



## Genus *Bungona* Harker, 1957 (Ephemeroptera: Baetidae) from China, with descriptions of three new species and a key to Oriental species

WEIFANG SHI<sup>1,2</sup> & XIAOLI TONG<sup>2,3</sup>

<sup>1</sup>Guizhou Center for Disease Control and Prevention, Guiyang 550001, China

<sup>2</sup>Department of Entomology, College of Agriculture, South China Agricultural University, Guangzhou 510642, China

<sup>3</sup>Corresponding author. E-mail: [xtong@scau.edu.cn](mailto:xtong@scau.edu.cn)

### Abstract

Six species of *Bungona* Harker, including three species of the subgenus *Centroptella* Braasch & Soldán and three species of subgenus of *Chopralla* Waltz & McCafferty, are reported from China. Of which, three new species, *Bungona* (*Centroptella*) *ovata* sp. nov., *Bungona* (*Centroptella*) *quadrata* sp. nov. and *Bungona* (*Chopralla*) *bifida* sp. nov., are described based on nymphal materials. In addition, *Bungona* (*Chopralla*) *liebenauae* (Soldán, Braasch & Muu, 1987) that was previously known only from Vietnam is newly recorded in China. An identification key to *Bungona* species known from Oriental Region is presented.

**Key words:** Mayfly, *Centroptella*, *Chopralla*, nymph, new species, China

### Introduction

The genus *Bungona* was established by Harker (1957) as a monobasic genus with type species *B. narilla* from Australia. In 1998, Lugo-Ortiz and McCafferty reported that genus *Cloeodes* was firstly found from Australia and described two new species, *Cloeodes fustipalpus* Lugo-Ortiz & McCafferty 1998 and *C. illiesi* Lugo-Ortiz & McCafferty 1998, from the continent (Lugo-Ortiz & McCafferty 1998). However, subsequently these two species were treated as synonyms of *Bungona narilla* by Suter and Pearson (2001). Later, based on mitochondrial and morphological data, Webb and Suter (2010) removed *Cloeodes illiesi* from the synonymy with *Bungona narilla* and considered it as a valid species of *Bungona*. Although the genus *Bungona* has been erected more than half a century since 1957, the systematic position of *Bungona* has scarcely been discussed until Salles *et al.* (2016) who clarified the relationship between *Cloeodes* Traver, 1938 and related genera including *Bungona* by phylogenetic analysis, with resultant clarification of much taxonomic confusion. According to their concept of the *Cloeodes* complex, *Cloeodes* is restricted to the New World, while *Bungona* is the only genus among the *Cloeodes* complex present in the Middle East, Asia and Australasian regions (Salles *et al.* 2016; Sroka *et al.* 2019). At present, the genus *Bungona* is composed of three subgenera: *Bungona*, *Centroptella* and *Chopralla*, which suggested that the genus is much more diverse and widespread than originally conceived (Salles *et al.* 2016; Marle *et al.* 2016; Sroka *et al.* 2019). The species of *Bungona* in China are poorly documented, only two species have been reported (Tong & Dudgeon 2003; Tong *et al.* 2003): *B. (Centroptella) longisetosa* (Braasch & Soldán, 1980) and *B. (Chopralla) fusina* (Tong & Dudgeon, 2003). During sorting out the mayfly samples collected from different parts of China, hundreds of specimens were identified as species of *Bungona*. The purpose of this study is to review the Chinese *Bungona* species including descriptions of three new species and one species newly recorded from China, together with a key to Oriental *Bungona* species based on mature nymphal stages.

## Material and methods

All nymphal material used for this study were collected with a D-frame net from streams and then were directly placed into vials containing 90% ethanol in the field. Some specimens were dissected under the stereomicroscope and were mounted on slides with Hoyer's solution for examination. Mounted structures were examined and photographed under the microscope with a digital camera attached. In addition, some specimens were observed under the SEM (FEI/Philips XL-30-ESEM) operated at 20 kV. All type specimens are deposited in the Insect Collection, South China Agricultural University (SCAU), Guangzhou, China.

## Taxonomy

### *Bungona (Centroptella) longisetosa* (Braasch & Soldán, 1980)

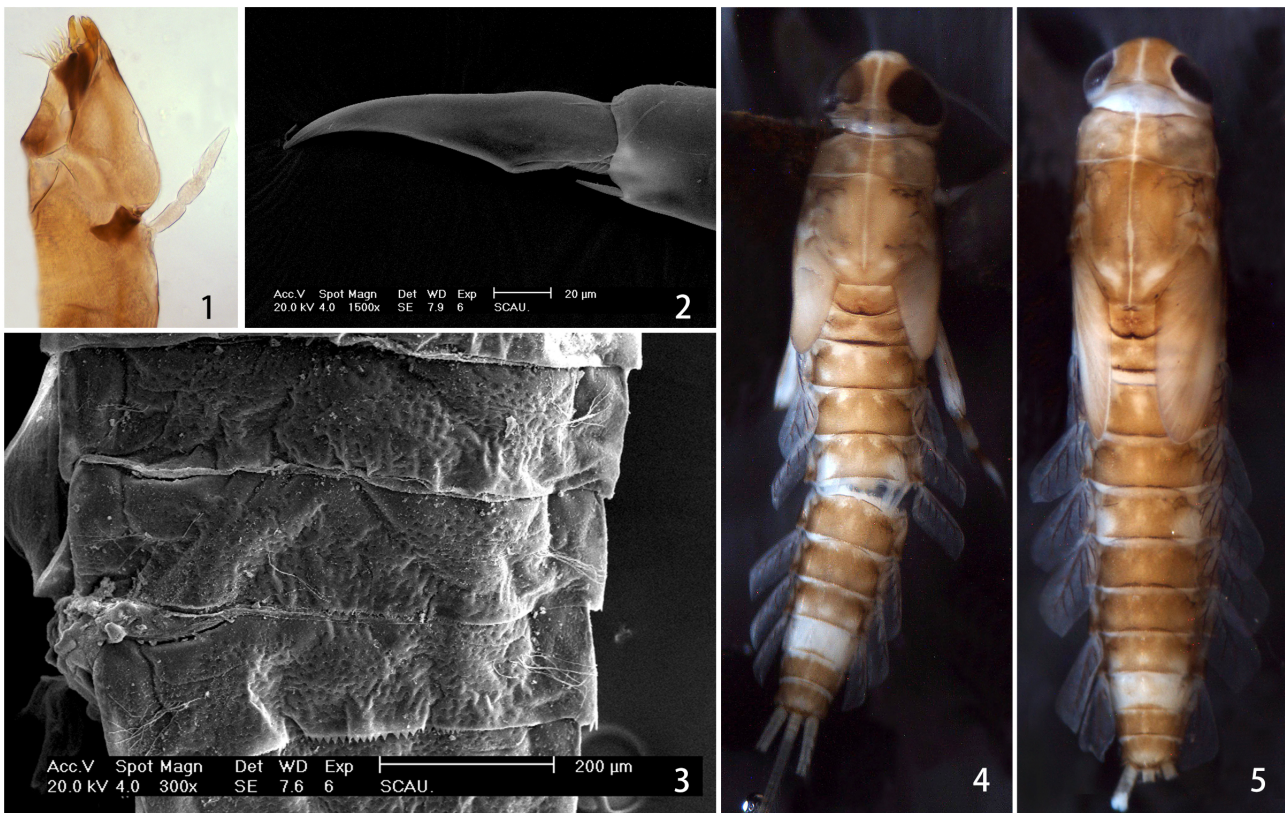
(Figs 1–5)

*Centroptella longisetosa*: Braasch & Soldán, 1980: 123.

*Cloeodes longisetosus*: Waltz & McCafferty, 1987a: 177; 1987b: 201; Tong, Dudgeon & McCafferty, 2003: 669.

*Bungona (Centroptella) longisetosa*: Salles, Gattolliat & Sartori, 2016: 104.

**Material examined** (deposited in ethanol unless otherwise stated). Besides the material examined by Tong *et al.* (2003), the following additional specimens have been studied: **CHINA. Guangdong:** 1 nymph, Wengyuan County, Xinjiang Town, Yangzigang (24.48°N, 113.80°E, alt. 128m), 21.v.2011, coll. Weifang Shi; 1 nymph, Dongguan City, Xiegang Town, Yingpingzui Forest Park (22.90°N, 114.22°E, alt. 160m), 22.x.2011, coll. Weifang Shi; 1 nymph, Conghua City, Bishuiwan (23.70°N, 113.72°E, alt. 60m), 19.xi.19.2011, coll. Weifang Shi. **Hainan:** 2 nymphs, Wangning City, Nanqiao Town (18.69°N, 110.16°E, alt. 50m), 22.iv.2011, coll. Weifang Shi; 1 nymph, Baisha County, Yinggeling National Nature Reserve (19.03°N, 109.54°E, alt. 540m), 27.iv.2011, coll. Weifang Shi.



**FIGURES 1–5.** Nymph of *Bungona (Centroptella) longisetosa* (Braasch & Soldán) (1) right maxilla; (2) claw; (3) abdominal sterna IV–VI; (4) habitus of male nymph (dorsal view); (5) habitus of female nymph (dorsal view).

**Distribution and biology.** China (Guangdong, Hainan, Hong Kong). The nymphs usually inhabit the stone surfaces in slow current streams. Presumably it has a wide geographical range in southern China.

**Comments.** This species was originally described by Braasch and Soldán (1980) based on nymphs from Liu Chui, China. Later, Tong *et al.* (2003) redescribed the nymphal stage and provided the description of imagoes reared in the laboratory from mature nymphs, thereby confirming their association. The nymph of *B. (C.) longisetosa* (Figs 4–5) is characterized by the extremely short maxillary palpus (about 1/2 the length of galealacinia) (Fig. 1) and abdominal sternites IV–VI each with a pair of long and fine setal tufts (i.e. with contiguous setal bases) (Fig. 3). In male imaginal stage, it can be easily separated from the imaginal congeners by the presence of a well-developed rectangular protuberance between the genital forceps bases (Tong *et al.* 2003).

***Bungona (Centroptella) ovata* Shi & Tong, sp. nov.**

(Figs 6–15, 47)

**Material examined. Holotype.** 1 mature nymph in ethanol, **CHINA, Sichuan**, Xuyong County, Shuiwei Town, Huagaoxi National Nature Reserve (24.20°N, 110.29°E, alt. 770m), 3.iv.2012, coll. Weifang Shi.

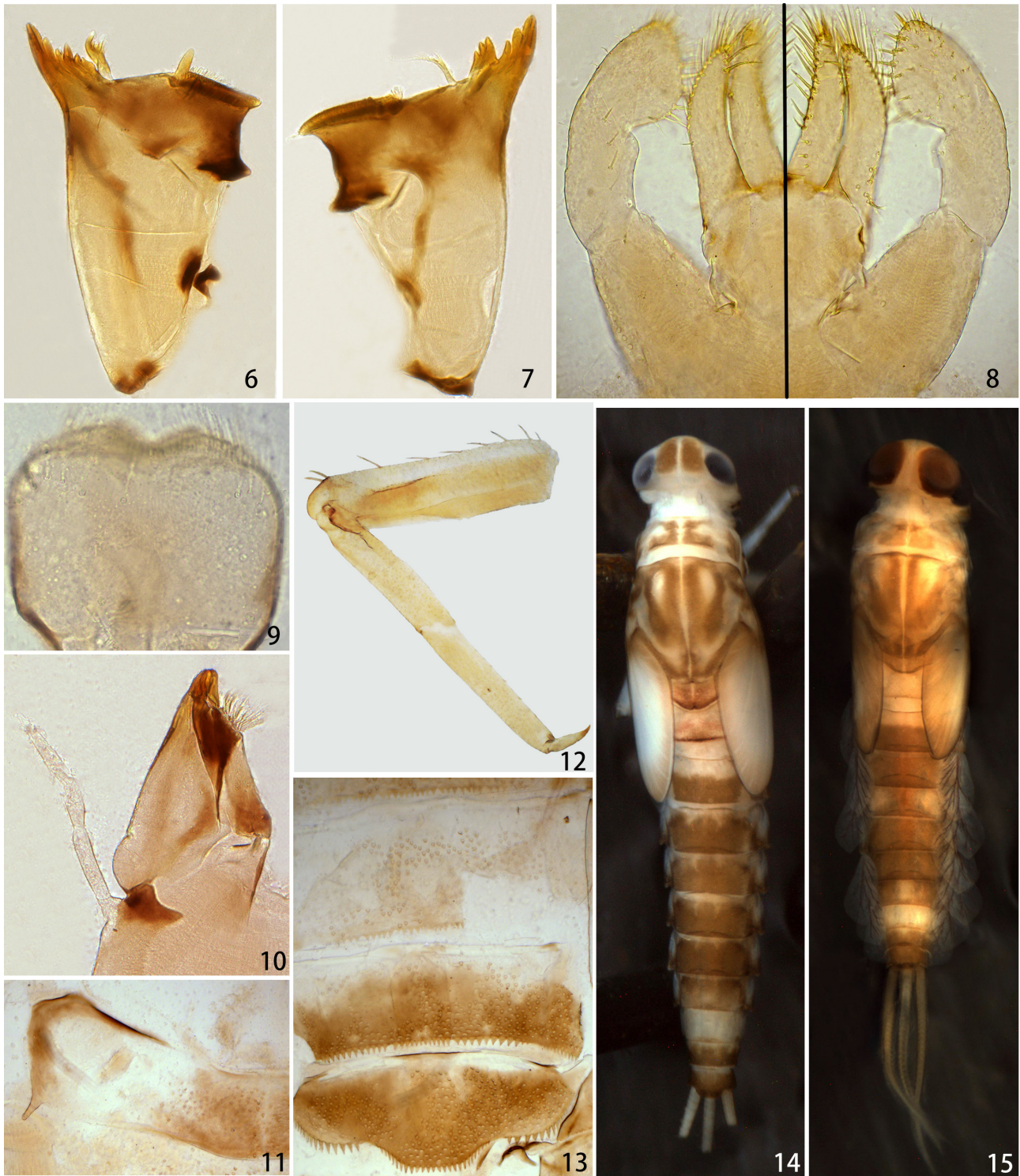
**Paratypes** (deposited in ethanol unless otherwise stated). 1 nymph on slides and 3 nymphs, same data as holotype. **CHINA, Guizhou:** 1 nymph on slides and 14 nymphs, Xishui County, Sanchahe Scenic, 6.viii.2011, coll. Xianfu Li; 1 nymph, Chishui City, Foguangyan Scenic, 31.iii.2012, coll. Weifang Shi.

**Description. Mature nymph.** Body length 3–3.5mm, cerci 1–1.2mm, median caudal filament slightly shorter than cerci.

**Colouration.** Body with contrasting colour pattern (Figs 14–15); vertex brown with white ecdysial line; pronotum brown with one pair of yellowish white oval markings transversely, mesonotum brown with 2 pairs of longitudinal yellowish white markings; all legs yellowish brown except for femora tinged with brown apically; abdominal tergites largely brown except for tergite I, anterior half of tergite II and tergite VIII yellow-white (Fig. 14); cerci off-white to yellowish brown. Male nymph similar to female in colouration, but tergite IV with one pair of oval yellow-white markings and tergite VI with one pale brown marking medially (Fig. 15).

**Head.** Antennae slightly longer than width of head, pedicel slightly longer than scape. Labrum rectangular (Fig. 9), approximately 1.5 times as wide as long; anteromedian notch shallow with one small rounded lobe at base; dorsally each side with one median long setae and one row of 4 robust and simple submarginal setae, a few fine setae scattered posteriorly (Fig. 9); ventrally bordered with feathered setae along distal margin and one distomedial arc of very fine setae. Left mandible (Fig. 6): incisors fused, with 6 denticles apically; prosthema robust, apically with 2 acute and 3 blunt denticles; margin between incisors and molar region straight and without any setae. Right mandible (Fig. 7): incisors partially fused, inner and outer incisors each with 3 denticles apically; prosthema slender, plumose and bifurcated at middle; margin between incisor base and molar with one spine-like seta. Hypopharynx with a median projection and superlinguae broadly truncate, covered with abundant fine setae. Maxillae (Fig. 10): galealacinia with one row of 4 long basal setae and one short bristle-like hump seta basally; maxillary palpus slightly shorter than galealacinia; segment II approximately 1.6 x length of segment I. Labium (Fig. 8): glossae slightly longer than paraglossae, ventrally with one row of 11–13 acute, stout setae along the inner margin and 3 robust setae at the apex, dorsally with 3–4 long, stout setae along the outer margin; paraglossae subequal to glossae in width, ventrally with one row of 3–4 acute, stout setae along the inner margin and 11–13 acute, stout setae along outer margin, dorsally scattered with 6–7 short, fine setae on basal area; segment I of labial palpus about 3/4 of the length of segment II and III combined; segment II dorsally with one row of 4 long, simple setae distomedially; segment III irregular trapezoidal and with distal margin truncated, length of inner margin approximately 1/2 of outer margin, dorsal surface smooth and ventral surface with plenty of stout and simple setae.

**Thorax.** Pronotum surface smooth, without tubercles. Hindwing pads minute but visible (Fig. 11). Leg surfaces scattered with trapezoidal scale bases. Femora approximately 4.5 x maximum width, dorsally with row of 7–8 long, robust setae (approximately 1/3 of femoral width) and one pair of stout subapical setae (Fig. 12), ventrally with numerous pores; tibiae dorsally with fine setae, ventrally with one row of slightly acute stout setae and a pair of long, stout, slightly feathered setae apically; tarsi dorsally with fine setae, ventrally with one row of slightly acute stout setae. Claw smooth, without denticles, apically with 6–8 furrows; subapical setae vestigial.



**FIGURES 6–15.** Nymph of *Bungona (Centroptella) ovata* sp. nov. (6) left mandible; (7) right mandible; (8) labium (left: dorsal view; right: ventral view); (9) dorsal view of labrum; (10) left maxilla; (11) metanotum; (12) foreleg; (13) abdominal terga VIII–X; (14) habitus of female nymph (dorsal view); (15) habitus of male nymph (dorsal view).

**Abdomen.** Abdominal terga densely scattered with trapezoidal scale bases and triangular scales; posterior margin of tergites III–X with contiguous acute spines (Fig. 13), successively increasing in length backwards; sternal surface scattered with trapezoidal scale bases and triangular scales; posterior margin of sternites V–IX with triangular spines; sternites II–VI each with one pair of setal tufts anterolaterally; paraproct subtriangular (Fig. 47), with trapezoidal scale bases and pores medially, inner margin with 10–11 acute spines. Gills with 7 pairs, asymmetric and well tracheated (Fig. 15). Median caudal filament slightly shorter than cerci, inner margin of cerci and both sides of median caudal filament fringed with swimming bristles.

**Imagoes.** Unknown.

**Etymology.** The specific epithet “*ovata*” is from Latin adjective “*ovatus*”, meaning “*oval*”, in reference to the pro- and mesonotum having oval yellowish markings.

**Distribution and biology.** China (Guizhou, Sichuan). The nymphs are usually found in slow to moderately rapid mountain streams with cobble and gravel substrates.

**Comments.** Nymph of *B. ovata* **sp. nov.** is superficially similar to *B. longisetosa*, but it can be easily distinguished from the latter by following characteristics: (1) pro- and mesonotum having oval yellowish markings, while those in *B. longisetosa* are almost uniformly brown; (2) abdominal tergite I and anterior half of tergite II yellow-white (vs. tergites I–II largely brown in *B. longisetosa*); (3) maxillary palpus subequal to galealacinia in length (vs. only about 1/2 length of galealacinia in *B. longisetosa*); (4) segment II of labial palpus dorsally with one row of 4 long, simple setae apicomediaally, distal margin of segment III truncated (vs. segment II dorsally with row of 3 long, simple setae apicomediaally and segment III trapezoidal in *B. longisetosa*).

***Bungona (Centroptella) quadrata* Shi & Tong, sp. nov.**

(Figs 16–31,48)

**Material examined. Holotype.** 1 mature nymph in ethanol, **CHINA, Guangxi**, Jinxiu County, Fenzhan (24.12°N, 110.21°E, alt. 779m), 16.xi.2011, coll. Weifang Shi.

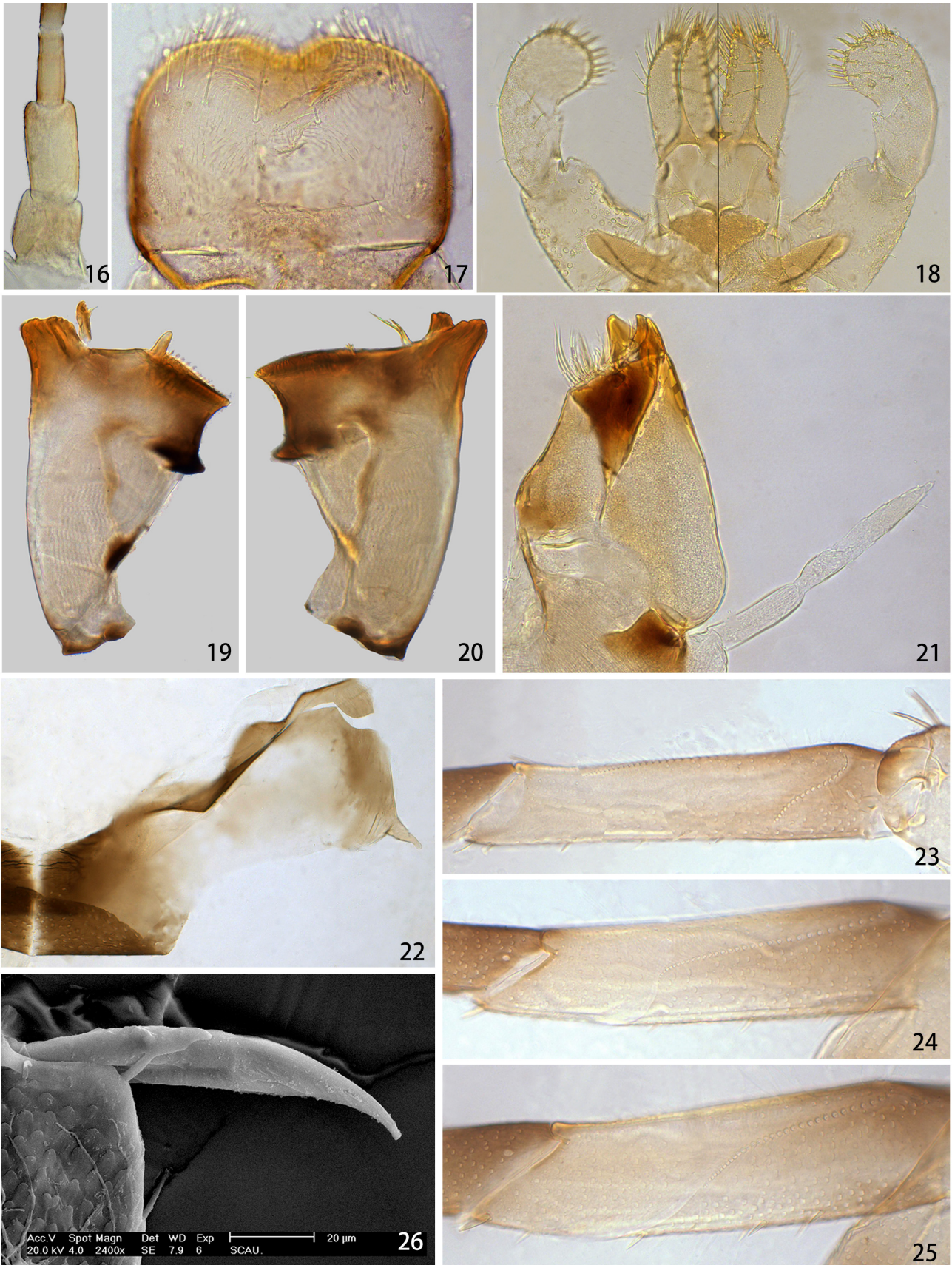
**Paratypes** (deposited in ethanol unless otherwise stated). 2 nymphs on mounted slides and 1 nymph, same data as holotype; **CHINA. Guangxi:** 3 nymphs, Wuming County, Daming Mountain (23.52°N, 108.34°E, alt. 830m), 8.ix.2011, coll. Weifang Shi. **Guangdong:** 1 nymph on mounted slides and 1 nymph, Heyuan City, Yequgou Scenic (23.71°N, 114.62°E, alt. 210m), 14.ix.2011, coll. Weifang Shi. 2 nymphs, Yingde City, Shimentai Nature Reserve, Hengshitang (24.43°N, 113.31°E, alt. 810m), 2.xi.2011, coll. Weifang Shi.

**Description. Mature nymph.** Body length 3.3–3.7mm, cerci 1.3–1.7mm, median caudal filament slightly shorter than cerci.

**Colouration.** Vertex brown with white ecdysial line. Thorax pale brown shading to brown smudges on pro- and mesonotum; femora pale brown shaded with one brown marking submedially, tibiae and tarsus pale brown with dark brown proximally. Abdominal tergites almost uniformly brown (Fig. 31). Cerci cream to yellowish brown.

**Head.** Antennae approximately 1.3 x width of head, pedicel approximately 2 x length of scape (Fig. 16). Labrum (Fig. 17): rectangular, width approximately 1.6 x length; anteromedian notch shallow with one small rounded lobe at base; dorsally each side with one medial long seta and one row of 3–4 robust and simple submarginal setae, fine and simple setae scattered posteriorly; ventrally bordered with feathered setae along distal margin and one disto-medial arc of very fine setae. Left mandible (Fig. 19): incisors fused, apically with 6 denticles; prosthema robust with 2 acute and 3 blunt denticles apically; plane of mandible between incisor base and molar region smooth. Right mandible (Fig. 20): incisors partially fused, inner and outer incisors with 3+3 denticles respectively; prosthema slender, plumose and bifurcated at middle; plane of mandible between incisor base and molar region smooth. Hypopharynx with one median projection and superlinguae broadly truncate, covered with abundant fine setae. Maxillae (Fig. 21) with one row of 4 long basal setae and one short bristle-like hump seta on basis of galealacinia; maxillary palpus 2-segmented, weakly shorter than galealacinia, segment II pointed apically, approximately 2.0 x length of segment I. Labium (Fig. 18): glossae slightly longer than paraglossae, ventrally with one row of 10–12 acute, stout setae along the inner margin and 4 robust setae at the apex, dorsally with 5–6 long, stout setae along the outer margin; paraglossae ventrally with one row of 5–6 acute, stout setae along the inner margin and 11–13 acute, stout setae along the outer margin. Labial palpus 3-segmented; segment I subequal to segment II and III combined in length, scattered with numerous pores dorsally and fine setae ventrally; segment II slightly projected apically, dorsal surface with one row of 3 long, acute setae apicomediaally, ventrally scattered with numerous fine, simple setae; terminal segment rectangle, scattered with plenty of stout, simple setae ventrally.

**Thorax.** Pronotum surface smooth without tubercles. Hindwing pads minute but visible (Fig. 22). Leg surfaces scattered with trapezoidal scale bases. Femora approximately 4.5 x maximum width, dorsally with row of about 6 long, robust setae which approximately 1/3–1/4 of femoral width and one pair of close-set stout subapical setae (Fig. 27), ventrally with numerous pores; tibiae (Figs 23–25) dorsally with fine setae, ventrally with one row of



**FIGURES 16–26.** Nymph of *Bungona* (*Centroptella*) *quadrata* sp. nov. (16) antenna; (17) dorsal view of labrum; (18) labium (left: dorsal view; right: ventral view); (19) left mandible; (20) right mandible; (21) right maxilla; (22) metanotum; (23) fore tibia; (24) mid tibia; (25) hind tibia; (26) claw.



**FIGURES 27–31.** Nymph of *Bungona* (*Centroptella*) *quadrata* sp. nov. (27) foreleg; (28) abdominal tergum VIII; (29) abdominal sterna IV–IX; (30) cerci; (31) habitus of female nymph (dorsal view).

slightly acute stout setae and one pair of long, stout, slightly feathered setae apically; tarsi dorsally with fine setae, ventrally with one row of slightly acute stout setae. Claw smooth without denticles (Fig. 26), apically with 3–4 furrows; subapical setae vestigial.

**Abdomen.** Abdominal tergal surface scattered with scale bases and triangular scales densely (Fig. 28). posterior margin of tergites II–X with contiguous acute spines, successively increasing in length backwards; sternal surface scattered with numerous scale bases and pores; sternites IV–IX with triangular spines posteriorly (Fig. 29); sternites II–VI each with one pair of setal tufts anterolaterally; paraproct (Fig. 48) subtriangular, surface scattered with trapezoidal scale bases and triangular scale densely, inner margin with 8–9 long and pointed spines. Gills with 7 pairs, asymmetric and well tracheated (Fig. 31). Median caudal filament slightly shorter than cerci; inner margin of cerci and two sides of median caudal filament fringed with long swimming bristles; distal margin of each segment with trapezoidal scale bases and every two segments with long, stout spines distally (Fig. 30).

**Imagoes.** Unknown.

**Etymology.** The specific epithet “*quadrata*” is from Latin adjective “*quadratus*”, meaning “rectangular” and referring to the terminal segment of labial palpus rectangle-shape.

**Distribution and biology.** China (Guangxi, Guangdong). The nymphs are usually found on the stone surfaces in shallows or lentic habitats of mountainous streams.

**Comments.** Compared with other species of the subgenus *Centroptella* whose body with relatively contrasting

colour pattern, this new species is easily recognized by the body coloration relatively uniformly brown. Apart from that, this new species is somewhat similar to *B. (C.) ovata* sp. nov. in structure, but it can be separated from the latter by (1) antennal pedicel much longer, approximately 2 x length of scape (Fig. 16); (2) terminal segment of labial palpus rectangular (Fig. 18) instead of irregular trapezoidal and with distal margin truncated (Fig. 8); (3) posterior marginal spines present on tergites II–X, while such spines present on tergites III–X in *B. (C.) ovata* sp. nov..

***Bungona (Chopralla) bifida* Shi & Tong, sp. nov.**

(Figs 32–46, 49)

**Material examined. Holotype.** 1 mature nymph in ethanol, **CHINA, Sichuan**, Huagaoxi National Nature Reserve, Xuyong County, Shuiwei Town (24.20°N, 110.29°E, alt. 770m), 3.iv.2012, coll. Weifang Shi.

**Paratypes** (deposited in ethanol unless otherwise stated). 2 nymphs on slides and 4 nymphs, same date as holotype. **CHINA, Guizhou:** 1 nymph on mounted slides and 5 nymphs, Suiyang County, Kuankuoshui National Nature Reserve, Maoya Town, Zhongping (28.20°N, 107.04°E, alt. 640m), 26.iii.2012, coll. Weifang Shi. **Hubei:** 1 nymph, Yingshan County, Taohuachong Scenic (30.99°N, 116.04°E, alt. 600m), 24.vi.2014, coll. Weifang Shi. **Sichuan:** 1 nymph, Pingwu County, Laohegou (32.47°N, 104.67°E, alt. 1480m), 25.v.2012, coll. Weifang Shi.

**Description. Mature nymph.** Body length: 4.5–6mm, cerci 2.5–3mm, filament slightly shorter than cerci.

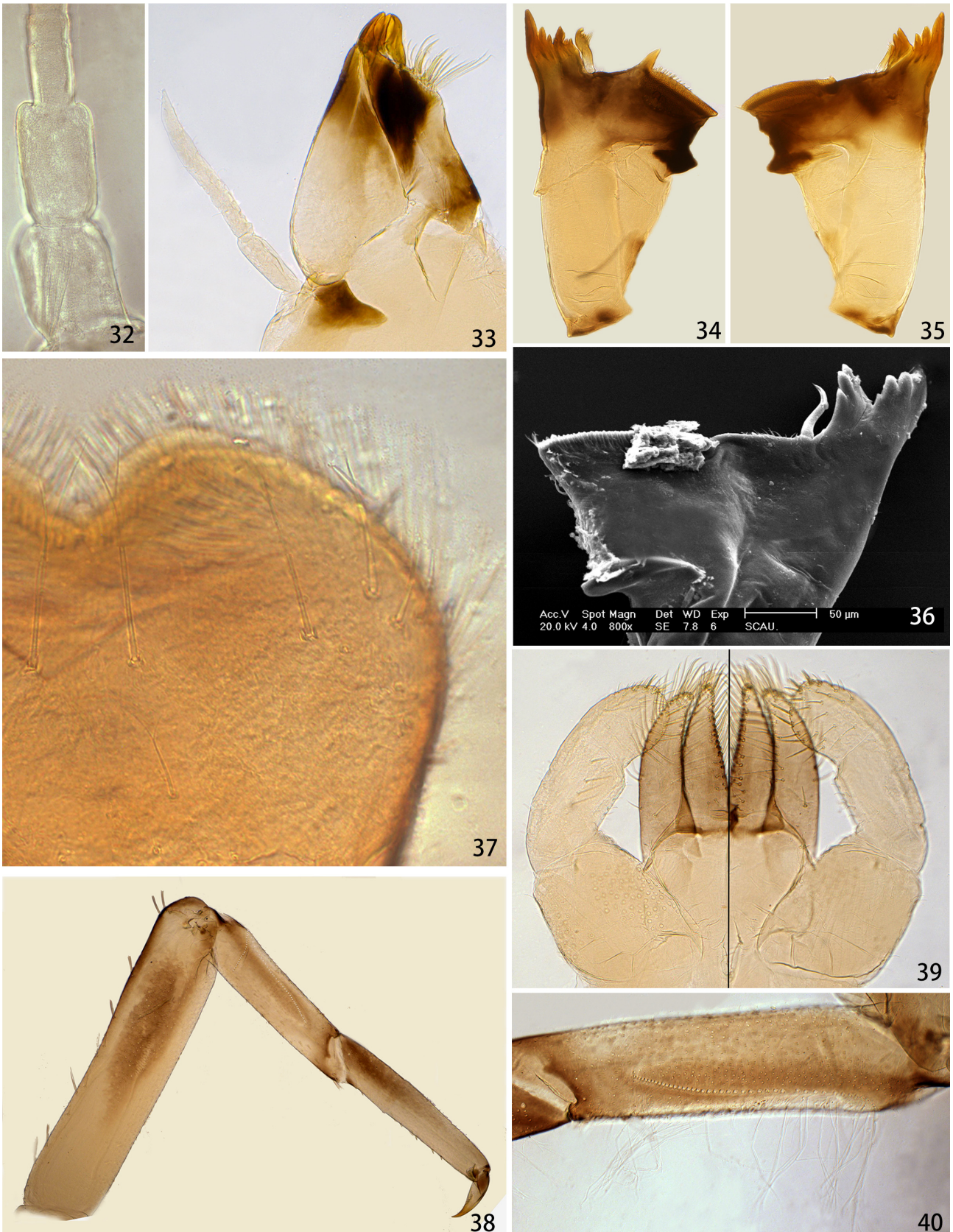
**Colouration.** Body with contrasting colour pattern (Fig. 46) which fit well with the typical of the subgenus *Chopralla*.

**Head.** Antennae yellow-brown, approximately 1.8 x head width; pedicel slightly longer than scape (Fig. 32). Labrum rectangular, width approximately 1.7 x length, anteromedial notch deeply with one small rounded lobe at base; each side of dorsal surface with one medial seta and one row of 3–4 submarginal setae sublaterally, which are all bifurcated at middle or 2/3 from base (Fig. 37); ventrally bordered with feathered setae along margin and one disto-medial arc of very fine setae. Left mandible (Fig. 34): incisors with 6 fused denticles, prostheca robust with 3 blunt and 3 acute denticles; spine-like setae between incisor base and molar present. Right mandible (Fig. 35): incisors partially fused, inner and outer incisors with 6–7 denticles respectively, prostheca close to incisors and with slender medial process, neither bifid nor plumose but with small denticles apically; margin between incisors base and molar scattered with one tuft of spine-like setae. Hypopharynx: lingua with one median projection, covered with abundant setae. Maxillae (Fig. 33): galealacinia with one row of 3–5 long basal setae and one short spine-like hump seta basally; maxillary palpus 2-segmented, slightly shorter than galealacinia and scattered with fine setae on surface, segment II approximately 2 x length of segment I. Labium (Fig. 39): glossae slightly longer than paraglossae and subequal to paraglossae in width, ventrally with one row of 15–17 acute, long setae along inner margin and 3 stout setae and 1 robust setae at apex, dorsally with 5–6 acute, long setae along outer margin; paraglossae ventrally with one row of 17–19 acute, stout setae along outer margin and 5–7 long, stout setae along inner margin; labial palpus 3-segmented, segment I about 0.8 x length of segment II and III combined, scattered with numerous fine setae ventrally and pores dorsally; segment II wider than segment III, dorsally with one row of 4 long, simple setae apicomediaally; segment III about 1.3 x maximum width.

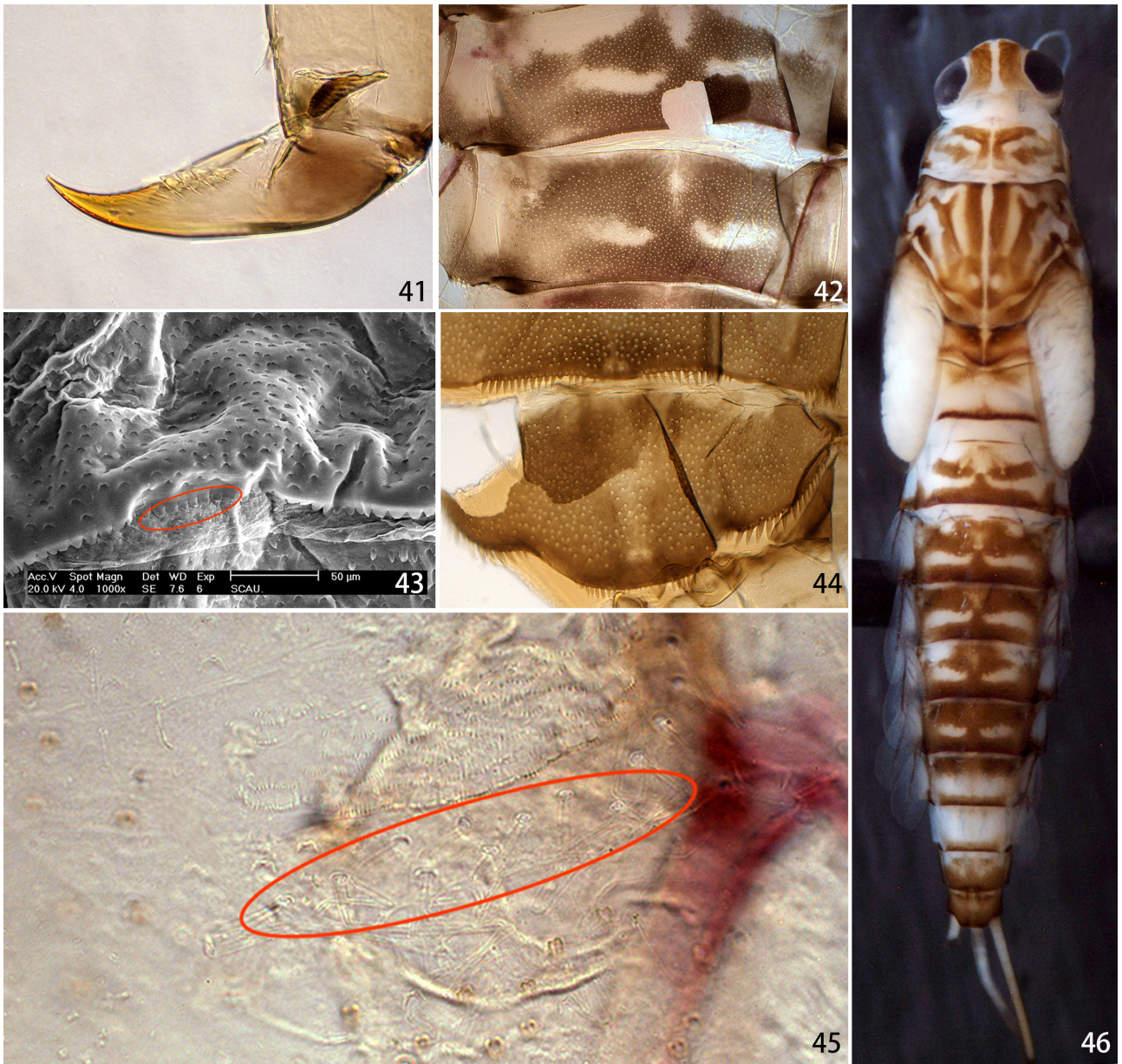
**Thorax.** Pronotum surface smooth without tubercles. Hindwing pads minute but visible. Leg surfaces scattered with trapezoidal scale bases. Femora approximately 4 x maximum width, dorsally with one row of about 5–7 long, robust setae which approximately 1/2 femoral width and one pair of close-set stout subapical setae (Fig. 38), ventrally with numerous pores; tibiae dorsally with fine setae, ventrally with one row of slightly acute stout setae and one pair of long, stout, slightly feathered setae apically; patella-tibial suture absent on fore tibia (Fig. 40) and present on mid- and hind tibia submedially; tarsi dorsally with fine setae, ventrally with a row of short, acute setae. Claw with two rows of 3–4 denticles (Fig. 41), apically with 4–5 furrows; two subapical setae present laterally but vestigial.

**Abdomen** (Fig. 46): Abdominal tergal surface covered with trapezoidal scale bases and lanceolate scales densely (Figs 42–44). Posterior margin of tergites II–VIII with semicircular, blunt spines which successively increasing in length backwards (Figs 42–43); posterior marginal spines on tergites IX–X with wide gap medially (Fig. 44); sternites generally yellowish-white, sternal surface with numerous pores and scale bases; sternites III–VI each with one pair of setal tufts anterolaterally (Fig. 45); posterior margins of sternites V–IX with triangular spines;





**FIGURES 32–40.** Nymph of *Bungona (Chopralla) bifida* sp. nov. (32) antenna; (33) left maxilla; (34) left mandible; (35, 36) right mandible; (37) dorsal view of labrum; (38) foreleg; (39) labium (left: dorsal view; right: ventral view); (40) fore tibia.



**FIGURES 41–46.** Nymph of *Bungona (Chopralla) bifida* sp. nov. (41) mid-claw; (42) abdominal terga V and VI; (43) abdominal tergum VI; (44) abdominal terga IX and X; (45) abdominal sternum IV; (46) habitus of female nymph (dorsal view).



**FIGURES 47–49.** Paraprocts (47) *Bungona (Centroptella) ovata* sp. nov.; (48) *Bungona (Centroptella) quadrata* sp. nov.; (49) *Bungona (Chopralla) bifida* sp. nov.

paraproct (Fig. 49) subtriangular, with pores, trapezoidal scales bases and fine hairs on surface and 8–9 pointed spines along inner margin. Gills present on tergites I–VII, asymmetric lanceolate, moderately tracheated (Fig. 46). Median caudal filament slightly shorter than cerci, inner margin and both sides of median caudal filament fringed with well-developed swimming bristles.

**Imagoes.** Unknown.

**Etymology.** The epithet *bifida* is from Latin adjective “bifidus”, meaning “cleft, divided into two parts” and referring to the shape of submarginal setae on labrum.

**Distribution and biology.** China (Sichuan, Hubei, Guizhou). The nymphs usually inhabit in slow-flowing mountain streams.

**Comments.** This new species, along with *Bungona* (*C.*) *liebenauae* (Soldán, Braasch & Muu, 1987), *Bungona* (*C.*) *pontica* Sroka, Godunko & Gattolliat, 2019 and Genus No. 2 sp. 1, *sensu* Müller-Liebenau, 1984, presents a very unique characteristic: right prostheca robust rather than bifid and plumose, which suggest that these four species may have an isolated position within the subgenus (Soldán *et al.* 1987; Marle *et al.* 2016; Sroka *et al.* 2019). *Bungona* (*C.*) *bifida* **sp. nov.** is closely related to *Bungona* (*C.*) *pontica* from Turkey, but it can be easily distinguished from the latter by the following combination of features: (1) body colour pattern; (2) submarginal setae on labrum are forked apically (Fig. 37) (vs. simple in *pontica*); (3) segment I of labial palpus about 0.8 x length of segment II and III combined, segment III about 1.3 x maximum width (vs. segment I slightly longer than II and III combined, length of segment III subequal to the width in *pontica*). The new species is similar to *B. (C.) liebenauae* in body colour pattern, while the pronotum of new species has no paired median tubercles. This new species is also similar to the ‘Genus No. 2 sp.1’ described and illustrated by Müller-Liebenau (1984) from West Malaysia, however, body colour pattern, bifurcated submarginal setae on labrum, segment II of labial palpus dorsally with a row of 4 long, acute setae apicomediaally and paraproct with 8–9 spines along the inner margin, clearly indicate that *B. (C.) bifida* **sp. nov.** is not conspecific with the Genus No. 2 sp.1, *sensu* Müller-Liebenau, 1984.

### ***Bungona (Chopralla) fusina* (Tong & Dudgeon, 2003)**

(Figs. 50–59)

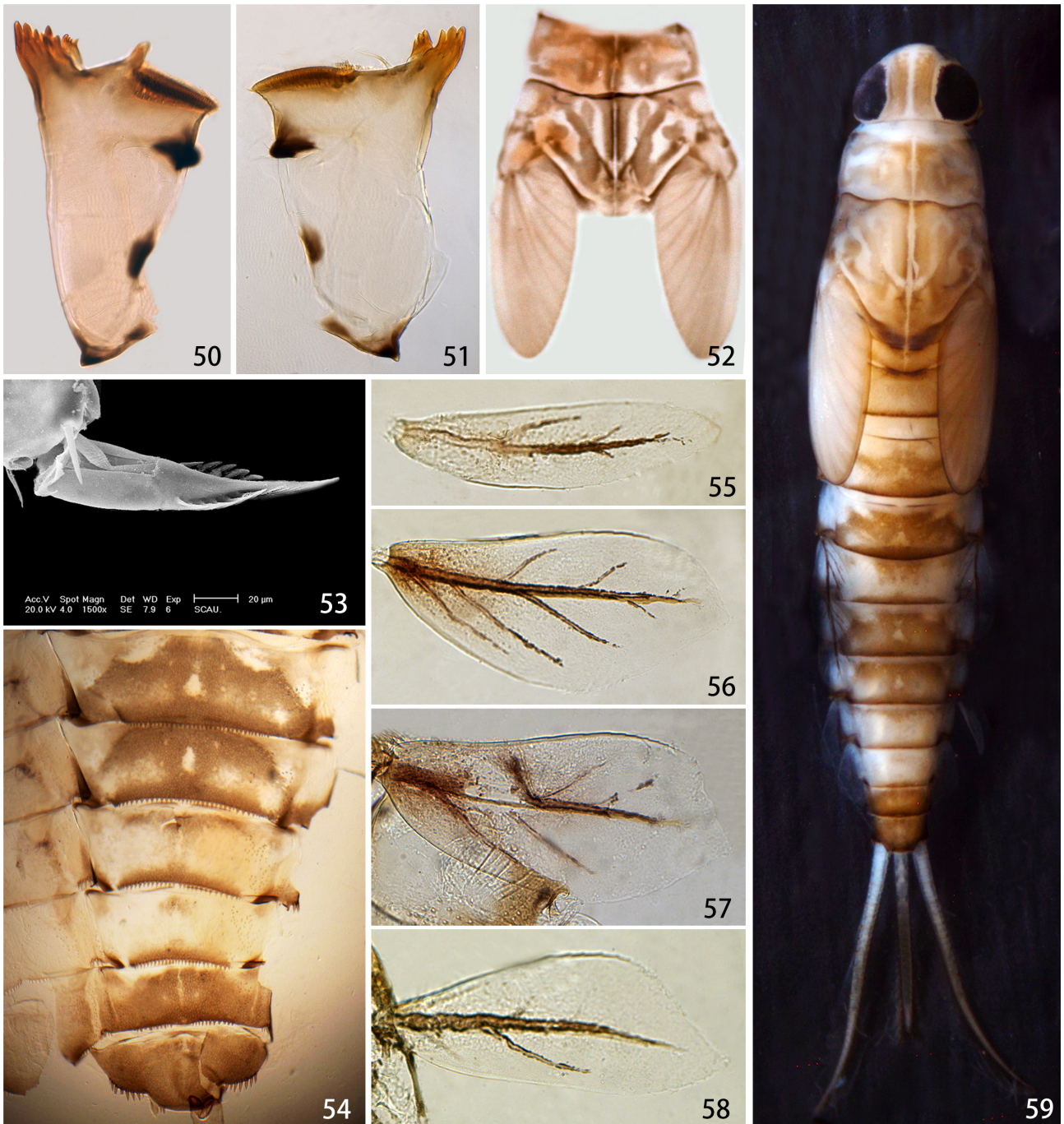
*Chopralla fusina*: Tong & Dudgeon, 2003: 17.

*Bungona (Centropptella) fusina*: Salles, Gattolliat & Sartori, 2016: 104.

**Material examined** (deposited in ethanol unless otherwise stated). Besides the material examined by Tong & Dudgeon (2003), the following additional specimens have been studied: **CHINA. Guangdong:** 1 nymph on slides and 1 nymph, Shixing County, Chebaling National Nature Reserve (21.70°N, 114.25°E, alt. 370m), 21.iv.2002, coll. Xiaoli Tong. **Hainan:** 9 nymphs, Changjiang County, Bawangling National Nature Reserve, Dongliu (19.12°N, 109.09°E, alt. 220m), 12.ix.2003, coll. Wenli Wang; 10 nymphs, Baisha County, Yinggeling National Nature Reserve, Nandanxi Stream, 25.xi.2005, coll. Haiyuan Yao; 1 nymph on slides and 13 nymphs, Baisha County, Yinggeling National Nature Reserve, Daoyin Protection Station (19.01°N, 109.36°E, alt. 640m), 5.xii.2005, coll. Haiyuan Yao; 1 nymph on slides and 14 nymphs, Ledong County, Jianfengling National Nature Reserve (18.76°N, 108.89°E, alt. 800m), 28.xi.2011, coll. Weifang Shi.

**Distribution and biology.** China (Guangdong, Hainan, Hong Kong). This species is widespread in southern China in association with the stone surfaces in slow-flowing or lentic habitat of streams.

**Comments.** Described originally based on nymph and imago from Hong Kong in the genus *Chopralla* (Tong and Dudgeon 2003), this species was moved to the subgenus *Chopralla* of *Bungona* by Salles *et al.* (2016). *Bungona* (*Ch.*) *fusina* appears to be closely related to *B. (Ch.) colorata* from Vietnam based on structure, however, the body colour pattern, in particular of pro- and mesonotum (Figs 52, 59), is distinctly different from the latter. Furthermore, the following combination of characteristics also can be useful to distinguish them: (1) the prostheca of right mandible bifurcated and plumose (Fig. 51) (vs. the right prostheca plumose but not bifurcated in *B. colorata*); (2) tergites V–X with acute triangular spines on posterior margins (Fig. 54) (vs. tergites IV–X with such spines in *B. colorata*); (3) gill I less than 4 times as long as wide, and other gills relatively broad, much less than 2.5 times as long as wide) (Figs 55–58) (vs. in *B. colorata*, gill I more than 5 times as long as wide and other gills narrow-elongate and at least 2.5 times as long as wide).



**FIGURES 50–59.** Nymph of *Bungona* (*Chopralla*) *fusina* Tong & Dudgeon (50) left mandible; (51) right mandible; (52) pro- and mesonotum; (53) claw; (54) abdominal terga V–X; (55–58) gills 1, 3, 5, 7; (59) habitus of female nymph (dorsal view).

***Bungona* (*Chopralla*) *liebenauae* (Soldán, Braasch & Muu, 1987)**  
(Figs 60–67)

*Centropptella liebenauae*: Soldán, Braasch & Muu, 1987: 342.

*Chopralla liebenauae*: Tong & Dudgeon, 2003b: 17.

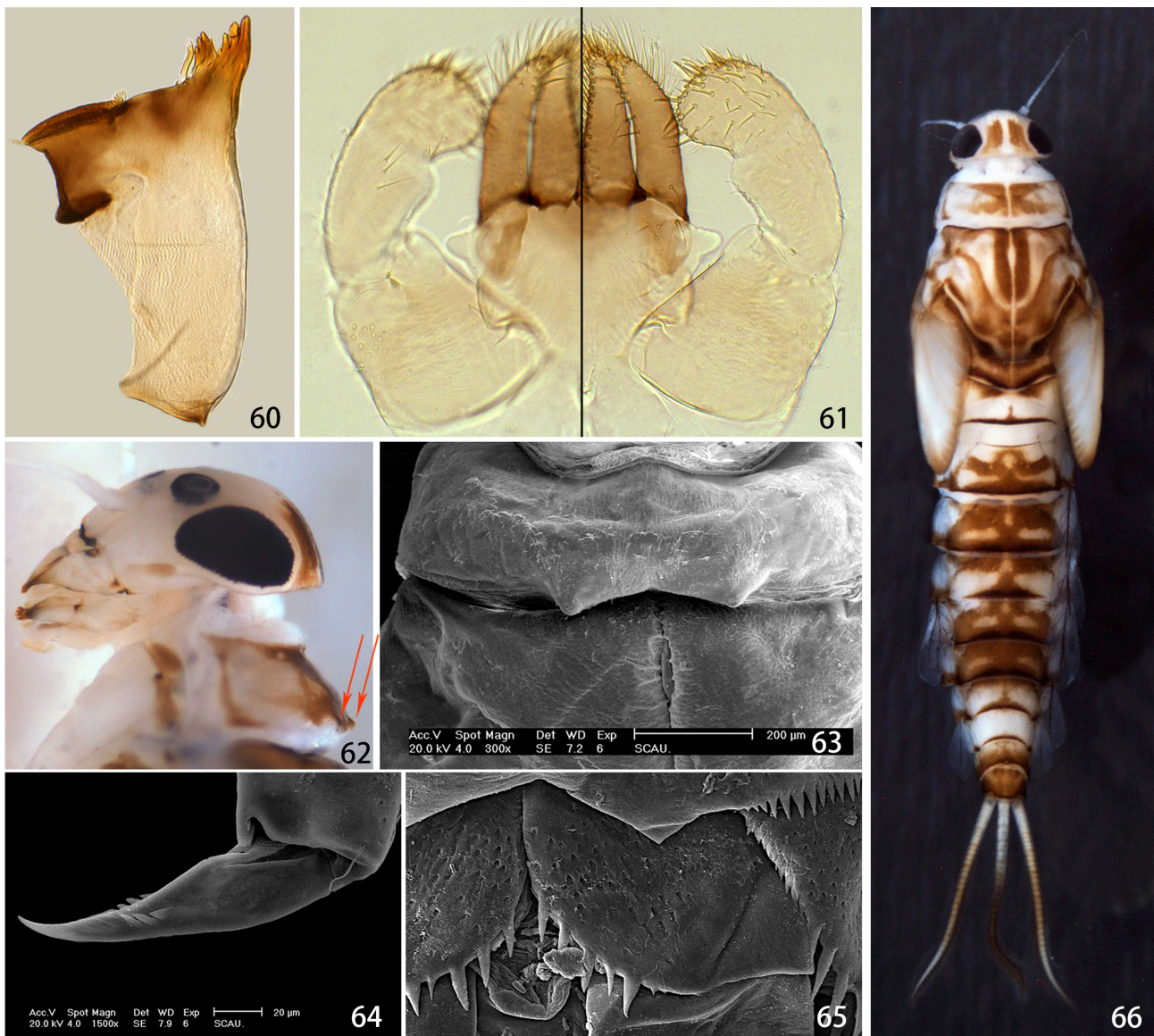
*Bungona* (*Chopralla*) *liebenauae*: Salles, Gattolliat & Sartori, 2016: 104.

**Material examined . CHINA. Guangdong:** 70 nymphs, Huizhou, Nankunshan Nature Reserve (23.63°N, 113.89°E, alt. 670m), 26.v.2003, coll. Xiaoli Tong; 1 nymph, Yangchun, Xinning, Hecang River (22.5°N, 111.5°N, alt. 440m), 16.v.2004, coll. Sanbao Tang; 1 nymph on slides and 95 nymphs, Xinyi, Tianmashan Mountain

(22.46°N, 110.69°E, alt. 380m), 2.iv.2011 and 19.ix.2011, coll. Weifang Shi. **Guangxi**: 102 nymphs, Jinxiu, Dayaoshan National Nature Reserve (24.12°N, 110.21°E, alt. 780m), 26.ix.2011, coll. Weifang Shi & Shulan Yang; 5 nymphs, Jinxiu, Laoshan Forest Station (24.12°N, 110.20°E, alt. 920m), 17.xi.2011, coll. Weifang Shi & Shulan Yang; 2 nymphs on slides and 16 nymphs, Jinxiu, Shibajia Forest Station (24.20°N, 110.29°E, alt. 770m), 18.xi.2011, coll. Weifang Shi & Shulan Yang. **Yunnan**: 1 nymph, Yangbi County, Pingpo Town, Pingpo Bridge (25.59°N, 100.05°E, alt. 1400m), 21.vii.2013, coll. Hongxing Chen.

**Distribution and biology.** China (Yunnan, Guangxi, Guangdong); Vietnam. The nymphs (Fig. 59) are usually found in slow current reaches of clean mountain streams (Fig. 67) and sometimes with substantial populations on the stone surfaces as indicated from the specimens listed above.

**Comments.** Described based on nymphs and imagoes from Vietnam in the genus *Centroptella* (Soldán *et al.* 1987), this species was transferred to the subgenus *Chopralla* of *Bungona* by Salles *et al.* (2016) based on the tarsal claws bearing two rows of denticles. *Bungona* (*Ch.*) *liebenauae* is here recorded from China for the first time. This species has an unusual characteristics which can easily distinguish it from its congeners: the presence of a pair of submarginal median tubercles posteriorly on pronotum (Figs 62–63). Other features, such as base of glossa not reaching inner 1/3 of paraglossa (Fig. 61), dentate tarsal claws (Fig. 64) and characteristic contrasting body colour pattern (Fig. 66), clearly fit the concept of *Chopralla* proposed by Salles *et al.* (2016).



**FIGURES 60–66.** Nymph of *Bungona* (*Chopralla*) *liebenauae* (Soldán) Braasch & Luu (60) right mandible; (61) labium (left: dorsal view; right: ventral view); (62) lateral view of head and prothorax; (63) dorsal view of prothorax; (64) claw; (65) paraprocts; (66) habitus of female nymph (dorsal view).



FIGURE 67. Habitat of *Bungona (Chopralla) liebenauae* (Soldán, Braasch & Muu, 1987) in China.

**Key to *Bungona* species known from Oriental Region (mature nymphs)**

(Excluding Genus No. 2 sp. 1, *sensu* Müller-Liebenau, 1984. \*Based on the original description)

- 1. Tarsal claws dentate (Figs 41, 53, 64); posterior marginal spines of tergite IX with broadly interrupted medially (Figs 44, 54) ..... 2 (subgen. *Chopralla*)
- Tarsal claws edentate (Figs 2, 26); posterior marginal spines of tergite IX contiguous and complete (Fig. 13). ..... 9 (subgen. *Centroptella*)
- 2 (1). Prosthema of right mandible neither bifid nor plumose, situated close to incisors (Figs 35–36, 60)... 3
- Prosthema of right mandible forked and plumose, situated relatively far from incisors (Fig. 51) ..... 4
- 3 (2). Pronotum with a pair of submarginal median tubercles posteriorly (Figs 62–63); labrum surface with simple submarginal setae [China, Vietnam] ..... *B. (Ch.) liebenauae*
- Pronotum smooth without any tubercles; labrum surface with forked submarginal setae (Fig. 37)[China]..... *B. (Ch.) bifida* sp. nov.
- 4 (2). Hindwing pads completely absent (cf. Müller-Liebenau 1983:fig. 2b)... 5
- Hindwing pads minute but visible ..... 6
- 5 (4). Abdominal tergite I uniformly yellow-white (cf. Müller-Liebenau 1983:fig. 6); tergites IX–X with spines on posterior margin (Marle *et al.* 2016: table 1) [Sri Lanka] ..... *B. (Ch.) similis*\*
- Abdominal tergite I yellow-white tinged with irregular brown markings (cf. Marle *et al.* 2016: fig. 19); tergites VIII–X with spines on posterior margin (Marle *et al.* 2016: table 1) [Indonesia] ..... *B. (Ch.) bintang*\*
- 6 (4). Posterior marginal spines present only on tergites IX–X ..... 7
- Posterior marginal spines present on tergites IV–X ..... 8
- 7 (6). Segment II of labial palpus dorsally with a row of 4 long, simple setae on distomedial area, dorsal margin of femora with 11–15 long, clavate setae (Marle *et al.* 2016: table 1) [Sri Lanka]..... *B. (Ch.) ceylonensis*\*
- Segment II of labial palpus dorsally with a row of 3 long, simple setae on distomedial area, dorsal margin of femora with 8–10 long, clavate setae (Marle *et al.* 2016: table 1) [Malaysia]. ..... *B. (Ch.) pusilla*\*
- 8 (6). Prosthema of right mandible bifurcated and plumose; tergites V–X with acute triangular spines on posterior margins; gill I less than 4 times as long as wide [China]..... *B. (Ch.) fusina*
- Prosthema of right mandible plumose but not forked; tergites IV–X with acute triangular spines on posterior margins (Marle *et al.* 2016: table 1); gill I more than 5 times as long as wide [Vietnam]..... *B. (Ch.) colorata*\*
- 9 (1'). Hindwing pads completely absent ..... 10
- Hindwing pads minute but visible ..... 11

- 10 (9). Outer incisors of mandibles with a small lateral denticle, segment III of labial palpus rounded with distal margin slightly expanded (Müller-Liebenau 1983) [Sri Lanka]. . . . . **B. (C.) soldani\***
- Outer incisors of mandibles without lateral denticle, segment III of labial palpus subrectangular with distal margin straight and unexpanded (Marle *et al.* 2016) [Indonesia]. . . . . **B. (C.) papilionodes\***
- 11 (9'). Length of maxillary palpus approximately 1/2 of galealacina [China]. . . . . **B. (C.) longisetosa**
- Maxillary palpus subequal to galealacina in length . . . . . 12
- 12 (11'). Body with relatively uniformly brown colouration (Fig. 31); antennal pedicel about 2 x length of scape (Fig. 16); terminal segment of labial palpus rectangular (Fig. 18); posterior marginal spines present on tergites II–X [China] . . . . . **B. (C.) quadrata sp. nov.**
- Body with relatively contrasting colour pattern (Figs 14–15); antennal pedicel slightly longer than scape; terminal segment of labial palpus irregular trapezoidal, distal margin truncated (Fig. 8); posterior marginal spines present on tergites IV–X [China]. . . . . **B. (C.) ovata sp. nov.**

## Acknowledgements

This study was partly supported by the National Natural Science Foundation of China (31872265) and the sub-project of National Science & Technology Major Project (No. 2009ZX07211-009-02). We especially wish to acknowledge Ms. Chen Xinfang (The Instrumental Analysis and Research Center, SCAU) for assistance with the SEM. Thanks are also due to the referees for their advice and constructive comments.

## References

- Braasch, D. & Soldán, T. (1980) *Centroptella* n. gen., eine neue Gattung der Eintagsfliegen aus China (Baetidae, Ephemeroptera). *Reichenbachia Staatliches Museum für Tierkunde in Dresden*, 18, 123–127. Available from: <http://www.insecta.bio.spbu.ru/z/pdf/BraaschSoldan1980p123.pdf> (Accessed 17 Apr. 2019)
- Harker J.E. (1957) Some new Australian Ephemeroptera. *Proceeding of the Royal Entomological Society of London B*, 26, 69–78.
- Marle, P., Salles, F.F. & Gattolliat, J.-L. (2016) Two new species of *Bungona* Harker, 1957 (Ephemeroptera: Baetidae) from Borneo, Indonesia. *Zootaxa*, 4088 (2), 221–235. <https://doi.org/10.11646/zootaxa.4088.2.4>
- Müller-Liebenau, I. (1983) Three new species of the genus *Centroptella* Braasch & Soldán, 1980, from Sri Lanka (Insecta: Ephemeroptera). *Archiv für Hydrobiologie*, 97, 486–500.
- Müller-Liebenau, I. (1984) New genera and species of the family Baetidae from West-Malaysia (River Gombak) (Insecta: Ephemeroptera). *Spixiana*, 7, 253–284. Available from: <http://biostor.org/reference/47587> (accessed 3 June 2014)
- Salles, F.F., Gattolliat, J.-L. & Sartori, M. (2016) Phylogenetic analysis of *Cloeodes* Traver, 1938 and related genera (Ephemeroptera: Baetidae). *Systematic Entomology*, 41, 93–111. <https://doi.org/10.1111/syen.12144>
- Soldán, T., Braasch, D. & Muu, L.T. (1987) Two new species of *Centroptella* (Ephemeroptera, Baetidae) from Vietnam, with a description of the adult stage of the genus. *Acta Entomologica Bohemoslovaca*, 84, 242–249.
- Sroka, P., Godunko, R.J., Rutschmann, S., Angeli, K.B., Salles, F.F. & Gattolliat, J.-L. (2019) A new species of *Bungona* in Turkey (Ephemeroptera, Baetidae): an unexpected biogeographic pattern within a pantropical complex of mayflies. *Zoosystematics and Evolution*, 95 (1), 1–13. <https://doi.org/10.3897/zse.95.29487>
- Suter, P.J. & Pearson, M.J. (2001) Redescription of *Bungona* Harker with new synonyms in the Australian Baetidae (Insecta:Ephemeroptera). *Memoirs of the Museum of Victoria*, 58, 247–254. <https://doi.org/10.24199/j.mmv.2001.58.14>
- Tong, X. & Dudgeon, D. (2003) First record of the genus *Chopralla* (Ephemeroptera: Baetidae) from China and description of a new species. *The Raffles Bulletin of Zoology*, 51, 17–19. Available from: <http://www.insecta.bio.spbu.ru/z/pdf/TongDudgeon2003p17.pdf> (Accessed 17 Apr. 2019)
- Tong, X., Dudgeon, D. & McCafferty, M.P. (2003) The adult of *Cloeodes longisetosus* (Braasch & Soldán, 1980) and a revised description of the larva (Ephemeroptera, Baetidae). *Acta Zootaxonomica Sinica*, 28 (4), 669–672. Available from: <http://www.insecta.bio.spbu.ru/z/pdf/TongDudgeonMcCafferty2003p669.pdf> (Accessed 17 Apr. 2019)
- Waltz, R.D. & McCafferty, W.P. (1987a) Generic revision of *Cloeodes* and description of two new genera (Ephemeroptera: Baetidae). *Proceedings of the Entomological Society of Washington*, 89, 177–184. Available from: <http://www.insecta.bio.spbu.ru/z/pdf/WaltzMcCafferty1987p177.pdf> (Accessed 17 Apr. 2019)
- Waltz, R.D. & McCafferty, W.P. (1987b) Revision of the genus *Cloeodes* Traver (Ephemeroptera: Baetidae). *Annals of the Entomological Society of America*, 80 (2), 191–207. <https://doi.org/10.1093/aesa/80.2.191>
- Webb, J.M. & Suter, P.J. (2010) Revalidation and redescription of *Bungona illiesi* (Lugo-Ortiz & McCafferty) (Ephemeroptera: Baetidae) from Australia, based on mitochondrial and morphological evidence. *Zootaxa*, 2481, 37–51.