

Revision of the *Conwentzia* Enderlein, 1905 (Neuroptera, Coniopterygidae) of China, combining morphological and molecular characters

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Academic editor: S. Winterton | Received 5 December 2020 | Accepted 11 February 2021 | Published 25 March 2021

<http://zoobank.org/ECFB847D-637E-4CDE-81A5-952123911295>

Citation: Zhao Y, Li Y, Liu Z (2021) Revision of the *Conwentzia* Enderlein, 1905 (Neuroptera, Coniopterygidae) of China, combining morphological and molecular characters. ZooKeys 1026: 1–15. <https://doi.org/10.3897/zookeys.1026.61700>

Abstract

The Chinese species of *Conwentzia* Enderlein are revised by integrating morphological characters and molecular data. *Conwentzia yunguiana* Liu & Yang, 1993 is proposed as a junior synonym of *Conwentzia nietoi* Monserrat, 1982, **syn. nov.** and *Conwentzia orthotibia* Yang, 1974 is proposed as a junior synonym of *Conwentzia pineticola* Enderlein, 1905, **syn. nov.** Moreover, a key to the adult males of the *Conwentzia* from China and DNA barcodes are provided.

Keywords

DNA barcoding, dusty lacewings, faunistics, identification key, taxonomy

Introduction

The dusty lacewing genus *Conwentzia* belongs to the subfamily Coniopteryginae of family Coniopterygidae and it is a species-poor genus, including only fourteen described species (Sziráki 2011; Oswald 2020). However, *Conwentzia* is relatively widespread, and widely distributed in the Palaearctic, Nearctic, Oriental and Afro-tropical regions (Meinander 1972; Sziráki 2011). This genus was originally erected by Enderlein (1905) based on the type species *Conwentzia pineticola* Enderlein, 1905.

All *Conwentzia* species are easily set apart from other Coniopteryginae due to the highly reduced hind wings, except the North American species *C. barretti* (Banks 1899), which has fully developed hind wings (Meinander 1972; Sziráki 2011). Like other dusty lacewings, *Conwentzia* species are predators of small phytophagous arthropods – including notorious pests such as phylloxerids and tetranychid mites – and are thus potential biocontrol agents, being quite common in orchards, especially on *Citrus* (Collyer 1951; Meinander 1972; Pantaleoni 2007). Consequently, it is necessary to effectively identify *Conwentzia* species. Although *Conwentzia* species can be identified by male genitalia, it is still hard to identify their females and larvae. At the same time, type material is not easily accessible for all students of this genus. These problems highlight the necessity for accurate and easy methods to identify *Conwentzia* species.

DNA barcoding is a useful tool to identify species (Hebert et al. 2003). In many insects, the partial mitochondrial cytochrome c oxidase subunit I (COI) gene is an effective marker (Raupach et al. 2020), and it can also be used for dusty lacewings (Morinière et al. 2014; Yi et al. 2018). We collected some fresh specimens of *Conwentzia* species from China in the past three years, and decided to provide DNA barcodes for these species.

In China, there are four species of *Conwentzia* (Sziráki 2011; Oswald 2020). However, *Conwentzia fraternalis* Yang, 1974 is only known based on a single female and its status remains enigmatic. The aim of the present paper is to review the three remaining Chinese species of *Conwentzia* using morphological characters and molecular data.

Material and methods

Morphological comparisons

The examined specimens are preserved in 95% ethyl alcohol and deposited in the Entomological Museum of China Agricultural University, Beijing (CAU). The abdomen was dissected from the body and macerated in a heated solution of 5% KOH for 5 minutes, then rinsed in water and 95% ethyl ethanol. The cleared abdomen was transferred to glycerol for dissection and study. After examination, the abdomen was placed in glycerol and in a 200 μ L microtube for long-term preservation, while the head and thorax were placed in 95% ethyl alcohol and in another 200 μ L microtube. The two 200 μ L microtubes were then placed in a 5 mL microtube at -20°C .

Terminology

Morphological terminology mostly follows Meinander (1972) for general morphology and Aspöck and Aspöck (2008) for male genitalia.

Imaging

Specimens were examined with an Optec SZ760 stereomicroscope. Photos were taken with a Nikon D5300 digital camera attached to a Leica DM2500 stereomicroscope. The resulting images were edited and processed with Adobe Photoshop CC 2018.

DNA extraction and sequencing protocols

Total genomic DNA was extracted based on the method of Lu et al. (2018) with the commercial Ezup Column Animal Genomic DNA Purification Kit (Sangon Biotech, China) and following the manufacturer's protocol. The PCR primer and reaction conditions for the COI region followed Folmer et al. (1994) and Lu et al. (2018). Products were sequenced in a single direction by Sangon (Shanghai) Co., Ltd. Sequences were edited and analyzed using the software Chromas version 2.3 and BioEdit 7.0.4.1 (Hall 1999). In addition, sequences were translated into amino acids to check for NUMTS and test for quality.

Sequence analysis

The barcoding gap was assessed by means of the following methods. Pairwise genetic distances for COI genes were computed with the Kimura 2-parameter (K2P) method in the MEGA 6.0 software (Tamura et al. 2011). Finally, all sequences were deposited in GenBank. In order to better analyze the data, sequences of *C. pineticola* from Bavaria in Germany were downloaded from GenBank. The accession numbers of these sequences are as follows: JN299372, JN299373, JN299374, JN299347, JN299348.

Results

Morphological characters

Genus *Conwentzia* Enderlein, 1905

Type species. *Conwentzia pineticola* Enderlein, 1905

Diagnosis. Fore wing with RP vein forked. Hind wing reduced except in *C. barretti*. Male genitalia with gonocoxites 9 absent, gonapophyses 9 (when present) originating from sclerotized ring of segment 9.

Comments. There are fourteen species in the genus *Conwentzia*. The species described before 1972 are well known thanks to Meinander's (1972) comprehensive revision. However, *Conwentzia inverta* Withycombe, 1925 was not redescribed by Meinander (1972) because the type material in the Natural History Museum, London is in rather bad condition (Meinander 1972). However, Monserrat found that

Barnard had a specimen collected from the type locality, Pusa, in India, by Withycombe in 1925, which he examined and used for his redescription of *C. inverta* (Montserrat 1982). Species described after 1972 are well known thanks to Sziráki's (2011) comprehensive revision. Thus, all species in the genus *Conwentzia* are relatively well known.

Key to Chinese species of *Conwentzia* (males)

Note: *Conwentzia fraternalis* Yang, 1974 is not included in the key as the specimen is only known based on a single female.

- 1 Gonocoxites 9 (inner process of ectoprocts *sensu* Meinander 1972) present (Fig. 6c–f) *C. pineticola* Enderlein
- Gonocoxites 9 absent (Figs 2c–f, 4c–f) 2
- 2 Gonapophyses 9 (stylus *sensu* Meinander 1972) short basally (Fig. 2a, b).....
..... *C. sinica* Yang
- Gonapophyses 9 long and slender (Fig. 4a, b)..... *C. nietoi* Montserrat

Conwentzia sinica Yang, 1974

Figs 1, 2

Conwentzia sinica Yang, 1974: 84. Type locality: China (Shaanxi).

Type material examined. *Holotype*: male (CAU), CHINA: Shaanxi (Province): Xian (City): Zhouzhi (County), [34.0588°N, 108.3371°E], 13–18.viii.1962, leg. Chikun Yang and Fasheng Li.

Other material examined. 14 males and 31 females (CAU), CHINA: Zhejiang (Province): Jiaying (City): Wuzhen (Town), [30.7509°N, 120.5024°E], 18.v.2018, leg. Zhiqi Liu. 13 males and 26 females (CAU), CHINA: Yunnan (Province): Kunming (City), [25.1371°N, 102.7493°E], 31.vii.2019, leg. Yaru Zhao and Ying Li. 5 males and 9 females (CAU), CHINA: Jilin (Province): Yanji (City), [42.9057°N, 129.4955°E], 1.viii.2019, leg. Yaru Zhao and Ying Li. 5 males and 7 females (CAU), CHINA: Jilin (Province): Yanji (City), [43.8293°N, 126.5253°E], 2.viii.2019, leg. Yaru Zhao and Ying Li. 5 males and 9 females (CAU), CHINA: Jilin (Province): Yanji (City), [42.9057°N, 129.4955°E], 1.viii.2019, leg. Yaru Zhao and Ying Li. 4 males and 6 females (CAU), CHINA: Shanghai (City), [31.2118°N, 121.4981°E], 14.xi.2019, leg. Mingming Zou. 46 males and 83 females (CAU), CHINA: Shaanxi (Province): Xian (City): Zhouzhi (County), [34.0588°N, 108.3371°E], 13–18.viii.1962, leg. Chikun Yang and Fasheng Li. 1 male and 1 female (CAU), CHINA: Shaanxi (Province): Xi'an (City): Qinling (Mountain), [33.9717°N, 109.0112°E], 5–7.viii.1962, leg. Chikun Yang and Fasheng Li.

Diagnosis. Gonocoxites 9 absent; gonocoxites 11 (tenth sternite) forming a parallelogram in lateral view; gonapophyses 9 slender in caudal view.

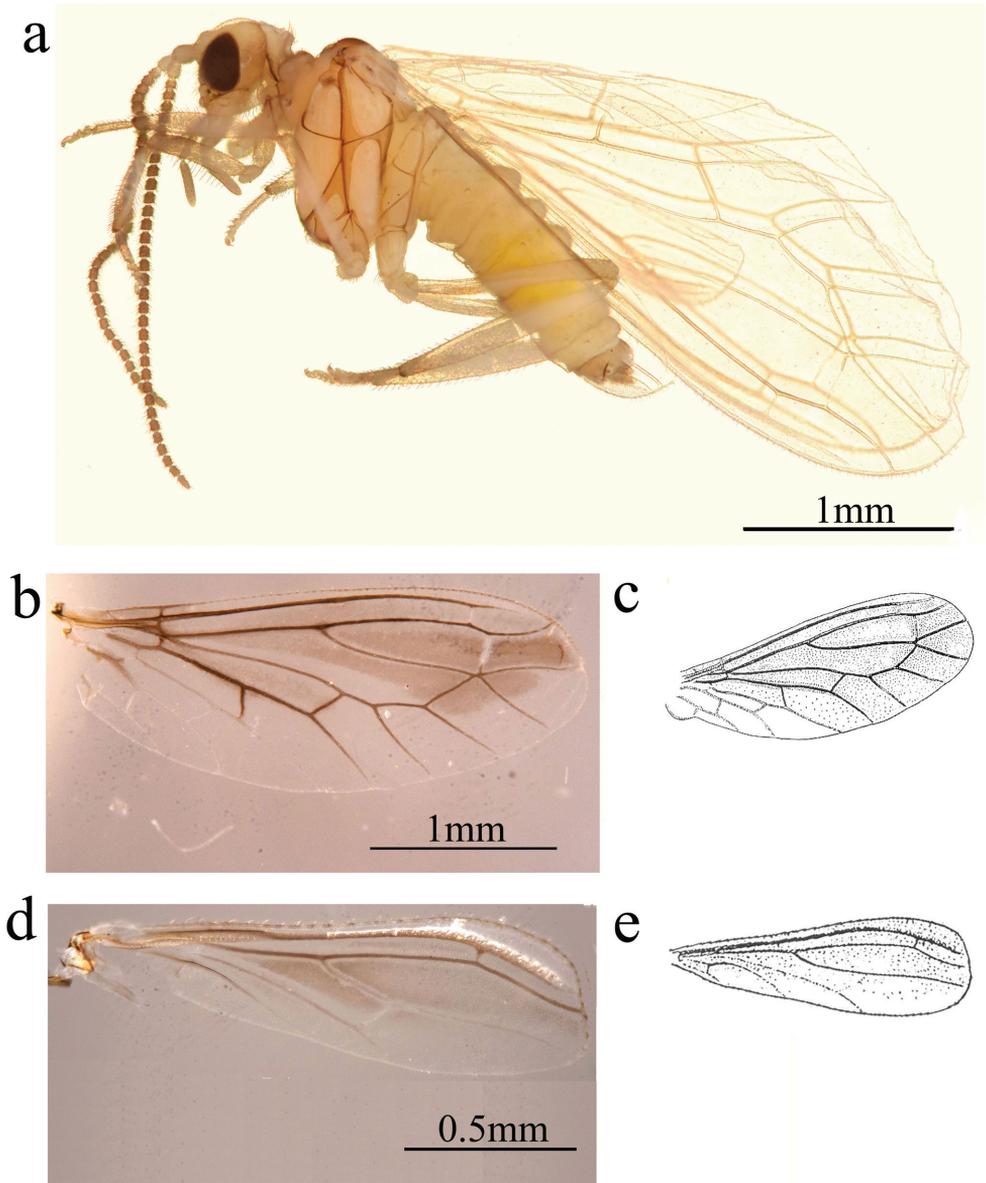


Figure 1. *Conwentzia sinica* Yang, 1974, male **a** habitus, lateral view **b, c** fore wing **d, e** hind wing.

Redescription. Measurements. Forewing length 2.5–3.4 mm, width 0.9–1.5 mm. Hindwing reduced; length 1.0–1.6 mm, width 0.4–0.6 mm.

Head (Fig. 1a). Yellowish brown. Compound eyes large and dark. Antennae brown, 31–36-segmented. Scape relatively broad and blunt. Pedicel cylindrical and longer than wide. Scape and pedicel light brown. Flagellomeres dark brown. Maxillary and labial palps brown.

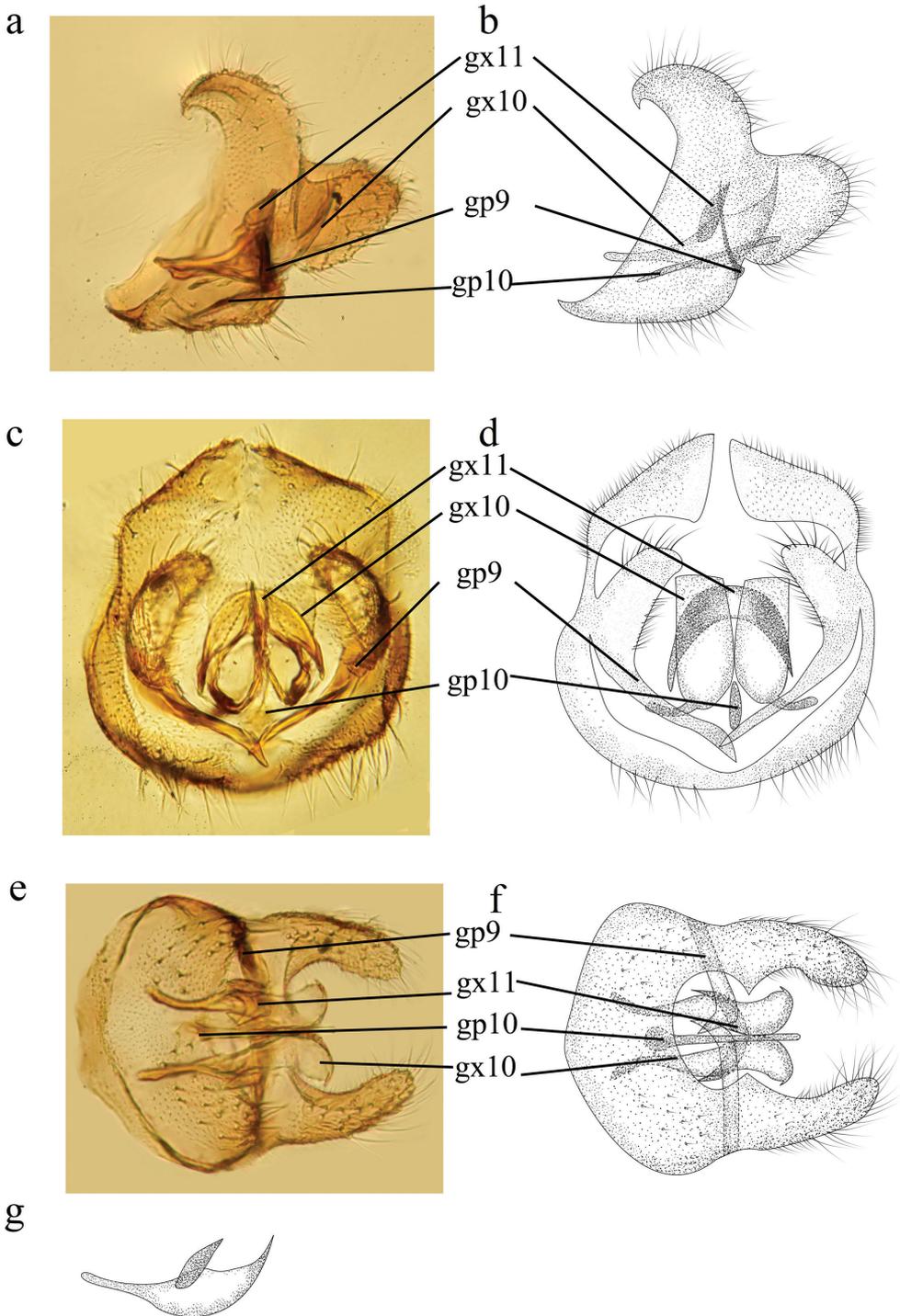


Figure 2. *Conwentzia sinica* Yang, 1974, male genitalia **a, b** lateral view **c, d** caudal view **e, f** ventral view **g** gonocoxites 10, lateral view.

Thorax. Brown. Nota with dorsal dark spots. Legs brown.

Wing (Fig. 1b–e). Wing membrane almost hyaline, light greyish brown.

Male genitalia (Fig. 2a–g). Outer process of ectoprocts relatively broad in lateral view. Gonocoxites 9 (inner process of ectoprocts *sensu* Meinander 1972) absent. Gonapophyses 9 (stylus *sensu* Meinander 1972) short with a hook in distal part ventrally (Fig. 2e–f). Gonocoxites 10 (paramere *sensu* Meinander 1972) relatively short in basal part, median section wider and stout, distal section bent upward in lateral view (Fig. 2a, b). Gonapophyses 10 (penis *sensu* Meinander 1972) slender and swollen at base in ventral view (Fig. 2e, f). Gonocoxites 11 (tenth sternite *sensu* Meinander 1972) sub-rectangular in lateral view (Fig. 2a, b).

Distribution. China (Hebei, Shanxi, Liaoning, Jilin, Jiangsu, Zhejiang, Fujian, Guangdong, Guangxi, Yunnan, Shaanxi, Gansu).

Conwentzia nietoi Monserrat, 1982

Figs 3, 4

Conwentzia nietoi Monserrat, 1982: 24. Type locality: Sri Lanka (Colombo).

Conwentzia yunguiana Liu & Yang, 1993: 256. Type locality: China (Guizhou: Guiyang). Syn. nov.

Type material examined. *Holotype* of *Conwentzia yunguiana*: male (CAU), CHINA: Guizhou (Province): Guiyang (City), [26.5003°N, 106.7467°E], 29.viii.1987, leg. Hongye Chen. *Paratypes*: 3 males, same data as holotype (CAU).

Other material examined. 1 male (CAU), CHINA: Guizhou (Province): Libo (County), [25.2681°N, 108.0780°E], 18.v.1990, leg. Chunqing Yang. 1 male (CAU), CHINA: Yunan (Province): Jinghong (City), [21.8566°N, 100.9582°E], 12.ix.1989, leg. Fasheng Li. 1 male (CAU), CHINA: Guangxi (Province): Lingui (City): Yanshan (District), [24.9265°N, 110.5040°E], 13.vi.1982, leg. Fasheng Li. 1 male (CAU), CHINA: Sichuan (Province): Leshan (City): E'meishan (Mountain), [29.5738°N, 103.3563°E], 15.iv.1990, leg. Chunqing Yang and Zhiqi Liu.

Diagnosis. Gonocoxites 9 absent; gonocoxites 11 subtriangular in lateral view; gonapophyses 9 basally broad and blunt in caudal view.

Redescription. Measurements. Forewing length 2.5–3.2 mm, width 0.9–1.3 mm. Hindwing reduced; length 1.0–1.5 mm, width 0.2–0.3 mm.

Head (Fig. 3a). Brown. Compound eyes large and dark. Antennae brown (except light brown scape), 34–35-segmented. Scape broad and blunt. Pedicel cylindrical and longer than broad. Antennae entirely brown, scape light brown. Maxillary and labial palps brown.

Thorax. Yellowish-brown. Nota with dorsal dark spots. Legs brown.

Wing (Fig. 3b–e). Wing membrane almost hyaline, light greyish brown.

Male genitalia (Fig. 4a–h). Outer process of ectoprocts finger-like in ventral view, longer than wide in lateral view (Fig. 4a, b). Gonocoxites 9 absent. Gonapophyses 9

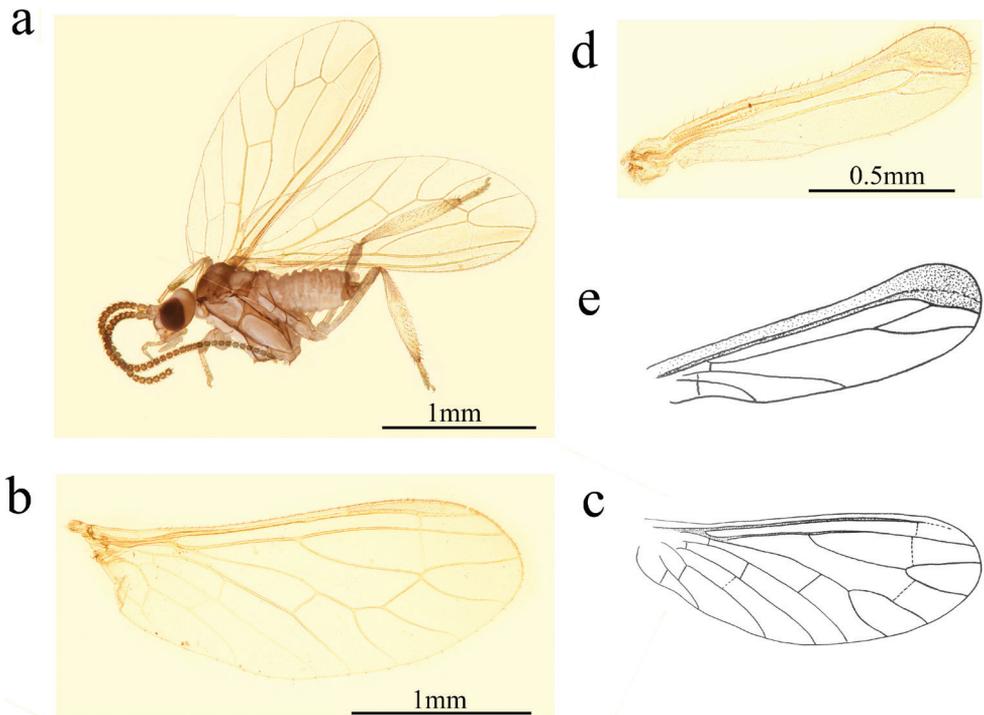


Figure 3. *Conwentzia nietoi* Monserrat, 1982, male **a** habitus, lateral view **b**, **c** fore wing **d**, **e** hind wing.

hooked downward in lateral view (Fig. 4a, b). Gonocoxites 10 slender, distal section bent upward in lateral view (Fig. 4a, b). Gonapophyses 10 small and short in ventral view (Fig. 4e, f). Gonocoxites 11 subtriangular in caudal view (Fig. 4c, d) and ventral view (Fig. 4e, f).

Distribution. China (Guangxi, Sichuan, Guizhou, Yunnan).

Conwentzia pineticola Enderlein, 1905

Figs 5, 6

Conwentzia pineticola Enderlein, 1905: 10. Type locality: Germany (Berlin).

Conwentzia orthotibia Yang, 1974: 88. Type locality: China (Gansu: Longnan). Syn. nov.

Type material examined. *Holotype* of *Conwentzia orthotibia*: male (CAU), CHINA: Gansu (Province): Longnan (city): Wudu (District), [33.3740°N, 104.9665°E], 25.vi.1958, leg. Xuemin Zhang. *Paratype*: 1 male, same data as holotype (CAU).

Other material examined. 7 males and 10 females (CAU), CHINA: Gansu (Province): diebu (County), [34.1286°N, 106.5364°E], 9.vii.2017, leg. Yaru Zhao and Mingwei Ma. 23 males and 30 females (CAU), CHINA: Gansu (Province): Zhangye (City), [34.1669°N, 106.5400°E], 13.vii.2017, leg. Yaru Zhao and Mingwei Ma. 5

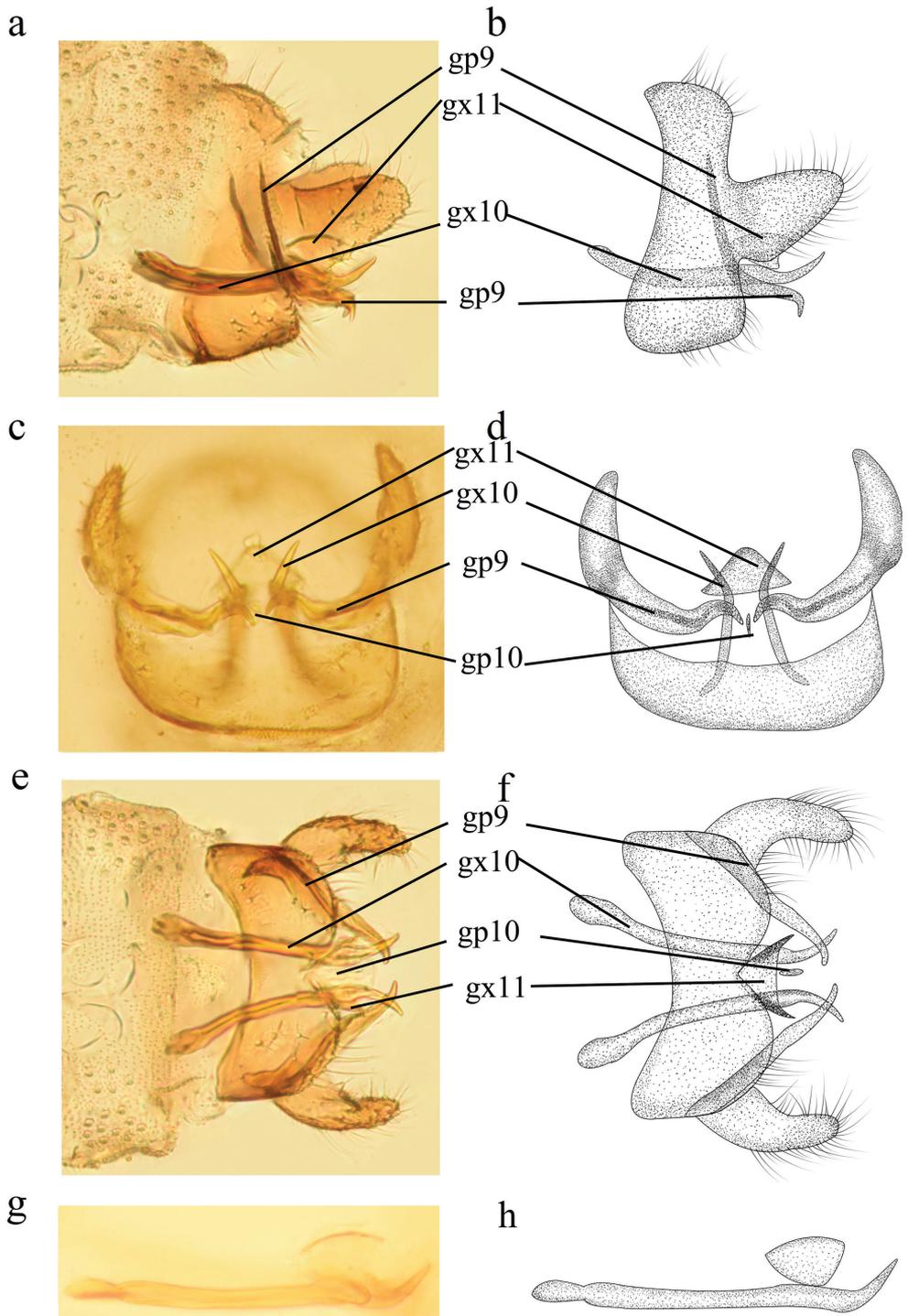


Figure 4. *Conwentzia nietoi* Monserrat, 1982, male genitalia **a, b** lateral view **c, d** caudal view **e, f** ventral view **g, h** gonocoxites 10, lateral view.

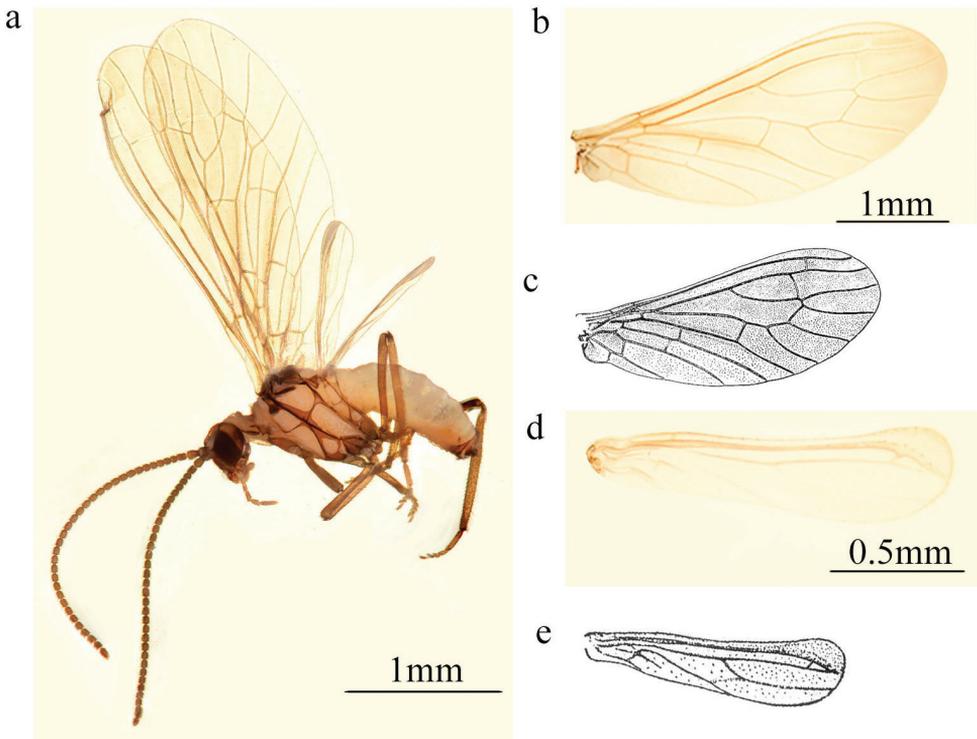


Figure 5. *Conwentzia pineticola* Enderlein, 1905, male **a** habitus, lateral view **b, c** fore wing **d, e** hind wing.

males and 6 females (CAU), CHINA: Gansu (Province): diebu (County), [33.9583°N, 103.5506°E], 13. vii.2017, leg. Yaru Zhao and Mingwei Ma. 1 male (CAU), CHINA: Liaoning (Province): Dandong (City), [40.1247°N, 124.3928°E], 27.vii.2017, leg. Yaru Zhao and Ying Li. 1 male and 3 females (CAU), CHINA: Liaoning (Province): Dandong (City), [40.1247°N, 124.3928°E], 28.vii.2017, leg. Yaru Zhao and Ying Li. 5 males and 4 females (CAU), CHINA: Sichuan (Province): Panzhihua (City), [25.0120°N, 98.4800°E], 3.iv.2019, leg. Yaru Zhao and Mingming Zou.

Diagnosis. Gonocoxites 9 present; gonocoxites 11 rod-shaped in lateral view; gonapophyses 9 basally broad in caudal view.

Redescription. Measurements. Forewing length 3.1–3.5 mm, width 1.1–1.4 mm. Hindwing reduced; length 1.3–1.4 mm, width 0.5–0.6 mm.

Head (Fig. 5a). Yellowish-brown. Compound eyes large and dark. Antennae 36–37-segmented in males and 32–36-segmented in females. Scape relatively broad and blunt. Pedicel cylindrical, longer than wide. Antennae brown; scape light brown in some specimens. Scape broad and blunt. Pedicel cylindrical and longer than broad. Maxillary and labial palpus brown.

Thorax. Brown. Nota with dorsal dark spots. Legs brown.

Wing (Fig. 5b–e). Wing membrane almost hyaline, light greyish brown.

Male genitalia (Fig. 6a–g). Outer process of ectoprocts finger-like in lateral view (Fig. 6a, b). Gonocoxites 9 furcate, with dorsal branch slightly longer than ventral one

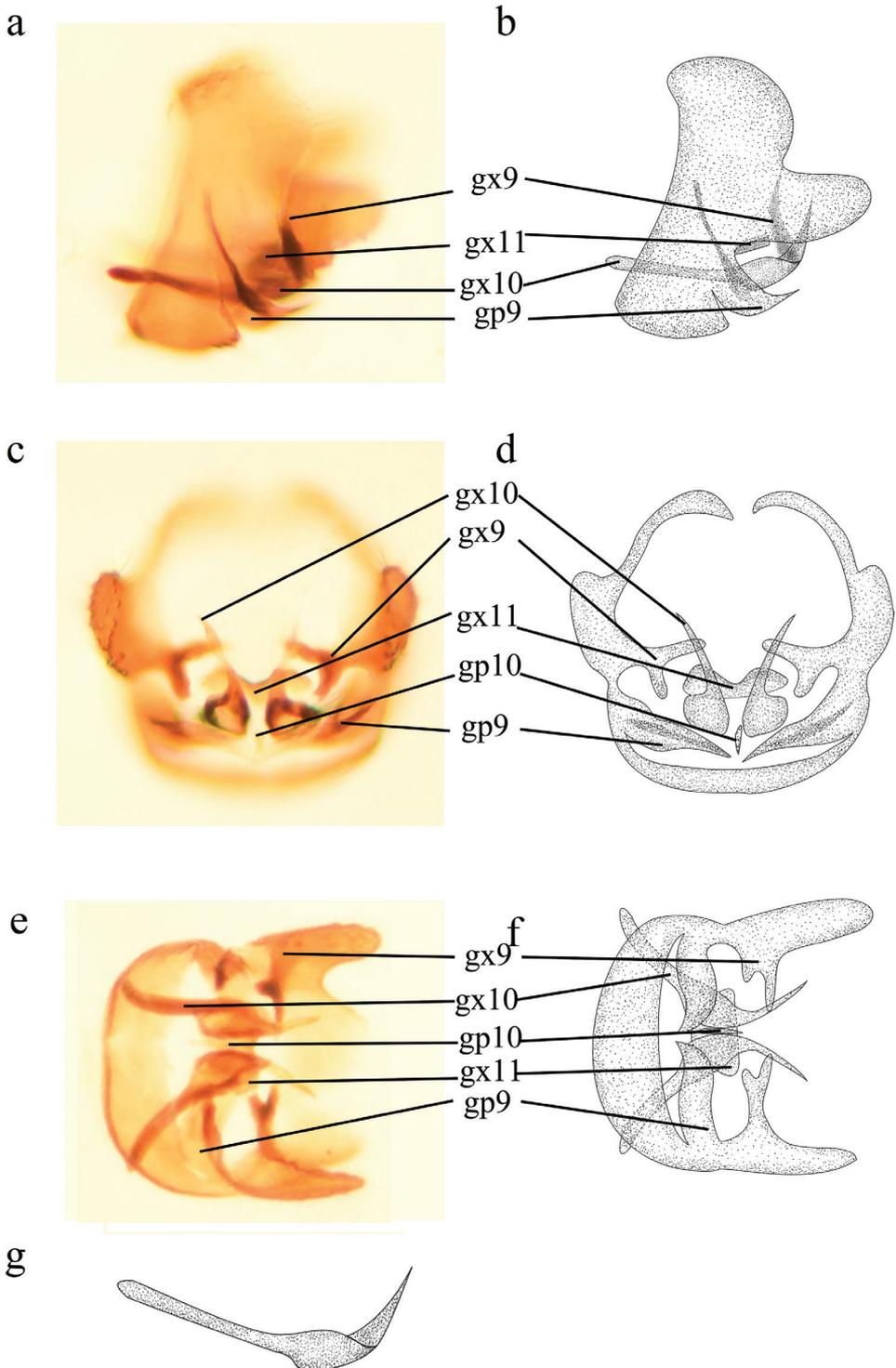


Figure 6. *Conwentzia pineticola* Enderlein, 1905, male genitalia **a, b** lateral view **c, d** caudal view **e, f** ventral view **g** gonocoxites 10, lateral view.

Table 1. *Conwentzia* specimens used in this study, with information on locality, geographic coordinates, sex, GenBank accession numbers and voucher specimen numbers.

Species	Locality	Geographic coordinates	Sex	Accession number	Voucher specimen number
<i>C. sinica</i>	Ruili, Dehong, China	24.0723°N, 97.8174°E	Male	MW093443	CAU-CONIO-00000348
	Ruili, Dehong, China	24.0723°N, 97.8174°E	Male	MW093444	CAU-CONIO-00000349
	Ruili, Dehong, China	24.0723°N, 97.8174°E	Male	MW093445	CAU-CONIO-00000350
<i>C. nietoi</i>	Longchuan, Dehong, China	24.1776°N, 97.7947°E	Male	MW093440	CAU-CONIO-00000320
	Longchuan, Dehong, China	24.1776°N, 97.7947°E	Male	MW093441	CAU-CONIO-00000322
<i>C. pineticola</i>	Yuanjiang, Yuxi, China	23.6001°N, 102.0098°E	Male	MW093442	CAU-CONIO-00000374
	Diebu, Gannan, China	33.9583°N, 103.5506°E	Male	MW093437	CAU-CONIO-00000026
	Diebu, Gannan, China	33.9583°N, 103.5506°E	Male	MW093438	CAU-CONIO-00000027
	Diebu, Gannan, China	34.1286°N, 106.5364°E	Male	MW093439	CAU-CONIO-00000043
	Ganzhou, Zhangye, China	34.1669°N, 106.5400°E	Male	MW093435	CAU-CONIO-00000025
	Ganzhou, Zhangye, China	34.1669°N, 106.5400°E	Male	MW093436	CAU-CONIO-00000023
	Panzhihua, Sichuan, China	25.0120°N, 98.4800°E	Male	MW093434	CAU-CONIO-00000338

Table 2. Intra- and interspecific Kimura 2-parameter average divergence values (%) of the COI gene analyzed by the MEGA 6.0 software. * = sequences of *C. pineticola* from Bavaria in Germany downloaded from GenBank.

Species	<i>C. pineticola</i>	<i>C. sinica</i>	<i>C. pineticola</i> *	<i>C. nietoi</i>
<i>C. pineticola</i>	0.10	–	–	–
<i>C. sinica</i>	14.14	0.10	–	–
<i>C. pineticola</i> *	2.19	14.54	0.52	–
<i>C. nietoi</i>	12.93	11.14	12.70	0.10

in caudal view (Fig. 6c, d). Gonapophyses 9 broad, distally hooked in ventral view (Fig. 6e, f). Gonocoxites 10 slender, distally bent upward in lateral view (Fig. 6a, b). Gonapophyses 10 short and straight in ventral view (Fig. 6e, f). Gonocoxites 11 sub-triangular in ventral view (Fig. 6e, f).

Distribution. China (Hebei, Shanxi, Jilin, Heilongjiang, Henan, Hubei, Chongqing, Sichuan, Yunnan, Tibet, Gansu, Qinghai, Ningxia, Xinjiang, Liaoning, Sichuan).

Molecular data

DNA barcoding

For the three *Conwentzia* species treated in this paper, accession numbers of DNA barcodes are listed in Table 1.

Genetic divergence among species

The average intraspecific genetic distance based on the K2P model was 0.10% for *Conwentzia sinica* Yang, 1974, 0.10% for *Conwentzia orthotibia* Yang, 1974, 0.10% for *Conwentzia yunguiana* Liu & Yang, 1993, and 0.52% for *C. pineticola*. The average interspecific genetic distance based on the K2P model was 2.19%

between *C. orthotibia* and *C. pineticola*. The other average interspecific genetic distances based on K2P model were 11.14–14.54%. The results (Table 2) showed that all intraspecific genetic distances were less than 2.0%, and all the interspecific genetic distance values exceeded 10% (except for the *C. orthotibia* and *C. pineticola* genetic distance).

Discussion

Conwentzia sinica is similar to *C. inverta* but differs in the shape of the male genitalia. *Conwentzia sinica* is characterized by a slender gonapophyses 10 in lateral view (Fig. 2a, b), while it is short (Monserrat 1982: 26, fig. 39) in *C. inverta*, therefore *C. sinica* is three times longer than *C. inverta* for gonapophyses 10. Moreover, the basal part of gonapophyses 10 is broad and blunt ventrally in *C. sinica* but acute in *C. inverta*. Furthermore, gonocoxites 10 are rectangular caudally in *C. sinica* (Fig. 2c, d) but oval in *C. inverta* (Monserrat 1982: 26, fig. 38). The morphological differences between *C. sinica* and *C. inverta* are mainly centered around the gonapophyses 10 and gonocoxites 10. However, both structures are almost transparent, requiring careful examination.

For *C. yunguiana*, we found that those specimens do not have clear differences after comparison of the type specimens of *C. yunguiana* with the description of *Conwentzia nietoi* Monserrat, 1982. Nevertheless, the distal part of gonocoxites 11 is blunt laterally in *C. yunguiana* (Fig. 4a, b), while it is acute in *C. nietoi* (Monserrat 1982: 26, fig. 34). The differences are mainly centered around the distal part of gonocoxites 11 in lateral view, which may be caused by the arched shape above the gonocoxites 10 in lateral view. Besides, the rim is so obscure for the gonocoxites 11 is membranous and transparent in distal part. And we also discussed with György Sziráki, who examined the type specimen of *C. nietoi*, and his opinion is the same as ours. Therefore, we ascribe the differences in gonocoxites 11 to intraspecific morphological variation.

We found no clear morphological differences between *C. orthotibia* and *C. pineticola* after comparison of the type specimens of *C. orthotibia* with the description of *C. pineticola*. Nevertheless, the distal part of gonocoxites 11 is wavy caudally in *C. orthotibia* (Fig. 6c, d), while it is arched in *C. pineticola* (Meinander 1972: 300, fig. 195F). We were not sure whether such differences should be ascribed to intraspecific morphological variation between *C. orthotibia* and *C. pineticola*. The type species was described from Berlin in Germany (Enderlein 1905) and we obtained DNA barcodes of *C. pineticola* from Bavaria in Germany from NCBI. The results show that the mean interspecific divergence between *C. orthotibia* and *C. pineticola* was 2.19%, which is inconsistent with Morinière et al.'s (2014) suggestion that the mean interspecific divergence is 10–20% in the Coniopterygidae, Hemerobiidae, and Myrmeleontidae. Our results suggest that the differences between *C. orthotibia* and *C. pineticola* are intraspecific.

Conclusion

Conwentzia yunguiana Liu & Yang, 1993 is proposed as a junior synonym of *Conwentzia nietoi* Monserrat, 1982, syn. nov. and *Conwentzia orthotibia* Yang, 1974 is proposed as a junior synonym of *Conwentzia pineticola* Enderlein, 1905, syn. nov. In this study, we added three species barcodes to the *Conwentzia* DNA library and the mean intraspecific divergence was 11.14–14.54% for the species analysed.

Acknowledgements

We thank Dr. György Sziráki for providing specimens for examination and Dr. Davide Badano for providing suggestions that helped improve the manuscript. This research was supported by the National Natural Science Foundation of China (Grants 31772499).

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Census of the fruit and flower chafers (Coleoptera, Scarabaeidae, Cetoniinae) of the Macau SAR, China

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Academic editor: A. Frolov | Received 26 October 2020 | Accepted 5 February 2021 | Published 25 March 2021

<http://zoobank.org/B5E52548-328B-44C9-9B54-45028CDE642D>

Citation: Perissinotto R, Clennell L (2021) Census of the fruit and flower chafers (Coleoptera, Scarabaeidae, Cetoniinae) of the Macau SAR, China. ZooKeys 1026: 17–43. <https://doi.org/10.3897/zookeys.1026.60036>

Abstract

The coleopteran fauna of the Macau SAR in southern China has historically received only limited attention and no updated information has been published since the last substantial works produced in the 1990s. An annotated and illustrated review of the fruit and flower chafers (Scarabaeidae, Cetoniinae) of this region is here presented, in order to provide an account of the current status of the taxonomic diversity and ecology of this important insect group. Eleven species were observed in the SAR during an intense investigation undertaken during the period 2017–2020, with six of these representing new records for Macau and two for the broader region of the Pearl River Delta, also known as the Greater Bay Area. Although this census leads to a substantial increase in the number of species known for the area, it also highlights the threats that the recent escalation in urban development and land-use transformation are posing to a number of species which seem unable to maintain a sustainable population in the region, mainly due to habitat destruction.

Keywords

Cetoniini, new records, Palearctic Region, Schizorhinini, Taenioderini

Introduction

Fruit and flower chafers are good indicators of environmental health status and are increasingly used in environmental assessment and planning studies (e.g., Mawdsley et al. 2011; Mudge et al. 2012; Touroult and Le Gall 2013; Correa et al. 2019). They constitute a very diverse group of insects, with currently almost 5000 described species,

and play a very important ecological role in processes such as pollination and nutrient recycling in the soil (Beutel and Leschen 2005). Their larvae are typical white grubs, generally living within the soil as plant detritivores or in decomposing wood as part of a saproxylic community (Correa et al. 2019). Conversely, the adults are normally brightly-coloured beetles with diurnal activity and feed on a variety of flowers, overripe fruits and tree sap flows (Beutel and Leschen 2005; Krikken 1984).

Unlike in the other Chinese SAR in the same region, Hong Kong, in Macau there has been relatively little research undertaken in the past on its insect fauna, with only a handful of publications produced on the subject to date. Among these, to our knowledge only three have reported records of occurrence of Cetoniinae, namely Easton (1991: “*Agestrata orichalea* and *Protaetia orientalis* G. & P.”), Easton (1993: “*Protaetia orientalis* Gory & Percheron”) and Pun and Batalha [1997: “*Agestrata orichalcea* Linnaeus, *Protaetia orientalis* Gory & Percheron, *Oxycetonia jucunda* Faldermann and *Thaumastopeus nigritus* (Frohlich)”]. Thus, in essence only four species in this beetle group have been reported in the literature to date. So, it is not surprising that Cetoniinae records for Macau have largely been ignored or omitted in all the major works undertaken on this group of insects in the broader Chinese region and the world. For instance, despite explicitly mentioning Macau/Macao as part of the region included in their revisions, neither Krajcik (2011) nor Bezděk (2016) mention any specific Cetoniinae record from this SAR in their reviews. Similarly, Macau does not feature at all in Sakai and Nagai’s (2008) outstanding overview of the cetoniines of the world, neither in the list of specific records, nor in any citation of geographic distribution.

This under-reporting is further compounded by issues of outdated or incorrect identifications. The main purpose of this work is, therefore, to provide a modern census of the cetoniine beetles of the Macau SAR, based on extended and frequent field surveys, comprehensive observation gathering methods and updated identification approaches using local and global expertise. To our knowledge, along with a similar study undertaken recently by Leong et al. (2017) on the ants (Hymenoptera, Formicidae) of Macau, this represents the only modern census of a group of insects undertaken during the current century in this Chinese SAR. It is hoped that this will stimulate further research and interest in the region, as well as provide the local authorities with supporting information towards their ongoing environmental management and biodiversity conservation programmes.

Materials and methods

Macau is characterised by a subtropical climate and what remains of its natural terrestrial plant assemblages includes five vegetation types, namely coniferous forest, coniferous and broad-leaved mixed forest, evergreen broad-leaved forest, evergreen and deciduous broad-leaved mixed forest and shrub (Peng et al. 2014). Although biogeographically it is part of the Palearctic Region, it lies at the interface with the Oriental Region and, consequently, there is a large overlap in the occurrence of species from both regions within its boundaries (Löbl and Löbl 2016).



Figure 1. Map of the Macau SAR showing its various components including the Peninsula, the islands of Taipa and Coloane as well as the reclaimed lands of Cotai, the International Airport and the Hong Kong – Zhuhai – Macau Bridge Port (adapted from: <https://www.britannica.com>; used with permission).

The Macau Special Administrative Region (SAR) of China consists of the Macau Peninsula, linked directly to the mainland province of Guangdong, and one larger island resulting from the merger of the two previous islands of Taipa and Coloane through the land reclaimed area of Cotai (Fig. 1). Other land reclamations have also added the International Airport to the Taipa-Coloane complex and more recently the Hong Kong-Zhuhai-Macau Bridge Port to the Peninsula, which now connects the three regions that constitute the so-called Greater Bay Area of the Pearl River Estu-

ary (Fig. 1). An advanced network of road and bridge infrastructure also connects all the components of the SAR, which currently has a total areal extent of ca. 30 km² (Leong et al. 2017).

The Macau SAR is a very prosperous region, reportedly enjoying one of the highest per capita incomes in the world, but is also among the most densely populated areas on the planet. Remarkably, despite its extraordinary population pressure and developmental momentum, some areas of its original, natural landscape still remain, although they are often encroached upon by alien vegetation (Leong et al. 2017). These consist mainly of densely forested hilly outcrops intersected by networks of hiking trails, service roads and recreational facilities. The largest are located in the Coloane area (e.g., Alto de Coloane, Barragem de Ká-Hó and Monte de Ká-Hó) and Taipa (Taipa Grande and Taipa Pequena), but there are lesser pockets in the Peninsula as well (e.g., Colina da Guia, Colina da Barra, Parque Municipal de Mong Há and Ilha Verde) (Figs 1, 2). All these sites were visited on a regular basis during the census period, in order to provide an areal cover as comprehensive as possible of the potential habitats for Cetoniinae within the SAR.

Cetoniine observations were undertaken on an opportunistic basis from Sep 2017 and virtually on a daily basis during the two-year period Oct 2018–Oct 2020. This generally involved non-manipulative methods, with photographs taken in situ as much as possible. Fruit-baited traps were deployed during the summer of 2019 in urban marginal areas, with the main purpose of attempting to run a mark-recapture exercise and estimate the numerical abundance for the various species. Unfortunately, too few specimens and species were found to enter the traps and therefore the attempt was abandoned thereafter. Traps were made using a standard 1 L bottle with the neck cut-off and inverted inside the bottle in order to create a funnel-like entrance that would allow beetles to enter, but not re-exit (Touroult and Le Gall 2013; Correa et al. 2019). The bait consisted of a variety of fermenting fruits, mainly banana, lychee, pineapple and grape, mixed with brown sugar and red wine. Traps were suspended on tree branches, ca. 2–3 m above the ground and inspected on a daily basis. Trapped beetles were sexed, sized, photographed and immediately released.

Occasionally, mature adults ready to emerge were excavated from decomposing tree trunks still in their cocoons, or obtained after rearing third instar larvae collected in the wild, under laboratory controlled-conditions. In the latter case, larvae were kept in plastic containers of 1 L capacity, containing the natural wood material found in situ. Water was sprayed on the soil surface at regular intervals of ca. 1–2 weeks until pupation. Voucher specimens for reference and identification verification purposes were usually selected from specimens found already dead in the field. These are currently housed in the Macau Anglican College, Taipa (**MACT**) or in the reference collection of Stanislav Jákl, Prague (**SJCP**) for further investigation. Other specimens for analysis were accessed from the historical Easton Collection currently housed in the Library of the University of Macau (**UMEC**). Preserved specimens were analysed in detail for the typical diagnostic characters of each species, including aedeagal parameres. Observations and data records were also obtained from the citizen science platform iNaturalist

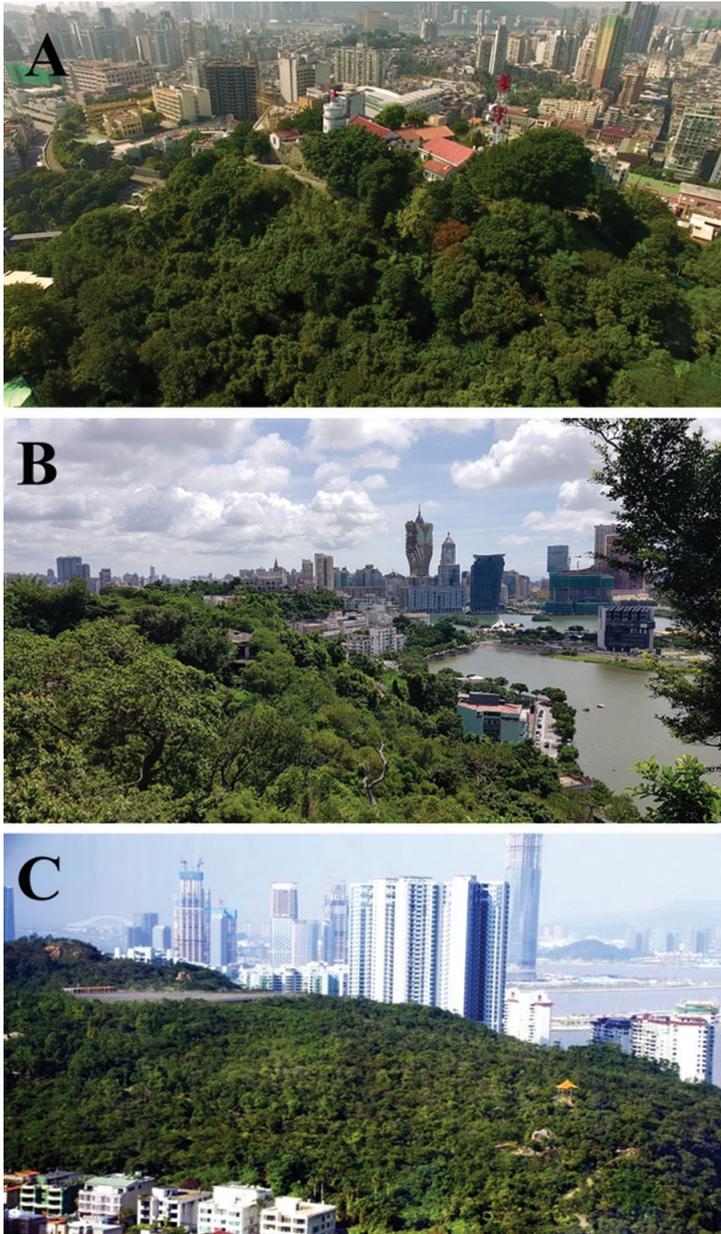


Figure 2. Examples of remaining pockets of subtropical evergreen forest in Macau **A** Colina da Guia (Macau Peninsula) **B** Colina da Barra (Macau Peninsula) **C** Taipa Pequena (Taipa). Photographs: **A** Shutterstock.com **C** JTM.co.mo **B** Lynette Clennell.

(www.inaturalist.org), after direct verification with each individual observer. The following literature references were used to extract historical information records: Easton (1991), Easton (1993) and Pun and Batalha (1997).

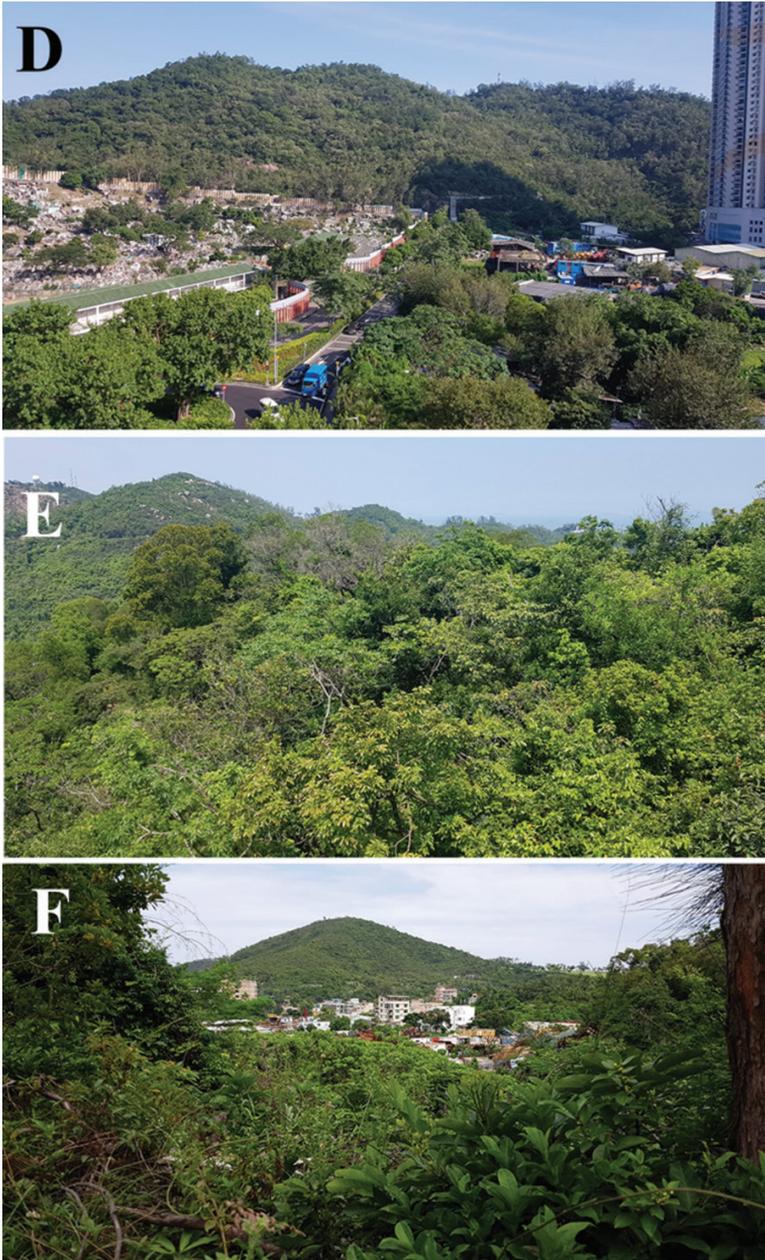


Figure 2. Continued. **D** Taipa Grande (Taipa) **E** Alto de Coloane (Coloane) **F** Monte de Ká-Hó (Coloane). Photographs: **D–F** Lynette Clennell.

Photographs of specimen dorsal and lateral views were generally taken in situ as far as practical, using a Nikon CoolPix S9700 digital camera with macro setting. Where this was not possible in the field, specimens were photographed, sexed and measured

under controlled conditions and released immediately afterwards. On rare occasions, visual disturbances were removed from the photographs using Microsoft Word 2010 (Picture Tools), in order to increase clarity and resolution of the images. Specimen total length (TL) and maximum width (MW) were measured using a Vernier calliper, from the anterior margin of the clypeus to the apex of the pygidium and at the widest point of the elytra, respectively.

In this work, all the species recorded during the census in the Macau SAR are illustrated with photos of live specimens in their natural or reconstructed setting, highlighting their key dorsal and, where possible, lateral characters. For a comprehensive list of currently recognised synonyms, the reader is referred to the latest revision of the Palearctic Coleoptera by Löbl and Löbl (2016).

Taxonomy

Tribe Cetoniini Leach, 1815

Genus *Gametis* Burmeister, 1842

Type species. *Cetonia versicolor* Fabricius, 1775.

Gametis bealiae (Gory & Percheron, 1833)

Fig. 3

Cetonia bealiae Gory & Percheron, 1833: 282.

Distribution. Within the Palearctic Region, *G. bealiae* is known from the Chinese provinces of Fujian, Guangdong, Hebei, Hubei, Jiangxi, Zhejiang and the Hong Kong SAR (Yiu 2010; Lirong et al. 2013; Bezděk 2016). It is also widely distributed across the Oriental Region, specifically in Myanmar, Laos, northern Vietnam and north-eastern India (Sakai and Nagai 1998; Krajcik 2011).

Material examined. 1♂: Coloane Village, 29 Jun 2019, in fruit-baited trap, R Perissinotto & L Clennell (MACT).

Other Macau records. Taipa Pequena, 4 Mar 2019, on flowers of *Ligustrum sinense*, R Perissinotto; Coloane, Hác-Sá, 4 Apr 2019, on flowers of *L. sinense*, R Perissinotto & L Clennell; ibidem 11 Apr 2020, R Perissinotto & L Clennell.

Remarks. In Macau, this species varies in size between 12.5 and 15 mm in TL and between 7 and 9 mm in MW. Colour forms range from black to olive green background, with testaceous to reddish green pronotum and ochreous to testaceous mid-elytral bands. The white maculation on the general surface appears to be consistent. During 2019, one individual was retrieved inside a fruit-baited trap, while four others were observed feeding on flowers of *Ligustrum sinense*. In 2020, only one specimen was observed while feeding on flowers of *L. sinense*. In Macau, this species appears to have



Figure 3. *Gametis bealiae* (Gory & Percheron, 1833): dark green and ochreous form (left), olive green and testaceous form (right) observed at Coloane on 4 Apr 2019 (photographs: Lynette Clennell).

its peak of adult activity between early spring and early summer, while no specimens have been recorded in late summer, autumn, or winter. In nearby Hong Kong, this species has been recorded feeding on flowers of *Viburnum odoratissimum* and *Lonicera* sp. between March and May (Yiu 2010) as well as on flowers of *Zanthoxylum avicennae* in October (<https://www.inaturalist.org/observations/62885551>). No information is available on larval or pupal stages in the region.

***Gametis jucunda* (Faldermann, 1835)**

Fig. 4

Cetonia jucunda Faldermann, 1835: 386.

Distribution. Mainly a Palearctic species, recorded from the Chinese provinces and municipalities of Beijing, Chongqing, Fujian, Gansu, Guizhou, Guangxi, Hainan, Hebei, Heilongjiang, Hubei, Jiangsu, Jiangxi, Liaoning, Nei Mongol, Sichuan, Shanghai, Shandong, Shanxi, Yunnan, Zhejiang and the Hong Kong SAR (Lirong et al. 2013; Bezděk 2016). Also found in Pakistan, Nepal, the Indian Sikkim Province, North and South Korea, Mongolia, Russian Far East and Japan (Sakai and Nagai 1998; Krajcik 2011; Bezděk 2016). According to Bezděk (2016), it also occurs in the Oriental Region.

Material examined. 1♂, 1♀: Coloane, Hác-Sá, 8 Apr 2020, on flowers of *Ligustrum sinense*, R Perissinotto (MACT).

Other Macau records. No locality and date, 14 mm (in Pun and Batalha 1997: 65, fig. 108 as *Oxycetonia jucunda* Faldermann); Taipa Pequena, 11 Mar 2019, on flowers of *Toddalia asiatica*, R Perissinotto & L Clennell.

Remarks. A rare species in Macau, despite its widespread distribution and common occurrence in the surrounding regions, such as the Hong Kong SAR (Yiu 2010;



Figure 4. *Gametis jucunda* (Faldermann, 1835): dorsal (left) and side (right) views of typical specimens observed at Taipa (11 Mar 2019) and Coloane (8 Apr 2020), respectively (photographs: Lynette Clennell).

iNaturalist observations). The dorsal background colour is always predominantly green, ranging from bright to olive grade, while the white maculation can vary somehow in extent. In particular, the discal spots on both pronotum and elytra can fade completely in exceptional cases. Specimens range in size within the approximate range of 12–15 mm TL and 6–8 mm MW. The period of adult activity appears to peak in the spring and no specimens have been recorded in Macau during summer or autumn yet, although their occurrence during these seasons is well established in nearby Hong Kong (Yiu 2010). In Macau, adults were observed feeding on flowers of *Ligustrum sinense*, *Clausena lansium* and *Toddalia asiatica*, while in Hong Kong they were also found on *Guilandina bonduc*, *Rhus chinensis* and *Schima superba* (Yiu 2010). The 1st–3rd instar larvae of *G. jucunda* have been comprehensively described and illustrated by Murayama (1931), Medvedev (1952), Zhang (1984) and Sawada (1991) (Šípek and Král 2012).

Genus *Glycyphana* Burmeister, 1842

Subgenus: *Glycyphana* Burmeister, 1842

Type species. *Cetonia horsfieldii* Hope, 1831.

Glycyphana (*Glycyphana*) *horsfieldii* Hope, 1831

Fig. 5

Cetonia horsfieldii Hope, 1831: 25.

Distribution. Known in the Palearctic Region from the Himalayan countries of Nepal, Bhutan, and the Sikkim Province of India, as well as the Chinese provinces of



Figure 5. *Glycyphana (Glycyphana) horsfieldii* Hope, 1831: dorsal (left) and side (right) views of typical specimens observed at Taipa (11 Oct 2019) and Coloane (7 Apr 2020), respectively (photographs: Lynette Clennell).

Guizhou, Jiangxi, Yunnan, and the island of Taiwan (Bezděk 2016). It has only recently been recorded from Hong Kong for the first time (Aston and Melsom 2019). In the Oriental Region, it has been reported from Myanmar, Vietnam, Thailand, Laos, India and Sri Lanka (Sakai and Nagai 1998; Krajcik 2011).

Material examined. 1♂: Taipa Monument, 27 Sep 2018, dead on path, R Perissinotto (MACT); 1♀: Coloane Village, 28 Aug 2019, on flowers of *Zanthoxylum avicennae*, R Perissinotto & L Clennell (MACT).

Other Macau records. Macau, Guia Hill, 25 Oct 2017, R Perissinotto & L Clennell; Taipa Pequena, 4 May 2018, R Perissinotto & L Clennell; ibidem 11 Oct 2018, R Perissinotto & L Clennell; Macau Peninsula, 22 Dec 2019, Angus Chan (pers. comm.); Coloane, Hác-Sá, 7 Apr 2020, on flowers of *Ligustrum sinense*, R Perissinotto & L Clennell.

Remarks. This species appears to be a new record for the broader region, having also been observed for the first time in Hong Kong only in April 2018 (Aston and Melsom 2019). The subspecies *G. h. chinensis*, originally described by Mikšić (1970) based on its wider extent of the red pronotal margin over the nominal subspecies (e.g., Ma 1995), is no longer recognised and has been synonymised with *G. horsfieldii* (Jákl in Löbl and Löbl 2016: 18). Specimens in Macau range in size from approximately 13 to 16 mm TL and from 6 to 8 mm MW. The period of adult activity seems to extend throughout the year, but most observations are from the spring (Apr–May) and autumn (Sep–Oct) months. While the larval stages are not known, adults have been recorded on flowers of *Ligustrum sinense*, *Zanthoxylum avicennae*, *Shefflera heptaphylla* and *Homalium cochinchinense*.

Subgenus *Glycyphaniola* Mikšić, 1968

Type species. *Cetonia modesta* Fabricius, 1792

***Glycyphana (Glycyphaniola) laotica* Mikšić, 1968**

Fig. 6

Glycyphaniola nicobarica laotica Mikšić, 1968: 48.

Distribution. According to Jákl (in Löbl and Löbl 2016: 18), it is currently known from the Hong Kong SAR and parts of the Oriental Region. It is likely that it occurs through much of southern China.

Material examined. 1♀: Taipa Central, October 2017, Jeff Lei (MACT); 1♂: Barra Hill, 5 May 2018, dead on roadside, L Clennell (MACT); 1♂: Taipa Pequena, 26 Sep 2018, on flowers of *Rhus chinensis* by roadside, R Perissinotto & L Clennell (MACT); 1♀: Coloane Village, 13 Mar 2019, on flowers of *Bidens* sp., R Perissinotto (SJCP); 1♂: ibidem 13 Apr 2019, R Perissinotto (SJCP).

Other Macau records. Taipa Pequena, 26 Oct 2017, on flowers of *Rhus chinensis*, R Perissinotto & L Clennell; ibidem 2 Mar 2020; Coloane Village, 2 Jul 2019, on flowers of *Bidens* sp., R Perissinotto & L Clennell; ibidem, 29 Sep 2018, R Perissinotto & L Clennell; Coloane, Ká-Hó, 7 Oct 2018, R Perissinotto & L Clennell; Macau, Guia Hill, 14 Mar 2020, on flowers of *Ligustrum sinense*, R Perissinotto & L Clennell; St. Francis Xavier's Parish, Macau [Coloane], 7 Jul 2019 13:04, Kit Chang (<https://www.inaturalist.org/observations/28360614>); ibidem 12 Apr 2020 13:29, L Clennell (<https://www.inaturalist.org/observations/55132359>); ibidem 27 Sep 2020 14:59, L Clennell (<https://www.inaturalist.org/observations/60940151>); ibidem 30 Sep 2020, L Clennell (<https://www.inaturalist.org/observations/61293565>); Our Lady of Carmel's Parish [Taipa], 17 Aug 2020 14:14, L Clennell (<https://www.inaturalist.org/observations/56723739>); ibidem 14 Sep 2020 16:07, Kit Chang (<https://www.inaturalist.org/observations/59561942>); Circuito da Barragem de Hac-Sá, Coloane, 4 Jul 2020 15:26, Annie Lao (<https://www.inaturalist.org/observations/51892005>).

Remarks. This taxon has recently been elevated to species rank by Jákl (in Löbl and Löbl 2016: 18), on the basis of comparative studies of numerous specimens from continental Asia and the type material of *Glycyphana nicobarica* Janson, 1877. Thus, all previous identifications of the local *G. (Glycyphaniola)* species occurring in Macau and nearby Hong Kong almost certainly refer to this species rather than to *G. nicobarica*, which is probably an endemic to the Nicobar Islands (S Jákl, pers. comm.). Specimens range in size between approximately 9–12 mm in TL and 5–6 mm in MW. The background colour of their body surface can vary from bright light green, to dark olive-green (Fig. 6) and in extreme cases even brown to brick-red. The extent of white maculation also varies substantially across both elytral and pronotal surfaces.

Larvae, cocoons, and freshly emerged adults have been observed inside decomposing tree trunks and branches (pers. obs.), thereby confirming the saproxylic habit of its immature stages. In Hong Kong (then referred to as *Glycyphana nicobarica*), larvae were successfully reared to adulthood on fermented sawdust, and several adult specimens were found inside a compost heap composed of pig waste and sawdust (Yiu 2010). Adults have been recorded feeding on a variety of flowers, including *Rhus chinensis*, *Ligustrum sinense*,



Figure 6. *Glycyphana (Glycyphaniola) laotica* Mikšič, 1968: dorsal (left) and side (right) views of typical specimens observed at Taipa (14 Mar 2019) and Coloane (20 Apr 2020), respectively (photographs: Lynette Clennell).

Mallotus paniculatus, *Murraya paniculata*, *Schefflera heptaphylla*, *Viburnum odoratissimum*, *Zanthoxylum avicennae*, *Bauhinia championii*, and even on the alien invasive herbs *Bidens alba* and *B. pilosa*. They do not seem to be attracted to fruit-baited traps and have not been observed on sap flows either. This is one of the most often encountered species in the Macau SAR, but never in abundance. It occurs all year round, with distinct peaks of adult activity in the spring (Mar–Apr) and autumn (Sep–Oct).

Genus *Protaetia* Burmeister, 1842

Type species. *Cetonia mandarina* Weber, 1801 (= *Cetonia fusca* Herbst, 1790).

Subgenus *Calopotosia* Reitter, 1899

Type species. *Cetonia submarmorea* Burmeister, 1842.

Protaetia (Calopotosia) orientalis orientalis (Gory & Percheron, 1833)

Fig. 7

Cetonia orientalis Gory & Percheron, 1833: 193

Distribution. Within the Palearctic Region, this species is known from the Chinese provinces of Chongqing, Fujian, Guangxi, Guizhou, Hubei, Hunan, Jiangxi, Sichuan, Shandong, Zhenjiang, the Hong Kong SAR, North and South Korea as well as the



Figure 7. *Prototaetia (Calopotosis) orientalis orientalis* (Gory & Percheron, 1833): dorsal view of typical specimen (left) and aggregation of several individuals (right) on sap flow of *Albizia lebbbeck*, observed at Coloane on 18 May 2019 and 15 Jun 2019, respectively (photographs: Lynette Clennell).

Russian Far East (Lirong et al. 2013; Bezděk 2016). It is also widespread in the Oriental Region, specifically in northern India, the Kashmir region, northern Vietnam, and Laos (Sakai and Nagai 1998; Krajcik 2011).

Material examined. 1♂, 1♀: Coloane, Ká-Hó, 16 Jun 2018, dead on roadside, L Clennell (MACT); 1♂: Coloane, A-Mà Cultural Village, 13–15 Jun 2019, aggregation on sap of *Albizia lebbbeck*, R Perissinotto & L Clennell (MACT); 1♂: Macau, University of East Asia Library, 4 May 1990, ER Easton leg (UMEC); 1♀: ibidem, on building, 1 Aug 1989, ER Easton leg (UMEC); 1♂: ibidem 30 Jul 1989, ER Easton leg (UMEC); 1♂: ibidem, on building, 12 Jul 1989, ER Easton leg (UMEC); 1♀: ibidem no data, ER Easton leg (UMEC).

Other Macau records. Taipa, University of East Asia Campus, near library, 28 May 1991 (Easton 1991: 111; 1993: 55); No locality and date, 18 mm (Pun and Batalha 1997: 66, fig. 109); Taipa Grande, 22 May 2018, L Clennell; Coloane, 10 May 2019, R Perissinotto & L Clennell; ibidem 18 May 2019, R Perissinotto & L Clennell; Macau, 15 Jun 2019, Peggí Chao (pers. comm.); ibidem 8 Aug 2019, Ben Wong (pers. comm.); Alto de Coloane, 23 May 2020, R Perissinotto & L Clennell; ibidem 5 Jul 2020, feeding on sap of *Sapium discolor* R Perissinotto & L Clennell; Barra Hill, Macau, 9 Jul 2018 12:58, Kisu Wong (<https://www.inaturalist.org/observations/23843295>); Coloane Alto, Macao, 15 Jun 2019 16:11, L Clennell (<https://www.inaturalist.org/observations/56299608>); St. Francis Xavier's Parish [Coloane], 12 May 2019 10:27, Kit Chang (<https://www.inaturalist.org/observations/24989100>); ibidem 5 Jul 2020 13:56, L Clennell (<https://www.inaturalist.org/observations/56110922>); Avenida Doutor Stanley Ho [Macau], 24 May 2020 11:44, Benny Kuok (<https://www.inaturalist.org/observations/47261733>).

Remarks. This is the only species currently seen in reasonable numbers in the Macau SAR, but only from late spring and throughout the summer. Specimens are

generally of a bright green colour with golden sheen and white markings, but the background colour can turn olive-green or even darker in some specimens. Adult size varies within the approximate range of 20–25 mm in TL and 10–13 mm in MW. Its diet appears to be the most variable exhibited by any of the cetoniines encountered in Macau, with adults recorded in aggregations on sap flows of *Albizia lebbbeck* (Fig. 7) and *Sapium discolor*. It also enters regularly into fruit-baited traps and has been observed feeding on wild figs and lychee fruits. Among the flowering trees that attract this species are *Acronychia pedunculata*, *Litsea glutinosa*, *Paliurus spina-christi* and *Syzigium buxifolium*.

Easton (1993) reported that this species was regarded a minor pest, as the adults fed on lychees and other soft fruits such as peaches, while their grubs were believed to feed on the roots of grasses. Although adults are typically diurnal, with activity peaking in the hottest part of the day, they have also been found on the walls of buildings illuminated at night (Easton 1993). The 3rd instar larva of this species was comprehensively described and illustrated by Sawada (1991). In Hong Kong, larvae have been successfully reared in captivity using fermented sawdust as food (Yiu 2010).

Subgenus *Liocola* CG Thomson, 1859

Type species. *Cetonia marmorata* Fabricius, 1792

Protaetia (Liocola) speculifera (Swartz, 1817)

Fig. 8

Cetonia speculifera Swartz, 1817: 53.

Distribution. In the Palearctic Region this species is only known from the Chinese provinces of Hainan, Henan, Hunan and Jiangxi (Sakai and Nagai 1998; Bezděk 2016). It has also been recorded in the Oriental Region from northern Vietnam and Laos (Krajcik 2011).

Material examined. 1♂: Coloane, A-Mà Cultural Village, 19 Jun 2019, dead under tree, R Perissinotto & L Clennell (MACT).

Other Macau records. Alto de Coloane, 14 Jun 2019, on sap flow of *Albizia lebbbeck*, R Perissinotto & L Clennell; ibidem 5 Jul 2020, on sap flow of *Sapium discolor*, R Perissinotto & L Clennell; Coloane Village, 8 Jul 2020, landing on tree trunk, R Perissinotto & L Clennell.

Remarks. This species has a rather sporadic occurrence in Macau, having been observed only twice in 2019 and always on sap flows of *Albizia lebbbeck*, and then again on another two occasions in 2020, on sap flows of *Sapium discolor* and in hovering flight respectively (pers. obs.). Adult size varies in the approximate range of 20–23 mm TL and 11–13 mm MW. Although it has not been recorded formally from nearby Hong Kong, a few observations reported on the citizen science platform



Figure 8. *Prototaetia (Liocola) speculifera* (Swartz, 1817): dorsal (left) and side (right) views of typical specimens observed at Coloane on 14 Jun 2019 and 8 Jul 2020, respectively (photographs: Lynette Clennell).

iNaturalist from that area (e.g., <https://www.inaturalist.org/observations/25994523>; <https://www.inaturalist.org/observations/24358351>; <https://www.inaturalist.org/observations/1126433>) indicate that this species [or the closely related *P. (L.) brevitarsis* (Lewis, 1879)] may occur there too. It has probably been overlooked in the past, as superficially it resembles quite well *P. (C.) orientalis orientalis* both in size and general appearance. Even an alerted observer needs to be within close distance in order to be able to appreciate the stockier body shape, the reduction of white maculation on the dorsal surface and the gold-red sheen that allow the diagnosis of this species against *P. (C.) orientalis orientalis*. Adult activity of *P. (L.) speculifera* in Macau seems to be restricted to the summer months.

Subgenus *Potosia* Mulsant & Rey, 1871

Type species. *Cetonia floricola* Herbst, 1790 (= *Cetonia metallica* Herbst, 1782)

Prototaetia (Potosia) intricata WW Saunders, 1852

Fig. 9

Prototaetia intricata WW Saunders, 1852: 31

Distribution. This species appears to be rather restricted geographically, having so far been recorded only in the Chinese provinces of Fujian and Zhejiang (Bezděk 2016; Krajcik 2011).

Material examined. 1♂: Coloane, Ká-Hó, 2 Jun 2019, on flowers of *Syzigium buxifolium*, R Perissinotto & L Clennell (SJCP).



Figure 9. *Prottaetia (Potosia) intricata* WW Saunders, 1852: dorsal habitus of the male specimen observed at Coloane on 2 Jun 2019 (photographs: Lynette Clennell).

Other Macau records. Coloane, Ká-Hó, 29 May 2020, on flowers of *Syzigium buxifolium*, R Perissinotto [identification uncertain].

Remarks. This is certainly the rarest cetoniine recorded so far in Macau, having been observed with certainty only once in June 2019, feeding on flowers of *Syzigium buxifolium*. A second potential specimen was observed in a nearby locality on the same flowers in May 2020, but its identification could not be conclusively verified as it was too far above the ground. According to S. Jákl (pers. comm.), this species is extremely rare throughout its limited distribution range and to our knowledge has not been reported from Hong Kong yet. The approximate size of the 2019 male specimen was 15 mm TL and 9 mm MW.

Subgenus *Prottaetia* Burmeister, 1842

Type species. *Cetonia mandarina* Weber, 1801 (= *Cetonia fusca* Herbst, 1790)

Prottaetia (Prottaetia) fusca (Herbst, 1790)

Fig. 10

Cetonia fusca Herbst, 1790: 257

Distribution. Occurring widely in the Palearctic Region, especially the Chinese provinces and municipalities of Fujian, Guangdong, Guangxi, Hainan, Hubei, Jiangxi, Zhenjiang, Shanghai, the Hong Kong SAR and the island of Taiwan as well as Japan and India's Sikkim Province (Bezděk 2016). Also found in the Oriental, Australian,



Figure 10. *Protactia (Protactia) fusca* (Herbst, 1790): dorsal (left) and side (right) views of typical specimens observed at Coloane on 4 Apr 2019 and 17 Jul 2020, respectively (photographs: Lynette Clennell).

Afrotropical, and Pacific regions (Bezděk 2016), particularly across SE Asia, Australia, New Guinea, Madagascar, Mauritius, Hawaii, Polynesia, Micronesia, and Melanesia (Sakai and Nagai 1998; Krajcik 2011). It has recently been intercepted in Florida and in the Caribbean countries of Bahamas and Barbados (Woodruff 2006), thus becoming a near-cosmopolitan species.

Material examined. 1♂: Macau, University of East Asia, Jun 1990, ER Easton leg (UMEC); 1♂: Coloane, Cheoc Van, 29 Jun 2019, crushed on sidewalk, R Perissinotto & L Clennell (MACT).

Other Macau records. Coloane, Hác-Sá, 4 Apr 2019, on flowers of *Ligustrum sinense*, R Perissinotto; Coloane Village, 17 Jul 2020, on building wall, L Clennell; Coloane, Oscar Farm, on rice stem, 24 Oct 2020, Kit Chang (pers. comm.).

Remarks. Despite being one of the most worldwide spread cetoniine, this species is extremely scarce in Macau. Adults are active mainly in spring and summer and range in size from approximately 13 to 15 mm TL and from 8 to 9 mm MW. In Macau, they have been observed feeding only on flowers of *Ligustrum sinense*, but the widely used common name of Asian mango flower beetle for the species indicates a diet with this staple component in its natural habitat. Globally, it has actually shown a very variable diet, including a multitude of flowers, fruits and even bee honey. In Hawaii, where it was first recorded in 1949 (Maehler 1950), it is regarded as a pest, causing damage to commercially cultivated roses, maize and a wide variety of flowers and fruits. The damage caused has been regarded significant enough to justify the introduction of parasitic wasps from other regions, in an effort to exert biological control over its rapidly expanding population (Woodruff 2006). The entire life cycle of this species, including egg, 1st–3rd instar larvae and pupa, was comprehensively described and illustrated by Simpson (1990). Larvae are compost feeders and have not been observed to attack roots of healthy plants and thus, unlike their adults, are not regarded as pests (Simpson 1990).

Tribe Schizorhinini Burmeister, 1842**Genus *Agestrata* Eschscholtz, 1829**

Type species. *Agestrata luconica* Eschscholtz, 1829

***Agestrata orichalca orichalca* (Linnaeus, 1769)**

Fig. 11

Scarabaeus orichalcus Linnaeus, 1769: 504.

Distribution. North-eastern India (Sikkim and Arunachal Pradesh), the Chinese provinces of Guangdong, Guangxi and Hainan, the Hong Kong SAR and Taiwan. Also widespread in the Oriental Region (Bezděk 2016), occurring specifically in Myanmar, Vietnam, Laos, Thailand, Malaysia and the Indonesian islands of Sumatra and Java (Sakai and Nagai 1998; Krajcik 2011).

Material examined. 1♂: Macau, University of East Asia, 28 May 1989, ER Easton leg (UMEC); 1♂: Coloane, Cheoc Van, 15 Jun 2019, crushed on road under street light, R Perissinotto & L Clennell (MACT); unknown sex: Alto de Coloane, 18 Oct 2020, elytron found under spot-light, R Perissinotto & L Clennell (MACT).

Other Macau records. Taipa, University of East Asia Campus, 3 Sep 1991, near library (in Easton 1991: 111, misspelt as *Agestrata orichalea*); No locality and date, 42 mm (in Pun and Batalha 1997: 65, fig. 107, misspelt as *Agestrata orichalcea*); Alto de Coloane, 18 Aug 2020, on spot-light surface, R Perissinotto & L Clennell; St. Francis Xavier's Parish [Coloane], 18 Aug 2020, 14:55, L Clennell (<https://www.inaturalist.org/observations/56913518>).

Remarks. This is by far the largest cetoniine beetle in Macau, reaching a total length of 40–45 mm and a maximum width of 18–20 mm. Although it is regularly recorded in nearby Hong Kong (see e.g., https://www.inaturalist.org/observations?place_id=7613&subview=grid&taxon_id=127588), it is a rare occurrence in Macau. During this study only two males were recorded, one crushed on a road under a street light and a second, which also died after flying into an incandescent spot-light at the Coloane A-Mà statue. The remnants of a third specimen were also retrieved in October 2020 under the same spot-light. According to Yiu (2010), this species feeds on a variety of fruits in captivity and is attracted to artificial light at night. The 3rd instar larva of this species was comprehensively described and illustrated by Zhang (1984). The larval stage is most probably strictly saproxylic, and thereby depends on availability of decomposing tree trunks, which are rapidly disappearing in the area as more and more parts of the remaining natural vegetation are converted to city parks and gardens.



Figure 11. *Agestrata orichalca orichalca* (Linnaeus, 1769): dorsal (left) and side (right) views of male specimen observed at Alto de Coloane on 18 Aug 2020 (photographs: Lynette Clennell).

Genus *Thaumastopeus* Kraatz, 1885

Type species. *Lomaptera mohnikii* J. Thomson, 1877

Thaumastopeus shangaicus Neervoort van de Poll, 1886

Fig. 12

Thaumastopeus shangaicus Neervoort van de Poll, 1886: 181.

Distribution. Known in the Palearctic Region from the Chinese provinces of Hainan and Yunnan, the Shanghai Municipality and the Hong Kong SAR (Yiu 2010; Bezděk 2016). Also widespread in the Oriental Region, specifically in Vietnam, Thailand, Laos, peninsular Malaysia as well as Sumatra and the Nias Islands in Indonesia (Sakai and Nagai 1998; Krajcik 2011).

Material examined. 1♀: Coloane Village, 31 Mar 2019, extracted prematurely from broken cocoon, R Perissinotto & L Clennell (MACT); 1♀: Coloane Village, 22 May 2020, on flowers of *Psychotria serpens*, R Perissinotto (MACT); 1♂: ibidem 28 May 2020, dead on roadside, R Perissinotto (MACT).

Other Macau records. No locality and date, 23 mm [in Pun and Batalha 1997: 66, fig. 110, reported as *Thaumastopeus nigritus* (Frohlic)]; Coloane Village, 14 Jun 2019, on flowers of *Paliurus spina-christi*, R Perissinotto & L Clennell; ibidem 30 Apr 2020, on flowers of *Psychotria serpens* R Perissinotto & L Clennell; Coloane, Hác-Sá, 29 Apr 2019, emerged from cocoon found in decomposing wood, R Perissinotto & L Clennell; Coloane, Cheoc Van, 4 May 2019, on flowers of *Litsea glutinosa*, R Perissinotto & L Clennell; Alto de Coloane, 23 May 2020, R Perissinotto & L Clennell; ibidem 11 Jul 2020, on sap flow of *Sapium discolor*, R Perissinotto & L Clennell;



Figure 12. *Thaumastopeus shangaicus* Neervoort van de Poll, 1886: dorsal (left) and side (right) views of typical specimens observed at Coloane on 30 Apr 2019 and 23 May 2020, respectively (photographs: Lynette Clennell).

Macau, Barra Hill, 16 Apr 2019, on flowers of *Ligustrum sinense*, R Perissinotto & L Clennell; Coloane Village, 1 Jun 2019 13:51, Hannah Leung (<https://www.inaturalist.org/observations/27733112>); Taipa Pequena, 23 May 2020 9:56, Eric Kwan (<https://www.inaturalist.org/observations/47007347>).

Remarks. This is the second largest cetoniine species found in Macau, attaining a size in the range of 22–30 mm TL and 9–13 mm MW. Specimens are very stable in their colour, which is generally shiny and black with a dark blue sheen. It has been confused in the past with the closely related *T. nigritus* (Frölich, 1792) (e.g., Pun and Batalha 1997; Yiu 2010; Yiu and Yip 2011), which actually occurs mainly in the Indian subcontinent including the Himalayan region (Krajcik 2011; Bezděk 2016). The correct identification of *T. shangaicus* in the Macau and Hong Kong area has now been conclusively established through analysis of aedeagal material (S. Jákl, pers. comm.). The species is saproxylic, with larvae, cocoons and even adults having been found regularly inside decomposing tree trunks and branches (pers. obs.). Adults appear to have a very broad diet, feeding on fruits, flowers, and sap flows, but do not seem to be attracted into fruit-baited traps. In Macau, several specimens were observed on sap flows of *Sapium discolor* in July 2020 and in Hong Kong this species has often been found feeding on ripe fruits of longan and figs (Yiu 2010). Among the plants where *T. shangaicus* has been recorded feeding on flowers are *Litsea glutinosa*, *Psychotria serpens*, *Paliurus spina-christi*, *Ligustrum sinense*, and *Acronychia pedunculata*.

Tribe Taenioderini Mikšić, 1976

Genus *Euselates* J Thomson, 1880

Type species. *Euselates magna* J Thomson, 1880

Subgenus *Euselates* J Thomson, 1880

Type species. *Euselates magna* J Thomson, 1880

Euselates (Euselates) magna J Thomson, 1880

Fig. 13

Euselates magna J. Thomson, 1880: 277

Distribution. Known in the Palearctic Region from the Chinese provinces of Hainan, Hubei and the Hong Kong SAR (Bezděk 2016). It is also widespread in the Oriental Region specifically in Vietnam, Laos and Thailand (Sakai and Nagai 1998; Krajcik 2011).

Material examined. 1♀: Coloane, Hác-Sá, 14 May 2019, on flowers of *Psychotria serpens*, R Perissinotto (MACT); 1♂, 1♀: Coloane Village, 2 Jul 2019, dead on roadside, R Perissinotto & L Clennell (MACT).

Other Macau records. Coloane, Hác-Sá, 28 Apr 2019, on flowers of *Lonicera japonica*, R Perissinotto & L Clennell; ibidem 3 May 2019, on flowers of *Psychotria serpens*, R Perissinotto & L Clennell; ibidem 15 May 2020, R Perissinotto; St. Francis Xavier's Parish [Coloane], 16 May 2020 10:35, L Clennell (<https://www.inaturalist.org/observations/56121519>); ibidem 11 Jul 2020 9:45, Kisu Wong (<https://www.inaturalist.org/observations/57338916>); ibidem 11 Jul 2020 10:45, Kit Chang (<https://www.inaturalist.org/observations/52662946>).

Remarks. This species has been previously reported from nearby Hong Kong with its synonymic name of *E. schoenfeldti* Kraatz, 1893 (Yiu 2010; Yiu and Yip 2011). In Macau it is occasionally seen between late April and August, but only in the largest patches of natural vegetation. Adults exhibit an approximate size in the range of 19–22 mm TL and 8–10 mm MW. They are very consistent in their colour pattern and are active during the hottest part of the day, but even under overcast conditions. They are typically flower feeders, having been observed on *Litsea glutinosa*, *Lonicera japonica*, *Psychotria serpens* and in Hong Kong also on *Cleistocalyx operculatus* (Yiu 2010). On one occasion, a male specimen was found inside a fruit-baited trap containing a mixture of fermenting banana, pineapple, brown sugar, and red wine. The larvae are unknown, but most likely saproxylic, as on two occasions females were observed while entering crevices in decomposing tree trunks.

Discussion

Results of this census show a significant increase in the number of cetonine species occurring in the Macau SAR to eleven, compared to only four reported in previous publications (Easton 1991; Easton 1993; Pun and Batalha 1997). This is undoubtedly related to the escalation in observation efforts applied in this study, with visits in



Figure 13. *Euselates (Euselates) magna* J Thomson, 1880: dorsal (left) and side (right) views of typical specimens observed at Coloane on 3 May 2019 and 15 May 2020, respectively (photographs: Lynette Clennell).

the field undertaken almost on a daily basis for a period of more than two years and covering virtually all the major pockets of natural vegetation that are still found in the region. Thus, the total number of cetoniine species recorded in Macau now compares relatively well with that of Hong Kong, where 15 species have so far been confirmed (Yiu 2010; Bezděk 2016). This is particularly relevant, considering that the total surface area of the Hong Kong SAR is approximately 36 times larger than that of Macao and exhibits a much larger diversity of vegetation types and habitats (Dudgeon and Corlett 1994). For a larger-scale regional comparison, it is worth noting that the cetoniine diversity observed in Macau and Hong Kong is also similar to that recorded so far in the mainland province of Guangdong (17 species), but drastically lower than the numbers recorded on the islands of Hainan (36 species) and especially Taiwan (80 species).

Of special interest are the two *Protaetia* species [*P. (L.) speculifera* and *P. (P.) intricata*] that were previously unreported from the region, including Hong Kong, possibly due to their low frequency of occurrence in this area or to their superficial resemblance with other sympatric species. Both factors appear to be involved, as the two species were observed only on two occasions and only once, respectively, in each year of the census. *Protaetia (P.) intricata* is known for its remarkable scarcity across its entire and relatively small distribution range (S. Jákl, pers. comm.). Because of its small size and dark brown to olive-green background colour, it can potentially be confused with poorly ornamented varieties of the more common *P. (P.) fusca* by an untrained eye, or when not inspected at close range. *Protaetia (L.) speculifera*, on the other hand, is regarded as relatively common and much more widely distributed than *P. (P.) intricata*. However, it can be easily confused with the numerically dominant *P. (C.) o. orientalis*, and ever more so with the closely related *P. (L.) brevitarsis*, when not analysed in detail. The latter species has apparently been recorded in the mainland province of Guangdong, but not in either Macau or Hong Kong (Bezděk 2016). Recent postings from Hong Kong in the citizen science platform iNaturalist, however, show several specimens with reduced dorsal white

maculation and dark green background colour or reddish gold sheen. These are consistent with the superficial appearance of *P. (L.) brevitarsis* and *P. (L.) speculifera*, respectively, and it is thus likely that at least one of the two species, or perhaps even both, may occur there. Further detailed analyses of some of these specimens will be required in order to test this hypothesis, and this will have to include a comparison of aedeagal parameres.

While the cetoniine diversity of Macau is larger than expected, what is of concern is the relatively poor abundance of most species recorded. Indeed, the frequency of occurrence of the various species reveals that only *P. (C.). o. orientalis* and *Glycyphana (G.) laotica* can be regarded as widespread and seasonally relatively common in Macau. All the others were recorded only on a few occasions and generally as single individuals, which is an indication that most local populations are under extreme stress and on the verge of becoming unsustainable. Some of the records may actually represent migrants from neighbouring regions on a dispersal flight and, thus, may not even have viable populations established within the Macau SAR.

Unfortunately, the few remaining areas of natural vegetation in the territory, mainly hills, are being systematically manipulated with undergrowth vegetation and dead or moribund trees removed, shredded and turned to compost. This process was escalated in the wake of the destructive impact of Typhoon Hato in August 2017, when trees were uprooted and damaged on a large-scale. The prompt intervention of the authorities ensured that all the damaged trees were cut and removed and, in their place, new young trees were planted within an ongoing rehabilitation programme. The problem is that these new trees are planted in an plantation-type manner, with ample space between each other and removal of any undergrowth inadvertently regarded as weeds. Trees are also regularly pruned of their lower branches. While all this is presumably done with the purpose of improving the aesthetic appearance of these green areas, it deprives the soil of its natural buffer against desiccation and extreme temperatures, thereby annihilating the habitat of soil invertebrates, including cetoniine larvae. The removal and destruction of the older, dead, or moribund trees also deprives the larval stages of all saproxylic species of their natural habitat. This seems to be impacting negatively in particular the two Schizorhinini species, which are also the largest cetoniines occurring in Macau, namely *Agestrata orichalca* and *Thaumastopeus shangaicus*. Both were regularly recorded in the past (Easton 1991; Pun and Batalha 1997), but now appear to have become a rare occurrence and are possibly under serious threat because of the rapid disappearance of their habitat, which consists of large decomposing tree trunks and branches that are still standing (pers. obs.). Thus, should the practices highlighted above continue into the future, it seems inevitable that invertebrate biodiversity in the SAR will steadily decline, with some species probably becoming locally extinct, including fruit and flower chafers.

Acknowledgements

We thank the Macau Anglican College (Taipa, Macau) for supporting this project and providing funding towards its completion. We are particularly grateful to Stanislav Jákľ

(Prague, Czech Republic) for his invaluable assistance with the taxonomic revision of the more complex species. We wish to extend our thanks to a number of members of the Macau Entomological Society and general public for contributing with photos and observations to the compilation of the species record. These include Kit Chang, Kisu Wong, Hannah Leung, Erik Kwan, Annie Lao, Peggi Chao, Ben Wong, Chi-Man Leong and Angus Chan. Philip Kuok is also thanked for his invaluable help with flower and host-plant identifications. Finally, we are grateful to Wilson Hoi and Suki Chong (University of Macau Library) for facilitating access to the Easton Collection and providing photographs and data of relevant specimens.

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Seven new species of the *Exocelina ekari* group from New Guinea central and coastal mountains (Coleoptera, Dytiscidae, Copelatinae)

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Academic editor: M. Michat | Received 1 December 2020 | Accepted 9 February 2021 | Published 25 March 2021

<http://zoobank.org/A3212DAA-CEF2-4A1F-93CC-1823940C0108>

Citation: Shaverdo H, Surbakti S, Sumoked B, Balke M (2021) Seven new species of the *Exocelina ekari* group from New Guinea central and coastal mountains (Coleoptera, Dytiscidae, Copelatinae). ZooKeys 1026: 45–67. <https://doi.org/10.3897/zookeys.1026.61554>

Abstract

Seven new species of the genus *Exocelina* Broun, 1886 are described from three different mountain ranges of New Guinea: *E. foja* **sp. nov.**, *E. riberai* **sp. nov.**, *E. apistefii* **sp. nov.**, and *E. waaf* **sp. nov.** from the Foja Mountains; *E. hudsoni* **sp. nov.** from the Cyclops Mountains; *E. ekpliktiki* **sp. nov.** and *E. oraia* **sp. nov.** from Wano Land. All of them are placed into the *E. ekari* group based on the structure of their male genitalia. The species are characteristic dytiscid elements of the fauna of northern coast and the western part of central orogen of New Guinea. Two taxonomic notes are presented: *Exocelina athesphati* is a correct name for the recently described *Exocelina athesphatos* Shaverdo et al., 2020; *Exocelina bacchusi* Balke, **nom. nov.** is a replacement name for *Exocelina bacchusi* (Balke, 1998), formerly *Copelatus (Papuadytes) bacchusi* Balke, 1998, a junior homonym of *Copelatus bacchusi* Wewalka, 1981.

Keywords

Australasia, distribution, *Exocelina*, new species, systematics

Introduction

Even after more than 20 years of research on New Guinea *Exocelina* diving beetles, the island's rugged mountain regions continue to reveal new species (Shaverdo et al. 2020a, b). Our examination of specimens found in the northern Foja and Cyclops Mountains, as well as in the Wano Land, a mountain area of the western central orogen, revealed seven new species. So far, only *E. bewaniensis* Shaverdo et al., 2014 (*E. ekari* group) had been known from the Foja Mountains, where four additional new species were found. From the Cyclops Mountains, only *E. cyclops* Shaverdo et al., 2018 (*E. casuarina* group) was known to date; here we describe one additional new species from this steep mountain range. From the Wano Land, six closely related species had been described, which constitute a complex close to the *E. ekari* group (Shaverdo et al. 2017), as well as *E. sumokedi* Shaverdo & Balke, 2018 from the *E. casuarina* group. We studied unidentified material from this region and discovered the presence of *E. bewaniensis* and two new species.

All seven new species were found to belong to the *E. ekari* group. To date, this, the largest *Exocelina* species group, contains 63 species; 152 *Exocelina* species are now described from New Guinea and 209 species worldwide.

Materials and methods

The material studied is housed in the following collections:

- KSP** Koleksi Serangga Papua, at the Biology Department of Universitas Cenderawasih (UNCEN), Wamena, Papua, Indonesia;
MZB Museum Zoologicum Bogoriense, Cibinong, Indonesia.

Our methods follow those described in detail in our previous articles (Shaverdo et al. 2012, 2014; Shaverdo and Balke 2014). The terminology to denote the orientation of the genitalia follows Miller and Nilsson (2003). All specimen data are quoted as they appear on the labels attached to the specimens. Label text is cited using quotation marks; comments in square brackets are ours. The following abbreviations were used: **MW** (maximum body width), **TL** (total body length), **TL-H** (total body length without head).

Results

Descriptions of the species from the Foja Mountains

Exocelina foja Shaverdo, Surbakti & Balke, sp. nov.

<http://zoobank.org/464A09DF-E5D6-4D1D-9455-59676F42C60D/>

Figures 1, 5, 15

Exocelina nr. *pseudosoppi* #7286: Toussaint et al. 2021: figs 3–6.

Type locality. INDONESIA: Papua Province, Sarmi Regency, Foja Mts, 02°34'18.6"S, 138°43'02.1"E, 1700 m a.s.l.

Type material. Holotype: male "Indonesia: Papua, Foja Mountains, bog camp, 1700m, 23.v.-3.vi.2016, -2.571839 138.717250, Sumoked (Pap058)" (MZB).

Paratypes: 26 males, 19 females with the same label as the holotype, three males with additional handwritten labels "creek A", "creek C" and "creek D" (MZB, KSP). 1 male, 6 females "Indonesia (1700A): Papua, Foja Mountains, bog camp, 1700m, 23.v.-3.vi.2016, -2.571839 138.717250, Sumoked (Pap058)" (KSP). 4 males, 5 females "Indonesia (1700B): Papua, Foja Mountains, bog camp, 1700m, 23.v.-3.vi.2016, -2.571839 138.717250, Sumoked (Pap058)" (MZB, KSP). 2 males, 3 females "Indonesia (1700D): Papua, Foja Mountains, bog camp, 1700m, 23.v.-3.vi.2016, -2.571839 138.717250, Sumoked (Pap058)" (KSP). 13 males, 10 females "Indonesia: Papua, Foja Mountains, bog camp, 1700m, 23.v.-3.vi.2016," "-2.571839 138.717250, Sumoked (Pap058)", two females with additional green text labels "7357" and "7358" (MZB, KSP). 2 males, 4 females "Indonesia: Papua, Foja Mountains, river camp, 1600m, 23.v.-3.vi.2016, -2.561006 138.711487, Sumoked (Pap059)", one male with an additional handwritten label "forest near bog camp", the other male with an additional green text label "7286" (MZB, KSP).

Description. Body size and form: Beetle small: TL-H 3.30–3.85 mm, TL 3.70–4.30 mm, MW 1.80–2.10 mm (holotype: TL-H 3.85 mm, TL 4.30 mm, MW 2.10 mm), with oblong-oval habitus (Fig. 1).

Colouration: Dorsally dark brown to piceous, with paler head and sides of pronotum (Fig. 1). Head more or less uniformly dark brown to reddish brown, darker around eyes, or slightly paler anteriorly; pronotum dark brown to piceous on disc and distinctly paler (to yellowish red) anteriorly, posteriorly, and especially laterally; dark area on disc sometimes represented just as median band; elytra dark brown to piceous, with reddish brown sutural lines; head appendages and legs yellowish red to reddish brown. Teneral specimens paler.

Surface sculpture: Shiny dorsally, with fine punctation and microreticulation. Head with dense and coarse punctation (spaces between punctures 0–3 times size of punctures), distinctly finer and sparser anteriorly and posteriorly; diameter of punctures equal to diameter of cells of microreticulation. Pronotum with distinctly finer and sparser punctation than on head. Elytra with very sparse and fine punctation, almost invisible. Pronotum and elytra with weakly impressed microreticulation; head with stronger microreticulation. Metaventricle and metacoxa distinctly but weakly microreticulate, metacoxal plates with longitudinal striae and transverse wrinkles. Abdominal ventrites with weak microreticulation, striae, and fine sparse punctation, coarser and denser on two terminal abdominal ventrites.

Structures: Pronotum with narrow lateral bead. Base of prosternum and neck of prosternal process with ridge, slightly rounded anteriorly. Blade of prosternal process lanceolate, relatively narrow, slightly convex medially, with distinct bead and few setae. Abdominal ventrite 6 broadly rounded apically.

Male: Antenna simple. Pro- and mesotarsomeres 1–3 not dilated, narrow. Protarsomere 4 cylindrical, narrow, with medium-sized, thick, strongly curved anterolateral

hook-like seta. Protarsomere 5 ventrally with anterior row of eleven and posterior row of six short setae (Fig. 5A). Median lobe with distinctly discontinuous outline; in lateral view, almost straight, with apex broad, curved downwards, and sharply pointed at tip; in ventral view, with distinct submedian constriction, distal part narrower than proximal one, apex truncate (Fig. 5B, C). Paramere with strong notch on dorsal side and subdistal part relatively large and elongate; subdistal setae very few, dense and flattened: three upper longer, thinner, curved at apex and four lower shorter, almost straight, thicker; proximal setae hair-like, numerous, dense, but distinctly more inconspicuous than subdistal ones (Fig. 5D). Abdominal ventrite 6 broadly rounded, with 5–9 lateral striae on each side.

Female: Pro- and mesotarsi not modified. Abdominal ventrite 6 without striae.

Affinities. The species evidently belongs to the *E. ekari* group due to the discontinuous outline of its median lobe. Within the group, it can be placed close to *E. oceai* Shaverdo et al., 2012 due to presence of the pronotal lateral bead. Shape of its median lobe is similar to that of *E. pseudosoppi* Shaverdo et al., 2012; setation of the paramere is very characteristic.

Distribution. INDONESIA: Papua Province. This species is known only from Foja Mountains, from and near the type locality (Fig. 15).

Habitat. The specimens were collected from small, shallow forest creeks.

Etymology. The species is named after Foja Mountains. The name is a noun in the nominative singular standing in apposition.

***Exocelina apistefti* Shaverdo, Surbakti & Balke, sp. nov.**

<http://zoobank.org/7862C435-10FA-4ED3-B73E-BACCE3D10EBB>

Figures 4, 8, 15

Exocelina nr. *brahminensis* #7287: Toussaint et al. 2021: figs 3–6.

Type locality. INDONESIA: Papua Province, Sarmi Regency, Foja Mts, 02°34'18.6"S, 138°43'02.1"E, 1700 m a.s.l.

Type material. Holotype: male “Indonesia: Papua, Foja Mountains, bog camp, 1700m, 23.v.-3.vi.2016, -2.571839 138.717250, Sumoked (Pap058)”, “7287” [green text] (MZB).

Paratypes: 2 females with the same label as the holotype (KSP). 1 male, 1 female “Indonesia: Papua, Foja Mountains, river camp, 1600m, 23.v.-3.vi.2016, -2.561006 138.711487, Sumoked (Pap059)” (MZB, KSP).

Description. Body size and form: Beetle small: TL-H 3.45–3.7 mm, TL 3.8–4.05 mm, MW 1.85–2 mm (holotype: TL-H 3.5 mm, TL 3.9 mm, MW 1.9 mm), with oblong-oval habitus (Fig. 4).

Colouration: Dorsally piceous, with paler lateral sides of pronotum (Fig. 4). Head piceous, with slightly paler, dark brown, anterior margin; pronotum piceous, slightly

paler towards lateral sides, lateral sides brown to dark brown, yellowish to reddish brown at anterior angles; elytra uniformly piceous; head appendages and proximal part of legs yellowish brown, legs distally brown.

Surface sculpture: Shiny dorsally, with fine microreticulation and almost invisible punctation on elytra. Head with dense and coarse punctation (spaces between punctures 0–3 times size of punctures), distinctly finer and sparser anteriorly and posteriorly; diameter of punctures equal to diameter of cells of microreticulation. Pronotum with distinctly finer and sparser punctation than on head. Elytra with very sparse and fine punctation, almost invisible. Elytra with weakly impressed microreticulation; pronotum and especially head with stronger microreticulation. Metaventricle and metacoxa distinctly but weakly microreticulate, metacoxal plates with longitudinal striae and transverse wrinkles. Abdominal ventrites with weak microreticulation, striae, and fine sparse punctation, coarser and denser on two last abdominal ventrites.

Structures: Pronotum without lateral bead. Base of prosternum and neck of prosternal process with ridge, slightly rounded anteriorly. Blade of prosternal process lanceolate, relatively narrow, slightly convex medially, with distinct bead and few setae. Abdominal ventrite 6 broadly rounded apically.

Male: Antenna simple. Pro- and mesotarsomeres 1–3 not dilated, narrow. Protarsomere 4 cylindrical, narrow, with medium-sized, thick, strongly curved anterolateral hook-like seta. Protarsomere 5 ventrally with anterior row of 13 and posterior row of six short setae (Fig. 8A). Median lobe with distinctly discontinuous outline; in lateral view, almost straight, with apex broad, curved downwards, and pointed at tip; in ventral view, with distinct submedian constriction, distal part narrower than proximal one, apex deeply and narrowly concave (Fig. 8B, C). Paramere with strong notch on dorsal side, with median notch tip sharply pointed, and subdistal part large and elongate; subdistal setae long and dense, of two kind: more numerous upper ones thin and lower setae shorter, thicker and flattened; proximal setae hair-like, distinctly more inconspicuous than subdistal ones (Fig. 8D). Abdominal ventrite 6 broadly rounded, with 9–11 lateral striae on each side.

Female: Pro- and mesotarsi not modified. Abdominal ventrite 6 without striae.

Affinities. The species evidently belongs to the *E. ekari* group due to the discontinuous outline of its median lobe. The species is very similar to *E. brahminensis* Shaverdo et al., 2012 in general appearance and structure of male genitalia, especially in the sharply pointed median notch tip of paramere, but differs from it in larger size (TL-H 3.15–3.3 mm for *E. brahminensis*), darker dorsal colouration, shape of the median lobe, and paramere setation.

Distribution. INDONESIA: Papua Province. This species is known only from Foja Mountains, from and near the type locality (Fig. 15).

Habitat. The specimens were collected from small, shallow forest creeks.

Etymology. The species name *apistefti* derives from Greek *ἀπίστευτος* (feminine *ἀπίστευτη*) meaning unbelievable. The name is an adjective in the nominative singular.

***Exocelina riberai* Shaverdo, Surbakti & Balke, sp. nov.**

<http://zoobank.org/44511064-4B35-4242-8018-898B0BAB4B0C>

Figures 3, 7, 15

Exocelina “Foja” #7282: Toussaint et al. 2021: figs 3–6.

Type locality. INDONESIA: Papua Province, Sarmi Regency, Foja Mts, N Waaf Village, 02°22'29.6"S, 138°44'19.9"E, 115 m a.s.l.

Type material. Holotype: male “Indonesia: Papua, Foja Mountains N foot, N Waaf vill, 115m, 23.v.-3.vi.2016, -2.374874 138.738855, Sumoked (Pap060)” (MZB).

Paratypes: 3 males, 5 females with the same label as the holotype (MZB, KSP). 2 males “Indonesia: Papua, Foja Mountains N foot, N Waaf vill, pondok, 150m, 4.–7. vi.2016, -2.406142 138.74399, Sumoked (Pap061)”, one male with an additional green text label “7282” (KSP).

Description. Body size and form: Beetle small to medium-sized: TL-H 3.45–3.85 mm, TL 3.8–4.3 mm, MW 1.85–2.1 mm (holotype: TL-H 3.6 mm, TL 4.1 mm, MW 1.9 mm), with oblong-oval habitus (Fig. 3).

Colouration: Dorsally dark brown to piceous, usually with paler, reddish brown, head and pronotum (Fig. 3). Head reddish brown, reddish anteriorly, dark brown around eyes; pronotum reddish brown to brown, with darker, to dark brown, disc; elytra dark brown, sometimes with reddish brown sutural lines; head appendages yellow, legs yellowish red to reddish brown. One specimen (from locality Pap061) piceous, with dark brown pronotal lateral sides. Most specimens from locality Pap060 teneral, therefore, paler.

Surface sculpture: Shiny dorsally, with inconspicuous, almost invisible elytral punctuation and weakly impressed microreticulation. Head with relatively fine and sparse punctuation (spaces between punctures 1–4 times size of punctures); diameter of punctures smaller than diameter of cells of microreticulation. Pronotum with finer, sparser, and more evenly distributed punctuation than on head, often inconspicuous. Elytra with very sparse and fine punctuation, almost invisible. Elytra with weakly impressed microreticulation; pronotum and especially head with stronger microreticulation. Metaventrite and metacoxa distinctly but weakly microreticulate, metacoxal plates with longitudinal strioles and very weak transverse wrinkles. Abdominal ventrites with weak microreticulation, strioles, and punctuation visible only on two last abdominal ventrites.

Structures: Pronotum without lateral bead, in some specimens (especially characteristic for females) with bead traces or even with narrow bead on lateral sides of pronotum. Base of prosternum and neck of prosternal process with distinct ridge, slightly rounded anteriorly. Blade of prosternal process lanceolate, relatively broad, slightly convex, with distinct lateral bead and few setae. Abdominal ventrite 6 broadly rounded.

Male: Antenna simple. Pro- and mesotarsomeres 1–3 not dilated, narrow. Protarsomere 4 cylindrical, narrow, with medium-sized, thick, distinctly curved anterolateral hook-like seta. Protarsomere 5 ventrally with anterior row of ten and posterior row of

five short setae (Fig. 7A). Median lobe with distinctly discontinuous outline; in lateral view, almost straight, with apex narrow, curved downwards, and strongly protruding at tip forming a long thin prolongation; in ventral view, with weak submedian constriction, distal part narrower than proximal one, apex slightly and evenly concave, with distinct protruding tip (Fig. 7B, C). Paramere with strong notch on dorsal side and subdistal part subquadrate, large and broad; subdistal setae dense, rather short, flattened; proximal setae hair-like, numerous, dense, and long (Fig. 7D). Abdominal ventrite 6 broadly rounded, with 13–16 lateral striae on each side.

Female: Pro- and mesotarsi not modified. Abdominal ventrite 6 without lateral striae. Bead traces or even with narrow bead on lateral margins pronotum present in majority of females.

Affinities. The new species evidently belongs to the *E. ekari* group due to the discontinuous outline of its median lobe. The species is similar to *E. pinocchio* Shaverdo & Balke, 2014 in general appearance and shape of median lobe, but differs from it in more straight apical prolongation of the median lobe and in subquadrate, large and broad subdistal part of the paramere (distinctly more elongate in *E. pinocchio*) and its setation.

Distribution. INDONESIA: Papua Province. This species is known only from Foja Mountains, from and near the type locality (Fig. 15).

Habitat. The specimens were collected from shaded waterholes on a riverbank.

Etymology. The species is named to honour Dr Ignacio Ribera Galán, a leading water beetle specialist and our dear colleague who passed away on 15 April 2020. The name is a noun in the genitive case.

***Exocelina waaf* Shaverdo, Surbakti & Balke, sp. nov.**

<http://zoobank.org/F172B13F-AF66-40E4-B0C3-67267C6811C3>

Figures 2, 6, 15

Exocelina nr. *utowaensis* #7281: Toussaint et al. 2021: figs 3–6.

Type locality. INDONESIA: Papua Province, Sarmi Regency, Foja Mts, N Waaf Village, 02°22'29.6"S, 138°44'19.9"E, 115 m a.s.l.

Type material. Holotype: male “Indonesia: Papua, Foja Mountains N foot, N Waaf vill, 115m, 23.v.-3.vi.2016, -2.374874 138.738855, Sumoked (Pap060)” (MZB).

Paratypes: 7 males, 2 females with the same label as the holotype, one male with an additional green text label “7281” (MZB, KSP).

Description. Body size and form: Beetle small to medium-sized: TL-H 3.55–3.75 mm, TL 3.9–4.2 mm, MW 1.95–2.0 mm (holotype: TL-H 3.65 mm, TL 4.1 mm, MW 1.95 mm), with oblong-oval habitus (Fig. 2).

Colouration: Dorsally piceous, with paler lateral sides of pronotum (Fig. 2). Head piceous, with slightly paler, dark brown, anterior margin; pronotum piceous, slightly paler towards lateral sides, lateral sides brown to dark brown, yellowish red to reddish

brown at anterior angles; elytra uniformly piceous or with dark brown sutural lines; head appendages and proximal part of legs yellowish brown, legs distally brown.

Surface sculpture: Shiny dorsally, with inconspicuous, almost invisible elytral punctation and weakly impressed microreticulation. Head with uneven, sparse punctation (spaces between punctures 1–4 times size of punctures); diameter of punctures smaller than or almost equal to diameter of cells of microreticulation; punctation sparser and finer anteriorly and posteriorly. Pronotum with distinctly finer, sparser, and more evenly distributed punctation than on head. Elytra with very sparse and fine punctation, almost invisible. Elytra and pronotum with weakly impressed microreticulation; head with stronger microreticulation. Metaventricle and metacoxa distinctly but weakly microreticulate, metacoxal plates with longitudinal striae and transverse wrinkles. Abdominal ventrites with weak microreticulation, striae, and fine punctation.

Structures: Pronotum without lateral bead. Base of prosternum and neck of prosternal process with distinct ridge, slightly rounded anteriorly. Blade of prosternal process lanceolate, narrow, convex, with distinct lateral bead and few setae. Abdominal ventrite 6 concave apically.

Male: Antenna simple (Fig. 2). Pro- and mesotarsomeres 1–3 not dilated, relatively narrow. Protarsomere 4 cylindrical, narrow, with medium-sized, long, relatively slender, strongly curved anterolateral hook-like seta. Protarsomere 5 ventrally with anterior row of 14 and posterior row of five short setae (Fig. 6A). Median lobe with distinctly discontinuous outline; in lateral view, almost straight, with large, evenly tapering and curved downwards apex; in ventral view, with weak submedian constriction, distal part distinctly narrower than proximal one, apex truncate (Fig. 6B, C). Paramere with strong notch on dorsal side and subdistal part subquadrate, large and broad; subdistal setae long, dense, thick, and flattened; proximal setae hair-like, numerous, more inconspicuous than subdistal ones (Fig. 6D). Abdominal ventrite 6 distinctly concave, with 9–11 lateral striae on each side.

Female: Pro- and mesotarsi not modified. Abdominal ventrite 6 slightly concave, without lateral striae.

Affinities. The new species evidently belongs to the *E. ekari* group due to the discontinuous outline of its median lobe. The species is very similar to *E. utowaensis* Shaverdo et al., 2012 in general appearance, apically concave abdominal ventrite 6, and structure of the male genitalia, but differs from in more slender male antennae and shape of the median lobe and paramere.

Distribution. INDONESIA: Papua Province. This species is known only from the type locality in Foja Mountains (Fig. 15).

Habitat. The specimens were collected from shaded waterholes on a riverbank.

Etymology. The species is named after Waaf Village. The name is a noun in the nominative singular standing in apposition.

Key to the species from the Foja Mountains

Since five different species are now known from the Foja Mountains, it is worth providing a key to identify them. All species belong to the *E. ekari* group and are

similar to each other in their external morphology. Therefore, the key is based mostly on characters of the male genitalia. Because of that, females cannot be often assigned to species and should be identified in association with males from the same population.

- 1 Pronotum with narrow lateral bead. Median lobe and paramere as in Fig. 5 *foja*
- Pronotum without lateral bead, sometimes (especially in females) with bead traces or even narrow bead, in this case, several specimens of population should be checked..... **2**
- 2 Abdominal ventrite 6 concave apically. Median lobe and paramere as in Fig. 6 *waaf*
- Abdominal ventrite 6 broadly rounded **3**
- 3 Apex of median lobe very strongly protruding, forming long, thin prolongation in lateral view (Fig. 7C) *riberai*
- Apex of median lobe broad, short, and pointed at tip in lateral view **4**
- 4 Apex of median lobe broader in lateral view; in ventral view, deeply and narrowly concave (Fig. 8B, C). Paramere with strong dorsal notch and notch tip sharply pointed. Subdistal part of paramere elongate, with upper, hair-like setae more numerous and strong (Fig. 8D) *apistefti*
- Apex of median lobe narrower in lateral view; in ventral view, shallowly and evenly concave (Figs 21–23C, D in Shaverdo et al. 2014). Paramere with weaker dorsal notch and notch tip absent. Subdistal part of paramere rounded, with upper, hair-like setae less numerous and weak (Figs 21–23E in Shaverdo et al. 2014) *bewaniensis*

Descriptions of the species from the Cyclops Mountains

Only two species are known from the Cyclops Mountains: *E. cyclops* Shaverdo & Balke, 2018 from the *E. casuarina* group and the newly described *E. hudsoni* sp. nov. from the *E. ekari* group. They can be easily distinguished due to smaller body size of *E. cyclops* (TL-H 3.0–3.25 mm), its reddish dorsal colouration, unmodified male antennae, and different structure of the male genitalia (Shaverdo et al. 2018).

Exocelina hudsoni Shaverdo, Surbakti & Balke, sp. nov.

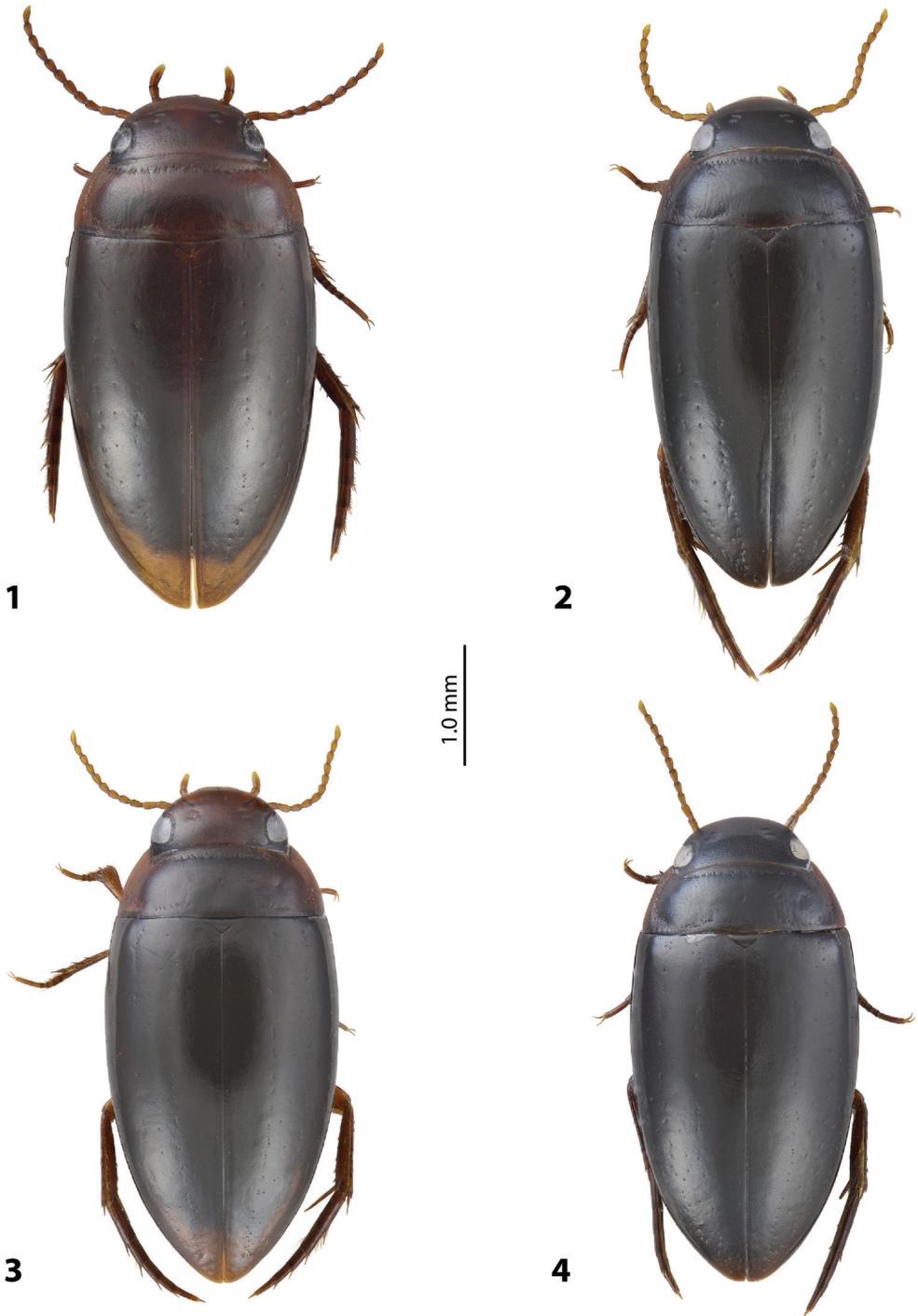
<http://zoobank.org/95FBA44C-42AA-4F8F-8919-244FD403A912>

Figures 9, 10, 15

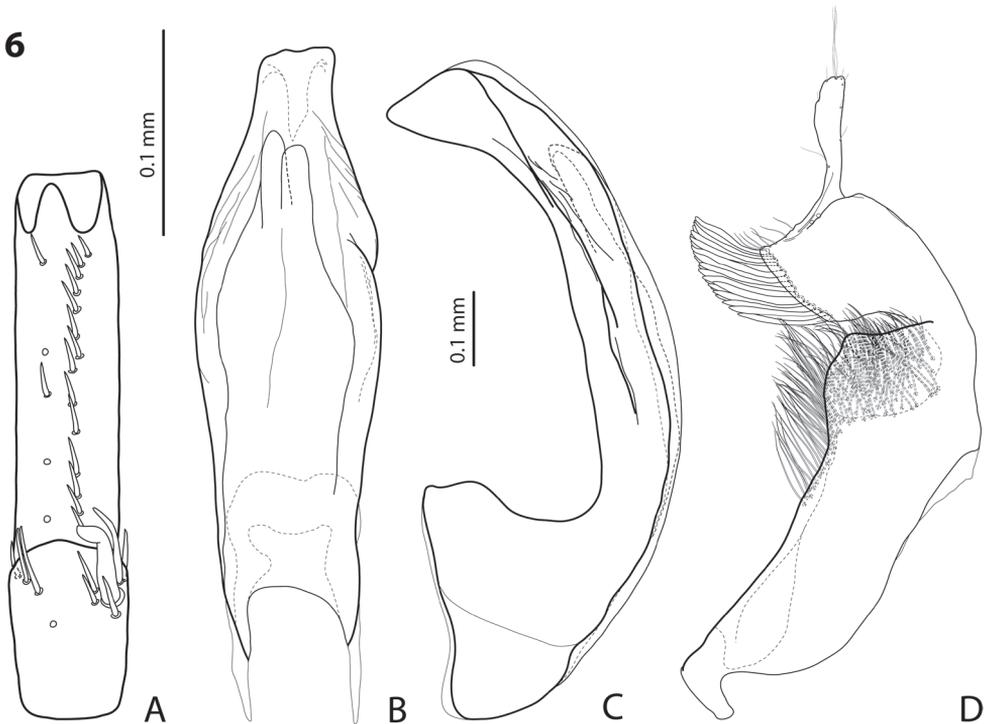
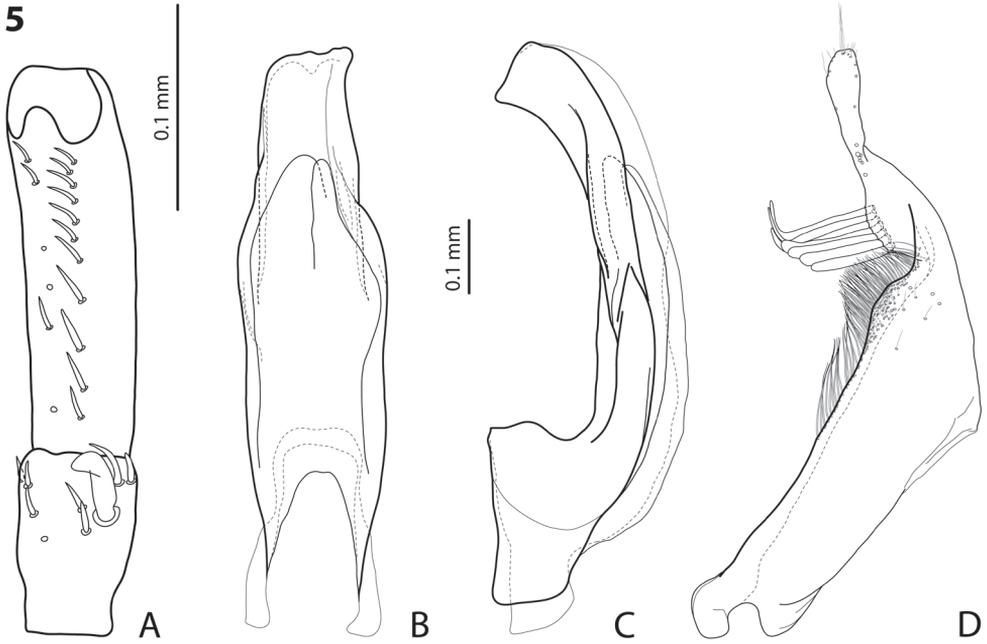
Type locality. INDONESIA: Papua Province, Jayapura Regency, Cyclops Mts, 1880 m a.s.l.

Type material. Holotype: male “Indonesia: Papua, Cyclops Mountains, below summit, 1880m, ii.201, Sentani Naturalist Club (Pap70)” (MZB).

Paratypes: 7 females with the same label as the holotype (MZB, KSP).

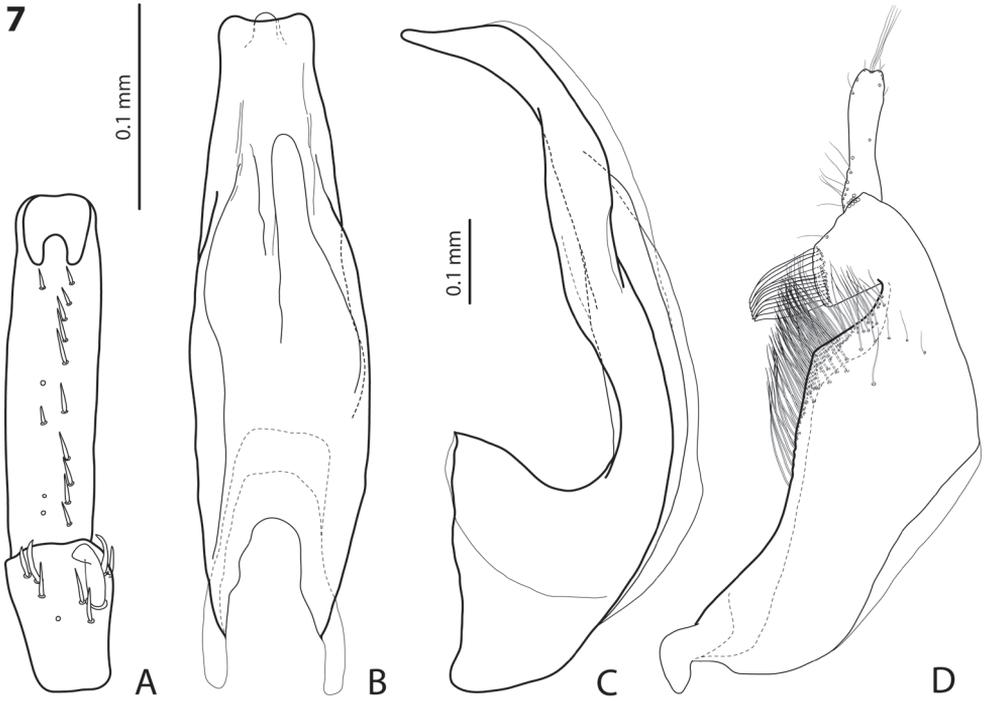


Figures 1–4. Habitus and colouration of holotype 1 *Exocelina foja* sp. nov. 2 *E. waaf* sp. nov. 3 *E. riberai* sp. nov. 4 *E. apistefii* sp. nov.

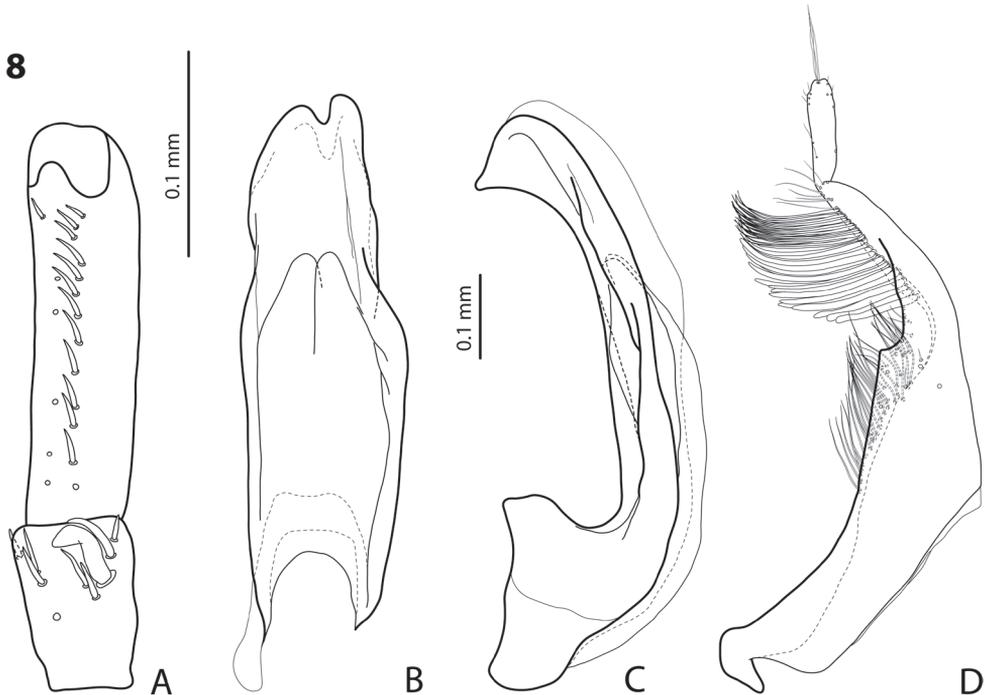


Figures 5, 6. **5** *Exocelina foja* sp. nov., holotype **6** *E. waaf* sp. nov., holotype **A** right protarsomeres 4 and 5 in ventral view **B** median lobe in ventral view **C** median lobe in lateral view **D** right paramere in external view.

7



8

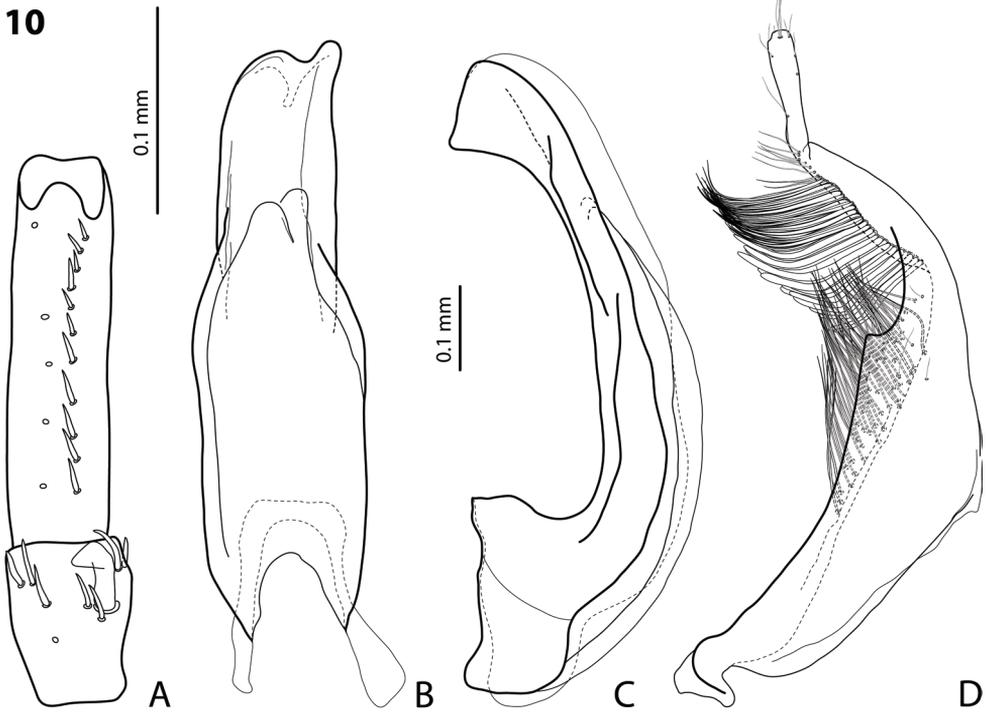


Figures 7, 8. 7 *Exocelina riberai* sp. nov., holotype 8 *E. apistefi* sp. nov., holotype **A** right protarsomeres 4 and 5 in ventral view **B** median lobe in ventral view **C** median lobe in lateral view **D** right paramere in external view.

9



10



Figures 9, 10. *Exocelina hudsoni* sp. nov., holotype **9** habitus and colouration **10** male structures **A** right protasomeres 4 and 5 in ventral view **B** median lobe in ventral view **C** median lobe in lateral view **D** right paramere in external view.

Description. Body size and form: Beetle small to medium-sized: TL-H 3.4–3.75 mm, TL 3.75–4.2 mm, MW 1.8–2.05 mm (holotype: TL-H 3.4 mm, TL 3.8 mm, MW 1.8 mm), with oblong-oval habitus (Fig. 9).

Colouration: Dorsally piceous, with paler head and pronotum (Fig. 9). Head piceous in posterior half and dark brown in anterior half; pronotum piceous on disc, sometimes narrowly, and brown to dark brown on sides, yellowish red to reddish brown at anterior angles; elytra piceous, with brown to dark brown sutural lines; head appendages and proximal part of legs yellowish brown, legs distally reddish brown.

Surface sculpture: Submatt dorsally, with inconspicuous elytral punctation and strongly impressed dorsal microreticulation. Head with sparse central punctation (spaces between punctures 1–4 times size of punctures), denser towards eyes; diameter of punctures smaller than diameter of cells of microreticulation; punctation relatively shallow. Pronotum with distinctly finer, sparser, and more evenly distributed punctation than on head. Elytra with very sparse and fine punctation, almost invisible. Dorsal surface with strongly impressed microreticulation, microreticulation weaker on elytra and stronger on pronotum and head. Metaventrite and metacoxa distinctly but weakly microreticulate, metacoxal plates with longitudinal strioles and very weak transverse wrinkles. Abdominal ventrites with weak microreticulation, strioles, and almost invisible punctation.

Structures: Pronotum with lateral bead. Base of prosternum and neck of prosternal process with distinct ridge, slightly rounded anteriorly. Blade of prosternal process lanceolate, relatively broad, convex, with distinct lateral bead and few setae. Abdominal ventrite 6 broadly rounded.

Male: Antennomeres 4–10 slightly but distinctly enlarged (Fig. 9). Pro- and mesotarsomeres 1–3 not dilated, narrow. Protarsomere 4 cylindrical, narrow, with large, thick, strongly curved anterolateral hook-like seta. Protarsomere 5 ventrally with anterior row of eleven and posterior row of five short setae (Fig. 10A). Median lobe with distinctly discontinuous outline; in lateral view, almost straight, with apex broad, curved downwards, and pointed at tip; in ventral view, with distinct submedian constriction, distal part narrower than proximal one, apex asymmetrical, narrowly concave (Fig. 10B, C). Paramere with strong notch on dorsal side, with median notch tip sharply pointed, and subdistal part large and elongate; subdistal setae long, dense, curved at apex, and of two different types: upper setae thinner, more hair-like and lower setae thick and flattened; proximal setae hair-like, more inconspicuous than subdistal ones (Fig. 10D). Abdominal ventrite 6 broadly rounded, with nine lateral striae on each side.

Female: Antennomeres 4–10 stout. Pro- and mesotarsi not modified. Abdominal ventrite 6 without lateral striae.

Affinities. The species evidently belongs to the *E. ekari* group due to the discontinuous outline of its median lobe. The species is very similar to *E. brahminensis* and *E. apistefi* sp. nov. in general structure of male genitalia, especially in the sharply pointed median notch tip of paramere, but differs from them in submatt dorsal surface due to stronger microreticulation, presence of pronotal bead, enlarged antennomeres 4–10, shape of the median lobe, and setation of the paramere.

Distribution. INDONESIA: Papua Province. This species is known only from the type locality in Cyclops Mountains (Fig. 15).

Habitat. The specimens were collected from small puddles at low spot of a small ravine.

Etymology. This species is named after Hudson Wild, a most dedicated naturalist and community worker in Papua. The name is a noun in the genitive case.

Descriptions of the species from the Wano Land

Ten species are now recorded from the Wano Land: *E. sumokedi* of the *E. casuarina* group, six species, mentioned in the Introduction, from the complex close to the *E. ekari* group (Shaverdo et al. 2017: 109, key), two species described herein, and the newly recorded *E. bewaniensis*. Diagnostic characters of latter three are discussed below; since they belong to the *E. ekari* group, they could be easily distinguished from the other *Exocelina* species occurring in this region (see Shaverdo et al. 2017, 2018).

Exocelina ekpliktiki Shaverdo, Surbakti & Balke, sp. nov.

<http://zoobank.org/5869A521-DFF6-45B6-9481-96A9C0D9F3D2>

Figures 11, 12, 15

Exocelina nr. *oceai* #6504: Toussaint et al. 2021: figs 3–6.

Type locality. INDONESIA: Papua Province, Puncak Regency, south from Iratoi, 03°54'20.4"S, 137°12'03.2"E, 378 m a.s.l.

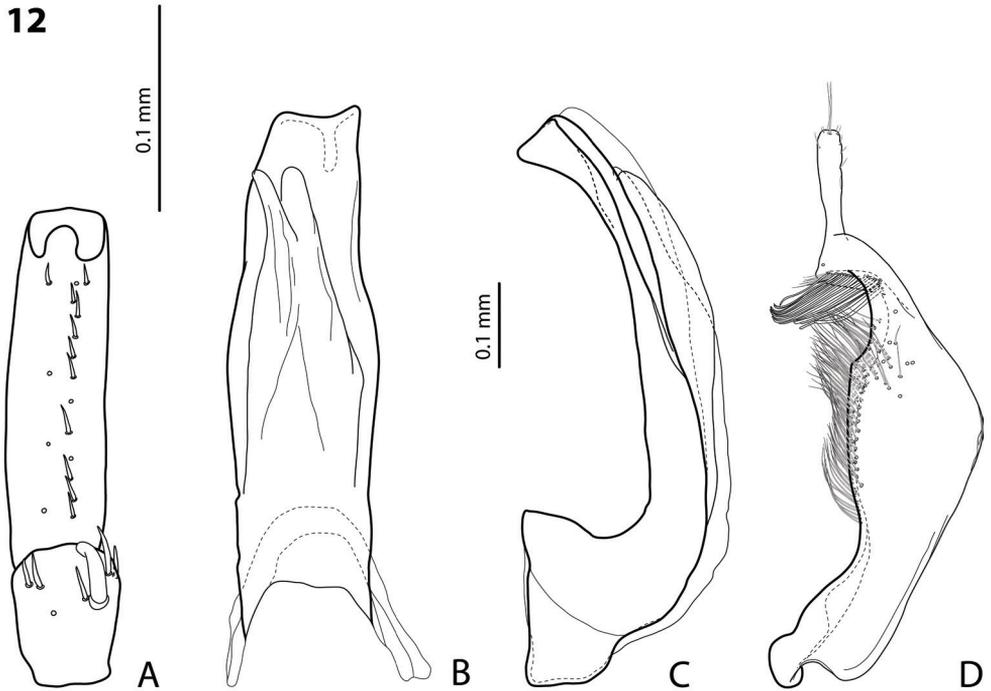
Type material. *Holotype*: male “Indonesia: Papua, S Iratoi, forest, 378m, 22.v.2015, -3,3904028 137,32009999, Pele & Sumoked (Pap037)” (MZB).

Paratypes: Puncak Regency: 16 males, 8 females with the same label as the holotype (MZB, KSP). 3 males “Indonesia: Papua, S Iratoi, forest, 378m, 22.v.2015, -3,3904028031975 137,320099985226, Pele & Sumoked (Pap037)”, one male an additional label “KSP6983” [green text] (KSP). 5 males, 2 females “Indonesia: Papua, S Iratoi, forest, 553m, 22.v.2015, -3,3919226937 137,3235277, Pele & Sumoked (Pap038)” (KSP). 1 male, 1 female “Indonesia: Papua, S Iratoi, forest, 553m, 22.v.2015, -3,39192269369959 137,323527764528, Pele & Sumoked (Pap038)”, with additional green text labels “6989” and “6988”, respectively (KSP). 17 males, 11 females “Indonesia: Papua, S Iratoi, forest, 450m, 23.v.2015, near -3,39192 137,323527764528, Pele & Sumoked (Pap039)” (MZB, KSP). 2 males “Indonesia: Papua, S Iratoi, forest, 450m, 23.v.2015, near -3,391922694 137,323527764528, Pele & Sumoked (Pap039)”, with additional green text labels “6986” and “6987” (KSP). 13 males, 5 females “Indonesia: Papua, Wano Land, red clay creek nr cave, 1100m, 3.ix.2014, nr -3.587955 137.5114945, Bennji (Pap024)”, one male an additional label “6517” [green text] (MZB, KSP).

11



12



Figures 11, 12. *Exocelina ekpliktiki* sp. nov., holotype **11** habitus and colouration **12** male structures **A** right protarsomeres 4 and 5 in ventral view **B** median lobe in ventral view **C** median lobe in lateral view **D** right paramere in external view.

Puncak Jaya Regency. 3 males “Indonesia: Papua, S Iratoi, forest, 220m, 21.v.2015, -3,38095162063837 137,311441982164, Pele & Sumoked (Pap036)”, one male an additional label “6982” [green text] (MZB, KSP). 6 males, 6 females “Indonesia: Papua, Rouaffer, Iratoi, hill in forest, 164m, 6.ix.2014, -3,2403086 137,3329744, Pele & Sumoked (Pap028)”, two males with additional green text labels “6504” and “6505” (KSP).

Description. Body size and form: Beetle small: TL-H 2.95–3.35 mm, TL 3.35–3.65 mm, MW 1.6–1.8 mm, excluding the locality Pap024, (holotype: TL-H 3.15 mm, TL 3.55 mm, MW 1.7 mm), with oblong-oval habitus (Fig. 11), some specimens, especially teneral slightly egg-shaped.

Colouration: Dorsally dark brown to piceous, with paler, reddish brown anterior half of head and lateral sides of pronotum (Fig. 11). Head dark brown posteriorly and largely (to half) reddish brown anteriorly; pronotum dark brown to piceous, with reddish to reddish brown lateral sides, sometimes also narrowly anteriorly and posteriorly leaving dark brown disc; elytra dark brown to piceous, with reddish brown sutural lines; head appendages yellow, legs yellowish red to reddish brown. Teneral specimens paler, to pale brown, with yellow anterior half of head and pronotal sides.

Surface sculpture: Shiny dorsally, with inconspicuous, almost invisible elytral punctation and weakly impressed microreticulation. Head with relatively sparse punctation (spaces between punctures 1–3 times size of punctures), evidently finer and sparser anteriorly and posteriorly; diameter of larger punctures almost equal to diameter of cells of microreticulation. Pronotum with finer, sparser, and more evenly distributed punctation than on head, often inconspicuous. Elytra with very sparse and fine punctation, almost invisible. Pronotum and elytra with weakly impressed microreticulation, sometimes stronger on pronotal sides; head with microreticulation much stronger. Metaventrite and metacoxa distinctly microreticulate, metacoxal plates with longitudinal striae and transverse wrinkles. Abdominal ventrites with distinct microreticulation, striae, and very fine and sparse punctation.

Structures: Pronotum with distinct but narrow lateral bead, in some specimens reduced at posterior angles. Base of prosternum and neck of prosternal process with distinct ridge, slightly rounded anteriorly. Blade of prosternal process lanceolate, relatively narrow, slightly convex, with distinct lateral bead and few setae. Abdominal ventrite 6 broadly rounded.

Male: Antenna simple. Pro- and mesotarsomeres 1–3 narrow. Protarsomere 4 narrow, with medium-sized, slightly curved anterolateral hook-like seta. Protarsomere 5 ventrally with anterior row of 13 and posterior row of four short, pointed setae (Fig. 12A). Median lobe with distinctly discontinuous outline; in lateral view, almost straight, with curved downwards, broadly pointed apex; in ventral view, with weak submedian constriction, distal part only slightly narrower than proximal one, and evenly, shallowly concave apex (Fig. 12B, C). Paramere with strong notch on dorsal side and subdistal part short and small; subdistal setae long, dense, curved at apex, few lower ones slightly flattened; proximal setae numerous, dense, but weaker than subdistal ones (Fig. 12D). Abdominal ventrite 6 with 5–10 lateral striae on each side.

Female: Pro- and mesotarsi not modified. Abdominal ventrite 6 without lateral striae.

Variability. Beetles from the locality Pap024 are larger (TL-H 3.25–3.65 mm, TL 3.55–4.0 mm, MW 1.75–2.0 mm), with distinctly larger and more robust median lobe and paramere, though of the shape and setation of the median lobe and paramere are the same.

Affinities. The species evidently belongs to the *E. ekari* group due to the discontinuous outline of its median lobe. Based on body size and form, colouration, dorsal surface sculpture, shape of anterolateral hook-like seta of the protarsomere 4, and shape and setation of genitalia, the new species is very similar to *E. soppi* Shaverdo et al., 2012 and, especially, to *E. weylandensis* Shaverdo et al., 2012. However, it differs distinctly from them in presence of the pronotal bead and in that, it is similar to *E. oceai* Shaverdo et al., 2012 and can be as well as distinguished from the co-occurring species, *E. bewaniensis* and *E. oraia* sp. nov.; from *E. oraia* sp. nov. also by not having modified male antennae.

Distribution. Indonesia: Papua Province. This species is known only from the Wano Land (Fig. 15).

Habitat. The specimens were collected from small forest creeks.

Etymology. The species name *ekpliktiki* derives from Greek *εκπληκτικός* (feminine *εκπληκτική*) meaning fantastic. The name is an adjective in the nominative singular.

***Exocelina oraia* Shaverdo, Surbakti & Balke, sp. nov.**

<http://zoobank.org/6C3D5689-F5EA-4BA3-B1A6-0F28AD993842>

Figures 13–15

Exocelina nr. *irianensis* #6520: Toussaint et al. 2021: figs 3–6.

Type locality. INDONESIA: Papua Province, Puncak Jaya Regency, Puluk area, 03°39'37.0"S, 137°31'14.7"E, 1320 m a.s.l.

Type material. Holotype: male “Indonesia: Papua, Wano Land, Puluk, 1320m, 1.ix.2014, -3.660272 137.5207436, Bennji (Pap020)” (MZB). **Paratypes:** 14 males, 10 females with the same label as the holotype, one male with an additional label “6520” [green text] (MZB, KSP).

Description. Body size and form: Beetle small to medium-sized: TL-H 3.45–3.85 mm, TL 3.8–4.25 mm, MW 1.85–2.1 mm (holotype: TL-H 3.6 mm, TL 4 mm, MW 1.95 mm), with oblong-oval habitus (Fig. 13).

Colouration: Dorsally piceous (Fig. 13). Head piceous, with slightly paler, dark brown, anterior margin; pronotum piceous, with reddish brown anterior angles and dark brown lateral sides; elytra uniformly piceous; head appendages and proximal part of legs yellowish brown, legs distally brown. Teneral specimens paler.

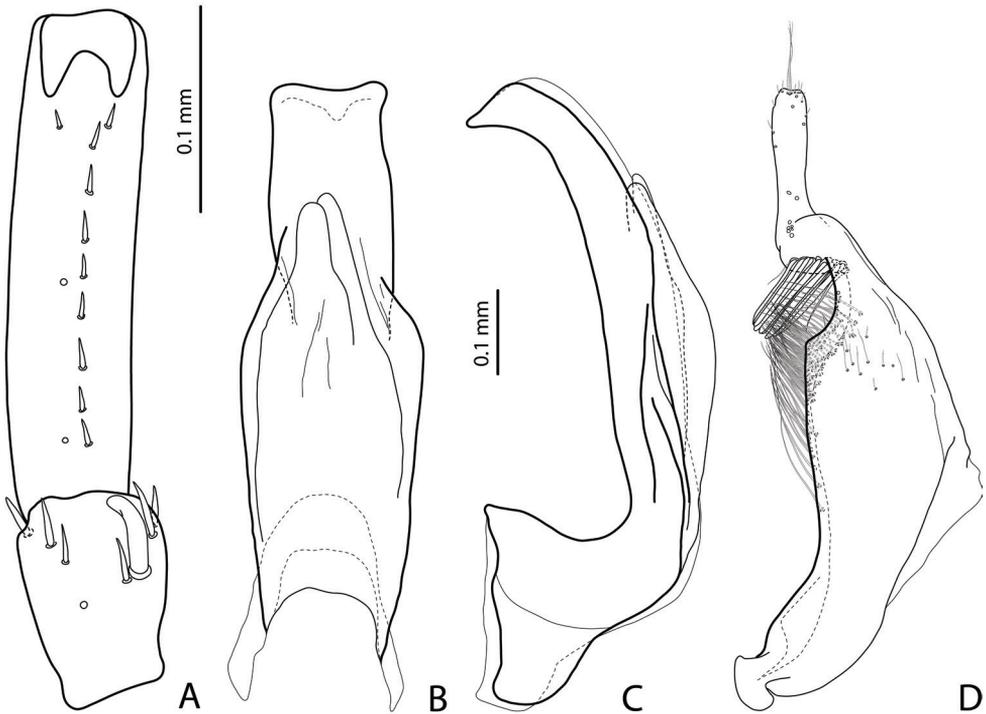
Surface sculpture: Shiny dorsally, with invisible elytral punctation and weakly impressed microreticulation. Head with relatively sparse punctation (spaces between punctures 1–3 times size of punctures), evidently finer and sparser anteriorly and posteriorly; diameter of punctures smaller than diameter of cells of microreticulation.

13



1.0 mm

14



Figures 13, 14. *Exocelina oraia* sp. nov., holotype **13** habitus and colouration **14** male structures **A** right protasomeres 4 and 5 in ventral view **B** median lobe in ventral view **C** median lobe in lateral view **D** right paramere in external view.

Pronotum with distinctly finer, sparser, and more evenly distributed punctation than on head, often inconspicuous. Elytra with extremely sparse and fine punctation, often invisible. Pronotum and elytra with weakly impressed microreticulation; head with microreticulation much stronger. Metaventricle and metacoxa distinctly but weakly microreticulate, metacoxal plates with longitudinal striae and very weak transverse wrinkles. Abdominal ventrites with distinct but weak microreticulation, striae, and extremely fine and sparse, often invisible punctation, more distinct on abdominal ventrite 6.

Structures: Pronotum without lateral bead, in some specimens (especially characteristic for females) with bead traces or even with narrow bead on lateral sides of pronotum. Base of prosternum and neck of prosternal process with distinct ridge, slightly rounded anteriorly. Blade of prosternal process lanceolate, relatively narrow, slightly convex, with distinct lateral bead and few setae. Abdominal ventrite 6 broadly rounded.

Male: Antenna modified (Fig. 13): antennomeres 3 and 4 strongly enlarged, distinctly larger than other antennomeres, antennomere 5 distinctly enlarged, 6–9 stout. Pro- and mesotarsomeres 1–3 narrow. Protarsomere 4 narrow, with medium-sized, slightly curved anterolateral hook-like seta. Protarsomere 5 ventrally with anterior row of nine and posterior row of three short setae (Fig. 14A). Median lobe with distinctly discontinuous outline; in lateral view, almost straight, with curved downwards, rather narrow, sharply pointed apex; in ventral view, with strong submedian constriction, distal part distinctly narrower than proximal one, apex symmetrical, slightly evenly concave (Fig. 14B, C). Paramere with strong notch on dorsal side and subdistal part short and small; subdistal setae relatively short, thick, flattened; proximal setae more numerous, dense, hair-like, weaker than subdistal ones (Fig. 14D). Abdominal ventrite 6 with 4–8 lateral striae on each side.

Female: Pro- and mesotarsi not modified. Abdominal ventrite 6 without lateral striae. Bead traces or even with narrow bead on lateral margins pronotum present in majority of females.

Affinities. The species evidently belongs to the *E. ekari* group due to the discontinuous outline of its median lobe. The new species is very similar to *E. irianensis* Shaverdo et al., 2012 and *E. wondiwoiensis* Shaverdo et al., 2012 in general appearance, modified male antennae, and structure of the male genitalia, but differs from them in shape of median lobe and setation of the paramere. Additionally, the species shows a stronger tendency to have the lateral bead of pronotum.

Distribution. INDONESIA: Papua Province. This species is known only from the type locality (Fig. 15).

Habitat. The specimens were collected from small forest creeks.

Etymology. The species name *oraia* derives from Greek *ωραία* (feminine *ωραία*) meaning nice, lovely. The name is an adjective in the nominative singular.

***Exocelina bewaniensis* Shaverdo, Menufandu & Balke, 2014**

New records. INDONESIA: Papua Province: Puncak Jaya Regency (first record): 2 male, 1 female “Indonesia: Papua, Wano Land, creek @ jungle helipad, 870m, 4.ix.2014, -3,584077 137,5042947, Bennji (Pap027)”, one male an additional label “6527”

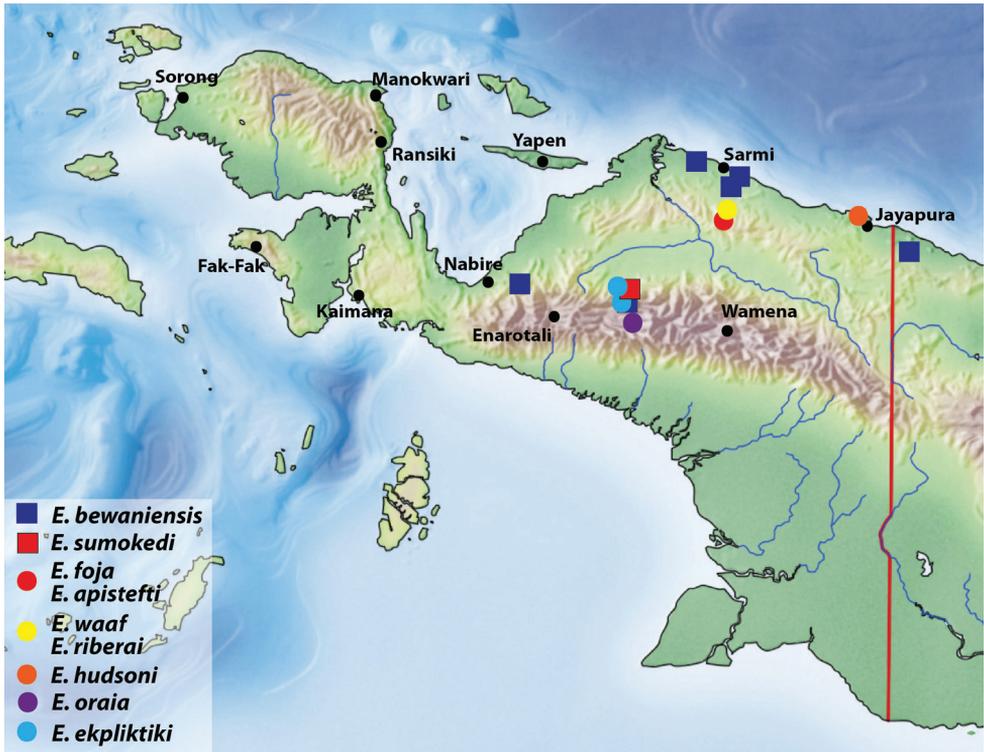


Figure 15. Map of the western part of New Guinea showing the species distribution.

[green text] (KSP). 1 male “Indonesia: Papua, S Iratoi, forest, 168m, 24.v.2015, -3,36070714518427 137,301383111625 (Pap040) Bennji” (KSP).

Distribution. Papua New Guinea: Sandaun Province; Indonesia: Papua Province: Sarmi, Mamberano Raya, Nabire/Paniai, and Puncak Jaya regencies. The present records confirm that this morphologically variable species is broadly distributed in the central-northern part of western New Guinea.

Corrections

The correct name for *Exocelina atthesphatos* Shaverdo et al., 2020 is *Exocelina atthesphati* since the species epithet *atthesphatos* should be feminine.

Exocelina bacchus Balke, nom. nov.

Copelatus (Papuadytes) bacchusi Balke, 1998, not *Copelatus bacchusi* Wewalka, 1981.

Remark. We provide a replacement name for *Exocelina bacchusi* (Balke, 1998), described as *Copelatus (Papuadytes) bacchusi* Balke, 1998, since the species name of the latter is preoccupied by Wewalka (1981) and, therefore, it is a junior homonym of

Copelatus bacchusi Wewalka, 1981. The species stays named for its collector, Mick Bacchus. The name is a noun in apposition.

Acknowledgements

We are grateful to Dr H. Schillhammer (Vienna) for the photographs and to Dr Dimitrios N. Avtzis (Trilofos, Thessaloniki) for his help with the Greek names. Specimens were loaned from MZB/KSP in the framework of a formally established longer-term capacity-building program between the Cenderawasih University (UNCEN, Waena, Papua) and SNSB-ZSM (Munich), with the most recent MTA, LoA, and MoU signed in 2019.

Financial support for the study was provided by the FWF (Fonds zur Förderung der wissenschaftlichen Forschung – the Austrian Science Fund) through the projects P 24312-B17 and P 31347-B25 to Helena Shaverdo. Michael Balke was supported by the German Science Foundation (DFG BA2152/11-1, 11-2, 19-1, 19-2). We are grateful for the generous support from the “SNSB-Innovativ” scheme, funded by the Bayerisches Staatsministerium für Wissenschaft und Kunst.

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A contribution towards checklist of fungus gnats (Diptera, Diadocidiidae, Ditomyiidae, Bolitophilidae, Keroplatidae, Mycetophilidae) in Georgia, Transcaucasia

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Academic editor: V. Blagoderov | Received 29 January 2021 | Accepted 8 March 2021 | Published 26 March 2021

<http://zoobank.org/05EFF10E-6214-4368-BE47-1AA57A2C38D7>

Citation: Kurina O (2021) A contribution towards checklist of fungus gnats (Diptera, Diadocidiidae, Ditomyiidae, Bolitophilidae, Keroplatidae, Mycetophilidae) in Georgia, Transcaucasia. ZooKeys 1026: 69–142. <https://doi.org/10.3897/zookeys.1026.63749>

Abstract

The fungus gnats of Georgia are studied based on 2682 specimens collected from 57 localities during 2011–2019. Altogether, 245 species are recorded including four species of Bolitophilidae, three species of Diadocidiidae, two species of Ditomyiidae, 34 species of Keroplatidae and 202 species of Mycetophilidae. 230 and 188 species are recorded from Georgia and the whole of Transcaucasia for the first time, respectively. Three new species – *Sciophila georgei* sp. nov., *Leia katae* sp. nov. and *Anatella metae* sp. nov. – are described including detailed illustrations of the male terminalia. Photographs are provided for an additional 38 species to highlight a variability of their general facies. Combined with earlier published data, the number of fungus gnat species in Georgia is set at 246. The estimated diversity of fungus gnats in Georgia is calculated using non-parametric methods and discussed with respect to other Western Palaearctic regions.

Keywords

Fungus gnats, Georgia, new species, Sciaroidea, species diversity, taxonomy, Transcaucasia

Introduction

The last decades can be characterized by an upturn of systematics, taxonomy and biodiversity studies (e.g. Padial et al. 2010; Kõljalg et al. 2020; Wheeler 2020). That is also true in the case of the insects order Diptera (e.g. Wiegmann et al. 2011; Kirk-Spriggs and Sinclair 2017; Borkent et al. 2018) including the superfamily Sciaroidea (e.g. Kjærandsen et al. 2007; Borkent and Wheeler 2012; Ševčík et al. 2013; Fitzgerald and Kerr 2014). Seven families and a *insertae sedis* group are included in Sciaroidea (Ševčík et al. 2016; Mantič et al. 2020), whereas five of them, viz. Diadocidiidae, Ditomyiidae, Bolitophilidae, Keroplatidae and Mycetophilidae are conjoined under a common name ‘fungus gnats’. Today, more than 5,500 species of fungus gnats are known globally (Evenhuis and Pape 2021; Fungus Gnats Online Authors 2021), however, their actual diversity is insufficiently known, especially in tropical regions of the world. As expected, the group is best studied in Europe with about 1,200 named species (Chandler 2013) yielded by more than 200 years of studies pioneered by the “father” of dipterology J.W. Meigen (e.g. Meigen 1804, 1818). Nevertheless, even in Europe, new species are described annually and e.g. in Nordic countries nearly 120 new species are waiting to be described (Kjærandsen and Søli 2020). While fungus gnats are mostly forest dwellers preferring shady and humid habitats, some species are also recorded from more open landscapes (Falk and Chandler 2005). They are small to medium size nematocerous flies with a humpbacked habitus, prominent coxae and hyaline or patterned wings (see e.g. Figs 8, 9). The trophic strategy of fungus gnats is diverse: the majority of the known associations are those with fungal fruiting bodies or mycelium-penetrated forest litter including decaying wood but several species develop in other terrestrial habitats and/or can also be sporophagous or predators in the larval stage (e.g. Matile 1997; Ševčík 2010; Jakovlev 2012; Pöldmaa et al. 2016; Mantič et al. 2020).

Transcaucasia, the area southwards from the Greater Caucasus Mountains that includes the countries of Georgia, Azerbaijan and Armenia, is considered one of the biodiversity hotspots of the world, with a remarkable number of endemic species (Myers et al. 2000). However, limited attention has been paid to the biodiversity research in the area so far (Mumladze et al. 2020) and most organism groups, including Diptera and fungus gnats in particular, are rather superficially studied. There are 33 species of fungus gnats recorded from Azerbaijan (Zaitzev 1994, 2003; Zaitzev and Ševčík 2003) and seven species from Armenia (Joost and Plassmann 1985, Zaitzev 1994). From Georgia, only one species was known (Zaitzev 1994) prior to Kurina and Jürgenstein (2013) who described two new *Orfelia* Costa (Keroplatidae) species from Marelisi, NW of Borjomi. Later on, Jürgenstein et al. (2015), Kurina et al. (2015), Kurina (2018), Thormann et al. (2019) and Ševčík et al. (2020) provided data on another twelve species and the number of fungus gnat species from Georgia is currently set at 15. Furthermore, an additional 24 fungus gnat species have been listed to occur in Transcaucasia but without a specified region (Zaitzev 1994, 2003). Concerning neighbouring areas, 91 species of fungus gnats are recorded from the northern slopes of the

Great Caucasus ridge, most of them from the surroundings of Mt Elbrus (Joost and Plassmann 1976, 1979, 1985, 1992, Plassmann 1976).

During the last decade, a considerable amount of fungus gnat material from Georgia has accumulated in the author's possession. The aim of the current contribution is to provide results of the study based on that material along with summarising all available published information on Georgian fungus gnats.

Material and methods

The material was collected from 2011 to 2019 using different methods in the course of 61 collecting events from 57 localities in Georgia (Table 1, Fig. 1). The majority of the material was collected sweeping during three expeditions by the author in May of 2012 and 2013 and August-September 2014. Additional material from Malaise trap samples is included from the provinces Samegrelo-Zemo-Svanethi, Imereti and Kakheti; a sporadic material as a by-product of light trap collecting is also included (Table 1). The collecting localities (see Fig. 2 for examples) varied from more open landscape in Vardzia (Table 1: SJ-10) to highly forested mountain areas in Kintrishi (Table 1: A-5–8), Mtirala (Table 1: A-1–4) and Borjomi-Kharagauli (Table 1: I-5–17) National Parks, and subalpine areas in the surroundings of Stepantsminda (Table 1: MM-1–6), Bakuriani (Table 1: SJ-6–7) and Ushguli (Table 1: SZS-2–3).

The vast majority of the material was initially preserved in 70% ethyl alcohol where most of it is also stored after determination. Every species per locality is arranged in a separate glass vial equipped with collecting and determination labels. Some specimens



Figure 1. Collecting localities in Georgia. The codes are those used in Table 1.

Table 1. Collecting data of fungus gnats in Georgia arranged by administrative regions of the country. Codes for the collecting events are used on the Figure 1 and within the list of species. The asterisk (*) indicates collecting with a Malaise trap for which the exact collecting dates are provided in the text.

Region	Locality	Coordinates	Altitude (m)	Collecting date(s)	Collecting method	Collector	Code
Samegrelo-Zemo Svanethi	Mestia	43°02.97'N, 42°44.72'E	1500	28.vii.2017	light trap	O. Kurina	SZS-1
	Chvabiani	43°02.47'N, 42°51.03'E	1630	29.vii.2017	light trap	O. Kurina	SZS-2
	S of Lkhushdi, meadow	42°59.93'N, 42°39.02'E	1270	13–14.vi.2019	Malaise trap	X. Mengual	SZS-3
	near Ushguli, path to glacier	42°56.62'N, 43°03.23'E	2220	15–17.vi.2019	Malaise trap	X. Mengual	SZS-4
Adjara	Mtirala NP, visitor centre	41°40.65'N, 41°51.30'E	240	19.v.2013	sweeping	O. Kurina	A-1
	Mtirala NP, visitor centre	41°40.65'N, 41°51.33'E	230	19.v.2013	at light	O. Kurina	A-2
	Mtirala NP, visitor centre	41°40.35'N, 41°52.53'E	270	20.v.2013	sweeping	O. Kurina	A-3
	Mtirala NP, visitor centre	41°40.91'N, 41°50.70'E	220	20.v.2013	at light	O. Kurina	A-4
	Kintrishi NP	41°45.76'N, 41°58.67'E	320	21.v.2013	sweeping	O. Kurina	A-5
	Kintrishi NP	41°45.76'N, 41°58.67'E	320	21.v.2013	at light	O. Kurina	A-6
	Kintrishi NP	41°45.20'N, 41°58.63'E	450	22.v.2013	sweeping	O. Kurina	A-7
	Kintrishi NP	41°46.40'N, 41°58.08'E	460	22.v.2013	sweeping	O. Kurina	A-8
Imereti	Chiatura	42°17.00'N, 43°17.00'E	480	17.v.2011	light trap	U. Jürivete	I-1
	Tshunkuri	42°24.00'N, 42°35.00'E	230	20.v.2011	light trap	U. Jürivete	I-2
	Patara Vardzia, W of Kharagauli	42°0.55'N, 43°04.62'E	740	v-x.2013*	Malaise trap	O. Kurina	I-3
	Patara Vardzia, W of Kharagauli	42°01.32'N, 43°11.10'E	370	18.v.2013	sweeping	O. Kurina	I-4
	Marelisi	41°57.07'N, 43°17.02'E	430	18.v.2012	sweeping	O. Kurina	I-5
	Marelisi	41°57.93'N, 43°17.35'E	410	19.v.2012	sweeping	O. Kurina	I-6
	Marelisi, on road to railway station	41°58.02'N, 43°17.35'E	440	19.v.2012	at light	O. Kurina	I-7
	Marelisi	41°57.00'N, 43°17.00'E	460	20.v.2012	indoors	O. Kurina	I-8
	Marelisi, on path to hill	41°56.38'N, 43°16.62'E	690	20.v.2012	sweeping	O. Kurina	I-9
	Marelisi	41°56.80'N, 43°17.05'E	450	20.v.2012	sweeping	O. Kurina	I-10
	Marelisi	41°58.02'N, 43°17.38'E	400	17.v.2013	sweeping	O. Kurina	I-11
	Marelisi	41°56.28'N, 43°16.98'E	460	17.v.2013	sweeping	O. Kurina	I-12
	Marelisi	42°56.46'N, 43°17.05'E	460	18.v.2013	at light	O. Kurina	I-13
	Marelisi	41°56.28'N, 43°16.98'E	460	29.viii.2014	sweeping	O. Kurina	I-14
	Marelisi	41°56.38'N, 43°16.47'E	760	30.viii.2014	sweeping	O. Kurina	I-15
Marelisi, close to railway station	41°58.23'N, 43°18.65'E	400	20.v.2012	at light	O. Kurina	I-16	
Marelisi, close to railway station	41°58.14'N, 43°18.63'E	410	23.v.2013	sweeping	O. Kurina	I-17	
Shida-Kartli	W of Surami	42°01.57'N, 43°29.88'E	940	18.v.2012	sweeping	O. Kurina	SK-1
Samtskhe-Javakheti	road from Abastumani to Saima, near river	41°46.63'N, 42°50.23'E	1370	10–11.vi.2019	Malaise trap	X. Mengual	SJ-1
	road from Abastumani to Saima	41°47.82'N, 42°50.63'E	1730	10–11.vi.2019	Malaise trap	X. Mengual	SJ-2
	Borjomi 3 km--W, Likani	41°50.15'N, 43°19.95'E	940	21.v.2012	sweeping	O. Kurina	SJ-3
	Borjomi 3.5 km--W, Likani	41°50.11'N, 43°19.92'E	950	31.viii.2014	sweeping	O. Kurina	SJ-4
	Bakuriani 2 km--NW	41°45.77'N, 43°30.28'E	1630	31.viii.2014	sweeping	O. Kurina	SJ-5
	Bakuriani 5 km--S, road from Bakuriani to Tabatskuri	41°42.33'N, 43°30.13'E	2120	1.ix.2014	sweeping	O. Kurina	SJ-6
	Bakuriani 3 km--SW, road from Bakuriani to Tabatskuri	41°43.33'N, 43°29.87'E	1870	1.ix.2014	sweeping	O. Kurina	SJ-7
	Bakuriani 1 km--SW, road from Bakuriani to Tabatskuri	41°44.22'N, 43°30.75'E	1740	1.ix.2014	sweeping	O. Kurina	SJ-8
	Bakuriani 2 km--NW	41°45.77'N, 43°30.28'E	1630	1.ix.2014	sweeping	O. Kurina	SJ-9
	Vardzia, near Tirebi guesthouse	41°24.17'N, 43°19.23'E	1260	22.v.2012	at light	O. Kurina	SJ-10
Mtskheta-Mtianethi	Stephantsminda	42°39.28'N, 44°39.28'E	1870	15.v.2012	at light	O. Kurina	MM-1
	Stephantsminda, road to Gegriti Trinity Church	42°39.77'N, 44°37.50'E	1980	16.v.2012	sweeping	O. Kurina	MM-2
	Gvelethi NW of Stephantsminda	42°42.28'N, 44°37.27'E	1640	16.v.2012	at light	O. Kurina	MM-3
	Gvelethi NW of Stephantsminda, surroundings of lake	42°43.37'N, 44°37.12'E	1520	17.v.2012	sweeping	O. Kurina	MM-4
	Gvelethi NW of Stephantsminda, surroundings of waterfall	42°42.23'N, 44°37.20'E	1570	17.v.2012	sweeping	O. Kurina	MM-5
	Stephantsminda, road to Gegriti Trinity Church	42°40.02'N, 44°37.15'E	2090	17.v.2012	at light	O. Kurina	MM-6
	Gudauri	42°26.23'N, 44°29.95'E	1780	8.vii.2019	light trap	A. Selin	MM-7
	Dgnali	42°13.43'N, 44°40.02'E	910	15.v.2012	sweeping	O. Kurina	MM-8

Region	Locality	Coordinates	Altitude (m)	Collecting date(s)	Collecting method	Collector	Code
Mtskhetha-Mthianethi	Zaridzeebi	42°42.08'N, 44°54.00'E	870	22.v.2011	light trap	U. Jürivete	MM-9
	Saguramo	41°54.00'N, 44°46.00'E	600	16.v.2011	light trap	U. Jürivete	MM-10
	Saguramo	41°53.07'N, 44°46.78'E	920	15.v.2012	sweeping	O. Kurina	MM-11
	Saguramo	41°53.07'N, 44°46.78'E	920	15.v.2013	sweeping	O. Kurina	MM-12
	Saguramo	41°53.07'N, 44°46.78'E	920	28.viii.2014	sweeping	O. Kurina	MM-13
	Saguramo	41°53.13'N, 44°46.73'E	890	4.ix.2014	sweeping	O. Kurina	MM-14
Kvemo Kartli	Manglisi 6 km-S	41°39.89'N, 44°23.10'E	1190	23.v.2012	sweeping	O. Kurina	KK-1
Kakheti	Dzveli Shuamta W of Telavi	41°54.60'N, 45°24.33'E	1000	2.ix.2014	sweeping	O. Kurina	K-1
	Gurgeniani, W of Lagotekhi	41°52.67'N, 46°14.55'E	630	3.ix.2014	sweeping	O. Kurina	K-2
	Matsimi near Lagotekhi	41°48.55'N, 46°18.73'E	440	3.ix.2014	at light	O. Kurina	K-3
	Lagodekhi NR, near administration building	41°50.50'N, 46°16.98'E	560	28.v-9.vi.2011	Malaise trap	G. Japoshvili	K-4
	Lagodekhi NR, Matsimi river gorge	41°47.75'N, 46°17.12'E	350	17-27.v.2011	Malaise trap	G. Japoshvili	K-5
	Lagodekhi NR (Malaise trap #3)	unavailable		15-25.vi.2014	Malaise trap	G. Japoshvili	K-6

were double pinned directly after collecting, whereas part of the initially alcohol-preserved specimens were mounted using the method described by Vockeroth (1966) and double pinned thereafter. The majority of the material was determined directly in alcohol as that also allowed observation of the terminalia. However, in a number of cases a more detailed study of male terminalia proved to be unavoidable. For that, terminalia were detached and treated with about 10% warm potassium hydroxide followed by neutralization with acetic acid and washing with distilled water. Terminalia were studied in glycerine and stored as glycerine preparations in small plastic vials attached to the rest of the specimen (see also Kurina 2008a).

Illustrations of the terminalia were prepared using a U-DA drawing tube attached to a compound microscope Olympus CX31. The digital images of the general habitus and terminalia were combined using the software LAS V.4.1.0. from multiple gradually focused images taken by a Leica DFC 450 camera attached to a Leica 205C stereomicroscope (see also Jürgenstein et al. 2015). Adobe Photoshop CS5 was used for editing the figures and compiling the plates. The morphological terminology follows Söli (1997, 2017) and that of the male terminalia is explained in Figs 4–7. The estimated species richness according to different non-parametric methods (Fig. 14) is calculated using the software EstimateS, Version 9.1.0. (Colwell 2013).

The material is deposited in the following collections:

- IUTG** Ilia State University, Tbilisi, Georgia;
IZBE Institute of Agricultural and Environmental Sciences, Estonian University of Life Sciences (former Institute of Zoology and Botany), Tartu, Estonia;
ZFMK Zoological Research Museum Alexander Koenig, Bonn, Germany.

The majority of the studied specimens are deposited in IZBE which is not repeated in the species list for every specimen. However, the material collected by X. Mengual (Bonn, Germany) in 2019 is divided between three institutions and the depository is specified in listed material sections below.



Figure 2. A gallery of collecting localities in Georgia. For codes see Table 1 **A** Mestia (SZS-1) **B** Mtirala NP (A-1) **C** Kintrishi NP (A-5) **D** Marelisi (I-12) **E** Bakurjani (SJ-6) **F** Lagotekhi (K-3) **G** Vardzia (SJ-10) **H** Gvelethi near Stepantsminda (MM-5) **I** Dgnali (MM-8).

Results

Altogether, 2682 studied specimens were identified to 245 different species, viz. four species of Bolitophilidae, three species of Diadocidiidae, two species of Ditomyiidae, 34 species of Keroplatidae and 202 species of Mycetophilidae including three species described as new to science. One additional species of Keroplatidae was included from the literature data (Zaitzev 1994). Moreover, six additional putatively new Mycetophilidae species were recorded, all represented by singletons, some of them of poor quality. Description of these species is deferred pending additional material to be collected. These six species are not included in the species list but are considered in the species richness calculations and distribution analysis (see Discussion). 230 and 188 species are recorded from Georgia and the whole Transcaucasia for the first time, respectively. In the species list, all available literature sources are cited for the species recorded earlier in Georgia and/or in Transcaucasia generally. The studied material is listed, using abbreviations of collecting events provided in Table 1, followed by total number of studied specimens. Distribution in Georgia is given by administrative provinces and the general distribution by zoogeographical regions or subregions. The latter is provided according to Chandler (2013) and subsequent published information available. Some remarks on distribution and/or taxonomy are included for species of special interest. To illustrate the diverse habitus of recorded fungus gnat species a gallery of photographs is provided (Figs 8, 9, 11, 12). In the list of species, the classification follows Fungus Gnats Online (<http://www.sciaroidea.info/>) except in two cases. Firstly, the subfamily Platyurinae of Keroplatidae is used according to Mantič et al. (2020). Secondly, *Brachycampta* Winnertz, 1863 is reinstated to the generic status from a subgenus of *Allodia* Winnertz, 1863 in accordance with a thorough study by Magnussen (2020); this opinion is also implemented in the recent checklist of fungus gnats of Norway by Kjærandsen and Søli (2020).

The new species

Sciophila georgei sp. nov.

<http://zoobank.org/D9E0ED72-E487-480C-A89F-4E6DDDD98C406>

Figs 3A, 4A–G

Type material. *Holotype*. Male, Georgia, Kakheti, Lagotekhi NR, Matsimi river gorge, 41°47.75'N, 46°17.12'E, 350 m a.s.l., 17–27.v.2011, Malaise trap, leg. G. Japoshvili [see Table 1: K-5] (mounted from alcohol, IZBE). *Paratype*. Male, same as holotype (mounted from alcohol, IZBE).

Diagnosis. *Sciophila georgei* sp. nov. can be distinguished by combination of the characters of the male terminalia as follows: lateral branch of gonostylus ventrally with two apical spine-like setae, small internal branch of gonostylus with one spine-like seta, tergite 9 large with medially rising apical margin that bears two large and simple setae, parameres straight and long, extending over tergite 9 apically, aedeagus small, star-shaped.

Description. Male. Body length 2.7–2.8 mm (n = 2). **Coloration.** Head with vertex and frons dark brown, face and clypeus brown and mouthparts including palpus

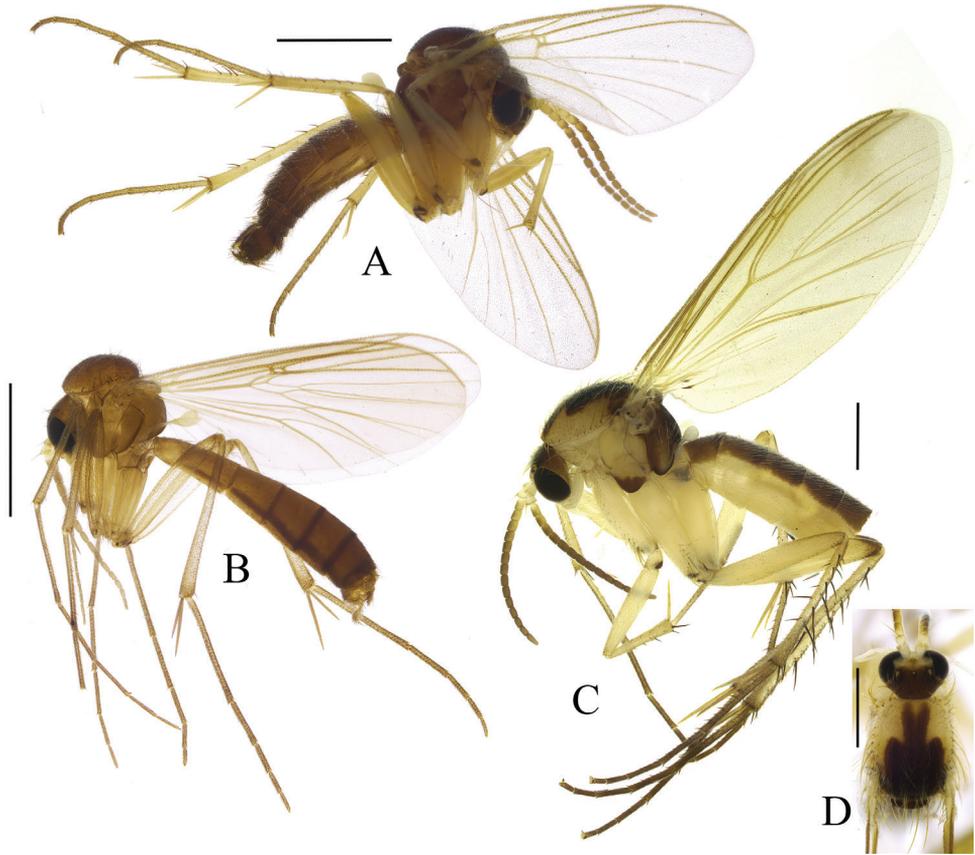


Figure 3. Habitus photos of new species **A** *Sciophila georgei* sp. nov., paratype **B** *Anatella metae* sp. nov., paratype **C** *Leia katae* sp. nov., holotype, terminalia detached. Scale bars: 1 mm.

pale yellow. Scape and pedicel yellow. First three or four flagellomeres yellowish, rest of flagellomeres light brown. Scutum entirely dark brown, antepronotum and proepisternum yellowish, anepisternum, anepimeron and katepisternum light brown, laterotergite and mediotergite brown, scutellum brown. Thoracic setae all yellowish. Wing hyaline, all veins brown including radial veins somewhat darker. Halter with stem and knob pale yellow. All coxae, femora and tibiae yellow, tarsi yellow but seem darker because of dense brown setae. Tibial setae brown, spurs yellowish. Abdomen with tergites light brown, 1–3 tergites somewhat lighter, all sternites yellowish. Abdominal vestiture yellow. Terminalia brown. **Head.** Ocelli in a shallow triangular arrangement. Medial ocellus somewhat smaller than laterals. Frontal furrow complete. Clypeus subrounded, about as long as broad. Fourth flagellar segment about as long as wide, apical flagellar segment 2.25 times as long as wide basally. Flagellar segments with dense yellowish short setae. **Thorax.** Scutum covered with short setae, with marginal and prescutellar setae stronger. Antepronotum with 8–9 setae. Proepisternum with 6–7 setae. Anepisternum with 5–6 setae on upper part, katepisternum and anepimeron non-setose. Laterotergite with 7–9 setae on posterior half. Mediotergite with 10–15 setae on lower part. Metepisternum

with setulae. Scutellum with setulae and marginal setae not arranged in pairs. **Wing.** Length 2.5–2.8 mm, length to width 2.4–2.7. Wing membrane uniformly covered with micro- and macrotrichia. All veins setose, except *sc-r*, *Rs*, *R*₂₊₃. Costa reaches about one fifth from *R*₄₊₅ to *M*₁. *Sc* ending on *C* before level of furcation of posterior fork. *Sc-r* located slightly before *Rs*. *r-m* about two times as long as *m-stem*. *M*₄ basally very faint or shortly interrupted at base. **Legs.** Ratio of femur to tibia for fore, mid and hind legs: 0.83–0.93; 0.89–0.97; 0.84–0.92. Ratio of tibia to basitarsus for fore, mid and hind legs: 1.26; 1.42–1.65; 1.33–1.37. Fore tibia with a spur 2.29–2.81 times of tibial maximum width. Mid tibia with anterior spur 3.08–3.15 times and posterior spur 3.42–3.69 times of tibial maximum width. Hind tibia with anterior spur 2.50–2.60 times and posterior spur 3.47–3.57 times of tibial maximum width. **Terminalia** (Fig. 4A–G). Gonocoxites fused for short distance ventrobasally forming medial triangular lobe with medial more sclerotized longitudinal ridge internally. Ventromedial margin of gonocoxite with a membranous flange drawn medially out into digitate apically hooked lobe. Gonocoxite covered with uniform setae except non-setose lateroapical and dorsomedial marginal areas. Dorsoposterior margin of gonocoxite with two prominent medially directed setae. Gonocoxal apodeme anteriorly enlarged, shoe-shaped, well discernible in dorsal view. Tergite 9 large, slightly convergent posteriorly, extending over gonocoxites, subapically constricted with two prominent simple setae apically, apical margin medially rising. Parameres long and straight, apically slightly widening, extending over tergite 9 apically. Aedeagus small, star-shaped, medially with posteriorly projecting digitate process. Lateral branch of the gonostylus laterally setose with aggregation of spine like setae along posterior margin; ventral part extended with two prominent apical spine-like setae. Medial branch of gonostylus with 25–30 furcated megasetae. Small internal branch of gonostylus with one prominent medially directed seta.

Female. Unknown.

Etymology. The species is named in honour of Prof. George Japoshvili (Tbilisi, Georgia) in recognition of his contribution to study of the insects' diversity in Georgia and his invaluable help in collecting the fungus gnat material that underlies the current communication. He was also the collector of the type material of this species.

Remarks. More than 190 species of *Sciophila* Meigen are known worldwide (Kurina 2020a, Taber 2021); the most comprehensive key to the Holarctic species is still that by Zaitzev (1982). Fortunately, all subsequently described species are supplemented with appropriate illustrations of the male terminalia (e.g. Polevoi 2001; Salmela and Kolcsár 2017; Taber 2021) that provides an adequate compendium of the morphological distinctions. Following the key by Zaitzev (1982), the new species runs to couplet 31 because of (1) wing with both macro- and microtrichia, (2) gonostylus without additional branches, (3) lateral branch of the gonostylus with two large setae ventroapically, (4) small internal branch of the gonostylus with one large seta, and (5) gonocoxites dorsoapically without protruding appendages. However, *S. georgei* sp. nov. differs from the species included in this couplet by details in the male terminalia. Notably, by the characters of tergite 9 (large, posteriorly convergent, extends over gonocoxites, bears two prominent simple setae apically, apical margin medially rising) and parameres (long, straight, extending over tergite 9 apically).

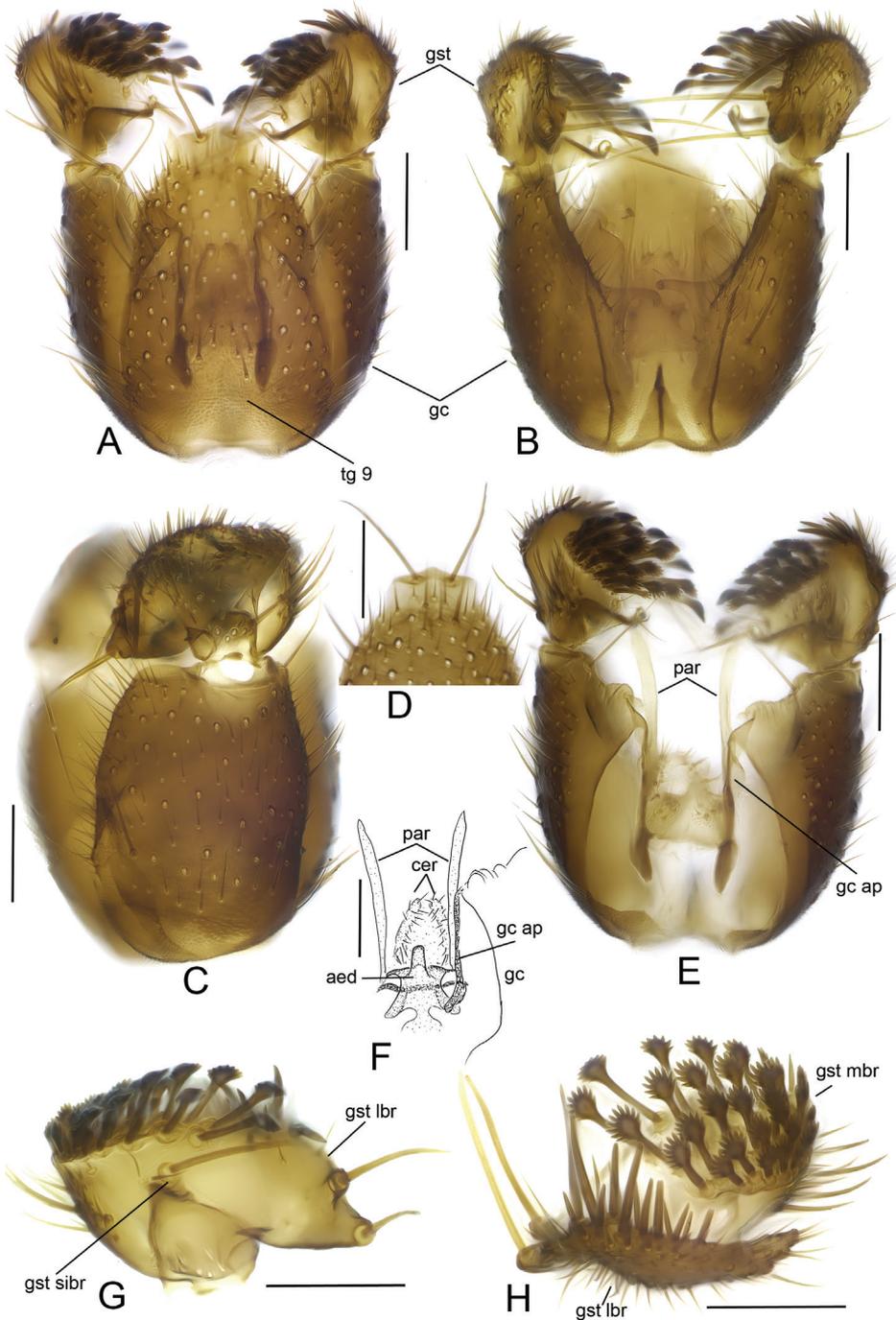


Figure 4. *Sciophilha georgei* sp. nov., male terminalia **A** dorsal view **B** ventral view **C** lateral view **D** apical part of tergite IX, dorsal view **E** dorsal view, tergite IX removed **F** aedeagal complex, dorsal view **G** gonostylus, internal view **H** gonostylus, posterior view. Abbreviations: aed = aedeagus, cer = cercus, gc = gonocoxite, gc ap = gonocoxal apodeme, gst lbr = lateral branch of gonostylus, gst mbr = medial branch of gonostylus, gst sibr = small internal branch of gonostylus, par = paramere, tg 9 = tergite IX. Scale bars: 0.1 mm.

***Leia katae* sp. nov.**

<http://zoobank.org/FDD299DF-4281-4DD0-9BAC-8B6050D98226>

Figs 3C, D, 5A–D, 6A–C

Type material. *Holotype.* Male, Georgia, Shida-Kartli, W of Surami, 42°01.57'N, 43°29.88'E, 940 m a.s.l., 18.v.2013, sweeping, leg. O. Kurina [see Table 1: SK-1] (mounted from alcohol, IZBE). ***Paratype.*** Male, GEORGIA, Samegrelo-Zemo-Svanethi, near Ushguli, path to glacier, 42°56.62'N, 43°03.23'E, 2220 m a.s.l., 15–17.vi.2019, Malaise trap, leg. X. Mengual [see Table 1: SZS-4] (in alcohol, ZFMK)

Diagnosis. *Leia katae* sp. nov. can be distinguished by the combination of characters as follows: thorax bicolored (scutum yellow, with brown longitudinal stripes; katepisternum with lower half brown), wing tinged yellowish, with faint preapical brownish band, male terminalia with bipartite gonostylus (lateral prong shorter, convolute and apically hooked; medial prong longer, tapering with preapical small tooth at ventral margin).

Description. Male. Body length 6.7–6.9 mm (n = 2). **Coloration.** Head with vertex brown, frons yellow, face, clypeus and mouthparts including palpus pale yellow. Scape and pedicel pale yellow. First two flagellomeres yellowish, flagellomeres 3–14 brown. Thorax bicoloured: scutum yellow with three brown longitudinal stripes, which are posteriorly completely fused, lateral stripes begin at a distance of one third from anterior margin, medial stripe shortly split anteriorly, lateral parts of scutum yellow; antepronotum, proepisternum and anepisternum yellow, posterior margin of anepimeron light brown, katepisternum with lower half brown and upper half yellow, laterotergite brown with posterior half yellowish, mediotergite brown, scutellum basally yellowish, apically brown. Thoracic setae all yellow. Wing with yellowish tinge and preapical very faint transverse brownish band reaching to M_2 , all veins yellowish including radial veins somewhat darker. Halter with stem and knob pale yellow. All coxae and femora yellow, except hind femur apically with narrow brown band, all tibiae, tarsi yellow but seem darker because of dense brown setae. Tibial setae brown, spurs yellowish. Abdomen with all tergites brown and sternites yellow. Abdominal vestiture yellow. Terminalia brown with gonocoxite medially and gonostylus anteriorly yellow. **Head.** Ocelli in a linear arrangement. Medial ocellus about twice smaller than laterals, which are separated from eye margins by less than their own diameter. Frontal furrow complete. Clypeus obovoid. Fourth flagellar segment about as long as wide, apical flagellar segment 2.5 times as long as wide basally. Flagellar segments with dense yellowish short setae. **Thorax.** Scutum densely covered with setae, with marginal and prescutellar setae stronger. Antepronotum with 6–7 strong and a number of weaker setae. Proepisternum with one very strong seta at anterior margin about 10 weaker setae. Anepisternum, katepisternum and anepimeron non-setose. Laterotergite with long fine setae on posterior half. Mediotergite non-setose. Scutellum with a row of marginal setae including two pairs remarkably stronger. **Wing.** Length 5.3–5.7 mm, length to width 2.3–2.8. All veins setose, except Sc , $sc-r$, R_s and extreme base of M_1 . Sc ending on C at level of furcation of posterior fork. R_{4+5} 3.3 times as long as R_1 . $r-m$ 1.47 times as long as $m-stem$. M_1 and M_2 apically convergent, apical third of both veins faint. M_4

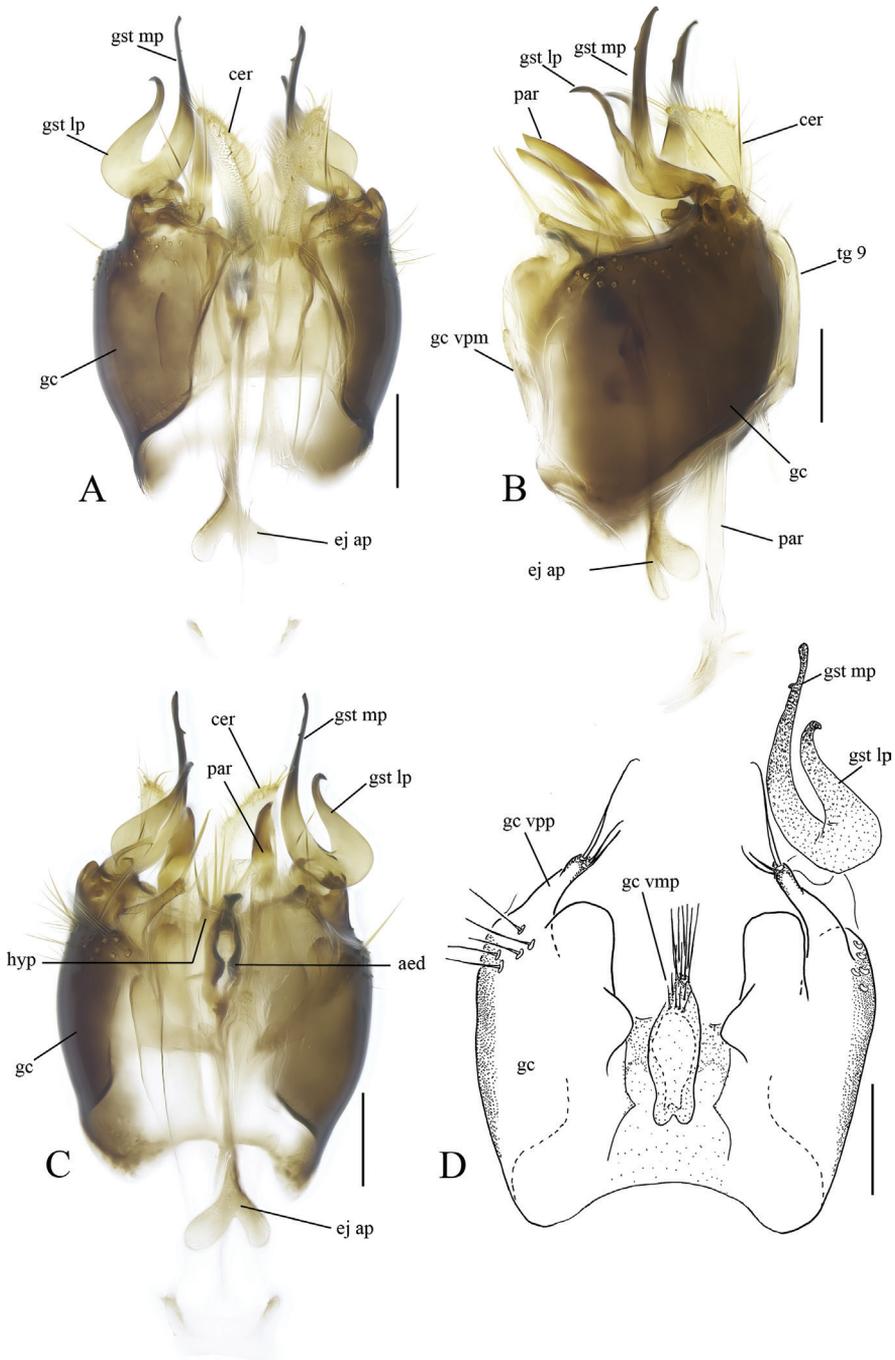


Figure 5. *Leia katae* sp. nov., male terminalia **A** dorsal view **B** lateral view **C** ventral view **D** gonocoxite and gonostylus, ventral view. Abbreviations: aed = aedeagus, cer = cercus, ej ap = ejaculatory apodeme, gc = gonocoxite, gc vmp = ventromedial process of gonocoxite, gc vpp = ventroposterior process of gonocoxite, gst lp = lateral prong of gonostylus, gst mp = medial prong of gonostylus, hyp = hypoproct, par = paramere, tg 9 = tergite IX. Scale bars: 0.2 mm.

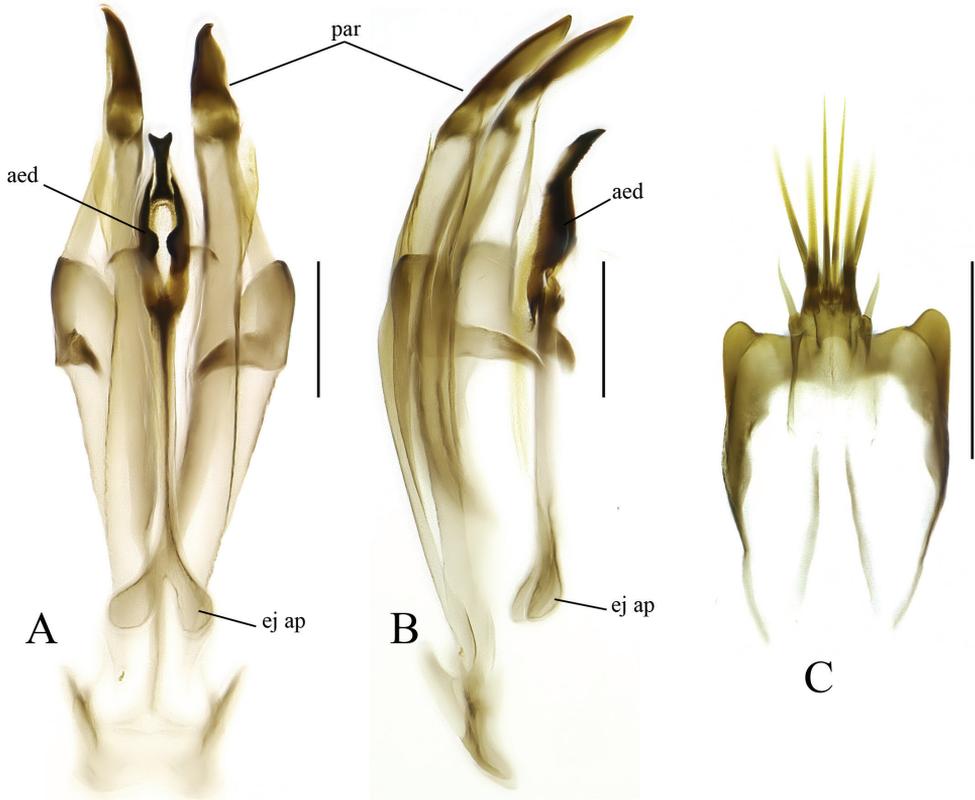


Figure 6. *Leia katae* sp. nov., male terminalia **A** aedeagal complex, ventral view **B** aedeagal complex, lateral view **C** hypoproct ventral view. Abbreviations: aed = aedeagus, ej ap = ejaculatory apodeme, par = paramere. Scale bars: 0.2 mm.

interrupted at base. *Rs* located distally of the anterior fork. **Legs.** Ratio of femur to tibia for fore, mid and hind legs: 1.16; 0.95; 0.86. Ratio of tibia to basitarsus for fore, mid and hind legs: 1.00; 1.66; 2.00. Fore tibia with a spur 2.95 times of tibial maximum width. Mid tibia with anterior spur 3.33 times and posterior spur 3.96 times of tibial maximum width. Hind tibia with anterior spur 3.33 times and posterior spur 4.58 times of tibial maximum width. **Terminalia** (Figs 5A–D, 6A–C). Gonocoxite with setae on apical fifth only. Ventromedial process of gonocoxite elongated ovoid with a row of long setae apically and an aggregation of shorter setae on apical fourth. Ventroposterior margin of gonocoxite drawn into a wide membranous non-setose medial lobe and a digitate more protruding lobe with one prominent and 2–3 weaker apical setae. Tergite 9 membranous, somewhat tapering, apically evenly rounded with apicocentral patch of short setae. Gonostylus bipartite: lateral prong shorter, convolute and apically hooked; medial prong longer, tapering with preapical small tooth at ventral margin. Aedeagus with sclerotized, cup-shaped apical portion, ejaculatory apodeme bilobed. Paramere about 1.6 times as long as aedeagus, bowed in lateral view, apically tapering, with ventral flange drawn out into a triangular membranous process in the middle;

anteriorly, parameres fused into a complex membranous structure with anterior concavity and well protruding lateral corners. Hypoproct with protruding apicolateral corners and medial part that bears a group of stout setae.

Female. Unknown.

Etymology. The species is named after my daughter Katariina (born 3 November 2000), an enthusiastic student of biology at the University of Tartu (Estonia). She participated in a trip to Georgia in 2017 that yielded several specimens of this study and she always insists we call her Kata.

Remarks. There are 166 *Leia* Meigen species known worldwide including 33 in the Palaearctic region (Polevoi and Salmela 2016). *Leia katae* sp. nov. differs from all known Palaearctic and Nearctic species by its peculiar structure of the gonostylus that is bipartite: medial prong long and slender with a preapical tooth, and lateral prong apically hooked, about 2/3 of the medial prong.

***Anatella metae* sp. nov.**

<http://zoobank.org/7CD91319-0672-4DC8-9CF6-7140ADF1F13E>
Figs 3B, 7A–G

Type material. Holotype. Male, Georgia, Mtskhetha-Mthianethi, Saguramo north of Tbilisi, 41°53.07'N, 44°46.78'E, 920 m a.s.l., 15.v.2013, sweeping, leg. O. Kurina [see Table 1: MM-12] (mounted from alcohol, IZBE). **Paratype.** Male, same as holotype (mounted from alcohol, IZBE).

Diagnosis. *Anatella metae* sp. nov. is characterized by the presence of a strong posteroventral fringe on mid femora with a row of strong setae, absence of anterior spur on mid tibia, absence of setae on hind coxa basally. The new species is closest to *A. atlanticiliata* Chandler and Ribeiro but differs in characters of the male terminalia: ventral branch of the gonostylus about twice as long as the dorsal branch, dorsal branch of the gonostylus with long and slender medial prong, medial branch of the gonostylus slender and apically hooked.

Description. Male. Body length 2.7–2.9 mm (n = 2). **Coloration.** Head with vertex, frons, face and clypeus brown, mouthparts including palpus pale yellow. Scape, pedicel and base of first flagellomere yellow, rest of flagellum light brown. Thorax with scutum and lateral parts light brown. Thoracic setae yellowish to brown, with thicker setae darker than finer ones. Wing hyaline, unmarked with yellowish tinge. Halter with stem and knob pale yellow. Legs yellow, tarsi yellow but seem darker because of dense brown setae. All setae on legs brown, tibial spurs yellowish. Abdomen mainly brown with first two segments somewhat lighter. Abdominal vestiture brown. Terminalia light brown. **Head.** Ocelli two, very close to eye margins, with dark brown patches at anterior margin. Frontal furrow complete. Clypeus rectangular. Fourth flagellar segment about 2.5 times as long as wide, apical flagellar segment 2.5 times as long as wide basally. Flagellar segments with dense whitish setae about one third of segments' width. **Thorax.** Scutum covered with setae, with marginal and prescutellar setae stronger. Anteprepronotum with 2 strong and 10–15 weaker setae. Proepisternum with two strong and 2–3 weaker setae.

Anepisternum, katepisternum and anepimeron non-setose. Laterotergite with about 10 setae on upper half. Mediotergite non-setose. Scutellum with about 10 setae on upper surface. **Wing.** Length 2.39–2.70 mm, length to width 2.75–2.90. *C*, *R*, *R*₁, *R*₄₊₅ setose, all other veins non-setose. *C* produced halfway between *R*₄₊₅ and *M*₁. *r-m* about as long as *m-stem*. Posterior fork at the level of anterior fork or slightly before. *CuA* slightly sinuous. **Legs.** Ratio of femur to tibia for fore, mid and hind legs: 1.08–1.17; 0.97–1.00; 0.65–0.90. Ratio of tibia to basitarsus for fore, mid and hind legs: 0.96–1.00; 1.21–1.28; 1.41–1.77. Fore tibia with a spur 2.00 times of tibial maximum width. Mid tibia with anterior spur absent and posterior spur 2.27–2.40 times of tibial maximum width. Hind tibia with anterior spur 2.71–3.33 times and posterior spur 3.93–4.66 times of tibial maximum width. Strong posteroventral fringe of mid femora with row of strong setae. Hind coxa without basal setae. **Terminalia** (Fig. 7A–G). Gonocoxite ventrally with (1) V-shaped wide incision anteriorly, (2) posteromedial non-setose tapering projection with deep slit, and (3) posterolateral large apically setose lobes. Gonostylus divided into four branches (Fig. 7F–G). The ventral branch of the gonostylus elongated digitate, apical half setose and with one strong seta apically deviating from other setosity. Dorsal branch of the gonostylus about half length of the ventral branch, divided into two prongs: medial finger like bare prong and lateral large apically and basally setose prong. Medial branch of the gonostylus slightly shorter than dorsal branch, slender, apically hooked. Internal branch of the gonostylus membranous, convolute with anterior lamellae.

Etymology. The species is named after my daughter Liisa-Meta (born 9 October 2004), a keen naturalist who also participated in a trip to Georgia in 2017.

Remarks. There are about 50 *Anatella* Winnertz species known in the Holarctic region (cf. Fungus Gnats Online Authors 2021), the vast majority of which are adequately described and figured. In having posteroventral fringe of mid femora with strong setae and absence of anterior spur of mid tibia, *A. metae* sp. nov. resembles *A. atlanticiliata* Chandler & Ribeiro, 1995 known only from Madeira Island. Also, the male terminalia of both species share the general outline (cf. Chandler and Ribeiro 1995: fig. 27). However, *A. metae* differs in the structure of the gonostylus as follows: (1) ventral branch of the gonostylus twice as long as dorsal branch (only somewhat longer in *A. atlanticiliata*), (2) dorsal branch of the gonostylus with medial prong long, anchored to lateral prong basally (medial prong short, anchored to lateral prong subapically in *A. atlanticiliata*), and (3) medial branch of gonostylus slender, apically hooked (medial branch stout, slightly curved in *A. atlanticiliata*).

List of fungus gnat species of Georgia

Family Bolitophilidae

1. *Bolitophila (Bolitophila) austriaca* (Mayer, 1950)

Material. 2♀♀, SJ-7; 4♀♀, SJ-8. Total: 6♀♀.

Distribution in Georgia. Samtskhe-Javakheti.

General distribution. Palaearctic.

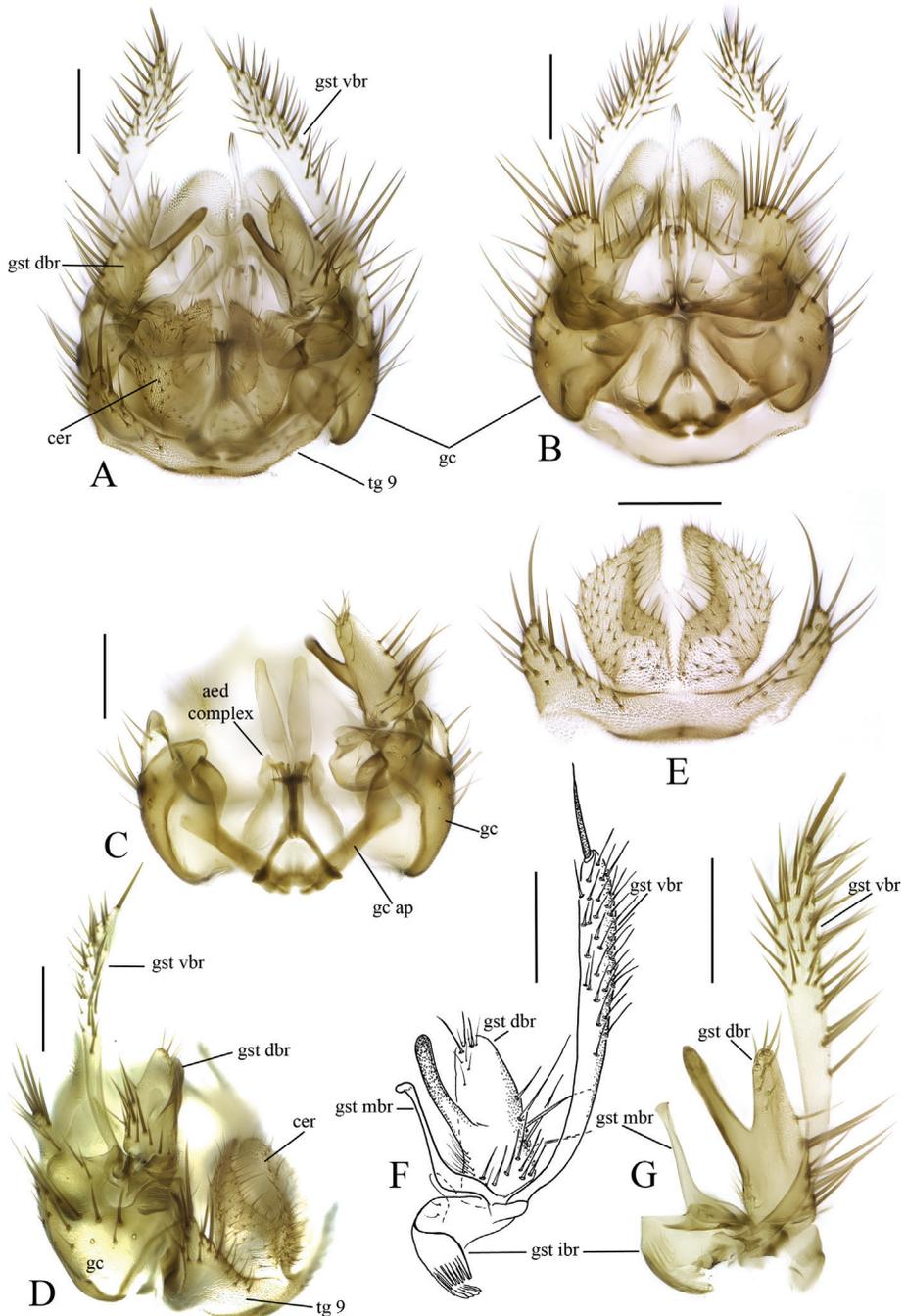


Figure 7. *Anateila metae* sp. nov. male terminalia **A** dorsal view **B** ventral view **C** dorsal view, cerci and tergite IX removed **D** lateral view **E** cerci and tergite IX, dorsal view **F, G** gonostylus, internal views from different angles. Abbreviations: aed complex – aedeagal complex, cer = cercus, gc = gonocoxite, gc ap = gonocoxal apodeme, gst dbr = dorsal branch of gonostylus, gst ibr = internal branch of gonostylus, gst mbr = medial branch of gonostylus, gst vbr = ventral branch of gonostylus, tg 9 = tergite IX. Scale bars: 0.1 mm.

2. *Bolitophila (Bolitophila) basicornis* (Mayer, 1951)

Fig. 9A

Material. 1♀, MM-1. Total: 1♀.**Distribution in Georgia.** Mtskhetha-Mthianethi.**General distribution.** Palaearctic.**3. *Bolitophila (Bolitophila) cinerea* Meigen, 1818****Material.** 1♂, MM-12. Total: 1♂.**Distribution in Georgia.** Mtskhetha-Mthianethi.**General distribution.** Palaearctic.**4. *Bolitophila (Cliopisa) fumida* Edwards, 1941****Material.** 1♂, SJ-9. Total: 1♂.**Distribution in Georgia.** Samtskhe-Javakheti.**General distribution.** Palaearctic.**Family Diadocidiidae****5. *Diadocidia (Adidocidia) valida* Mik, 1874****Material.** 1♀, SJ-1; 1♂, SK-1. Total: 1♂ 1♀.**Distribution in Georgia.** Shida Kartli, Samtskhe-Javakheti.**General distribution.** Western Palaearctic.**Remarks.** In Transcaucasia recorded from Azerbaijan (Zaitzev 1994).**6. *Diadocidia (Diadocidia) ferruginosa* (Meigen, 1830)****Material.** 1♂, SZS-3 (ZFMK); 2♂♂ 1♀, I-6; 2♂♂, I-9; 1♂, I-11; 1♂, A-1; 1♂, SJ-4; 1♂, SJ-7; 1♂, SJ-8; 4♂♂, SK-1. Total: 14♂♂ 1♀.**Distribution in Georgia.** Samegrelo-Zemo Svanethi, Shida Kartli, Imereti, Samtskhe-Javakheti.**General distribution.** Holarctic.

7. *Diadocidia (Diadocidia) spinosula* Tollet, 1948

Fig. 8G

Material. 1♂, SZS-3 (IZBE); 2♂♂, SK-1; 2♂♂, SJ-1 (ZFMK); 1♂, SJ-2 (IUTG); 1♂ 1♀, SJ-4; 2♂♂, SJ-7; 4♂♂ 3♀♀, SJ-9. Total: 13♂♂ 4♀♀.

Distribution in Georgia. Samegrelo-Zemo Svanethi, Shida Kartli, Samtskhe-Javakheti.

General distribution. Palaearctic.

Family Ditomyiidae

8. *Ditomyia fasciata* (Meigen, 1818)

Material. 2♂♂, I-9. Total: 2♂♂.

Distribution in Georgia. Imereti.

General distribution. Palaearctic.

Remarks. In Transcaucasia recorded from Azerbaijan (Zaitzev 1994).

9. *Symmerus annulatus* (Meigen, 1830)

Fig. 8A

Material. 6♂♂, SZS-3 (2♂♂ ZFMK, 2♂♂ IUTG, 2♂♂ IZBE); 1♂, A-1; 1♂ 1♀, A-3; 1♀, I-3 (18.v–1.vi.2013); 1♂, I-6; 1♂ 1♀, I-9; 1♂, I-10; 2♂♂, I-11; 1♂, I-12; 4♂♂, SJ-1 (2♂♂ ZFMK, 1♂ IUTG, 1♂ IZBE); 2♂♂, MM-12. Total: 20♂♂ 3♀♀.

Distribution in Georgia. Samegrelo-Zemo Svanethi, Adjara, Imereti, Samtskhe-Javakheti, Mtskhetha-Mthianethi.

General distribution. Palaearctic.

Remarks. In Transcaucasia recorded from Azerbaijan (Zaitzev 1994).

Family Keroplatidae

Subfamily Macrocerinae

10. *Macrocera centralis* Meigen, 1818

Material. 2♂♂, KK-1; 1♀, MM-14. Total: 2♂♂ 1♀.

Distribution in Georgia. Kvemo Kartli, Mtskhetha-Mthianethi.

General distribution. Palaearctic.

11. *Macrocera crassicornis* Winnertz, 1863

Material. 1♂, A-1. Total: 1♂.

Distribution in Georgia. Adjara.

General distribution. Palaearctic.

Remarks. In Transcaucasia recorded from Armenia (Zaitzev 1994).

12. *Macrocera fasciata* Meigen, 1804

Material. 1♂, SZS-3 (ZFMK). Total: 1♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi.

General distribution. Palaearctic.

13. *Macrocera fastuosa* Loew, 1869

Material. 2♂♂, A-1; 3♂♂, A-7. Total: 5♂♂.

Distribution in Georgia. Adjara.

General distribution. Europe.

14. *Macrocera lutea* Meigen, 1804

Material. 1♂, A-7; 1♂, KK-1. Total: 2♂♂.

Distribution in Georgia. Adjara, Kvemo Kartli.

General distribution. Palaearctic.

Remarks. In Transcaucasia recorded from Armenia (Joost and Plassmann 1985).

15. *Macrocera phalerata* Meigen, 1818

Material. 1♀, A-1; 1♀, A-6; 1♀, A-7. Total: 3♀♀.

Distribution in Georgia. Adjara.

General distribution. Palaearctic.

16. *Macrocera stigma* Curtis, 1837

Material. 1♂ 1♀, A-1; 4♂♂, A-7; 11♂♂ 3♀♀, I-6; 2♂♂, I-11; Total: 18♂♂ 8♀♀.

Distribution in Georgia. Adjara, Imereti.

General distribution. Palaearctic.

17. *Macrocera stigmoides* Edwards, 1925

Material. 44♂♂ 14♀♀, KK-1. Total: 44♂♂ 14♀♀.

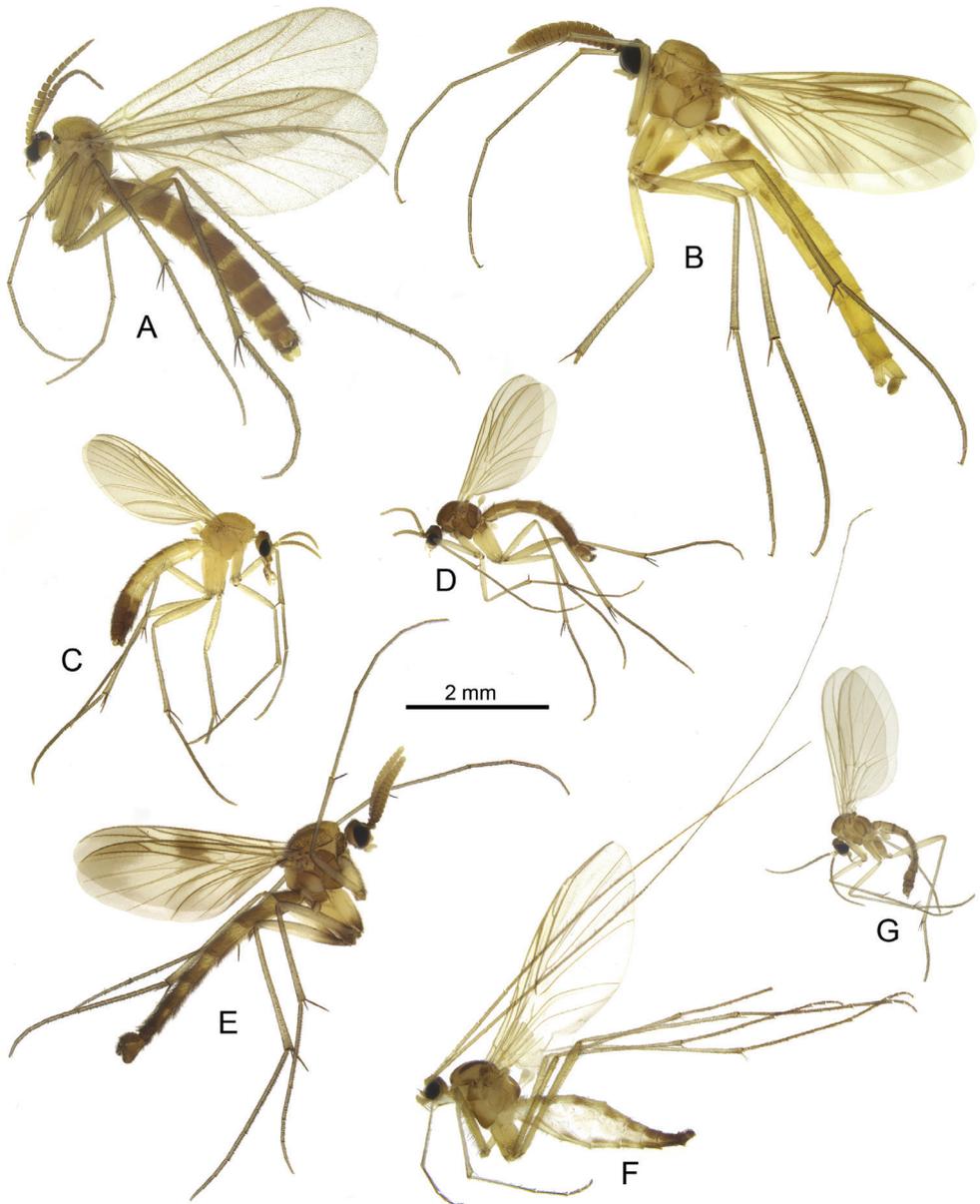
Distribution in Georgia. Kvemo Kartli.**General distribution.** Palearctic.

Figure 8. Habitus of Georgian fungus gnats of the families Ditomyiidae (**A**), Keroplatidae (**B–F**) and Diadocidiidae (**G**) **A** *Symmerus annulatus* (Meigen, 1830) **B** *Keroplatus testaceus* Dalman, 1818 **C** *Macrorrhyncha flava* Winnertz, 1846 **D** *Pyratula zonata* (Zetterstedt, 1855) **E** *Cerotelion racovitzai* Matile & Burghle-Balacesco, 1969 **F** *Macrocera vittata* Meigen, 1830 **G** *Diadocidia (Diadocidia) spinosula* Tolle, 1948.

18. *Macrocera vittata* Meigen, 1830

Fig. 8F

Material. 3♂♂, SJ-8; 2♂♂, MM-13; 1♂, MM-14. Total: 6♂♂.**Distribution in Georgia.** Samtskhe-Javakheti, Mtskhetha-Mthianethi.**General distribution.** Palaearctic.**Subfamily Keroplatinae****Tribe Keroplatini****19. *Cerotelion racovitzai* Matile & Burghele-Balacesco, 1969**

Fig. 8E

Material. 6♂♂, A-3; 1♂, A-5; 3♂♂, A-7; 14♂♂ 1♀, I-6; 1♀, I-8; 3♂♂, I-9; 1♂, I-10; 2♂♂, I-11; 2♂♂, I-14; 1♂, I-15; 1♀, MM-7; 3♂♂, MM-8. Total: 36♂♂ 3♀♀.**Distribution in Georgia.** Adjara, Imereti, Mtskhetha-Mthianethi.**General distribution.** Western Palaearctic.**Remarks.** In Transcaucasia recorded from Azerbaijan (Zaitzev 1994).**20. *Cerotelion striatum* (Gmelin, 1790)****Material.** 1♂, I-4. Total: 1♂.**Distribution in Georgia.** Imereti.**General distribution.** Western Palaearctic.**Remarks.** In Transcaucasia recorded from Azerbaijan (Zaitzev 1994).**21. *Keroplatus testaceus* Dalman, 1818**

Fig. 8B

Material. 2♂♂, I-6. Total: 2♂♂.**Distribution in Georgia.** Imereti.**General distribution.** Palaearctic.**Remarks.** In Transcaucasia recorded from Azerbaijan (Zaitzev 1994).**Tribe Orfeliini****22. *Isoneuromyia semirufa* (Meigen, 1818)****Georgian source.** Zaitzev 1994: 82 (from Adjara).**Distribution in Georgia.** Adjara.**General distribution.** Holarctic.

Remarks. Zaitzev (1994) studied a single male specimen from Batumi collected in 1908. The black colour of the body as noted by Zaitzev (1994) for the studied material is characteristic to *I. semirufa*. The other European species have the thorax yellow to orange with or without longitudinal stripes; also, see the next species and discussion by Mantič and Ševčík (2017).

23. *Isoneuromyia czernyi* (Strobl, 1909)

Material. 1♂, A-1; 1♂, A-5; 1♀, A-7; 1♂ 1♀, I-6. Total: 3♂♂ 2♀♀.

Distribution in Georgia. Adjara, Imereti.

General distribution. Europe.

Remarks. All studied Georgian specimens correspond to the diagnosis including figures provided recently by Mantič and Ševčík (2017), i.e. (1) scutum with longitudinal dark stripes which are, however, almost fused in female specimens (thorax all dark brown to blackish in *I. semirufa*), (2) wing with a distinct subapical band (anteriorly infuscated in *I. semirufa*) and (3) male terminalia with medial tooth of the gonostylus larger than the lateral one (both in subequal size in *I. semirufa*). *I. czernyi* is a rare European species known from the Mediterranean region and Slovakia (Mantič and Ševčík 2017).

24. *Macrorrhyncha flava* Winnertz, 1846

Fig. 8C

Material. 2♂♂, K-4; 7♂♂ 3♀♀, K-5. Total: 9♂♂ 3♀♀.

Distribution in Georgia. Kakheti.

General distribution. Europe.

25. *Monocentrotia lundstromi* Edwards, 1925

Material. 1♂, SZS-3 (IZBE). Total: 1♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi.

General distribution. Europe.

26. *Neoplatyura modesta* (Winnertz, 1863)

Material. 1♂, K-2; 1♀, K-3. Total: 1♂ 1♀.

Distribution in Georgia. Kakheti.

General distribution. Europe.

27. *Neoplatyura nigricauda* (Strobl, 1893)**Material.** 1♂, SZS-1. Total: 1♂.**Distribution in Georgia.** Samegrelo-Zemo Svanethi.**General distribution.** Europe.**28. *Orfelia discoloria* (Meigen, 1818)****Material.** 7♂♂, SZS-3(2♂♂ ZFMK, 3♂♂ IUTG, 2♂♂ IZBE); 1♂, A-3; 1♂, SJ-1 (ZFMK); 1♂, MM-7. Total: 10♂♂.**Distribution in Georgia.** Samegrelo-Zemo Svanethi, Adjara, Samtskhe-Javakheti, Mtskhetha-Mthianethi.**General distribution.** Holarctic.**29. *Orfelia georgica* Kurina & Jürgenstein, 2013**

Fig. 9B

Georgian source. Kurina and Jürgenstein 2013: 23 (fig. 2a–d)**Type material.** 1♂, I-10 (holotype); 1♂, I-9 (paratype); 10♂♂, I-6 (paratypes). Additional material. 12♂♂ 4♀♀, A-1; 34♂♂, A-3; 7♂♂, A-5; 76♂♂, A-7; 1♂, A-8; 5♂♂, I-6; 12♂♂, I-11; 1♂, I-12; 5♂♂, SJ-1; 1♂, SJ-2 (ZFMK); 4♂♂, K-4; 1♂, K-6. Total: 171♂♂ 4♀♀.**Distribution in Georgia.** Adjara, Imereti, Samtskhe-Javakheti, Kakheti.**General distribution.** Georgia.**30. *Orfelia trifida* Kurina & Jürgenstein, 2013****Georgian source.** Kurina and Jürgenstein 2013: 24 (fig. 3a–d).**Type material.** 1♂, I-5 (holotype). Additional material. 35♂♂, SZS-3 (12♂♂ ZFMK, 12♂♂ IUTG, 11♂♂ IZBE). Total: 36♂♂.**Distribution in Georgia.** Samegrelo-Zemo Svanethi, Imereti.**General distribution.** Georgia.**31. *Pyratula perpusilla* (Edwards, 1913)****Material.** 16♂♂, SJ-4. Total: 16♂♂.**Distribution in Georgia.** Samtskhe-Javakheti.**General distribution.** Europe.**Remarks.** The *P. perpusilla* species-group includes at least seven closely related species in Europe, separable only by small details of male terminalia (Chandler and Blasco-

Zumeta 2001). The studied Georgian specimens have the ventroapical margin of the gonocoxite with setose lobe (= without asetose protuberance) that is shared by three species, viz. *P. perpusilla*, *P. alpicola* Chandler, 2001 and *P. oracula* Chandler, 1994. The aedeagal complex is considerably short (elongate in *P. oracula*) and the aedeagal sheath is interrupted medially on the ventral side (with complete bridge in *P. alpicola*). However, the Georgian specimens are slightly different from *P. perpusilla* as figured by Chandler and Blasco-Zumeta (2001: Figs 9–12) in having the distal dorsal corner of the aedeagal sheath with a blunt protuberance that is otherwise typical to *P. alpicola*. The material was compared to that of *P. alpicola* and *P. oracula* from North Italy (cf. Kurina 2008b) and, pending a further molecular study of this species-group, is considered to be conspecific with *P. perpusilla*.

32. *Pyratula zonata* (Zetterstedt, 1855)

Fig. 8D

Material. 2♂♂, A-5; 1♂, I-6; 2♂♂, I-11; 2♂♂, SJ-1 (1♂ IUTG, 1♂ IZBE); 1♂ 1♀, SJ-2 (ZFMK); 1♂, SJ-3; 4♂♂, MM-11. Total: 13♂♂ 1♀.

Distribution in Georgia. Adjara, Imereti, Samtskhe-Javakheti, Mtskhetha-Mthianethi.

General distribution. Europe.

33. *Urytalpa dorsalis* (Staeger, 1840)

Material. 1♂, SZS-3 (IZBE); 3♂♂, SJ-1 (1♂ ZFMK, 1♂ IUTG, 1♂ IZBE); 1♂ 2♀♀, SJ-2 (1♂ 1♀ ZFMK, 1♀ IUTG). Total: 5♂♂ 2♀♀.

Distribution in Georgia. Samegrelo-Zemo Svanethi, Samtskhe-Javakheti.

General distribution. Europe.

Subfamily Platyurinae

34. *Platyura marginata* Meigen 1804

Material. 1♂, K-6. Total: 1♂.

Distribution in Georgia. Kakheti.

General distribution. Palaearctic.

Family Mycetophilidae

Subfamily Mycomyinae

35. *Mycomya (Cymomya) circumdata* (Staeger, 1840)

Material. 2♂♂, SZS-3 (1♂ ZFMK, 1♂ IZBE). Total: 2♂♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi.

General distribution. Palaearctic.

36. *Mycomya (Neomycomya) fimbriata* (Meigen, 1818)

Material. 1♂, A-7. Total: 1♂.

Distribution in Georgia. Adjara.

General distribution. Holarctic, extending to the Oriental region.

37. *Mycomya (Mycomya) bialorussica* Landrock, 1925

Material. 1♂, SZS-3 (ZFMK). Total: 1♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi.

General distribution. Europe.

38. *Mycomya (Mycomya) cinerascens* (Macquart, 1826)

Material. 1♂, SJ-8. Total: 1♂.

Distribution in Georgia. Samtskhe-Javakheti.

General distribution. Holarctic, extending to the Oriental region.

39. *Mycomya (Mycomya) flavicollis* (Zetterstedt, 1852)

Material. 6♂♂, A-5; 1♂, A-7; 4♂♂, I-6; 2♂♂, SJ-3; 29♂♂, SJ-4; 1♂, SJ-9; 1♂, MM-7; 2♂♂, MM-14; 1♂, K-6. Total: 47♂♂.

Distribution in Georgia. Adjara, Imereti, Samtskhe-Javakheti, Mtskhetha-Mthianethi, Kakheti.

General distribution. Western Palaearctic.

Remarks. In Transcaucasia recorded from Azerbaijan (Zaitzev 1994).

40. *Mycomya (Mycomya) griseovittata* (Zetterstedt, 1852)

Material. 1♂, SZS-3 (ZFMK). Total: 1♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi.

General distribution. Holarctic.

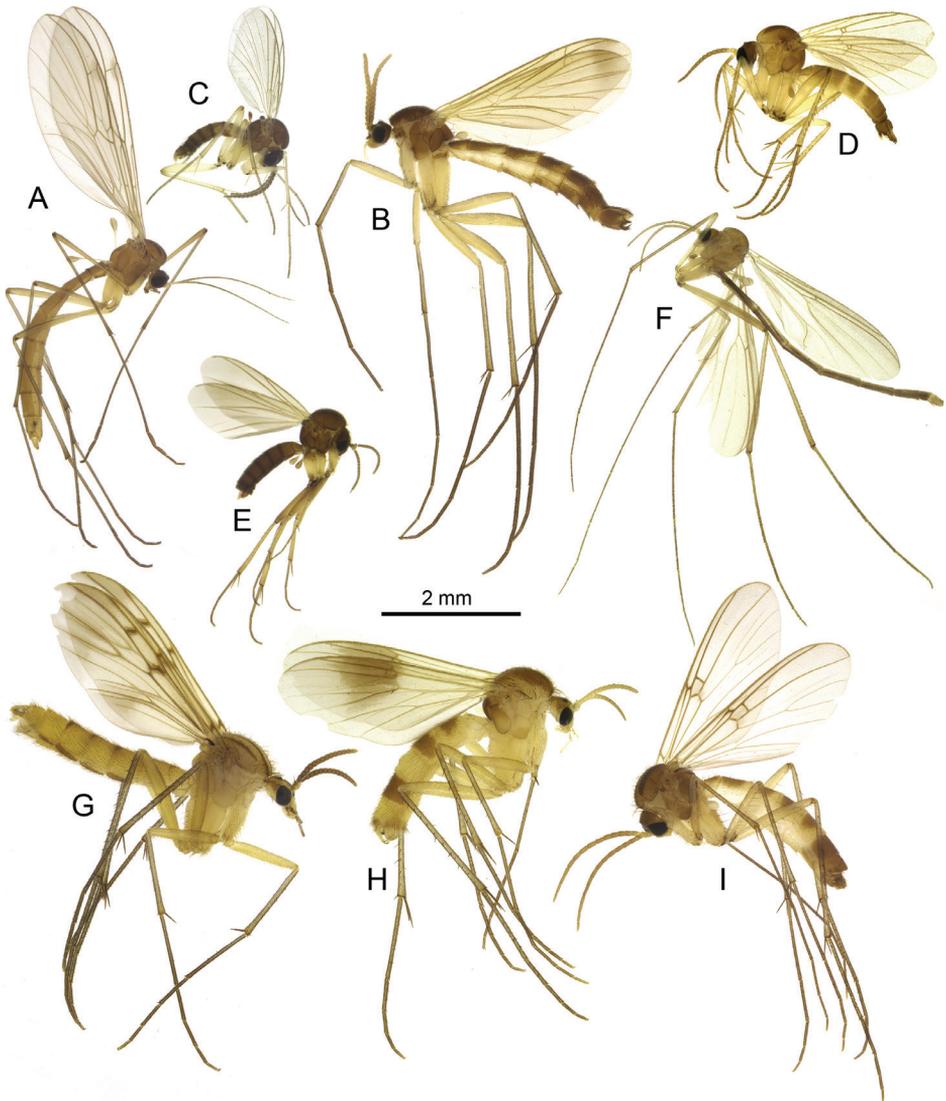


Figure 9. Habitus of Georgian fungus gnats of the families Bolitophilidae (**A**), Keroplatidae (**B**) and Mycetophilidae (**C–I**) **A** *Bolitophila (Bolitophila) basicornis* (Mayer, 1951) **B** *Orfelia georgica* Kurina & Jürgenstein, 2013 **C** *Acnemia nitidicollis* (Meigen, 1818) **D** *Monoclona rufilatera* (Walker, 1837) **E** *Azana (Azana) anomala* (Staeger, 1840) **F** *Phthinia byrcanica* Zaitzev, 1984 **G** *Neoempheria striata* (Meigen, 1818) **H** *Neoempheria brevilineata* Okada, 1939 **I** *Mycomya (Mycomya) marginata* (Meigen, 1818).

41. *Mycomya (Mycomya) marginata* (Meigen, 1818)

Fig. 9I

Material. 3♂♂, I-6; 1♂, I-17; 1♂, SJ-3; 2♂♂, MM-8; 1♂, MM-12. Total: 8♂♂.

Distribution in Georgia. Imereti, Samtskhe-Javakheti, Mtskhetha-Mthianethi.

General distribution. Palearctic.

42. *Mycomya (Mycomya) occultans* (Winnertz, 1863)

Material. 1♂, SJ-4. Total: 1♂.

Distribution in Georgia. Samtskhe-Javakheti.

General distribution. Palaearctic, extending to the Oriental region.

43. *Mycomya (Mycomya) tenuis* (Walker, 1856)

Material. 1♂, A-7; 1♂, SJ-4. Total: 2♂♂.

Distribution in Georgia. Adjara, Samtskhe-Javakheti.

General distribution. Palaearctic.

44. *Mycomya (Mycomya) tridens* (Lundström, 1911)

Material. 1♂, SZS-4 (ZFMK). Total: 1♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi.

General distribution. Europe.

45. *Mycomya (Mycomya) tumida* (Winnertz, 1863)

Material. 1♂, SZS-4 (ZFMK); 1♂, I-11. Total: 2♂♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi, Imereti.

General distribution. Palaearctic.

Remarks. In Transcaucasia recorded from Azerbaijan (Zaitzev 1994).

46. *Mycomya (Mycomya) winnertzi* (Dziedzicki, 1885)

Material. 1♂, SK-1; 1♂, SJ-8. Total: 2♂♂.

Distribution in Georgia. Shida Kartli, Samtskhe-Javakheti.

General distribution. Palaearctic, extending to the Oriental region.

47. *Mycomya (Mycomyopsis) affinis* (Staeger, 1840)

Material. 3♂♂, K-5; 1♂, K-6. Total: 4♂♂.

Distribution in Georgia. Kakheti.

General distribution. Palaearctic.

48. *Mycomya (Mycomyopsis) trilineata* (Zetterstedt, 1838)

Material. 5♂♂, K-6. Total: 5♂♂.

Distribution in Georgia. Kakheti.

General distribution. Palaearctic.

49. *Neoempheria brevilineata* Okada, 1939

Figs 9H, 10A–F

Material. 1♂, A-7; 2♂♂, I-6. Total: 3♂♂.

Distribution in Georgia. Adjara, Imereti.

General distribution. Palaearctic.

Remarks. The species description from Hokkaido (Japan) by Okada was supplemented by a black and white figure of the general habitus including wing venation and pattern (Okada 1939: plate XVI, fig. 3). The Georgian material was compared to that from Japan (1♂, JAPAN, Honshu, Ishikawa Prefecture, Kanazawa City, Kakuma Campus, window trap, 14.vii-21.vii.2006, Indah, T. leg.; Kjærandsen J. det., TSZD-JKJ-111335) and the small differences in male terminalia are considered to be within intraspecific variation. Figures of the male terminalia (Fig. 10A–F) are provided for the first time for the species.

50. *Neoempheria striata* (Meigen, 1818)

Fig. 9G

Material. 1♀, I-6; 1♂ 1♀, I-14. Total: 1♂ 2♀♀.

Distribution in Georgia. Imereti.

General distribution. Palaearctic.

Subfamily Sciophilinae**51. *Acnemia amoena* Winnertz, 1863**

Material. 1♂, I-6. Total: 1♂.

Distribution in Georgia. Imereti.

General distribution. Palaearctic.

52. *Acnemia hyrcanica* Zaitzev, 1984

Material. 1♂, SZS-3 (ZFMK); 1♂, I-6. Total: 2♂♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi, Imereti.

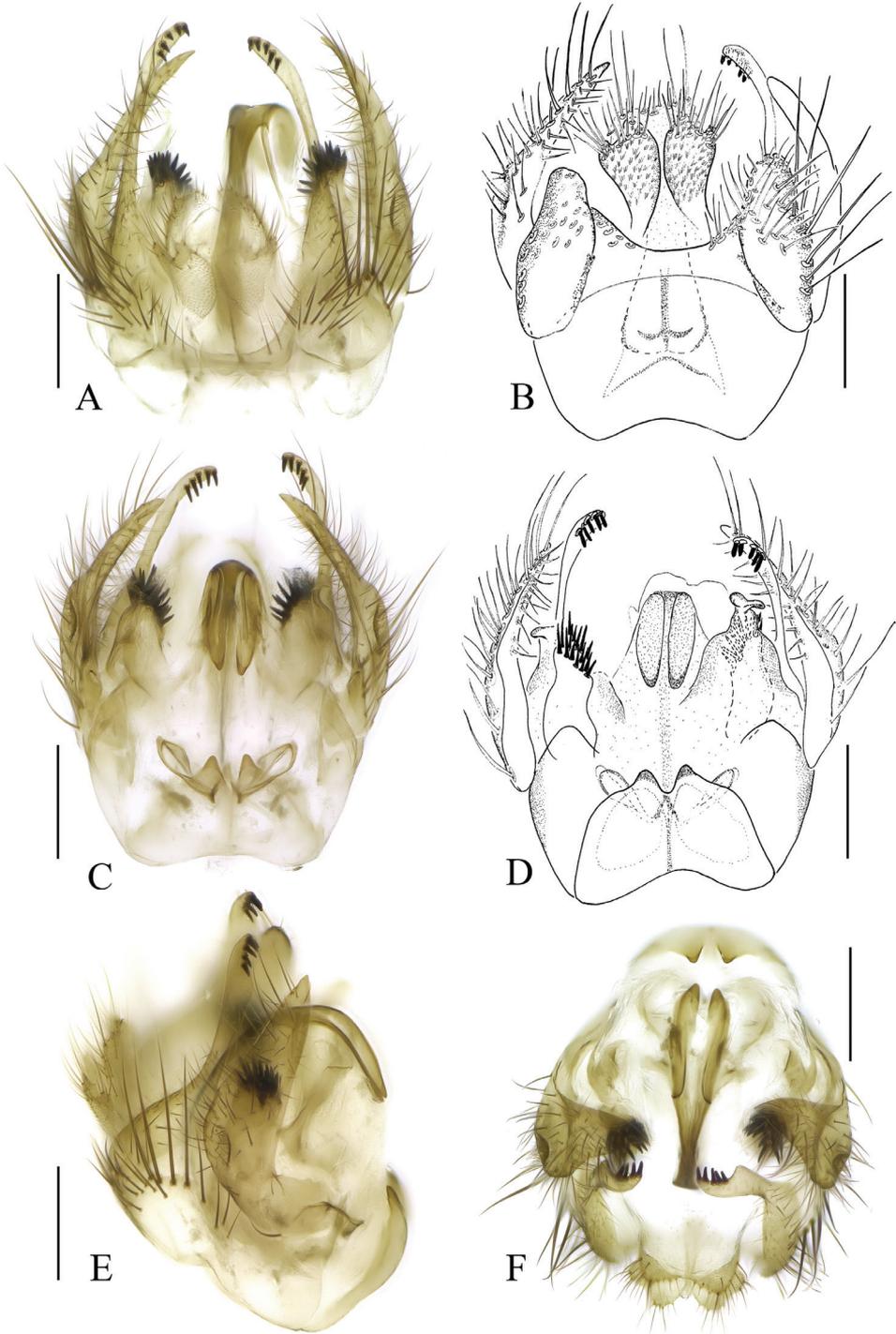


Figure 10. *Neompheria brevilineata* Okada, 1939, male terminalia **A, B**, dorsal view **C, D** ventral view **E** lateral view **F** posterior view. Scale bar: 0.2 mm.

General distribution. Caucasia.

Remarks. Recorded earlier from North Caucasus and Azerbaijan (Zaitzev 1994).

53. *Acnemia nitidicollis* (Meigen, 1818)

Fig. 9C

Material. 4♂♂, SZS-3 (2♂♂ ZFMK, 1♂ IUTG, 1♂ IZBE); 2♂♂, A-3; 2♂♂, A-7; 3♂♂ 1♀, K-4; 1♂, K-5; 1♂, K-6. Total: 13♂♂ 1♀.

Distribution in Georgia. Samegrelo-Zemo Svanethi, Adjara, Kakheti.

General distribution. Palaearctic.

54. *Allocotocera pulchella* (Curtis, 1837)

Fig. 11H

Material. 1♂, SJ-2 (ZFMK). Total: 1♂.

Distribution in Georgia. Samtskhe-Javakheti.

General distribution. Holarctic.

55. *Anaclileia adjarica* Kurina, 2018

Georgian source. Kurina 2018: 156 (figs 2–5).

Type material. 1♂, A-1 (holotype); 3♂♂, A-1 (paratypes); 3♂♂ 3♀♀, A-3 (paratypes); 1♂, A-7 (paratype). Total: 8♂♂ 3♀♀.

Distribution in Georgia. Adjara.

General distribution. Georgia.

Remarks. The species was recently described from material collected from Mtirala and Kintrishi National Parks in Adjara (Kurina 2018)

56. *Azana (Azana) anomala* (Staeger, 1840)

Fig. 9E

Material. 1♀, SJ-3. Total: 1♀.

Distribution in Georgia. Samtskhe-Javakheti.

General distribution. Europe.

57. *Azana (Jugazana) nigricoxa* Strobl, 1898

Material. 1♂, I-11. Total: 1♂.

Distribution in Georgia. Imereti.

General distribution. Europe.

58. *Megalopelma nigroclavatum* (Strobl, 1910)

Fig. 11F

Material. 2♂♂, I-6. Total: 2♂♂.

Distribution in Georgia. Imereti.

General distribution. Holarctic.

59. *Monoclona rufilatera* (Walker, 1837)

Fig. 9D

Material. 3♂♂, I-6; 1♂, SK-1. Total: 4♂♂.

Distribution in Georgia. Imereti, Shida Kartli.

General distribution. Holarctic.

Remarks. In Transcaucasia recorded from Azerbaijan (Zaitzev 1994).

60. *Neuratelia caucasica* Zaitzev, 1994

Georgian source. Kurina et al. 2015: 116 (figs 11, 12, 16).

Material. 1♀, SZS-3 (IZBE); 2♀♀, SZS-4 (1♀ ZFMK, 1♀ IUTG); 3♂♂ 4♀♀, A-3; 1♂ 2♀♀, A-7; 2♂♂ 10♀♀, I-6; 1♂ 1♀, I-9; 2♂♂ 2♀♀, SK-1; 1♂, SJ-1 (IZBE); 4♂♂ 1♀, SJ-2 (2♂♂ ZFMK, 1♂ 1♀ IUTG, 1♂ IZBE); 2♂♂ 1♀, SJ-3; 1♂, KK-1. Total: 17♂♂ 24♀♀.

Distribution in Georgia. Samegrelo-Zemo Svanethi, Adjara, Imereti, Shida Kartli, Samtskhe-Javakheti, Kvemo Kartli.

General distribution. Caucasia: Russia (Krasnodarskiy region), Georgia.

61. *Phthinia hyrcanica* Zaitzev, 1984

Fig. 9F

Material. 1♂, MM-8; 1♂, K-4. Total: 2♂♂.

Distribution in Georgia. Mtskhetha-Mthianethi, Kakheti.

General distribution. Caucasia.

Remarks. Known only from type locality in Azerbaijan (Zaitzev 1994).

62. *Polylepta zonata* Zetterstedt, 1852

Material. 1♂, A-5. Total: 1♂.

Distribution in Georgia. Adjara.

General distribution. Europe, with scattered distribution (Kurina 2003, Chandler 2013).

63. *Sciophila fenestella* Curtis, 1837

Material. 1♂, I-6. Total: 1♂.

Distribution in Georgia. Imereti.

General distribution. Holarctic.

64. *Sciophila georgei* sp. nov.

Material. See in species description above.

Distribution in Georgia. Kakheti.

General distribution. Georgia.

65. *Sciophila nitens* (Winnertz, 1863)

Material. 1♂, SZS-3 (ZFMK); 1♂, SJ-1 (IZBE); 1♂, SJ-2 (IUTG). Total: 3♂♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi, Samtskhe-Javakheti.

General distribution. Holarctic.

Remarks. In Europe recorded from mountain areas (Kurina 2004, 2008b).

66. *Sciophila thoracica* Staeger, 1840

Material. 1♂, SZS-3 (IZBE); 1♂, SJ-2 (ZFMK). Total: 2♂♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi, Samtskhe-Javakheti.

General distribution. Holarctic.

67. *Sytemna morosa* Winnertz, 1863

Material. 1♂, I-6; 1♂, I-9. Total: 2♂♂.

Distribution in Georgia. Imereti.

General distribution. Europe.

Subfamily Gnoristinae

68. *Apolephthisa subincana* (Curtis, 1837)

Material. 1♂, I-6. Total: 1♂.

Distribution in Georgia. Imereti.

General distribution. Western Palaearctic.

69. *Boletina borealis* Zetterstedt, 1852

Material. 1♂, SZS-2; 1♂, SZS-4 (ZFMK). Total: 2♂♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi.

General distribution. Palaearctic.

70. *Boletina digitata* Lundström, 1914

Material. 4♂♂, SZS-4 (2♂♂ ZFMK, 1♂ IUTG, 1♂ IZBE). Total: 4♂♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi.

General distribution. Western Palaearctic.

71. *Boletina dubia* (Meigen, 1804)

Material. 5♂♂, A-1; 3♂♂, A-3. Total: 8♂♂.

Distribution in Georgia. Adjara.

General distribution. Europe.

Remarks. The Georgian specimens have the ventral lobe of the gonostylus with a blunt small spine apically that is absent in studied specimens from Estonia and Sweden as well as in published figures (e.g. Landrock 1927, Hutson et al. 1980, Zaitzev 1994). Otherwise, the male terminalia including aedeagal complex do not have any substantial differences. Therefore, the Georgian material is considered to be conspecific pending further, more thorough study including that based on DNA sequencing.

72. *Boletina gripha* Dziedzicki, 1885

Material. 2♂♂, SZS-4 (1♂ ZFMK, 1♂ IZBE). Total: 2♂♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi.

General distribution. Palaearctic.

73. *Boletina moravica* Landrock, 1912**Material.** 1♂, SZS-4 (ZFMK). Total: 1♂.**Distribution in Georgia.** Samegrelo-Zemo Svanethi.**General distribution.** Europe.**74. *Boletina nitida* Grzegorzek, 1885****Material.** 10♂♂, SZS-3 (4♂♂ ZFMK, 4♂♂ IUTG, 2♂♂ IZBE); 1♂, SJ-1 (IZBE); 1♂, K-6. Total: 12♂♂.**Distribution in Georgia.** Samegrelo-Zemo Svanethi, Samtskhe-Javakheti, Kakheti.**General distribution.** Palaearctic.**75. *Boletina sciarina* Staeger, 1840****Material.** 3♂♂, SZS-4 (1♂ ZFMK, 1♂ IUTG, 1♂ IZBE). Total: 3♂♂.**Distribution in Georgia.** Samegrelo-Zemo Svanethi.**General distribution.** Holarctic.**76. *Boletina trivittata* (Meigen, 1818)**

Fig. 11A

Material. 4♂♂, SJ-8; 5♂♂, SJ-9. Total: 9♂♂.**Distribution in Georgia.** Samtskhe-Javakheti.**General distribution.** Palaearctic.**77. *Coelosia flava* (Staeger, 1840)**

Fig. 11I

Georgian source. Thormann et al. 2019: 279 (from Mtskhetha-Mthianethi).**Material.** 1♂, SZS-3 (ZFMK); 8♂♂ 1♀, KK-1. Total: 9♂♂ 1♀.**Distribution in Georgia.** Samegrelo-Zemo Svanethi, Mtskhetha-Mthianethi, Kvemo Kartli.**General distribution.** Europe.**78. *Docosia gilvipes* (Haliday in Walker, 1856)****Georgian source.** Ševčík et al. 2020: 21**Material.** 1♂, SZS-3 (ZFMK); 1♀, I-6. Total: 1♂ 1♀.

Distribution in Georgia. Samegrelo-Zemo Svanethi, Imereti.
General distribution. Palaearctic.

79. *Docosia flavicoxa* Strobl, 1900

Georgian source. Ševčík et al. 2020: 21
Material. 3♂♂, K-5. Total: 3♂♂.
Distribution in Georgia. Kakheti.
General distribution. Europe.

80. *Docosia moravica* Landrock, 1916

Georgian source. Ševčík et al. 2020: 23.
Material. 1♂, SJ-2 (ZFMK). Total: 1♂.
Distribution in Georgia. Samtskhe-Javakheti.
General distribution. Palaearctic.

81. *Docosia pannonica* Laštovka & Ševčík, 2006

Georgian source. Ševčík et al. 2020: 23
Material. 1♂, MM-3. Total: 1♂.
Distribution in Georgia. Mtskhetha-Mthianethi.
General distribution. Europe.
Remarks. Known from Central Europe (Laštovka and Ševčík 2006).

82. *Docosia svanetica* Kurina in Ševčík et al. 2020

Georgian source. Ševčík et al. 2020: 17.
Material. 1♂, SZS-4 (holotype, ZFMK); 5♂♂, SZS-4; 2♂♂, SZS-3; 1♂, SJ-1.
 Total: 9♂♂ (see Ševčík et al. 2020 for depository of paratypes).
Distribution in Georgia. Samegrelo-Zemo Svanethi, Samtskhe-Javakheti.
General distribution. Georgia.

83. *Ectrepesthoneura hirta* (Winnertz, 1846)

Fig. 11K

Material. 1♂, SJ-2 (ZFMK); 1♂, K-6. Total: 2♂♂.
Distribution in Georgia. Samtskhe-Javakheti, Kakheti.
General distribution. Europe.

84. *Grzegorzekia collaris* (Meigen, 1818)

Fig. 11C

Georgian source. Thormann et al. 2019: 279 (from Mtskhetha-Mthianethi).**Material.** 2♂♂, SZS-3 (1♂ ZFMK, 1♂ IZBE); 1♂, I-10; 1♂, SK-1. Total: 4♂♂.**Distribution in Georgia.** Samegrelo-Zemo Svanethi, Imereti, Shida Kartli, Mtskhetha-Mthianethi.**General distribution.** Palaearctic.**85. *Lusitanoneura chandleri* (Caspers, 1991)****Material.** 1♂, SZS-3 (ZFMK); 2♂♂, I-6. Total: 3♂♂.**Distribution in Georgia.** Samegrelo-Zemo Svanethi, Imereti.**General distribution.** Europe.**Remarks.** Known only from Grete and Cyprus (Caspers 1991, Chandler et al. 2006, Ribeiro and Chandler 2007).**86. *Palaeodocosia vittata* (Coquillett, 1901)****Material.** 1♂, A-1; 1♂, I-6. Total: 2♂♂.**Distribution in Georgia.** Adjara, Imereti.**General distribution.** Holarctic.**87. *Synapha fasciata* Meigen, 1818**

Fig. 11B

Material. 104♂♂, A-1; 54♂♂ 5♀♀, A-2; 70♂♂, A-3; 21♂♂ 2♀♀, A-4; 6♂♂ 4♀♀, A-5; 3♂♂, A-6; 173♂♂ 64♀♀, A-7; 14♂♂, I-1; 7♂♂, I-3 (18.v–1.vi.2013); 1♂, I-4; 138♂♂ 7♀♀, I-6; 25♂♂, I-7; 2♂♂ 3♀♀, I-9; 1♀, I-10; 8♂♂, I-11; 15♂♂, I-13; 2♂♂, I-16; 37♂♂, I-17; 1♂, MM-9. Total: 683♂♂ 86♀♀.**Distribution in Georgia.** Adjara, Imereti, Mtskhetha-Mthianethi.**General distribution.** Palaearctic.**Subfamily Leiinae****88. *Clastobasis alternans* (Winnertz, 1863)****Material.** 6♂♂ 2♀♀, SZS-3 (2♂♂ 1♀ ZFMK, 2♂♂ 1♀ IUTG, 2♂♂ IZBE); 1♂, K-4; 1♂, K-5. Total: 8♂♂ 2♀♀.**Distribution in Georgia.** Samegrelo-Zemo Svanethi, Kakheti.**General distribution.** Palaearctic.

89. *Clastobasis loici* Chandler, 2001

Fig. 11D

Material. 3♂♂, K-4; 22♂♂, K-5. Total: 25♂♂.**Distribution in Georgia.** Kakheti.**General distribution.** Palaearctic.**Remarks.** This very rare species was until recently recorded only from Channel Islands and Central Europe but Kurina (2020b) found it also from Japan. The record from Georgia suggests a wider distribution in the Palearctic region.**90. *Greenomyia mongolica* Laštovka & Matile, 1974****Material.** 1♂, SJ-5. Total: 1♂.**Distribution in Georgia.** Samtskhe-Javakheti.**General distribution.** Palaearctic.**Remarks.** A widely distributed Palaearctic species that has expanded its range in Europe during recent decades and is locally common also in anthropogenic environments (Kurina et al. 2011, *pers. observations*).**91. *Leia bimaculata* (Meigen, 1804)****Material.** 1♂, SZS-3 (IZBE); 1♂, SK-1; 1♂, SJ-2 (ZFMK); 1♂, SJ-9; 1♂, MM-7. Total: 5♂♂.**Distribution in Georgia.** Samegrelo-Zemo Svanethi, Shida Kartli, Samtskhe-Javakheti, Mtskhetha-Mthianethi.**General distribution.** Palaearctic.**Remarks.** Aedeagal complex of Georgian specimens is similar to that figured by Polevoi and Salmela (2016: fig. 7G) and gonostylus has a clear dorsal projection (Polevoi and Salmela 2016: fig. 7I, J).**92. *Leia cylindrica* (Winnertz, 1863)****Material.** 1♂ 1♀, I-6; 1♂, K-6. Total: 2♂♂ 1♀.**Distribution in Georgia.** Imereti, Kakheti.**General distribution.** Western Palaearctic.**93. *Leia katae* sp. nov.****Material.** See in species description above.

Distribution in Georgia. Samegrelo-Zemo-Svanethi, Shida-Kartli.

General distribution. Georgia.

94. *Leia piffardi* Edwards, 1925

Material. 1♂, I-6. Total: 1♂.

Distribution in Georgia. Imereti.

General distribution. Europe, with scattered distribution.

95. *Leia winthemii* Lehmann, 1822

Fig. 11G

Material. 3♂♂, I-10; 1♂, SJ-8. Total: 4♂♂.

Distribution in Georgia. Imereti, Samtskhe-Javakheti.

General distribution. Holarctic, extending to the Oriental region.

96. *Novakia scatopsiformis* Strobl, 1893

Fig. 11J

Material. 1♂ 1♀, SJ-2 (1♀ ZFMK, 1♂ IZBE); 1♂, K-4; 1♀, K-5. Total: 2♂♂ 2♀♀.

Distribution in Georgia. Samtskhe-Javakheti, Kakheti.

General distribution. Western Palaearctic.

Remarks. According to the recent molecular study by Kaspřák et al. (2019: Fig. 1), the genus *Novakia* Strobl, 1893 apparently belongs to the subfamily Gnoristinae. However, as the authors did not have further discussion about this relationship, I follow the current classification in Fungus Gnats Online (<http://www.sciar-oida.info/>).

Subfamily Manotinae

97. *Manota unifurcata* Lundström, 1913

Fig. 11E

Material. 1♂, I-6. Total: 1♂.

Distribution in Georgia. Imereti.

General distribution. Europe.

Remarks. A rare species, recorded from Central and Northern Europe with the south-eastern record on the Crimean Peninsula (Jaschhof et al. 2011). The current record from Georgia indicates a wider distribution in the Western Palaearctic.

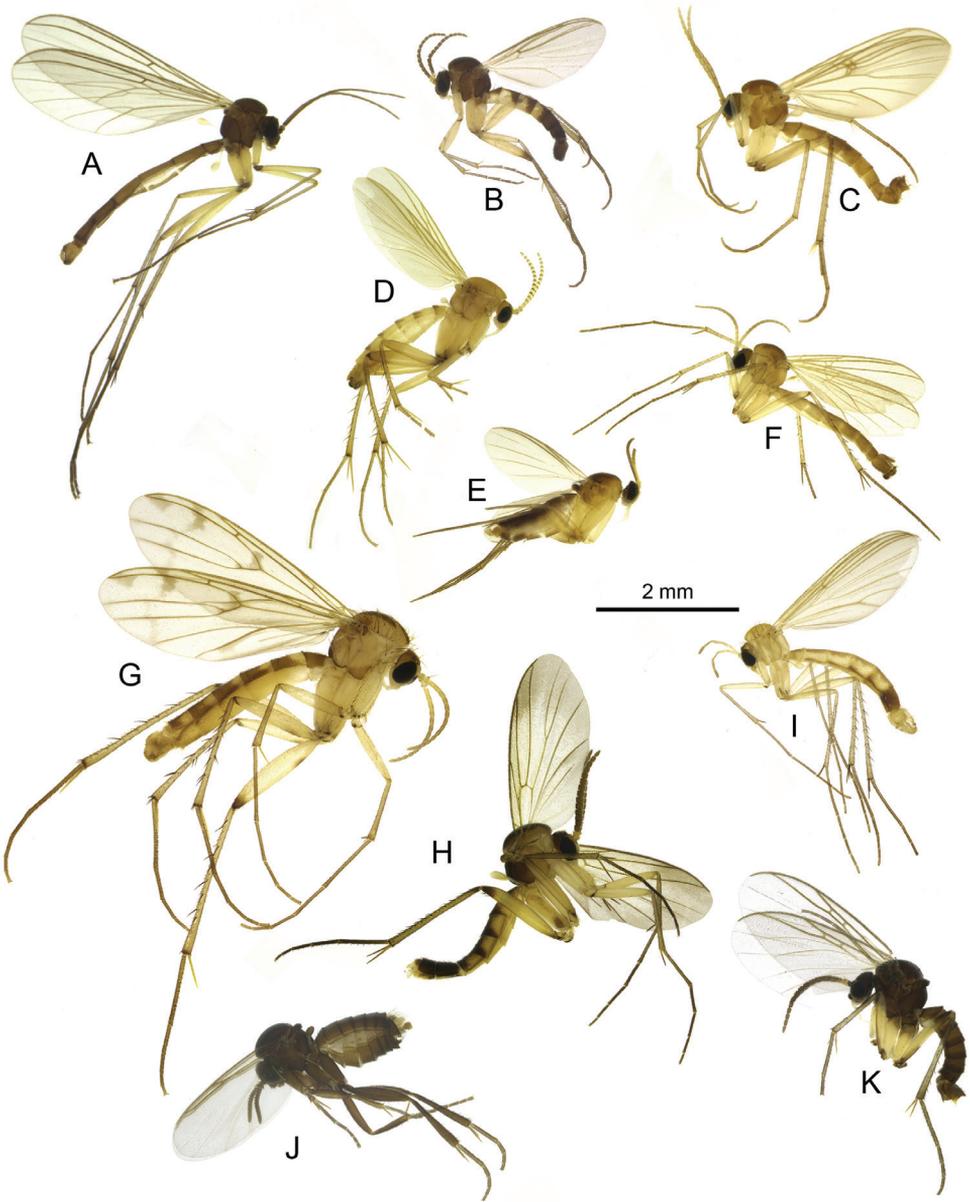


Figure 11. Habitus of Georgian fungus gnats of the family Mycetophilidae **A** *Boletina trivittata* (Meigen, 1818) **B** *Synapha fasciata* Meigen, 1818 **C** *Grzegorzekia collaris* (Meigen, 1818) **D** *Clastobasis loici* Chandler, 2001 **E** *Manota unifurcata* Lundström, 1913 **F** *Megalopelma nigroclavatum* (Strobl, 1910) **G** *Leia winthemii* Lehmann, 1822 **H** *Allocotocera pulchella* (Curtis, 1837) **I** *Coelosia flava* (Staeger, 1840) **J** *Novakia scatopsiformis* Strobl, 1893 **K** *Ectrepesthoneura hirta* (Winnertz, 1846).

Subfamily Mycetophilinae**Tribe Exechiini****98. *Allodia lugens* (Wiedemann, 1817)**

Material. 4♂♂, SZS-4 (2♂♂ ZFMK, 1♂ IUTG, 1♂ IZBE); 7♂♂, SJ-3; 1♂, SJ-8; 1♂, MM-2; 1♂, MM-11; 1♂, MM-12. Total: 15♂♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi, Samtskhe-Javakheti, Mtskhetha-Mthianethi.

General distribution. Holarctic.

Remarks. Listed to occur in Transcaucasia without further details (Zaitzev 2003).

99. *Allodia ornaticollis* (Meigen, 1818)

Material. 1♂, SJ-9; 1♂, MM-12; 1♂, MM-14; 1♂, K-1. Total: 4♂♂.

Distribution in Georgia. Samtskhe-Javakheti, Mtskhetha-Mthianethi, Kakheti.

General distribution. Holarctic.

Remarks. In Transcaucasia recorded from Azerbaijan (Zaitzev 2003).

100. *Allodia truncata* Edwards, 1921

Material. 1♂, SJ-8. Total: 1♂.

Distribution in Georgia. Samtskhe-Javakheti.

General distribution. Holarctic.

101. *Allodiopsis domestica* (Meigen, 1830)

Fig. 12A

Material. 1♂, A-7; 2♂♂, MM-2; 1♂, MM-8. Total: 4♂♂.

Distribution in Georgia. Adjara, Mtskhetha-Mthianethi.

General distribution. Holarctic.

Remarks. Listed to occur in Transcaucasia without further details (Zaitzev 2003).

102. *Allodiopsis korolevi* Zaitzev, 1982

Material. 1♂, SZS-4 (ZFMK); 1♂, SJ-9. Total: 2♂♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi, Samtskhe-Javakheti.

General distribution. Palaearctic.

103. *Alloidiopsis rustica* (Edwards, 1941)

Material. 2♂♂, SJ-8; 1♂, MM-12. Total: 3♂♂.

Distribution in Georgia. Samtskhe-Javakheti, Mtskhetha-Mthianethi.

General distribution. Palaearctic.

104. *Anatella longisetosa* Dziedzicki, 1923

Fig. 12E

Material. 1♂, SZS-3 (ZFMK); 3♂♂, SZS-4 (1♂ ZFMK, 1♂ IUTG, 1♂ IZBE). Total: 4♂♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi.

General distribution. Europe.

105. *Anatella metae* sp. nov.

Material. See in species description above.

Distribution in Georgia. Mtskhetha-Mthianethi.

General distribution. Georgia.

106. *Anatella simpatica* Dziedzicki, 1923

Material. 1♂, MM-2; 1♂, MM-12. Total: 2♂♂.

Distribution in Georgia. Mtskhetha-Mthianethi.

General distribution. Holarctic.

107. *Brachycampta alternans* (Zetterstedt, 1838)

Material. 1♂, MM-14. Total: 1♂.

Distribution in Georgia. Mtskhetha-Mthianethi.

General distribution. Holarctic.

108. *Brachycampta czernyi* (Landrock, 1912)

Material. 1♂, MM-2. Total: 1♂.

Distribution in Georgia. Mtskhetha-Mthianethi.

General distribution. Holarctic.

109. *Brachycampta grata* (Meigen, 1830)

Material. 4♂♂, I-6; 1♂, I-10; 1♂, SJ-3; 1♂, MM-5; 1♂, MM-8. Total: 8♂♂.

Distribution in Georgia. Imereti, Samtskhe-Javakheti, Mtskhetha-Mthianethi.

General distribution. Palaearctic.

Remarks. In Transcaucasia recorded from Azerbaijan (Zaitzev 2003).

110. *Brachycampta foliifera* (Strobl, 1910)

Material. 1♂, MM-2. Total: 1♂.

Distribution in Georgia. Mtskhetha-Mthianethi.

General distribution. Holarctic.

Remarks. In Transcaucasia recorded from Azerbaijan (Zaitzev 2003).

111. *Brachycampta neglecta* Edwards, 1925

Material. 1♂, I-6. Total: 1♂.

Distribution in Georgia. Imereti.

General distribution. Palaearctic.

112. *Brachycampta pistillata* (Lundström, 1911)

Material. 5♂♂, I-6. Total: 5♂♂.

Distribution in Georgia. Imereti.

General distribution. Holarctic.

Remarks. In Transcaucasia recorded from Azerbaijan (Zaitzev 2003).

113. *Brachycampta protenta* Laštovka & Matile, 1974

Material. 1♂, SZS-4 (ZFMK). Total: 1♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi.

General distribution. Holarctic.

114. *Brachycampta westerholti* Caspers, 1980

Material. 1♂, SJ-8. Total: 1♂.

Distribution in Georgia. Samtskhe-Javakheti.

General distribution. Western Palaearctic.

Remarks. In Transcaucasia recorded from Azerbaijan (Zaitzev 2003).

115. *Brevicornu auriculatum* (Edwards, 1925)

Material. 1♂, SZS-4 (ZFMK); 1♂, A-8. Total: 2♂♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi, Adjara.

General distribution. Palaearctic.

116. *Brevicornu bellum* (Johannsen, 1912)

Material. 1♂, SZS-4 (ZFMK). Total: 1♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi.

General distribution. Holarctic.

117. *Brevicornu fuscipenne* (Staeger, 1840)

Material. 1♂, I-6; 1♂, SJ-8. Total: 2♂♂.

Distribution in Georgia. Imereti, Samtskhe-Javakheti.

General distribution. Holarctic.

118. *Brevicornu griseicolle* (Staeger, 1840)

Fig. 12C

Material. 8♂♂, SZS-4 (3♂♂ ZFMK, 3♂♂ IUTG, 2♂♂ IZBE); 1♂, I-1; 2♂♂, I-6; 1♂, SK-1; 1♂, SJ-6; 4♂♂, SJ-7; 1♂, SJ-9; 1♂, MM-2; 1♂, MM-14; 1♂, K-1. Total: 21♂♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi, Imereti, Shida Kartli, Samtskhe-Javakheti, Mtskhetha-Mthianethi, Kakheti.

General distribution. Palaearctic.

119. *Brevicornu intermedium* (Santos Abreu, 1920)

Material. 1♂, I-11, 2♂♂, SJ-7; 2♂♂, SJ-8; 1♂, SJ-9; 1♂, MM-14. Total: 7♂♂.

Distribution in Georgia. Imereti, Samtskhe-Javakheti, Mtskhetha-Mthianethi.

General distribution. Western Palaearctic.

120. *Brevicornu proximum* (Staeger, 1840)

Material. 2♂♂, I-6; 1♂, I-11; 1♂, SJ-8; 1♂, SJ-9; 1♂, MM-5; 2♂♂, MM-12; 1♂, MM-13. Total: 9♂♂.

Distribution in Georgia. Imereti, Samtskhe-Javakheti, Mtskhetha-Mthianethi.

General distribution. Palaearctic.

Remarks. In Transcaucasia recorded from Azerbaijan (Zaitzev 2003).

121. *Brevicornu sericoma* (Meigen, 1830)

Material. 1♂, SZS-3 (ZFMK); 1♂, SZS-4 (IZBE); 1♂, SJ-7; 4♂♂, SJ-8; 1♂, SJ-9; 3♂♂, KK-1; 1♂, MM-2; 1♂, MM-8; 1♂, MM-14; 1♂, K-2. Total: 15♂♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi, Samtskhe-Javakheti, Kvemo Kartli, Mtskhetha-Mthianethi.

General distribution. Holarctic.

Remarks. Listed to occur in Transcaucasia without further details (Zaitzev 2003).

122. *Cordyla brevicornis* (Staeger, 1840)

Material. 1♂, SZS-3 (IZBE); 5♂♂, SZS-4 (3♂♂ ZFMK, 2♂♂ IUTG); 1♂, A-5; 1♂, A-7; 1♂, I-6; 1♂, SJ-2; 1♂ (IZBE), KK-1; 1♂ 2♀♀, MM-12; 1♂, K-6. Total: 13♂♂ 2♀♀.

Distribution in Georgia. Samegrelo-Zemo Svanethi, Adjara, Imereti, Samtskhe-Javakheti, Kvemo Kartli, Mtskhetha-Mthianethi, Kakheti.

General distribution. Palaearctic.

123. *Cordyla crassicornis* Meigen, 1818

Material. 1♂, I-1; 1♂, I-2; 1♂, I-6; 1♂, I-11; 1♂, MM-14; 1♂, K-4; 1♂, K-6. Total: 7♂♂.

Distribution in Georgia. Imereti, Mtskhetha-Mthianethi, Kakheti.

General distribution. Palaearctic.

124. *Cordyla fasciata* Meigen, 1830

Material. 1♂, MM-7. Total: 1♂.

Distribution in Georgia. Mtskhetha-Mthianethi.

General distribution. Palaearctic.

125. *Cordyla fusca* Meigen, 1804

Material. 2♂♂, SJ-2 (1♂ ZFMK, 1♂ IZBE). Total: 2♂♂.

Distribution in Georgia. Samtskhe-Javakheti.

General distribution. Palaearctic.

126. *Cordyla fissa* Edwards, 1925

Fig. 12D

Material. 1♂, I-2; 1♂, I-3 (18.v–1.vi.2013); 1♂, SJ-7; 1♂, KK-1. Total: 4♂♂.**Distribution in Georgia.** Imereti, Samtskhe-Javakheti, Kvemo Kartli.**General distribution.** Palaearctic.**127. *Cordyla insons* Laštovka & Matile, 1974****Material.** 2♂♂, SJ-2 (1♂ ZFMK, 1♂ IZBE). Total: 2♂♂.**Distribution in Georgia.** Samtskhe-Javakheti.**General distribution.** Palaearctic.**128. *Cordyla murina* (Winnertz, 1863)****Material.** 2♂♂, I-3 (18.v–1.vi.2013 and 5–19.x.2013); 1♂, SJ-12. Total: 3♂♂.**Distribution in Georgia.** Samtskhe-Javakheti.**General distribution.** Palaearctic.**129. *Cordyla nitidula* Edwards, 1925****Material.** 1♂, I-14; 1♂, K-5. Total: 2♂♂.**Distribution in Georgia.** Imereti, Kakheti.**General distribution.** Palaearctic.**130. *Cordyla pusilla* Edwards, 1925****Material.** 3♂♂, SZS-3 (IZBE); 45♂♂, SZS-4 (16♂♂ ZFMK, 16♂♂ IUTG, 13♂♂ IZBE); 2♂♂, I-6; 2♂♂, K-4; 1♂, K-6. Total: 53♂♂.**Distribution in Georgia.** Samegrelo-Zemo Svanethi, Imereti, Kakheti.**General distribution.** Palaearctic.**131. *Exechia bicincta* (Staeger, 1840)****Material.** 4♂♂, A-5; 3♂♂, A-7; 1♂, I-9; 1♂, I-10; 1♂, I-11; 1♂, I-12; 1♂, MM-8; 1♂, MM-14; 1♂, K-2. Total: 14♂♂.**Distribution in Georgia.** Adjara, Imereti, Mtskhetha-Mthianethi, Kakheti.**General distribution.** Holarctic.**Remarks.** In Transcaucasia recorded from Azerbaijan (Zaitzev 2003).

132. *Exechia dentata* Lundström, 1916

Material. 1♂, A-7. Total: 1♂.

Distribution in Georgia. Adjara.

General distribution. Europe.

133. *Exechia dorsalis* (Staeger, 1840)

Material. 1♂, SJ-7; 2♂♂, MM-12; 1♂, MM-13; 3♂♂, MM-14. Total: 7♂♂.

Distribution in Georgia. Samtskhe-Javakheti, Mtskhetha-Mthianethi.

General distribution. Palaearctic.

134. *Exechia fusca* (Meigen, 1804)

Material. 2♂♂, I-6; 1♂, SJ-3; 2♂♂, MM-2; 1♂, MM-8; 2♂♂, MM-12. Total: 8♂♂.

Distribution in Georgia. Imereti, Samtskhe-Javakheti, Mtskhetha-Mthianethi.

General distribution. Holarctic.

135. *Exechia repanda* Johannsen, 1912

Material. 2♂♂, K-4. Total: 2♂♂.

Distribution in Georgia. Kakheti.

General distribution. Holarctic.

136. *Exechia repandoides* Caspers, 1984

Material. 1♂, A-3; 1♂, I-3 (24.viii–7.ix.2013); 1♂, SJ-4; 1♂, MM-12; 1♂, K-5. Total: 5♂♂.

Distribution in Georgia. Adjara, Imereti, Samtskhe-Javakheti, Mtskhetha-Mthianethi, Kakheti.

General distribution. Europe

137. *Exechia seriata* (Meigen, 1830)

Material. 1♂, A-5. Total: 1♂.

Distribution in Georgia. Adjara.

General distribution. Palaearctic.

138. *Exechiopsis (Exechiopsis) dimitrescae* (Burghel-Balacesco, 1972)

Material. 1♂, I-12. Total: ♂.

Distribution in Georgia. Imereti.

General distribution. Palaearctic.

139. *Exechiopsis (Exechiopsis) furcata* (Lundström, 1911)

Material. 1♂ 1♀, MM-1. Total: 1♂ 1♀.

Distribution in Georgia. Mtskhetha-Mthianethi.

General distribution. Europe.

140. *Exechiopsis (Exechiopsis) pseudindecisa* Laštovka & Matile, 1974

Material. 5♂♂, MM-2. Total: 5♂♂.

Distribution in Georgia. Mtskhetha-Mthianethi.

General distribution. Palaearctic.

Remarks. In Transcaucasia recorded from Armenia (Joost and Plassmann 1985).

141. *Exechiopsis (Exechiopsis) magnicauda* (Lundström, 1911)

Material. 1♂, MM-8; 2♂♂, MM-11. Total: 3♂♂.

Distribution in Georgia. Mtskhetha-Mthianethi.

General distribution. Europe.

142. *Notolopha cristata* (Staeger, 1840)

Material. 2♂♂, SJ-8; 1♂, SJ-9. Total: 3♂♂.

Distribution in Georgia. Samtskhe-Javakheti.

General distribution. Holarctic.

143. *Pseudexechia tuomikoskii* Kjærandsen, 2009

Material. 1♂, I-10. Total: 1♂.

Distribution in Georgia. Imereti.

General distribution. Europe.

144. *Rymosia affinis* Winnertz, 1863

Fig. 12B

Material. 1♂, SJ-8. Total: 1♂.**Distribution in Georgia.** Samtskhe-Javakheti.**General distribution.** Palaearctic.**145. *Rymosia fasciata* (Meigen, 1804)****Material.** 1♂, I-9. Total: 1♂.**Distribution in Georgia.** Imereti.**General distribution.** Europe.**146. *Stigmatomeria crassicornis* (Stannius, 1831)****Material.** 1♂, A-5; 1♂, SK-1; 1♂, SJ-3; 5♂♂, SJ-8; 1♂, MM-2; 8♂♂, MM-8; 5♂♂, MM-11; 4♂♂, MM-12. Total: 26♂♂.**Distribution in Georgia.** Adjara, Shida Kartli, Samtskhe-Javakheti, Mtskhetha-Mthianethi.**General distribution.** Holarctic.**147. *Synplasta venosa* (Dziedzicki, 1910)****Material.** 1♂, A-1. Total: 1♂.**Distribution in Georgia.** Adjara.**General distribution.** Europe.**148. *Tarnania fenestralis* (Meigen, 1838)****Material.** 1♂, SJ-7. Total: 1♂.**Distribution in Georgia.** Samtskhe-Javakheti.**General distribution.** Palaearctic.**Tribe Mycetophilini****149. *Dynatosoma cochleare* Strobl, 1895****Material.** 1♂, SJ-8. Total: 1♂.**Distribution in Georgia.** Samtskhe-Javakheti.**General distribution.** Palaearctic.

150. *Dynatosoma fuscicorne* (Meigen, 1818)

Material. 1♂, SZS-3 (ZFMK). Total: 1♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi.

General distribution. Holarctic.

151. *Dynatosoma majus* Landrock, 1912

Material. 1♀, SJ-8; 4♂♂ 1♀, MM-8; 1♂, K-6. Total: 5♂♂ 2♀♀.

Distribution in Georgia. Samtskhe-Javakheti, Mtskhetha-Mthianethi, Kakheti.

General distribution. Palaearctic.

152. *Dynatosoma nigromaculatum* Lundström, 1913

Material. 1♀, I-6. Total: 1♀.

Distribution in Georgia. Imereti.

General distribution. Palaearctic.

153. *Dynatosoma reciprocum* (Walker, 1848)

Fig. 12K

Material. 1♂, SJ-8. Total: 1♂.

Distribution in Georgia. Samtskhe-Javakheti.

General distribution. Palaearctic.

154. *Dynatosoma rufescens* (Zetterstedt, 1838)

Material. 1♂, K-6. Total: 1♂.

Distribution in Georgia. Kakheti.

General distribution. Europe.

155. *Epicyptha limnophila* Chandler, 1981

Material. 1♂, K-5. Total: 1♂.

Distribution in Georgia. Kakheti.

General distribution. Europe.

156. *Epicyptha scatophora* (Perris, 1849)

Fig. 12G

Material. 1♂, K-4; 7♂♂ 4♀♀, K-5. Total: 8♂♂ 4♀♀.**Distribution in Georgia.** Kakheti.**General distribution.** Palaearctic.**157. *Epicyptha torquata* Matile, 1977****Material.** 1♂, A-1; 1♂ 1♀, I-6; 1♂, MM-14; 1♂; K-2. Total: 4♂♂ 1♀.**Distribution in Georgia.** Adjara, Imereti, Mtskhetha-Mthianethi, Kakheti.**General distribution.** Western Palaearctic.**158. *Macrobriachius kowarzii* Dziedzicki, 1889****Material.** 1♂, I-6; 1♂, K-4. Total: 2♂♂.**Distribution in Georgia.** Imereti, Kakheti.**General distribution.** Europe.**159. *Mycetophila adumbrata* Mik, 1884****Material.** 1♂, SJ-8; 1♂, MM-13. Total: 2♂♂.**Distribution in Georgia.** Samtskhe-Javakheti, Mtskhetha-Mthianethi.**General distribution.** Europe.**160. *Mycetophila alea* Laffoon, 1965****Material.** 1♂, A-3; 35♂♂, I-6; 1♂, I-9; 1♂, I-14; 1♂, SK-1; 1♂, SJ-1 (ZFMK); 3♂♂, SJ-4; 2♂♂, SJ-9; 2♂♂, MM-8; 2♂♂, MM-11; 1♂, KK-1. Total: 50♂♂.**Distribution in Georgia.** Adjara, Imereti, Shida Kartli, Samtskhe-Javakheti, Mtskhetha-Mthianethi, Kvemo Kartli.**General distribution.** Holarctic.**161. *Mycetophila bialorussica* Dziedzicki, 1884****Material.** 1♂, SZS-4 (ZFMK); 1♂, SJ-4; 1♂, SJ-8; 1♂, SJ-9. Total: 4♂♂.**Distribution in Georgia.** Samegrelo-Zemo Svanethi, Samtskhe-Javakheti.**General distribution.** Palaearctic.

162. *Mycetophila blanda* Winnertz, 1863

Material. 2♂♂, I-6; 1♂, SJ-9. Total: 3♂♂.

Distribution in Georgia. Imereti, Samtskhe-Javakheti.

General distribution. Palaearctic.

163. *Mycetophila brevitarsata* (Laštovka, 1963)

Material. 1♂, SZS-4 (ZFMK). Total: 1♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi.

General distribution. Palaearctic.

Remarks. Listed to occur in Transcaucasia without further details (Zaitzev 2003).

164. *Mycetophila distigma* Meigen, 1830

Material. 1♂, SJ-8; 1♂, K-4; Total: 2♂♂.

Distribution in Georgia. Samtskhe-Javakheti, Kakheti.

General distribution. Europe.

165. *Mycetophila edwardsi* Lundström, 1913

Material. 1♂, SJ-7; 3♂♂, SJ-8; 1♂, MM-8. Total: 5♂♂.

Distribution in Georgia. Samtskhe-Javakheti, Mtskhetha-Mthianethi.

General distribution. Europe.

166. *Mycetophila exstincta* Loew, 1869

Material. 2♂♂, SZS-3 (1♂ ZFMK, 1♂ IZBE); 1♂, I-14; 2♂♂, K-4. Total: 5♂♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi, Imereti, Kakheti.

General distribution. Holarctic.

167. *Mycetophila formosa* Lundström, 1911

Material. 1♂, SJ-3; 1♂, SJ-8. Total: 2♂♂.

Distribution in Georgia. Samtskhe-Javakheti.

General distribution. Palaearctic.

168. *Mycetophila fungorum* (De Geer, 1776)

Material. 6♂♂ 3♀♀, SZS-3 (IZBE); 19♂♂ 10♀♀, SZS-4 (9♂♂ 5♂♀ ZFMK, 8♂♂ 5♀♀ IUTG, 2♂♂ IZBE); 1♂, I-3 (29.vi–13.vii.2013); 5♂♂ 2♀♀, I-6; 1♀, I-9; 1♂, I-10; 1♀, SK-1; 2♂♂, SJ-1 (IZBE); 2♀♀, SJ-3; 1♂, SJ-4; 2♂♂ 2♀♀, SJ-7; 4♂♂ 4♀♀, SJ-8; 2♂♂ 4♀♀, SJ-9; 1♂, SJ-10; 2♂♂, MM-3; 1♀, MM-6; 2♂♂ 7♀♀, MM-7; 1♂ 1♀, MM-8; 2♂♂ 2♀♀, MM-11; 1♀, MM-12; 1♂, MM-14; 1♂ 2♀♀, KK-1; 1♂, K-4. Total: 54♂♂ 43♀♀.

Distribution in Georgia. Samegrelo-Zemo Svanethi, Imereti, Shida Kartli, Samtskhe-Javakheti, Mtskhetha-Mthianethi, Kvemo Kartli, Kakheti.

General distribution. Holarctic (extending to the Oriental region).

169. *Mycetophila confluens* Dziedzicki, 1884

Material. 4♂♂, SJ-8; 1♂, MM-2. Total: 5♂♂.

Distribution in Georgia. Samtskhe-Javakheti, Mtskhetha-Mthianethi.

General distribution. Holarctic.

170. *Mycetophila curviseta* Lundström, 1911

Material. 4♂♂, SZS-4 (2♂♂ ZFMK, 1♂ IUTG, 1♂ IZBE); 1♂, I-3 (1–15.vi.2013); 3♂♂, I-6; 2♂♂, I-9; 1♂, I-12; 2♂♂, SK-1; 6♂♂, SJ-8; 5♂♂, SJ-9; 1♂, KK-1; 3♂♂, MM-8; 1♂, MM-13; 7♂♂, MM-14; 3♂♂, K-4; 1♂, K-5. Total: 40♂♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi, Imereti, Shida Kartli, Samtskhe-Javakheti, Kvemo Kartli, Mtskhetha-Mthianethi, Kakheti.

General distribution. Palaearctic.

171. *Mycetophila deflexa* Chandler, 2001

Material. 2♂♂, SZS-3 (1♂ ZFMK, 1♂ IZBE); 1♂, SZS-4 (IUTG). Total: 3♂♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi.

General distribution. Europe.

172. *Mycetophila dentata* Lundström, 1915

Material. 1♂, K-4. Total: 1♂.

Distribution in Georgia. Kakheti.

General distribution. Holarctic.

173. *Mycetophila gentilicia* Zaitzev, 1999**Material.** 1♂, SJ-8. Total: 1♂.**Distribution in Georgia.** Samtskhe-Javakheti.**General distribution.** Palaearctic.**174. *Mycetophila gibbula* Edwards, 1925****Material.** 1♂, SJ-3. Total: 1♂.**Distribution in Georgia.** Samtskhe-Javakheti.**General distribution.** Palaearctic.**175. *Mycetophila hetschkoi* Landrock 1918****Material.** 1♂, SZS-4 (ZFMK); 1♂, MM-11; 3♂♂, MM-14. Total: 5♂♂.**Distribution in Georgia.** Samegrelo-Zemo Svanethi, Mtskhetha-Mthianethi.**General distribution.** Palaearctic.**176. *Mycetophila hyrcania* Laštovka & Matile, 1969****Material.** 1♂, SZS-3 (ZFMK); 1♂, SJ-6; 1♂, KK-1; 3♂♂, K-4. Total: 6♂♂.**Distribution in Georgia.** Samegrelo-Zemo Svanethi, Samtskhe-Javakheti, Kvemo Kartli, Kakheti.**General distribution.** Western Palaearctic.**177. *Mycetophila ichneumonea* Say, 1823****Georgian source.** Jürgenstein et al. 2015: 30.**Material.** 6♂♂, SZS-4 (3♂♂ ZFMK, 2♂♂ IUTG, 1♂ IZBE); 1♂, SK-1; 1♂, SJ-2 (IZBE); 1♂, SJ-5; 3♂♂, SJ-8; 1♂, SJ-9. Total: 13♂♂.**Distribution in Georgia.** Samegrelo-Zemo Svanethi, Shida Kartli, Samtskhe-Javakheti.**General distribution.** Holarctic. Listed to occur in Transcaucasia without further details (Zaitzev 2003).**178. *Mycetophila idonea* Laštovka, 1972****Georgian source.** Jürgenstein et al. 2015: 31–32.

Material. 5♂♂, SZS-3 (2♂♂ ZFMK, 2♂♂ IUTG, 1♂ IZBE); 2♂♂, A-1; 1♂, A-3; 1♂, A-7; 10♂♂, I-6; 1♂, I-10; 1♂, SK-1; 1♂, SJ-1 (IZBE); 1♂, KK-1; 1♂, MM-7; 1♂, MM-8; 4♂♂, MM-11; 1♂, MM-14; 1♂, K-4; 1♂, K-5; 1♂, K-6. Total: 33♂♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi, Adjara, Imereti, Shida Kartli, Samtskhe-Javakheti, Kvemo Kartli, Mtskhetha-Mthianethi, Kakheti.

General distribution. Europe.

179. *Mycetophila lamellata* Lundström, 1911

Material. 4♂♂, SJ-7; 1♂, SJ-8; 2♂♂, MM-14. Total: 7♂♂.

Distribution in Georgia. Samtskhe-Javakheti, Mtskhetha-Mthianethi.

General distribution. Europe.

180. *Mycetophila lastovkai* Caspers, 1984

Material. 1♂, SZS-4 (ZFMK). Total: 1♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi.

General distribution. Europe.

181. *Mycetophila luctuosa* Meigen, 1830

Material. 1♂, SZS-4 (ZFMK); 1♂, I-10; 1♂, MM-4. Total: 3♂♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi, Imereti, Mtskhetha-Mthianethi.

General distribution. Holarctic.

182. *Mycetophila lunata* Meigen, 1804

Material. 1♂, A-1; 1♂, MM-12. Total: 2♂♂.

Distribution in Georgia. Adjara, Mtskhetha-Mthianethi.

General distribution. Palaearctic.

183. *Mycetophila magnicauda* Strobl, 1895

Fig. 12F

Material. 1♂, SJ-4; 4♂♂, SJ-8; 1♂, SJ-9. Total: 6♂♂.

Distribution in Georgia. Samtskhe-Javakheti.

General distribution. Palaearctic.

184. *Mycetophila marginata* Winnertz, 1863

Material. 1♂, I-6; 1♂, I-10; 4♂♂, SJ-7; 5♂♂, SJ-8; 2♂♂, SJ-9; 2♂♂, MM-2. Total: 15♂♂.

Distribution in Georgia. Imereti, Samtskhe-Javakheti, Mtskhetha-Mthianethi.

General distribution. Europe.

185. *Mycetophila morosa* Winnertz, 1863

Material. 1♂, MM-14. Total: 1♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi.

General distribution. Holarctic.

186. *Mycetophila nigrofusca* Dziedzicki, 1884

Material. 1♂, I-5; 1♂, MM-14. Total: 2♂♂.

Distribution in Georgia. Imereti, Mtskhetha-Mthianethi.

General distribution. Palaearctic.

187. *Mycetophila ocellus* Walker, 1848

Material. 1♂, I-10; 3♂♂, SJ-8; 2♂♂, MM-12. Total: 6♂♂.

Distribution in Georgia. Imereti, Samtskhe-Javakheti, Mtskhetha-Mthianethi.

General distribution. Holarctic.

188. *Mycetophila occultans* Lundström, 1913

Material. 6♂♂, SZS-3 (2♂♂ ZFMK, 2♂♂ IUTG, 2♂♂ IZBE); 1♂, I-6; 1♂, SJ-8; 1♂, SJ-9; 57♂♂, MM-13; 1♂, MM-14. Total: 67♂♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi, Imereti, Samtskhe-Javakheti, Mtskhetha-Mthianethi.

General distribution. Europe.

189. *Mycetophila ornata* Stephens, 1829

Material. 2♂♂, SJ-8; 1♂, SJ-9; 2♂♂, MM-12. Total: 5♂♂.

Distribution in Georgia. Samtskhe-Javakheti, Mtskhetha-Mthianethi.

General distribution. Palaearctic.

Remarks. In Transcaucasia recorded from Azerbaijan (Zaitzev 2003).

190. *Mycetophila pictula* Meigen, 1830

Material. 2♂♂, SJ-9. Total: 2♂♂.

Distribution in Georgia. Samtskhe-Javakheti.

General distribution. Holarctic.

191. *Mycetophila pumila* Winnertz, 1863

Material. 1♂, SZS-4 (ZFMK); 2♂♂, A-1; 2♂♂, A-3; 3♂♂, I-6; 1♂, I-9; 1♂, I-10; 1♂, MM-11; 4♂♂, MM-14; 1♂, K-2. Total: 16♂♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi, Adjara, Imereti, Mtskhetha-Mthianethi, Kakheti.

General distribution. Palaearctic.

192. *Mycetophila pseudoforcipata* Zaitzev, 1998

Material. 1♂, SJ-8; 1♂, SJ-9. Total: 2♂♂.

Distribution in Georgia. Samtskhe-Javakheti.

General distribution. Palaearctic.

193. *Mycetophila ruficollis* Meigen, 1818

Georgian source. Jürgenstein et al. 2015: 33.

Material. 1♂, K-6. Total: 1♂.

Distribution in Georgia. Kakheti.

General distribution. Palaearctic.

194. *Mycetophila scotica* Edwards, 1941

Material. 1♂, I-12. Total: 1♂.

Distribution in Georgia. Imereti.

General distribution. Holarctic.

195. *Mycetophila sigillata* Dziedzicki, 1884

Material. 3♂♂, I-6; 2♂♂, SJ-4. Total: 5♂♂.

Distribution in Georgia. Imereti, Samtskhe-Javakheti.

General distribution. Holarctic.

Remarks. Listed to occur in Transcaucasia without further details (Zaitzev 2003).

196. *Mycetophila sigmoides* Loew, 1869**Material.** 1♂, I-6. Total: 1♂.**Distribution in Georgia.** Imereti.**General distribution.** Holarctic.**197. *Mycetophila signata* Meigen, 1830****Material.** 10♂♂, I-6; 1♂, I-14; 1♂, SJ-4. Total: 12♂♂.**Distribution in Georgia.** Imereti, Samtskhe-Javakheti.**General distribution.** Palaearctic.**198. *Mycetophila signatoides* Dziedzicki, 1884****Material.** 1♂, SZS-4 (ZFMK); 2♂♂, I-6. Total: 3♂♂.**Distribution in Georgia.** Samegrelo-Zemo Svanethi, Imereti.**General distribution.** Western Palaearctic (see also comment in Kjærandsen et al. 2007).**199. *Mycetophila sordida* van der Wulp, 1874****Material.** 1♂, SZS-3 (ZFMK); 3♂♂, SZS-4 (1♂ ZFMK, 1♂ IUTG, 1♂ IZBE); 2♂♂, I-6; 1♂, SJ-4; 4♂♂, SJ-8; 1♂, SJ-9; 6♂♂, KK-1; 1♂, MM-11. Total: 19♂♂.**Distribution in Georgia.** Samegrelo-Zemo Svanethi, Imereti, Samtskhe-Javakheti, Kvemo Kartli, Mtskhetha-Mthianethi.**General distribution.** Holarctic.**200. *Mycetophila strigatoides* Landrock, 1927****Material.** 4♂♂, SZS-3 (2♂♂ ZFMK, 2♂♂ IZBE); 42♂♂, SZS-4 (13♂♂ ZFMK, 16♂♂ IUTG, 13♂♂ IZBE); 1♂, I-10; 1♂, SJ-1 (IZBE); 1♂, SJ-2 (ZFMK). Total: 49♂♂.**Distribution in Georgia.** Samegrelo-Zemo Svanethi, Imereti, Samtskhe-Javakheti.**General distribution.** Palaearctic.**201. *Mycetophila stylata* (Dziedzicki, 1884)****Material.** 9♂♂, SJ-8; 4♂♂, SJ-9. Total: 13♂♂.

Distribution in Georgia. Samtskhe-Javakheti.

General distribution. Palaearctic.

202. *Mycetophila sublunata* Zaitzev, 1998

Material. 1♂, SJ-9. Total: 1♂.

Distribution in Georgia. Samtskhe-Javakheti.

General distribution. Europe.

203. *Mycetophila subsigillata* Zaitzev, 1999

Material. 1♂, SJ-8. Total: 1♂.

Distribution in Georgia. Samtskhe-Javakheti.

General distribution. Palaearctic.

204. *Mycetophila sumavica* (Laštovka, 1963)

Material. 1♂, I-10. Total: 1♂.

Distribution in Georgia. Imereti.

General distribution. Europe.

205. *Mycetophila trinotata* Staeger, 1840

Material. 1♂, SZS-3 (ZFMK); 5♂♂, MM-13; 12♂♂, MM-14; 1♂, K-2. Total: 19♂♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi, Mtskhetha-Mthianethi, Kakheti.

General distribution. Holarctic.

206. *Mycetophila uliginosa* Chandler, 1988

Material. 1♂, SZS-4 (ZFMK). Total: 1♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi.

General distribution. Europe.

207. *Mycetophila unicolor* Stannius, 1831

Material. 3♂♂, A-1; 2♂♂, A-7; 1♂, SJ-2 (ZFMK). Total: 6♂♂.

Distribution in Georgia. Adjara, Samtskhe-Javakheti.

General distribution. Western Palaearctic.

208. *Phronia basalis* Winnertz, 1863

Material. 1♂, MM-10. Total: 1♂.

Distribution in Georgia. Mtskhetha-Mthianethi.

General distribution. Western Palaearctic.

209. *Phronia biarcuata* (Becker, 1908)

Material. 1♂, SJ-8; 1♂, SJ-9; 1♂, MM-12. Total: 3♂♂.

Distribution in Georgia. Samtskhe-Javakheti, Mtskhetha-Mthianethi.

General distribution. Holarctic.

Remarks. In Transcaucasia recorded from Armenia (Joost and Plassmann 1985).

210. *Phronia conformis* (Walker, 1856)

Material. 2♂♂, I-6. Total: 2♂♂.

Distribution in Georgia. Imereti.

General distribution. Holarctic.

211. *Phronia electa* Dziedzicki, 1889

Material. 1♂, SJ-8. Total: 1♂.

Distribution in Georgia. Samtskhe-Javakheti.

General distribution. Palaearctic.

212. *Phronia exigua* (Zetterstedt, 1852)

Material. 2♂♂, MM-2; 1♂, MM-8. Total: 3♂♂.

Distribution in Georgia. Mtskhetha-Mthianethi.

General distribution. Holarctic.

Remarks. Listed to occur in Transcaucasia without further details (Zaitzev 2003).

213. *Phronia humeralis* Winnertz, 1863

Material. 1♂, A-7; 1♂, SJ-4; 2♂♂, SJ-8; 2♂♂, SJ-9. Total: 6♂♂.

Distribution in Georgia. Adjara, Samtskhe-Javakheti.

General distribution. Palaearctic.

214. *Phronia forcipata* Winnertz, 1863

Material. 1♂, SZS-4 (ZFMK); 8♂♂, I-6. Total: 9♂♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi, Imereti.

General distribution. Palaearctic.

Remarks. Listed to occur in Transcaucasia without further details (Zaitzev 2003).

215. *Phronia nitidiventris* (van der Wulp, 1859)

Material. 2♂♂, I-6; 1♂, I-9; 1♂, I-10. Total: 4♂♂.

Distribution in Georgia. Imereti.

General distribution. Palaearctic.

Remarks. Listed to occur in Transcaucasia without further details (Zaitzev 2003).

216. *Phronia notata* Dziedzicki, 1889

Material. 1♂, SJ-8. Total: 1♂.

Distribution in Georgia. Samtskhe-Javakheti.

General distribution. Palaearctic.

217. *Phronia obtusa* Winnertz, 1863

Material. 1♂, I-6. Total: 1♂.

Distribution in Georgia. Imereti.

General distribution. Holarctic.

218. *Phronia petulans* Dziedzicki, 1889

Material. 6♂♂, MM-12. Total: 6♂♂.

Distribution in Georgia. Mtskhetha-Mthianethi.

General distribution. Holarctic.

219. *Phronia signata* Winnertz, 1863

Material. 9♂♂, I-6; 1♂, I-9; 4♂♂, I-10; 1♂, SJ-9; 8♂♂, MM-8; 1♂, MM-9. Total: 24♂♂.

Distribution in Georgia. Imereti, Samtskhe-Javakheti, Mtskhetha-Mthianethi.

General distribution. Palearctic.

Remarks. Listed to occur in Transcaucasia without further details (Zaitzev 2003).

220. *Phronia tenuis* Winnertz, 1863

Fig. 12H

Material. 2♂♂, SZS-4 (1♂ ZFMK, 1♂ IZBE); 1♂, I-10; 1♂, MM-12. Total: 4♂♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi, Imereti, Mtskhetha-Mthianethi.

General distribution. Holarctic, extending to the Oriental region.

221. *Phronia triangularis* Winnertz, 1863

Material. 1♂, I-6; 1♂, SJ-8; 1♂, MM-2; 1♂, MM-8. Total: 4♂♂.

Distribution in Georgia. Imereti, Samtskhe-Javakheti, Mtskhetha-Mthianethi.

General distribution. Western Europe.

222. *Platurocypta testata* (Edwards, 1925)

Material. 1♂, I-3 (13–27.vi.2013); 2♂♂, SJ-4; 1♂, K-4. Total: 4♂♂.

Distribution in Georgia. Imereti, Samtskhe-Javakheti, Kakheti.

General distribution. Holarctic.

223. *Platurocypta punctum* (Stannius, 1831)

Material. 1♂, K-2. Total: 1♂.

Distribution in Georgia. Kakheti.

General distribution. Holarctic.

224. *Sceptonia cryptocauda* Chandler, 1991

Material. 18♂♂, MM-13; 18♂♂, MM-14; 8♂♂, K-2. Total: 44♂♂.

Distribution in Georgia. Mtskhetha-Mthianethi; Kakheti.

General distribution. Western Palearctic.

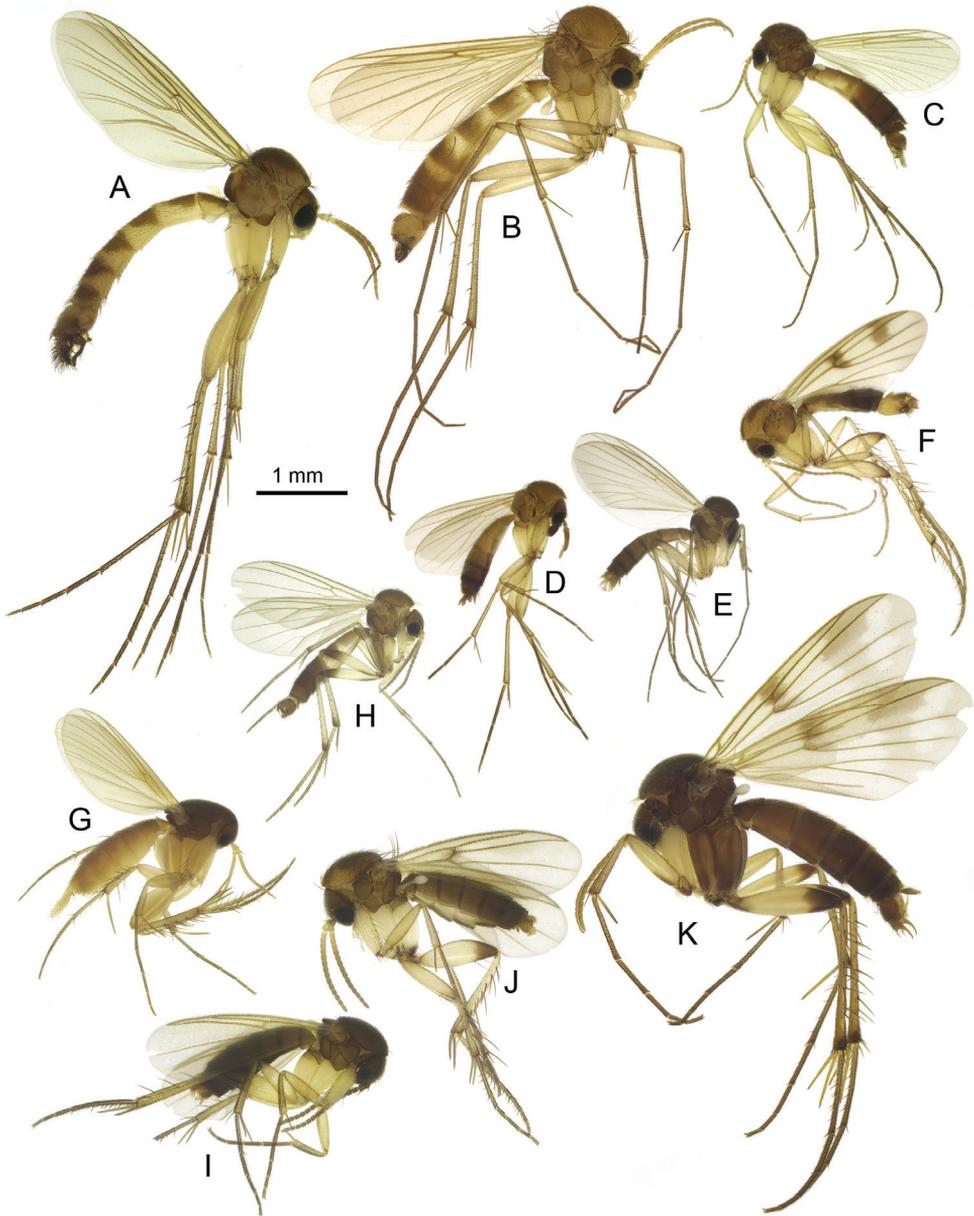


Figure 12. Habitus of Georgian fungus gnats of the family Mycetophilidae **A** *Allodiopsis domestica* (Meigen, 1830) **B** *Rymosia affinis* Winnertz, 1863 **C** *Brevicornu griseicolle* (Staeger, 1840) **D** *Cordyla fissa* Edwards, 1925 **E** *Anatella longisetosa* Dziedzicki, 1923 **F** *Mycetophila magnicauda* Strobl, 1895 **G** *Epicrypta scatophora* (Perris, 1849) **H** *Phronia tenuis* Winnertz, 1863 **I** *Sceptonia tenuis* Edwards, 1925 **J** *Zygomomyia humeralis* (Wiedemann, 1817) **K** *Dynatosoma reciprocum* (Walker, 1848).

225. *Sceptonia demeijerei* Bechev, 1997**Material.** 1♂, MM-5. Total: 1♂.**Distribution in Georgia.** Mtskhetha-Mthianethi.**General distribution.** Europe.**226. *Sceptonia flavipuncta* Edwards, 1925****Material.** 1♂, SZS-3 (IZBE); 6♂♂, I-6; 3♂♂, I-9; 2♂♂, I-14; 1♂, SJ-2 (ZFMK); 1♂, KK-1; 10♂♂, MM-13; 14♂♂, MM-14. Total: 38♂♂.**Distribution in Georgia.** Samegrelo-Zemo Svanethi, Imereti, Samtskhe-Javakheti, Kvemo Kartli, Mtskhetha-Mthianethi.**General distribution.** Europe.**227. *Sceptonia humerella* Edwards, 1925****Material.** 1♂, SJ-3; 1♂, SJ-4. Total: 2♂♂.**Distribution in Georgia.** Samtskhe-Javakheti.**General distribution.** Europe.**228. *Sceptonia membranacea* Edwards, 1925****Material.** 5♂♂, MM-13. Total: 5♂♂.**Distribution in Georgia.** Mtskhetha-Mthianethi.**General distribution.** Europe.**229. *Sceptonia nigra* (Meigen, 1804)****Material.** 2♂♂, A-3; 1♂, MM-13; 14♂♂, MM-14; 7♂♂, K-2. Total: 24♂♂.**Distribution in Georgia.** Adjara, Mtskhetha-Mthianethi, Kakheti.**General distribution.** Palaearctic.**230. *Sceptonia tenuis* Edwards, 1925**

Fig. 12 I

Material. 1♂, SK-1; 3♂♂, SJ-2 (1♂ ZFMK, 1♂ IUTG, 1♂ IZBE); 2♂♂, MM-12. Total: 6♂♂.

Distribution in Georgia. Shida Kartli, Samtskhe-Javakheti, Mtskhetha-Mthianethi.
General distribution. Europe.

231. *Trichonta aberrans* Lundström, 1911

Material. 1♂, I-6. Total: 1♂.

Distribution in Georgia. Imereti.

General distribution. Europe.

232. *Trichonta atricauda* (Zetterstedt, 1852)

Material. 1♂, I-6. Total: 1♂.

Distribution in Georgia. Imereti.

General distribution. Holarctic.

233. *Trichonta clavigera* Lundström, 1913

Material. 2♂♂, I-6; 1♂, KK-1; 1♂, MM-12. Total: 4♂♂.

Distribution in Georgia. Imereti, Kvemo Kartli, Mtskhetha-Mthianethi.

General distribution. Palaearctic.

234. *Trichonta falcata* Lundström, 1911

Material. 2♂♂, A-7. Total: 2♂♂.

Distribution in Georgia. Adjara.

General distribution. Holarctic.

Remarks. Listed to occur in Transcaucasia without further details (Zaitzev 2003).

235. *Trichonta fragilis* Gagne, 1981

Material. 1♂, I-6. Total: 1♂.

Distribution in Georgia. Imereti.

General distribution. Holarctic.

236. *Trichonta perspicua* van der Wulp, 1881

Material. 1♂, I-17. Total: 1♂.

Distribution in Georgia. Imereti.

General distribution. Holarctic.

237. *Trichonta subterminalis* Zaitzev & Menzel, 1996

Material. 4♂♂, I-6; 1♂, SK-1. Total: 5♂♂.

Distribution in Georgia. Imereti, Shida Kartli.

General distribution. Palaearctic.

238. *Trichonta trifida* Lundström, 1909

Material. 1♂, I-10. Total: 1♂.

Distribution in Georgia. Imereti.

General distribution. Northern Europe.

Remarks. Kjærøranden and Søli (2020) recently reinstated the species and provided detailed figures of the male terminalia of the allied species.

239. *Trichonta vitta* (Meigen, 1830)

Material. 9♂♂, I-6; 1♂, SJ-4; 1♂, SJ-8; 2♂♂, K-4; 2♂♂, K-5. Total: 15♂♂.

Distribution in Georgia. Imereti, Samtskhe-Javakheti, Kakheti.

General distribution. Holarctic.

240. *Trichonta vulgaris* Loew, 1869

Material. 1♂, SZS-4 (ZFMK); 2♂♂, SJ-8; 1♂, SJ-9. Total: 4♂♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi, Samtskhe-Javakheti.

General distribution. Holarctic.

Remarks. Listed to occur in Transcaucasia without further details (Zaitzev 2003).

241. *Zygomomyia humeralis* (Wiedemann, 1817)

Fig. 12J

Material. 1♂, SZS-3 (IZBE); 5♂♂, SZS-4 (2♂♂ ZFMK, 2♂♂ IUTG, 1♂ IZBE); 1♂, SJ-4; 2♂♂, MM-12; 1♂, MM-13; 3♂♂, MM-14. Total: 13♂♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi, Samtskhe-Javakheti, Mtskhetha-Mthianethi.

General distribution. Europe.

242. *Zygomomyia pseudohumeralis* Caspers, 1980

Material. 1♂, SJ-2 (ZFMK); 1♂, SJ-4; 1♂, SJ-7; 1♂, KK-1; 5♂♂, K-4. Total: 9♂♂.

Distribution in Georgia. Samtskhe-Javakheti, Kvemo Kartli, Kakheti.

General distribution. Palaearctic.

243. *Zygomomyia semifusca* (Meigen, 1818)

Material. 1♂, SZS-4 (ZFMK); 1♂, I-6; 1♂, SJ-3; 1♂, SJ-5. Total: 4♂♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi, Imereti, Samtskhe-Javakheti.

General distribution. Holarctic.

244. *Zygomomyia setosa* Barendrecht, 1938

Material. 1♂, K-4. Total: 1♂.

Distribution in Georgia. Kakheti.

General distribution. Europe.

Remarks. A very rare species with a scattered distribution in Europe: recorded from the Netherlands, Germany and Switzerland (Chandler 2013). There is an unpublished record also from Estonia (personal observation).

245. *Zygomomyia valida* Winnertz 1863

Material. 10♂♂, SZS-4 (4♂♂ ZFMK, 3♂♂ IUTG, 3♂♂ IZBE). Total: 10♂♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi.

General distribution. Palaearctic.

246. *Zygomomyia vara* (Staeger, 1840)

Material. 1♂, SZS-2; 1♂, SZS-4 (ZFMK); 1♂, A-1; 2♂♂, SJ-9. Total: 5♂♂.

Distribution in Georgia. Samegrelo-Zemo Svanethi, Adjara, Samtskhe-Javakheti.

General distribution. Holarctic.

Remarks. Listed to occur in Transcaucasia without further details (Zaitzev 2003).

Discussion

This is the first attempt to provide a synoptic list of Sciaroidea species of the Transcaucasian region. However, the recorded 246 species (245 from original study + one from literature data) of fungus gnats are the result of a preliminary survey, while further

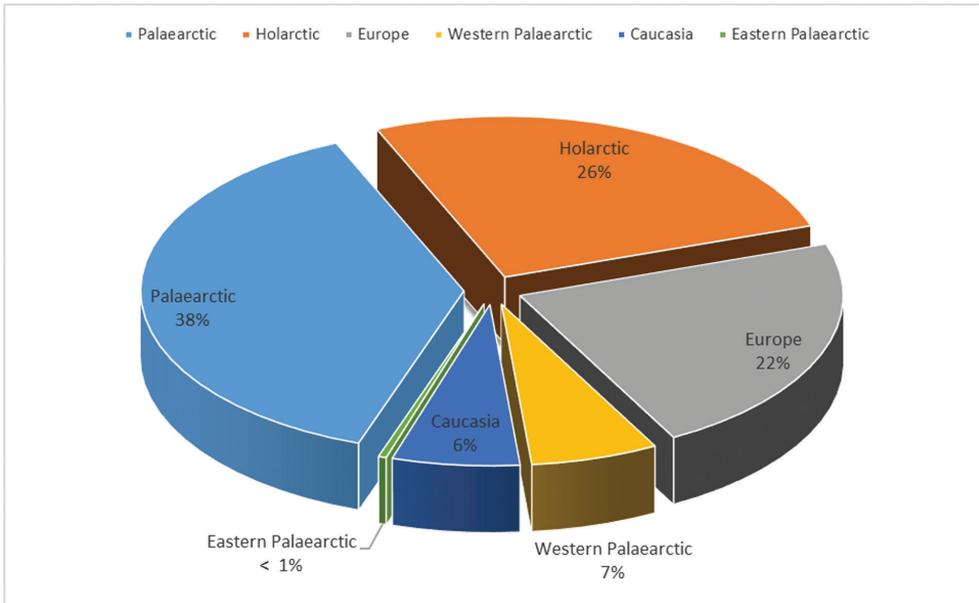


Figure 13. Grouping of the recorded Georgian fungus gnat species in accordance with their known distribution.

sweeping studies will probably increase that number considerably (see also below). As expected, the majority of the recorded species are widely distributed in the Palaeartic or Holarctic regions (38% and 26% of the recorded species, respectively), while 22% of species are restricted to Europe and 7% to the Western Palaeartic (Fig. 13). In addition, one species was so far known only from the Eastern Palaeartic and 17 species (11 described and 6 undescribed) are classified (tentatively) as Caucasian endemics. These proportions can change as fungus gnats are rather poorly known in several Palaeartic regions including the East Palaeartic, Asia Minor, Central Asia, as well as other regions in Caucasias.

The estimated species richness is the highest when calculated using Jackknife-2 nonparametric estimator (404 species, Fig. 14). This method has been discussed as possibly overestimating the true richness (e.g. Poulin 1998). On the other hand, Smith and van Belle (1984) showed that both Jackknife and Bootstrap estimators underestimate the actual number of species if there is a large number of rare species considered and number of samples is low. That can also be the case in the current data as the number of recorded singletons and doubletons is exceptionally high (82 and 42 species, respectively) and the number of species recorded from one sample only (= unique species) constitutes 43% of the observed diversity (107 out of the 251). Within the listed species, only nine were recorded from more than ten samples and 31 species from 5–10 samples. To compare, relatively well studied countries of similar size in Central and Northern Europe (e.g. Czech Republic, Slovak Republic, Estonia) have roughly 600 fungus gnat species recorded (Ševčík and Košel 2009, Ševčík and Kurina 2011a, b, *pers. observation*). Taking into account the mountainous landscape, high diversity of

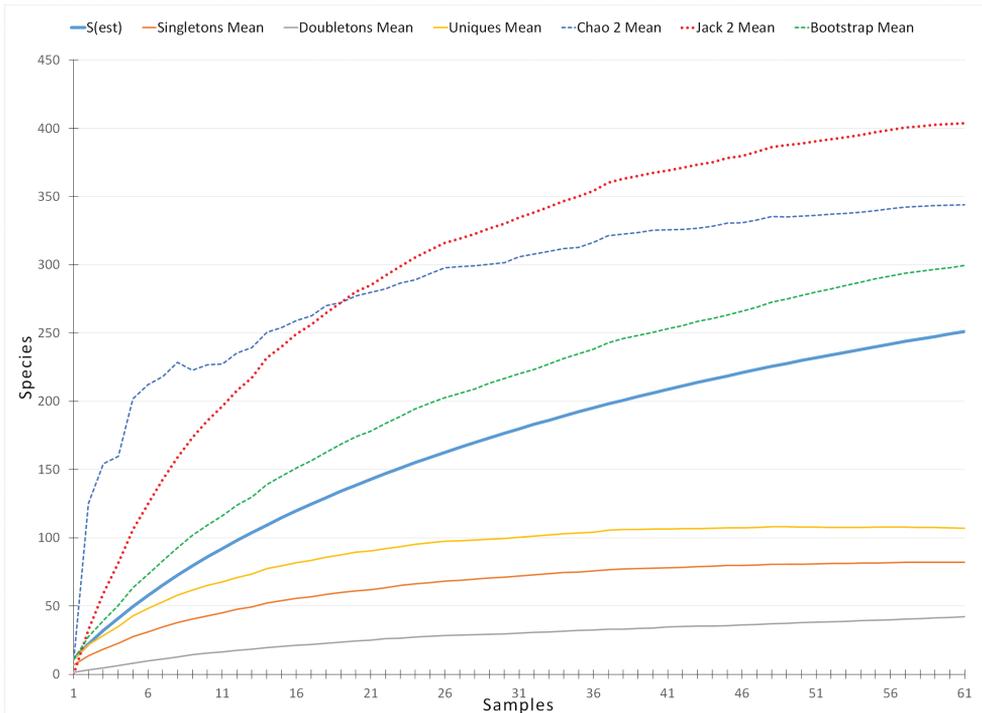


Figure 14. Species accumulation curves (EstimateS, Version 9.1.0.). Three nonparametric estimators (Chao 2, Jackknife 2 and Bootstrap) of total species richness are calculated. S(est) is the cumulative number of species observed.

habitats, microclimates in Georgia and that several regions were not covered by sampling of the current study (see Fig. 1), it can be presumed that the observed 245 species (+ one based on the literature data) do not constitute more than half of the actual diversity, probably less.

Surprisingly, the most abundant species was *Synapha fasciata* (769 specimens from 19 samples) followed by *Orfelia georgica* (175 specimens from 14 samples). In the European boreal and temperate regions, the most abundant species belong frequently to the subfamily Mycetophilinae and/or to the genera *Boletina* Staeger and *Mycomya* Rondani. Several of the recorded species considerably increase the knowledge of their distribution, the most remarkable of them include: *Neoempheria brevilineata* (earlier from Japan only), *Clastobasis loici* (earlier from Europe and Japan), *Lusitanoneura chandleri* (earlier from the Mediterranean Islands), *Zygomomyia setosa* (earlier with scattered distribution in Europe), *Manota unifurcata* (earlier from Europe only).

From the material underlining this study, four new species have been described earlier (Kurina and Jürgenstein 2013; Kurina 2018; Ševčík et al. 2020), three new species are described above and six putatively new species are left to be described in the future due to insufficiency of the available material or its quality. More exhaustive sampling will naturally yield a number of new taxa to be described in the future.

Acknowledgements

I am grateful to Prof. T. Tammaru (University of Tartu, Estonia) for organizing the collecting trips to Georgia in 2012 and 2013, and to Prof. G. Japoshvili (Agricultural University of Georgia, Tbilisi, Georgia) for help during the fieldwork including arrangement of permits. The study visit to the Zoological Research Museum Alexander Koenig, Bonn, Germany was funded by the European Commission's Research Infrastructure programme SYNTHESYS+ (DE-TAF-2498). I am grateful to X. Mengual (Bonn, Germany), U. Jürivete (Tallinn, Estonia) and A. Selin (Tallinn, Estonia) for providing specimens for this study. J. Kjærandsen (Tromsø, Norway), J. Salmela (Rovaniemi, Finland) and A. Polevoi (Petrozavodsk, Russia) are thanked for comments on particular species. I am much obliged to S. Fitzgerald (Corvallis, U.S.A.) for linguistic suggestions on the manuscript. A. Polevoi (Petrozavodsk, Russia), Jan Ševčík (Ostrava, Czech Republic) and P. Chandler (Melksham, United Kingdom) suggested valuable improvements to the manuscript.

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Diversity of intertidal, epibiotic, and fouling barnacles (Cirripedia, Thoracica) from Gujarat, northwest India

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Academic editor: A.Collareta | Received 13 November 2020 | Accepted 4 January 2021 | Published 26 March 2021

<http://zoobank.org/A27C7BA5-F206-46A2-B307-167C99BBFDDD>

Citation: Trivedi JN, Doshi M, Patel KJ, Chan BKK (2021) Diversity of intertidal, epibiotic, and fouling barnacles (Cirripedia, Thoracica) from Gujarat, northwest India. ZooKeys 1026: 143–178. <https://doi.org/10.3897/zookeys.1026.60733>

Abstract

The present work studied the diversity of intertidal, epibiotic, and fouling barnacles in the state of Gujarat, northwest India. In total, eleven species belonging to eight genera and five families were recorded in the present study. The Arabian intertidal species *Tetraclita ehsani* Shahdadi, Chan & Sari, 2011 and *Chthamalus barnesi* Achituv & Safriel, 1980 are common in the high- and mid-intertidal rocky shores of Gujarat suggesting that the Gujarat barnacle assemblages are similar to the assemblages in the Gulf of Oman Ecoregion. The biogeographical boundary between the Gulf of Oman and Western Indian ecoregions for barnacles should probably extend southward towards the waters adjacent to Mumbai, where Indo-Pacific species of intertidal barnacles dominate. This study provides the first reports of the common widely distributed balanomorph barnacles *Striatobalanus tenuis* (Hoek, 1883), *Tetraclitella karandei* Ross, 1971, *Amphibalanus reticulatus* (Utinomi, 1967), and lepadid barnacle *Lepas anatifera* Linnaeus, 1758 in Gujarat, as well as of the chthamalid barnacle *Chthamalus barnesi* in India.

Keywords

Arabian Sea, biogeography, ecoregions, new records, provinces

Introduction

Barnacles are marine crustaceans that inhabit a diverse range of substrates, including rocks, molluscan shells, corals, sponges, mangrove roots and leaves, turtle shells, and whale skin (Chan and Høeg 2015; Kim et al. 2020). Fossilized barnacle shells are often used to study the past environment (Bianucci et al. 2006a, b; Collareta et al. 2016a, b, 2018; Buckeridge et al. 2018, 2019). Burmeister (1834) was the first to classify barnacles into cirripedes, which later attracted the attention of numerous taxonomists including Charles Darwin (Anderson 1994). Barnacles have ecological and economic importance, as some species are biofoulers and others are considered seafood in some countries (Walker 1972; Newman and Abbott 1980; Santhakumaran and Sawant 1991; Rawangkul et al. 1995; Molnar et al. 2008; Sophia Rani et al. 2010; Holm 2012). More than 1400 species of barnacles are listed globally (Chan et al. 2009), and most are abundant along the intertidal and subtidal zones of temperate and tropical regions (Frith et al. 1976; Brickner and Høeg 2010; Brickner et al. 2010; Sophia Rani et al. 2010; Chen et al. 2012, 2014; Hayashi 2013; Yu et al. 2016). Taxonomic study of the Indian barnacle fauna dates back to the systemic work carried out by Darwin (1854), which was followed by several important studies in the 1900s (Annandale 1906, 1909, 1914; Nilsson-Cantell 1938; Daniel 1956, 1972, 1981). Fernando (2006) prepared a monograph on the barnacles of India in which he recorded 70 species of barnacles from Indian waters.

Spalding et al. (2007) classified the world's biogeographical provinces and ecoregions within provinces. The Persian Gulf, Gulf of Oman, and Arabian Sea belong to two provinces (Fig. 1A): the Arabian Province includes the Persian Gulf, Gulf of Oman, Western Arabian Sea, and Central Somali Coast Ecoregions. The West and South India Shelf Province covers the western and southern coastlines of India and Sri Lanka and is divided into the Western Indian Ecoregion and South India and Sri Lanka Ecoregion. Gujarat is the westernmost state of India and contains 1650 km of coastline (Fig. 1A, B). It possesses a variety of coastal habitats, including mangroves, coral reefs, rocky shores, mudflats, sandy shores, and estuaries (Fig. 1C–E; Trivedi et al. 2015). In the present work, we describe the species recorded in Gujarat and discussed the similarity in the assemblages of Gujarat between the Gulf of Oman and Western Indian Ecoregions.

Materials and methods

Study area

The coastal area of Gujarat is mainly divided into three major coastline regions: Saurashtra Coast, Gulf of Khambhat, and Gulf of Kachchh (Trivedi et al. 2015; Fig. 1B). Barnacle specimens were collected from five different sites: Jakhau (23°11.30'N, 68°37.35'E), Sutrapada (20°50.38'N, 70°28.46'E), Veraval (20°54.60'N, 70°21.13'E), Diu (20°42.88'N, 70°53.17'E) and Kuda Beach, Bhavnagar (21°37.70'N, 72°18.40'E) (Fig. 1B).

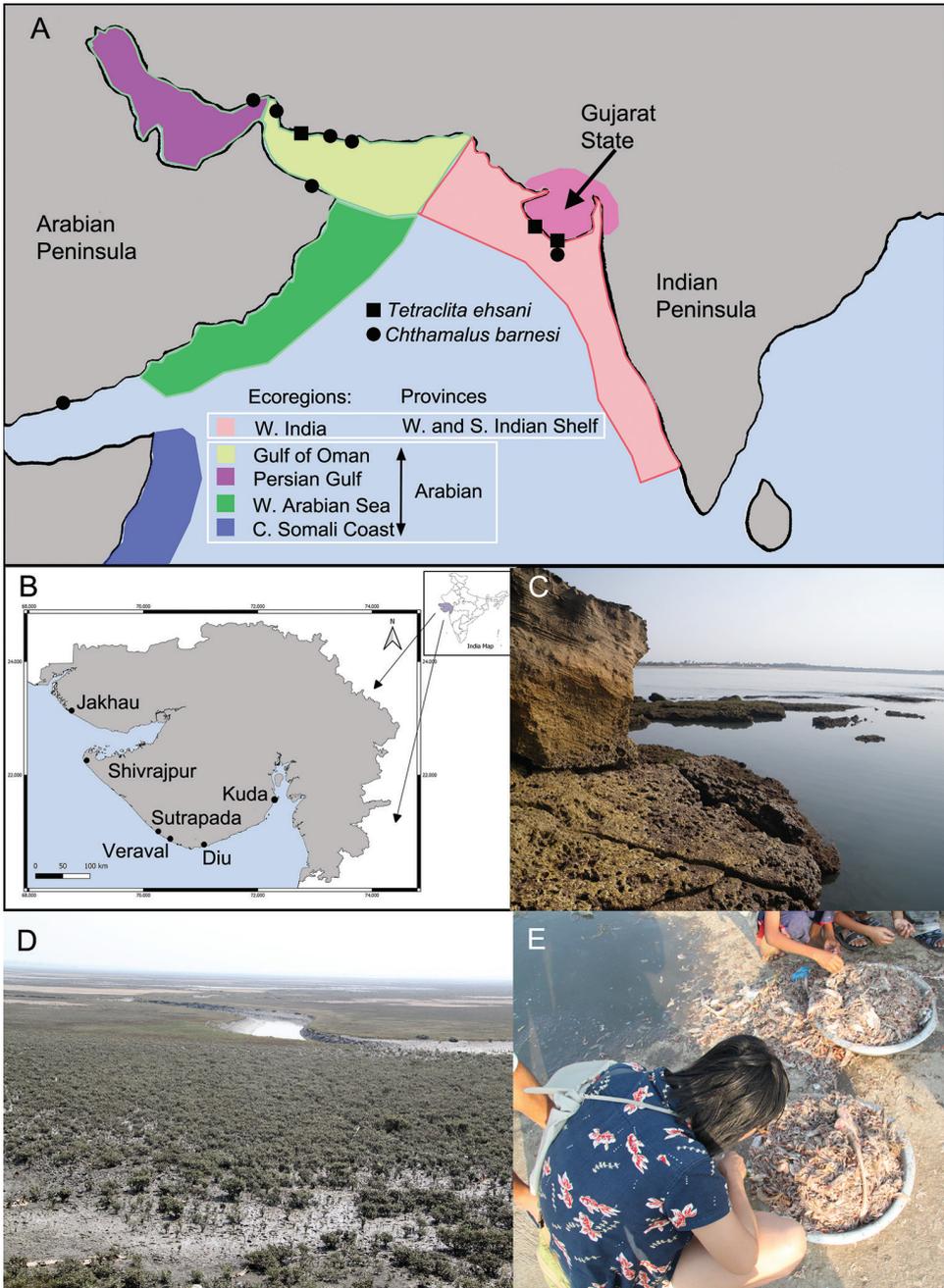


Figure 1. **A** map of the Arabian Sea and Indian Ocean showing the definition of ecoregions and provinces according to Spalding et al. (2007). The distribution records of *Chthamalus barnesi* and *Tetraclita ehsani* in the Persian Gulf, Gulf of Oman (Shahdadi and Sari 2011, Shahdadi et al. 2011), and in Gujarat (present study) are also plotted **B** map of Gujarat showing the sampling locations of barnacles collected in the present study **C** sandstone rocky intertidal at Diu, Gujarat **D** mangroves are common habitats in Gujarat and with *Amphibalanus amphitrite* on rocks **E** traditional Indian fish markets, where decapods with barnacles can be collected from the bulk by-catches gathered by fishermen.

Specimen collection and identification

Specimens were collected during low tides using a hammer and chisel from 2010–2020. Photographs of live specimens were taken in the field and then preserved in 10% formalin or 95% ethanol for further analysis in the laboratory. In the laboratory, barnacles were first identified based on their shell morphometry using a stereomicroscope. Specimens were gently dissected from their shell under a stereomicroscope with camera for specimen identification. The following barnacle parts were dissected: mouthparts (maxilla, maxillule, mandible, mandibulatory palp, and labrum), tergum, and scutum. The identification key of Chan et al. (2009) was used for basic taxonomic identification as well as for general terminologies of shell morphology and other important characters. All the specimens were deposited into the Zoological Reference Collection (**LFSc.ZRC**), Department of Life Sciences, Hemchandracharya North Gujarat University, Patan, Gujarat, India and Biodiversity Research Museum (**ASIZCR**), Academia Sinica, Taiwan. Rostral-carinal basal diameter of shells (**BD**) of sessile barnacles and capitulum length (**CL**, from the basal margin of scutum to apex of tergum) of stalked barnacles were measured to the nearest 0.01 mm.

Zonation pattern of rocky intertidal species at Diu, Gujarat

To examine the zonation of intertidal barnacles, stratified transect surveys were conducted in two rocky shores of Nagoa Beach in Diu (20°42.12'N, 70°55.0217'E and 20°42.17'N, 70° 53.94'E). The maximum tidal range at Diu is approximately 2.5 metres. At each shore, 10-m-long stretches of shoreline were selected. Sampling was conducted at the highest tidal level at which chthamaliid barnacles were found (2 m above Chart Datum, C.D.). Subsequent tidal levels were sampled at 0.5 m vertical intervals, 1.5 m above C.D. and 1.0 m above C.D. At each tidal level, ten random 0.25 × 0.25 m quadrats were established and the number of individuals of each species of barnacles was scored.

Results

A total of eleven barnacle species was recorded, belonging to six genera and five families. The common species recorded belonged to the family Balanidae (3 species, 2 genera), followed by Lepadidae (2 species, 1 genus), Chthamalidae (2 species, 2 genus), Tetraclitidae (2 species, 2 genus), Archaeobalanidae (1 species), and Chelonibiidae (1 species). *Chthamalus barnesi* Achituv & Safriel, 1980 was reported for the first time from India. *Lepas anatifera* Linnaeus, 1758 was reported for the first time from the west coast of India, while *Tetraclitella karandei* Ross, 1971, *Striatobalanus tenuis* (Hoek, 1883) and *Amphibalanus reticulatus* (Utinomi, 1967) were reported for the first time from the state of Gujarat.

Systematics

Cirripedia Burmeister, 1834

Thoracica Darwin, 1854

Sessilia Lamarck, 1818

Balanomorpha Pilsbry, 1916

Balanoidea Leach, 1817

Archaeobalanidae Newman & Ross, 1976

***Striatobalanus* Hoek, 1913**

***Striatobalanus tenuis* (Hoek, 1883)**

Figures 2A–C, 4

Examined material. four specimens (BD: 9.43–13.59 mm), LFSc.ZRC-157 (2 specimens on *Murex ternispina* Lamarck, 1822, one specimen on *Babylonia spirata* Linnaeus, 1758, and one specimen on *Bufonaria echinata* Link, 1807), Jakhau, Kachchh (23°11.30'N, 68°37.35'E), 9 January 2020, Gujarat, India, sandy shore, leg. M. Doshi.

Diagnosis (modified from Chan et al. 2009). Shell composed of six plates, conical, white, orifice deeply toothed (Fig. 2B). Scutum triangular, strongly sculptured on dorsal surface (Fig. 2C). Tergum triangular with long and narrow spur, scutal margin concave, medial furrow present on dorsal side of tergum (Fig. 2C). Scutal and tergal outer surfaces striated longitudinally. Maxilla triangular, covered with dense setae (Fig. 4A). Maxillule not notched, with two large setae on upper region (Fig. 4B). Mandible with five teeth excluding inferior angle, inferior angle blunt, 2nd and 3rd teeth bi-dentate (Fig. 4C–E). Mandibulatory palp rounded with setae at tip and superior margin (Fig. 4F). Labrum bullate shaped with distinct and deep notch having two prominent teeth on each side of cutting edge (Fig. 4G, H).

Remarks. The specimens examined in the present study agree with the description given by Chan (2009) and Chan et al. (2009). *Striatobalanus tenuis* closely resembles *S. amaryllis* (Darwin, 1854), but differs from the latter in the following characters: mandible with five equally spaced teeth (in *S. amaryllis*, the mandible has four teeth and the distance between the 3rd and 4th teeth is larger than the rest, Chan 2009); tergum triangular with short and wide spur (tergum narrow with beak produced apically in *S. amaryllis*, Chan 2009); and maxilla triangular, covered with dense setae (maxilla bilobed, elongated with dense setae on inferior margins in *S. amaryllis*, Chan 2009).

Striatobalanus tenuis also differs from *S. krugeri* (Pilsbry, 1916) and *S. taiwanensis* (Hiro, 1939) in that it has a median furrow on its tergum.

Worldwide distribution. This species has been reported from South Africa, East China Sea, South China Sea, Japan, the Philippines, Indonesia (Chan 2009), Vietnam (Poltarukha 2010) and India (Krishnamoorthy 2007).

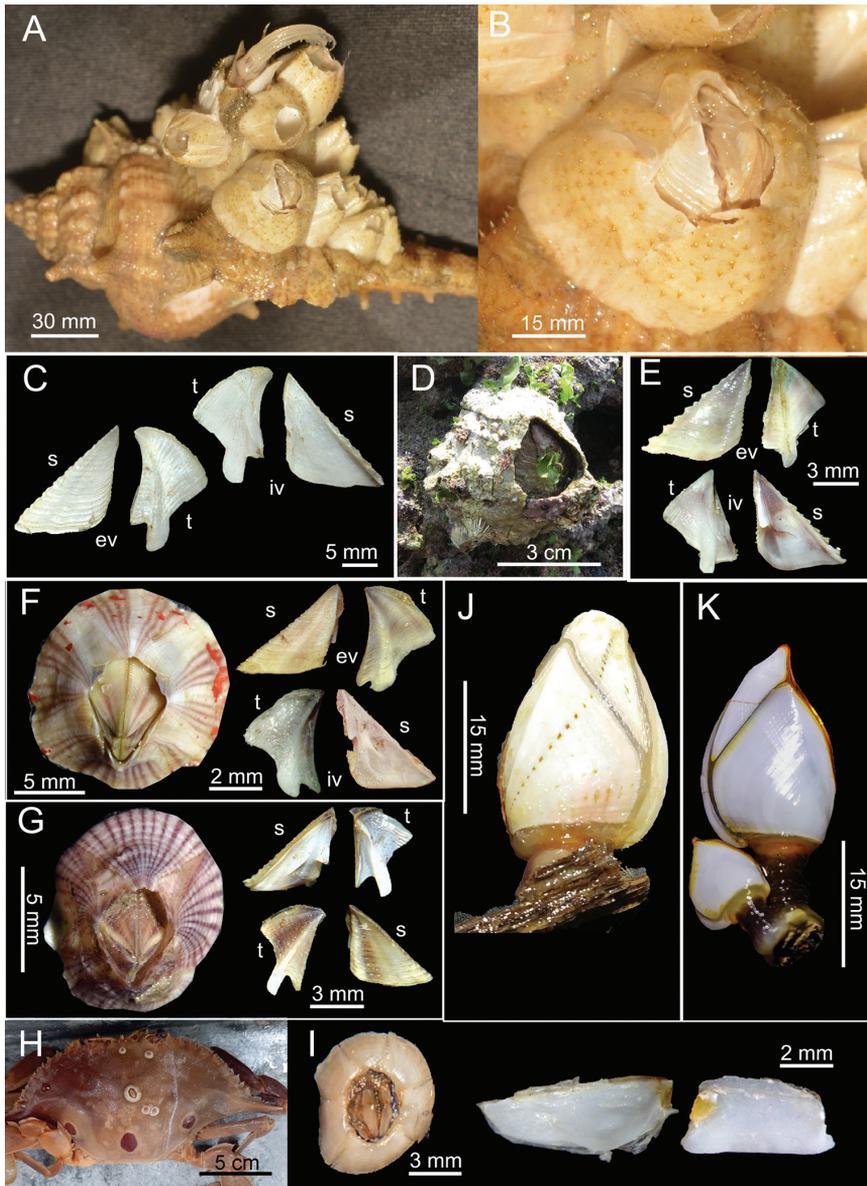


Figure 2. Gujarat barnacles **A** *Striatobalanus tenuis* (Hoek, 1883) on gastropod shell (*Murex ternispina* Lamarck, 1822) **B** top view of *Striatobalanus tenuis* (BD: 11.28 mm) LFSc.ZRC-157 **C** external and internal view of scutum and tergum **D** *Megabalanus tintinnabulum* on shores LFSc.ZRC-182 **E** external and internal view of scutum and tergum **F** *Amphibalanus amphitrite* (Darwin, 1854), top view, (BD: 12.38 mm) LFSc.ZRC-181, external and internal views of scutum and tergum **G** *Amphibalanus reticulatus* (Utinomi, 1967), top view, (BD: 14.99 mm) LFSc.ZRC-158, external and internal views of scutum and tergum **H** *Chelonibia testudinaria* (Linnaeus, 1758) on crab *Portunus sanguinolentus* **I** *Chelonibia testudinaria* (Linnaeus, 1758), top view (BD: 5.33 mm) LFSc.ZRC-159, internal view of scutum and tergum **J** *Lepas anatifera* Linnaeus, 1758, (CL: 16.39 mm) LFSc.ZRC-162, a. Side view of capitulum **K** *Lepas anserifera* Linnaeus, 1758, (CL: 16.28 mm) LFSc.ZRC-183, Side view of capitulum.

Distribution in India. This species has been reported from Gujarat (present study), Tamil Nadu (Krishnamoorthy 2007; Daniel 1956), Odisha (formerly Orissa) (Nilsson-Cantell 1938), and Karnataka (Nilsson-Cantell 1938).

Balanidae Leach, 1817

***Amphibalanus* Pitombo, 2004**

***Amphibalanus amphitrite* (Darwin, 1854)**

Figures 2F, 5

Examined material. five specimens (BD: 8.29–17.16 mm), LFSc.ZRC-181, on fishing boat surface, Jakhau, Kachchh (23°11.30'N, 68°37.35'E), 21 August 2019, Gujarat, India, sandy shore, leg. M. Doshi.

Diagnosis (modified from Chan et al. 2009). Shell conical, outer surface smooth, with longitudinal deep-purple striations (Fig. 2F). No horizontal striations on shell surface. Tergum with short, wide spur (Fig. 5). Scutum usually flat, occasionally concave between the apex and the basal margin. Articular ridges prominent (Fig. 5). Maxilla bilobed with dense setae on all margins (Fig. 5A). Maxillule not notched, cutting edge straight, upper and lower margins bearing fine setae (Fig. 5B). Mandible with five teeth, upper three teeth sharp, well developed (Fig. 5C–E). Mandibulatory palp bearing setae on superior margin (Fig. 5F). Labrum with a deep cleft, ca. 13–22 teeth on each side of cutting edge (Fig. 5G, H).

Remarks. The specimens examined in the present study agree with the descriptions given by Henry and McLaughlin (1975), Chan et al. (2009), and Pochai et al. (2017). *Amphibalanus amphitrite* closely resembles *A. reticulatus* (Utinomi, 1967) but differs from the latter in the following characters: the shell plates have only vertical purple striation (shell plates have longitudinal stripes intersected with transverse striations in *A. reticulatus*: Pochai et al. 2017), the shape of the shell is comparatively less columnar than in *A. reticulatus* (Pochai et al. 2017).

Worldwide distribution. This species has been reported from Bermuda and southeast USA to Brazil, Hawaii, California to southwest Mexico, western European waters, Mediterranean Sea, south coast of Africa, Red Sea, Black Sea, Southeast Africa, India (Trivedi et al. 2015), Australia, Indonesia, Singapore, Malaysia, Gulf of Siam in Cambodia (Jones and Hosie 2016), Vietnam (Condor Islands, Tang Trien (South Annam), Cauda Nhatrang, Hongay, Tonkin), the South China Sea, Bohai Sea (China), Taiwan, the Philippines, Japan (South Honshu, Kyushu and Ryukyu Islands) and Vladivostok (Russia) (see review in Henry and McLaughlin (1975)).

Distribution in India. This species has been reported from Gujarat (Trivedi et al. 2015; Parmar et al. 2018; present study), Maharashtra (Bhatt and Bal 1960), Goa (Desai et al. 2018), Kerala (Nilsson-Cantell 1938), Tamil Nadu (Prasanth and Sureshkumar 2020), Andhra Pradesh (Rao and Balaji 1988), Pulicat Lake (Sanjeeva 2006), Odisha (formerly Orissa) (Mitra et al. 2010), West Bengal (Ramakrishna and Talukdar 2003), and Andaman and Nicobar Islands (Mishra et al. 2010).

***Amphibalanus reticulatus* (Utinomi, 1967)**

Figures 2G, 6

Examined material. Two specimens (BD: 14.99 mm and 14.35 mm), LFSc.ZRC-158, Jakhau, Kachchh (23°11.30'N, 68°37.35'E), 9 January 2020, Gujarat, India, rock surface, leg. M. Doshi.

Diagnosis (modified from Chan et al. 2009). Shell conical surface smooth, having purple, pink, and white longitudinal stripes which intersect with transverse striations, operculum diamond-shaped (Fig. 2G). Scutum triangular with scutal margin straight (Fig. 2G). Tergum with straight occludent margins and short spur (Fig. 2G). Maxilla bilobed with margins bearing dense setae (Fig. 6A). Maxillule not notched (Fig. 6B). Mandible with four teeth excluding inferior, inferior angle blunt, 4th teeth bidentate (Fig. 6C–E). Mandibulatory palp with setae only on superior margin (Fig. 6F). Labrum with a deep cleft and four teeth on each side of cutting edge (Fig. 6G, H).

Remarks. The specimens examined in the present study agree with the descriptions and illustrations given by Chan et al. (2009) and Pochai et al. (2017). *Amphibalanus reticulatus* is very similar to *A. variegatus* (Darwin, 1854), in which both shells have striated patterns. Pitriana et al. (2020) illustrated the scutum, tergum, and mandibles of *A. variegatus*. The gaps between the teeth in the mandibles are smaller in *A. variegatus* than in *A. reticulatus*. In the present study, we concluded the mandibles of the specimens collected from India have relatively larger gaps between the teeth compared to the illustration in Pitriana et al. (2020). In addition, the tergum of *A. variegatus* illustrated in Pitriana et al. (2020) has a sharp spur, while the spur of the Indian specimen is blunt. We conclude the specimens collected in the present study represent *A. reticulatus*.

Worldwide distribution. This species has been reported from Japan, Indo-West Pacific (the Philippines, Hawaii, Gulf of Thailand, Indonesia; Chan et al. 2009; Pochai et al. 2017), Australia, Persian Gulf, and India (Fernando 2006).

Distribution in India. This species has been reported from Gujarat (present study), Maharashtra (Swami et al. 2011), and Tamil Nadu (Fernando 2006).

Megabalanus* Hoek, 1913**Megabalanus tintinnabulum* (Linnaeus, 1758)**

Figures 2D, E, 7

Examined material. Five specimens (BD: 10.57–24.26 mm), LFSc.ZRC-182, Veraval, Gir Somnath district (20°54.60'N, 70°21.13'E), 18 November 2019, Gujarat, India, rocky shore, leg. K. Patel.

Diagnosis (modified from Chan et al. 2009). Shell cylindrical to conical, colouration variable, mostly with rosy pink longitudinal stripes, surface smooth (Fig. 2D). Scutum triangular, with prominent transverse growth ridges, external surface bearing horizontal striations, inner surface with conspicuous articular ridges, articular ridges

broad (Fig. 2E). Tergum broad and triangular, spur long, narrow, prominent. External surface with median furrow (Fig. 2E). Maxilla bilobed with setae on all margins (Fig. 7A). Maxillule not notched, cutting edge straight (Fig. 7B). Mandible with 5 teeth excluding inferior angle, 1st tooth largest, sharply pointed, inferior angle blunt (Fig. 7C–E). Mandibulatory palp rectangular, with setae on superior margin (Fig. 7F). Labrum with very hairy crest and a deep cleft (Fig. 7G, H).

Remarks. The specimens examined in the present study agree with the original description given by Linnaeus (1758) and the more recent one by Chan et al. (2009). However, in the present specimen, the labrum does not possess teeth whereas the specimen examined by Chan et al. (2009) has three sharp teeth on each side of the cutting edge.

Megabalanus tintinnabulum closely resembles *M. validus* Darwin, 1854, but differs from the latter in having a conical shell with a coloured external surface. The species also resembles *M. volcano* (Pilsbry, 1916), but differs from the latter in having the maxillule not notched.

Worldwide distribution. The species has a cosmopolitan distribution with records from Brazil, Venezuela, European waters (UK, Ireland, Belgium and Netherlands; Southward, 2008) the Mediterranean Sea, Madagascar, Cape of Good Hope, New Zealand, Australia, Singapore, Thailand, Vietnam (Jones and Hosie 2016), Hong Kong, Taiwan, Japan, and India (Trivedi et al. 2015).

Distribution in India. This species has been reported from Gujarat (Trivedi et al. 2015; Parmar et al. 2018; present study), Maharashtra (Karande and Palekar 1966), Goa (Nandakumar 1990), Tamil Nadu (Krishnamoorthy 2007), Andhra Pradesh (Rao and Balaji 1988), Odisha (formerly Orissa) (Pati et al. 2009), West Bengal (Nilsson-Cantell 1938), Andaman and Nicobar Islands (Daniel 1972), and the Bay of Bengal (Nilsson-Cantell 1938).

Coronuloidea Leach, 1817

Chelonibiidae Pilsbry, 1916

***Chelonibia* Leach, 1817**

***Chelonibia testudinaria* (Linnaeus, 1758)**

Figures 2H, I, 8

Examined material. Two specimens (BD 5.33 and 5.59 mm), LFS_c.ZRC-159, on carapace of crab *Portunus sanguinolentus*, Kuda, Bhavnagar (21°37.70'N, 72°18.40'E), 17 April 2019, Gujarat, India, sandy shore, leg. J. Trivedi.

Diagnosis. Shell white, slightly conical and six-plated, radii board. Specimens living on turtles display oval-shaped depressions on radii of each shell plate. Specimens living on surfaces of decapods have a smooth outer surface, without any depressions on radii (Fig. 2I). Aperture large, scutum and tergum reduced, elongated rectangular in shape (Fig. 2I). Maxilla bilobed (Fig. 8A); maxillule feebly notched, cutting edge straight (Fig. 8B); mandible with five teeth, lower margin short (Fig. 8C–E).

Mandibulatory palp elongated with rough edges (Fig. 8F). Labrum having cleft with numerous sharp teeth (Fig. 8G, H).

Remarks. Previously, *Chelonibia* living on decapods were identified as *C. patula* and *Chelonibia* living on sea turtles as *C. testudinaria*. Cheang et al. (2013) and Zardus et al. (2014) revealed there is no significant genetic difference between *C. patula* and *C. testudinaria*, suggesting that these are the same species and their morphological differences are the result of phenotypic plasticity. We consider *C. testudinaria* as including two major morphs. The *patula* morph has a smooth white shell and lives mainly on decapods, while the *testudinaria* morph has oval depressions on the radii and lives mainly on surfaces of turtles. Dwarf males are often housed in these depressions on the *testudinaria* morph (Zardus and Hadfield 2004; Collareta 2020).

Worldwide distribution. *Chelonibia testudinaria* has been recorded in the Atlantic Ocean, Pacific Ocean and the Mediterranean Sea (Pasternak et al. 2002; Rawson et al. 2003) including Greece (Kitsos et al. 2003, 2005), Israel (Pasternak et al. 2002), Italy (Relini 1980; Frazier and Margaritoulis 1990), and Turkey (Bakir et al. 2010). Further records included Australia (Jones and Hosie 2016), Pakistan (Javed and Mustaqim 1994), and India (Krishnamoorthy 2007).

Distribution in India. This species has been reported from Gujarat (Frazier 1990; present study), Maharashtra (Wagh and Bal 1974), Kerala (Pillai 1958), Lakshadweep Islands (Hayashi 2013), Tamil Nadu (Daniel 1956; Krishnamoorthy 2007), Andhra Pradesh (Nilsson-Cantell 1938), Pulicat lake (Daniel 1981), Odisha (formerly Orissa) (Nilsson-Cantell 1938), west Bengal (Daniel 1981), and Andaman and Nicobar Islands (Nilsson-Cantell 1938).

Tetraclitoidea Gruvel, 1903

Tetraclitidae Gruvel, 1903

***Tetraclita* Schumacher, 1817**

***Tetraclita ehsani* Shahdadi, Chan & Sari, 2011**

Figures 3A, B, 9

Examined material. Five specimens (BD: 8.37–16.58 mm), LFSc.ZRC-184, Sutrapada, Gir Somnath district (20°50'23"N, 70°28'28"E), 22 December 2019, Gujarat, India, rocky shore, leg. K. Patel.

Diagnosis (modified from Shahdadi et al. 2011). Shell four-plated, conical, pink (Fig. 3A). Scutum and tergum white. Scutum narrow, external surface bearing faint horizontal striations, 1.5 × higher than wide, adductor muscle pit shallow, seven distinct rostral and four–six lateral depressor crests (Fig. 3B). Tergum long and narrow with ten definite depressor crests, spur long and narrow (Fig. 3B). Maxilla bilobed and setae present on both the lobes (Fig. 9A). Maxillule notched with two large and four small simple setae above notch (Fig. 9B). Mandible with five teeth excluding the inferior angle, 1st tooth separated from the remaining teeth, 2nd and 4th teeth bidentate, 3rd teeth tridentate, 5th tooth small and located close to the 4th tooth (Fig. 9C–E). Mandibulatory

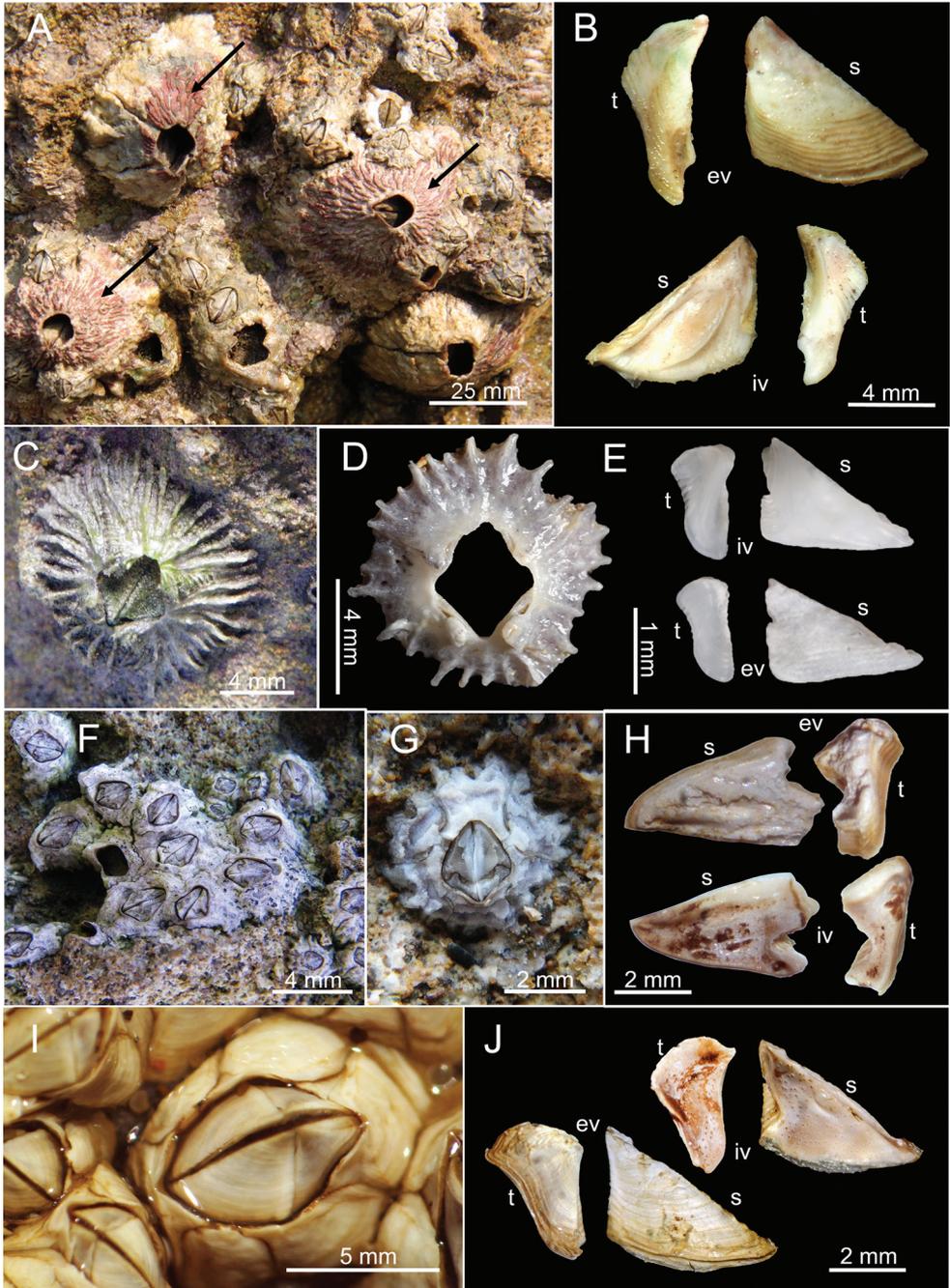


Figure 3. **A** *Tetraclita ehsani* LFSc.ZRC-184 on shores of Diu **B** *Tetraclita ehsani*, external and internal view of scutum and tergum **C** *Tetraclitella karandei* ASIZCR000454 on shores at Diu **D** shell of *T. karandei* **E** *Tetraclitella karandei* external and internal view of scutum and tergum **F** *Chthamalus barnesi* on shores **G** close up view of *C. barnesi* LFSc.ZRC-160 **H** Internal and external view of scutum and tergum of *C. barnesi* **I** *Microeuraphia withersi* LFSc.ZRC-161 (BD: 6.01 mm) **J** internal and external view of scutum and tergum of *M. withersi*.

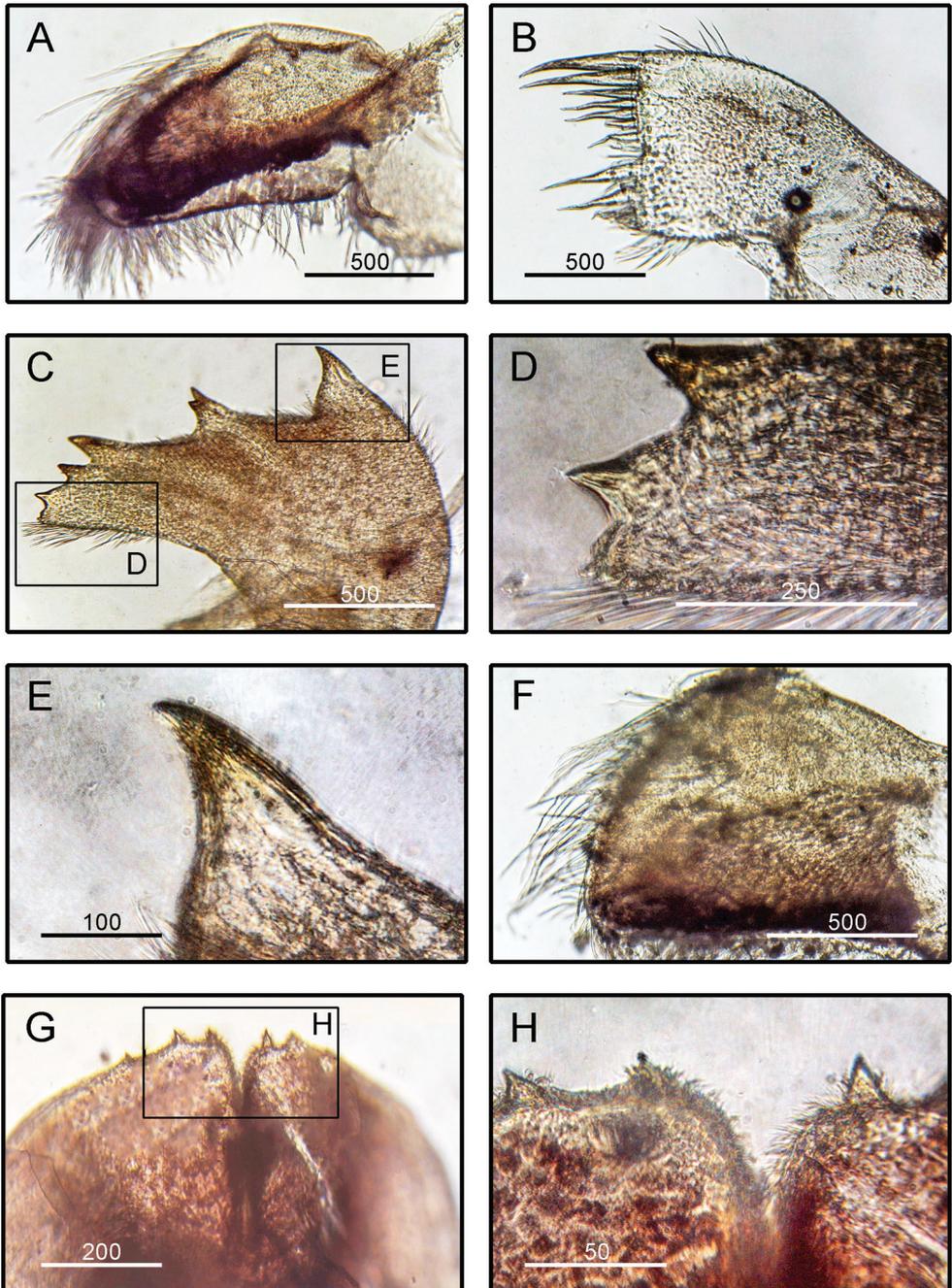


Figure 4. *Striatobalanus tenuis* (Hoek, 1883), (BD: 11.28 mm) LFSc.ZRC-157, Light microscopy on mouth parts **A** maxilla **B** maxillule **C** mandible **D** close up on the inferior angle of mandible **E** close up on the teeth of mandible **F** mandibulatory palp **G** labrum **H** close up view on the cutting edge of Labrum, showing the teeth. Scale bars in μm .

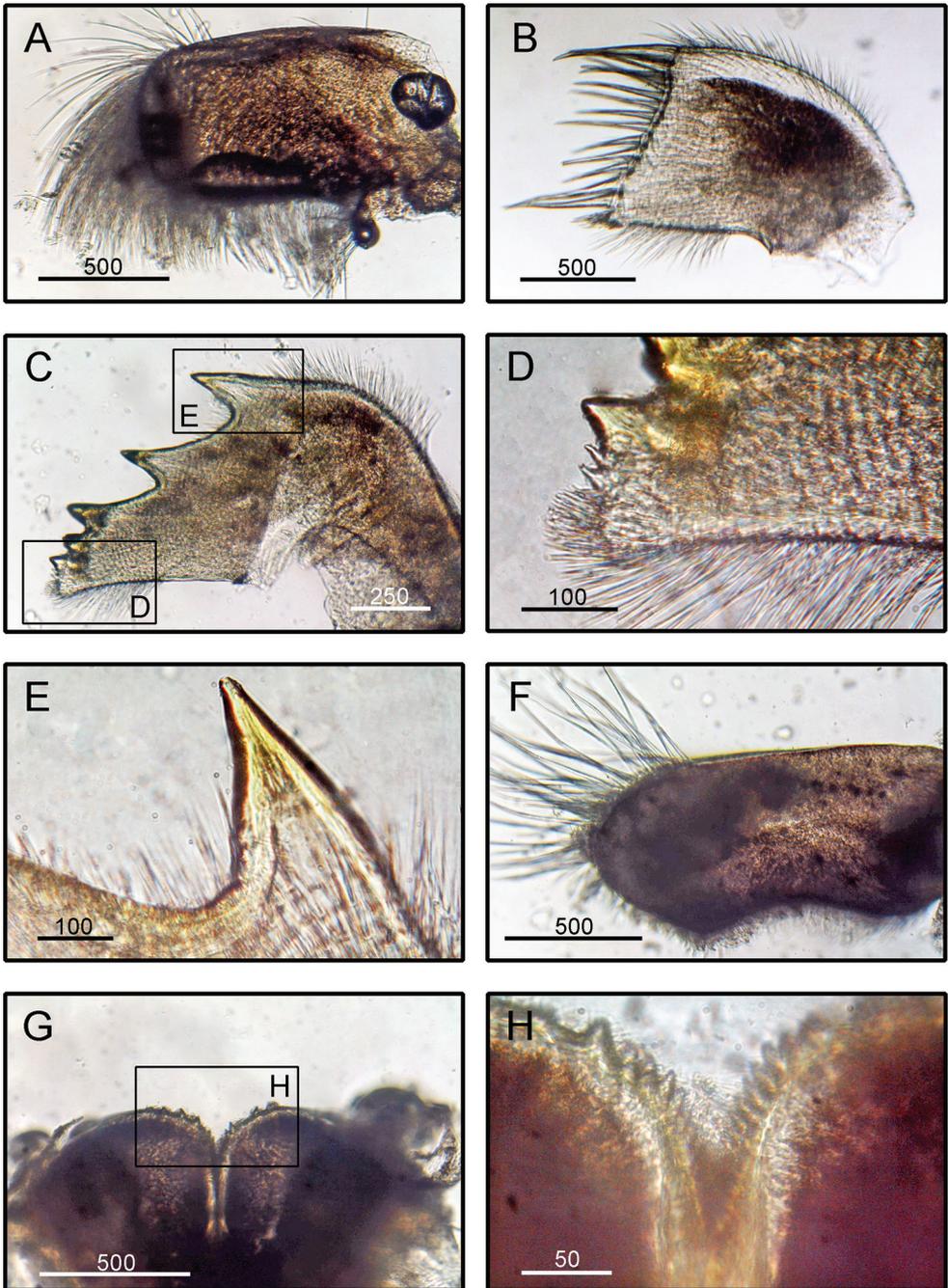


Figure 5. *Amphibalanus amphitrite* (Darwin, 1854), (BD: 12.38 mm) LFSc.ZRC-181, Light microscopy on mouth parts **A** maxilla **B** maxillule **C** mandible **D** close up on the inferior angle of mandible **E** close up on the teeth of mandible **F** mandibulatory palp **G** labrum **H** close up view on the cutting edge of Labrum, showing the teeth. Scale bars in μm .

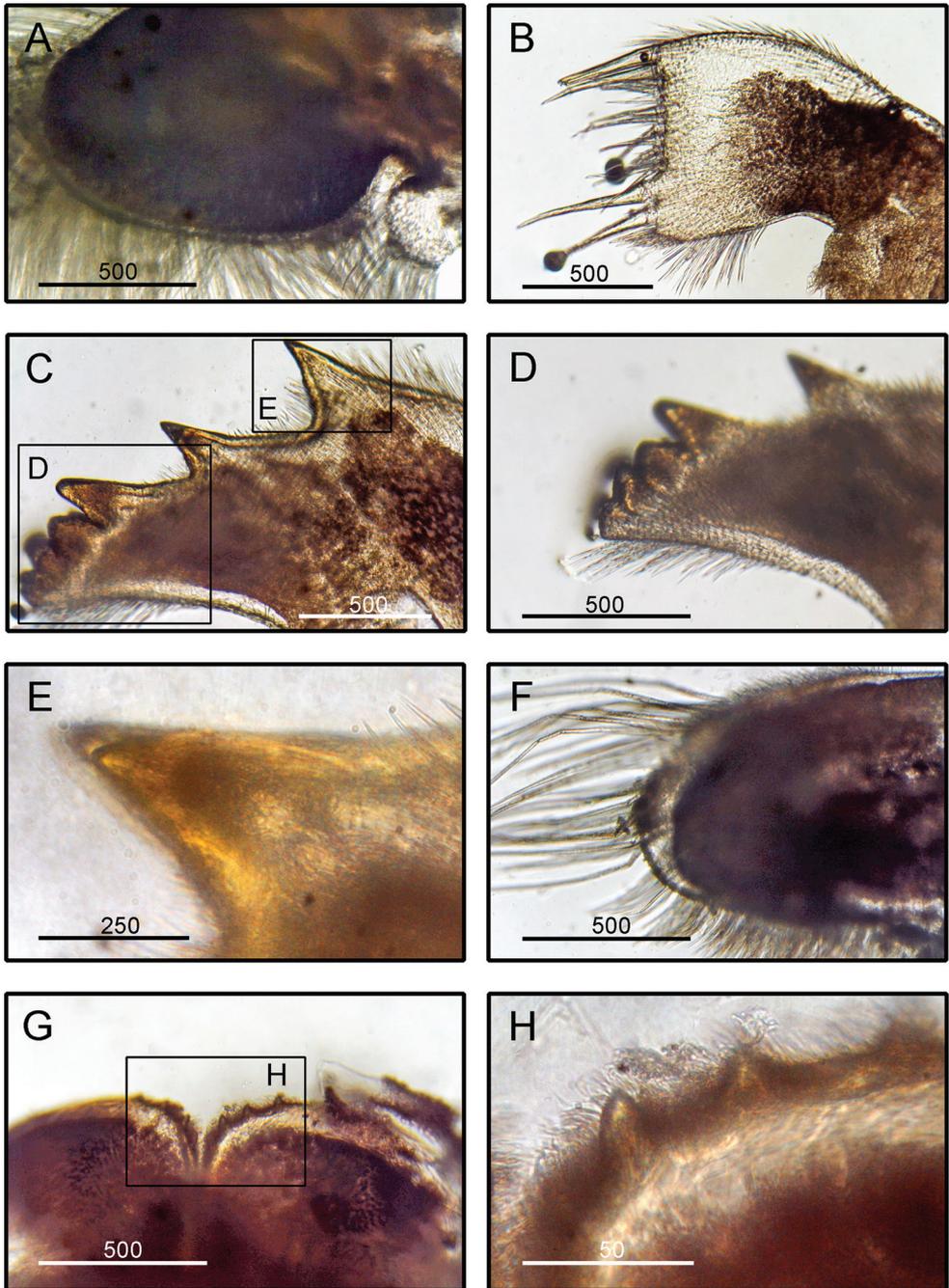


Figure 6. *Amphibalanus reticulatus* (Utinomi, 1967), (BD: 14.99 mm), LFSc.ZRC-158, light microscopy on mouth parts **A** maxilla **B** maxillule **C** mandible **D** close up on the inferior angle of mandible **E** close up on the teeth of mandible **F** mandibulatory palp **G** labrum **H** close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

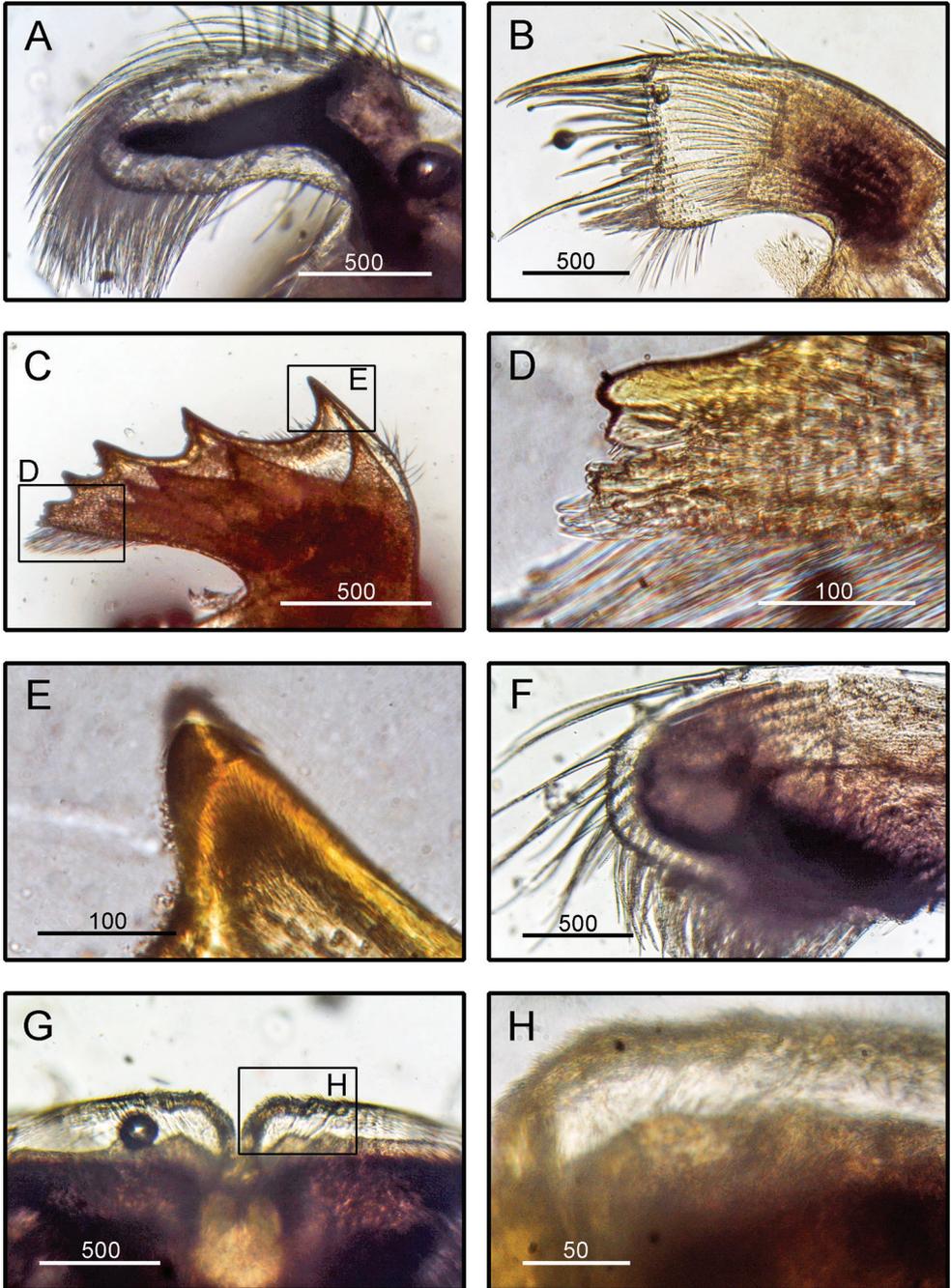


Figure 7. *Megabalanus tintinnabulum* (Linnaeus, 1758), (BD: 20.28 mm) LFSc.ZRC-182, Light microscopy on mouth parts **A** maxilla **B** maxillule **C** mandible **D** close up on the inferior angle of mandible **E** close up on the teeth of mandible **F** mandibulatory palp **G** labrum **H** close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

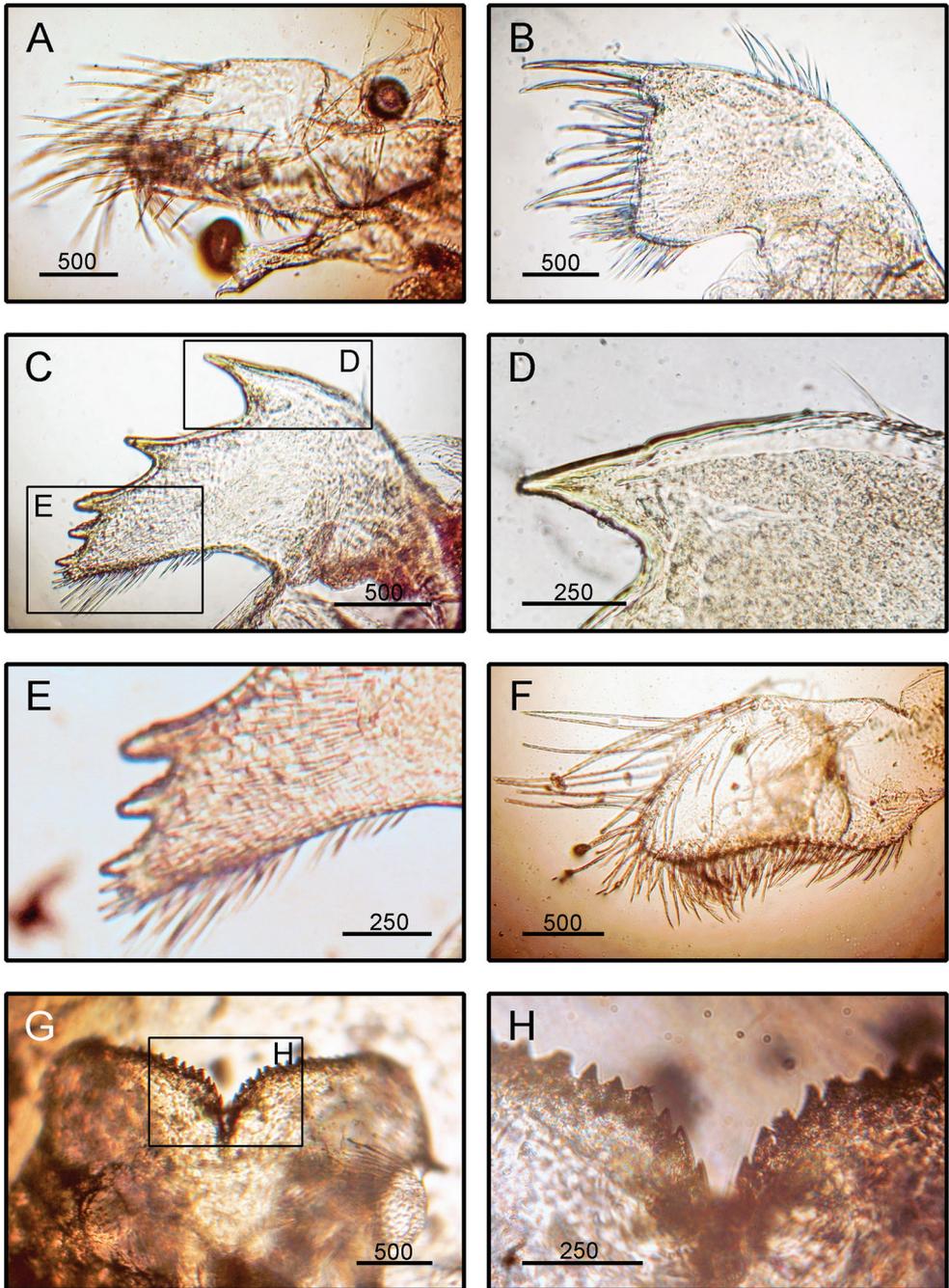


Figure 8. *Chelonibia testudinaria* (Linnaeus, 1758), (BD: 5.33 mm) LFSc.ZRC-159, Light Microscopy on mouth parts **A** maxilla **B** maxillule **C** mandible **D** close up on the inferior angle of mandible **E** close up on the teeth of mandible **F** mandibulatory palp **G** labrum **H** close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

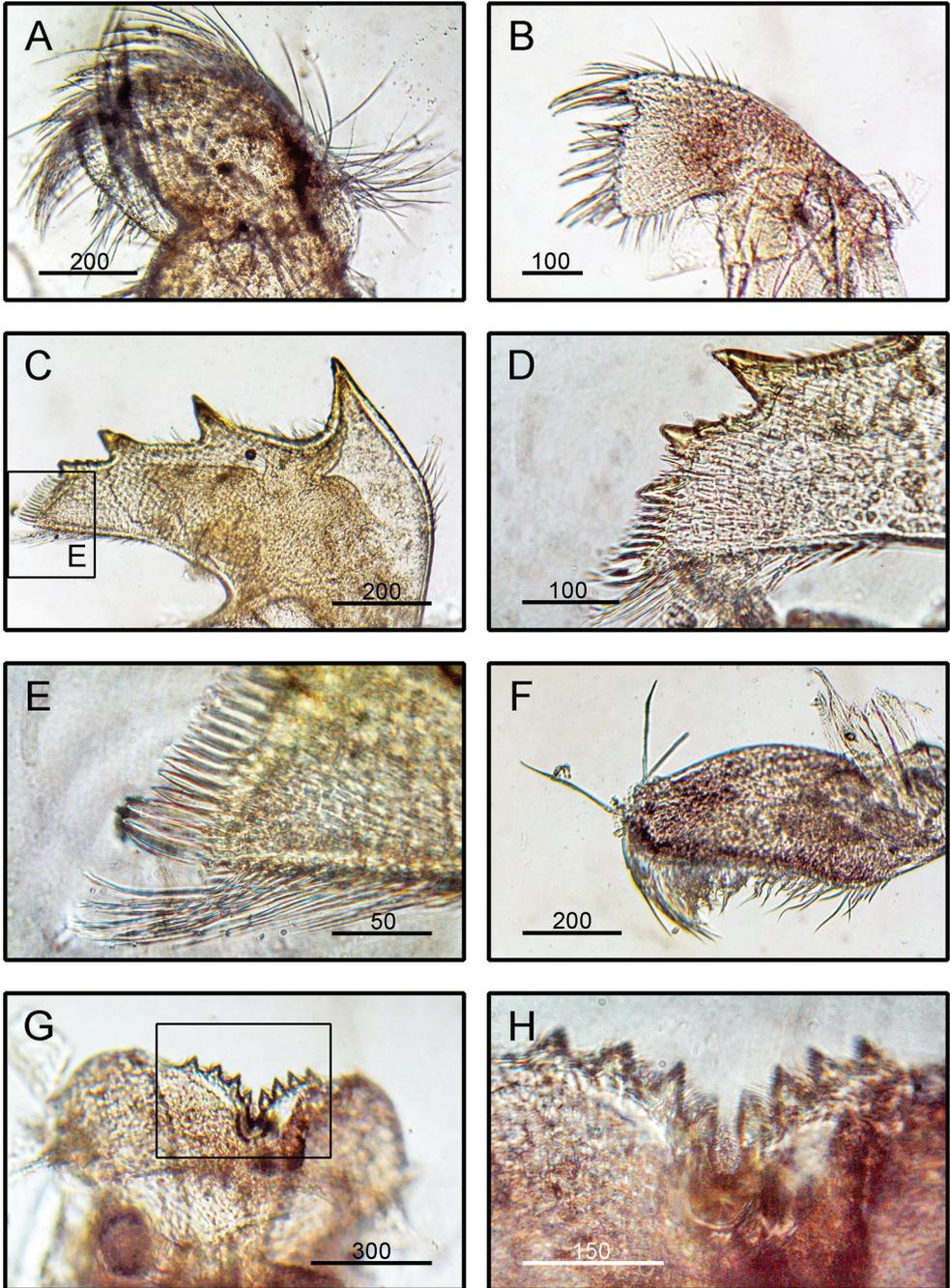


Figure 9. *Tetraclita ehsani* Shahdadi, Chan & Sari, 2010, (BD: 14.38 mm), LFSc.ZRC-184 Light microscopy on mouth parts **A** maxilla **B** maxillule **C** mandible **D** close up on the inferior angle of mandible **E** close up on the teeth of mandible **F** Mandibulatory palp **G** labrum **H** close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

palps elongated, superior margin bearing setae (Fig. 9F). Labrum notched, notch shallow, four erect large teeth on each side of the cutting edge (Fig. 9G, H).

Remarks. The examined specimens in the present study agree with the description given by Shahdadi et al. (2011). *Tetraclita ehsani* closely resembles *T. reni* Chan, Hsu & Tsai, 2009, *T. achituvi* Ross, 1999 and *T. rufotincta* Pilsbry, 1916, but can be differentiated from these species in the following characters: the tergum is very narrow, with the basal region slightly concave or almost straight vs. the broad tergum that has a strongly concave basal margin in *T. rufotincta* and *T. reni*, and the basi-carinal angle is larger ($\sim 100^\circ$) (the basi-carinal angle is smaller in *T. reni* (80°) and *T. rufotincta* (73°) (Shahdadi et al. 2011).

Worldwide distribution. This species has been reported from the Gulf of Oman in Iran (Shahdadi et al. 2011) and from northwest India (Tsang et al. 2012).

Distribution in India. This species has been reported from Gujarat (Tsang et al. 2012; present study). It is not found in the region further south of Gujarat and was confirmed to be absent in Mumbai and southern India (Tsang et al. 2012).

Tetraclitella Hiro, 1939

Tetraclitella karandei Ross, 1971

Figures 3C–E, 10

Examined material. Five specimens (BD: 5–10 mm), ASIZCR000454, Nagoa Beach, Diu ($20^\circ 42.12'N$, $70^\circ 55.02'E$), 22 March 2010, Gujarat, India, rocky shore, leg. B.K.K. Chan.

Diagnosis. Shell four-plated, surface of radii protruding with digit-like horizontal striations up to the shell apex, shell surface with fine hairs and chitin coating (Fig. 3C, D). Opercular plates white, scuta triangular, occludent margin and basal margin almost perpendicular, tergal margin straight; tergum higher than wide, scutal margin straight, spur small (Fig. 3E). Maxilla bilobed (Fig. 10A). Maxillule notched, with two cuspidate setae above notch (Fig. 10B). Mandible having four teeth, the 3rd and 4th of which are triple-dentated (Fig. 10C). Labrum slightly bullate, with two small teeth on each cutting edge (Fig. 10D). Mandibulatory palp elongated with dense setae on superior angle (Fig. 10E). Cirrus I: anterior ramus seven-segmented, posterior ramus longer and slender, nine-segmented. Cirrus II: rami subequal, anterior ramus six-segmented, posterior ramus seven-segmented (Fig. 10F–H). Cirrus III: both rami slender, anterior ramus 13-segmented, posterior ramus 14-segmented. Intermediate segment bears two pairs of long simple setae and three pairs of short simple setae (Fig. 10F–H).

Remarks. This species inhabits intertidal shore of the rocky intertidal region of Gujarat.

Worldwide distribution. This species has been recorded in India and Taiwan (Ross 1971, 1972).

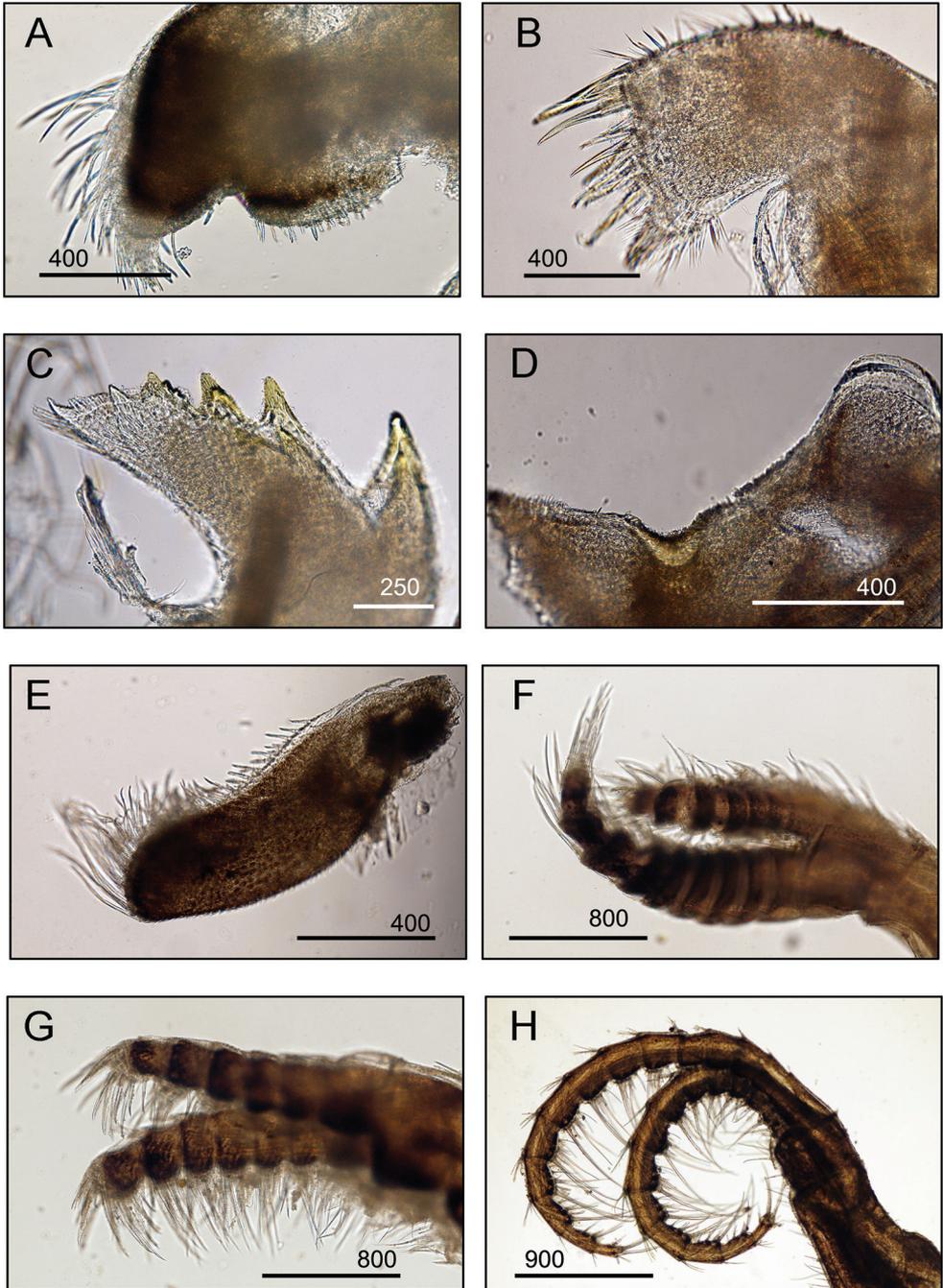


Figure 10. *Tetracitella karandei* Ross, 1971, (BD: 8.37 mm), ASIZCR000454, Light microscopy on mouth parts **A** maxilla **B** maxillule **C** mandible **D** labrum **E** mandibulatory palp **F** cirrus I **G** cirrus II **H** cirrus III. Scale bars in μm .

Distribution in India. This species has been reported from Gujarat (present study) and Mumbai (Ross 1971; Fernando 2006).

Chthamaloidea Darwin, 1854

Chthamalidae Darwin, 1854

***Chthamalus* Ranzani, 1817**

***Chthamalus barnesi* Achituv & Safriel, 1980**

Figures 3F–H, 11

Examined material. Five specimens (BD: 3.03–5.57 mm), LFSc.ZRC-160, Shivrajpur, Jamnagar District (22°20'03"N, 68°57'17"E), 17 February 2019, Gujarat, India, rocky shore, leg. M. Doshi.

Diagnosis (modified from Shahdadi and Sari 2011). Shell orifices almost kite-shaped (Fig. 3F, G). Tergum narrow with upper part broader than lower part and suture between tergum and scutum zigzag-shaped (Fig. 3H). Scutum elongated and triangular and lateral depressor muscle pit distinct without crest (Fig. 3H). Maxilla bilobed (Fig. 11A). Maxillule not notched or possess very shallow notch (Fig. 11B). Lower part of maxillule is setose. Mandible with four teeth (Fig. 11C). Basal comb with rows of 16–23 short spines and 2–4 stout large spines at lower angle (Fig. 11D). Mandibulatory palp with dense setae on all margins (Fig. 11E). Labrum with numerous fine teeth present (Fig. 11F). Cirrus I: anterior ramus (with seven or eight segments) longer than posterior (usually with 5–7 segments) (Fig. 11G). Cirrus II: anterior ramus (with six–seven segments) longer than posterior (usually with 5–7 segments) (Fig. 11H). Cirri III–VI: rami almost equal in size.

Remarks. The examined specimen in the present study agree with the description given by Achituv and Safriel (1980) and Shahdadi and Sari (2011). *Chthamalus barnesi* forms part of the *challengeri* group and closely resembles *C. moro* Pilsbry, 1916, *C. neglectus* Yan & Chan, 2004, and *C. challenger* Hoek, 1883, but can be differentiated based on the following characters: a depression towards the tergo-occludent corner of the scutum (*C. moro*, lacks this depression, Southward and Newman 2003), the tergal margin is not straight (tergal margin straight in *C. moro*, Southward & Newman, 2003), the scutal margin of the tergum shows a deep articular furrow (scutal margin of tergum almost straight in *C. neglectus*, Yan & Chan, 2004), and the maxillule possess a very shallow notch (maxillule possesses a distinct notch in *C. challenger*, Shahdadi & Sari, 2011).

Worldwide distribution. The species has been reported from the Red Sea, Gulf of Aden, and Gulf of Oman including Yemen, Oman, Iran, Saudi Arabia (Shahdadi and Sari 2011), and northwest India (present study).

Distribution in India. This species is reported for the first time in India from the coastal regions of Gujarat.

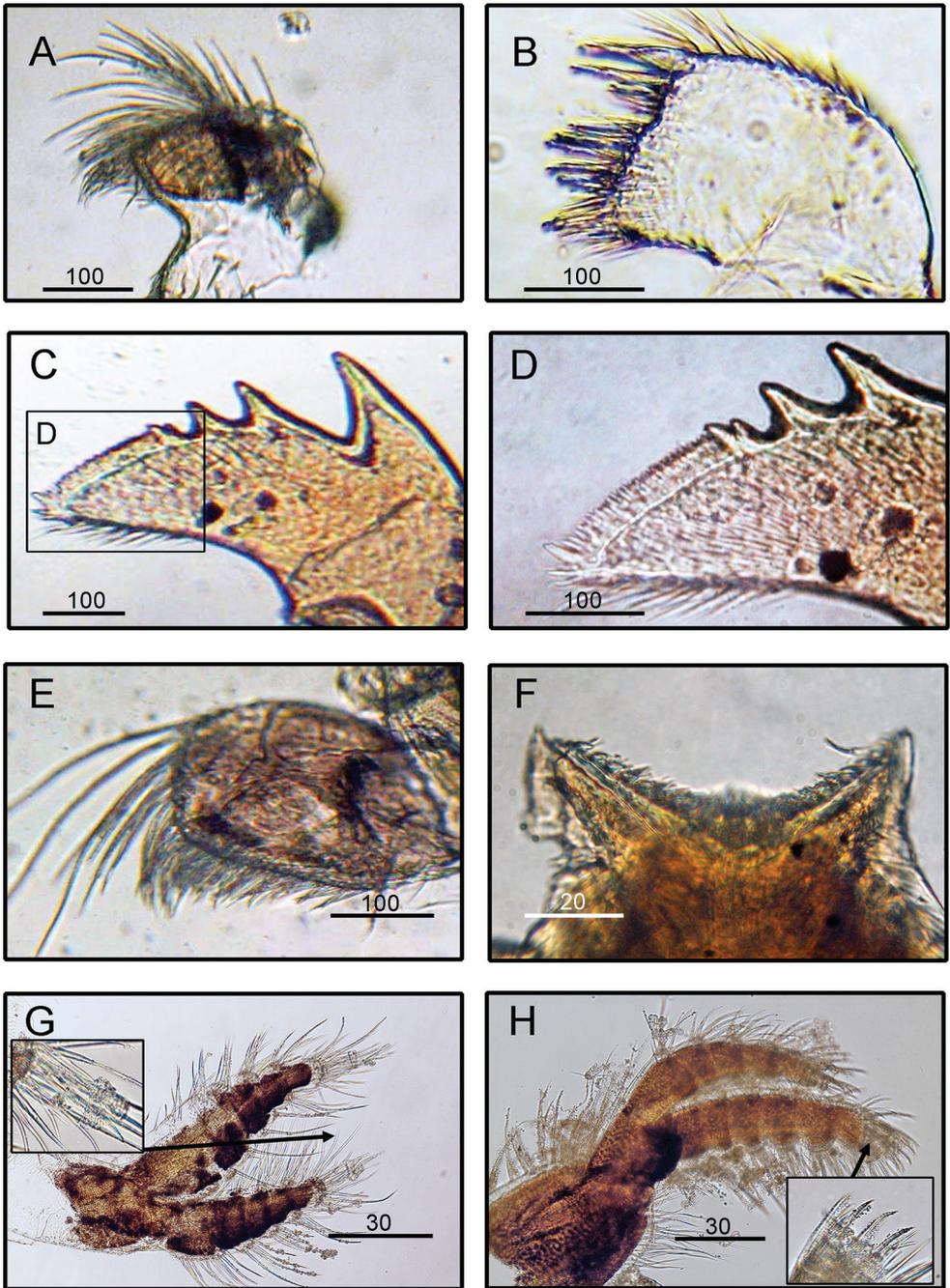


Figure 11. *Chthamalus barnesi* Achituv & Safrieli, 1980. (BD: 4.21 mm), LFSc.ZRC-160, Light microscopy on mouth parts **A** maxilla **B** maxillule **C** mandible **D** close up on the inferior angle of mandible **E** mandibulatory palp **F** labrum **G** cirrus II **H** cirrus III. Scale bars in μm.

Microeuraphia Poltarukha, 1997*Microeuraphia withersi* (Pilsbry, 1916)

Figures 3I, J, 12

Examined material. Five specimens (BD: 3.90–6.01 mm) LFSc.ZRC-161, Kuda, Bhavnagar (21°37.70'N, 72°18.40'E), 21 January 2020, Gujarat, India, muddy shore, leg. M. Doshi.

Diagnosis (modified from Pilsbry 1916). Specimens depressed, cinnamon-brown with smooth surface, with a large, wide aperture; alae broad with arched, sub-horizontal summits (Fig. 3I). Scutum thin, triangular, conical, almost twice as long as wide, lower part with fine growth-lines (Fig. 3J). Articular ridge feebly developed with median lobe, not extending beyond the scutal border. Articular furrow shallow and sharply notched. Tergum narrow, club-shaped, very thick (Fig. 3J). Cirrus I: anterior ramus (with seven or eight segments) longer than posterior (usually with six or seven segments). Cirrus II: anterior ramus (with seven or eight segments) longer than posterior (usually with six segments). Setae of terminal segment non-pectinated. The carinal lobe narrow, situated high. Maxilla bilobed (Fig. 12A), group of short spines on the lower edge. Maxillule not notched (Fig. 12B). Mandible with three large teeth and pectinated lower point with eight spines (Fig. 12C–E). Mandibulatory palp rectangular (Fig. 12F). Labrum with broad, nearly straight edge, the middle fold having a series of strong teeth (Fig. 12G, H).

Remarks. The specimens examined in the present study agree with the description by Pilsbry (1916). *Microeuraphia withersi* closely resembles *M. depressa* and *M. permitini*, but can be distinguished from the latter based on the following characters: the scutum is comparatively narrow in (*scutum is comparatively wide in M. depressa*, Poltarukha, 1997), the width to height ratio fluctuates from 0.8 to 1.4 (width to height ratio commonly > 1.5 in *M. depressa*, Poltarukha, 1997), the basal comb of mandible with eight equally distanced slender spines (1–3 stout spines after third tooth, and a row of small and 2–4 long spines in *M. permitini*, Shahdadi and Sari 2011), and both the rami of cirri II without finely pectinate setae on terminal segments (both rami of cirri II with finely pectinate setae on terminal segments in *M. permitini*; Shahdadi & Sari, 2011).

Worldwide distribution. The species has been reported from the Philippines (Pilsbry 1916), the west coast of Sumatra (Nilsson-Cantell 1921), Indonesia, Singapore, Java, Vietnam, Hong Kong, the South China Sea (Jones and Hosie 2016), the East China Sea (Zevina and Tarasov 1963), Australia, Madagascar (Utinomi 1968), and India (Nilsson-Cantell 1938).

Distribution in India. This species is reported from Gujarat (present study), Maharashtra (Nilsson-Cantell 1938; Karande and Palekhar 1966; Wagh and Bal 1974), and West Bengal (Daniel 1981).

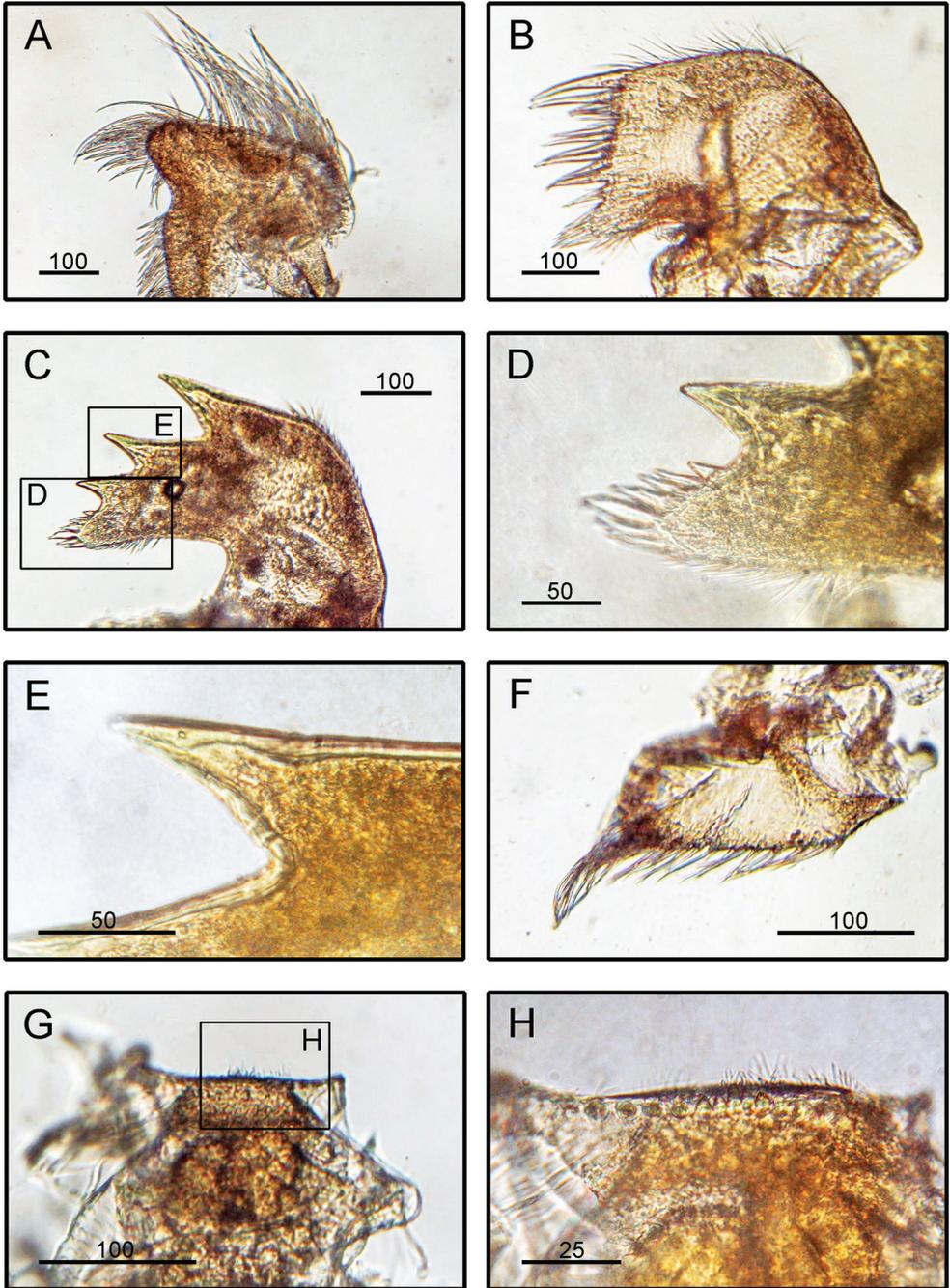


Figure 12. *Microeuraphia withersi* (Pilsbry, 1916). (BD: 6.01 mm), LFSc.ZRC-161, Light microscopy on mouth parts **A** maxilla **B** maxillule **C** mandible **D** close up on the inferior angle of mandible **E** close up on the teeth of mandible **F** mandibulatory palp **G** labrum **H** close up view on the cutting edge of labrum, showing the teeth. Scale bars in µm.

Lepadiformes Buckeridge & Newman, 2006**Lepadidae Darwin, 1852*****Lepas* Linnaeus, 1758*****Lepas anatifera* Linnaeus, 1758**

Figures 2J, 13

Examined material. Five specimens (CL: 8.29–16.39 mm), LFSc.ZRC-162, Jakhau, Kachchh (23°11.30'N, 68°37.35'E), 26 July 2019, Gujarat, India, fishing boat surface, leg. M. Doshi.

Diagnosis (modified from Chan et al. 2009). Capitulum with five smooth, white, thin plates. Capitulum white, peduncle dark brown in colour (Fig. 2J). Scutum triangular with occludent margin convex. Right scutum with inner umbonal tooth, sometimes rudimentary. Scutum sometimes with dark marking or spots, carina branched below umbo. Tergum triangular to quadrangular with occludent margin convex or angular, apex almost truncated. Carina generally smooth, occasionally barbed. Peduncle variable in length, sometimes several times longer than capitulum. Caudal appendages short and claw-shaped. Maxilla globular with setae over margins (Fig. 13A). Maxillule notched into four distinct regions (Fig. 13B). Mandible having five teeth excluding inferior angle, inferior angle pectinated (Fig. 12C–E). Mandibulatory palp triangular with setae on superior margin (Fig. 12F). Labrum prominently concave, fine setae and teeth on cutting edge (Fig. 12G, H).

Remarks. The specimens examined in the present study agree with the description given by Chan et al. (2009). *Lepas anatifera* closely resembles *L. anserifera* Linnaeus, 1767, but can be differentiated by the following characters: maxillule notched into four distinct regions (maxillule not clearly notched in *L. anserifera*, Chan et al. 2009), upper portion of tergum blunt (upper portion of tergum pointed in *L. anserifera*, Chan et al. 2009), scutum sometimes with dark marking or spots (no such markings or spots on scutum in *L. anserifera*, Chan et al. 2009).

Worldwide distribution. The species has a cosmopolitan distribution (Chan et al. 2009; Schiffer and Herbig 2016) that includes India (Krishnamoorthy 2007).

Distribution in India. This species has been reported from Gujarat (present study), Tamil Nadu (Krishnamoorthy 2007), Odisha (formerly Orissa) (Annandale 1909; Ramakrishna and Talukdar 2003), and Andaman and Nicobar Islands (Nilsson-Cantell 1938).

***Lepas anserifera* Linnaeus, 1767**

Figures 2K, 14

Examined material. Five specimens (CL: 11.39–22.13 mm), LFSc.ZRC-163, Vankbara beach, Diu (20°42.88'N, 70°53.16'E), 12 December 2019, Gujarat, India, fishing boat surface, leg. M. Doshi.

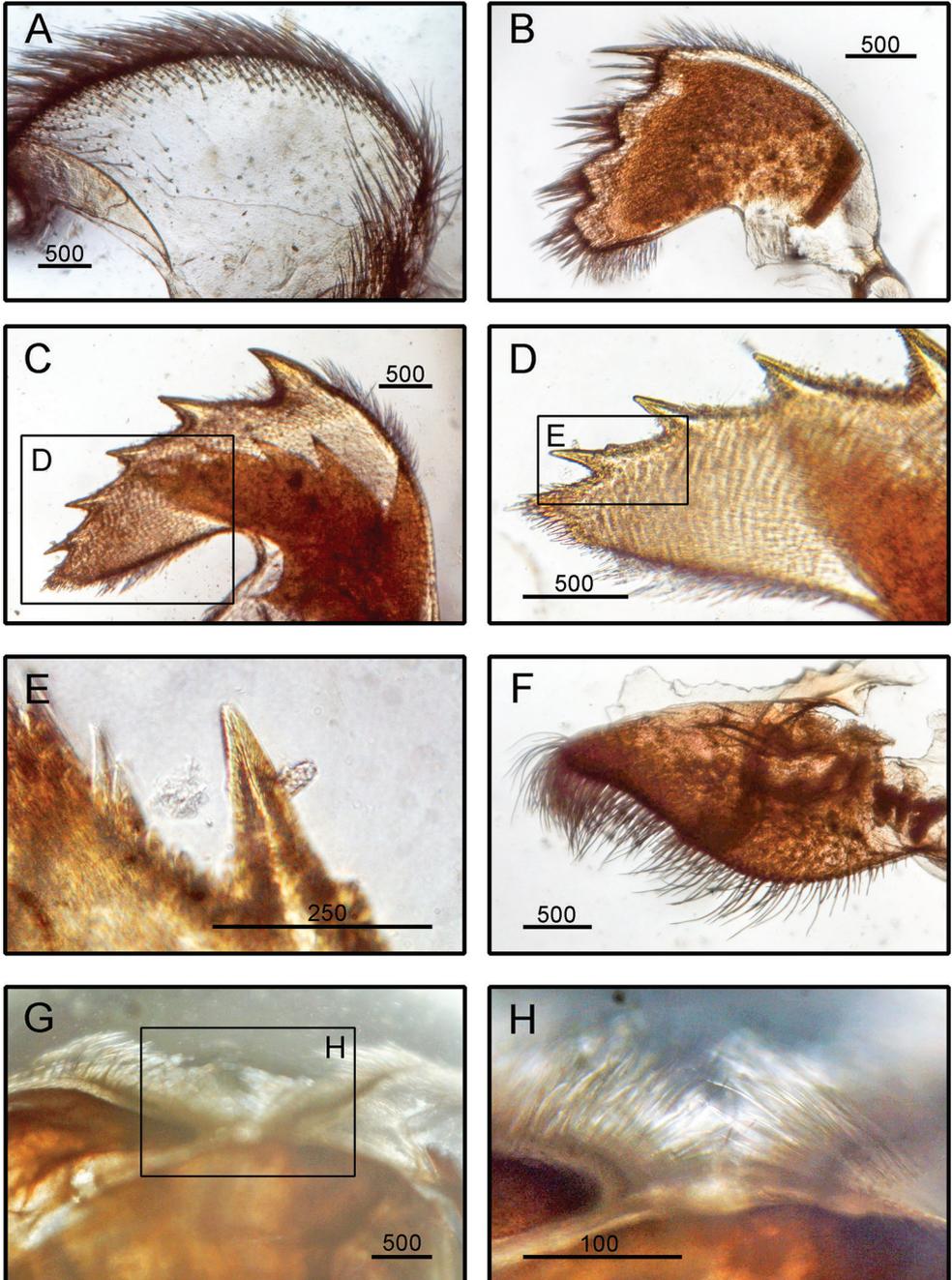


Figure 13. *Lepas anatifera* Linnaeus, 1758 (CL: 16.39 mm) LFSc.ZRC-162, Light microscopy on mouth parts **A** maxilla **B** maxillule **C** mandible **D** close up on the inferior angle of mandible **E** close up on the teeth of mandible **F** mandibulatory palp **G** labrum **H** close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

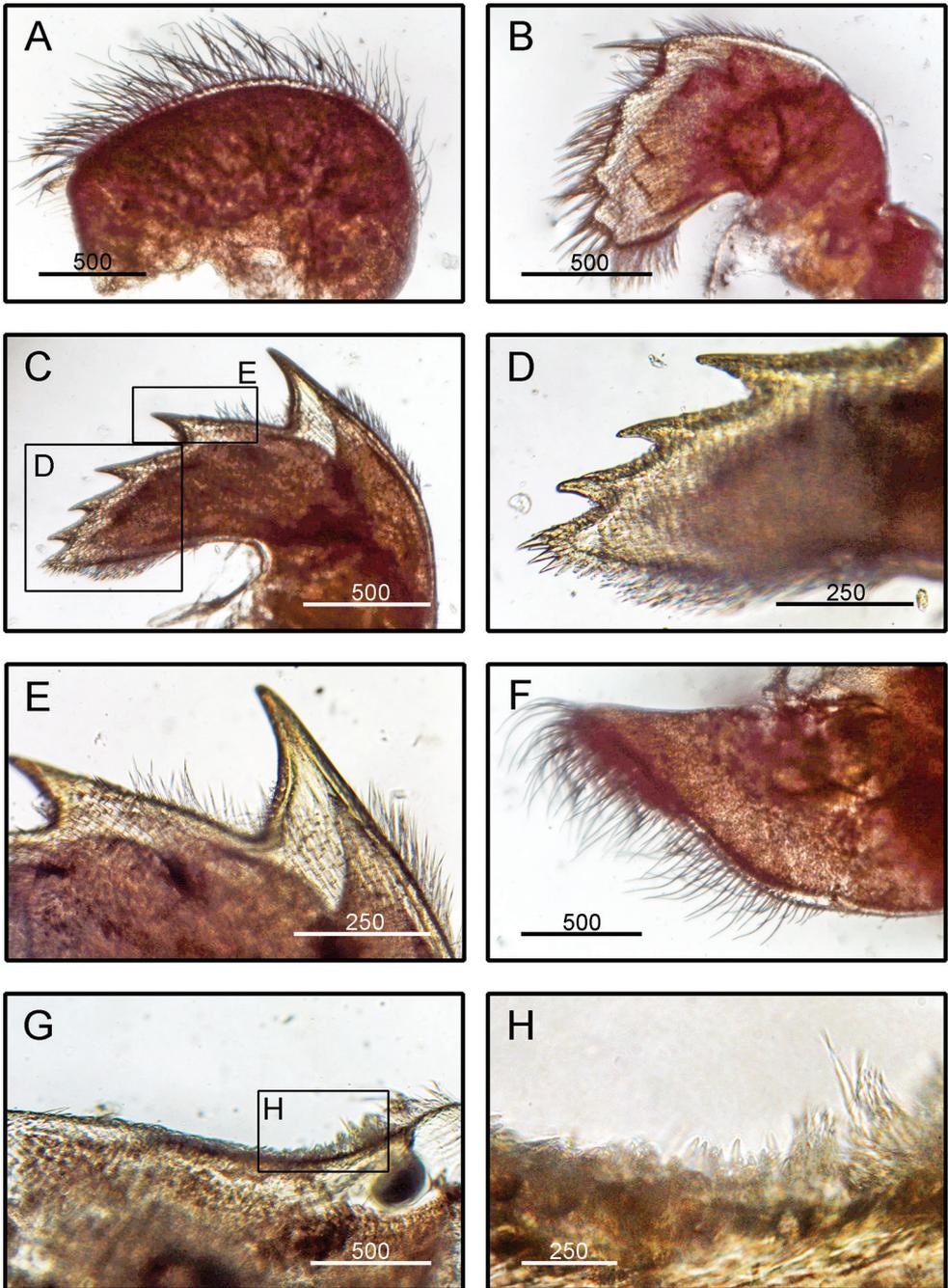


Figure 14. *Lepas anserifera* Linnaeus, 1758, (CL: 16.28 mm) LFSc.ZRC-183, Light microscopy on mouth parts **A** maxilla **B** maxillule **C** mandible **D** close up on the inferior angle of mandible **E** close up on the teeth of mandible **F** mandibulatory palp **G** labrum **H** close up view on the cutting edge of labrum, showing the teeth. Scale bars in μm .

Diagnosis (modified from Chan et al. 2009). Capitulum five-plated, plates thick, broadly triangular, slightly compressed, white, surface striated with radiating lines (Fig. 2K). Tergum quadrilateral, wider than high, apex beaked but sometimes rounded off. Scutum fan-shaped, occludent margin strongly convex. Carina forked, produced below the base of scutum. Maxilla globular (Fig. 14A). Maxillule not clearly notched, cutting edge with several dense setal aggregations (Fig. 14B). Mandible with five teeth excluding inferior teeth, lower angle pectinate (Fig. 14C–E). Mandibulatory palp triangular, setae present on inferior margin (Fig. 14F). Labrum concave bearing fine teeth (Fig. 14G, H).

Remarks. The specimens examined in the present study agree with the descriptions given by Fernando (2006) and Chan et al. (2009).

Worldwide distribution. This species has a cosmopolitan distribution in tropical and temperate seas (Chan et al. 2009; Jones and Hosie 2016; Schiffer and Herbig 2016) and in India (Annandale 1909).

Distribution in India. This species has been reported from Gujarat (Parmar et al. 2018; present study), Tamil Nadu (Sundararaj 1927), Andhra Pradesh (Nilsson-Cantell 1938), Odisha (formerly Orissa) (Annandale 1909), West Bengal (Annandale 1909), and Andaman and Nicobar Islands (Annandale 1909).

Zonation patterns of rocky intertidal species

The high shores (2 m above C.D.) of the sandstone rocky shores at Diu are filled with *Chthamalus barnesi*, reaching a mean abundance of 20–50 individuals per 0.25×0.25 m² quadrat. In the mid-shores (1.5 m above C.D.), *C. barnesi* and *T. ehsani* occur together, with similar abundances of 40–90 individuals per 0.25×0.25 m². In the low shores, *C. barnesi* is absent, and *T. ehsani* has a low abundance and co-exists with *Megabalanus tintinnabulum* (Fig. 15).

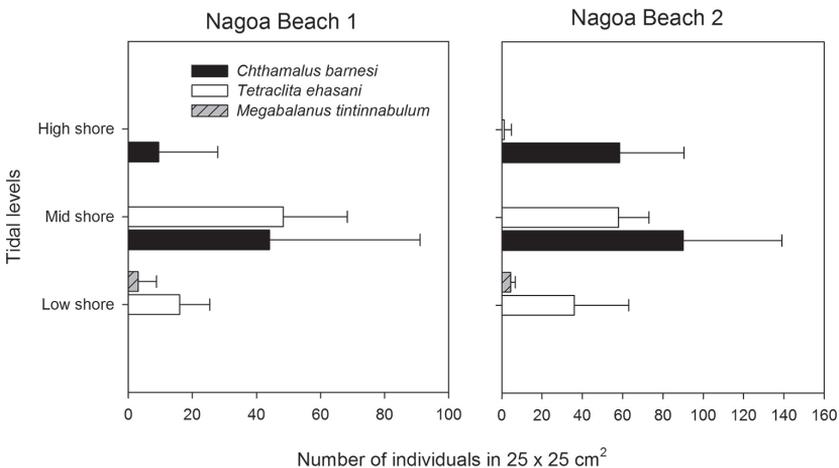


Figure 15. Mean (+1 SD, n = 10) density of barnacles on two rocky shores in Diu, Gujarat, India. High shore – 2 metres above C.D. Mid shore – 1.5 metres above C.D. Low shores 1 metre above C.D.

Key to barnacle species in Gujarat

1	Without a stalk.....	2
–	With a stalk.....	10
2	Shell six-plated.....	3
–	Shell four-plated.....	9
3	Shell surface with longitudinal purple stripes.....	<i>Amphibalanus amphitrite</i>
–	Shell without longitudinal stripes.....	4
4	Shell with striated lattice pattern.....	<i>Amphibalanus reticulatus</i>
–	Shell without striated lattice pattern.....	5
5	Base calcareous.....	6
–	Base membranous.....	8
6	Shell with very wide radii.....	<i>Megabalanus tintinnabulum</i>
–	Shell without wide radii.....	<i>Striatobalanus tenuis</i>
7	Scutum and tergum reduced–.....	<i>Chelonibia testudinaria</i>
–	Scutum and tergum not reduced.....	9
8	Mandible four-toothed.....	<i>Chthamalus barnesi</i>
–	Mandible three-toothed.....	<i>Microeuraphia withersi</i>
9	Shell without distinct radii.....	<i>Tetraclita ehsani</i>
–	Shell with wide radii, surface with digit-like patterns....	<i>Tetraclitella karandei</i>
10	Tergum without a sharp beak.....	<i>Lepas anatifera</i>
–	Tergum with a sharp beak.....	<i>Lepas anserifera</i>

Discussion

The present study reported a total of eleven species from Gujarat, northwest India and is the first record of the rocky intertidal barnacle *Chthamalus barnesi* in India. *Tetraclita ehsani* was previously recorded from the Gulf of Oman, Iran, and northwest India. *Tetraclita ehsani* is absent from the Persian Gulf and Red Sea, where *T. rufotincta* is a common species (Tsang et al. 2012). Northwest India is probably the southern limit of *T. ehsani*, as this species is absent from Mumbai and Tamil Nadu (based on personal sampling trips by BKKC). *Chthamalus barnesi* was first identified along the coastline of the inner Red Sea (Achituv and Safriel 1980) and was subsequently reported in the Persian Gulf and Gulf of Oman (Shahdadi et al. 2011). Northwest India appears to be the eastern biogeographical limit of *C. barnesi*, as it is absent from Mumbai and further south. From Mumbai and along the southern and eastern coastlines of India, *C. malayensis* becomes dominant (Tsang et al. 2012). Based on the classification of the world's biogeographical provinces and ecoregions by Spalding et al. (2007), Gujarat is located in the Western India Ecoregion of the West and South India Shelf Province (Fig. 1). The Gulf of Oman and Persian Gulf are two separate ecoregions located in the Arabian Province. Based on rocky intertidal barnacles, the Gulf of Oman Ecoregion should include Gujarat, while the boundary to the Western Indian Ecoregion appears to be adjacent to waters around Mumbai. Similar patterns may emerge from other groups of

marine species. Extensive studies on the biogeography of different groups of organisms across these two ecoregions should be conducted.

There are nine species with a very wide geographical distribution in the Indo-Pacific, all of which are recorded in Gujarat. *Lepas anatifera* and *L. anserifera* are pelagic species that attach to floating objects and get carried by ocean currents (Schiffer and Herbig 2016). *Chelonibia testudinaria* is epibiotic on turtle and decapod hosts. Population genetics studies revealed that there are genetic differences among Western Pacific, Eastern Pacific and Western Atlantic populations of *C. testudinaria* (Rawson et al. 2003).

Amphibalanus amphitrite, *A. reticulatus*, and *Megabalanus tintinnabulum* are common fouling species that disperse via ballast water or shipping industries. Chen et al. (2014) examined the world-wide genetic differentiation of *A. amphitrite* and identified three molecular clades, which include a worldwide clade (present in most of the world's oceans); a second clade common in tropical regions; and a third clade that is only found in the Eastern Atlantic waters. The genetic differentiation among fouling barnacles could be a result of the combined effects of historical events such as Pleistocene sea level changes and human-mediated dispersals (Chen et al. 2014).

Some Indo-Pacific species were recorded in the present study. The intertidal barnacle *T. karandei* was first identified in Mumbai, India (Ross 1971); Ross (1972) subsequently recorded it in Taiwan. The present study is the third report of this species in northwest India. *Striatobalanus tenuis* is a widely reported epibiotic species that often attaches to deep-water crustaceans and mollusc shells. *Microeuraphia withersi* is a high shore chthamalid barnacle common on shaded regions of the Indo-Pacific rocky shores (Poltarukha 1997). There are currently no genetic studies on the diversity or population genetics of these species. It is possible that cryptic species are present among these nominal species across the Indo-Pacific region, like for many other barnacles, as well as for hermit crabs and other decapods (Chan et al. 2007; Tsang et al. 2012; Jung et al. 2018; Shih and Poupin 2020) or that they are homogeneous populations across large geographical expanses (see example of intertidal blennies in Hongjamrassilp et al. 2020). Future research should also focus on the diversity and biogeography of rhizocephalan species in India, as this superorder of barnacles remains extremely understudied in India. It is possible that Indian rhizocephalan species are present in decapods and hermit crabs and exhibit distinct biogeographical distributions similar to the patterns recognised in the Northwest Pacific (Jung et al. 2019).

Acknowledgements

BKCC is supported by a grant from Ministry of Science and Technology, Taiwan (110-2923-B-001-003-MY3). We thank Wei-Peng Hsieh (Academia Sinica) for assisting in plate editing. Thanks are due to Noah Last (The Third Draft Editing Company) for editing the English of the MS. We would like to thank Subject Editor Alberto Colareta and the reviewers Romy Prabowo and Gianna Innocenti for providing constructive comments to further improve the quality of this manuscript.

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Triplophysa wulongensis, a new species of cave-dwelling loach (Teleostei, Nemacheilidae) from Chongqing, Southwest China

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Academic editor: Sven Kullander | Received 2 December 2020 | Accepted 3 March 2021 | Published 26 March 2021

<http://zoobank.org/0D92A9D4-4FA6-499F-83FD-D4206F11ED8A>

Citation: Chen S, Sheraliev B, Shu L, Peng Z (2021) *Triplophysa wulongensis*, a new species of cave-dwelling loach (Teleostei, Nemacheilidae) from Chongqing, Southwest China. ZooKeys 1026: 179–192. <https://doi.org/10.3897/zookeys.1026.61570>

Abstract

We describe a new species of cave-dwelling loach, *Triplophysa wulongensis* **sp. nov.**, based on specimens collected in a subterranean pool in a cave in Wulong County, Chongqing, Southwest China. The pool is connected to the Wujiang River drainage. *Triplophysa wulongensis* differs from its congeners by the following combination of characters: eyes present, caudal fin with 18 branched rays; posterior chamber of the air bladder degenerate; stomach U-shaped; intestine without bends or loops immediately posterior to stomach; body smooth and scaleless, and lateral line complete. The mitochondrial cytochrome *b* sequence differs from those of other published sequences of species of *Triplophysa* by 14.9–24.9% in K2P distance. Phylogenetic analysis based on cytochrome *b* gene sequences recovered *T. wulongensis* as sister taxon to all other cave-dwelling species of *Triplophysa*.

Keywords

Cavefish, *cytb* sequence, freshwater fish, ichthyology, phylogeny

Introduction

The genus *Triplophysa* Rendahl, 1933, currently comprises approximately 160 valid species, most of which are known from Qinghai-Tibet Plateau and to a lesser extent from Central Asia (Zhu 1989; Prokofiev 2010; Kottelat 2012; Fricke et al. 2020). *Triplophysa* is distinguished from other genera of Nemacheilidae by a marked sexual dimorphism, in which males have tubercle-bearing, elevated skin on the side of the head, and a thickened tuberculated pad on the dorsal surface of the thickened and widened rays of the pectoral fin. Species of *Barbatula* Linck, 1790 share the same sexual dimorphism, but *Triplophysa* can be distinguished from *Barbatula* by the closely situated nostrils (Bănărescu and Nalbant 1968; Prokofiev 2010; Yang et al. 2012; Liu et al. 2017).

To date, 33 cave-dwelling species of *Triplophysa* have been described from the karst areas of southern China where karst caves and subterranean streams are dominant geological features (Lan et al. 2013; Liu et al. 2017; Wu et al. 2018a). According to Lan et al. (2013), these species can be placed into three groups based on the state of the eyes, namely, eyes normal, reduced, or absent (Table 1).

We collected nine loach specimens from a subterranean pool in a cave located in Wulong County, Chongqing, Southwest China. Morphological and molecular analyses justified the recognition of this sample as representing a new species of *Triplophysa*, described below.

Materials and methods

After anesthesia, the specimens were fixed in 10% formalin and stored in 70% ethanol. Measurements were made with digital calipers and rounded off to the nearest 0.1 mm. All measurements were made point to point, and whenever possible, measurements and counts were recorded on the left side of the body following the methods described by Kottelat and Freyhof (2007). The standard length was measured from the tip of the snout to the end of the hypural complex; the length of the caudal peduncle was measured from behind the base of the last ray of the anal fin to the end of the hypural complex at mid-height of the base of the caudal fin. The last two branched rays articulating on a single pterygiophore in the dorsal and anal fins were counted as a single ray. Fin rays were counted using a stereo microscope. Vertebrae from five specimens were observed on X-radiographs. The specimens examined were deposited in the Southwest University School of Life Sciences (SWU) in Beibei, Chongqing, P. R. China. Abbreviations are defined as follows: SL, standard length; HL, head length; CLJH, Collection of Lan Jiahu (private collection); GIF, Guangxi Institute of Fisheries, Guangxi, China.

Data on *Triplophysa aluensis* Li & Zhu, 2000, *T. gejiuensis* (Chu & Chen, 1979), *T. nanpanjiangensis* (Zhu & Cao, 1988), *T. qiubeiensis* Li & Yang, 2008, *T. shilinensis* Chen & Yang, 1992, *T. tianxingensis* Yang, Li & Chen, 2016, *T. xiangshuingensis* Li, 2004 and *T. yunnanensis* Yang, 1990 are from Yang et al. (2016); *T. baotianensis* Li, Li, Liu & Li, 2018 and *T. longliensis* Ren, Yang & Chen, 2012 from Li et al. (2018); *T. maolanensis* (Li, Ran & Chen, 2006) and *T. posterodorsalis* (Li, Ran & Chen, 2006)

Table 1. Characters variable across cave-dwelling species of *Triplophysa* from China.

No	Species	Eyes	Scales	Lateral line	Posterior chamber of air bladder	Dorsal fin rays	Anal fin rays	Pectoral fin rays	Pelvic fin rays	Caudal fin rays	Tip of pelvic fin reaching anus	Anterior nostril barbel-like
1.	<i>T. altensis</i>	Reduced	Absent	Complete	Degenerated	iii, 7	iii, 5	i, 9	i, 6	13	No	Yes
2.	<i>T. anshuiensis</i>	Absent	Absent	Complete	Developed	iv, 7-8	ii, 6	i, 10	i, 6	14	Yes	Yes
3.	<i>T. haotianensis</i>	Normal	Absent	Complete	Degenerate	iii, 6-7	ii, 4-5	i, 9	i, 5	11-13	No	Yes
4.	<i>T. erythraea</i>	Absent	Absent	Complete	Developed	ii, 8	i, 6	ii, 10	ii, 5	17	Yes	No
5.	<i>T. fengshanensis</i>	Absent	Absent	Complete	-	ii, 8	ii, 6	i, 8-10	i, 6-7	16	No	Yes
6.	<i>T. flauticorpus</i>	Normal	Present	Complete	Degenerated	iii, 10	iii, 6-7	i, 11	i, 6-7	16	Yes	No
7.	<i>T. gytienensis</i>	Absent	Absent	Complete	Developed	iii, 7-8	iii, 4-6	i, 10	i, 5	14-15	Yes	Yes
8.	<i>T. guzibonensis</i>	Normal	Present	Complete	Developed	iii, 8	iii, 6	i, 8-9	i, 6	14	No	Yes
9.	<i>T. huaijiangensis</i>	Absent	Absent	Absent	Developed	iii, 8-9	iii, 6-7	i, 10-14	i, 6-7	13-14	No	Yes
10.	<i>T. huaijiangensis</i>	Normal	Present	Complete	Degenerated	iii, 8-9	iii, 5	i, 9-10	i, 5-6	16	No	No
11.	<i>T. langpingensis</i>	Reduced	Absent	Incomplete	-	iii, 7-8	iii, 5-6	i, 10-11	i, 6	14	Yes	Yes
12.	<i>T. lingyunensis</i>	Reduced	Present	Incomplete	Degenerated	iii, 7-8	iii, 5	i, 8-9	i, 5-6	16	No	Yes
13.	<i>T. longpectoralis</i>	Normal	Present	Complete	Degenerated	iii, 8	iii, 5-6	i, 9-10	i, 6	14-15	Yes	Yes
14.	<i>T. longlensis</i>	Normal	Absent	Complete	Developed	iii, 8	iii, 5	i, 10	i, 6	15-16	Yes	Yes
15.	<i>T. luochengensis</i>	Reduced	Present	Complete	Degenerated	iii, 8	iii, 6	i, 10	i, 6	16-17	No	Yes
16.	<i>T. macrocephala</i>	Reduced	Absent	Complete	Degenerated	iii, 7-9	iii, 5-6	i, 9-11	i, 6	15-17	Yes	Yes
17.	<i>T. maolanensis</i>	Absent	Absent	Complete	-	iii, 8	ii, 5	i, 11	i, 6	14	Yes	No
18.	<i>T. nandanensis</i>	Normal	Present	Complete	Degenerated	iv, 8	iv, 5	i, 9-10	i, 6	14-16	No	Yes
19.	<i>T. nanpanjiangensis</i>	Normal	Absent	Complete	Degenerated	iii, 7-8	ii, 5	i, 9-10	i, 6	16	No	Yes
20.	<i>T. naoobarbatula</i>	Normal	Present	Complete	Degenerated	iii, 8	iii, 5	i, 9	i, 6	15	Yes	Yes
21.	<i>T. postenorodorsalis</i>	Absent	Absent	Complete	-	iii, 6	iii, 4	i, 13	i, 5	15	No	Yes
22.	<i>T. qubieensis</i>	Absent	Absent	Complete	Degenerated	iii, 7	iii, 5	i, 7-9	i, 5	14-15	Yes	No
23.	<i>T. rosa</i>	Absent	Absent	Complete	-	iii, 9	iii, 6	i, 12	i, 7	14	Yes	Yes
24.	<i>T. sanduensis</i>	Normal	Present	Complete	Degenerated	ii, 8-9	i, 5	i, 8-9	i, 5	17-18	No	Yes
25.	<i>T. shilinensis</i>	Absent	Absent	Complete	Degenerated	iii, 7	iii, 5	i, 8-10	i, 6	14	No	Yes
26.	<i>T. tianensis</i>	Reduced	Absent	Complete	Degenerated	iii, 6-7	iii, 5	i, 8-9	i, 5-6	15-16	No	Yes
27.	<i>T. tianlinensis</i>	Reduced	Absent	Complete	Degenerated	iii, 7	iii, 5-6	i, 10	i, 6	15-16	Yes	Yes
28.	<i>T. tianxingensis</i>	Normal	Absent	Complete	Developed	iii, 8	ii, 5	i, 9	i, 5	16	No	No
29.	<i>T. wulongensis</i> sp. nov.	Normal	Absent	Complete	Degenerated	ii, 8-9	i, 5-6	i, 8-9	i, 5-7	18	No	Yes
30.	<i>T. xiangshuijiangensis</i>	Normal	Absent	Complete	Degenerated	iii, 6	iii, 5	i, 9	i, 6	14	No	Yes
31.	<i>T. xiangshuijiangensis</i>	Absent	Absent	Complete	Developed	iii, 8	iii, 6	i, 11	i, 6	16	Yes	Yes
32.	<i>T. xiangshuijiangensis</i>	Reduced	Absent	Complete	Developed	iii, 8	ii, 6	i, 9-10	i, 5-6	16	Yes	Yes
33.	<i>T. yunnanensis</i>	Normal	Present	Complete	Degenerated	iii, 7	iii, 5	i, 9-10	i, 7	15-16	No	Yes
34.	<i>T. zhenfengensis</i>	Normal	Present	Complete	Degenerated	iii, 7	iii, 5	i, 9	i, 5-7	14-15	No	Yes

from Li et al. (2006); *T. anshuiensis* Wu, Wei, Lan & Du, 2018, *T. flavicorpus* Yang, Chen & Lan, 2004, *T. guizhouensis* Wu, He, Yang & Du, 2018, *T. luochengensis* Li, Lan, Chen & Du, 2017 and *T. tianlinensis* Li, Li, Lan & Du, 2016 from Wu et al. (2018b); *T. erythraea* Liu & Huang, 2019 and *T. xichouensis* Liu, Pan, Yang & Chen, 2017 from Huang et al. (2019); and *T. xiangxiensis* (Yang, Yuan & Liao, 1986) from Yang et al. (1986). Other species used for comparative purposes were examined at CLJH, GIF, and SWU, China (Suppl. material 1: Table S1).

DNA extraction and PCR

Genomic DNA was extracted from ethanol-preserved fin tissue using a DNeasy Blood and Tissue Kit (QIAGEN, Shanghai, China). The primers used for PCR amplification of the mitochondrial cytochrome *b* (*cytb*) gene are described by Xiao et al. (2001). PCR amplifications were performed in a total volume of 25 μ L consisting of 14.8 μ L of dd H₂O, 2.0 μ L of DNA template (50 ng/ μ L), 1.0 μ L of each primer (10 μ M), 2.5 μ L of 10 \times PCR buffer, 1.5 μ L of 25 mM MgCl₂, 2.0 μ L of 2.5 mM dNTPs, and 0.2 μ L of rTaq DNA polymerase (TaKaRa; Dalian, China). The PCR conditions used were as follows: an initial denaturation step at 94 °C for 4 min followed by 34 cycles of 30 s at 94 °C, 50 s at 50–56 °C and 80 s at 72 °C; with a final extension of 8 min at 72 °C.

Molecular data analyses

We sequenced partial *cytb* gene of *T. longliensis*, *T. nandanensis* Lan, Yang & Chen, 1995, *T. sanduensis* Chen & Peng, 2019, *T. tianeensis* Chen, Cui & Yang, 2004, and *T. wulongensis* and retrieved the *cytb* gene sequences for other species of *Triplophysa* from GenBank (Table 2). *Barbatula nuda* (Bleeker, 1864) and *B. toni* (Dybowski, 1869) were selected as outgroup. Alignment of the *cytb* sequences was performed using the Clustal W algorithm in MEGA7 (Kumar et al. 2016), with manual checks for inconsistencies. MEGA7 was also used to calculate Kimura's 2-parameter genetic

Table 2. The species used in this study with their GenBank accession number for the mitochondrial *cytb* gene sequences.

Species	GenBank accession number	Species	GenBank accession number
<i>Barbatula nuda</i>	KF574248	<i>Triplophysa minxianensis</i>	KT213596
<i>Barbatula toni</i>	AB242162	<i>Triplophysa nandanensis</i>	MW582824
<i>Triplophysa anterodorsalis</i>	KJ739868	<i>Triplophysa rosa</i>	JF268621
<i>Triplophysa bleekeri</i>	JQ686729	<i>Triplophysa sanduensis</i>	MW582822
<i>Triplophysa brevicauda</i>	KT213588	<i>Triplophysa siluroides</i>	KT213603
<i>Triplophysa chondrostoma</i>	KT213589	<i>Triplophysa tianeensis</i>	MW582826
<i>Triplophysa erythraea</i>	MG967615	<i>Triplophysa tibetana</i>	KT224364
<i>Triplophysa huapingensis</i>	MG697589	<i>Triplophysa wulongensis</i>	MW582823
<i>Triplophysa lewangensis</i>	KU987438	<i>Triplophysa xiangxiensis</i>	KT751089
<i>Triplophysa longliensis</i>	MW582825	<i>Triplophysa xichangensis</i>	KT224366
<i>Triplophysa markehenensis</i>	KT213594	<i>Triplophysa zhenfengensis</i>	MK610360
<i>Triplophysa microps</i>	KT213595		

distances (K2P). For phylogenetic reconstructions, the datasets were analyzed based on Bayesian inference (BI) methodology using MrBayes 3.2 (Ronquist et al. 2012) and the maximum likelihood (ML) method of MEGA7 (Kumar et al. 2016). MrBayes used the Generalized Time Reversible model (nst = 6) and gamma-distributed rate variation and the proportion of invariable positions (GTR+G+I) for the *cytb* datasets. For BI, we ran four simultaneous Monte Carlo Markov chains for 2,000,000 generations, with sampling every 1,000 generations, and the first 25% of samples were discarded as burn-in. Tracer v. 1.7 (Rambaut et al. 2018) was used to assess convergence of the posterior, which was determined when effective sample size (ESS) values reached 200. For ML analyses, we conducted heuristic searches (1,000 runs) using a Kimura's 2-parameter (K2P) model. The phylogenetic trees were visualized and edited using FigTree v. 1.4.2 (Rambaut 2014).

Results

Triphophysa wulongensis sp. nov.

<http://zoobank.org/C5034BEA-EC81-4BC1-ADA8-E45CB1699B46>

Figures 1, 2; Table 3

Type material. *Holotype*. SWU2019051309, male, 64.0 mm SL. P.R. China: Chongqing City; Wulong County: subterranean pool in Furong Cave (29°24'1.09"N, 107°54'11.60"E); collected by Ni Liu, May 2019.

Paratypes. SWU2019051301–2019051308, 8 ex., 49.0–67.2 mm SL; collected with the holotype.

Diagnosis. *Triphophysa wulongensis* can be distinguished from its congeners by the following combination of characters: eyes present (vs absent in *T. anshuiensis*, *T. erythraea*, *T. huanjiangensis* Yang, Wu & Lan, 2011, *T. rosa* Chen & Yang, 2005, *T. xiangxiensis* and *T. posterodorsalus*); anterior nostril barbel-like (vs anterior nostril not elongate to barbel-like in *T. erythraea*, *T. flavicarpus*, *T. huapingensis* Zheng, Yang & Chen, 2012 and *T. tianxingensis*); caudal fin with 18 branched rays (vs 14–16 in *T. guizhouensis*, *T. lingyunensis* (Liao, Wang & Luo, 1997), *T. nandanensis*, *T. shilinensis* and *T. zhenfengensis* Wang & Li, 2001), vertebrae 4+38–39 (vs 36–37 in *T. nasobarbatula* Wang & Li, 2001 and *T. sanduensis*; 42–43 in *T. siluroides*); predorsal length 50.4–54.2% of standard length (vs 46.1–48.0% in *T. sanduensis*); posterior chamber of gas bladder degenerate (vs developed in *T. anshuiensis*, *T. tianxingensis* and *T. xichouensis*); body smooth and scaleless (vs body covered by scales in *T. longipectoralis* Zheng, Du, Chen & Yang, 2009 and *T. yunnanensis*); lateral line complete (vs incomplete in *T. huanjiangensis*); and pelvic-fin tip not reaching to anus (vs reaching to anus in *T. gejiuensis*, *T. macrocephala* Yang, Wu & Yang, 2012, *T. rosa* and *T. qiubeiensis*).

Description. Morphometric data of the type specimens of *T. wulongensis* are presented in Table 3. D, 2/8–9; A, 1/5–6; P, 1/8–9; V, 1/5–7; C, 18; vertebrae: 4+38–39 (five specimens).

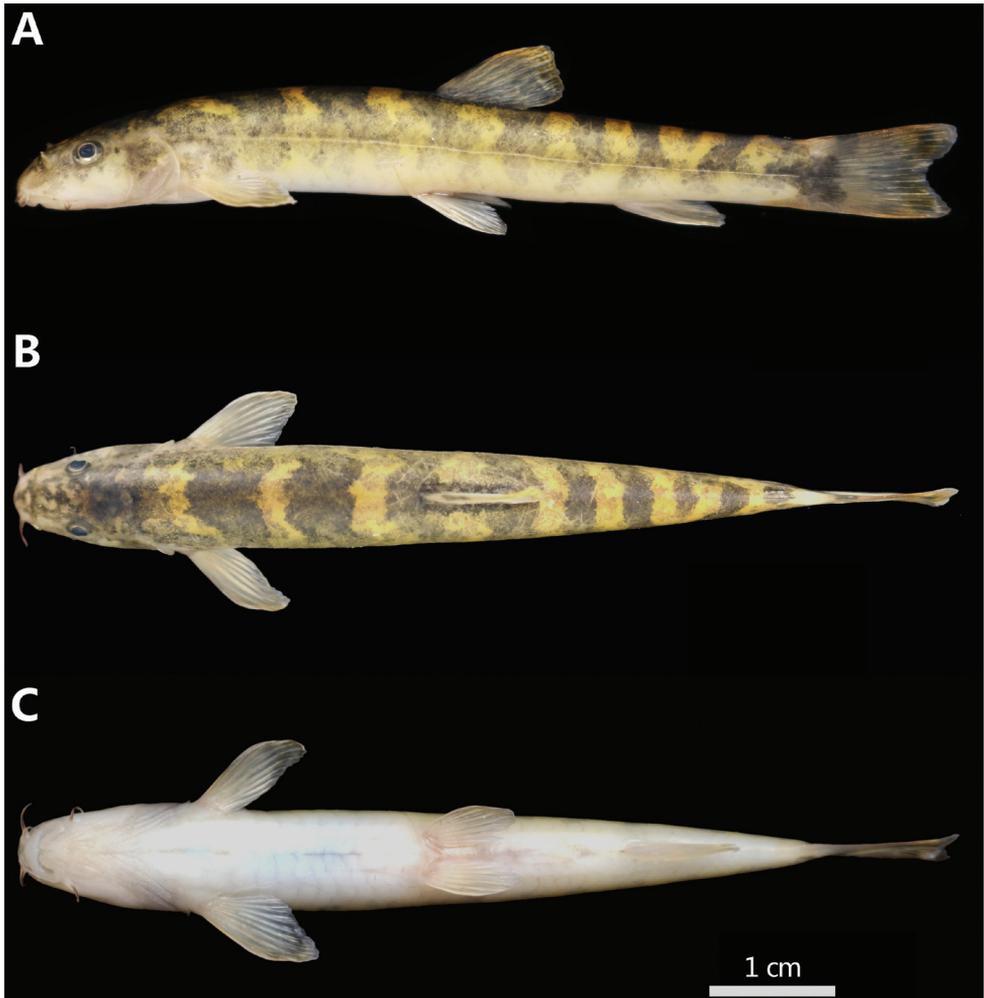


Figure 1. *Triplophysa wulongensis* sp. nov., holotype, SWU 2019051309, 64.0 mm SL **A** lateral view **B** dorsal view **C** ventral view.



Figure 2. *Triplophysa wulongensis* sp. nov., holotype SWU 2019051309, 64.0 mm SL; head in dorsal and ventral view.

Table 3. Morphometric data of type specimens of *Triplophysa wulongensis* sp. nov. SD = standard deviation.

Morphometric characters	Holotype	Paratypes (SWU2019051301–08)			
	SWU2019051309	Min	Max	Mean	SD
SL (mm)	64	49	67.2	55.7	
% SL					
Lateral head length (HL)	22.9	20.4	23.5	22.6	1
Body depth	13.3	9.3	13.6	12.1	1.3
Predorsal length	54.2	50.4	53.3	51.9	0.9
Postdorsal length	40.7	34	39.4	36.7	1.4
Prepelvic length	49.6	48.3	50.9	49.7	0.9
Preanal length	76	71.5	77.7	73.4	1.8
Preanus length	70	67.4	70.2	69	1
Dorsal-fin height	15.9	15	19.8	16.5	1.5
Dorsal-fin base length	12	10.7	13.4	12.4	0.9
Anal-fin height	14.1	12.4	16.5	14.5	1.3
Anal-fin base length	6.6	6.6	8.2	7.4	0.6
Pelvic-fin length	12.4	12.5	14.5	13.2	0.6
Pectoral-fin length	16.6	15.6	18.4	17.6	1
Caudal-fin length	17.8	15.9	20.8	18.1	1.3
Caudal-peduncle length (CPL)	20.8	14.2	18.4	16.6	1.2
Caudal-peduncle depth (CPD)	9.4	7.6	9.4	8.5	0.7
Pectoral-pelvic distance	26.8	24.6	28.6	26.6	1.1
Pelvic-anal distance	26.4	21.6	26.9	23.7	1.4
Vent-anal fin origin distance	6.2	4	7.2	5.8	1
%HL					
Head depth	53.8	45.3	54.2	50.6	2.9
Head width	62.2	55.7	65.8	62.4	3.5
Snout length	39	38.9	45	41.9	1.9
Eye diameter	11.1	12.2	19.1	17	2.1
Interorbital width	38.7	38.5	43.1	41.3	1.5
Postorbital head length	45	37.9	46.8	43.8	2.8
Maxillary barbel length	21.8	27.2	35.9	29.8	3.2
Inner rostral barbel length	16.5	20.1	23.4	21.6	1.2
Outer rostral barbel length	21.4	25.9	41.5	32.4	4.5
CPD/CPL	45.3	44.3	57.4	51.2	4.5

Body elongated, slightly compressed anteriorly and more strongly compressed posteriorly. Deepest point of body in front of dorsal fin origin, body depth 9.3–13.6% of SL. Caudal peduncle depth/caudal peduncle length range from 44.3% to 57.4%. Head depressed, width greater than depth (62.4% vs 50.6% of HL). Snout moderately blunt and snout length almost equal to postorbital length, approximately 38.9–45.0% of HL. Anterior and posterior nostrils adjacently located; anterior nostril in short tube, each with tip elongated to form a short barbel. Tip of nostril appendage not reaching the anterior margin of eyes. Eyes present, diameter 11.1–19.1% of HL. Mouth inferior, arched; mouth corner situated below anterior nostril. Lips thin; lower lip with well-marked, V-shaped, median notch (Fig. 2). Upper jaw covered by upper lip; lower jaw scoop-shaped, not covered medially by lower lip. Three pairs of barbels; inner rostral barbel extending to rictus, 16.5–23.4% of HL; outer rostral barbel not extending to anterior margin of eyes, 21.4–41.5% of HL; maxillary barbel extending to anterior margin of eyes, 21.8–35.9% of HL.

Dorsal fin emarginate, origin posterior to pelvic fin insertion, situated slightly posterior to midpoint between snout tip and caudal fin base; first branched ray longest; dorsal fin height shorter than lateral head length; tip of dorsal fin reaching vertical of anus. Pectoral fin moderately developed, 56.6–72.9% of distance between pectoral fin

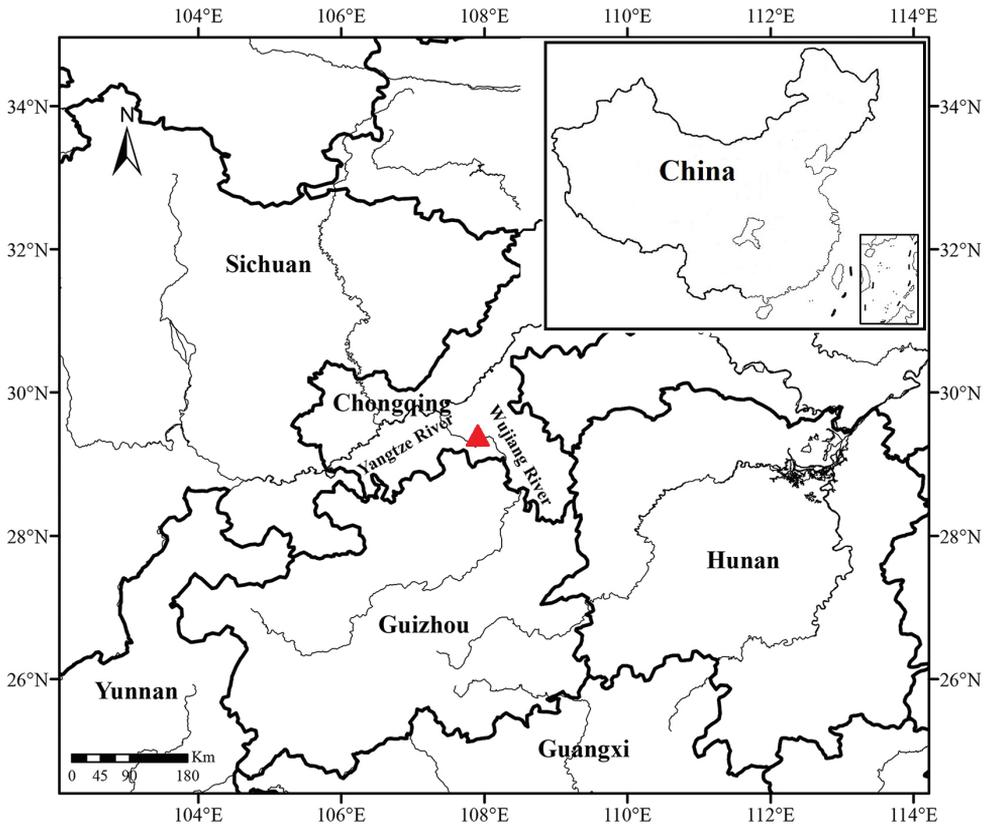


Figure 3. Collection site of *Triplophysa wulongensis* sp. nov. (red triangle) in Chongqing, Southwest China.

and pelvic-fin origins. Pelvic-fin origin situated almost at midpoint between pectoral-fin origin and anal-fin origin, tip of pelvic fin not reaching to anus. Anal-fin origin situated almost at midpoint between pelvic-fin origin and caudal-fin base, distal margin of anal fin truncate; posterior tip of anal fin reaching approximately half distance between anal-fin origin and caudal-fin base. Vent-anal fin-origin distance 4.0–7.2% of SL. Caudal fin emarginate.

Body smooth and scaleless. Cephalic lateral line system developed. Lateral line complete, ending at caudal-fin base. Intestine without bends or loops immediately posterior to stomach; stomach U-shaped. Posterior chamber of gas bladder degenerate.

Coloration. In formalin-fixed specimens, body yellowish dorsally, gradually lighter toward ventral side. Fins semitransparent. Body dorsally and laterally covered with irregular, brown blotches; 6–8 distinct dark brown blotches along dorsal midline.

Sexual dimorphism. Sexual dimorphism was not detected. This may reflect that the sampling time was outside the breeding season of this species.

Geographical distribution. Known only from the type series, from a pool in Furong Cave, connected to the Wujiang River near Wulong, (Fig. 3). *Triplophysa wulongensis* was found syntopic with *T. rosa*.

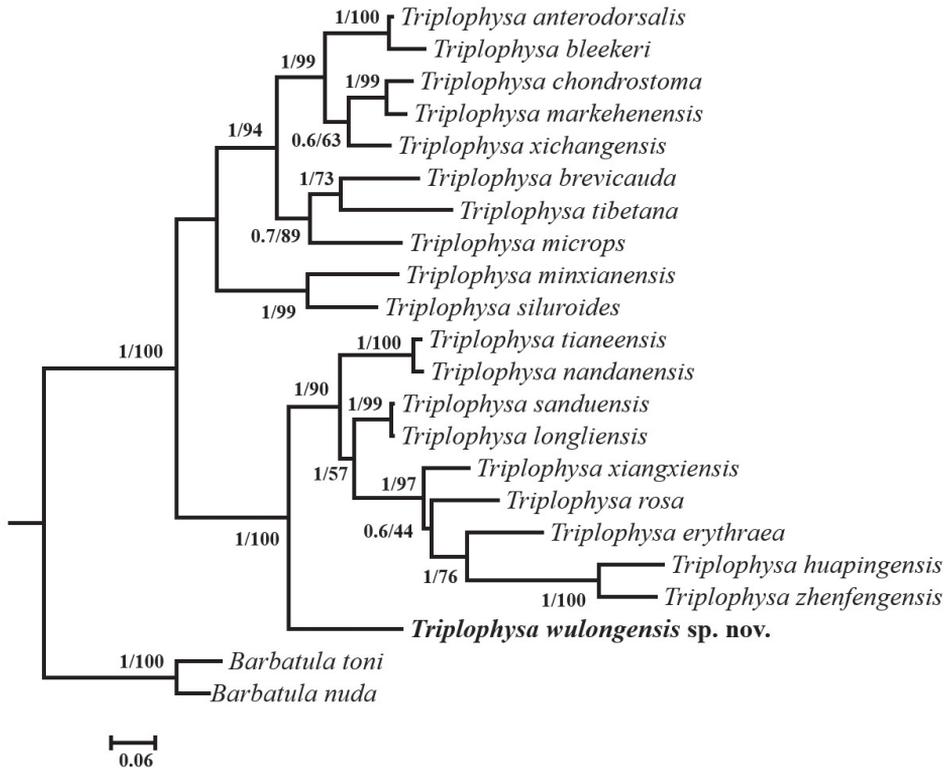


Figure 4. Phylogeny of some species of *Triplophysa* and two outgroup species based on maximum likelihood (ML) and Bayesian inference (BI) methods using mitochondrial *cytb* gene sequences. The ML bootstrap values and BI posterior probabilities are shown at the nodes

Etymology. The specific name, *wulongensis*, refers to the type locality in Wulong County, where the type specimens were collected; it is an adjective with alternative endings *-is* and *-e*.

Discussion

In previous studies, the cave dwelling species of *Triplophysa* were nested in a basal position to congeners in phylogenetic reconstructions (Wang et al. 2016; Chen and Peng 2019; Wu et al. 2020). Our phylogenetic analysis based on *cytb* (Fig. 4) resolved two monophyletic clades, one of which comprises cave-dwelling species, and the other includes non-cave-dwelling species, concordant with Chen and Peng (2019). *Triplophysa wulongensis* is located in a basal position of the cave-dwelling clade (Fig. 4). The K2P genetic distances show less differentiation between *T. wulongensis* and *T. sanduensis* (14.9%) than between *T. wulongensis* and its other congeners in this study. The K2P genetic distance (ranges from 14.9% to 24.9%) between the new species and some of the other species of *Triplophysa* based on *cytb* markers is consistent with species-level divergences in other fish taxa (Ward et al. 2005; Wang et al. 2016; Wu et al. 2020).

The presence or absence of the secondary sexual characteristics is important for the generic diagnosis of loaches (Bănărescu and Nalbant 1968; Zhu 1989). The presence of tubercles on the pectoral fin can be considered as an autapomorphy and is the single diagnostic character of *Triplophysa* (Prokofiev 2010). Nevertheless, according to Liang and Zhou (2019), some cave-dwelling species of *Triplophysa*, e.g. *T. nasobarbatula* and *T. zhenfengensis*, have lost secondary sexual characteristics. Sexual dimorphism was not evident in the type series of *T. wulongensis*, but the phylogenetic analysis confirmed the generic classification.

The majority of the cave-dwelling species of *Triplophysa* were described from karst caves and subterranean streams in the Pearl river basin and the upper Yangtze river basin, with an additional two species (*T. erythraea* and *T. xiangxiensis*) reported from the Yuanjiang river drainage (a tributary of the middle Yangtze River) and a single species (*T. rosa*) described from the Wujiang river drainage (Lan et al. 2013; Liu et al. 2017; Wu et al. 2018b; Chen and Peng 2019; Huang et al. 2019). In terms of morphology, *T. wulongensis* is distinguished from the co-occurring *T. rosa* by the presence of eyes (vs absence), 8 or 9 branched pectoral-fin rays (vs 12), 18 branched caudal-fin rays (vs 14), a pectoral fin length that is 15.6–18.4% that of the SL (vs 26.6%), and a body with irregular brown blotches (vs pale blotches).

The rate of discovery of new cave-dwelling species of *Triplophysa* has increased in recent years (Yang et al. 2016; Li et al. 2017a, b, 2018; Liu et al. 2017; Wu et al. 2018a, b; Chen and Peng 2019; Huang et al. 2019), while a taxonomic revision of these species is lacking. Hence, further systematic and phylogenetic study based on both morphometric and molecular approaches is needed.

Key to the cave-dwelling species of *Triplophysa*

- | | | |
|---|------------------------------------------------------------------------------------------------|--------------------------------|
| 1 | Eyes normal | 2 |
| – | Eyes reduced or absent | 16 |
| 2 | Scales absent | 3 |
| – | Body covered by scales | 8 |
| 3 | Tip of pelvic fin reaching anus, outer gill rakers on first gill arch absent | |
| | | <i>T. longliensis</i> |
| – | Tip of pelvic fin not reaching anus; outer gill rakers on first gill arch present | 4 |
| 4 | Posterior chamber of air bladder developed; anterior nostril not elongate to barbel-like | <i>T. tianxingensis</i> |
| – | Posterior chamber of air bladder degenerated; anterior nostril elongate to barbel-like | 5 |
| 5 | Dorsal-fin origin closer to caudal-fin base than to snout tip | <i>T. wulongensis</i> sp. nov. |
| – | Dorsal-fin origin closer to snout tip than to caudal-fin base | 6 |
| 6 | Dorsal-fin origin opposite vertical line trough pelvic-fin origin | |
| | | <i>T. nanpanjiangensis</i> |
| – | Dorsal-fin origin anterior to vertical line trough pelvic fin origin | 7 |
| 7 | Caudal fin deep forked with 11–13 branched fin rays | <i>T. baotianensis</i> |

–	Caudal fin slightly forked with 14 branched fin rays	<i>T. xiangshuingsensis</i>
8	Processus dentiformis present in upper jaw	<i>T. zhenfengensis</i>
–	Processus dentiformis absent in upper jaw.....	9
9	Posterior chamber of air bladder developed	<i>T. guizhouensis</i>
–	Posterior chamber of air bladder degenerated	10
10	Tip of depressed pelvic fin exceeding anus.....	11
–	Tip of depressed pelvic fin not reaching anus	13
11	Anterior nostril not elongate to barbel-like; branched dorsal-fin rays 10.....	<i>T. flavicorpus</i>
–	Anterior nostril elongate to barbel-like; branched dorsal-fin rays 8.....	12
12	Tip of pectoral fin extending beyond pelvic-fin origin.....	<i>T. longipectoralis</i>
–	Tip of pectoral fin not reaching pelvic-fin origin	<i>T. nasobarbatula</i>
13	Branched dorsal-fin rays 7, branched anal-fin rays 7.....	<i>T. yunnanensis</i>
–	Branched dorsal-fin rays 8, branched anal-fin rays 5–6.....	14
14	Dorsal-fin origin opposite vertical line trough pelvic-fin origin....	<i>T. nandanensis</i>
–	Dorsal fin origin anterior to vertical line trough pelvic fin origin.....	15
15	Anterior nostril not elongate to barbel-like; branched caudal-fin rays 16.....	<i>T. huapingensis</i>
–	Anterior nostril elongate to barbel-like; branched dorsal-fin rays 17–18	<i>T. sanduensis</i>
16	Eyes reduced	17
–	Eyes absent.....	24
17	Body covered with scales	18
–	Scales absent, body smooth	19
18	Lateral line complete, branched anal-fin rays 6.....	<i>T. luochengensis</i>
–	Lateral line incomplete, branched anal-fin rays 5.....	<i>T. lingyunensis</i>
19	Lateral line incomplete; adipose keels present on upper or lower side of caudal peduncle	<i>T. langpingensis</i>
–	Lateral line complete; adipose keels absent from caudal peduncle.....	20
20	Posterior chamber of air bladder developed	<i>T. xichouensis</i>
–	Posterior chamber of air bladder degenerated	21
21	Tip of pelvic fin reaching anus	22
–	Tip of pelvic fin not reaching to anus	23
22	Tip of pectoral fin reaching to midway between pectoral-fin origin and pelvic-fin origin; Spots absent from body.....	<i>T. tianlinensis</i>
–	Tip of pectoral fin reaching a vertical through dorsal-fin origin; spots present on body.....	<i>T. macrocephala</i>
23	Dorsal-fin origin posterior to or at to vertical line trough pelvic-fin origin; branched caudal-fin rays 13.....	<i>T. aluensis</i>
–	Dorsal-fin origin anterior to vertical line trough pelvic-fin origin; branched caudal-fin rays 15–16.....	<i>T. tianeensis</i>
24	Lateral line absent	<i>T. huanjiangensis</i>
–	Lateral line complete.....	25

25	Tip of pelvic-fin not reaching to anus.....	26
–	Tip of pelvic fin reaching to anus	28
26	Adipose keels present on upper or lower side of caudal peduncle.....	
 <i>T. posterodorsalis</i>	
–	Adipose keels absent from caudal peduncle	27
27	Branched dorsal-fin rays 8; branched caudal-fin rays 16	<i>T. fengshanensis</i>
–	Branched dorsal-fin rays 7; branched caudal-fin rays 14	<i>T. shilinensis</i>
28	Anterior nostril not elongate to barbel-like.....	29
–	Anterior nostril elongate to barbel-like	31
29	Lips developed, papillary process absent, branched caudal-fin rays 17	
 <i>T. erythraea</i>	
–	Lips developed, papillary process present, branched caudal-fin rays 14–15	30
30	Branched dorsal fin rays 8; branched pectoral-fin rays 11	<i>T. maolanensis</i>
–	Branched dorsal-fin rays 7; branched pectoral-fin rays 7–9.....	<i>T. qiubeiensis</i>
31	Distal margin of dorsal fin truncate; branched dorsal-fin rays 7–8; branched pectoral-fin rays 9–11; branched pelvic-fin rays 6.....	32
–	Distal margin of dorsal-fin concave; branched dorsal-fin rays 9; branched pectoral-fin rays 12; branched pelvic-fin rays 7	<i>T. rosa</i>
32	Snout blunt; tip of pectoral fin not reaching vertical level of dorsal fin origin; tip of caudal-fin lobes pointed; branched caudal-fin rays 14–15	33
–	Snout rectangle-like; tip of pectoral fin reaching a vertical through dorsal-fin origin; tip of caudal-fin lobe sharp; branched caudal-fin rays 16	<i>T. xiangxiensis</i>
33	Cephalic lateral-line canals with 5 supraorbital and 7 preoperculo-mandibular pores	<i>T. gejiuensis</i>
–	Cephalic lateral-line canals with 8 supraorbital and 12–13 preoperculo-mandibular pores	<i>T. anshuiensis</i>

Acknowledgements

We are indebted to Ms Ni Liu for her help with the specimen collections. This work was supported by grant from the National Natural Science Foundation of China (31872204).

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Supplementary material I

Table S1

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Data type: Specimen list

Explanation note: Material examined of *Triplophysa* species from China.

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Link: <https://doi.org/10.3897/zookeys.1026.61570.suppl1>