

## ORTHOPTERA OF THE EXHUMED BIDADARI CEMETERY, SINGAPORE

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**ABSTRACT.** — The diversity of Orthoptera of the exhumed Bidadari Cemetery is inventorized. Based on three months of nocturnal surveys, 31 species of Orthoptera representing five families were recorded. Bidadari Cemetery appears to be the only known site for the crickets *Tarbinskiellus portentosus* and *Trigonidium* (?) sp. in Singapore. The cone-headed katydids *Conocephalus* cf. *cognatus* and *Euconocephalus mucro* are found to be unusually common there.

**KEY WORDS.** — Orthoptera, Bidadari Cemetery, diversity, ecology, Singapore

### INTRODUCTION

The exhumed Bidadari Cemetery between Upper Aljunied Road and Bartley Road was slated for development of a new housing estate with work commencing by the end of 2012 (Chua, 2012; Teo, 2012). Similar to many other vacant sites in Singapore, Bidadari Cemetery provides various habitats for many animals, including the Orthoptera which prefer grassy and shrubby plots and secondary forest (Tan, 2010a; Tan, 2011; M. K. Tan, pers. obs.). Tan (2011) previously documented the cone-headed katydids of the tribe Copiphorini (Tettigoniidae: Conocephalinae) in the Bidadari Cemetery, in which three of the seven Singaporean species were recorded. However, the overall diversity of Orthoptera in the exhumed cemetery is unknown. A short term monitoring was carried out over a period of three months from Jul.2012 to Sep.2012 with the aim of documenting the orthopteran diversity and ecology at the location.

### METHODS

From Jul.2012 to Sep.2012, nocturnal surveys were conducted in two sample sites within the exhumed Bidadari Cemetery, as shown on the Google Map (<http://tinyurl.com/Bidadaricemetery>): (1) Site A, along Bartley Road; and (2) Site B, along Upper Serangoon Road. Both sites are grassy plots. Surveys were conducted once every month at each of the two sample sites. Each survey lasted 1.5 hours and involved opportunistic collection and photographic recording of specimens within each site. Specimens were dry-mounted and subsequently deposited in the Zoological Reference Collection (ZRC), Raffles Museum of Biodiversity Research (RMBR), National University of Singapore. Specimens were catalogued as ZRC.ORT.418–433 and ZRC.ORT.435–438. Measurements of dried-pinned specimens were made using a 0.05 mm vernier caliper. Measurements given in the figure captions indicate the body lengths (BL) of dry-pinned specimens collected.

### RESULTS

In total, six surveys were conducted in the exhumed Bidadari Cemetery, with three at each sample site. Thirty-one species of Orthoptera representing five families were recorded. Diversity is higher for the suborder Ensifera compared to the suborder Caelifera (32 and eight species, respectively). The family Tettigoniidae is represented with the most species (12), followed by the Gryllidae (10). The families Pyrgomorphidae and Gryllacrididae were only represented with a single species each. During each survey, 11–17 species were recorded (Fig. 1). Twenty species were recorded from Site A, whereas 26 species were recorded from Site B. This trend can be seen in Fig. 1 in which more species were generally recorded during a survey in Site B compared to a corresponding survey in Site A of the same month. Fifteen species were recorded from both sites. Eleven species appear to be restricted to Site B, while only five were restricted to Site A. All species recorded during the monitoring are listed in the Appendix.

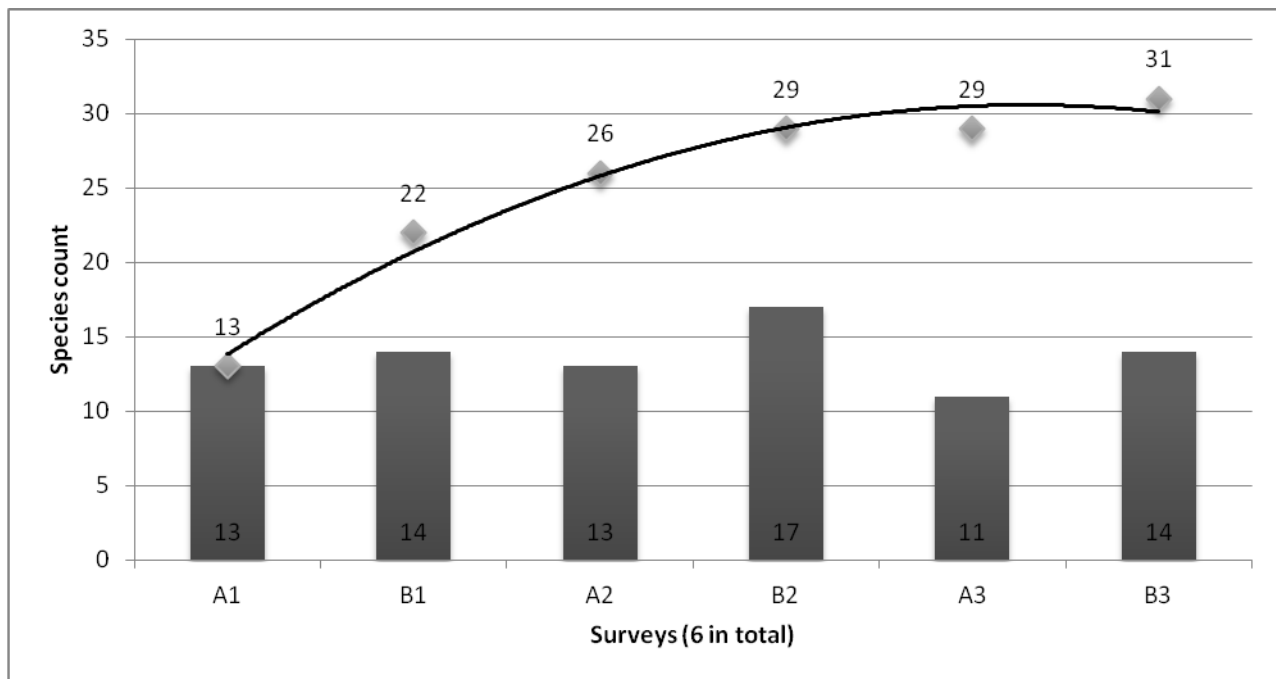


Fig. 1. Bar chart of the number of species recorded from each survey. Trend line shows the cumulative species curve.

The numbers of species by taxon are summarised below:

Order Orthoptera (31 species)

Suborder Caelifera (8 species)

Family Acrididae (7 species)

Family Pyrgomorphidae (1 species)

Suborder Ensifera (23 species)

Family Gryllacrididae (1 species)

Family Gryllidae (10 species)

Family Tettigoniidae (12 species)

## DISCUSSION

The majority of the orthopteran species recorded from the exhumed Bidadari Cemetery are common and can be found in other parts of Singapore (Tan, 2010b, 2012, in press; Tan et al., 2011). Nevertheless, there are also some noteworthy species: *Tarbinskiellus portentosus*, *Trigonidium* (?) sp., *Euconocephalus mucro*, and *Euconocephalus varius* are hitherto not recorded in the nature reserves and parks. Furthermore, Bidadari Cemetery appears to be the only known site for the two species of crickets (*Tarbinskiellus portentosus* and *Trigonidium* (?) sp.) in Singapore. *Tarbinskiellus portentosus* is a huge cricket which is located acoustically as the males stridulate at the opening of their burrows and produce a high-pitched and resonant buzz (Willemse, 2001). Interestingly, in the Bukit Timah and Central Catchment nature reserves (BTNR, CCNR), similarly large crickets which call from the opening of their burrows at night belong to two *Gymnogryllus* species which were not sighted in Bidadari Cemetery (Tan, 2012b). *Trigonidium* (?) sp. is a species of sword-tailed cricket belonging to the subfamily Trigonidiinae. Although the subfamily requires a taxonomic overhaul, the species is morphologically distinct from the other species recorded from the BTNR, the CCNR, and parks in Singapore (Tan et al., 2011; Tan, 2012b). The two species have not been found elsewhere in the country so far. The clearance of the grassy habitat in the exhumed Bidadari Cemetery for development may be a threat to the survival of these species in Singapore.

The monitoring also revealed some interesting observations on the ecology of some Orthoptera in the Bidadari Cemetery, in particular the cone-headed katydids (Tettigoniidae: Conocephalinae). It was found that *Conocephalus* cf. *cognatus* is distinctly more abundant than *Conocephalus maculatus* because *Conocephalus* cf. *cognatus* was recorded during all six surveys whereas *Conocephalus maculatus* was recorded only twice. This is unlike most grassy plots studied in Singapore where the more widely distributed *Conocephalus maculatus* tends to be more abundant than the more narrowly distributed *Conocephalus* cf. *cognatus* (Tan et al., 2011). This is also the case for the *Euconocephalus* recorded from the Bidadari Cemetery. The more widely-distributed and abundant *Euconocephalus pallidus* is least common among the three species of *Euconocephalus* recorded from Bidadari Cemetery. On the other hand, *Euconocephalus mucro*, currently known only from Bidadari Cemetery and Chestnut Avenue, is the most dominant

species along with *Euconocephalus varius* (Tan, 2011). With very little information known about the biology of these Conocephalinae, it is not possible to explain this observation.

In conclusion, although the diversity of Orthoptera in the exhumed Bidadari Cemetery is nowhere near that of the BTNR and CCNR, the three-month survey has shown that the Bidadari Cemetery is comparatively more diverse in Orthoptera than most of the parks investigated by Tan et al. (2011). While a more comprehensive monitoring over a longer period of time would provide more in-depth understanding and analysis of the orthopteran diversity and ecology in Bidadari Cemetery, this might not be possible as the habitats at this site may be cleared for development.

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## APPENDIX

Conservation status is preliminary and provided for species based on records from recent research by the author only. The status assigned to each species reflects how likely the species may be encountered in Singapore, rather than its absolute abundance and distribution and without reference to any specific locality, including the exhumed Bidadari Cemetery. Abbreviations for the conservation statuses are as follow: C = common; UC = uncommon; R = rare; VR = very rare. The 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.

Species	Site A	Site B	Status	Material Collected
<b>SUBORDER CAELIFERA</b>				
<b>FAMILY ACRIDIDAE</b>				
<b>Subfamily Catantopinae</b>				
<i>Apalacris varicornis</i> Walker		+	UC	
<i>Xenocatantops humilis</i> (Serville)		+	C	
<b>Subfamily Oxyinae</b>				
<i>Gesonula mundata</i> (Walker) (Fig. 2A)		+	UC	ZRC.ORT.82
<i>Oxya hyla intricata</i> (Stål) (Fig. 2B)	+	+	C	ZRC.ORT.427
<i>Oxya japonica japonica</i> (Thunberg) (Fig. 2C)	+	+	C	ZRC.ORT.418
<i>Pseudoxya diminuta</i> (Walker) (Fig. 2D)	+	+	C	ZRC.ORT.419
<b>Subfamily Spathosterninae</b>				
<i>Spathosternum prasiniferum</i> (Walker) (Fig. 3)	+	+	UC	ZRC.ORT.420
<b>FAMILY PYRGOMORPHIDAE</b>				
<b>Subfamily Pyrgomorphinae</b>				
<i>Atractomorpha psittacina psittacina</i> (de Haan)	+	+	C	ZRC.ORT.421
Species	Site A	Site B	Status	Material Collected
<b>SUBORDER ENSIFERA</b>				
<b>FAMILY GRYLLIDAE</b>				
<b>Subfamily Euscyrtinae</b>				
<i>Euscyrtus concinnus</i> (de Haan)	+	+	C	
<b>Subfamily Gryllinae</b>				
<i>Loxoblemmus</i> cf. <i>parabolicus</i> Saussure (Fig. 4A, B)	+	+	UC	ZRC.ORT.423, 429, 438
<i>Tarbinskiellus portentosus</i> (Lichtenstein) (Fig. 4C)		+	VR	ZRC.ORT.117
<i>Teleogryllus</i> sp. (Fig. 4D)	+		C	ZRC.ORT.428
<b>Subfamily Nemobiinae</b>				
<i>Pteronemobius</i> sp. (Fig. 5A)	+	+	C	ZRC.ORT.430
<i>Pteronemobius</i> sp. 2		+	R	
<b>Subfamily Trigonidiinae</b>				
<i>Homoeoxipha lycoides</i> (Walker) (Fig. 5G, H)	+	+	C	
<i>Metioche pallipes</i> (Stål) (Fig. 5E, F)	+	+	UC	ZRC.ORT.431
<i>Svistella</i> (?) sp. (Fig. 5B)		+	C	ZRC.ORT.426
<i>Trigonidium</i> (?) sp. (Fig. 5C, D)	+		R	ZRC.ORT.432
<b>FAMILY GRYLLACRIDIDAE</b>				
<b>Subfamily Gryllacridinae</b>				
<i>Gryllacris (signifera</i> group) sp.	+		UC	ZRC.ORT.88
<b>FAMILY TETTIGONIIDAE</b>				
<b>Subfamily Conocephalinae</b>				
<i>Conocephalus</i> cf. <i>cognatus</i> (Redtenbacher) (Fig. 6A)	+	+	UC	ZRC.ORT.89–91
<i>Conocephalus maculatus</i> (Le Guillou) (Fig. 6B)	+	+	C	
<i>Euconocephalus mucro</i> (de Haan) (Fig. 6C)	+	+	R	ZRC.ORT.01, 07, 55–57
<i>Euconocephalus pallidus</i> (Redtenbacher)	+		UC	ZRC.ORT.03, 63, 64
<i>Euconocephalus varius</i> (Walker) (Fig. 6D)	+	+	R	ZRC.ORT.02, 59, 60

Species	Site A	Site B	Status	Material Collected
<b>Subfamily Hexacentrinae</b>				
<i>Hexacentrus unicolor</i> Serville		+	C	ZRC.ORT.424
<b>Subfamily Meconematinae</b>				
<i>Alloteratura</i> sp.	+		UC	ZRC.ORT.422
<b>Subfamily Mecopodinae</b>				
<i>Mecopoda elongata</i> (Linnaeus)		+	C	ZRC.ORT.425
<b>Subfamily Phaneropterinae</b>				
<i>Ducetia japonica</i> (Thunberg) (Fig. 7A)		+	C	ZRC.ORT.435
<i>Elimaea (Elimaea)</i> sp. (Fig. 7B)	+	+	C	ZRC.ORT.433
<i>Holochlora</i> cf. <i>obtusa</i> Brunner von Wattenwyl (Fig. 7C)		+	R	ZRC.ORT.436
<i>Phaneroptera brevis</i> (Serville) (Fig. 7D)		+	C	ZRC.ORT.437



Fig. 2. Subfamily Oxyinae: A, *Gesonula mundata* (Walker) male adult (BL = ca. 16.6 mm); B, *Oxya hyla intricata* (Stål) female adult (BL = ca. 19.6 mm); C, *Oxya japonica japonica* (Thunberg) female adult (BL = ca. 20.0 mm); D, *Pseudoxya diminuta* (Walker) male adult (BL = ca. 15.0 mm).



Fig. 3. *Spathosternum prasiniferum* (Walker) adults: A, B, females (BL = ca. 16.3 mm); and C, D, males (BL = ca. 14.4 mm).



Fig. 4. Subfamily Gryllinae: A, B, *Loxoblemmus* c.f. *parabolicus* Saussure male adult (BL = ca. 11.7 mm); C, *Tarbinskiellus portentosus* (Lichtenstein) male adult (BL = ca. 34.1 mm); D, *Teleogryllus* sp. female nymph (BL = ca. 18.6 mm).



Fig. 5. Subfamilies Nemobiinae and Trigonidiinae: A, *Pteronemobius* sp. male adult (BL = ca. 4.9 mm); B, *Svistella* (?) sp. male adult (BL = 4.5 mm); *Trigonidium* (?) sp. male (C) and female (D) adults (BL = ca. 3.8 mm); *Metioche pallipes* (Stål) male (E; BL = ca. 4.9 mm) and female (F; BL = ca. 4.3 mm) adults; *Homoeoxipha lycoides* (Walker) male (G) and female (H) adults (BL = ca. 5.9 mm).

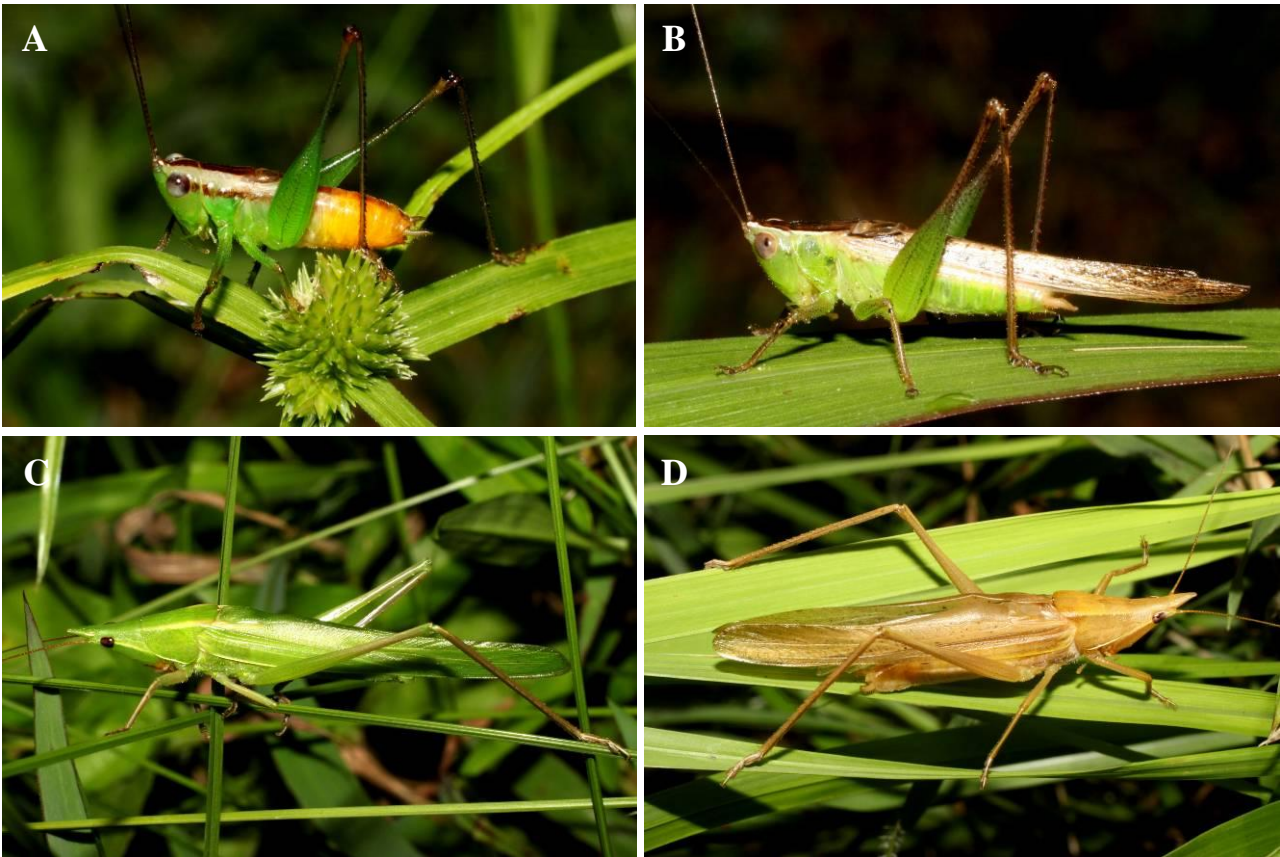


Fig. 6. Subfamily Conocephalinae: A, *Conocephalus* c.f. *cognatus* (Redtenbacher) male adult (BL = ca. 14.4 mm); B, *Conocephalus maculatus* (Le Guillou) male adult (BL = ca. 12.9 mm); C, *Euconocephalus mucro* (de Haan) male adult (BL = ca. 31.6 mm); D, *Euconocephalus varius* (Walker) male adult (BL = ca. 30.0 mm).

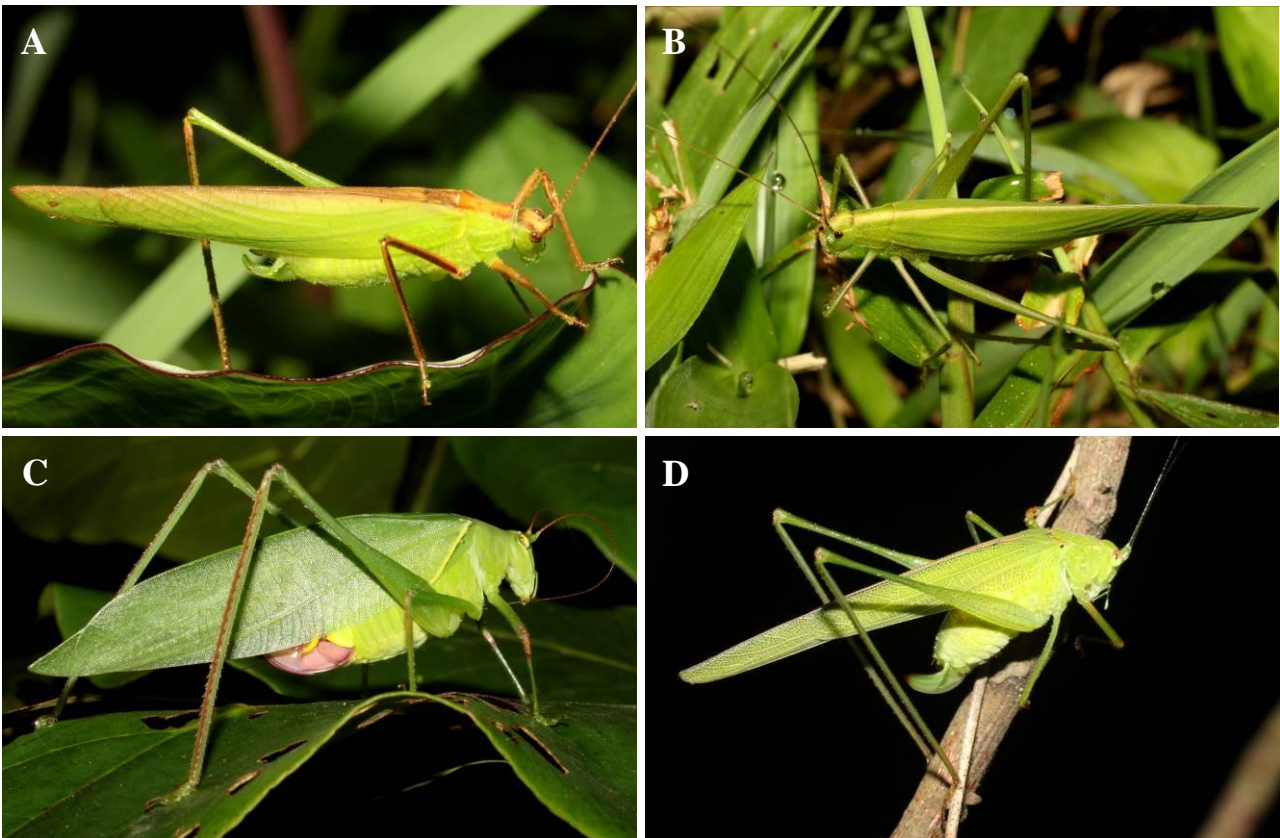


Fig. 7. Subfamily Phaneropterinae: A, *Ducetia japonica* (Thunberg) male adult (BL = 15.9 mm); B, *Elimaea (Elimaea)* sp. female adult (BL = ca. 23.7 mm); C, *Holochlora* c.f. *obtusa* Brunner von Wattenwyl female adult (BL = 28.0 mm); D, *Phaneroptera brevis* (Serville) female adult (BL = 13.0 mm).