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New data on some crickets of the subfamilies Landrevinae, Phaloriinae and Podoscirtinae (Orthoptera: Grylloidea) from Laguna (Philippines: Luzon Island)

Running title: new Grylloidea from Luzon

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Abstract

Recent orthopteran sampling at Laguna in Luzon Island of the Philippines revealed noteworthy crickets from the subfamilies Landrevinae, Phaloriinae and Podoscirtinae. We describe three species new to science from the subfamily Podoscirtinae: *Mnesibulus laguna* **n. sp.**, *Misthenkoana matcha* **n. sp.** and *Misthenkoana sursa* **n. sp.** We record new locality and complete the genitalia description of *Phaloria* (*Phaloria*) *modulator* (Saussure, 1878), previously described with incomplete parts of genitalia in the holotype. We also differentiate *Duolandrevus* (*Jorama*) *curtipennis* Chopard, 1937 from Laguna which varies slightly from the subspecies from Palawan and Mindoro.

Key words: Gryllidae, new species, Southeast Asia, taxonomy

Introduction

The Philippines remains a hotspot for new species discovery of Orthoptera, as sampling in this archipelago is fragmented spatially and temporally (Tan *et al.*, 2017). In the last four years, as many as 15 new species have been reported from across the phylogeny, ranging from pygmy grasshoppers (e.g., Skejo & Caballero, 2016; Tan *et al.*, 2019a), scaly crickets (e.g., Tan *et al.*, 2019b), raspy cricket (e.g., Ingrisch, 2018), true crickets (e.g., Robillard & Yap, 2015; Gorochoy, 2016; Baroga-Barbecho *et al.*, 2016, 2019; Tan *et al.*, 2019c, 2019d) and three katydids (e.g., Tan *et al.*, 2018). As more materials are assembled and more attention given, more new species can be discovered. Crickets of the subfamilies Landrevinae, Phaloriinae and Podoscirtinae are such examples. These plant-dwelling crickets are speciose in Southeast Asia, and species are generally morphologically very similar. Species are generally identified and delimited using genitalia morphology, typically in the epiphallal processes, ectoparameres and rachis, which exhibits intraspecific stability and distinct interspecific differences (Gorochoy, 2015). However, a small amount of materials is available for many of these species, making it difficult to examine intra-specific variations thoroughly. Recent collections of orthopterans at Laguna in Luzon Island enable us to re-examine the taxonomy of *Duolandrevus* (*Jorama*) *curtipennis* Chopard, 1937 and *Phaloria* (*Phaloria*) *modulator* (Saussure, 1878), as well as to describe new species of Podoscirtini and Aphonoidini from the subfamily Podoscirtinae: *Mnesibulus laguna* **n. sp.**, *Misthenkoana matcha* **n. sp.** and *Misthenkoana sursa* **n. sp.**

Materials and Methods

Orthopteran surveys were done by M. K. Tan, J. B. Baroga-Barbecho and S. A. Yap in Laguna between 2018 and 2019: Mount Makiling (Los Baños) between 10 and 11 April 2018; University of Philippines (UP) Land Grant (Barangay Ilaya Norte, Paete) (Tan *et al.*, 2020: Fig. 1) between 11 and 12 May 2019 and between 6 and 7 September 2019. Opportunistic sampling and sweep-netting were conducted during daytime (0830 to 1500 hours) and/or during night-time (1930 to 2300 hours). Whenever possible, in-situ images were taken using a Canon EOS 500D digital SLR camera with a compact-macro lens EF 100 mm f/2.8 Macro USM and Canon Macro Twin Lite MT-24EX was used for lighting and flash.

The specimens were preserved in absolute analytical grade ethanol and later pinned and dry-preserved. A single hind leg was preserved in absolute analytical grade ethanol for future molecular work. Close-up images of habitus and morphological features were done using a Canon EOS 700D digital SLR camera with a macro photo lens MP-E 65mm f/2.8 USM (1–5×) with Canon Macro Twin Lite MT-24EX used for lighting and flash.

Male genitalia were dissected from softened specimens and were removed by squeezing the cerci against one another laterally. The male genitalia were then cleaned using aqueous KOH and subsequently preserved in glycerine. Photographs of male genitalia were done with a binocular microscope Leica MZ16 with AmScope Microscope Eyepiece Camera (MU1000, 10 MP Aptina Colour, CMO50) attached via an AmScope FMA050 fixed microscope adaptor and the montage software AMScope version ×64, 3.7. Image editing was accomplished using Adobe Photoshop CC2014. Terminology used to describe the male genitalia follows Tan & Kamaruddin (2016), Tan & Wahab (2017) and Tan *et al.* (2019).

Classification and nomenclature of species was based on the OSF (Cigliano *et al.*, 2020). All specimens collected were deposited in the University of the Philippines Los Baños Museum of Natural History (UPLBMNH) and the Zoological Reference Collection (ZRC), Lee Kong Chian Natural History Museum, Singapore.

Abbreviations used for measurements:

BL	body length
PL	pronotum length
PW	pronotum width
TL	tegmen length
HWT	hind wing tail length (part of hind wing surpassing tegmen)
HFL	hind femur length
HTL	hind tibia length
OL	ovipositor length

Abbreviations for museums and collections:

DORSA	German Orthoptera collections database, SysTax
MfN	Museum für Naturkunde, Berlin, Germany
MNHN	Muséum national d'Histoire naturelle, Paris, France
NHMUK	Natural History Museum, London, U.K.
UPLBMNH	University of the Philippines Los Baños Museum of Natural History, Philippines
ZRC	Zoological Reference Collection, Lee Kong Chian Natural History Museum, Singapore

Results

Subfamily Landrevinae

Genus *Duolandrevus* Kirby, 1906

Gorochov, 1996: 35; Gorochov, 2016: 25

Remarks. So far, 86 species from eight subgenera are known (Cigliano *et al.*, 2020). Gorochov (2016) provides a key to subgenera.

Subgenus *Jorama* Otte, 1988

Otte, 1988: 316; Gorochov, 1996: 40; Ma *et al.*, 2015: 445; Gorochov, 2016: 26

Remarks. This subgenus is characterised by the head moderately depressed dorsoventrally; male anal plate with widely rounded or widely truncate apex and without strong setae directed upwards at apex or on dorsum along median part of its posterior edge; the male genitalia with posterolateral epiphallic lobes not widened and having numerous small denticles or tubercles (Gorochov, 2016). Eight species are known from the Philippines, New Guinea, Taiwan and Lesser Sunda Islands (Cigliano *et al.*, 2020). These species are typically differentiated by the shape of male metanotal gland and male genitalia (particularly the shape of posterolateral epiphallic lobes and ectoparameres). Three species are known in the Philippines (Cigliano *et al.*, 2020): *Duolandrevus (Jorama) curtipennis* Chopard, 1937 of Palawan and Mindoro; *Duolandrevus (Jorama) isagorensis* (Otte, 1988) of Camarines Sur; and *Duolandrevus (Jorama) palawanensis* (Otte, 1988) of Palawan.

***Duolandrevus (Jorama) curtipennis* Chopard, 1937**

(Fig. 1)

Chopard (1937): 139; Otte (1988): 317; Gorochov (1996): 40; Gorochov (2016): 69

Material examined. 1 male (UPLG.19.52): **Philippines**, Luzon Island, Laguna, Paete, Barangay Ilaya Norte, UP Land Grant, N14.40035, E121.54249, 317.8±5.8 m, 1936 hours, hiding underneath tree trunk, 6 September 2019, coll. M. K. Tan, J. B. Baroga-Barbecho, C. C. Lucañas and S. A. Yap, pinned and genitalia dissected; 1 male, same locality, 6–7 September 2019, coll. J. B. Baroga-Barbecho & C. C. Lucañas, pinned and genitalia dissected (all UPLBMNH and ZRC).

Distribution. Palawan Island, Mindoro Island, Luzon Island

Comparisons with subspecies *curtipennis* Chopard, 1937 and *mindoro* Gorochov, 2016. The male genitalia differs predominantly by the shape of posterolateral epiphallic lobes (p.ep): dorso-external process (de.l) of the posterolateral epiphallic lobe not pointing as dorsad as in *D. c. curtipennis* (sensu Gorochov, 1996: 40) and *D. c. mindoro* (sensu Gorochov 2016: 69); inner process (i.p) not as long as in *D. c. mindoro* but not as smoothly curved as in *D. c. curtipennis*. Other important characters such as shape of ectoparameres and posteromedial lobule of epiphallus very similar among the different populations.

The metanotal glands of the specimens from Luzon are also different from that of *D. c. mindoro* (sensu Gorochov 2016: 69). We could not examine the metanotal gland of *D. c. curtipennis* because we could not access the type specimen and that it was not previously described.

Discussion. The slight differences in the genitalia and metanotal gland suggest that the populations from Palawan, Mindoro and Luzon islands can represent either unique species (or subspecies) or a single but variable species. However, we refrain from describing the population from Luzon as another species or subspecies until we have clearer understanding of their species delimitation through acoustic recording and DNA analysis, whenever possible in the future.

Subfamily Phaloriinae

Genus *Phaloria* Stål, 1877

Gorochov, 1996: 60

Remarks. 68 species from four subgenera are currently known (Cigliano *et al.*, 2020).

Subgenus *Phaloria* Stål, 1877

Otte & Alexander, 1983: 372; Gorochov, 1985: 19; Yin & Liu, 1995: 212; Gorochov, 1996: 60; Desutter-Grandcolas, 2009: 629

Remarks. 18 species are currently known (Cigliano *et al.*, 2020). Two species are known in the Philippines: *Phaloria (Phaloria) amplipennis* Stål, 1877, *Phaloria (Phaloria) modulator* (Saussure, 1878) (Cigliano *et al.*, 2020).

***Phaloria (Phaloria) modulator* (Saussure, 1878)**

(Fig. 2)

Saussure (1878): 537 [685]; Bolívar (1889): 426; Casto de Elera (1895): 219; Kirby (1906): 91; Bruner (1915): 263; Chopard (1968): 360; Gorochov (1996): 60

Type material examined (images). Male holotype (DORSA-BG00002S01), **Philippines**, Luzon Island, Manila, coll. Meyen (MfN).

Material examined. 2 males (UPLG.19.45, 57): **Philippines**, Luzon Island, Laguna, Paete, Barangay Ilaya Norte, UP Land Grant, N14.40167, E121.54278, 303.5±4.1 m, 1649 hours, N14.39870, E121.54249, 349.0±5.3 m, 2030 hours, 6 September 2019, on foliage, coll. M. K. Tan, J. B. Baroga-Barbecho, C. C. Lucañas and S. A. Yap, pinned and genitalia dissected (all UPLBMNH and ZRC)

Distribution. This species was described from the Philippines and is currently known only in Luzon Island. The holotype collected from Manila is apparently missing (Hollier *et al.*, 2013). This species was also known from Nueva Cáceres (now part of Naga) (Bruner, 1915). Our material represents the first record of this species in Laguna—albeit not surprising—between Manila in the north of Laguna and Naga in the south of Luzon Island.

Genitalia description (Figs. 2C–E). The genitalia of the male holotype is partly missing, with only the epiphallus (including the bridge, posterolateral epiphallic lobes, posteromedial epiphallic lobule) and ectoparameres present; while rami, rachis (= guiding rod), endoparameres are missing (Gorochov, 1996; Cigliano *et al.*, 2020). The males from Laguna have very similar epiphallic morphology, which are distinct from other congeners: epiphallus (ep) with posterior margin broadly concave posterolateral epiphallic lobes (p.ep) slender, flattened and bent at 90° internally at the apex with apex subacute; posteromedial epiphallic lobule (m.ep) stout with obtuse apices; ectoparameres strongly sclerotized and stoutly triangular, each with a basal dorsal lobe with subacute apex, taper apically into an acute apex that slightly surpassing posterolateral epiphallic lobes. Here we describe the missing parts of the genitalia: endoparamere (en) forked posteriorly, anterior end straight but not surpassing rami; rami (r) slender, gently curved, anterior end acute; rachis (ra) straight, relatively narrow, anterior end somewhat arrowed-shaped, posterior end truncated and slightly surpassing posteromedial lobule of epiphallus.

Subfamily Podoscirtinae

Genus *Mnesibulus* Stål, 1877

Remarks. 20 species from two subgenera are currently known. Subgenus *Amnesibulus* Gorochov, 2003 consists of two species from Sulawesi and differs from subgenus *Mnesibulus* Stål, 1877 by male tegmina with strongly reduced stridulatory apparatus (Gorochov, 2003).

Subgenus *Mnesibulus* Stål, 1877

Remarks. 20 species from China mainland, India subcontinent, Taiwan, Malay Peninsula, Borneo, the Philippines, Sumatra, Java, Sulawesi, Maluku and Lesser Sunda Islands (Cigliano *et al.*, 2020). *Mnesibulus* (*Mnesibulus*) *lineolatus* Stål, 1877, *Mnesibulus* (*Mnesibulus*) *luzoni* Gorochoff, 2003, *Mnesibulus* (*Mnesibulus*) *pallidulus* Bolívar, 1889, *Mnesibulus* (*Mnesibulus*) *splendidulus* Stål, 1877 and *Mnesibulus* (*Mnesibulus*) *strigatipes* Bolívar, 1913 are known to occur in the Philippines (Cigliano *et al.*, 2020). Here, we describe another species from the Philippines.

Mnesibulus laguna new species

(Figs. 3–5)

Material examined. Male holotype (UPLG.19.41), **Philippines**, Luzon Island, Laguna, Paete, Barangay Ilaya, UP Land Grant, N14.39826, E121.55703, 401.1±6.5 m.a.s.l., 1417 hours, 6 September 2019, under foliage, coll. M. K. Tan, J. B. Baroga-Barbecho, C. C. Lucañas and S. A. Yap, pinned and genitalia dissected (UPLBMNH).

Female allotype (UPLG.19.64), same locality as holotype, N14.39612, E121.54702, 437.5±5.6 m.a.s.l., 1105 hours, 7 September 2019, on foliage, coll. M. K. Tan, J. B. Baroga-Barbecho, C. C. Lucañas and S. A. Yap, pinned (ZRC).

Diagnosis. This new species differs from all known congeners by the combination of these characters: abdominal gland with posterior margin of fifth segment rectangularly, emarginated in middle, tubercle on sixth segment with anterior apex triangular and apex; anal plate deeply and narrowly excised in middle, lateral of excision with dense strong setae pointing posteriorly, with a dorsal oval plate slightly surpassing lateral lobes, with posterior margin somewhat truncated; apical epiphallallic process large, extending beyond lateral margin of epiphallus, curved anteriorly at apex into a hook-like acute apex; mold of the spermatophore attachment plate with anterior end broadly rounded with two pyriform lateral lobes joined together by a narrow ‘bridge’ in the middle; apical process of rachis produced well beyond apex of epiphallus, enlarged at apex and unique shape.

Comparison with congeners. The male genitalia is most similar to *M. pallidulus* Bolívar, 1889 from Sibul in Luzon Island (unclear whether it is referring to Sibul in Bataan or Bulacan) but differs by: apical epiphallallic process longer and extending beyond lateral margins of epiphallus and with apex of process more strongly curved; mold of the spermatophore attachment plate transversely oval with anterior end broadly rounded (instead of lobular in the middle). It also differs by male ninth abdominal tergite much more elongated than supra-anal plate (shorter in *M. pallidulus*) and with a distinct longitudinal fissure in middle (absent in *M. pallidulus*); and by male metanotal gland.

The new species is also similar to *M. bicolor* (Haan, 1844) from Java, *M. luzoni* Gorochoff, 2003 from Batangas in Luzon Island but differs by epiphallus distinctly slenderer, apical epiphallallic process (term sensu Gorochoff, 2003) larger and more strongly curved with apex acute and hooked (not strongly curved and without hooked apex in *M. bicolor* and shorter and faintly curved in *M. luzoni*); apical part of guiding rod (= rachis) with widened apex more longitudinally oblong and well surpassing posterior apex of epiphallus (transversely oblong in *M. bicolor* and rounded in *M. luzoni*); ectoparameres longer, also surpassing posterior end of epiphallus and more strongly curved at apex than *M. bicolor* and *M. luzoni*, and slenderer at apex than *M. luzoni*.

The mirror area of tegmen also differs with that of *M. bicolor* and *M. luzoni*: anterior half (with straight veins) as long as posterior half, unlike *M. bicolor* (anterior half shorter); transverse veins more similar to that of *M. bicolor*.

The new species also differs from other species from the Philippines: *M. lineolatus* Stål, 1877 (*M. simodus* Saussure, 1878) and *M. splendidulus* Stål, 1877 by clearly more uniform colouration of pronotum and legs; and *M. strigatipes* Bolívar, 1913 from Mindanao by colouration of head and structure of the male genitalia.

Description. Male. Body small for genus, very similarly sized as *M. pallidulus*, dorsoventrally compressed (Figs. 3A, 3B). Head slightly raised in posterior half behind eyes, flattened between eyes. Head rostrum 1.6 times as wide as scapus, 0.9 times as wide as eyes, with apex truncated (in dorsal

view) (Figs. 3A, 3C). Scapus elongated. Eyes distinctly vertically oblong, barely projected laterally (Fig. 3B); median and lateral ocelli very oblong, positioned behind antennal scapus; median ocellus distinctly wider than long and located very slightly before lateral ocelli; lateral ocellus more bean-shaped, located between scapus and anterior margin of eye (Fig. 3C). Maxillary palpi fairly stout, with apical (fifth) segment elongated, slightly more swollen, obliquely triangular (but its apex truncated) but shorter than third and subapical (fourth) segments (Fig. 3D). Posterior of eye above gena finely pubescent. Pronotal disc 0.6 times as long as wide, trapezoidal (Fig. 3A). Pronotal lateral lobe 1.2 times as long as tall, finely pubescent and margin with longer and thicker setae (Fig. 3D). Fore tibia with large and swollen conchate inner tympanum and large oval and open outer tympanum (Fig. 3E); fore and middle legs generally finely pubescent, with a few stout setae located usually along ventral margin; without subapical spines on ventral margins.

Male. Tegmen extending beyond abdominal apex; dorsal field barely longer than lateral field; mirror large, 2.2 times as long than wide, diamond-shaped with anterior and posterior parts narrowly angular, separated by a transverse vein in middle (Fig. 3A); with five harp veins (Fig. 3A); Sc with seven branches (Fig. 3B). Hind wings surpassing tegmen. Abdominal gland with posterior margin of fifth segment rectangularly, emarginated in middle, tubercle on sixth segment with anterior apex triangular and apex (Figs. 4A, 4B). Anal plate strongly and narrowly excised in middle, lateral of excision with dense strong setae pointing posteriorly; with a dorsal oval plate slightly surpassing lateral lobes, with posterior margin somewhat truncated (Fig. 4C). Male genitalia as shown in Figs. 4D–4F: epiphallus (ep) elongated, tapering slightly posteriorly, at posterior end excised deeply and broadly with two strongly sclerotized apical epiphallic processes (ep.p) produced at base of excision, pointing externally; apical epiphallic process large, extending beyond lateral margin of epiphallus, curved anteriorly at apex into a hook-like acute apex. Ectoparameres (ecp) producing slightly beyond apex of epiphallus, slender, slightly curved with apex subacute. Rachis (= guiding rod) with apical process (p.ra) produced well beyond apex of epiphallus, enlarged at apex, with a dorsal lobe bent anteriorly. Formula (f) very slender and elongated, forked at posterior end. Mold of the spermatophore (m.sp) attachment plate with anterior end broadly rounded with two pyriform lateral lobes joined together by a narrow ‘bridge’ in the middle; sits at base of rachis. Endoparameral apodeme (ap) very long slender and straight, surpassing anterior end of formula. Rami slightly longer than epiphallus, slightly curved at anterior end.

Female (Fig. 5). Body structure similar to that of male but with following differences: tegmen with nine longitudinal veins joined cross veins. Subgenital plate about as long as wide, posterior margin roundly excised, base of excision somewhat straight, lobe lateral of excision rounded (Fig. 5C). Ovipositor very short, surpassing tegmen but not hindwings (Fig. 5D).

Colouration. Head generally red brown, distinctly darker dorsally; scapus and pedicel red brown, darker dorsally; maxillary palpi and clypeus red brown, slightly darker at the apex. Pronotum also red brown but distinctly paler than dorsum of head. Tegmen in male pale yellow brown, unicolourous; in female pale yellow brown in dorsal field, dark red brown lateral field ventrad of Sc. Fore and middle legs generally red brown, darker in female. Hind femur whitish, with three broad dark red brown bands, all with irregular margins, one at the base, one slightly behind middle (broadest) and one at the knee; hind tibia red brown. Tergites generally yellow brown, sternites generally pale whitish.

Measurements (in mm). Male holotype: BL = 11.0; PL = 1.6; PW = 2.5; TL = 10.1; HWT = 2.4. Female allotype: BL = 12.2; PL = 2.0; PW = 2.8; TL = 12.2; HWT = 3.9; HFL = 8.1; HTL = 7.3; OL = 4.2.

Etymology. This species is named after the type locality, Laguna in Luzon; noun in apposition. This new species from Laguna differs from similar looking species from nearby regions Bataan or Bulacan and Batangas.

Genus *Mistshenkoana* Gorochoy, 1990

Remarks. 59 species are currently known and described from Australia (1 species), Borneo (4), Sumatra (3), Java (2), Lesser Sunda Islands (5), Malay Peninsula (5), New Guinea (10), Philippines (2), Solomon Islands (5), Southwestern Pacific Islands (17), Indochina (5) (Gorochoy, 2006, Cigliano *et al.*, 2020). Only *Mistshenkoana gracilis* (Chopard, 1925) and *Mistshenkoana cicur* (Saussure, 1878)

were described from the Philippines (Gorochoy, 2006). Species of *Mistshenkoana* are similar to species of *Munda* Stål, 1877 and *Aphonoides* Chopard, 1940 but differs from *Munda* by branches of Sc obliquely produced from Sc (instead of produced at the base of Sc and run nearly parallel to Sc) and from *Aphonoides* by more elongated male subgenital plate with more elongated spermatophore (Gorochoy, 2006).

***Mistshenkoana matcha* new species**

(Figs. 6–8)

Gorochoy (2006): 296 (*Mistshenkoana ?gracilis*)

Material examined. Male holotype (UPLBMNH-ORT-1330), **Philippines**, Luzon Island, Laguna, Mount Makiling, N14.14767, E121.23094, 205.5±7.1 m.a.s.l., 11 April 2018, 2007 hours, on foliage of trees, coll. M. K. Tan, H. Yeo & C. C. Lucañas, pinned and genitalia dissected (UPLBMNH).

Paratypes. 1 male (UPLG.19.16), **Philippines**, Luzon Island, Laguna, Paete, Barangay Ilaya, UP Land Grant, N14.40005, E121.54313, 365.8±8.3 m.a.s.l., 1032 hours, 12 May 2019, coll. M. K. Tan, J. B. Baroga-Barbecho and S. A. Yap, pinned and genitalia dissected; 1 male, same locality, 6–7 September 2019, coll. J. B. Baroga-Barbecho & C. C. Lucañas, pinned and genitalia dissected (ZRC).

Other material examined. 1 male, **Philippines**, Luzon Island, Laguna, Mount Makiling, coll. C. Baker (NHMUK).

Diagnosis. The new species differs from congeners by the combination of these characters: distinct paler colouration of body compared to wings and colour difference between lateral field and dorsal field of tegmen; shapes of apical epiphallallic process and ectoparameres.

Comparison with congeners. We compared our specimens with the images of *M. gracilis* female allotype (MNHN-EO-ENSIF6739) from northwest Panay and male holotype (MNHN-EO-ENSIF6738) from Butuan, Mindanao in MNHN online collection and *M. ?gracilis* from Mount Makiling, Luzon (sensu Gorochoy, 2006).

The specimens we collected differ from the *M. gracilis* holotype by distinct paler colouration of the body compared to tegmina and colour difference between lateral field and dorsal field of tegmen; cells between M and R infumated white near basal part of tegmen. Our specimens also differ distinctly from the *M. gracilis* allotype by pale yellow colouration (especially the head, pronotum and legs; rather than pale brown), absence of distinct dark spots on legs (although presence of a few on hind femur); fastigium not darkened; presence of faint longitudinal medial stripe on pronotum dorsum; presence of distinct darkish humeral stripe running from their base to their distal part and distinct colour difference between tegmen and rest of body; dorsal field of tegmen without markings on the cross-veins; cells between M and R infumated white near the basal part of the tegmen; cross-veins of lateral field of tegmen white.

The specimens we collected from Mount Makiling and Paete mostly resemble *M. ?gracilis* from Mount Makiling, Luzon (sensu Gorochoy, 2006): dorsal surface of hind tibia with large dark spot in the middle; distinct colour difference between tegmen and rest of body and distinct darkish humeral stripe running from their base to their distal part. Likewise, the male genitalia are also indistinguishable between these specimens.

Therefore, it is possible that *M. ?gracilis* from Mount Makiling (sensu Gorochoy, 2006) or the two female syntypes from Mount Makiling (sensu Chopard, 1925) belong to a different undescribed species from the types from Panay.

This species also differs from *M. cicur* (Saussure, 1878) from Luzon by pale colouration (especially the head, pronotum and legs), presence of faint longitudinal medial stripe on pronotum; pronotal lobe without dark transverse stripe along hind margin of pronotum; presence of dark lateral stripe on tegmen and distinct colour difference between tegmen and rest of body; cross veins on tegminal not white.

This species also resembles *M. bilineata* (Chopard, 1954) from Java by pale colouration and faint longitudinal medial stripe on pronotum but differs by shape of phallus (more elongated and slenderer epiphallus than *M. bilieanta*) and absence of dark stripe around tegminal dorsal field.

Description. Male. Body typical of genus (Figs. 6, 7). Head rostrum 1.3 times as wide as scapus, 0.8 times as wide as eye, with apex truncated (in dorsal view) (Fig. 7C). Scapus elongated (Fig. 7B). Eyes distinctly vertically oblong, projected anteriorly (Figs. 7B, 7C); median and lateral ocelli very oblong; median ocellus distinctly wider than long and located between scapi; lateral ocellus between postero-inner margin of scapus and anterior margin of eye. Maxillary palpi cylindrical, with apical (fifth) segment elongated, obliquely swollen in middle with truncated apex, longer than third and subapical (fourth) segments; subapical segment slightly widened apically, shorter than third segment (Fig. 7D). Posterior of eye above gena finely pubescent. Pronotal disc 0.9 times as long as wide, anterior margin straight, posterior margin distinctly angular in middle (Fig. 7C). Pronotal lateral lobe 1.4 times as long as high, finely pubescent and margin with longer and thicker setae (Fig. 7B). Fore tibia with large oval and open inner tympanum and without outer tympanum; fore and middle legs generally finely pubescent, with a few stout setae located along ventral margin; without subapical spines on ventral margins.

Male. Tegmen extending beyond abdominal apex; dorsal field longer than lateral field; dorsal field with four main longitudinal veins; basal most vein splits at base on anal side and in middle on basal side; latter splits again in middle at anal side (Fig. 7E). Lateral field with many cross veins (some of which fused together) between M and Sc (Fig. 7A); Sc with 5 branches with a few cross-veins between branches (Fig. 7A). Hind wings surpassing tegmen. Male genitalia as shown in Fig. 8: epiphallus (ep) elongated, tapering slightly posteriorly, divided into two parts at posterior end and angularly and narrowly excised; posterior end produced into apical epiphallic process. Apical epiphallic process (ep.p) in dorsal view flattened, triangular and pointing posterior-externally with apex obtuse, posterior-inner margin with dense setae; in lateral view with dorsal margin straight and ventral margin concave, apex truncated. Ectoparameres (ecp) in dorsal view elongated, very slender and narrowly forked at posterior end, basally enlarged and appear flattened. Rachis (ra) (= guiding rod) small, slender and straight, with apex acute.

Female. Unknown.

Colouration. Head, pronotum and legs generally yellow green when alive, pale yellow when dry-pinned; tegmen with distinctly different colouration as body. Scapus and antennae with tint of brown. Maxillary palps generally pale, with apical segment darker. Pronotal dorsal disc with anterior and posterior margins brown in middle, with a faint darkened median longitudinal band. Lateral lobe pale, with margins brown. Fore and middle femora yellow green, tibiae and tarsi pale brown. Hind femur yellow green with some small black spots dorsally; knee brown. Hind tibia yellow green (typically darker than hind femur) with a few small black spots, with a broad spot slightly after middle. Tegmen with dorsal field brown, with veins slightly darker; area between M and R including veins black, darkest in middle; area between R and Sc infumated white at basal half, apical half transparent with cross veins infumated white; Sc and branches brown with white margins, cross veins white. Hind wings with cross-veins infumated darkened. Abdominal tergite yellow green, sternite white.

Measurements (in mm). Male (n = 2): BL = 11.4–11.6; PL = 2.2–2.3; PW = 2.4–2.5; TL = 13.3–13.5; HWT = 4.1–4.3; HFL = 9.9; HTL = 9.9.

Etymology. The species name refers to the matcha (tea green) coloured body (including head, pronotum and legs) when alive, which is unique in this species compared to sympatric congeners and related species from the Philippines; noun in apposition.

***Mistshenkoana gracilis* (Chopard, 1925)**

(Figs. 9, 10)

Chopard (1925): 327; Chopard (1929): 117; Chopard (1968): 400; Gorochoy (1990): 21; Ichikawa *et al.* (2000): 278

Type material examined (images). Male holotype (MNHN-EO-ENSIF6738, MNHN online collection), **Philippines**, Mindanao, Butuan, coll. P. I. Baker; female allotype (MNHN-EO-ENSIF6739, MNHN online collection), **Philippines**, Western Visayas, Northwest Panay, coll. P. I. Baker.

Remarks. Whether the male holotype and female allotype from two different parts of the Philippines belong to the same species need to be verified. The holotype and allotype differ slightly by apical segment of maxillary palp distinctly enlarged in allotype but less so in holotype; pronotum and legs of holotype homogeneously brown but with dark spots in allotype.

New materials collected from Paete and Mount Makiling show that sympatric species can have very similar external morphology, but different male genitalia and that sexual dimorphism is obvious in *Mistshenkoana*. This lends support that the differences in between holotype and allotype are likely to be species variations, especially since the specimens were collected from separate islands belonging to two biogeographic regions.

Notes made by Chopard (1925) about females of '*M. gracilis*' from Luzon are probably also belonging to another species.

***Mistshenkoana cicur* (Saussure, 1878)**

(Fig. 11)

Saussure (1878): 647; Bolívar (1889): 430; Casto de Elera (1895): 222; Kirby (1906): 104; Bruner (1915): 266; Chopard (1968): 410; Gorochoy, 2006: 275

Type material examined (images). Female holotype (DORSA-BG00016S01), Luzon, coll. Pfeiffe (MfN).

***Mistshenkoana* sp. 1**

(Fig. 12)

Material examined. 1 female (UPLG.19.54), **Philippines**, Luzon Island, Laguna, Paete, Barangay Ilaya, UP Land Grant, N14.39978, E121.54204, 325.3±6.0 m.a.s.l., on foliage, 1955 hours, 6 September 2019, coll. M. K. Tan, J. B. Baroga-Barbecho, C. C. Lucañas and S. A. Yap, pinned.

Remarks. The female specimen resembles *M. gracilis* female allotype from Panay and *M. cicur* female holotype from Luzon; but differs from *M. cicur* holotype by slightly more numerous cross-veins between R and Sc, with slightly thicker infumation; subgenital plate with posterior margin truncated and not narrowly excised in the middle. It also differs from *M. gracilis* female allotype by fewer spots on the body (including head, pronotal dorsal disc and legs); more numerous and finer cross-veins between R and Sc and between Sc projections; shape of subgenital plate tapering to a narrowly concave apex (instead of broadly concave apex).

***Mistshenkoana* sp. 2**

(Fig. 13)

Material examined. 1 male (UPLBMNH-ORT-1314), N14.185, E121.23227, 185.6±4.9 m.a.s.l., 10 April 2018, 2000 hours, on foliage of trees coll. M. K. Tan, Huiqing Yeo, C. C. Lucañas and L. S. Crispolon (UPLBMNH).

Remarks. The male specimen is very similar to *M. cicur* (Saussure, 1878) female holotype in patterns and colours and tegminal venations (including cross veins on lateral and dorsal fields) but differs by R with five projections (instead of six). The specimen also differs from the holotype and allotype of *M. gracilis* from Panay by more and finer cross-veins between R and Sc and between Sc projections. This male specimen also differs from our female specimen from Paete (*Mistshenkoana* sp. 1) by fewer but thicker cross-veins between basal most longitudinal vein of the dorsal field and M; fewer cross-veins between R and Sc, with thinner infumation; R with five projections (instead of six).

***Mistshenkoana sursa* new species**

(Figs. 14–17)

Material examined. Male holotype (UPLG.19.12), **Philippines**, Luzon Island, Laguna, Paete, Barangay Ilaya, UP Land Grant, N14.40052, E121.54238, 309.2±5.4 m.a.s.l., 0933 hours, 12 May 2019, forest edge, coll. M. K. Tan, J. B. Baroga-Barbecho and S. A. Yap, pinned and genitalia dissected (UPLBMNH).

Paratypes. 1 female (UPLG.19.15), same locality, N14.40025, E121.54202, 320.3±5.9 m.a.s.l., 0958 hours, 12 May 2019, forest edge coll. M. K. Tan, J. B. Baroga-Barbecho and S. A. Yap, pinned; 1 male (UPLG.19.31) and 1 female (UPLG.19.32), **Philippines**, Luzon Island, Laguna, Paete, Barangay Ilaya, UP Land Grant, N14.39622, E121.56037, 405.2±5.3 m.a.s.l., 1448 hours, 12 May 2019, coll. M. K. Tan, J. B. Baroga-Barbecho and S. A. Yap, pinned (ZRC).

Diagnosis. This new species differs from congeners by the combination of these characters: apical (fifth) segment elongated, but not widened apically with apex rounded; epiphallus stout with apical epiphallic process bent perpendicular at base from epiphallus; apical epiphallic process pointing dorsad, slender and in middle bent angularly in lateral view, in dorsal view curved, pointing externally with obtuse apex in anterior view.

Remarks on material. The new species shares many morphological similarities from *Mistshenkoana* sp. 2. We can identify the female materials to belong to the males of this new species, instead of *Mistshenkoana* sp. 2 by this inference: the males (UPLG.19.12 and 31) collected from the same place but different time have identical genitalia. Since a pair of this species were found in the pre-copulation stage (i.e., UPLG.19.31, 32), we can identify the female of this species reliably. By comparing the morphology among the females, we can identify the female (UPLG.19.15) to also belong to this species, despite some variations in the tegminal cross-veins and branches of Sc.

Comparison with congeners. The male genitalia is typically similar to species with stout epiphallus with slender apical epiphallic process pointing dorsad. Genitalia is most similar to *M. pileata* Gorochov, 2008 from Solomon Islands by shape of epiphallus and apical epiphallic process but differs by shape of ectoparameres and spermatophore.

Genitalia differs from that of *M. tembelingi* Gorochov, 2007 from Malay Peninsula, *M. pangrango* Gorochov, 2007 from Java, *M. asymmetrica* Gorochov, 2008 from New Guinea, *M. beybienkoi* Gorochov, 1990 from Lesser Sunda Islands, *M. erromango* Gorochov, 2008 from Vanuata and *M. yaeyamensis* Oshiro, 1998 from islands off Japan by apical epiphallic process bent perpendicular at base from epiphallus and more angularly bent in middle (in lateral view) and shape of ectoparameres; from *M. belokobylskiji* Gorochov, 2006 and *M. nhachangi* Gorochov, 2007 from Vietnam by longer and more slender (from lateral view) apical epiphallic process and shape of ectoparameres; from *M. caudatus* (Bey-Bienko, 1966) from Komodo Island by middle of anterior margin of epiphallus with distinct excision; from *M. kolobagara* Gorochov, 2008 and *M. rennell* Gorochov, 2008 from Solomon Islands by longer apical epiphallic process (otherwise very similar by bent perpendicular at the base from epiphallus and more angularly bent in middle in lateral view).

Description. Male. Body typical of the genus (Figs. 14A, 14B, 17). Head rostrum somewhat elongated, 1.7 times as wide as scapus, 1.1 times as wide as eyes, with apex obtusely rounded (in dorsal view) (Fig. 14C). Scapus elongated. Eyes distinctly vertically oblong, projected anteriorly (Figs. 14C, 14D); median and lateral ocelli very oblong; median ocellus distinctly wider than long and located very slightly before lateral ocelli; lateral ocellus longer than wide, located between scapus and anterior margin of eye. Maxillary palpi cylindrical, with apical (fifth) segment elongated, but not widened apically with apex rounded, longer than subapical (fourth) segments but subequal length as third segment; subapical segment slightly widened apically, shorter than third segment (Fig. 14D). Posterior of eye above gena finely pubescent (Fig. 14D). Pronotal disc 0.9 times as long as wide, anterior margin straight, lateral margin slightly widening apically (more obvious at apical third), posterior margin distinctly angular in middle (Fig. 14C). Pronotal lateral lobe 1.4 times as long as high, finely pubescent and margin with longer setae (Fig. 14D). Fore tibia with very large oval and open inner tympanum, outer tympanum absent; fore and middle legs generally finely pubescent, with a few stout setae located usually along ventral margin; without subapical spines on ventral margins.

Male. Tegmen extending beyond abdominal apex; dorsal field longer than lateral field; dorsal field with four main longitudinal veins; basal most vein splits at base on anal side and in middle on basal side; latter splits again in middle at anal side (Fig. 14A). Lateral field with few widely spaced cross veins (some of which fused together) between M and Sc (Fig. 14B); Sc with 5 branches with a

few cross-veins between branches (Fig. 14B). Hind wings surpassing tegmen. Male genitalia as shown in Fig. 15: epiphallus stout compared to *M. matcha* **sp. nov.** and *Mistshenkoana* sp. 2, anterior end truncated with a broad rounded excision in middle, tapering slightly posteriorly; posterior end produced into apical epiphallic process, process bent perpendicular from epiphallus. Apical epiphallic process (ep.p) pointing dorsad, slender and in middle bent angularly in lateral view, in dorsal view curved, pointing externally with obtuse apex in anterior view, apex with a few setae. Ectoparameres slender. Rachis (= guiding rod) small, slender and straight, with apex acute. Endoparameral apodeme slightly surpassing anterior margin of epiphallus. Rami perpendicular to epiphallus.

Female. Very similar to male, including tegminal venations (Figs. 16A, 16B). Subgenital plate 1.5 times as long as wide, tapers slightly posteriorly, with apex concave (Fig. 16C). Ovipositor with apex as in Fig. 16D.

Colouration. Head, pronotum and legs generally brown. Head dorsum slightly darker. Scapus and antennae pale brown. Ventral of eye with a black vertical band. Maxillary palps generally pale. Pronotal dorsal disc pale brown, with faint darkened patterns (Fig. 14C). Lateral lobe pale brown. Fore and middle femora pale, with some black/ dark brown spots at apical half, tibiae brown with dark spots. Hind femur pale brown with some small dark brown/ black spots dorsally; knee brown. Hind tibia brown, with dorsal surface with an irregular black longitudinal stripe. Tegmen brown, with longitudinal veins slightly darker; and cross-veins pale. Hind wings with cross-veins infumated darkened. Abdominal tergite and sternite white.

Measurements (in mm). Male holotype: BL = 11.7; PL = 1.9; PW = 2.1; TL = 10.0; HWT = 5.4; HFL = 8.6; HTL = 8.1. Females (n = 2): BL = 9.8–10.8; PL = 1.8–2.0; PW = 2.5–2.9; TL = 11.6–12.5; HWT = 0.9?–1.8; HFL = 8.8–9.8; OL = 7.7–8.4.

Etymology. The species name refers to the apical epiphallic process pointing dorsad, perpendicular from the epiphallus (sursum = upward in Latin).

Natural history. A female was photographed feeding on flowers. Such behaviour is also not previously recorded (Tan *et al.*, 2017).

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Figure captions

FIGURE 1. *Duolandrevus (Jorama) curtipennis* male: live habitus (A), metanotal gland in dorsal view (B), abdominal apex in dorsal view (C), genitalia in dorsal (D), ventral (E) and lateral (F) views. Scale bars: 1 mm.

FIGURE 2. *Phaloria (Phaloria) modulator* male: live habitus (A), tegmen in dorsal view (B), genitalia in dorsal (C), ventral (D) and lateral (E) views. Scale bar: 2 mm.

FIGURE 3. *Mnesibulus laguna* n. sp. male holotype: habitus in dorsal (A) and lateral (B) views, face in anterior view (C), head and pronotum in lateral view (D), anterior tympanum in anterior view (E). Scale bars: 2 mm (A, B), 1 mm (C–E).

FIGURE 4. *Mnesibulus laguna* n. sp. male holotype: metanotal gland in dorsal views (A, B), abdominal apex in dorsal view (C), genitalia in dorsal (D), ventral (E) and lateral (F) views. Scale bars: 1 mm (A–C).

FIGURE 5. *Mnesibulus laguna* n. sp. female allotype: habitus in dorsal (A) and lateral (B) views, subgenital plate in ventral view (C), apex of ovipositor in lateral view (D). Scale bars: 5 mm (A, B), 1 mm (C, D).

FIGURE 6. *Mistshenkoana matcha* n. sp. males in their natural environment.

FIGURE 7. *Mistshenkoana matcha* n. sp. male: habitus in lateral view (A), head and pronotum in lateral (B) and dorsal (C) views, maxillary palps in lateral view (D), tegmen in dorsal view (E). Scale bars: 5 mm (A, E), 1 mm (B–D).

FIGURE 8. *Mistshenkoana matcha* n. sp. male genitalia in dorsal (A), ventral (B) and lateral (C) views.

FIGURE 9. *Mistshenkoana gracilis* male holotype in dorsal (A), ventral (B) and lateral (C) views, face in anterior view (D), label (E). Images from MNHN online collection by Marion Depaetere (<http://coldb.mnhn.fr/catalognumber/mnhn/eo/ensif6738>).

FIGURE 10. *Mistshenkoana gracilis* female allotype in dorsal (A), ventral (B) and lateral (C) views, face in anterior view (D), apex of ovipositor in lateral view (E), label (F). Images from MNHN online collection by Marion Depaetere (<http://coldb.mnhn.fr/catalognumber/mnhn/eo/ensif6739>).

FIGURE 11. *Mistshenkoana cicur* female holotype in dorsal (A), ventral (B) and lateral (C) views, subgenital plate in ventral view (D), apex of ovipositor in lateral view (E), label (F). Images from DORSA by S. Ingrisch.

FIGURE 12. *Mistshenkoana* sp. 1 female in its natural environment (A), habitus in dorsal (B) and lateral (C) views, subgenital plate in ventral view (D), apex of ovipositor in lateral view (E). Scale bars: 5 mm (B, C), 1 mm (D, E).

FIGURE 13. *Mistshenkoana* sp. 2 male habitus in dorsal (A) and lateral (B) views, genitalia in dorsal (C), ventral (D) and lateral (E) views. Scale bars: 5 mm.

FIGURE 14. *Mistshenkoana sursa* n. sp. male habitus in dorsal (A) and lateral (B) views, anterior half of body in dorsal (C) and lateral (D) views, face in anterior view (E). Scale bars: 5 mm (A, B), 2 mm (C, D), 1 mm (E).

FIGURE 15. *Mistshenkoana sursa* n. sp. male genitalia in dorsal (A), lateral (B), anterior (C) and posterior (D) views, spermatophore in lateral view (E).

FIGURE 16. *Mistshenkoana sursa* **n. sp.** female habitus in dorsal (A) and lateral (B) views, subgenital plate in ventral view (C), apex of ovipositor in lateral view (D). Scale bars: 5 mm (A, B), 1 mm (C, D).

FIGURE 17. *Mistshenkoana sursa* **n. sp.** in its natural environment.