

**ORTHOPTERA IN THE BUKIT TIMAH AND
CENTRAL CATCHMENT NATURE RESERVES
(PART 1): SUBORDER CAELIFERA**



Ming Kai Tan

Raffles Museum of Biodiversity Research
National University of Singapore
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Cover photograph of *Traulia azureipennis* (black forest grasshopper), one of the many grasshoppers seen in the forests of the Bukit Timah Nature and Central Catchment Nature Reserves © Chan Jia Yee Jerelyn.

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CONTENTS

1.	Introduction	1
2.	Methods	1
3.	Results and Observations	4
4.	Caelifera Recorded from Bukit Timah and Central Catchment Nature Reserves	5
a.	Family Acrididae	5
b.	Family Chorotypidae	10
c.	Family Pyrgomorphidae	13
d.	Family Tetrigidae	14
e.	Family Trigonopterygidae	21
5.	Morphological Keys	35
a.	Morphological Key to the Families of Caelifera of BTNR and CCNR	35
b.	Artificial Morphological Key to the Subfamilies, Genera, and Species of Acrididae	35
c.	Artificial Morphological Key to the Genera of Chorotypidae	37
d.	Artificial Morphological Key to the Species of Pyrgomorphidae	37
e.	Artificial Morphological Key to the Subfamilies and Genera of Tetrigidae	38
6.	Discussion and Conclusions	38
7.	Acknowledgements	39
8.	Literature Cited	39
9.	How to Cite this Book	40

INTRODUCTION

This publication reviews the diversity of Caelifera from the Bukit Timah Nature Reserve (BTNR) and Central Catchment Nature Reserve (CCNR) of Singapore. The suborder Caelifera, commonly known as the grasshoppers, belongs to the order Orthoptera of the class Insecta in the phylum Arthropoda. This publication represents the first of a few revisions on the diversity of Orthoptera from the BTNR and CCNR. Collections and a number of publications on the Orthoptera in BTNR and CCNR were made primarily by D. H. Murphy in the 1970s (Chan, 1991). Although these works remain impressive and important to date, the checklists may have become outdated.

In this book, preliminary results from 12 months of survey and collections between Oct.2010 and Sep.2011 are reported. An inventory and morphological keys for different families and subfamilies of the Caelifera are included. The compilation of these findings aims to increase the scientific and communal attention to the diversity of Caelifera in Singapore and their conservation needs, as well as to provide fundamental information necessary for effective protection and conservation of Orthoptera (Hoekstra, 1998). Colour plates illustrating the habitus and diagnostic characters are presented to aid in species identification, and hopefully, to help dispel the public's general perception of grasshoppers or locusts as harmful pests (Hoekstra, 1998). The purpose of this publication is to reach out to locals, professionals, and the laymen, to discover and explore the Orthoptera in Singapore — with a sense of wonder but a touch of concern” (Rentz et al., 2003: viii).

METHODS

Surveys and opportunistic collections. — A total of 152 surveys were conducted along 25 trails and sites within and around the Bukit Timah Nature Reserve (BTNR) and the Central Catchment Nature Reserve (CCNR) from Oct.2010 to Sep.2011 (Figs. 1, 2):

1. Bukit Timah Nature Reserve (BTNR): Belukar Track, BTNR main road (Hindhede Drive), Dairy Farm Loop, Hindhede Way, Jungle Fall Valley, Senapang Link, and Seraya Valley
2. Dairy Farm Nature Park (DFNP): Dairy Farm Pass and Wallace Trail
3. Hindhede Nature Park (HNP)
4. Central Catchment Nature Reserve (CCNR): Chestnut Track, Eco-Bridge (CCNR side), Mandai Avenue felled forest, Mandai Track 15, Mousedeer Track (along Old Upper Thomson Road), Nee Soon pipeline (en route to Nee Soon swamp forest), Nee Soon swamp forest, Upper Seletar Trail, and Woodcutter Track
5. MacRitchie Catchment Area: Lornie Trail, Lower Peirce Reservoir Park, MacRitchie Nature Trail, Rifle Range Link, Sime Track (Sime forest), and Venus Trail

Opportunistic collections of adult specimens were carried out by: searching vegetation, ground and tree felling; raking litters; sweeping vegetation; breaking off branches and examining the interior; searching burrows; and locating calls. All surveys and collections were conducted at night unless otherwise stated.

Examination and identification. — Specimens collected were euthanized in a freezer. Morphological data was recorded from freshly euthanized specimens and measurements were made with a 0.05 mm vernier caliper. Close-up photographs of freshly euthanized specimens were taken using a digital SLR camera with compact-macro lens EF 50 mm at f/2.5. Smaller details were captured on a digital camera attached to a stereozoom microscope. Scales provided with the images are approximates. The specimens were first identified using reference to keys and descriptions (Hancock, 1907; Willemse, 1930; Kevan, 1963; Hollis, 1968, 1971; Ingrisch & Willemse, 1988; Willemse, 2001; Rentz et al., 2003; Mahmood et al., 2007a, 2007b; Wei et al., 2007; Yin & Shi, 2007; Yin & Yin, 2009) and by comparison with voucher specimens. Subsequently, the identities of the specimens were verified by Hendrik Devriese, Luc Willemse, and Sigfrid Ingrisch.

Depositories. — Voucher specimens were either dry-mounted or preserved in alcohol (70% or 90%, volume/volume), and subsequently deposited in the Zoological Reference Collection (ZRC) of the Raffles Museum of Biodiversity Research (RMBR), National University of Singapore.

Classification. — Classification was based on the Orthoptera Species File Online Version 2.0/4.0 (Eades et al., 2012). The families, subfamilies, and genera are arranged alphabetically for ease of reference. In the habitus photographs, measurement indicates the body length of freshly euthanized specimens (from the vertex of fastigium to the abdominal apex, exclusive of ovipositor or cercus).

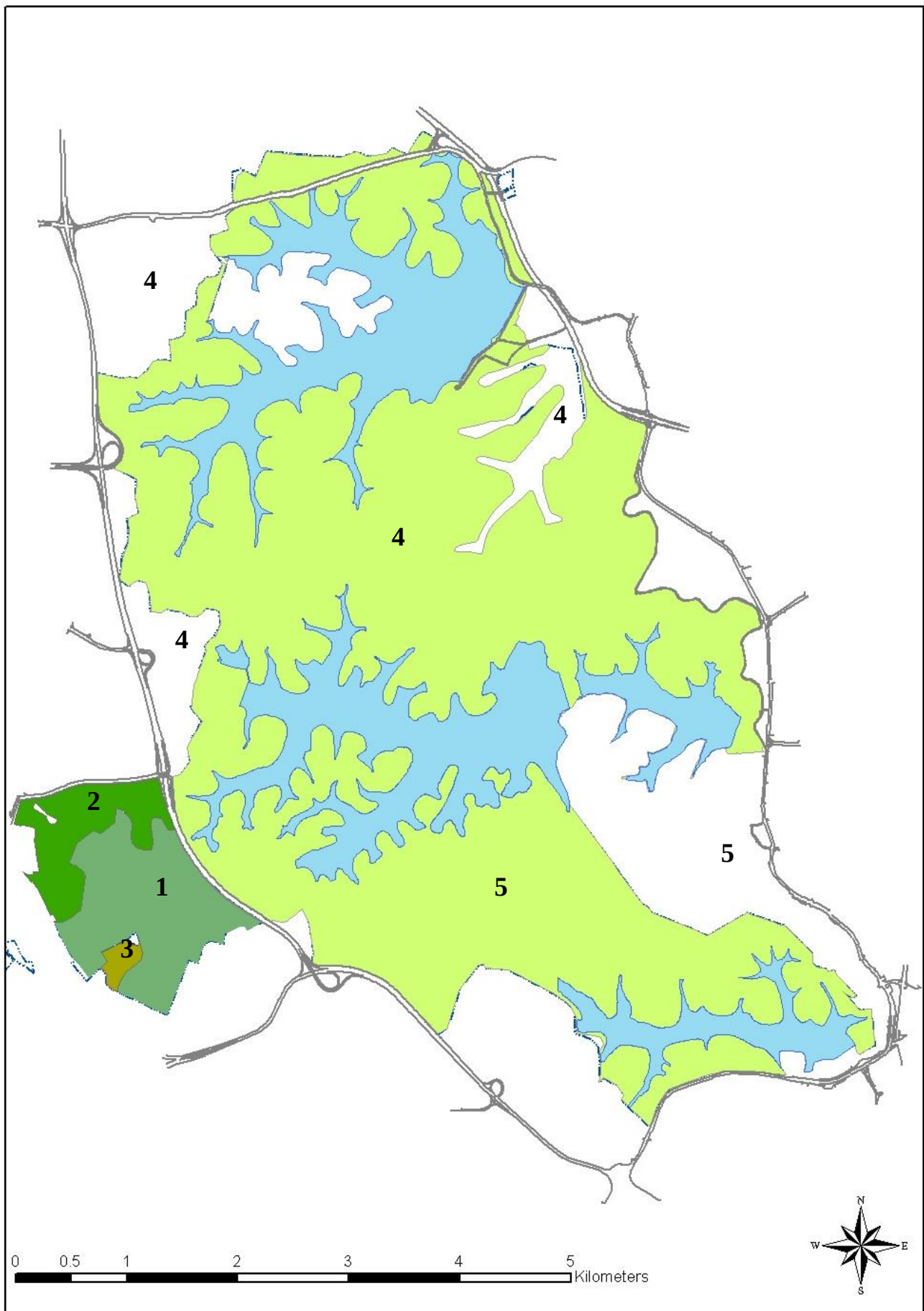


Fig. 1. Map of areas surveyed within and around BTNR and CCNR: (1) BTNR, (2) DFNP, (3) HNP, (4) CCNR, and (5) MacRitchie Catchment Area.

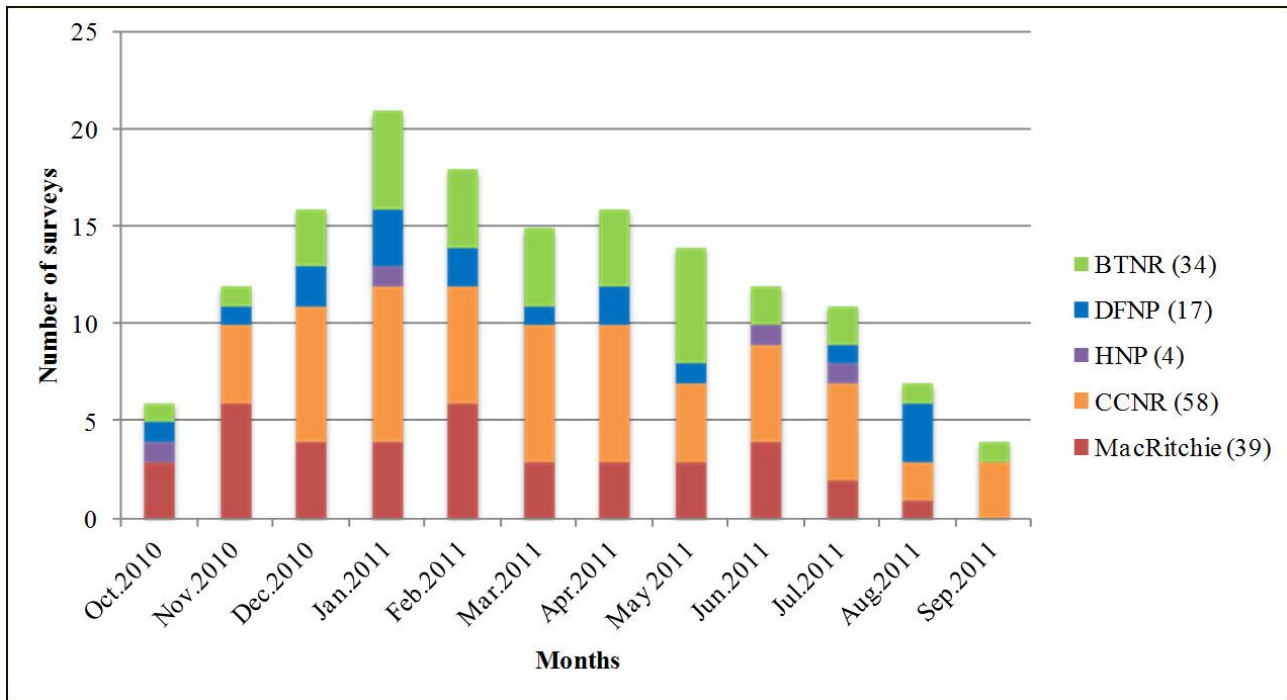


Fig. 2. Number of surveys conducted over the 12 months (from Oct.2010 to Sep.2011) in BTNR and CCNR (number of surveys conducted in each area in brackets).

RESULTS AND OBSERVATIONS

At least 33 known species from 30 genera representing five families from the suborder Caelifera were collected from the BTNR and CCNR and examined. The superfamily Acridomorpha (23 species from four families) is represented with far more species compared to Tetrigoidea (10 species from one family). Diversity is highest in the family Acrididae (15 species), followed by Tetrigidae (10 species). In contrast, the family Trigonopterygidae is represented by only a single species.

Order Orthoptera

Suborder Caelifera

Infraorder Acrididea

Superfamily group Acridomorpha (23)

Family Acrididae (15)

Family Chorotypidae (4)

Family Pyrgomorphidae (3)

Family Trigonopterygidae (1)

Superfamily group Tetrigoidea (10)

Family Tetrigidae (10)

Suborder Ensifera

**CAELIFERA RECORDED FROM BUKIT TIMAH AND
CENTRAL CATCHMENT NATURE RESERVES**

FAMILY ACRIDIDAE

Subfamily Acridinae

Phlaeoba antennata Brunner von Wattenwyl

Figs. 3, 36A,B

Material examined. — ZRC.ORT.307, 1 male, Mandai Track 15, 21 Jun.2011, coll. M. K. Tan, R. W. J. Ngiam, J. J. Y. Chan & T. Robillard.



Fig. 3. *Phlaeoba antennata* Brunner von Wattenwyl: ZRC.ORT.307, male, 20.6 mm.

Subfamily Catantopinae

Apalacris varicornis Walker

Figs. 4, 37A, 38A, 39A,E, 40A,F

Material examined. — ZRC.ORT.333, 1 male, Wallace Trail, 1 Aug.2011, coll. M. K. Tan.

Lucretilis sp.

Figs. 5, 37B, 38B, 39B,F, 40G

Material examined. — ZRC.ORT.238, 1 male, Lornie Trail, 24 Feb.2011, coll. M. K. Tan.

Meltripata picta Bolívar

Figs. 6, 37C, 38C, 40H

Material examined. — ZRC.ORT.215, 1 female, Chestnut Track, 29 Jan.2011, coll. M. K. Tan.

Pareuthymia sp.

Figs. 7, 37D, 38D, 39G, 40E

Material examined. — ZRC.ORT.224, 1 male, Nee Soon swamp forest, 15 Feb.2011, coll. M. K. Tan & R. W. J. Ngiam.

Stenocatantops splendens (Thunberg)

Figs. 8, 37E, 38E, 39C,H, 40C,I

Material examined. — ZRC.ORT.340, 1 female, Mandai Track 15, 9 Aug.2011, coll. M. K. Tan & J. J. Y. Chan.

Traulia azureipennis (Serville)

Figs. 9, 37F, 38F, 40B,D,J

Material examined. — ZRC.ORT.111, 1 male, Lower Peirce Reservoir Park, 22 Oct.2010, coll. M. K. Tan.

***Xenocatantops humilis* (Serville)**

Figs. 10, 37G, 38G, 39D,I, 40K

Material examined. — ZRC.ORT.306, 1 male, Mandai Track 15, 21 Jun.2011, coll. M. K. Tan, R. W. J. Ngiam, J. J. Y. Chan & T. Robillard.



Fig. 4. *Apalacris varicornis* Walker: ZRC.ORT.333, male, 15.8 mm.



Fig. 5. *Lucretilis* species: ZRC.ORT.238, male, 26.9 mm.



Fig. 6. *Meltripata picta* Bolívar: ZRC.ORT.215, female, 18.9 mm.



Fig. 7. *Pareuthymia* species: ZRC.ORT.224, male, 28.8 mm.



Fig. 8. *Stenocatantops splendens* (Thunberg): ZRC.ORT.340, female, 35.7 mm.

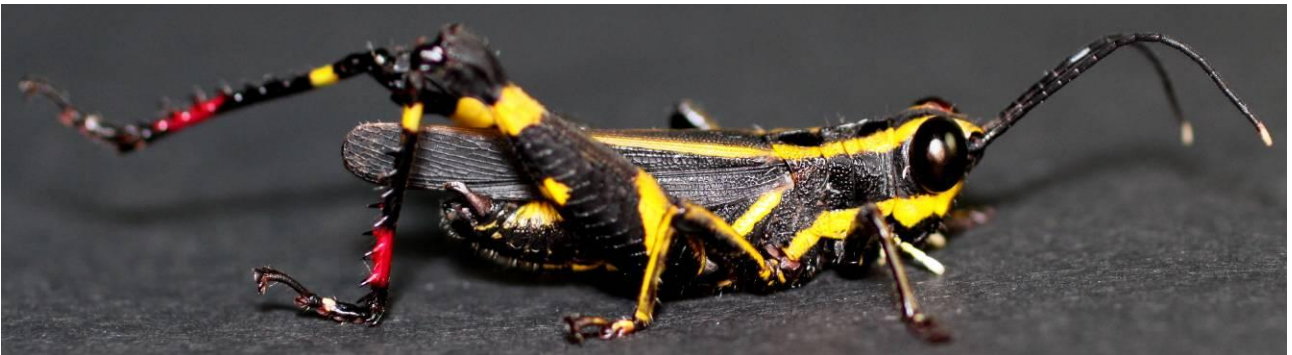


Fig. 9. *Traulia azureipennis* (Serville): ZRC.ORT.111, male, 20.5 mm.



Fig. 10. *Xenocatantops humilis* (Serville): ZRC.ORT.306, male, 20.9 mm.

Subfamily **Cyrtacanthacridinae**

Valanga nigricornis (Burmeister)

Figs. 11, 41A–D

Material examined. — ZRC.ORT.234, 1 female, Mandai Track 15, 22 Feb.2011, coll. M. K. Tan.



Fig. 11. *Valanga nigricornis* (Burmeister): ZRC.ORT.234, female, 51.4 mm.

Subfamily **Oedipodinae**

Aiolopus thalassinus tamulus (Fabricius)

Figs. 12, 42A,B

Material examined. — ZRC.ORT.341, 1 male, Chestnut Track, 13 Aug.2011, coll. M. K. Tan.

Trilophidia annulata (Thunberg)

Figs. 13, 42C,D

Material examined. — ZRC.ORT.334, 1 male, Wallace Trail, 1 Aug.2011, coll. M. K. Tan.



Fig. 12. *Aiolopus thalassinus tamulus* (Fabricius): ZRC.ORT.341, male, 17.7 mm.



Fig. 13. *Trilophidia annulata* (Thunberg): ZRC.ORT.334, male, 14.5 mm.

Subfamily **Oxyinae**

Gesonula mundata (Walker)

Figs. 14, 43A, 44A,D

Material examined. — ZRC.ORT.263, 1 female, Venus Trail, 9 Apr.2011, coll. M. K. Tan.

Oxya hyla intricata (Stål)

Figs. 15, 43B,E,H, 44B,E

Material examined. — ZRC.ORT.337, 1 male, Venus Trail, 8 Aug.2011, coll. M. K. Tan.

Oxya japonica japonica (Thunberg)

Figs. 16, 43C,F,I

Material examined. — ZRC.ORT.331, 1 male, Wallace Trail, 1 Aug.2011, coll. M. K. Tan.

Pseudoxya diminuta (Walker)

Figs. 17, 43D,G,J, 44C

Material examined. — ZRC.ORT.305, 1 male, Mandai Track 15, 21 Jun.2011, coll. M. K. Tan, R. W. J. Ngiam, J. J. Y. Chan & T. Robillard.



Fig. 14. *Gesonula mundata* (Walker): ZRC.ORT.263, female, 18.3 mm.



Fig. 15. *Oxya hyla intricata* (Stål): ZRC.ORT.337, male, 18.9 mm.



Fig. 16. *Oxya japonica japonica* (Thunberg): ZRC.ORT.331, male, 21.2 mm.



Fig. 17. *Pseudoxya diminuta* (Walker): ZRC.ORT.305, male, 15.5 mm.

FAMILY CHOROTYPIDAE
Subfamily **Erianthinae**

***Erianthus* sp.**

Figs. 18, 45B

Material examined. — ZRC.ORT.209, 1 female, Mandai Track 15, 19 Dec.2010, coll. M. K. Tan & H. P. M. Woo.



Fig. 18. *Erianthus* species: ZRC.ORT.209, female, 26.5 mm.

Subfamily **Eruciinae**

Erucius cf. *apicalis* (Westwood)

Figs. 19, 45A

Material examined. — ZRC.ORT.147, 1 male, 1 female, Wallace Trail, 3 Dec.2010, coll. M. K. Tan.



Fig. 19. *Erucius* species cf. *apicalis* (Westwood): ZRC.ORT.147, male, 17.7 mm (A); female, 23.2 mm (B).

Subfamily **Mnesicleinae**

***Mnesicles* sp. 1**

Figs. 20, 45C

Material examined. — ZRC.ORT.248, 1 male, Mandai Avenue felled forest, 17 Mar.2011, coll. M. K. Tan & R. W. J. Ngiam; ZRC.ORT.293, 1 male, Nee Soon pipeline, 31 May 2011, coll. M. K. Tan, R. W. J. Ngiam & W. L. Lim.

***Mnesicles* sp. 2**

Figs. 21, 45D

Material examined. — ZRC.ORT.313, 1 female, Belukar Track, 30 Jun.2011, coll. M. K. Tan & M. R. B. Ismail.

Remarks. — This specimen may be a sexual dimorphism or colour morph of *Mnesicles* sp. (Ingrisch, in litt.).



Fig. 20. *Mnesicles* species 1: ZRC.ORT.248, male, 15.1 mm.



Fig. 21. *Mnesicles* species 2: ZRC.ORT.313, female, 25.7 mm.

FAMILY PYRGOMORPHIDAE

Subfamily **Orthacridinae**

Mitricephala milleri Ramme

Figs. 22, 46A,F, 47A,D

Material examined. — ZRC.ORT.126, 1 female, Lornie Trail, 15 Nov.2010, coll. M. K. Tan & M. R. B. Ismail.



Fig. 22. *Mitricephala milleri* Ramme: ZRC.ORT.126, female, 36.9 mm.

Subfamily **Pyrgomorphinae**

Atractomorpha psittacina psittacina (de Haan)

Figs. 23, 46B,D, 47B,E

Material examined. — ZRC.ORT.338, 1 male, Mandai Track 15, 9 Aug.2011, coll. M. K. Tan & J. J. Y. Chan.

Tagasta marginella (Thunberg)

Figs. 24, 46C,E, 47C,F

Material examined. — ZRC.ORT.319, 1 male, Hindhede Way, 11 Jul.2011, coll. M. K. Tan; ZRC.ORT.345, 1 male, Mandai Track 15, 1 Sep.2011, coll. M. K. Tan.



Fig. 23. *Atractomorpha psittacina psittacina* (de Haan): ZRC.ORT.338, male, 23.1 mm.



Fig. 24. *Tagasta marginella* (Thunberg): ZRC.ORT.345, male, 19.4 mm.

FAMILY TETRIGIDAE

Subfamily **Cladonotinae**

Potua coronata Bolívar

Fig. 25

Material examined. — ZRC.ORT.223, 1 female, Wallace Trail, 12 Feb.2011, coll. M. K. Tan.



Fig. 25. *Potua coronata* Bolivar: ZRC.ORT.223, female, 9.3 mm.

Subfamily **Scelimeninae**

Criotettix cf. ***robustus*** (Hancock)

Figs. 26, 48A–C

Material examined. — ZRC.ORT.249, 1 male, Chestnut Track, 22 Mar.2011, coll. M. K. Tan; ZRC.ORT.259, 1 female, Wallace Trail, 7 Apr.2011, coll. M. K. Tan; ZRC.ORT.273, 1 female, Wallace Trail, 10 May 2011, coll. M. K. Tan & J. J. Y. Chan; ZRC.ORT.303, 1 female, Mandai Track 15, 21 Jun.2011, coll. M. K. Tan, R. W. J. Ngiam, J. J. Y. Chan & T. Robillard.

Eucriotettix sp.

Figs. 27, 48D,E

Material examined. — ZRC.ORT.181, 1 female, Nee Soon swamp forest, 20 Dec.2010, coll. M. K. Tan, R. W. J. Ngiam & M. R. B. Ismail.

Loxilobus spp.

Figs. 28, 48F

Material examined. — ZRC.ORT.202, 1 female, Wallace Trail, 27 Jan.2011, coll. M. K. Tan; ZRC.ORT.312, 1 male, BTNR main road, 29 Jun.2011, coll. M. K. Tan & J. J. Y. Chan.

Remarks. — The species of *Loxilobus* cannot be identified without study of specimens identified by Bolívar (1887), Hancock (1907), and Günther (1937, 1941) deposited in various museums in Europe. The taxonomy of the genus is in a chaotic state (Kevan, 1966; Devriese, in litt.).

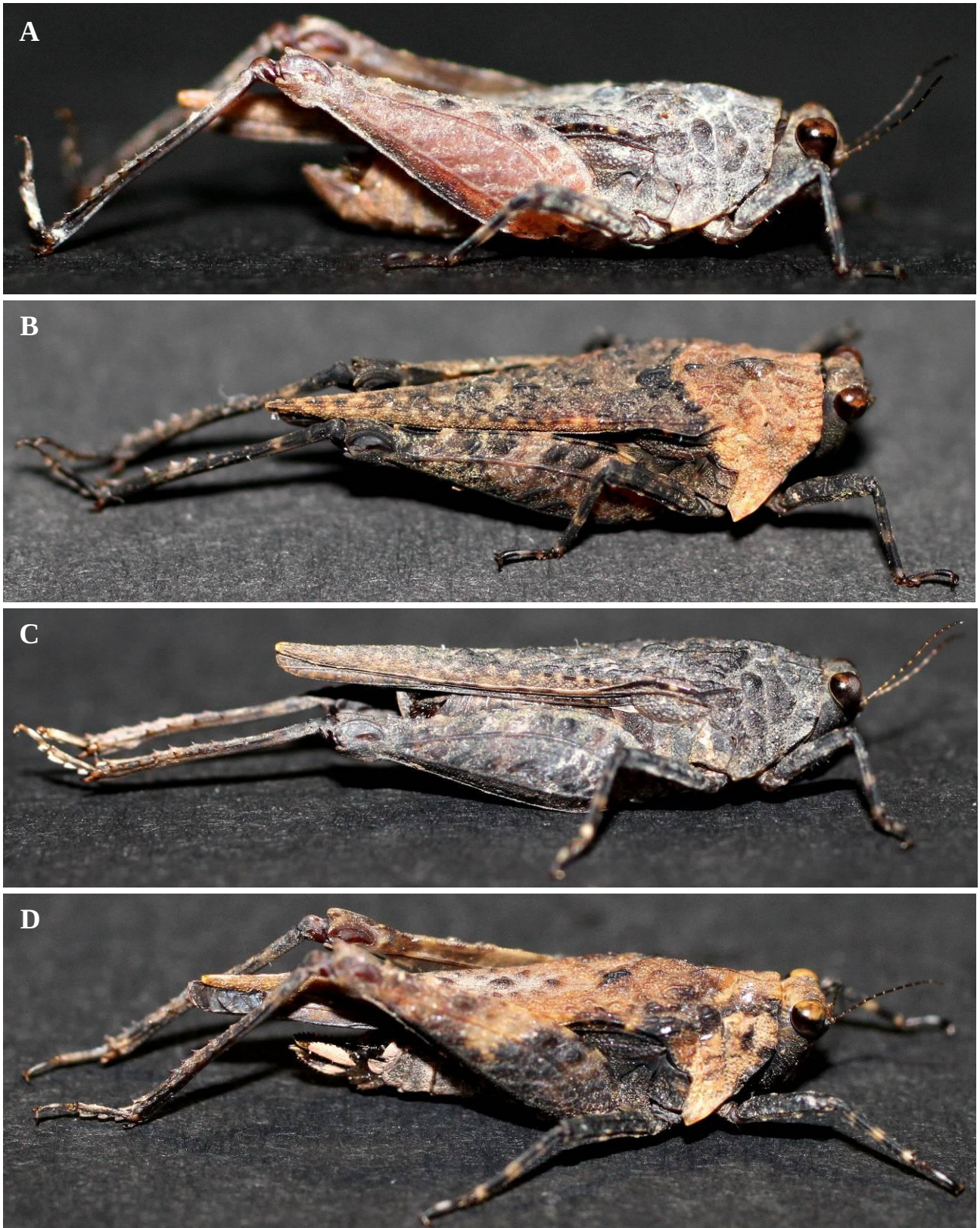


Fig. 26. *Criotettix* species cf. *robustus* (Hancock): ZRC.ORT.249, male, 10.6 mm (A); ZRC.ORT.259, female, 12.4 mm (B); ZRC.ORT.273, female, 12.8 mm (C); ZRC.ORT.303, female, 12.4 mm (D).



Fig. 27. *Eucriotettix* species: ZRC.ORT.181, female, 8.4 mm.



Fig. 28. *Loxilobus* species: ZRC.ORT.202, female, 7.5 mm (A); ZRC.ORT.312, male, 7.2 mm (B).

Subfamily **Tetriginae**

***Coptotettix* spp.**

Figs. 29, 49B

Material examined. — ZRC.ORT.185, 1 female, Mandai Track 15, 18 Jan.2011, coll. M. K. Tan & H. P. M. Woo; ZRC.ORT.186, 1 male, Mandai Track 15, 18 Jan.2011, coll. M. K. Tan & H. P. M. Woo; ZRC.ORT.189, 1 female, Mandai Track 15, 18 Jan.2011, coll. M. K. Tan & H. P. M. Woo; ZRC.ORT.232, 1 female, Chestnut Track, 20 Feb.2011, coll. M. K. Tan; ZRC.ORT.235, 1 female, Mandai Track 15, 22 Feb.2011, coll. M. K. Tan; ZRC.ORT.236, 1 male, Mandai Track 15, 22 Feb.2011, coll. M. K. Tan; ZRC.ORT.321, 1 female, Nee Soon pipeline, 14 Jul.2011, coll. M. K. Tan, M. R. B. Ismail & L. F. Cheong; ZRC.ORT.322, 1 male, 1 female, Nee Soon pipeline, 14 Jul.2011, coll. M. K. Tan, M. R. B. Ismail & L. F. Cheong.

Remarks. — Bolívar (1887) and Hancock (1907) described many species from the region. Material should be compared with specimens identified by those two authors.

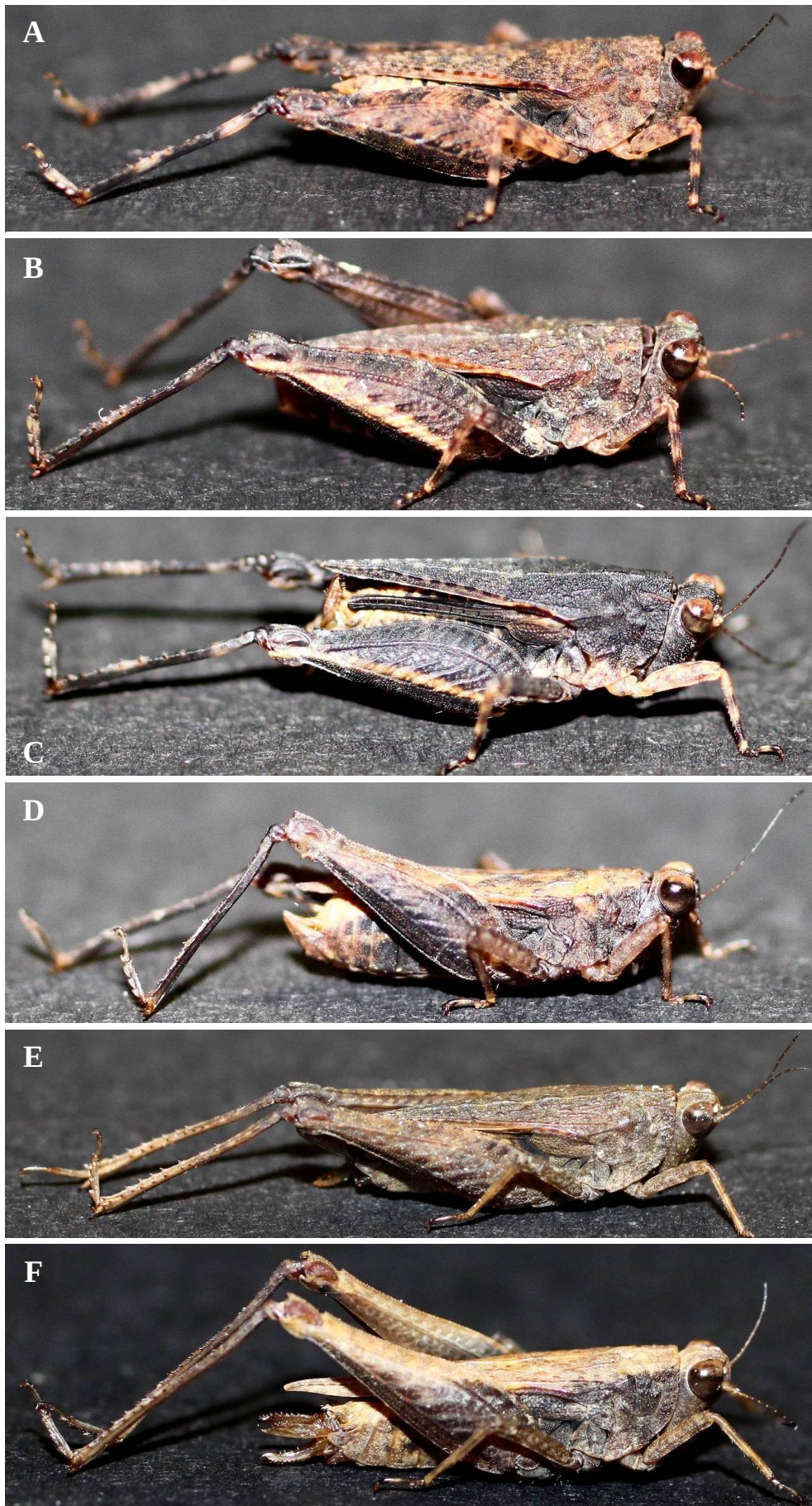


Fig. 29. *Coptotettix* species: ZRC.ORT.185, female, 9.6 mm (A); ZRC.ORT.186, male, 7.6 mm (B); ZRC.ORT.232, female, 9.7 mm (C); ZRC.ORT.236, male, 8.4 mm (D); ZRC.ORT.321, female, 10.0 mm (E); ZRC.ORT.322, female, 9.7 mm (F).

***Ergatettix dorsiferus* (Walker)**

Figs. 30, 49C,D

Material examined. — ZRC.ORT.178, 1 female, Chestnut Track, 20 Nov.2010, coll. M. K. Tan; ZRC.ORT.316, 1 female, Dairy Farm Pass, 6 Jul.2011, coll. M. K. Tan; ZRC.ORT.344, 1 female, Chestnut Track, 13 Aug.2011, coll. M. K. Tan.

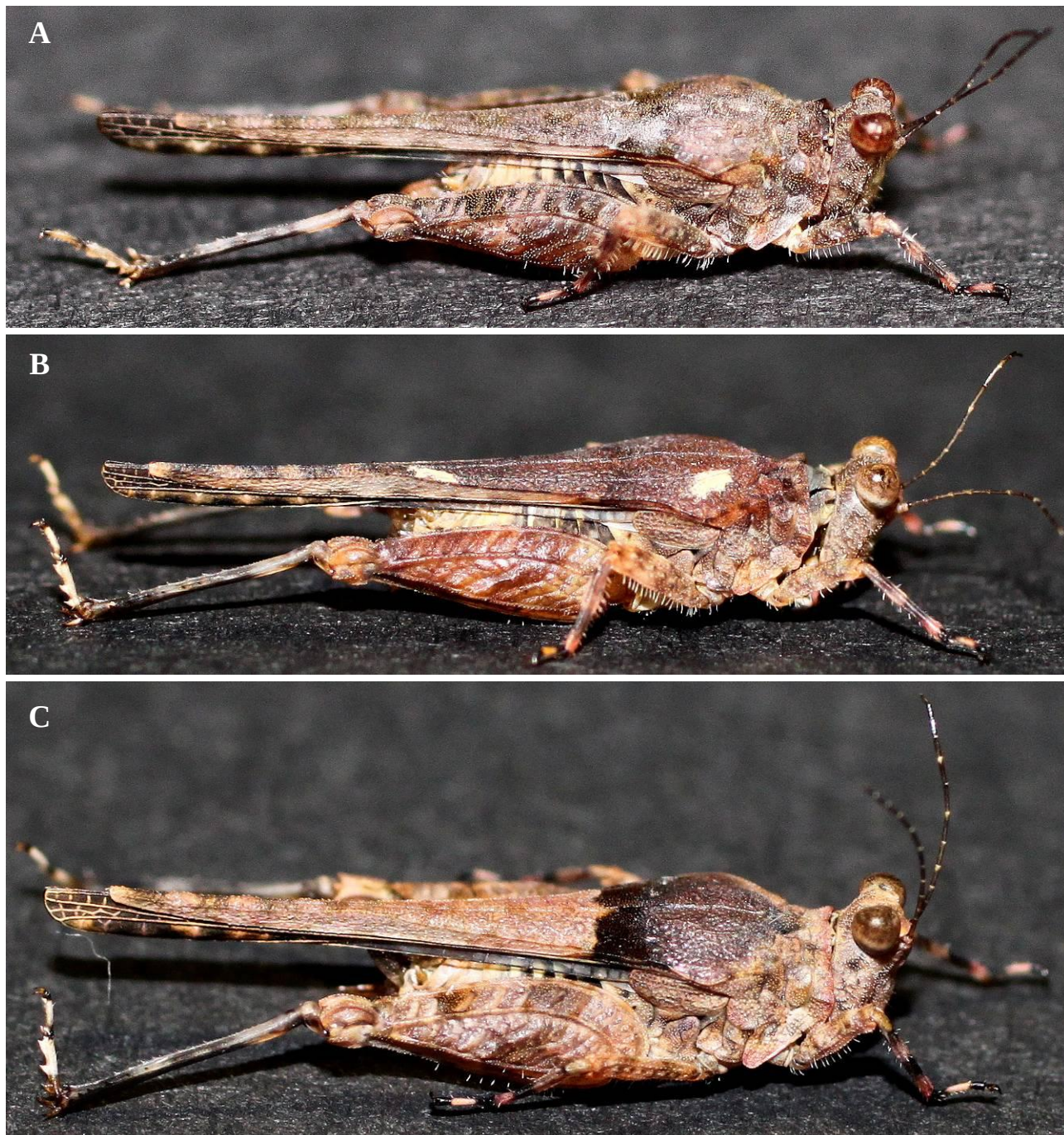


Fig. 30. *Ergatettix dorsiferus* (Walker): ZRC.ORT.178, female, 7.5 mm (A); ZRC.ORT.316, female, 7.3 mm (B); ZRC.ORT.233, female, 7.9 mm (C).

***Euparatettix variabilis* (Bolívar)**

Figs. 31, 49E,F

Material examined. — ZRC.ORT.283, 1 male, Mandai Track 15, 24 Apr.2011, coll. M. K. Tan; ZRC.ORT.339, 1 male, Mandai Track 15, 9 Aug.2011, coll. M. K. Tan & J. J. Y. Chan.

***Euparatettix* sp.**

Fig. 32

Material examined. — ZRC.ORT.188, 1 female, Mandai Track 15, 18 Jan.2011, coll. M. K. Tan & H. P. M. Woo; ZRC.ORT.203, 1 female, Wallace Trail, 27 Jan.2011, coll. M. K. Tan.

***Paratettix curtipennis* (Hancock)**

Figs. 33, 49G

Material examined. — ZRC.ORT.342, 1 female, Chestnut Track, 13 Aug.2011, coll. M. K. Tan; ZRC.ORT.343, 1 female, Chestnut Track, 13 Aug.2011, coll. M. K. Tan.

***Phaesticus insularis* (Hancock)**

Figs. 34, 49A,H

Material examined. — ZRC.ORT.187, 1 male, Mandai Track 15, 18 Jan.2011, coll. M. K. Tan & H. P. M. Woo; ZRC.ORT.199, 1 male, Hindhede Way, 26 Jan.2011, coll. M. K. Tan; ZRC.ORT.317, 1 male, 1 female, Dairy Farm Pass, 6 Jul.2011, coll. M. K. Tan.



Fig. 31. *Euparatettix variabilis* (Bolívar): ZRC.ORT.283, male, 7.4 mm (A); ZRC.ORT.339, male, 6.6 mm (B).



Fig. 32. *Euparatettix* species: ZRC.ORT.203, female, 8.6 mm.



Fig. 33. *Paratettix curtipennis* (Hancock): ZRC.ORT.342, female, 8.3 mm (A); ZRC.ORT.343, female, 9.0 mm (B).



Fig. 34. *Phaesticus insularis* (Hancock): ZRC.ORT.317, female, 9.8 mm.

FAMILY TRIGONOPTERYGIDAE

Subfamily **Trigonopteryginae**

Systella rafflesii Westwood

Figs. 35, 50

Material examined. — ZRC.ORT.128, 1 female, Nee Soon pipeline, 18 Nov.2010 (day), coll. M. R. B. Ismail; ZRC.ORT.135, 1 female, Nee Soon pipeline, 25 Nov.2010, coll. M. K. Tan, R. W. J. Ngiam & M. R. B. Ismail; ZRC.ORT.155, 1 male, Nee Soon swamp forest, 13 Dec.2010, coll. M. K. Tan & M. R. B. Ismail.

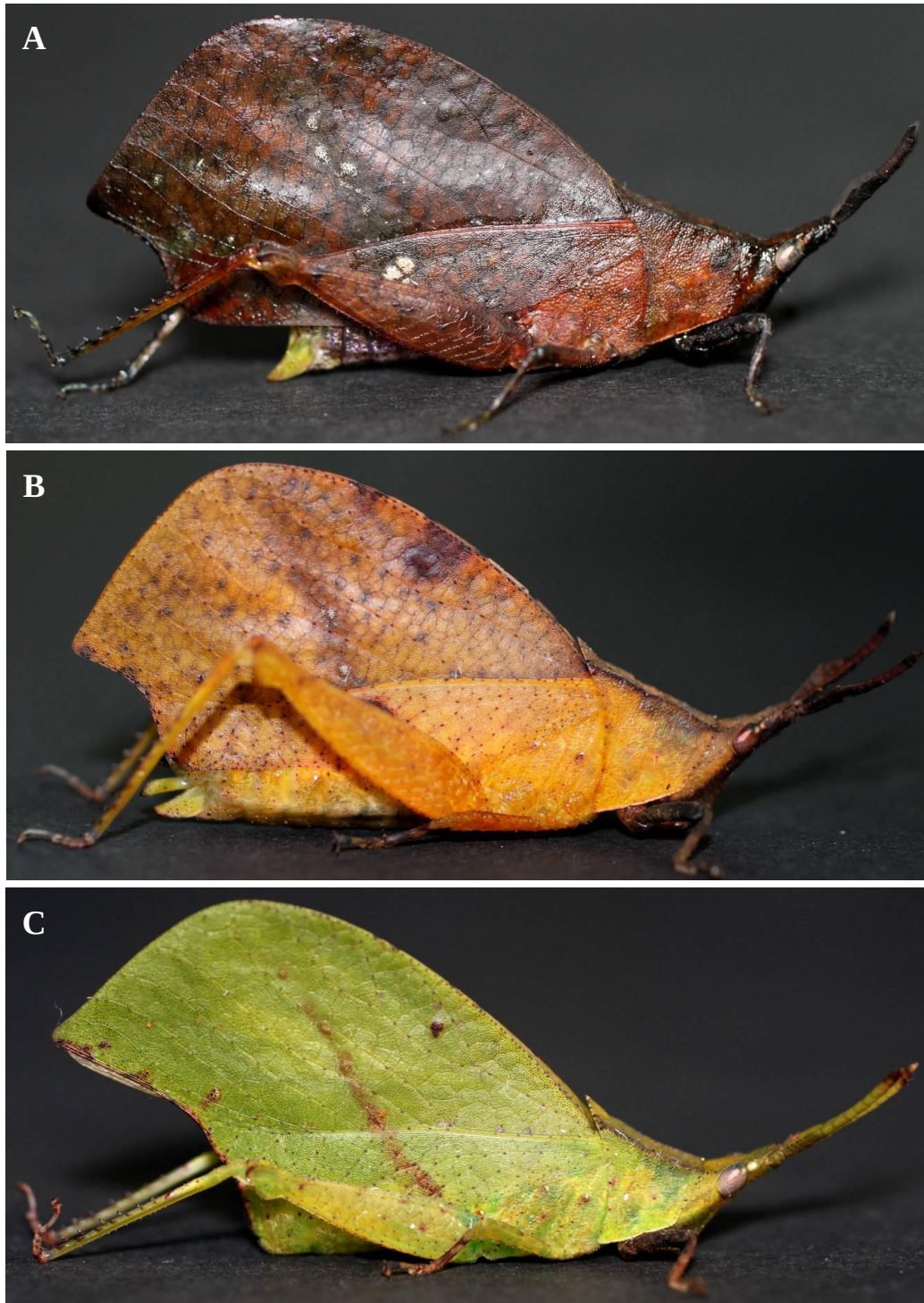


Fig. 35. *Systella rafflesii* Westwood: ZRC.ORT.128, female, 35.5 mm (A); ZRC.ORT.135; female, 40.1 mm (B); ZRC.ORT.155, male, 30.6 mm (C).



Fig. 36. *Phlaeoba antennata*: Profile of head and pronotum (A); head, dorsal view (B). Scale bar = 1 mm.

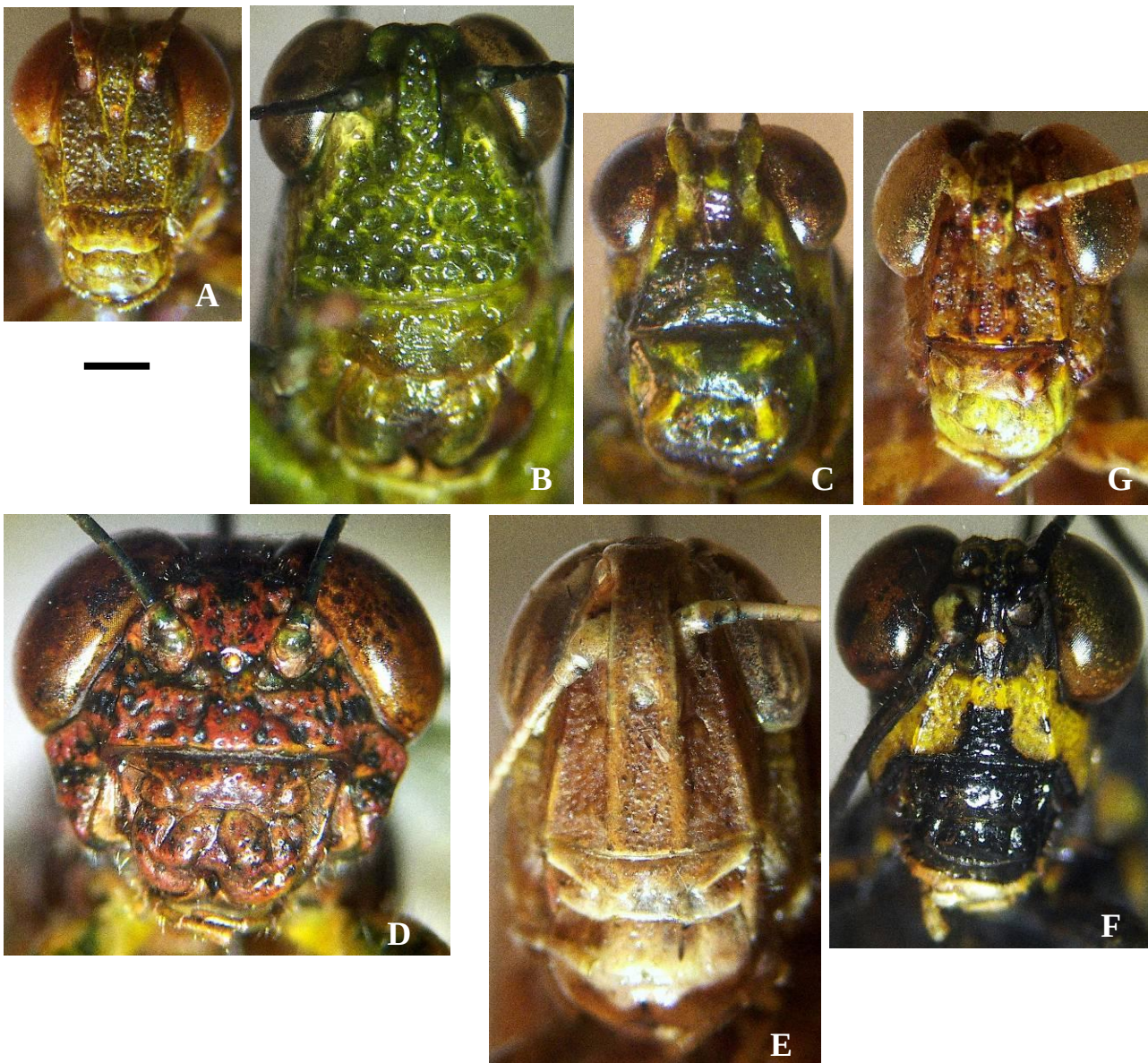


Fig. 37. Subfamily Catantopinae: Face in frontal view of *Apalacris varicornis* (A), *Lucretilis* species (B), *Meltripata picta* (C), *Pareuthymia* species (D), *Stenocatantops splendens* (E), *Traulia azureipennis* (F), and *Xenocatantops humilis* (G). Scale bar = 1 mm.

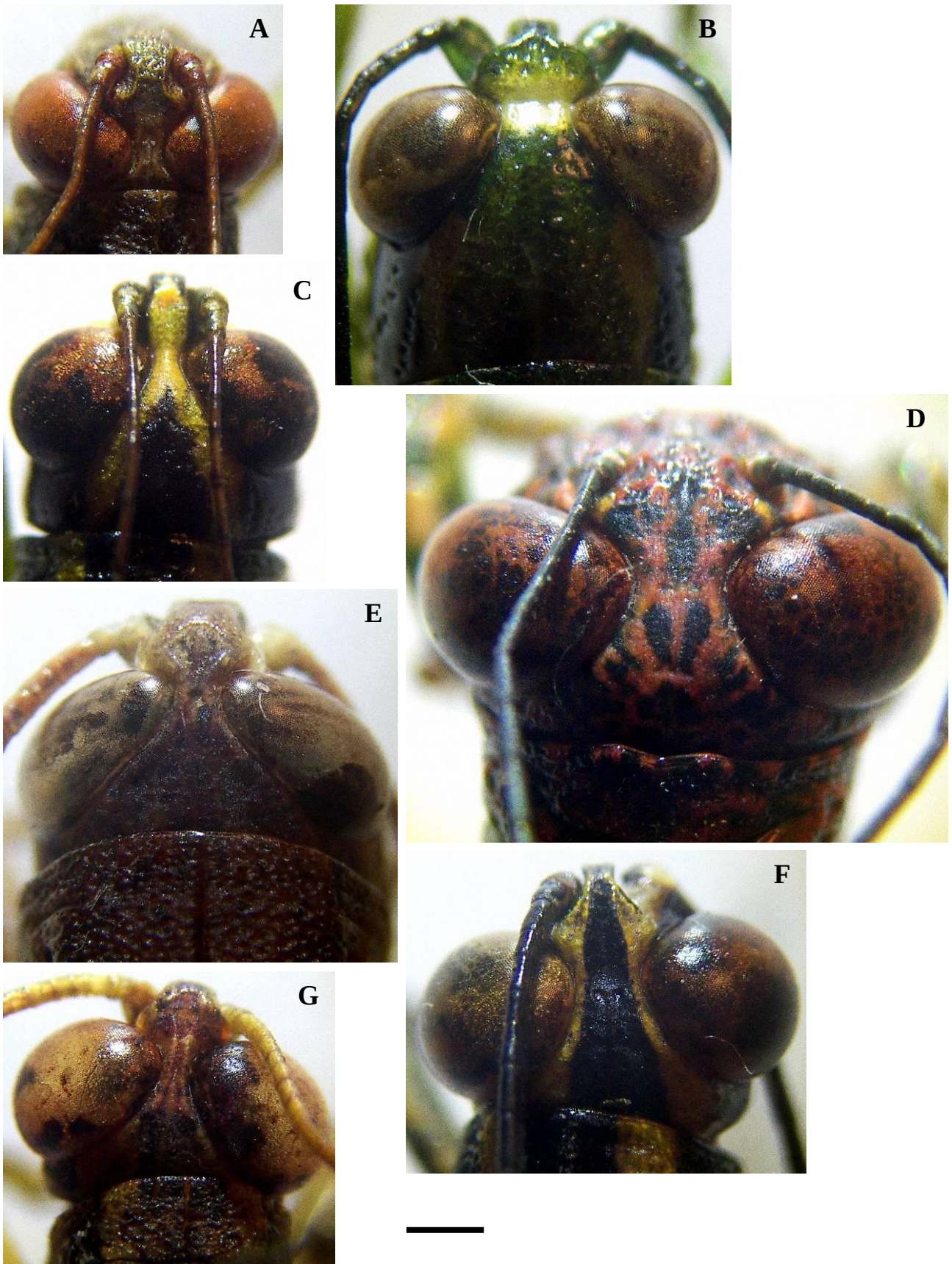


Fig. 38. Subfamily Catantopinae: Head in dorsal view of *Apalacris varicornis* (A), *Lucretilis* species (B), *Meltripata picta* (C), *Pareuthymia* species (D), *Stenocatantops splendens* (E), *Traulia azureipennis* (F), and *Xenocatantops humilis* (G). Scale bar = 1 mm.

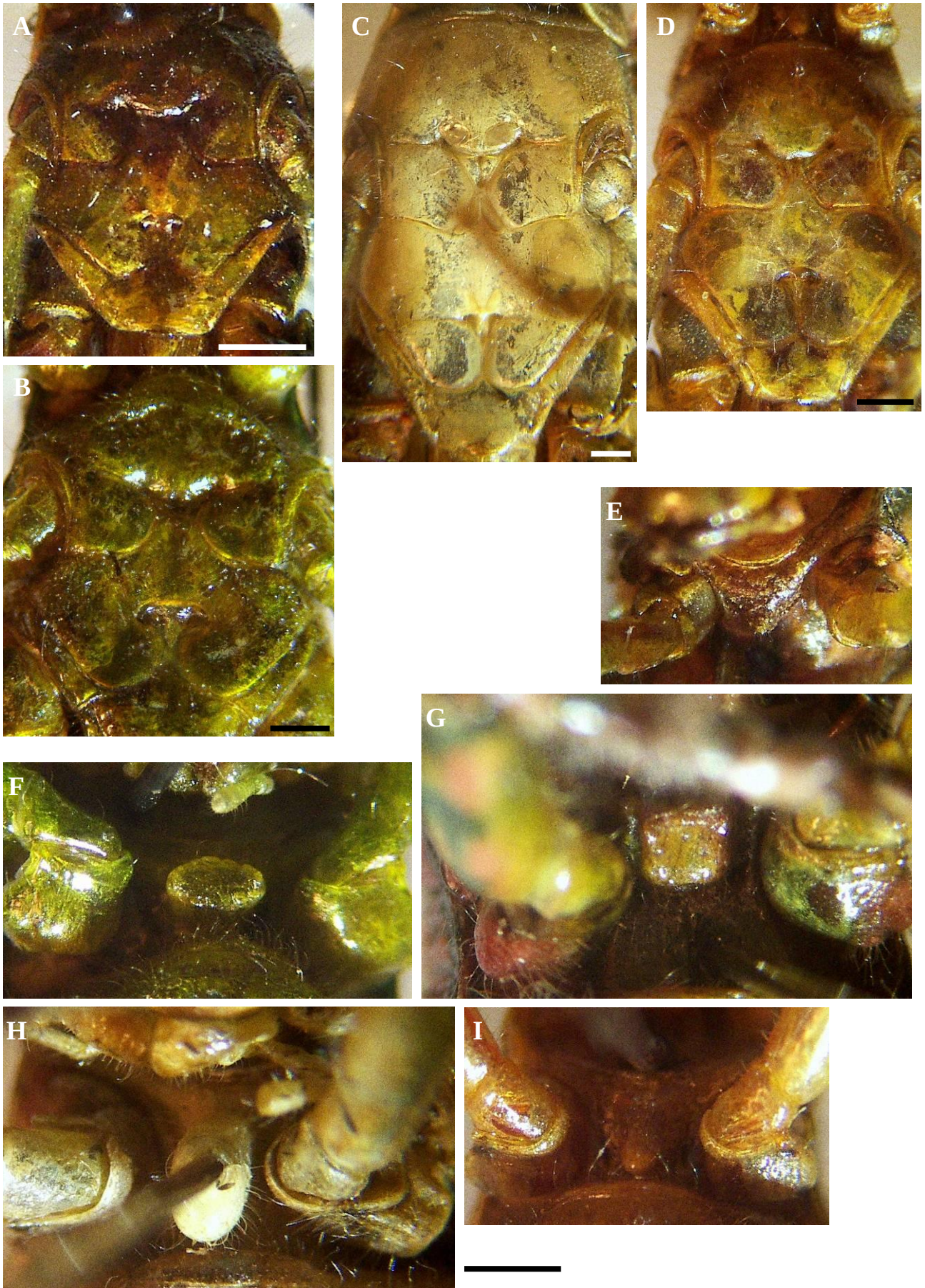


Fig. 39. Subfamily Catantopinae: Thorax in ventral view (A–D) and prosternal process in ventral or ventro-frontal view (E–I) of *Apalacris varicornis* (A, E), *Lucretilis* species (B, F), *Pareuthymia* species (G), *Stenocatantops splendens* (C, H), and *Xenocatantops humilis* (D, I). Scale bars = 1 mm.

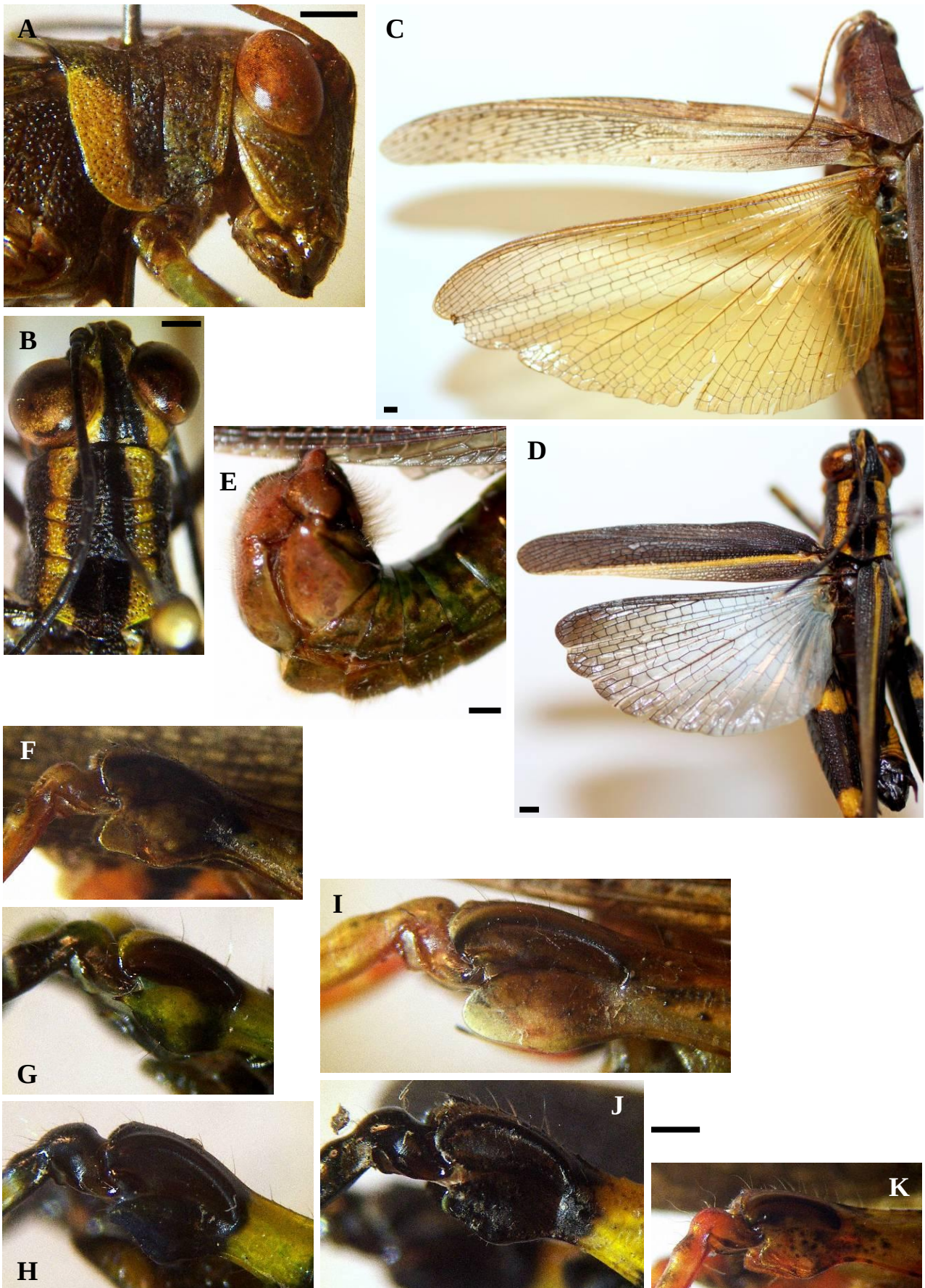


Fig. 40. Subfamily Catantopinae: Pronotum and head, profile view (A), dorsal view (B); wings, dorsal view (C, D); abdominal apex, profile view (E); and hind knee, profile view (F–K), of *Apalacris varicornis* (A, F), *Lucretilis* species (G), *Meltripata picta* (H), *Pareuthymia* species (E), *Stenocatantops splendens* (C, I), *Traulia azureipennis* (B, D, J), and *Xenocatantops humilis* (K). Scale bars = 1 mm.

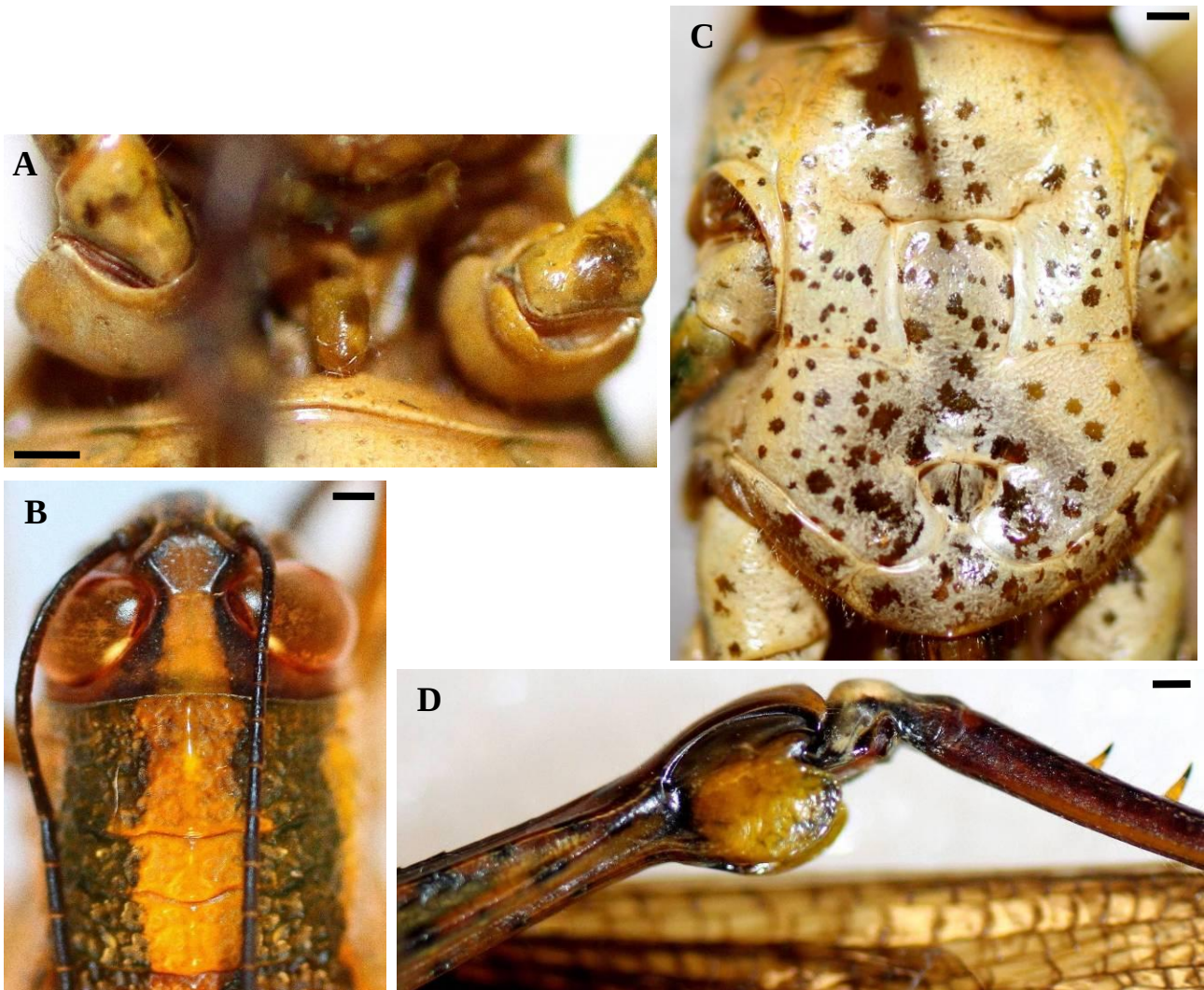


Fig. 41. *Valanga nigricornis*: Prosternal process in ventral view (A); head and pronotum in dorsal view (B); thorax in ventral view (C); hind knees (D). Scale bars = 1 mm.

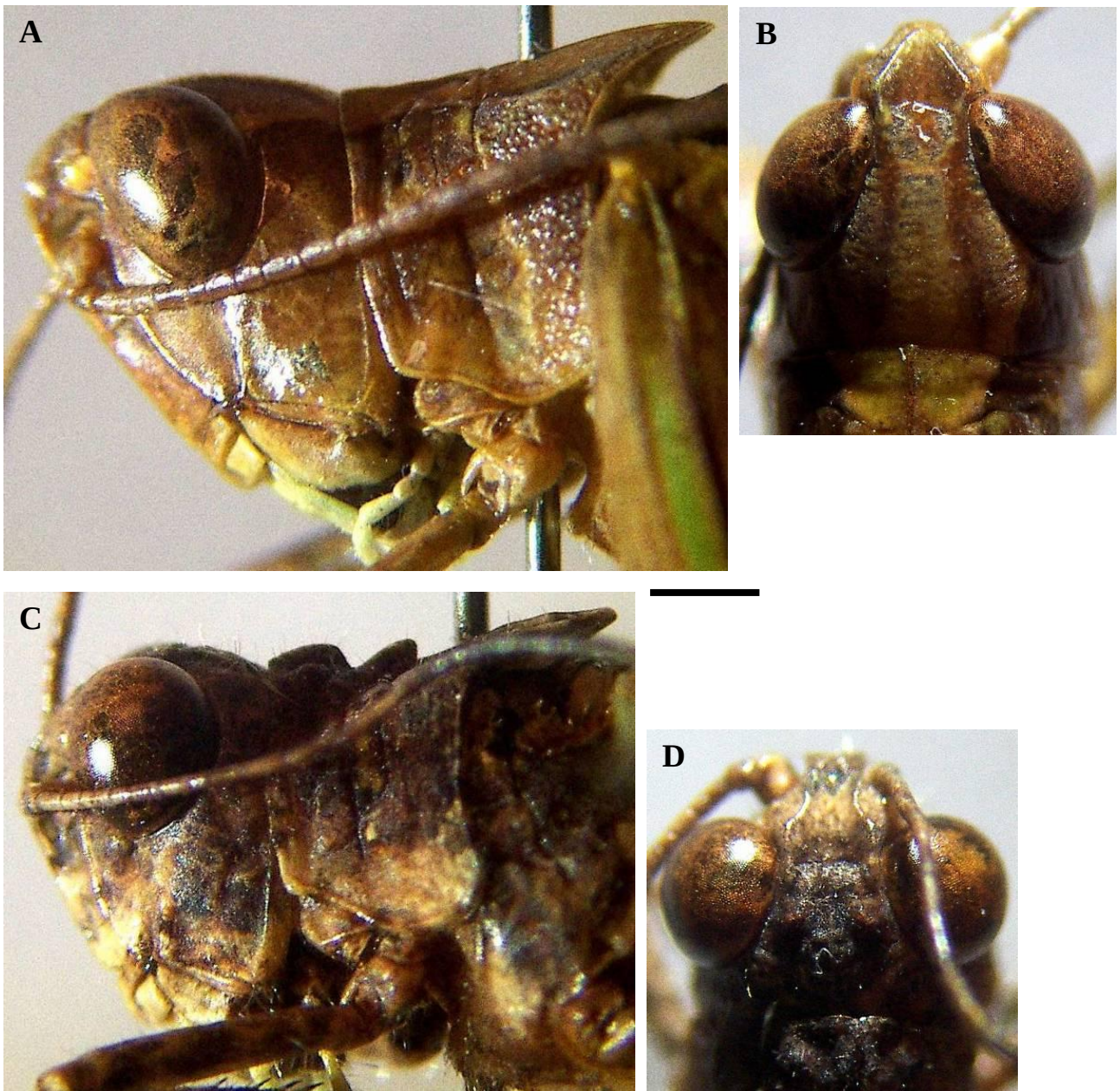


Fig. 42. Subfamily Oedipodinae: Head and/or pronotum of *Aiolopus thalassinus* (A, B) and *Trilophidia annulata* (C, D) in profile view (A, C) and dorsal view (B, D). Scale bar = 1 mm.

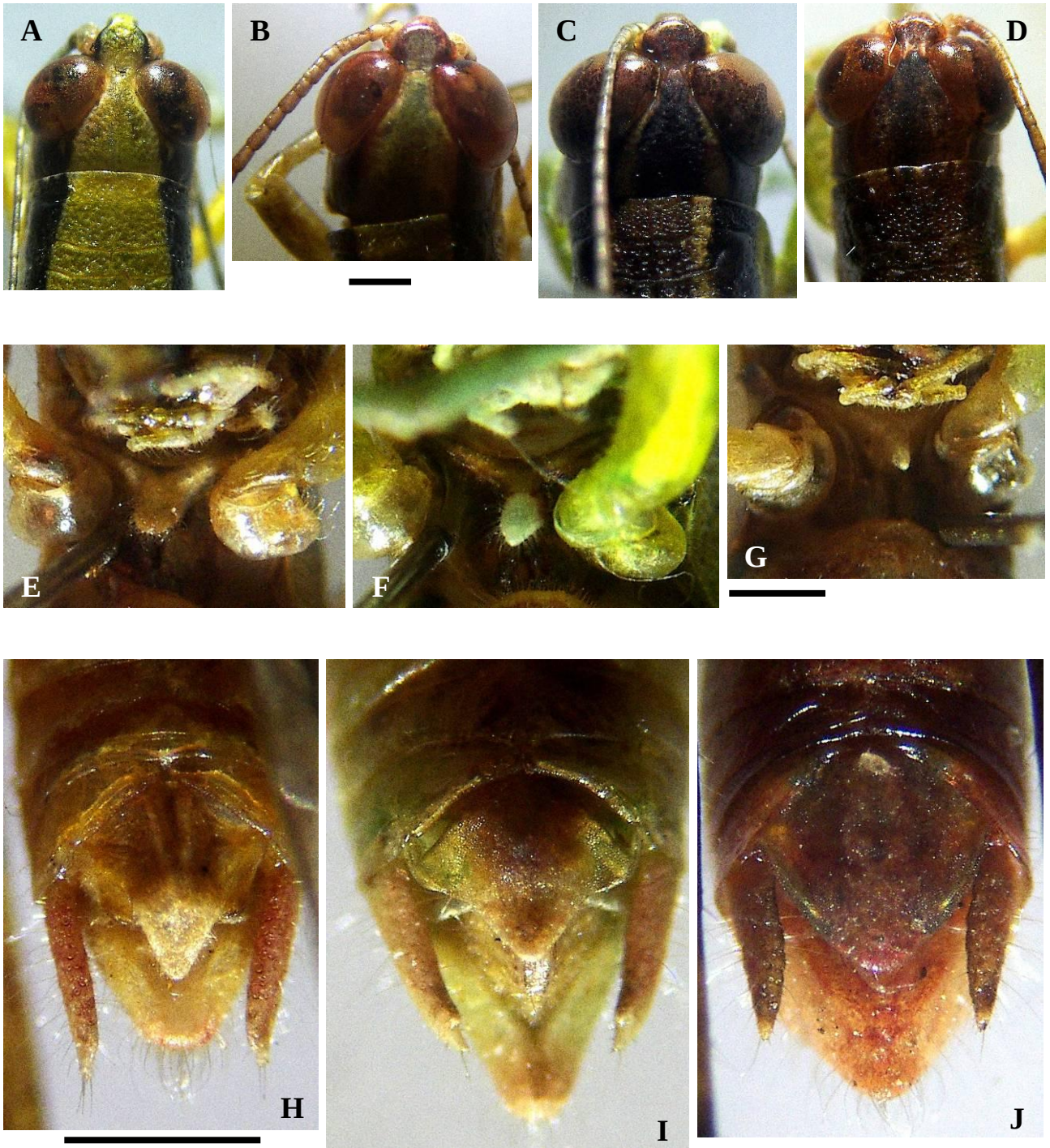


Fig. 43. Subfamily Oxyinae: Head in dorsal view (A–D), prosternal process in ventral view (E–G) and abdominal apex in dorsal view (H–J) of *Gesonula mundata* (A), *Oxya hyla intricata* (B, E, H), *Oxya japonica japonica* (C, F, I), and *Pseudoxya diminuta* (D, G, J). Scale bars = 1 mm.

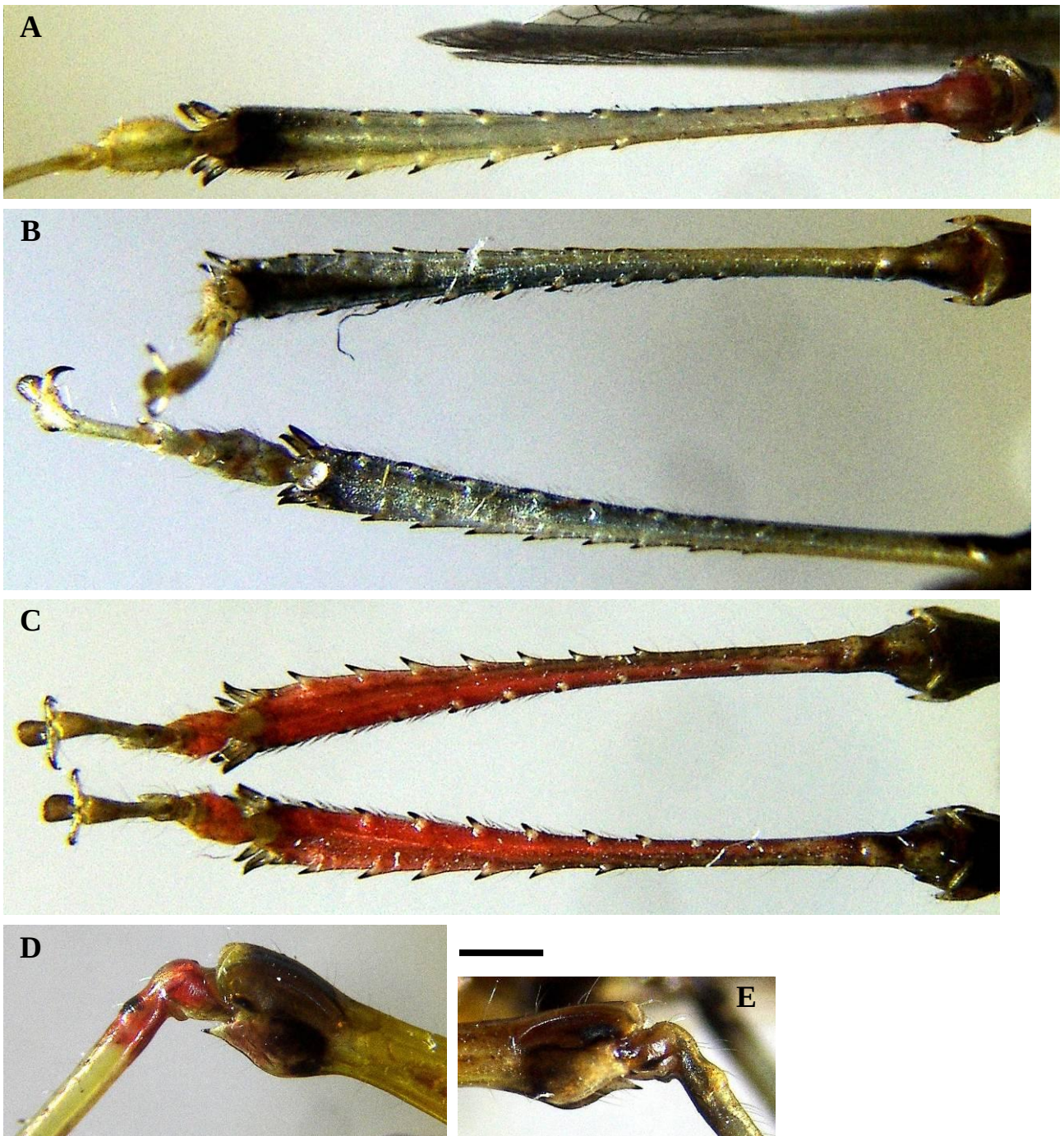


Fig. 44. Subfamily Oxyinae: Hind tibiae in ventral view (A–C) and hind knees in profile view (D, E) of *Gesonula mundata* (A, D), *Oxya hyla intricata* (B, E), and *Pseudoxya diminuta* (C). Scale bar = 1 mm.

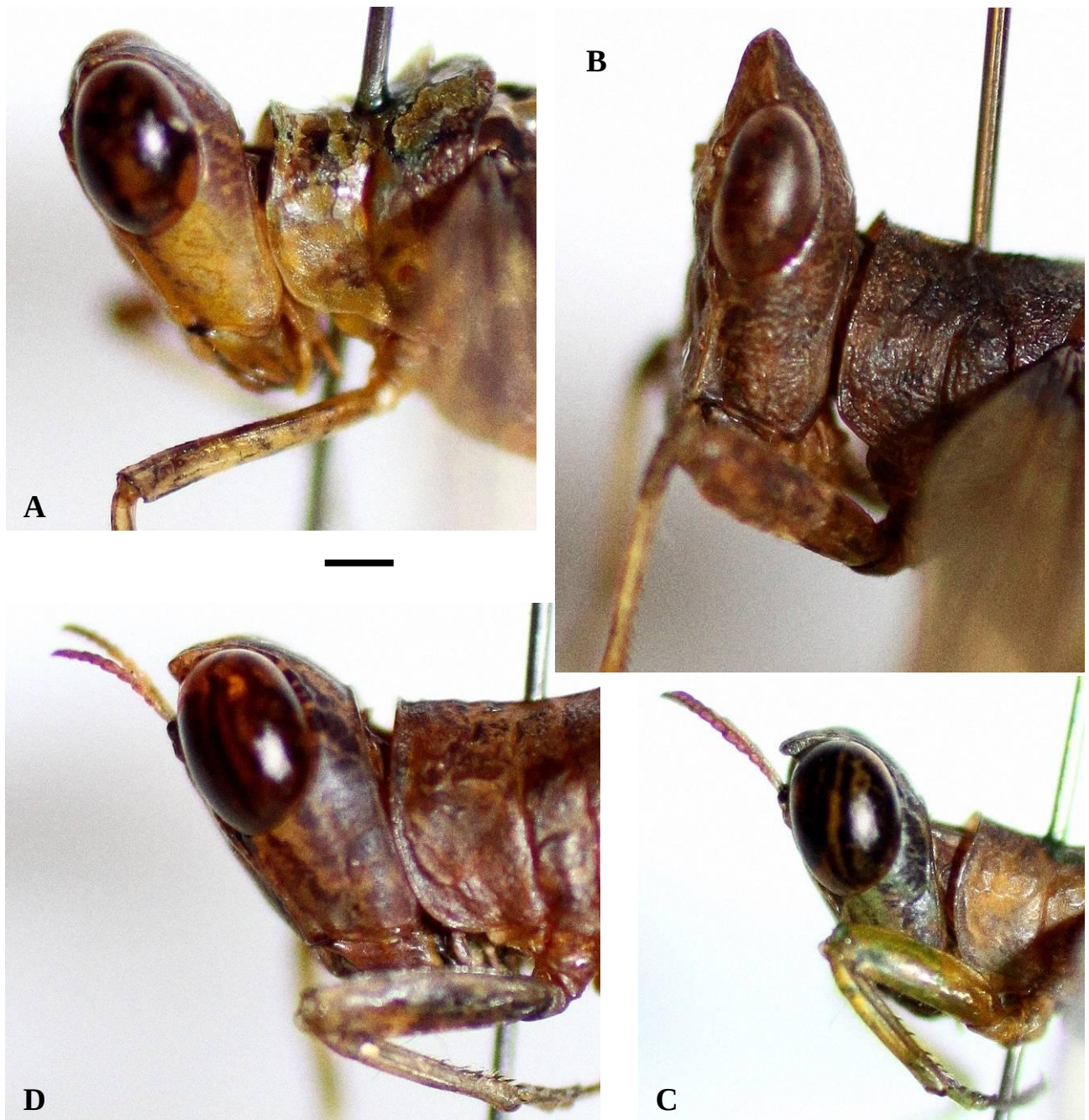


Fig. 45. Family Chorotypidae: Head in profile view of *Erucius* species cf. *apicalis* (A); *Erianthus* species (B); *Mnesicles* species (C); *Mnesicles* species 2 (D). Scale bar = 1 mm.

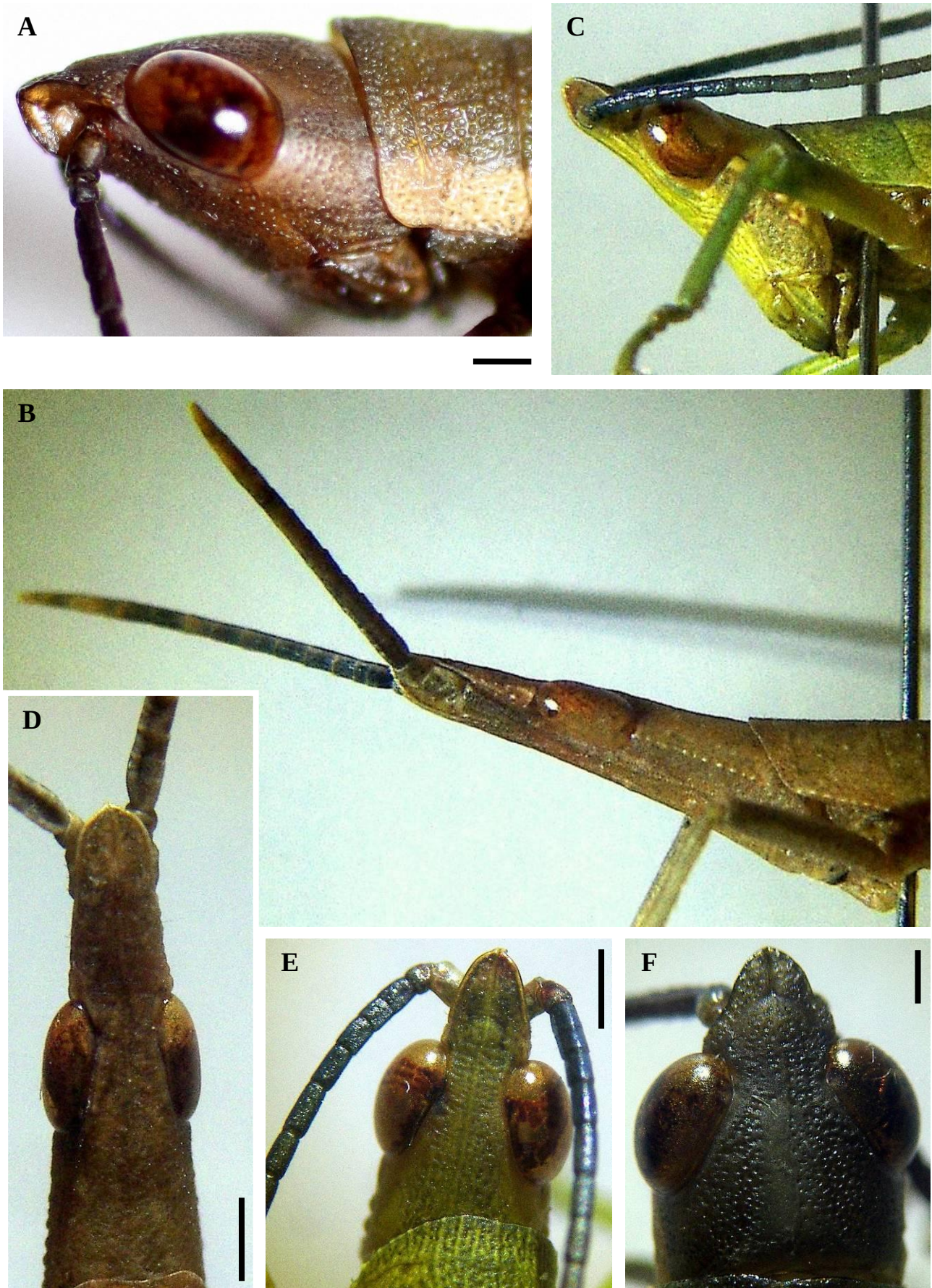


Fig. 46. Family Pyrgomorphidae: Head in profile view (A–C) and dorsal view (D–F) of *Mitricephala milleri* (A, F), *Atractomorpha psittacina* (B, D), and *Tagasta marginella* (C, E). Scale bars = 1 mm.

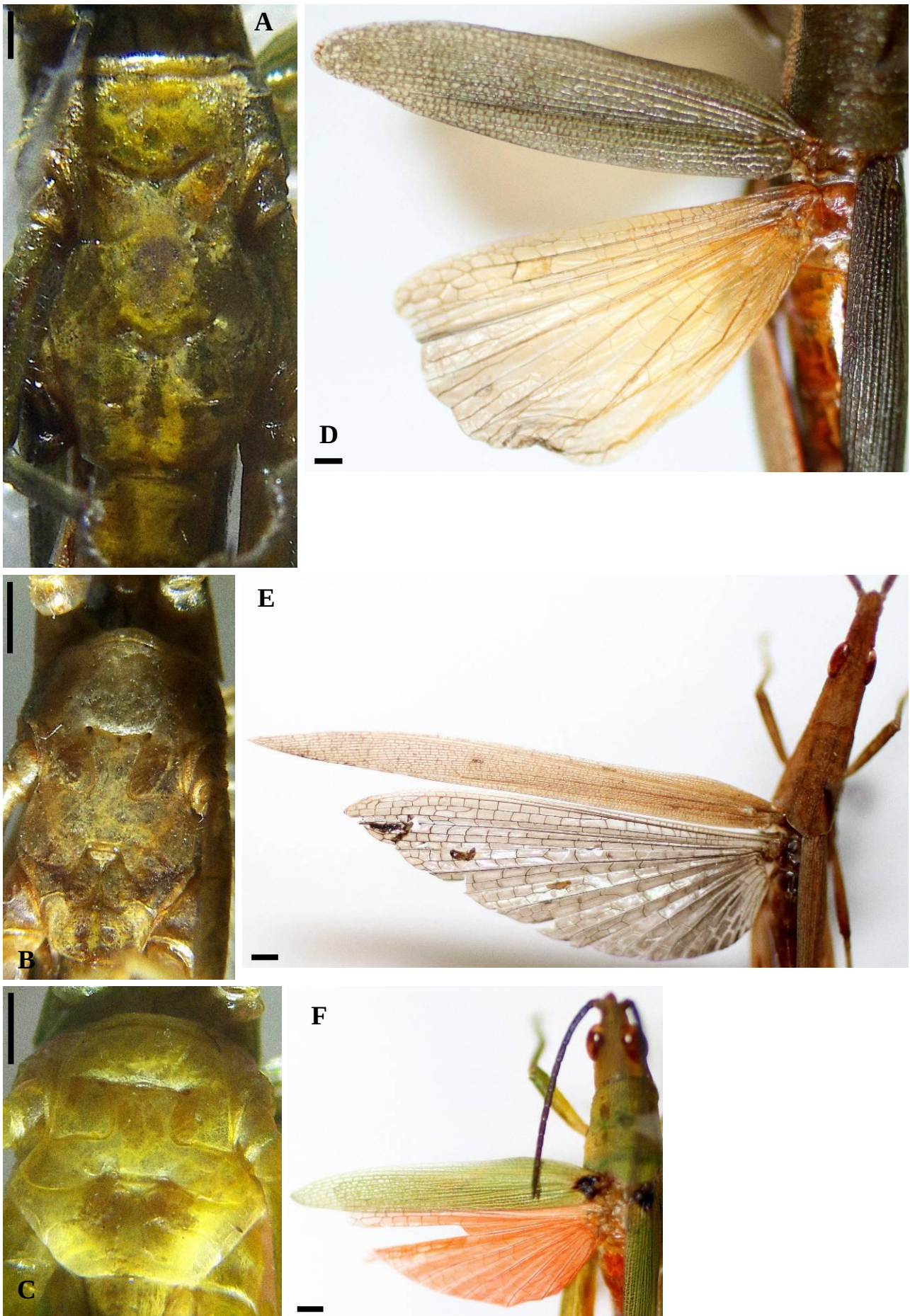


Fig. 47. Family Pyrgomorphidae: Thorax, ventral view (A–C) and wings, dorsal view (D–F), of *Mitricephala milleri* (A, D), *Atractomorpha psittacina* (B, E), and *Tagasta marginella* (C, F). Scale bars = 1 mm.

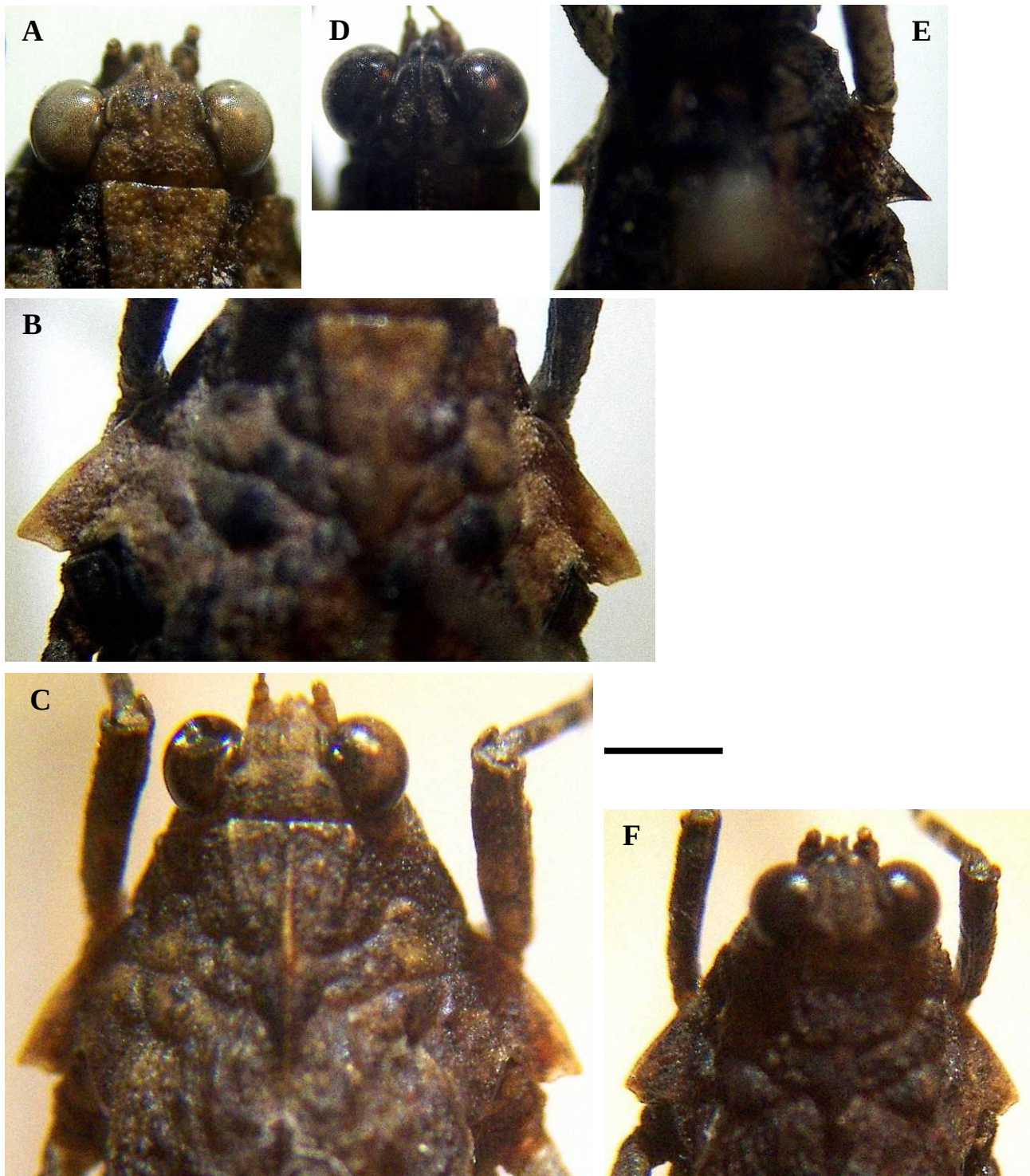


Fig. 48. Subfamily Scelimeninae: Head and/or pronotum in dorsal view (A–F) of *Criotettix robustus* (A–C), *Eucriotettix* species (D, E), and *Loxilobus* species (F). Scale bar = 1 mm.

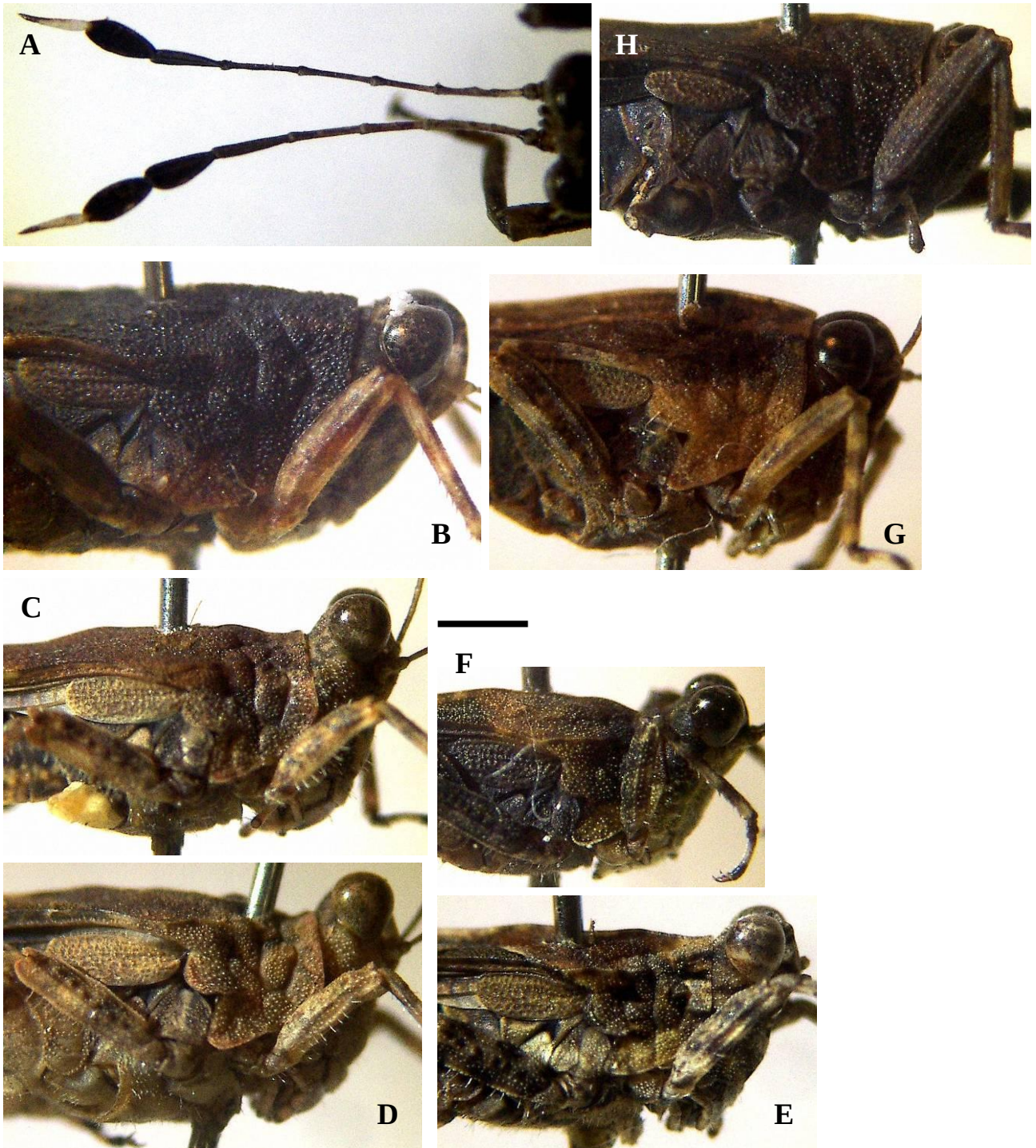


Fig. 49. Subfamily Tetriginae: Antennae in dorsal view (A) and head and pronotum in profile view (B–H) of *Coptotettix* species (B), *Ergatettix dorsiferus* (C, D), *Euparatettix variabilis* (E, F), *Paratettix curtippennis* (G), and *Phaesticus insularis* (A, H). Scale bar = 1 mm.



Fig. 50. *Systella rafflesii*: Antennae and head in dorsal view. Scale bar = 1 mm.

MORPHOLOGICAL KEYS

Morphological Key to the Families of Caelifera of the BTNR and CCNR

In devising this key, references and modifications were made to keys by Willemse (1930), Willemse (2001), and Rentz et al. (2003), whenever appropriate.

1. Pronotum produced backwards, reaching or extending beyond abdominal apex (Figs. 25–34, 49B–H) Family **Tetrigidae**
- Pronotum not produced backwards 2
2. Antennae very short, shorter than fore femora. Tegmina and wings, when folded, separated from the dorsal of abdomen (Figs. 18–21) Family **Chorotypidae**
- Antennae longer than fore femora. Tegmina and wings, when folded, covering at least part of the dorsal of abdomen 3
3. Head, in profile, generally vertical, or slightly oblique (except *Phlaeoba* species—Fig. 36A). Fastigium and vertex without medial groove dorsally (Figs. 36B, 38, 41B, 42B, 42D, 43A–D) Family **Acrididae**
- Head, in profile, generally coned headed (except *Mitricephala* species—see Fig. 46A). Fastigium and vertex with medial groove dorsally (Figs. 46D–F, 50) 4
4. Antennae distinctly dilated basally and narrowed near the middle (Fig. 50). Tegmina very broad and large, much wider than width of body (Fig. 35) Family **Trigonopterygidae**
- Antennae regularly flattened (Figs. 46B, 46C). Tegmina not broad, nearly as wide as width of body Family **Pyrgomorphidae**

Artificial Morphological Key to the Subfamilies, Genera, and Species of Acrididae of the BTNR and CCNR

This key is only useful in differentiating species collected from BTNR and CCNR. In devising this key, references, and modifications were made to keys by Willemse (1930), Hollis (1968, 1971), Willemse (2001), and Mahmood et al. (2007b), whenever appropriate. It should be noted that the key focuses on morphological features, although genitalia character states remain the most reliable species-diagnostic features of many Orthoptera species.

1. Prosternal process present (Figs. 39E–I, 41A, 43E–G) 2
- Prosternal process absent 4

2. Lower external lobe of hind knees with apex acute or spine-like (Fig. 44D, E). Hind tibiae, in ventral view, with apical half laminately expanded (Fig. 44A–C)Subfamily **Oxyinae (5)**
 - Lower external lobe of hind knees with apex obtuse (Figs. 40F, H–K, 41D) (except *Lucretilis* species—Fig. 40G). Hind tibiae, in ventral view, rounded..... 3
3. Mesosternal lobes rectangular, with inner margins straight or substraight (Fig. 41C)
 -Subfamily **Cyrtacanthacridinae**
 - Mesosternal lobes not rectangular, with inner margins curved or angulated (Fig. 39A–D)
 -Subfamily **Catantopinae (8)**
4. Head, in profile, oblique; fastigium verticis and frontis meet at an acute angle (Fig. 36A). Antennae slightly dilated, more distinct at the base (Fig. 36A)Subfamily **Acridinae**
 - Head, in profile, vertical; fastigium verticis and frontis meet at an obtuse angle (Fig. 42A, C). Antennae not dilated (Fig. 42A)Subfamily **Oedipodinae (14)**
5. Tegmina short, not reaching abdominal apex (Fig. 17). Male external genitalia as shown in Fig. 43J. Hind tibiae bright red (Fig. 44C) ***Pseudoxya diminuta***
 - Tegmina long, surpassing abdominal apex and hind knees (Figs. 14–16). Male external genitalia not as above. Hind tibiae not red (Fig. 44A, B) 6
6. Fastigium as shown in Fig. 43A. Hind tibiae red near hind knees; with 8 inner subapical spines (Fig. 44A) ***Gesonula mundata***
 - Fastigium not as above. Hind tibiae mostly blue, dark near hind knees; with 9–10 inner subapical spines (Fig. 44B) ***Oxya* species (7)**
7. Dorsum of head and pronotum pale green, sometimes yellow green. Prosternal process as shown in Fig. 43E. Male external genitalia as shown in Fig. 43H. Hind femora yellow brown; hind knees yellow brown (Fig. 44E) ***Oxya hyla intricata***
 - Dorsum of head and pronotum red brown. Prosternal process as shown in Fig. 43F. Male external genitalia as shown in Fig. 43I. Hind femora yellow green, hind knees dark blue
 - ***Oxya japonica japonica***
8. Face as shown in Fig. 37D. Fastigium as shown in Fig. 38D. Prosternal process as shown in Fig. 39G. Male abdominal apex distinctly swollen (Fig. 40E) ***Pareuthymia* species**
 - Face, fastigium and prosternal process not as above. Male abdominal apex not swollen 9
9. Tegmina short, not reaching abdominal apex. Hind tibiae dark blue 10
 - Tegmina long, surpassing abdominal apex. Hind tibiae not dark blue 11
10. Antennae unicolourous, without white tip. Face as shown in Fig. 37B. Fastigium as shown in Fig. 38B. Prosternal process as shown in Fig. 39F. Lower external lobe of hind knees with apex spine-like (Fig. 40G). Hind femora without ring near knees. Aroliis red ***Lucretilis* species**
 - Antennae with white tip. Face as shown in Fig. 37C. Fastigium as shown in Fig. 38C. Prosternal process not as above. Lower external lobe of hind knees with apex obtuse (Fig. 40H). Hind femora with yellow ring near knees. Aroliis not red ***Meltripata picta***
11. Hind femora with external surface with oblique bands 12
 - Hind femora with external surface without bands 13
12. Antennae with white tip. Face as shown in Fig. 37A. Fastigium as shown in Fig. 38A. Prosternal process as shown in Fig. 39E. Lateral lobes of pronotum with large yellow spot along hind margin, less distinct in females (Fig. 40A). Hind knee as shown in Fig. 40F. Hind femora pale yellow with two black oblique bands ***Apalacris varicornis***
 - Antennae without white tip. Face as shown in Fig. 37G. Fastigium as shown in Fig. 38G. Prosternal process as shown in Fig. 39I. Lateral lobes of pronotum without yellow spot. Hind knee as shown in Fig. 40K. Hind femora pale yellow with two brown oblique bands
 - ***Xenocatantops humilis***
13. Brown in general. Antennae unicolourous, without white tip. Face as shown in Fig. 37E. Fastigium as shown in Fig. 38E. Prosternal process as shown in Fig. 39H. Pronotum not velvety. Hind wings hyalinous yellow (Fig. 40C). Hind knee as shown in Fig. 40I. Hind tibiae mostly red ***Stenocatantops splendens***

- Black with yellow patterns. Antennae with white tip. Face as shown in Fig. 37F. Fastigium as shown in Fig. 38F. Prosternal process not as above. Pronotum velvety black at the metazona and anterior of prozona (Fig. 40B). Hind wings blue, apex infumated black (Fig. 40D). Hind knee as shown in Fig. 40J. Hind tibia black, with yellow ring near knees and red ring near tarsi *Traulia azureipennis*
- 14. Brown and green variants present. Fastigium as shown in Fig. 42B. Pronotum with median keel not incised, without sulcus (Fig. 42A). Hind tibiae pale blue, white near knees and red near tarsi *Aiolopus thalassinus*
- Brown only. Fastigium as shown in Fig. 42D. Pronotum with median keel incised to form two sulci (Fig. 42C). Hind tibiae black with white rings *Trilophidia annulata*

Artificial Morphological Key to the Genera of Chorotypidae of the BTNR and CCNR

This key is only useful in differentiating species collected from the BTNR and CCNR. In devising this key, references and modifications were made to keys by Willemse (1930), whenever appropriate. It should be noted that the key focuses on morphological features although genitalia character states remain the most reliable species-diagnostic features of many Orthoptera (Ingrisch & Willemse, 1988).

1. Fastigium verticis and frontis meet to form a rounded angle (Fig. 45A)..... *Erucius* species
- Fastigium verticis and frontis meet to form an acute angle (Fig. 45B–D)..... 2
2. Fastigium and vertex strongly erected vertically, beyond the eyes (Fig. 45B). Tegmina with apex obliquely truncated (Fig. 18)..... *Erianthus* species
- Fastigium and vertex projecting horizontally, slightly beyond the eyes (Fig. 45C,D). Tegmina with apex rounded (Figs. 20, 21)..... *Mnesicles* species

Artificial Morphological Key to the Species of Pyrgomorphidae of the BTNR and CCNR

This key is only useful in differentiating species collected from the BTNR and CCNR. In devising this key, references and modifications were made to keys by Willemse (1930), whenever appropriate. It should be noted that the key focuses on morphological features although genitalia character states remain the most reliable species-diagnostic features of many Orthoptera.

1. Head, in profile, slightly oblique (Fig. 46A). Metasternal foveolae large and contiguous; metasternal lobes separated by a small interspace (Fig. 47A). Subfamily Orthacridinae..... *Mitricephala milleri*
- Head, in profile, distinctly oblique (Figs. 46B,C). Metasternal foveolae small and broadly separated; metasternal lobes separated by a transverse interspace (Fig. 47B,C). Subfamily Pyrgomorphinae 2
2. Green and brown variant present. Tegmina long, greatly surpassing abdominal apex and hind knees; apex of tegmina very acute; hind wings mostly hyalinous (Figs. 23, 47E). Hind tibiae green or brown, homogenous to colour variant..... *Atractomorpha psittacina*
- Always yellowish green. Tegmina shorter, barely reaching abdominal apex and hind knees; apex of tegmina less acute; hind wings mostly infumate, orange red (Figs. 24, 47F). Hind tibiae blue... *Tagasta marginella*

Artificial Morphological Key to the Subfamilies and Genera of Tetrigidae of the BTNR and CCNR

Until a revision of the family is completed, this key is tentative, and only useful in differentiating species collected from the BTNR and CCNR. In devising this key, references and modifications were made to keys by Willemse (1930) and Mahmood et al. (2007a), whenever appropriate. It should be noted that the key focuses on morphological features although genitalia character states remain the most reliable species-diagnostic features of many Orthoptera.

1. Habitus stout and rounded (Fig. 25).....*Potua* species
 – Habitus more elongated..... **2**
2. Lateral lobes of pronotum with posterior angles produced outwards, often acute or spine-like (Fig. 48B,C,E,F)..... Subfamily **Scelimeninae (3)**
 – Lateral lobes of pronotum with posterior angles turned down, rounded, truncated or obtuse, not acute or spine-like (Figs. 49B–H) Subfamily **Tetriginae (5)**
3. Vertex wider than or as wide as eye (Fig. 48A,C,F). Pronotum produced backward, barely surpassing abdominal apex..... **4**
 – Vertex narrower than eye (Fig. 48D). Pronotum produced backward, significantly surpassing abdominal apex (about twice as long as body) (Fig. 27) *Eucriotettix* species
4. Larger in size. Length of pronotum 11.6 mm (n = 1 male) and 14.4–14.7 mm (n = 3 females)
 *Criotettix* species
 – Smaller in size. Length of pronotum 8.1 mm (n = 1 male) and 8.3 mm (n = 1 female)
 *Loxilobus* species
5. Antennae with apical segments foliaceous, compressed and dilated (Fig. 49A)
 *Phaesticus* species
 – Antennae filliform **6**
6. Pronotum produced backward, distinctly surpassing abdominal apex and hind knees (Figs. 30–32)..... *Euparatettix* or *Ergatettix* species
 – Pronotum produced backward, not or barely reaching abdominal apex and hind knees (Figs. 29, 33)..... *Coptotettix* or *Paratettix* species

DISCUSSION AND CONCLUSIONS

In an attempt to revise the diversity of Orthoptera from the BTNR and CCNR, both suborders Caelifera and Ensifera were collected and examined during the 12-month survey. Only Caelifera species are represented here. Material belonging to the suborder Ensifera is currently being examined and evaluated, and these include numerous undescribed species. A second volume on suborder Ensifera is to be expected.

It should be noted that this is a preliminary inventory of Caelifera in the BTNR and CCNR, and is subjected to further updates, which may include changes in figures, nomenclature, and classification schemes. The orthopteran survey will be extending to its second year, and when completed, is expected to uncover more species of Caelifera.

In addition, this publication also outlines the need for the revision of the Tetrigidae of Singapore and the region. The taxonomy of Tetrigidae, as represented by genera *Coptotettix* (Tetrigidae: Tetriginae) and *Loxilobus* (Tetrigidae: Scelimeninae) from the BTNR and CCNR, is hitherto problematic owing to the lack of reliable diagnostic characters and narrow species distributions (Blackith & Blackith, 1987). This has resulted in great disparities in their identification, and a huge amount of synonymy in their nomenclature (Blackith & Blackith, 1987). This also signifies that work on the taxonomy of Orthoptera is far from complete.

While this inventory is only a provisional representation of the Orthoptera diversity in the BTNR and CCNR, such baseline information provides an insight to the biodiversity of the forested nature reserves of Singapore. The author hopes that this book will promote greater awareness and appreciation of Singapore orthopterans, thus encouraging further research into the largely ignored Orthoptera of Singapore.

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LITERATURE CITED

- Blackith R. E. & R. M. Blackith, 1987. Tridactylids and tetrigids (Orthoptera) from Sulawesi, Indonesia. *Overgedrukt uit het Tijdschrift voor Entomologie*, **130**: 1–10.
- Bolívar, I., 1887. Essai sur les Acridiens de la tribu des Tettigidae. *Annales de la Société Entomologique de Belgique*, **31**: 175–313.
- Chan, K. L., 1991. The Dennis H. Murphy valedictory issue. *The Raffles Bulletin of Zoology*, **39**: iii–viii.
- Eades, D. C., D. Otte, M. M. Cigliano & H. Braun, 2012. *Orthoptera Species File Online*. Version 2.0/4.0. <http://Orthoptera.SpeciesFile.org>. (Accessed 15 Dec. 2011).
- Günther, K., 1937. Acrydiinae (Orthopt. Acrididae) von Java, den Kleinen Sunda-Inseln und Nordostaustralien. *Revue Suisse de Zoologie*, **44**: 121–142.
- Günther, K., 1941. Revision der Acrydiinausbeute H. Sauters von Formosa (Orthoptera). *Stettiner Entomologische Zeitung*, **102**: 145–165.
- Hancock, J. L., 1907. Studies of the Tetriginae (Orthoptera) in the Oxford University Museum. *Transactions of the Entomological Society of London*, **1907**: 213–244.
- Hoekstra, J. M., 1998. Conserving Orthoptera in the wild: Lessons from *Trimerotropis infantilis* (Oedipodinae). *Journal of Insect Conservation*, **2**: 179–185.
- Hollis, D., 1968. A revision of the genus *Aiolopus* Fieber (Orthoptera: Acridoidea). *Bulletin of the British Museum (Natural History) Entomology*, **22**: 307–355.
- Hollis, D., 1971. A preliminary revision of the genus *Oxya* Audinet-Serville (Orthoptera: Acridoidea). *Bulletin of the British Museum (Natural History) Entomology*, **26**: 267–343.
- Ingrisch, S. & F. Willemse, 1988. Revision of the genus *Erianthus* in Thailand and Malaysia (Orthoptera: Eumastacoidea: Erianthinae). *Entomologica scandinavica*, **19**: 98–107.
- Kevan, D. K. McE., 1963. A preliminary revision of the genera *Mitricephala* Bolívar, 1898, and *Verdulia* Bolívar, 1905 (Orthoptera: Acridoidea: Pyrgomorphidae). *Pacific Insects*, **5**: 771–795.
- Kevan, D. K. McE., 1966. Some Orthoptera-Caelifera from the Philippines, Bismark, and Solomon Islands, with a few interesting records from New Guinea and the Moluccas. *Entomologische Meddelelser*, **34**: 375–420.

- Mahmood, K., A. B. Idris & Y. Salmah, 2007a. Tetrigidae (Orthoptera: Tetrigoidea) from Malaysia with the description of six new species. *Acta Entomologica Sinica*, **50**: 1272–1284.
- Mahmood, K., D. Samira & A. B. Idris, 2007b. Acrididae (Orthoptera: Acridoidea) of Malaysia with the description of a new species. *Acta Entomologica Sinica*, **50**: 1146–1161.
- Rentz, D. C. F., R. C. Lewis, Y. N. Su & M. S. Upton, 2003. *A Guide to Australian Grasshoppers and Locusts*. Natural History Publications (Borneo), Kota Kinabalu. 420 pp.
- Wei, S., Z. Zheng & W. Deng, 2007. A review of the genus *Criotettix* Bolívar (Orthoptera: Scelimenidae) from China. *Zootaxa*, **1423**: 39–49.
- Willemse, C., 1930. Fauna Sumatrensis (Bijdrage Nr. 62): Preliminary revision of the Acrididae (Orthoptera). *Overgedrukt uit het Tijdschrift voor Entomologie*, **73**: 1–210.
- Willemse, L. P. M., 2001. *Fauna Malesiana: Guide to the Pest Orthoptera of the Indo-Malayan region*. Backhuys Publishers, Leiden. 160 pp.
- Yin, X.-C. & J.-P. Shi, 2007. A new species and a key to know species of the genus *Atractomorpha* (Orthoptera, Acridoidea, Pyrgomorphidae) from China. *Zootaxa*, **1453**: 63–68.
- Yin, X.-C. B.-H. Ye, Z. Yin, 2009. A taxonomic study of the genus *Tagasta* Bolívar from China (Orthoptera: Acridoidea: Chrotogonidae). *Acta Entomologica Sinica*, **52**: 1244–1248.

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