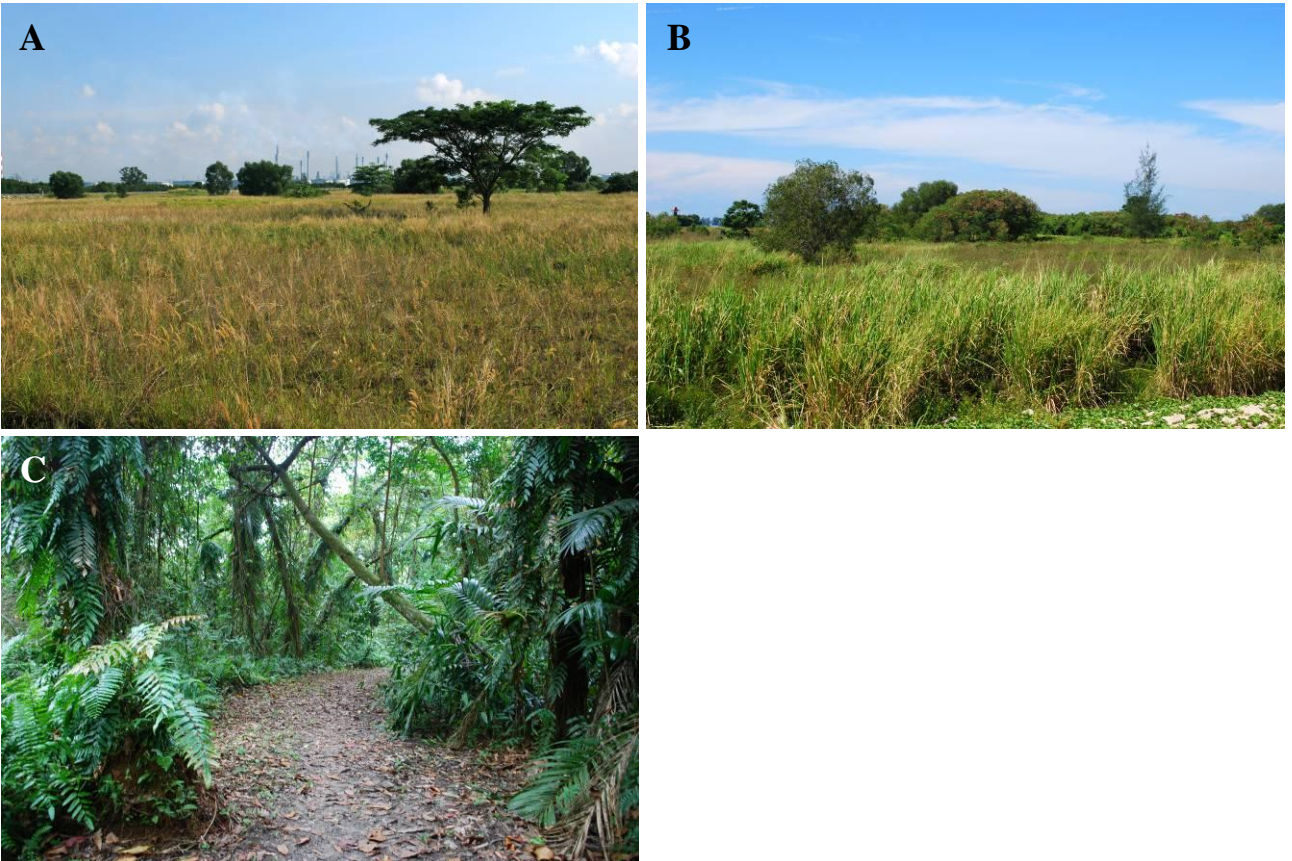


Fig. 2. Different terrestrial habitats on the Semakau Landfill in which sweep-netting was carried out: A, B, grassy plots of filled cells, and C, secondary forest.

## RESULTS

Twenty known species from six families were recorded from the Semakau Landfill and examined. More species of the suborder Caelifera (grasshoppers) were recorded compared to that of the suborder Ensifera (crickets and katydids) (12 and eight species, respectively), although both suborders are represented with three families each. The family Acrididae is the largest with eight species, within the Caelifera and overall diversity. This is followed by the family Tettigoniidae with four species.

Order Orthoptera (20 species)

Suborder Caelifera (12 species)

Family Acrididae (8 species)

Family Pyrgomorphidae (2 species)

Family Tetrigidae (2 species)

Suborder Ensifera (8 species)

Family Gryllidae (3 species)

Family Mogoplistidae (1 species)

Family Tettigoniidae (4 species)

### ORTHOPTERA RECORDED FROM SEMAKAU LANDFILL

#### SUBORDER CAELIFERA

#### FAMILY ACRIDIDAE

#### Subfamily Catantopinae

*Xenocatantops humilis* (Serville)

Material examined. — ZRC.ORT.369, 1 female, forest, 5 Dec.2009.

#### Subfamily Cyrtacanthacridinae

*Valanga nigricornis* (Burmeister) (Fig. 3)

Material examined. — ZRC.ORT.370, 2 nymphs, landfill, 4 Dec.2009.

Remark. — Although no adult specimen was collected, an adult was photographed on 13 Aug.2011 (Fig. 3).



Fig. 3. *Valanga nigricornis* (Burmeister), taken on 13 Aug.2011. (Photograph by: Martina Chia).



Subfamily **Gomphocerinae**

*Gonista* cf. *bicolor* (de Haan) (Fig. 4)

Material examined. — ZRC.ORT.371, 1 male, landfill, 8 Nov.2009; ZRC.ORT.372, 1 female, landfill, 8 May 2011; ZRC.ORT.373, 2 females, landfill, 18 Jun.2011.

Remarks. — This represents the first published record for Singapore (Willemse, 2001; Eades et al., 2012). There was no previous publication on this species in Singapore even though voucher specimens collected from Kent Ridge in 1970 and 1975 by D. H. Murphy were deposited in the ZRC.

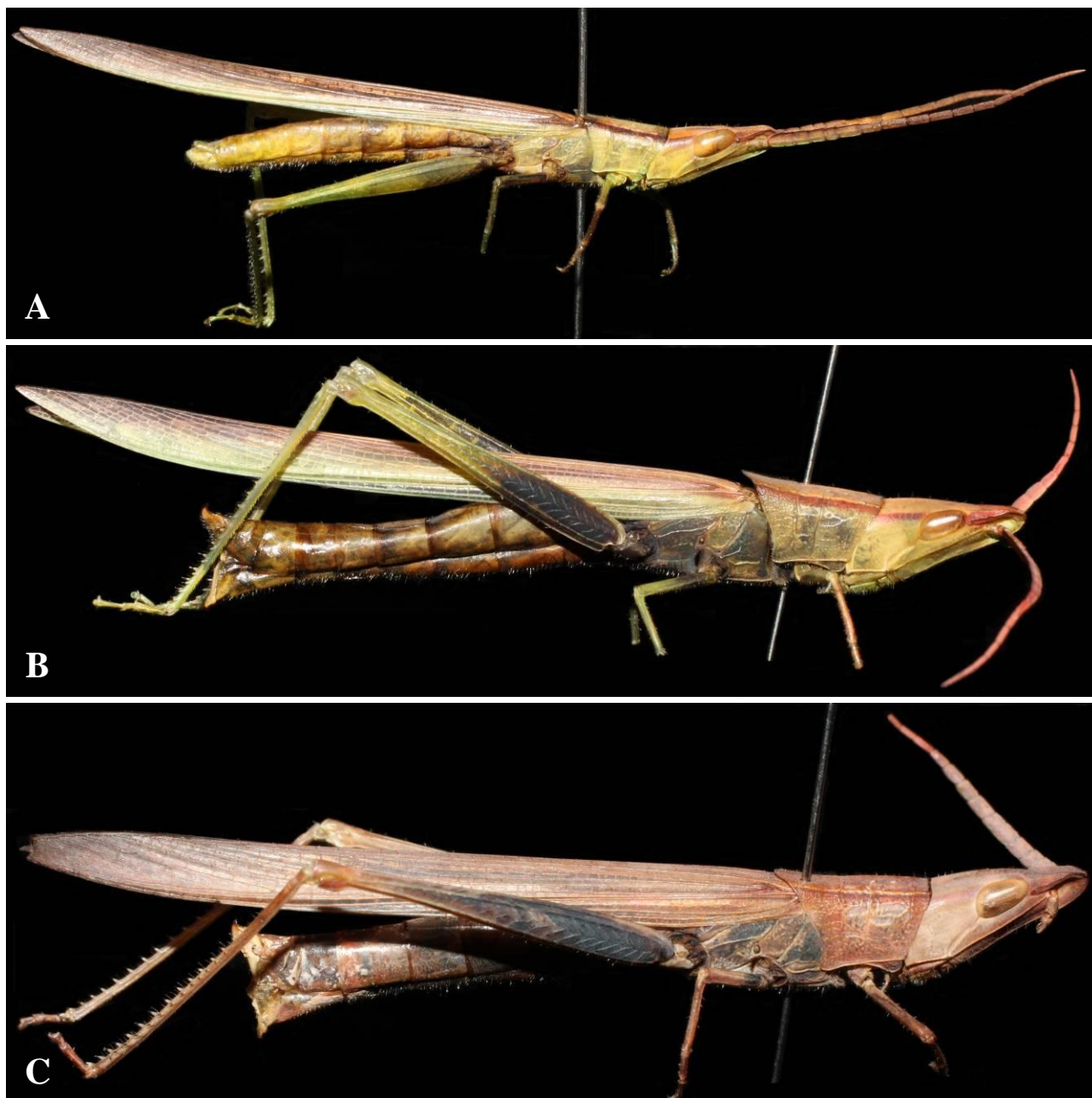


Fig. 4. *Gonista* c.f. *bicolor* (de Haan): A, ZRC.ORT.371, male, 29.1 mm ; B, ZRC.ORT.372, female, 40.0 mm; C, ZRC.ORT.373, female, 38.6 mm.

Subfamily **Oedipodinae**

*Aiolopus thalassinus tamulus* (Fabricius)

Material examined. — ZRC.ORT.374, 1 male, landfill, 4 Dec.2009.

*Gastrimargus marmoratus* (Thunberg) (Fig. 5)

Material examined. — ZRC.ORT.375, 1 male, landfill, 8 Nov.2009.



Fig. 5. *Gastrimargus marmoratus* (Thunberg): ZRC.ORT.375, male, 29.4 mm.

Subfamily **Oxyinae**

*Gesonula mundata* (Walker)

Material examined. — ZRC.ORT.376, 1 male, landfill, 23/24 Oct.2010.

*Oxya hyla intricata* (Stål)

Material examined. — ZRC.ORT.377, 1 male, landfill, 7 Nov.2009.

*Oxya japonica japonica* (Thunberg)

Material examined. — ZRC.ORT.378, 3 males, landfill, 8 Nov.2009; ZRC.ORT.379, 1 male, landfill, 4 Dec.2009.

FAMILY **PYRGOMORPHIDAE**

Subfamily **Pyrgomorphinae**

*Atractomorpha* sp.

Material examined. — ZRC.ORT.380, 3 males, landfill, 7 Nov.2009; ZRC.ORT.381, 1 male, landfill, 8 Nov.2009; ZRC.ORT.382, 1 female, landfill, 8 May 2011; ZRC.ORT.383, 2 males, 2 females, landfill, 23/24 Oct.2010.

*Tagasta marginella* (Thunberg)

Material examined. — ZRC.ORT.384, 1 male, forest, 27 Nov.2009.

FAMILY **TETRIGIDAE**

Subfamily **Scelimeninae**

*Loxilobus* spp. (Fig. 6)

Material examined. — ZRC.ORT.385, 2 females, 18 Feb.2012.

Remark. — This genus is in need of revision before species can be determined (Kevan, 1966; Tan, 2012; H. Devriese, in litt.).

Subfamily **Tetriginae**

*Euparatettix* sp. (Fig. 7)

Material examined. — ZRC.ORT.386, 1 female, landfill, 7 Nov.2009.



Fig. 6. *Loxilobus* sp.: ZRC.ORT.385, female, 9.8 mm.



Fig. 7. *Euparatettix* sp.: ZRC.ORT.386, female, 10.5 mm.



SUBORDER ENSIFERA

FAMILY GRYLLIDAE

Subfamily Eneopterinae

*Lebinthus* sp. (Fig. 8)

Material examined. — ZRC.ORT.387, 1 female, forest, 5 Dec.2009; ZRC.ORT.388, 1 male, forest, 27 Nov.2011; ZRC.ORT.389, 1 female, 18 Feb.2012.

Remark. — Examination of the male genitalia indicates that this species is not *Lebinthus bitaeniatus* Stål, and it may be an undescribed species.

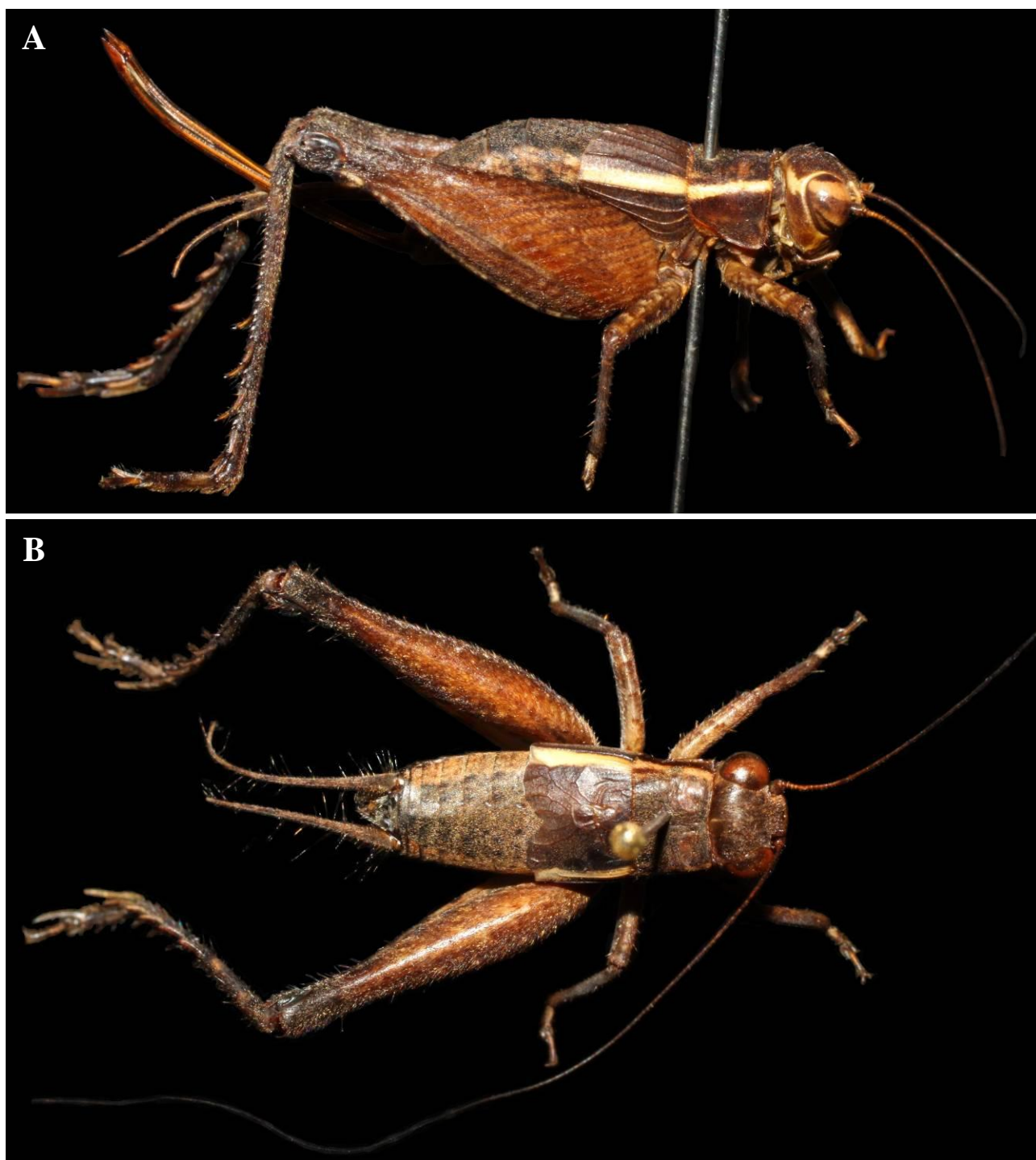


Fig. 8. *Lebinthus* sp.: A, ZRC.ORT.387, female, 15.2 mm; B, ZRC.ORT.388, male, 15.5 mm.

Subfamily **Oecanthinae**

*Oecanthus* sp. (Fig. 9)

Material examined. — ZRC.ORT.390, 1 male, 2 females, landfill, 7 Nov.2009; ZRC.ORT.391, 1 female, landfill, 4 Dec.2009; ZRC.ORT.392, 1 male, 2 females, landfill, 23/24 Oct.2010.



Fig. 9. *Oecanthus* sp.: ZRC.ORT.392, male, 13.4 mm.

Subfamily **Trigonidiinae**

*Metioche pallipes* (Stål)

Material examined. — ZRC.ORT.393, 1 male, landfill, 7 Nov.2009.

FAMILY **MOGOPLISTIDAE**

Subfamily **Mogoplistinae**

*Ornebius* sp. (Fig. 10)

Material examined. — ZRC.ORT.394, 2 females, 18 Feb.2012.



Fig. 10. *Ornebius* sp.: ZRC.ORT.394, female, 10.8 mm.



FAMILY TETTIGONIIDAE

Subfamily **Conocephalinae**

*Conocephalus maculatus* (Le Guillou)

Material examined. — ZRC.ORT.395, 1 female, landfill, 7 Nov.2009; ZRC.ORT.395, 1 male, landfill, 7 May 2011.

Subfamily **Mecopodinae**

*Mecopoda elongata* (Linnaeus)

Material examined. — ZRC.ORT.396, 1 male, forest, 27 Nov.2011.

Subfamily **Phaneropterinae**

*Ducetia japonica* (Thunberg)

Material examined. — ZRC.ORT.397, 1 male, landfill, 7 Nov.2009.

*Phaneroptera brevis* (Serville)

Material examined. — ZRC.ORT.398, 1 male, 1 female, landfill, 7 Nov.2009

DISCUSSION

Of the orthopteran species recorded, most are fairly common and also occur on Singapore Island. The record of *Gonista* cf. *bicolor*, however, is an exception. Last collected from Kent Ridge in 1970 and 1975, there was no sighting during recent orthopteran studies by Tan and others on Singapore Island, including Kent Ridge Park, and offshore islands such as Pulau Ubin since 2009 (Tan 2010a, 2010b, 2012; Tan et al., 2012; M. K. Tan, per. obs.). Without further investigation, it is not possible to establish if this is a result of local extinction on Singapore Island or that of poor sampling. Thus far, it may only be postulated that *Gonista* cf. *bicolor* may hitherto be restricted to the Semakau Landfill, even though the documentation of its existence in Singapore is still positive.

Based on the material acquired, it appears that more species of Orthoptera were recorded from the grassy plots of the landfill cells as compared to the coastal forest (14 and four, respectively, and two species unknown). The species appear to be restricted to the respective habitats they were collected from. This, however, does not necessarily represent the overall orthopteran diversity in the two different terrestrial habitats on Pulau Semakau. This is because nocturnal surveys were not conducted and many forest-dwelling orthopterans tend to be nocturnal. As most katydids and crickets are more active at night, this could explain the greater diversity of grasshoppers obtained on the surveys. There are species of Orthoptera which were sighted but not collected. These include a slime cricket (Gryllidae: Euscyrtinae: cf. *Beybienkoana* species) photographed on 7 May 2011 (Fig. 11). It is therefore evident that the inventory of Orthoptera



Fig. 11. *Beybienkoana* sp., taken on 7 May 2011. (Photograph by: Ahmad Syalabi Adi Sunaryo).

from the Semakau Landfill presented here is not exhaustive, and more species are still waiting to be discovered. Given the limited material collected, it is also not possible to comment on the relative abundance of the different orthopteran species. To have a comprehensive understanding of the Orthoptera from the Semakau Landfill, continuous monitoring of the fauna may be necessary.

#### ACKNOWLEDGEMENTS

The authors thank sponsorship from the Hongkong and Shanghai Banking Corporation Limited (HSBC) which made Project Semakau possible; the National Environment Agency (NEA) for granting access to the landfill for surveys and for assistance with the transport logistics at Semakau Landfill; the Project Semakau volunteers who helped in the surveys and assisted in pinning the specimens; the Centre for Remote Imaging, Sensing and Process (CRISP) for the satellite image of the Semakau Landfill (Fig. 1); Lua Hui Kheng for granting access to examine the orthopteran specimens from Project Semakau under her care at the Zoological Reference Collection, Raffles Museum of Biodiversity Research; and Martina Chia and Ahmad Syalabi Adi Sunaryo for permitting the use of their photographs.

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