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Two new species of *Bungona* Harker, 1957 (Ephemeroptera: Baetidae) from Borneo, Indonesia

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Abstract

Two new species of *Bungona*, belonging to the subgenera *Chopralla* Waltz & McCafferty, 1987 and *Centroptella* Braasch & Soldán, 1980, are described based on larvae from Kalimantan (Borneo, Indonesia). *Bungona (Centroptella) papilionodes* **n. sp.** is the third species described for the subgenus. It can be distinguished from *Bungona (Centroptella) longisetosa* (Braasch & Soldán, 1980) and *Bungona (Centroptella) soldani* (Müller-Liebenau, 1983) by the length of the maxillary palp, the presence or absence of an additional small denticle on the lateral margin of the distal incisor, and the spination of the paraproct. This new report of the subgenus greatly increases its geographic range of distribution, as it was known only from Sri-Lanka and China. *Bungona (Chopralla) bintang* **n. sp.** is the seventh species described for the subgenus *Chopralla* and the second described from Borneo. It differs from others species of the subgenus and especially from *Bungona (Chopralla) pusilla* (Müller-Liebenau, 1984) (Borneo) by the combination of lacking hindwing pads, the particular spination of distal margins of tergites, and the shape of the maxillary palp. The two new species fit into the recently revised concepts of *Chopralla* and *Centroptella* and confirm the characters used to support these taxa as valid subgenera.

Key words: *Centroptella, Chopralla, Cloeodes* complex, new species, Kalimantan

Introduction

Despite some important studies in the 1940's and 1980's (especially Ulmer 1939, Müller-Liebenau 1983, 1984; for a complete review of these studies see Gattolliat 2012; Gattolliat & Nieto 2009) and a few recent improvements (Gattolliat 2012; Gattolliat 2011; Kluge & Novikova 2011; Kluge 2011), the knowledge of the Baetidae (Ephemeroptera) from South East Asia is still in great need of taxonomic work.

Cloeodes Traver, 1938 and related genera were recently the subject of global morphological and phylogenetic studies with important systematic implications for the whole tropical area of the planet, including the Oriental realm (Salles *et al.* 2016). The concept of *Cloeodes* was restricted to the New World while the genus *Chopralla* Waltz & McCafferty, 1987 was considered as a subgenus of the Australasian genus *Bungona* Harker, 1957. *Centroptella* Braasch & Soldán, 1980 was revalidated and also considered as a subgenus of *Bungona* and no longer as a junior synonym of *Chopralla.* Therefore *Bungona* is the only genus of the *Cloeodes* complex present in the Oriental realm, and it has two subgenera: *Centroptella* and *Chopralla.*

The genus *Bungona* can be distinguished from the other genera of Baetidae and especially from other genera of the *Cloeodes* complex in the larval stage by: long, sparse setae on the dorsal margin of femora; spine-like setae between prostheca and mola of right mandible; right prostheca elongate and bifid; and in the imaginal stage by: forewings with double marginal intercalary veins; hindwings absent or vestigial; and segment III of male genital forceps elongate (Salles *et al.* 2016). The subgenera *Chopralla* and *Centroptella* can be distinguished mainly by characteristics of tarsal claws: in *Chopralla* with unusual flat and broad teeth, while edentate in *Centroptella* (Waltz & McCafferty 1987); body colour pattern of thorax and abdomen: very contrasted with characteristic pattern in

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Chopralla, rather uniform in *Centroptella*. The subgenus *Chopralla* encompasses six species, *Bungona (Chopralla) ceylonensis* (Müller-Liebenau, 1983) from Sri-Lanka; *Bungona (Chopralla) colorata* (Soldán *et al.*, 1987) from Vietnam; *Bungona (Chopralla) fusina* (Tong & Dudgeon, 2003) from Hong Kong; *Bungona (Chopralla) liebenauae* (Soldán *et al.*, 1987) from Vietnam; *Bungona (Chopralla) pusilla* (Müller-Liebenau, 1984) from Malaysia (Sabah); *Bungona (Chopralla) similis* (Müller-Liebenau, 1983) from Sri-Lanka (Müller-Liebenau 1983; Müller-Liebenau 1984; Soldán *et al.* 1987; Tong & Dudgeon 2003). Only two species are included in the subgenus *Centroptella: Bungona (Centroptella) longisetosa* (Braasch & Soldán, 1980) from China and *Bungona (Centroptella) soldani* (Müller-Liebenau, 1983) from Sri-Lanka (Braasch and Soldán 1980; Müller-Liebenau 1983). Few of these species have been mentioned after their original description; therefore, the geographical distribution of the different species remains provisionally restricted to the type locality. *Bungona (Chopralla) pusilla* is the only species reported from Borneo or surrounding islands (Müller-Liebenau 1984).

Borneo is part of the Great Sunda Islands, and it is the third largest island in the world (approximately 736 000 km²). Geographically, the island is located close to the Wallace line, at the boundary of the Oriental and Australasian realms. Deforestation for agriculture and sylviculture activities deeply endanger Borneo's ecosystem. In Kalimantan, the Indonesian part of Borneo, industrial oil palm plantations increased from about 8 000 km² to 31 500 km² between 2000 and 2010, and 100 000 km² could finally be converted by 2020 (Carlson *et al.* 2013). This overexploitation is severely damaging terrestrial and freshwater ecosystems due to pollution and habitat degradation (Koh *et al.* 2011; Miettinen *et al.* 2013).

To assess the effect of logging activities on water quality and aquatic communities, a survey of aquatic insects was conducted in 85 km² area in the Bulungan forest, Malinau District East Kalimantan, Borneo (Derleth 2003). Details of collecting methods, as well as environmental parameters, are described by Derleth (2003). Sampling took place in 2000 and 2001 in 35 localities, revealing a high diversity and numerous unknown taxa (Sartori *et al.* 2003). Part of the fauna has already been the subject of taxonomic studies (Sartori & Gattolliat 2003; Jacobus & Sartori 2004; Sartori *et al.* 2007; Sartori *et al.* 2008; Ubero-Pascal & Sartori 2009; Sartori & Derleth 2010; Webb & McCafferty 2007; Gattolliat 2011; Gattolliat 2012; Malzacher 2013).

Two new species of *Bungona* were found in the material collected as part of this survey. Despite light trapping and rearing of mature larvae for many species, no imagos could be associated with larvae, so the two new species are known only from the larval stage.

Holotypes and part of the paratypes of the new species are housed in the Museum of Zoology, Lausanne, Switzerland (MZL); other paratypes are deposited in the Museum of Zoology, Bogor, Indonesia (LIPI) and Coleção Zoológica Norte Capixaba, Universidade Federal do Espírito Santo, São Mateus, Brazil (CZNC).

Bungona (Centroptella) papilionodes **Gattolliat & Marle n.sp.**

Figures 1–18

Material examined. ***Holotype:*** B0433D (GBIFCH00235745): 1 ♂ larva; Indonesia; East Kalimantan; Langap Sud (1995); Bas. Malinau; Riv. Ngayo (Rian tributary); Long/Lat 116°30'58"E / 3°04'56"N; 160 m.a.s.l.; 14.iv.2001 (MZL). Coll. P. Derleth. ***Paratypes:*** B1111P1 (GBIFCH00235743): 9 ♂ larvae, 5 ♀ larvae, Indonesia; East Kalimantan; Seturan (1999-bloc 27); Bas. Malinau; Riv. Seturan; Long/Lat 116°30'31"E / 3°00'57"N; 170 m.a.s.l.; 18.vii.2000 (LIPI). B0833C (GBIFCH00235734): 1 ♂ larva; Indonesia; East Kalimantan; Seturan (2000-bloc 43); Bas. Malinau; Riv. Temalat (Sungai Guang) (Seturan tributary); Long/Lat 116°33'29"E / 2°59'29"N; 240 m.a.s.l.; 16.iv.2001 (MZL). B1313A (GBIFCH00235748) + B1313P (GBIFCH00235718): 4 ♀ larvae, 1 ♂ larva; Indonesia; East Kalimantan; Seturan (unexploited); Bas. Malinau; Riv. Seturan; Long/Lat 116°30'48"E / 3°00'05"N; 28.iii.2001 (MZL). B1113C (GBIFCH00235742) + B1113P (GBIFCH00235754): 4 ♂ larvae, 4 ♀ larvae; Indonesia; East Kalimantan; Seturan (1999-bloc 27); Bas. Malinau; Riv. Seturan; Long/Lat 116°30'31"E / 3°00'57"N; 140 m.a.s.l.; 26.iii.2001 (MZL, except 1 ♂ larva, 1 ♀ larva CZNC). B0913B (GBIFCH00235740) + B0913C (GBIFCH00235752) + B0913P (GBIFCH00235730): 3 ♂ larvae, 2 ♀ larvae; Indonesia; East Kalimantan; Seturan (1998-bloc 28); Bas. Malinau; Riv. Kipah (Seturan tributary); Long/Lat 116°29'48"E / 3°01'48"N; 150 m.a.s.l.; 29.iii.2001 (MZL). All Coll. P. Derleth.

Diagnosis. Larvae: A) Dorsal margin of femora with about seven long, clavate setae (Fig. 14); B) Maxillary palp apically pointed, subequal to galea-lacinia (Figs. 6a, b); C) Outer incisor on both mandibles longer than inner

incisor and without additional external small denticle (Figs. 4a, 5); D) Segment III of labial palp subrectangular with the distal margin almost straight (Fig. 7); E) Spines present on posterior margin of tergites I to X; F) Spines present on posterior margin of sternites III to IX; G) Triangular scale on surface of abdominal tergites (Fig. 8).

Description. Larvae: *Measurements*. Length (mm). Body: 2.3–2.8; cerci: 1.0–1.1; terminal filament: 0.9–1.0; antenna: 0.5.

Colouration (Fig. 1). Head uniformly yellowish. Turbinate eyes dark purple-grey. Pronotum yellowish with bowtie-like, medium brown mark; mesonotum yellowish, medium brown on posterior margin; metanotum light yellow. Legs light yellow. Abdomen: tergites IV, VII, VIII and IX light yellow; tergites I–III, V and X dark brown, sometimes with moon-shaped brown mark. Cerci light yellow.

FIGURE 1. Male larvae of *Bungona (Centroptella) papilionodes* n.sp., dorsal view.

Head. *Antenna*. Scape and pedicel sub-cylindrical.

Labrum (Fig. 2). Subrectangular. Length about 0.5 × maximum width. Distal margin with shallow medial emargination; dorsally with one central, long, stout, simple seta and submedian arc composed of about 6 long stout setae; few short, fine setae scattered on dorsal face; distal margin with row of multifid (disto-laterally) and bifid (disto-medially) setae. Ventral surface laterally with 3 short, stout setae.

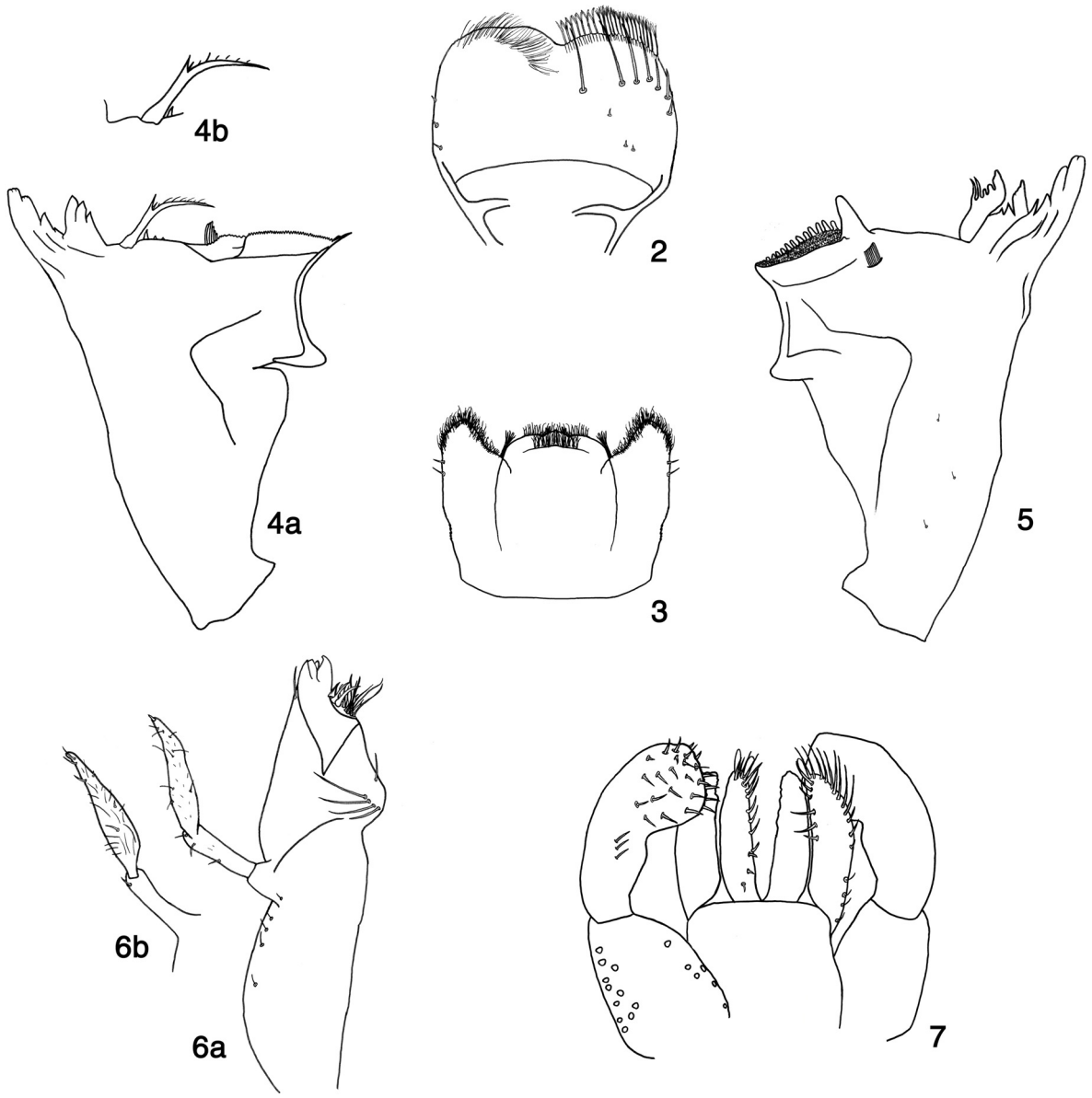
Hypopharynx (Fig. 3). Lingua shorter than superlingua; distal margin rounded; covered with short, fine, simple setae. Superlingua with apex triangular; fine, simple setae scattered over distal margin.

Right mandible (Figs. 4a, 4b). Two slender incisor sets, partially fused; inner and outer sets with 4 + 3 denticles, respectively. Prostheca slender, bifurcated at middle (Fig. 4b). Margin between prostheca and mola straight with about 3 spine-like setae. Apex of mola with 2 setae.

Left mandible (Fig. 5). Incisors partially fused, inner and outer sets of incisors with 4 + 3 denticles, respectively. Prostheca robust, apically with 4 denticles and 1 comb-shaped structure. Margin between prostheca and mola straight, without setae. Denticles of mola not constricted. Tuft of setae at apex of mola absent.

Maxilla (Figs. 6a, 6b). Apex of lacinia with row of setae with 2 denti-setae, 10 long, simple setae and 6 short spine-like setae; outer base of denticles with one simple seta. Maxillary palp 2-segmented, slightly shorter than galea-lacinia, and covered with medium, fine, simple setae; palp segment I 0.6 × length of segment II; segment II enlarged proximally and sharply pointed apically.

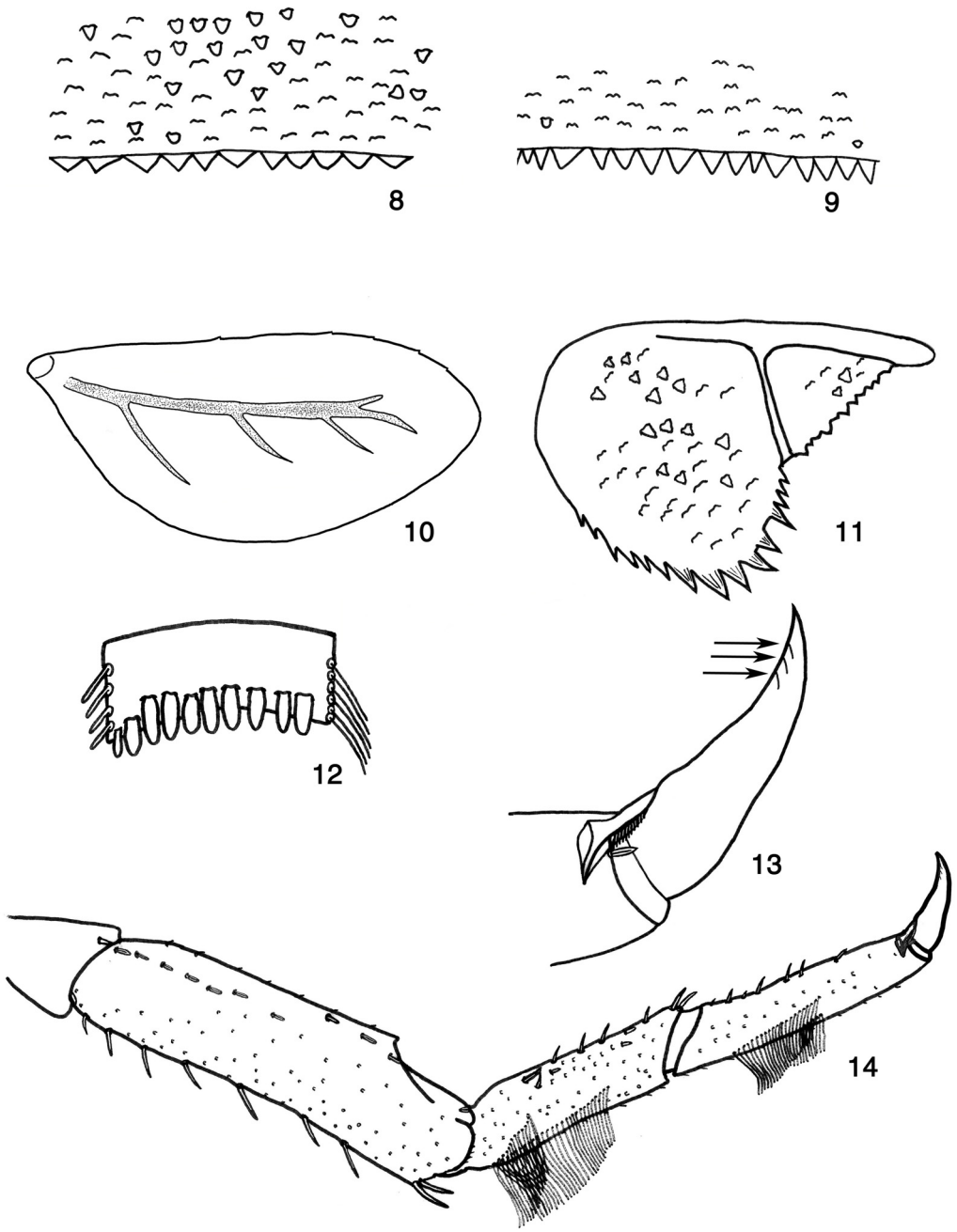
Labium (Fig. 7). Glossae slightly longer than paraglossae; inner margin with about 14 stout setae increasing in length apically; apex with two clavate setae, and 3 stout setae; outer margin without setae. Paraglossae falciform; base with 4 short, fine, simple setae; outer margin with row of 16 long, stout setae increasing in length apically, apex with one short clavate seta, inner margin with few stout setae. Labial palp with segment I 0.7 × length of segments II and III combined; segment I covered with micropores; segment II slightly projected apically, one row of 3 stout setae ventrally, inner and outer margin bare; segment III subrectangular with distal margin straight, covered by medium simple stout setae scattered over ventral surface.



FIGURES 2–7. Larval structures of *Bungona (Centroptella) papilionodes* n.sp. (2) Labrum (left: ventral view; right: dorsal view). (3) Hypopharynx. (4a) Right mandible. (4b) Right prostheca. (5) Left mandible. (6a) Right maxilla. (6b) Right maxillary palp. (7) Labium (left: ventral view; right: dorsal view).

Thorax. *Hindwing pads* absent.

Legs (Figs. 13, 14, 15, 16). *Femur*. Length about 4.0 × maximum width; dorsally with row of about 7 long setae and 2 spine-like setae at apex; length of setae about 0.4 × maximum width of femur; ventrally with short, clavate, stout setae roughly arranged in one row, one clavate seta at apex (Fig. 15, but not illustrated on Fig. 14). *Tibia.* Dorsally with only tiny setae; ventrally with one row of short, stout setae and two feathered setae at apex. *Tarsus.* Dorsally with only tiny setae; ventrally with one row of feathered setae almost absent in distal half. Tarsal claw without denticles (Figs. 13, 16), apically with 3 furrows (Fig. 13); subapical setae present but only visible by SEM (Fig. 16).



FIGURES 8–13. Larval structures of *Bungona (Centroptella) papilionodes* n.sp. (8) Distal margin of abdominal tergite IV. (9) Distal margin of abdominal sternite IV. (10) Gill IV. (11) Paraproct. (12) Segment of cercus. (13) Tarsal claw (arrows indicate furrows). (14) Foreleg.

Abdomen. *Tergites*. Surfaces with triangular scales and scale bases (Figs. 8, 18); posterior margins of segments I–X with spines present (Figs. 8, 17).

Sternites (Fig. 9). Row of insertions of setae present on sternites IV to VI; insertions also present on sternites II and III, or III only, but generally not arranged in rows; long setae only visible by SEM. Spines present on posterior margins of segments III–X. Few triangular scales and scale bases scattered over surface.

Gills (Fig. 10). Present on segments I–VII, slightly asymmetrical, posterior margins smooth but anterior margins slightly serrate. Tracheation well-marked but poorly branched. Gill I about 1/3 length of Gill IV.

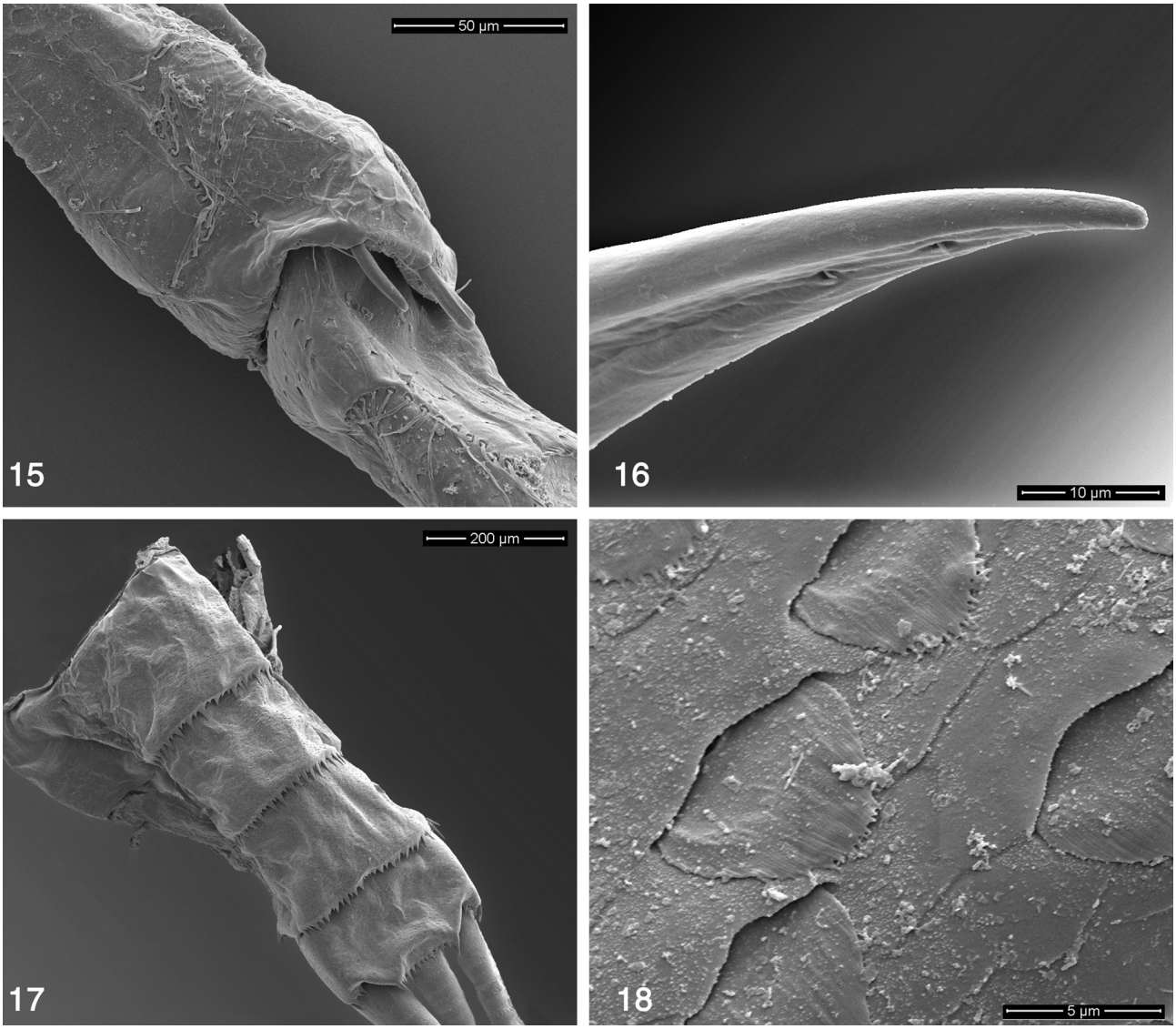
Paraproct (Fig. 11). With 15 marginal spines. Surface with triangular scales and scale bases. Postero-lateral extension with small marginal triangular spines; surface with scales and scale bases.

Caudal filaments. Distal margin of each segment with scales (Fig. 12); inner margin with 4 setae and outer margin with 6 long, simple setae.

Imagos: Unknown.

Etymology. "Papilionodes" means "looking like a butterfly"; it refers to the pronotum pattern.

Discussion. *Bungona (Centroptella) papilionodes* presents all the characteristics of *Bungona*: sternites IV to VI with a row of long, tubular setae; arcs of long, tubular setae on femora, tibiae and tarsi (Figs. 14, 15); dorsal margins of femora with scarce spatulate setae (Fig. 14); spine-like setae between prostheca and mola of right mandible (Fig. 4b); right prostheca bifid (Fig. 4a) (Salles *et al.* 2016). The absence of denticles on tarsal claws (Fig. 13), the labrum with a subdmedian arc composed of about 6 long stout setae (Fig. 2) and the relatively uniform colouration of the body (Fig. 1) indicate that the species belongs to the subgenus *Centroptella* rather than *Chopralla* or *Bungona s.s.* (Salles *et al.* 2016).



FIGURES 15–18. Larval structures of *Bungona (Centroptella) papilionodes* n.sp., Scanning Electron Micrographs. (15) Apex of forefemur. (16) Apex of fore tarsal claw. (17) Tergites VII–X. (18) Surface of tergite IV.

Besides the new species described herein, the subgenus *Centroptella* encompasses two other species: *B. (C.) soldani* and *B. (C.) longisetosa* (Salles *et al.* 2016). The main characters used to distinguish these three species are the length of maxillary palp, being short in *B. (C.) longisetosa* (less than one third of maxilla length); and the presence of an additional small denticle on the outer margin of the outer incisor in *Centroptella* species except in *B. (C.) papilionodes*. Additional features that also can be used include the third segment of the labial palp, which is broader in *B. (C.) soldani* (apical width of segment III is 1.6 × base) than in *B. (C.) longisetosa* and *B. (C.) papilionodes; B. (C.) papilionodes* has small triangular spines on the margin of the lateral extension of the paraproct, whereas these spines are not present in the two other species; the left prostheca has four denticles in *B. (C.) longisetosa* but three denticles in *B. (C.) soldani* and *B. (C.) papilionodes* (Braasch & Soldán 1980; Müller-Liebenau 1983).

Using the identification key from Soldán *et al.* (1987), *B. (C.) papilionodes* will match couplet 11; the species can be separated from *C. soldani* by the characters listed above. Notice also that *B. (C.) similes* is wrongly located in couplet 12, as it implies tarsal claws without denticles, whereas they are present, as indicated by the original description (Müller-Liebenau 1983).

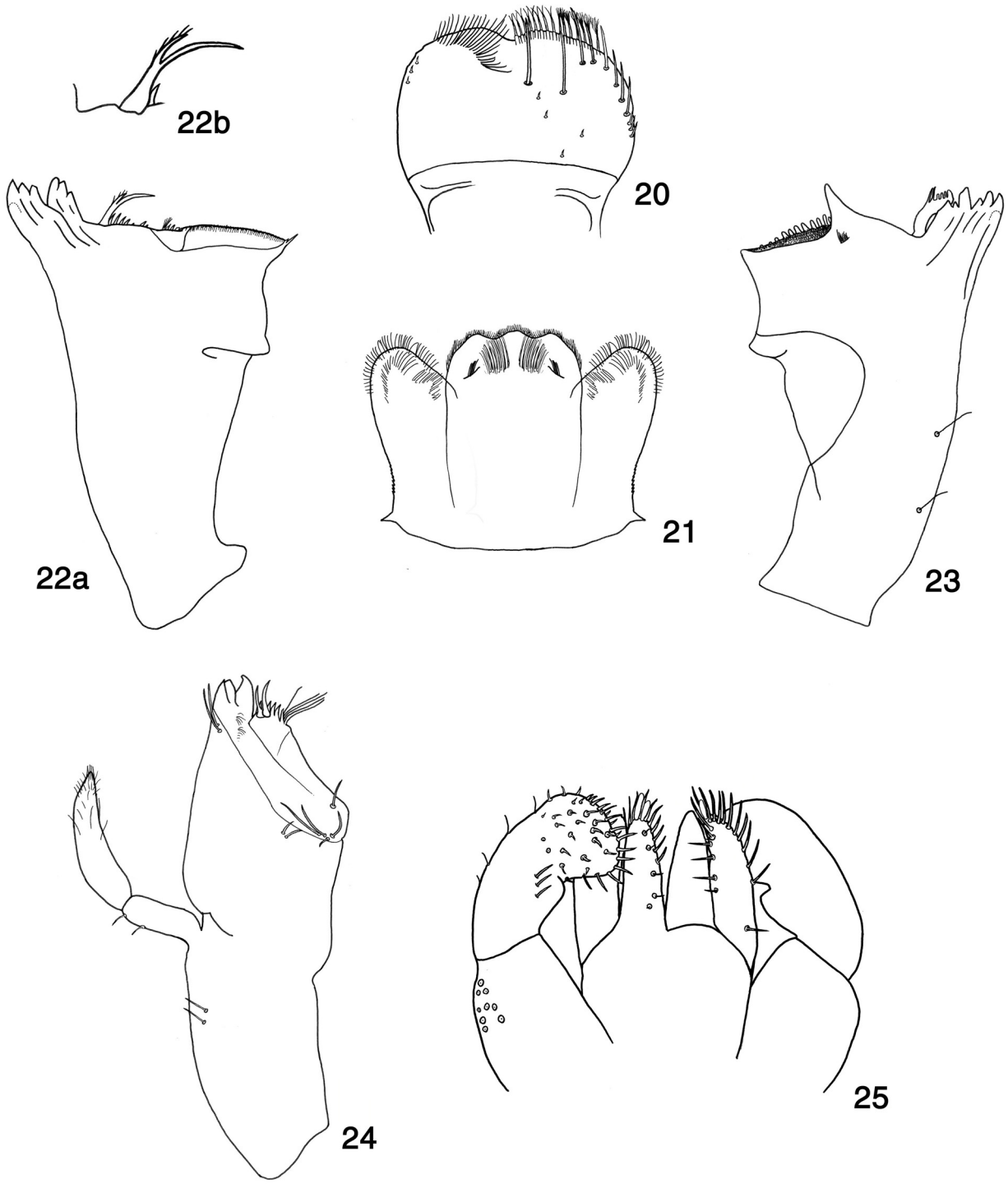
Bungona (Chopralla) bintang **Gattolliat & Marle n.sp.**
Figures 19–36

Material examined. ***Holotype:*** B0521C (GBIFCH00238399): ♂ larva; Indonesia; East Kalimantan; Seturan (2001-bloc 57); Bas. Malinau; Riv. Tamalang (Seturan tributary); Long/Lat 116°30'29"E / 2°59'50"N; 150 m.a.s.l.; 19.vii.2000. (MZL). Coll. P. Derleth. ***Paratypes***: B0521C GBIFCH00238421) 2 ♂ larvae, 6 ♀ larvae same data as holotype (in LIPI). B0713A (GBIFCH00238387) + B0713P (GBIFCH00238388): 2 ♂ larvae; Indonesia; East Kalimantan; Seturan (2000-bloc 44-45); Bas. Malinau; Riv. Wok (Sungai Guang) (Seturan tributary); Long/Lat 116°33'11"E / 2°59'12"N; 205 m.a.s.l.; 05.iv.2001. (MZL). B0433D (GBIFCH00238389) + B0433P (GBIFCH00238402): 1 ♂ larva, 3 ♀ larvae; Indonesia; East Kalimantan; Langap Sud (1995); Bas. Malinau; Riv. Ngayo (Rian tributary); Long/Lat 116°30'58"E / 3°04'56"N; 160 m.a.s.l.; 14.iv.2001. (MZL). B0711P (GBIFCH00238390): 1 ♀ larva; Indonesia; East Kalimantan; Seturan (2000-bloc 44-45); Bas. Malinau; Riv. Wok (Sungai Guang) (Seturan tributary); Long/Lat 116°33'11"E / 2°59'12"N; 205 m.a.s.l.; 17.vi.2000. (MZL). B0513C (GBIFCH00238391): 1 ♀ larva; Indonesia; East Kalimantan; Seturan (2001-bloc 57); Bas. Malinau; Riv. Tamalang (Seturan tributary); Long/Lat 116°30'29"E / 2°59'22"N; 160 m.a.s.l.; 10.iv.2001. (MZL). B0431P (GBIFCH00238403): 1 ♂ larva, 1 ♀ larva; Indonesia; East Kalimantan; Seturan camp; Bas. Malinau; Riv. Seturan; Long/Lat 116°30'36"E / 3°00'20"N; 140 m.a.s.l.; 13.vii.2000. (MZL). B0521A (GBIFCH00238407) + B0521B (GBIFCH00238409), B0521P(GBIFCH00238401): 1 ♂ larva, 2 ♀ larvae; Indonesia; East Kalimantan; Seturan (2001-bloc 57); Bas. Malinau; Riv. Tamalang (Seturan tributary); Long/Lat 116°30'29"E / 2°59'50"N; 150 m.a.s.l.; 19.vii.2000. (MZL). B0531A(GBIFCH00238424) + B0531D (GBIFCH00238400): 2 ♀ larvae; Indonesia; East Kalimantan; Seturan (2001-bloc 57); Bas. Malinau; Riv. Tamalang (Seturan tributary); Long/Lat 116°30'46"E / 2°59'22"N; 155 m.a.s.l.; 08.viii.2000. (MZL). B0813A (GBIFCH00238412) + B0813P (GBIFCH00238392): 2 ♀ larvae; Indonesia; East Kalimantan; Seturan (2000-bloc 43); Bas. Malinau; Riv. Temalat (Sungai Guang) (Seturan tributary); Long/Lat 116°33'29"E / 2°59'29"N; 230 m.a.s.l.; 16.iv.2001. (MZL). B0811P (GBIFCH00238414): 1 ♂ larva, 1 ♀ larva; Indonesia; East Kalimantan; Seturan (2000-bloc 43); Bas. Malinau; Riv. Temalat (Sungai Guang) (Seturan tributary); Long/Lat 116°33'29"E / 2°59'29"N; 230 m.a.s.l.; 18.vi.2000. (MZL). B1113A (GBIFCH00238404): 1 ♀ larva; Indonesia; East Kalimantan; Seturan (1999-bloc 27); Bas. Malinau; Riv. Seturan; Long/Lat 116°30'31"E / 3°00'57"N; 235 m.a.s.l.; 26.iii.2001. (MZL). B1011P2 (GBIFCH00238405): 1 ♀ larva; Indonesia; East Kalimantan; Seturan (1998-bloc 32-33); Bas. Malinau; Riv. Rian; Long/Lat 116°32'16"E / 3°00'57"N; 250 m.a.s.l.; 03.08.2000. (MZL). B1313A (GBIFCH00238410) + B1313B (GBIFCH00238408) + B1313P (GBIFCH00238393): 12 ♂ larvae, 5 ♀ larvae; Indonesia; East Kalimantan; Seturan (unexploited); Bas. Malinau; Riv. Seturan; Long/Lat 116°30'48"E / 3°00'05"N, 235 m.a.s.l.; 28.iii.2001. (MZL). B0511C (GBIFCH00238416): 1 ♂ larva; Indonesia; East Kalimantan; Seturan (2001-bloc 57); Bas. Malinau; Riv. Tamalang (Seturan tributary); Long/Lat 116°30'29"E / 2°59'22"N; 225 m.a.s.l.; 18.vii.2000. (MZL). B0541P (GBIFCH00238419): 4 ♂ larvae, 3 ♀ larvae; Indonesia; East Kalimantan; Seturan (2001-bloc 57); Bas. Malinau; Riv. Tamalang (Seturan tributary); Long/Lat 116°30'46"E / 2°59'22"N; 135 m.a.s.l.; 19.viii.2000. (MZL). B1211B (GBIFCH00238396): 1 ♂ larva, 3 ♀ larvae; Indonesia; East Kalimantan; Langap Sud (1999-bloc 24); Bas. Malinau; Riv. Rian; Long/Lat 116°31'05"E / 3°01'40"N; 135 m.a.s.l.; 11.vii.2000. (MZL). B0113C (GBIFCH00238397): 3 ♀ larvae; Indonesia; East Kalimantan; Langap Sud (1997-bloc 6); Bas. Malinau; Riv. Belakau (Rian tributary); Long/Lat 116°30'26"E / 3°04'04"N; 100 m.a.s.l.; 20.iv.2001. (MZL). B0533C

(GBIFCH00238386): 1 ♂ larva, 3 ♀ larvae; Indonesia; East Kalimantan; Seturan (2001-bloc 57); Bas. Malinau; Riv. Tamalang (Seturan tributary); Long/Lat 116°30'46"E / 2°59'22"N; 135 m.a.s.l.; 11.iv.2001. (MZL). B0511P: 2 ♂ larvae; Indonesia; East Kalimantan; Seturan (2001-bloc 57); Bas. Malinau; Riv. Tamalang (Seturan tributary); Long/Lat 116°30'29"E / 2°59'22"N; 225 m.a.s.l.; 18.vii.2000. (CZNC). All. Coll. P. Derleth.

FIGURE 19. Male larvae of *Bungona (Chopralla) bintang* n.sp., dorsal view.

Diagnosis. Larvae: A) Dorsal margin of femora with eight to eleven long, clavate setae (Fig. 31a); B) Few short spine-like setae between prostheca and mola of right mandible (Fig. 22a); C) Right prostheca bifid (Fig. 22b); D) Thick maxillary palp, apically pointed, slightly shorter than galea-lacinia (Fig. 24); E) Segment III of labial palp subrectangular and globular, with the distal margin almost straight (Fig. 25); F) Thorax and abdomen with very distinctive dark brown pattern (Fig. 19); G) Hindwing pads absent; H) Spines present on posterior margins of tergites VIII to X; I) Spines present on posterior margins of sternites V to IX; J) Scales lanceolate on surface of abdominal tergites (Fig. 26).



FIGURES 20–25. Larval structures of *Bungona (Chopralla) bintang* n.sp. (20) Labrum (left: ventral view; right: dorsal view). (21) Hypopharynx. (22a) Right mandible. (22b) Right prostheca. (23) Left mandible. (24) Right maxilla. (25) Labium (left: ventral view; right: dorsal view).

Description. Larvae: *Measurements*. Length (mm). Body: 3.3–3.9; cerci: 0.8–1.1; terminal filament: 0.8–1.1; antenna: 0.5.

Colouration (Fig. 19): General colouration brown. Head uniformly brown; turbinate eyes brown. Pronotum with M-shaped pattern; mesonotum with complex but consistent pattern, similar to lyre or trident; metanotum with pattern similar to abdominal tergites. Legs light yellow, except for brown stripes at apices of femur and tibia. Abdominal tergites brown with specific pattern composed of two lateral yellowish spots and one smaller, central

yellowish spot, except tergites VII and VIII light yellow. Cerci whitish at base and light brown at apex, with one brown stripe every five segments.

Head. *Antenna*. Scape and pedicel sub-cylindrical.

Labrum (Fig. 20). Length about 0.6 × maximum width. Distal margin rounded and with shallow medial emargination; dorsally with two long, central, stout setae and submedian arc composed of nine stout setae; few short setae scattered on dorsal face. Distal margin with row of multifid (disto-laterally) and bifid (disto-medially) setae. Ventral surface laterally with three short, stout setae.

Hypopharynx (Fig. 21). Lingua slightly longer than superlingua. Distal margin trilobed; covered with short, fine, simple setae. Superlingua subtriangular; fine, simple setae scattered over distal margin.

Right mandible (Fig. 22a). Two incisor sets partially fused, inner and outer sets with 3 + 3 denticles respectively, one additional reduced denticle on lateral margin of outer incisor. Prostheca slender, bifurcated (Fig. 22b). Margin between prostheca and mola straight with seven spine-like setae. Apex of mola with two setae.

Left mandible (Fig. 23). Two incisor sets almost completely fused, inner and outer set of incisors with 3 + 3 denticles respectively, one additional reduced denticle on lateral margin of distal incisor. Prostheca robust, with denticles and comb-shaped structure. Margin between prostheca and mola almost straight. Triangular process next to mola slender with slightly concave margin, pointing upwards. Denticles of mola not constricted. Tuft of setae at apex of mola absent.

Maxilla (Fig. 24). Apex of lacinia with row of setae with two denti-setae, five long and simple setae and six shorter spine-like setae; outer base of denticles with two simple setae. Maxillary palp 2-segmented, shorter than galea-lacinia; palp segment II 2.0 × length of segment I; medium, fine, simple setae scattered over surface of maxillary palp; segment II enlarged and apically pointed.

Labium (Fig. 25). Glossae slightly longer than paraglossae; inner margin with five stout setae increasing in length apically; apex with two clavate setae; outer margin with three or four stout setae. Paraglossae: apex with stout setae and one short clavate seta; outer margin with row of about ten long, stout setae. Labial palp with segment I 0.8 × length of segments II & III combined; segment I covered with micropores; segment II slightly projected apically; one row of three spine-like setae ventrally; segment III globular; covered with short and long stout simple setae scattered over ventral surface.

Thorax. *Hindwing pads* absent.

Legs (Figs. 31a, 31b, 32, 33, 34). *Femur*. Length about 3.5 × maximum width; dorsally with row of 8–11 clavate setae and two clavate setae at apex (Fig. 31b); length of setae about 0.3 × maximum width of femur (Fig. 31a); ventrally with scattered short stout setae, arc of long and tubular setae present (Fig. 33, but not illustrated on Fig. 31a). *Tibia.* Dorsally bare except for two small setae at base and one seta at apex; ventrally with one row of about seven short, stout setae and two clavate setae at apex; lateral face with few short, stout setae, tibio-patellar suture present with arc of long and tubular setae. *Tarsus.* Dorsally with short, minute setae scarce; arc of long, tubular setae; ventrally with one row of about five minute setae and one single longer seta at apex. Tarsal claw with two rows of three or four broad and flattened denticles, apically with two or three furrows (Figs. 32, 34); subapical setae present but only visible by SEM (Fig. 34).

Abdomen. *Tergites*. Surface with lanceolate scales and scale bases (Figs. 26, 35); posterior margins with free lanceolate scales (Fig. 26); spines present on distal margins of segments VIII–X; disto-lateral spines present on segments V–X (Fig. 27).

Sternites. Rows of insertions of setae present on sternites V and VI, poorly visible on adjacent segments; long setae only visible at SEM. Lanceolate scales and scale bases on distal halves of segments I–X; with spines on posterior margins of segments V–IX.

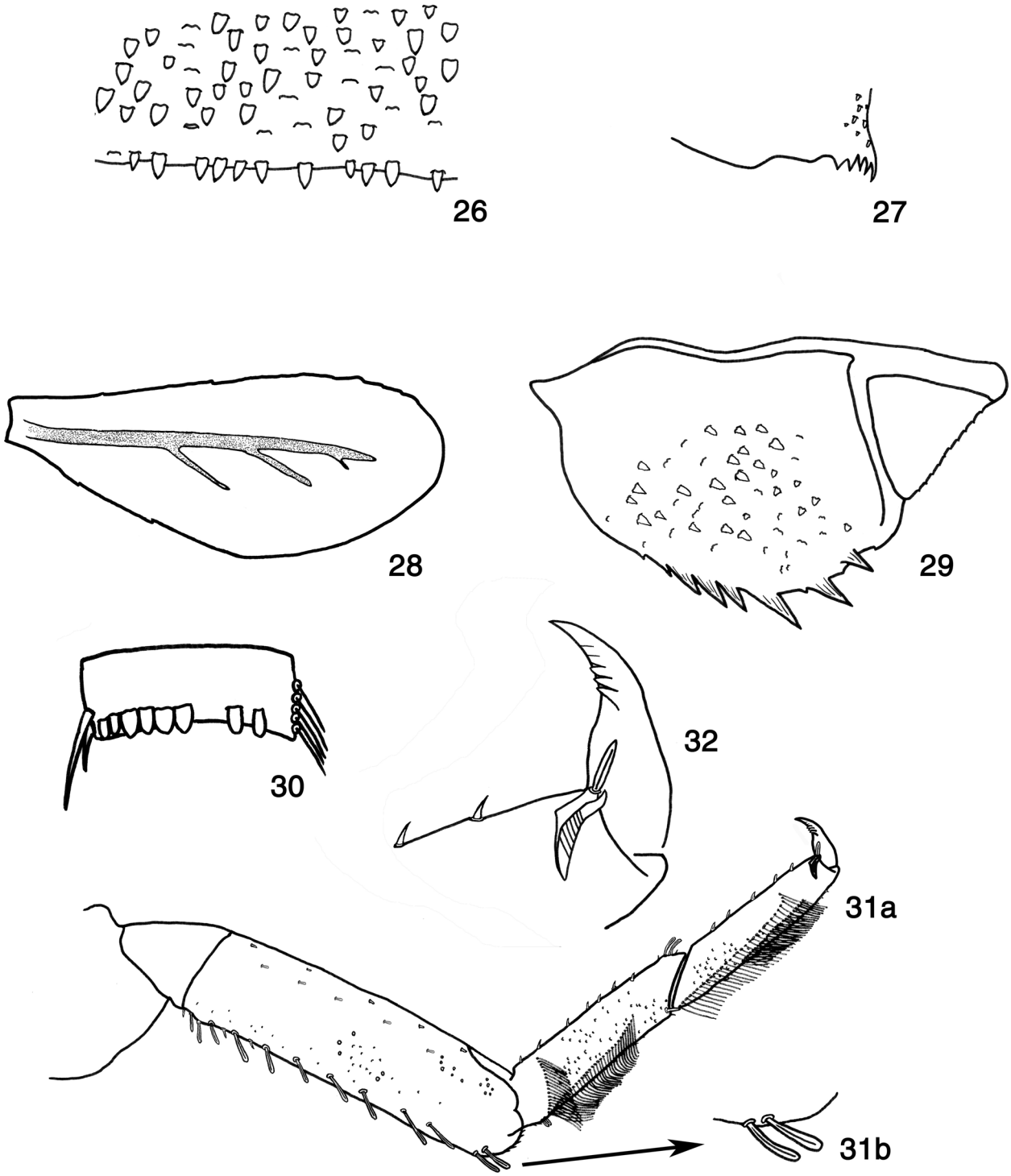
Gills (Fig. 28). Present on segments I–VII. Slender and elongate. Inner and outer margins smooth, only slightly serrated apically. Tracheation well-marked but poorly branched. Gill I about ½ length of gill IV.

Paraproct (Fig. 29). With nine marginal spines, increasing in length. Surface with scale or scale bases. Postero-lateral extension with minute marginal spines.

Caudal filaments. Posterior margins of segments each with two long spines and five or six long, lanceolate scales (Figs. 30, 36).

Imagos: Unknown.

Etymology. The Indonesian word “Bintang” means “Star” in both the astronomical and figurative senses.

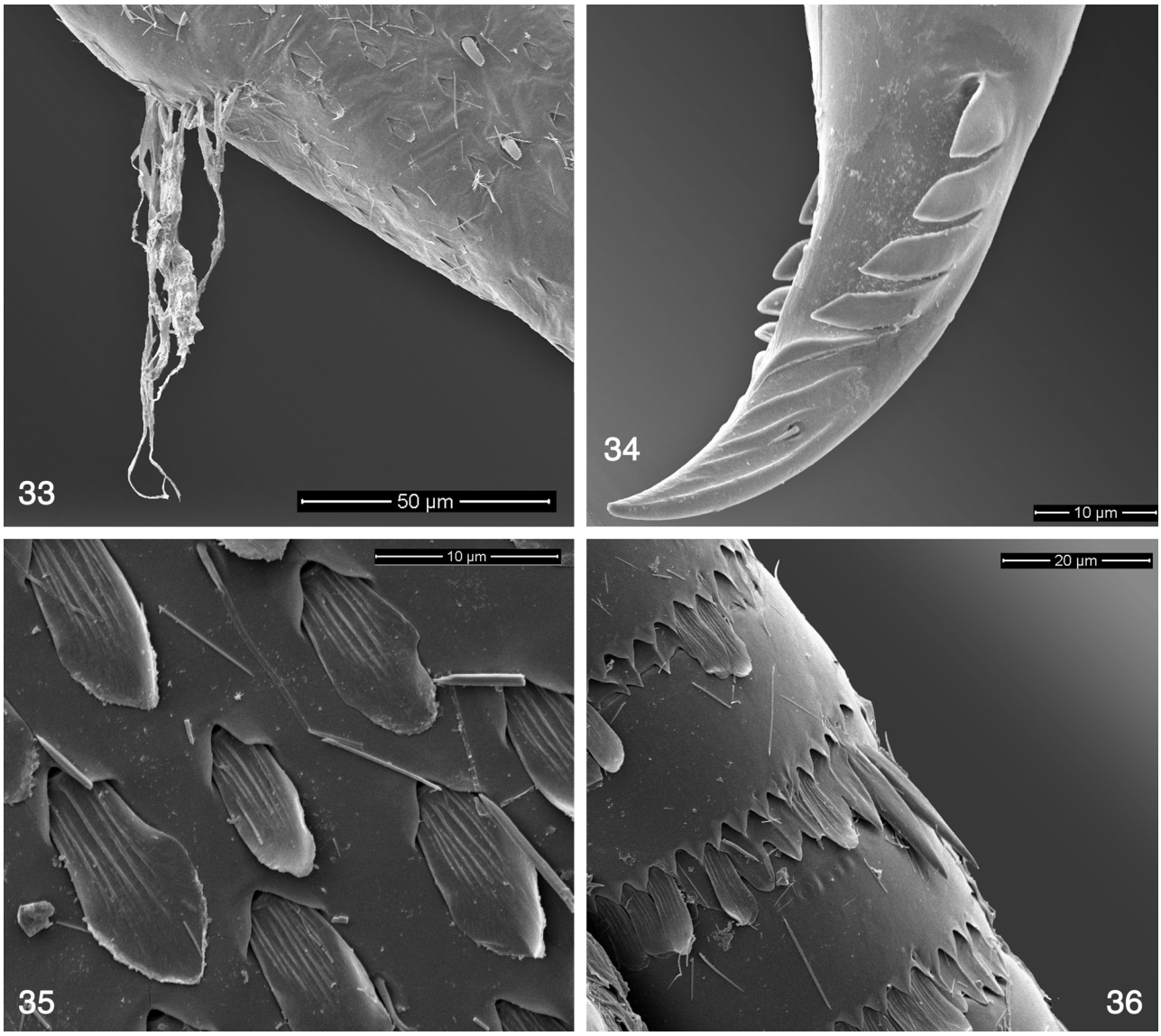


FIGURES 26–32. Larval structures of *Bungona (Chopralla) bintang* n.sp. (26) Distal margin of abdominal tergite IV. (27) Disto-lateral spines on segment IV. (28) Gill IV. (29) Paraproct. (30) Segment of cercus. (31a) Foreleg. (31b) Apex of forefemur. (32) Fore tarsal claw.

Discussion

Bungona (Chopralla) bintang possesses all the characters of the genus *Bungona* (Salles *et al.* 2016). The presence of two rows of flat denticles on the tarsal claws (Fig. 32) and the peculiar body pattern, especially on the pronotum (Fig. 19), clearly indicate that the species belongs to the subgenus *Chopralla*.

Including the new species described herein, *Chopralla* encompasses seven formally described species and Genus No. 2 sp. 1, sensu Müller-Liebenau, 1984. Four named species (*B. (C.) colorata, B. (C.) pusilla, B. (C.) ceylonensis, B. (C.) liebenauae*), and Genus No. 2 sp. 1, possess minute but visible hindwing pads, while *B. (C.) fusina, B. (C.) similis* and *B. (C.) bintang* have no hindwing pads (Müller-Liebenau 1983; Müller-Liebenau 1984; Tong & Dudgeon 2003; Soldán *et al.* 1987).



FIGURES 33–36. Larval structures of *Bungona (Chopralla) bintang* n.sp., Scanning Electron Micrographs. (33) Forefemur. (34) Apex of fore tarsal claw. (35) Surface of tergite IV. (35) Detail of cercus.

The three species without hindwing pads can be distinguished by the number of tergites with spines on the posterior margins: V–X for *B. (C.) fusina*, IX–X for *B. (C.) similis*, and VIII–IX for *B. (C.) bintang* (Table 1). Additional features may be used, especially features of the maxillary palp, which is relatively thin in *B. (C.) fusina* and *B. (C.) similis*, while it is thicker in *B. (C.) bintang*; *B. (C.) fusina* apparently does not possess stout setae between the prostheca and mola, while they are present in the two other species (Müller-Liebenau 1983; Müller-Liebenau 1984; Tong & Dudgeon 2003; Soldán *et al.* 1987).

Bungona (C.) liebenauae and Genus No. 2 sp. 1 are the unique species of the subgenus, having a right prostheca not bifid and not plumose (Soldán *et al.* 1987; Müller-Liebenau 1984). This character clearly indicates that *B. (C.) liebenauae* and Genus No. 2 sp. 1 have an isolated position within the subgenus (Soldán *et al.* 1987).

B. (C.) bintang cannot be included in the identification key of Soldán *et al.* (1987), as none of the combination of characters in couplets 7–10 correspond (hindwing pads absent—couplet 10; with denticles on tarsal claw and contrasting colour pattern—couplet 7).

TABLE 1. Main morphological differences and known distributions of the different species of *Chopralla.*

	***bintang* n.sp.**	***ceylonensis*** (Müller-Liebenau, 1983)	***colorata*** (Soldán, Braasch & Lun, 1987)	***fusina*** (Tong & Dudgeon, 2003)	***liebenauae*** (Soldán, Braasch & Lun, 1987)	***pusilla*** (Müller-Liebenau, 1984)	***similis*** (Müller-Liebenau, 1983)
Distribution	Borneo	Sri-Lanka	Vietnam	Hong Kong	Vietnam	Borneo	Sri-Lanka
Hindwing pads	absent	minute	minute	absent	minute	minute	absent
Tergites with spines on posterior margin	VIII–X	IX–X	IV–X	V–X	III–X	IX–X	IX–X
Rigth mandible, margin between prostheca and mola	A few short stout spine-like setae	A few short stout spine-like setae	Two stout spine-like setae	Absent	Tiny spine-like setae	A few short spine-like setae	A few short stout spine-like setae
Right prostheca	Bifid	Bifid	Bifid	Bifid	Simple	Bifid	Bifid
Shape of segment III of labial palp	Broad and apically straight	Broad and apically straight	Broad and apically rounded	Broad and apically straight	Falcate, apically rounded	Broad and apically straight	Broad and apically straight
Spination of paraproct	Increasing in length	All equal, medium size	Increasing in length	Increasing in length	All equal, long and slender	Increasing in length	Increasing in length
Amount of clavate setae on dorsal margin of femora	8–11	11–15	6–9	7–11	8–10	8–10	11–15
Maxillary palp	Thick	Thin	Thin	Thin	Thin	Thin	Thin

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