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Pleurolucina from the western Atlantic and eastern Pacific Oceans: a new intertidal species from Curaçao with unusual shell microstructure (Mollusca, Bivalvia, Lucinidae)

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Abstract

A new shallow water species of the lucinid bivalve *Pleurolucina* is described from Curaçao in the southern Caribbean Sea and compared with known species of the genus from the western Atlantic and eastern Pacific Oceans. Although confused with the Floridian species *P. leucocyma*, it is most similar to the eastern Pacific *P. undata*. As in all studied lucinids, the new species possesses symbiotic bacteria housed in the ctenidia. The shell microstructure is unusual with repeated and intercalated conchiolin layers that have sublayers of 'tulip-shaped' calcareous spherules. Predatory drillings by naticid gastropods frequently terminate at the conchiolin layers.

Keywords

Bacterial symbionts, Caribbean, conchiolin layers, defensive adaptation, Lucinidae, *Pleurolucina*

Introduction

The tropical and subtropical western Atlantic is one of the major centres of marine molluscan diversity and bivalves in the speciose family Lucinidae, with an estimated 46 species in this ocean, have been the focus of many studies since the discovery of their chemosymbiosis with sulphide-oxidising bacteria (e.g. Giere 1985, Fisher and Hand 1984, Frenkiel and Mouëza 1995, Frenkiel et al. 1996, Gros et al. 1998, 1998, 2012). Nonetheless, new species from both shallow and deep water are still discovered and new genera identified (Taylor and Glover 2009, Taylor et al. 2013). Additionally, within the area there are several cryptic species with narrower ranges nestled among supposedly widespread species (Huber 2015, Taylor and Glover submitted. Distributional data for western Atlantic lucinids indicates that although some are widespread, others have more restricted ranges. A recurring pattern is of congeneric pairs, one largely restricted to the Gulf of Mexico and Florida and the other with a more southerly Caribbean range as exemplified by *Lucinisca nassula* and *L. muricata* (Taylor and Glover submitted). This dual distribution is similar to that proposed by Petuch (1982) as a relict of the Caloosahatchee-Gatunian pattern dating from the Pliocene but possibly inherited by present day taxa. Additionally, in the eastern Pacific, there are lucinids closely similar morphologically and genetically to those of the western Atlantic and presumably separated by the rise of the Central American Isthmus around 3.5 mya. Examples of these are the pair *Radiolucina amianta* (Atlantic) and *R. cancellaris* (Pacific) (see Garfinkle 2012), and the pair *Ctena imbricatula* (Atlantic) and *Ctena mexicana* (Pacific) (Taylor et al. 2011).

Pleurolucina (Dall, 1901) is a genus of small lucinids characterised by broad radial ribs. The type species, *Lucina leucocyma* Dall, 1886, first described from off the Florida Keys, is documented as having a distribution from North Carolina to Colombia including Yucatan Peninsula (Britton 1970, Vokes and Vokes 1983, Huber 2015). Two other species, *P. hendersoni* Britton, 1972 and *P. sombrerensis* (Dall, 1886), are known from the western Atlantic (Britton 1972), while three further species are recorded from the Eastern Pacific (Coan and Valentich-Scott 2012). During field sampling in shallow seagrass around Curaçao in May 2015 we collected a *Pleurolucina* that we recognised as similar to, but likely distinct from, *P. leucocyma*. Further research showed this to be an undescribed species more widely distributed in the southern Caribbean and confounded with *P. leucocyma.* An apparent high incidence of failed naticid drill holes focused attention on the shell microstructure revealing intercalated organic layers. Thought to be related to *Lucina* or *Cavilinga* (Britton 1972, Bretsky 1976) and included by Taylor et al. (2011) in the subfamily Lucininae, no *Pleurolucina* species has previously been included in molecular analyses.

We describe this new *Pleurolucina* from Curaçao in comparison with other western Atlantic and Eastern Pacific species, detail its phylogenetic position and illustrate its unusual shell microstructure with calcified conchiolin layers.

Material and methods

Samples of the new species were collected in southern Curaçao – location below. Details of ctenidia and sperm were studied using critical point dried glutaraldehyde-fixed specimens. Shells, microstructure and anatomy were imaged using a Quanta FEI 650 FEG scanning electron microscope. Comparative shell material was studied in USNM and NHMUK.

Institutional abbreviations

FMNH	Field Museum of Natural History, Chicago, USA
MCZ	Museum of Comparative Zoology, Harvard University, USA
MNHN	Muséum national d'Histoire Naturelle, Paris, France
RMNH	Rijksmuseum van Natuurlijke Histoire, Leiden, Netherlands
NHMUK	The Natural History Museum, London, UK
SBMNH	Santa Barbara Museum of Natural History, USA
USNM	United States National Museum of Natural History, USA

Other abbreviations

H	shell height
L	shell length
LV	left valve
PI	protoconch I length
PII	protoconch II length
RV	right valve
SEM	scanning electron microscopy
T	tumidity single valve

Systematics

Family Lucinidae Fleming, 1828

Subfamily Lucininae Fleming, 1828

Pleurolucina Dall, 1901

Dallucina Olsson & Harbison, 1953. Type species, by original designation, *Lucina* (*Here*) *amabilis* Dall, 1898. Pliocene, Florida. Gender feminine.

Type species. *Lucina leucocyma* Dall, 1886, by original designation. Recent, western Atlantic Ocean. Gender feminine.

Diagnosis. Shell small, L to 27 mm (*P. sombrerensis* usually less than 10 mm), subcircular to ovate, generally higher than long, inflated to highly inflated. Sculpture of 4–6 broad radial ribs separated by broad sulci, sometimes absent in adult shells, crossed by closely-spaced, often terraced, commarginal lamellae. Lunule deeply excavated to shallow. Ventral margin finely beaded. Hinge: RV with two cardinal teeth, posterior-most sometimes bifid, anterior and posterior lateral teeth present; LV with two cardinal teeth, anterior smaller, with anterior and posterior lateral teeth. Anterior adductor muscle scar relatively short, broad, separate from pallial line for about ½ to 2/3 of length, pallial line entire.

Included species. Western Atlantic: *P. leucocyma* (Dall, 1886), *P. hendersoni* Britton, 1972, *P. sombrerensis* (Dall, 1886). Eastern Pacific: *P. leucocymoides* (Lowe, 1935), *P. taylori* Coan & Valentich-Scott, 2012, *P. undata* (Carpenter, 1865).

Distribution. Western Atlantic: northern Florida to Brazil (*P. sombrerensis* Espirito Santo, Rios 1994). East Pacific: Baja California Mexico to Ecuador, Galapagos Islands (Coan and Valentich-Scott 2012).

Geological range. Early Oligocene to Recent. *Pleurolucina amabilis* (Dall, 1898) is a distinctive, laterally compressed species from the Late Pliocene to mid-Pleistocene of Florida. It was made type species of the new genus *Dallucina* by Olsson and Harbison (1954) but other than the lateral compression it is similar in most characters to *P. leucocyma.* From Miocene deposits of Ecuador Olsson (1964) described *Paslucina* with *Lucina* (*Paslucina*) *follis* Olsson, 1964 as type species. This has the shape and radial folds typical of *Pleurolucina* species and may be an antecedent.

Pleurolucina quadricostata (Dall, 1903) from the Pliocene Bowden Formation of Jamaica (Woodring 1925: 121, pl. 16, figs 4-6) resembles the living *P. leucocyma*. From the same deposit, *Phacoides* (*Linga*) *tithonis* (Dall, 1903) (Woodring 1925: 120, pl. 16, figs 2, 3) is similar to *P. sombrerensis.* A species described as *Lucina* (*Cavilinga*) *triloba* (Dockery 1982, pl. 19, fig 4) from the Early Oligocene, Vicksburg Group, Mississippi, USA, has characters of *Pleurolucina* but with only two radial folds. From the same deposits, *Lucina* (*Cavilinga*) *imbricolamella* Dockery (1982 pl. 20, figs 11–12) resembles the Recent *Pleurolucina sombrerensis.*

Relationships. From morphological characters of the shells, *Pleurolucina* species are usually regarded as being related to *Lucina* s.s. or *Cavilinga* (Britton 1972, Bretsky 1976). *Pleurolucina harperae* below is the only member of the genus yet to be included in molecular analyses and results (Taylor et al. submitted) show that it groups within the Lucininae, close to *Cavilinga blanda*, in a subclade of *Lucina* and *Divalinga* species.

Remarks. In the absence of molecular evidence, other than for *P. harperae*, our concept of *Pleurolucina* embraces a range of shell morphologies from species like *P. leucocyma*, *P. undata* and *P. taylori* that have prominent radial ribs, through the less ribbed *P. hendersoni* and *P. leucocymoides*, to the small *P. sombrerenis* that has a rounded shell lacking radial ribs. Nevertheless, they are all rather inflated with similar dentition, anterior adductor muscle scars and beaded inner margins.

***Pleurolucina harperae* n. sp.**
http://zoobank.org/D9916BAC-D208-4A5B-8499-6FE1B5ADC3BB
Figs 1–5

Lucina leucocyma: Daccarett and Bossio 2011: 177, fig. 1243.
Pleurolucina leucocyma: Huber 2015: 433, fig. p. 85.

Type material. *Holotype*: 1 whole shell L 8.8, H 8.5 T 3.2 mm (NHMUK 20160338), southwestern Curaçao, channel into Spaanse Water, opposite Hyatt Resort, 12º03'57" N 68º51'13" W. BivAToL stn Cur-5-15-009, 22 May 2015.

Paratypes: 92 valves (NHMUK 20160339), 2 paired valves (RMNH 5003991–50003992), 3 paired valves (FMNH344698), 2 paired valves (USNM 1411553). Same locality as holotype.

Other material. 19 ethanol preserved specimens (NHMUK), same locality as holotype.

Description. Shell subovate, slightly anteriorly extended, L to 9.6 mm, H to 9.7 mm, H/L 0.99, moderately inflated, sculpture of flat, closely spaced commarginal lamellae, with four prominent, broad ribs with interspaces variable in width, but always narrower than ribs themselves; microsculpture of tight rows of shallow pits (Fig. 1 P). Umbones low, situated on midline. Anterior dorsal area arcuate. Protoconch: PI 217 µm, PI + PII 228 µm, PII a narrow rim with fine increments (Fig. 1 O). Lunule short, semicircular, slightly impressed. Ligament short, set in shallow resilifer. Hinge teeth: LV with two cardinal teeth; a robust anterior lateral tooth and smaller posterior lateral. RV with a single large cardinal tooth and anterior and posterior lateral teeth. Anterior adductor muscle scar short, broad, widely divergent from pallial line (60–70 µm) for about half of length (Fig. 2 A), posterior scar ovate; pallial line entire, pallial blood vessel scar sometimes visible. Shell margin finely beaded, sinuate with anterior sinus deeper. Shell within pallial line often patchily eroded to expose inner shell layers. Colour grey-white.

Anatomy. General anatomy resembles most other described lucinids (Fig. 3). Mantle fusion ventral to the posterior apertures is very short. Foot short and broad when retracted but can be vermiform when extended (Fig. 3 A) with a small heel. Visceral pouches absent. Distinct mantle gills are absent but the inner mantle ventral to the anterior adductor muscle is thickened (Fig. 3 C) and may be a respiratory area with blood space as seen in other lucinids (Taylor and Glover 2000). Labial palps are very short. In common with all other studied Lucinidae, *P. harperae* has ctenidia comprising inner demibranchs only; these were pink in life, large, thick and occupying much of the mantle cavity (Fig. 3 B). Ctenidial filaments are approx. 40 µm thick and 380 µm deep with a narrow 45 µm ciliated zone and a deep bacteriocyte zone (Fig 3 D). Bacteriocytes were packed with 'potato-shaped' bacteria 3–5 µm long and 1.5–2.0 µm wide (Figs 3 G, H). The surface of the microvilli-covered bacteriocytes and intercalary cells were colonised by abundant spirochaetes 2.5 µm long and 0.2 µm wide (Fig. 3 F) similar to those re-

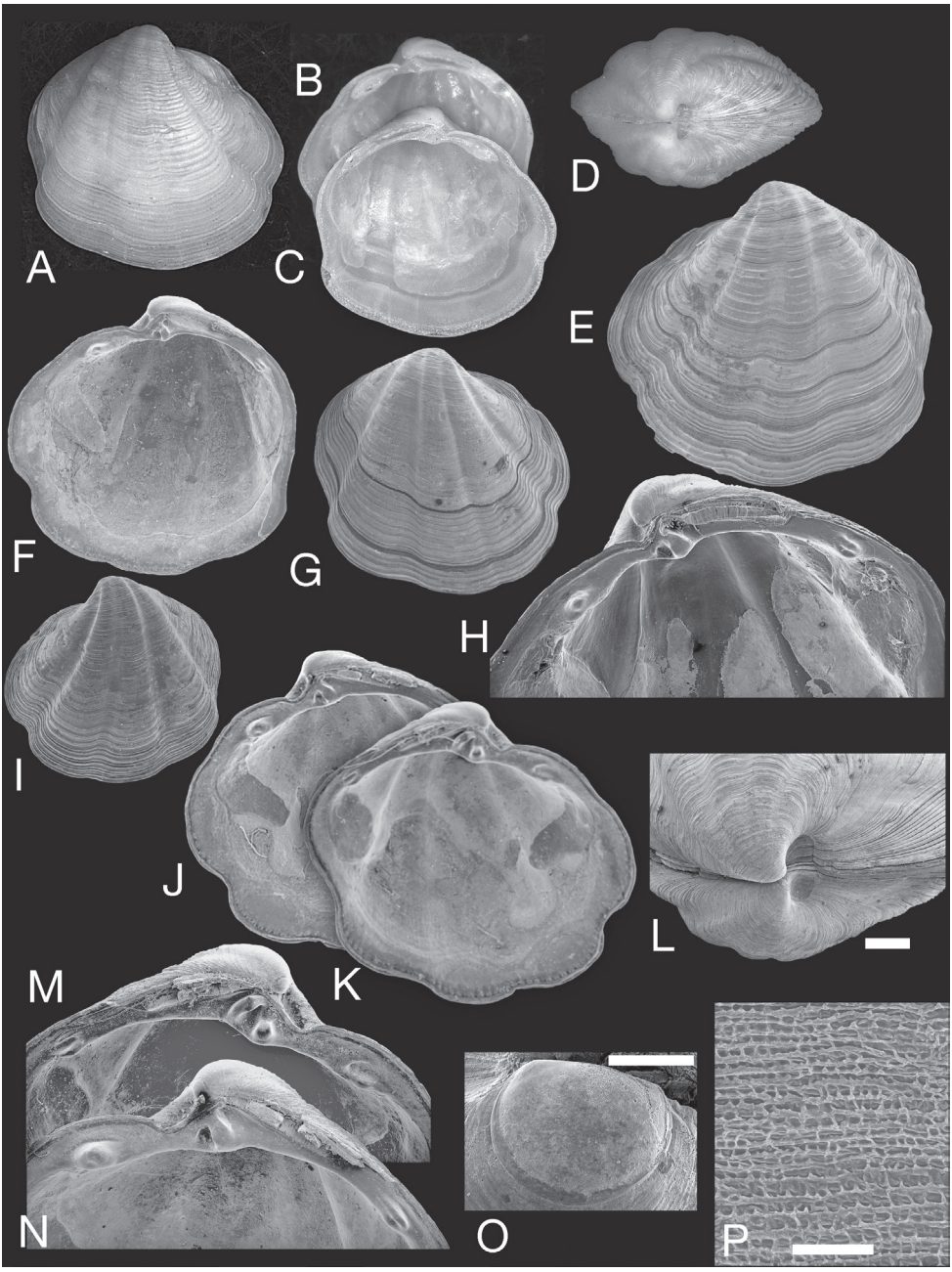

Figure 1. *Pleurolucina harperae* sp. n. **A–C** Holotype NHMUK 20160338 exterior of right and interior of right and left valves L 8.8 mm. **D–P** Paratypes. NHMUK 20160339 dorsal view L 7.6 mm. **E** Exterior of left valve L 7.7 mm. **F** Interior of right valve L 6.3 mm. **G** Exterior of right valve L 7.9 mm. **H** Hinge area of right valve L 8.6 mm. **I** Exterior of left valve L 63 mm. **J, K** Interiors of right and left valves L 5.0 mm. **L** Dorsal view showing lunule. Scale bar = 0.5 mm. **M, N** Details of hinge teeth of J, K. **O** Protoconch. Scale bar = 100 μm. **P** Detail of microsculpture. Scale bar = 20 μm.

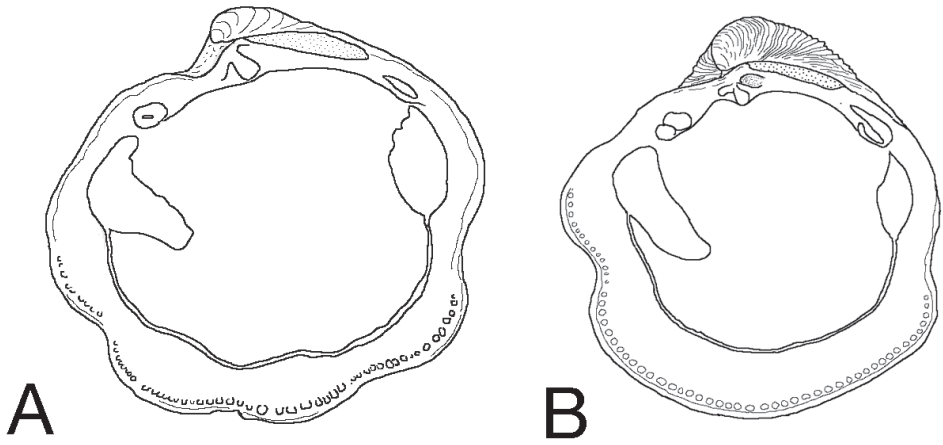

Figure 2. Outline drawings of shell interiors of **A** *P. harperae* and **B** *P. leucocyma*.

ported by Ball et al. (2009) from *Euanodontia ovum* (Reeve, 1850). In comparison the symbiotic bacteria of *Clathrolucina costata* collected at the same time and same habitat were longer and rod shaped, 8–10 μm in length and approx. 1 μm wide.

The sperm of *P. harperae* were 9 μm long and 1.2 μm wide at the base, tapering and curved distally (Figs 3 J, K). From the same locality, sperm of *Clathrolucina costata* were shorter, 4.8–5 μm and 1–1.2 μm wide with blunt tips. Oocytes of *P. harperae* were approx. 200 μm in diameter (Fig. 3 I). Comparative sperm data is available for a few other western Atlantic lucinids (Bigatti et al. 2004); sperm of *Codakia orbicularis* were 14–15 μm long, tapering with a width of 0.8 μm; *Ctena orbiculata* were cylindrical, slightly curved, 7.5 μm long and 1–1.2 μm wide at base and *Lucina pensylvanica* were 15.5 μm long, with curved tapering heads and 1.1 μm wide at the posterior.

Shell microstructure. Within a very thin (ca 1 μm) periostracum, *Pleurolucina harperae* has a basic four layered shell (Figs 4 A,B); an outer composite prismatic layer, followed inwards by a thin crossed-lamellar layer, then a thicker layer of irregular spherulitic prisms and within the pallial line a complex crossed-lamellar layer with sublayers of irregular prisms. The shell layers are interrupted by sheets of conchiolin around 20–90 μm in thickness, each with repeated sublayers of small discrete 'tulip-shaped' calcified spherulites approx. 5 μm in diameter (Figs 4 D, F). Each spherulite is joined to those of the layer below with a narrow (0.5 μm) semicalcified channel through the conchiolin (Figs 4 E, F). At the shell surface, the conchiolin sheets correspond to major depositional halts (Fig. 4 A) visible as notches in the shell with the conchiolin appearing contiguous with the invaginated periostracum. In each shell there may be between 1–5 of such sheets.

Drill holes in *Pleurolucina harperae* produced by predatory naticid gastropods were observed with full penetration in 14 out of 114 single valves, but with 12 records of

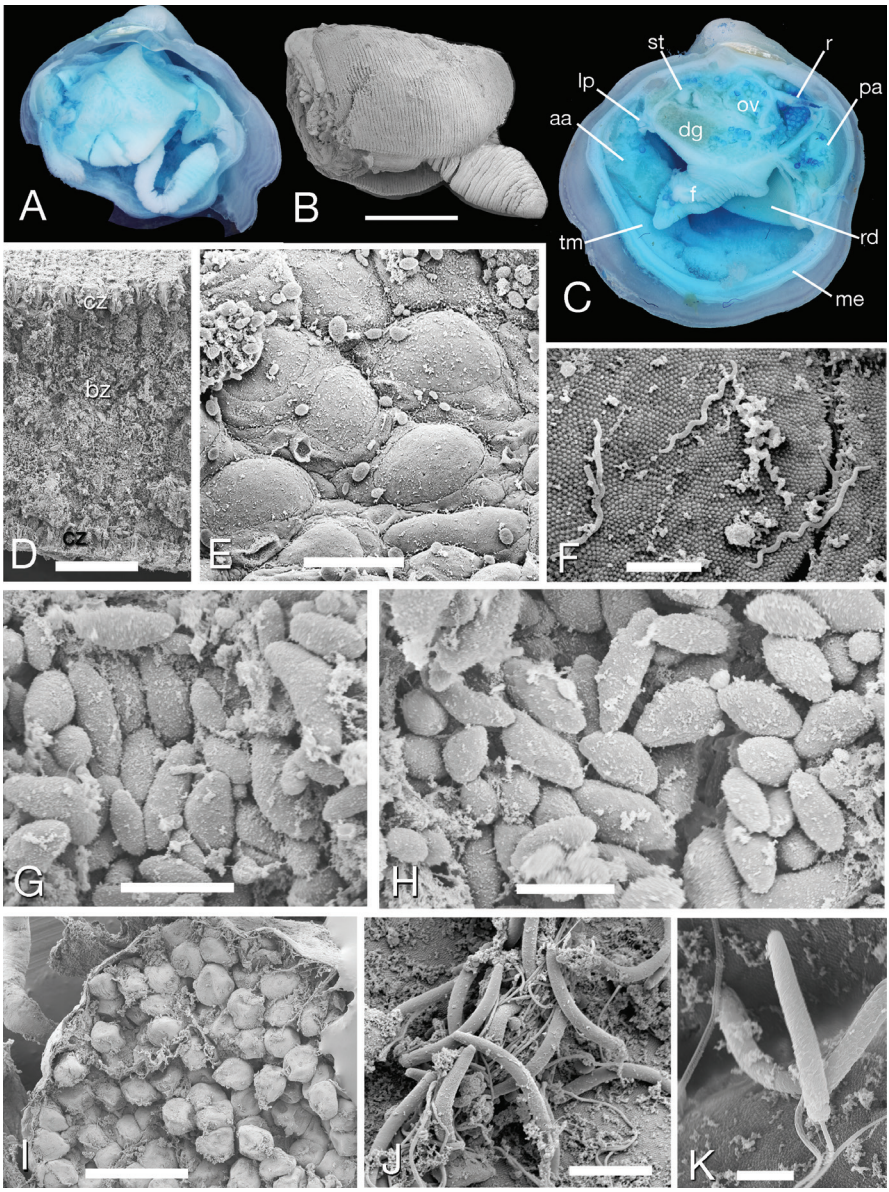

Figure 3. *Pleurolucina harperae*, general anatomy, ctenidia, bacteria, oocytes and sperm. **A** Right side, with mantle removed, right demibranch and extended foot stained with methylene blue L 7 mm **B** Left demibranch and foot, critical point dried preparation. Scale bar = 1 mm **C** Cut section to show general anatomy, stained with methylene blue L 8 mm **D** Transverse section through single ctenidial demibranch. Scale bar = 100 µm **E** Surface of bacteriocytes and intercalary cells on lateral view of a ctenidial filament. Scale bar = 15 µm **F** Spirochaete bacteria on surface of bacteriocytes. Scale bar = 2 µm **G, H** Symbiotic bacteria contained in bacteriocyte. Scale bar = 5 µm **I** Developing oocytes. Scale bar = 500 µm **J, K** Sperm. Scale bars = 5, 2 µm respectively. **aa** anterior adductor muscle **bz** bacteriocyte zone **cz** ciliated zone **dg** digestive gland **f** foot **lp** labial palps **me** mantle edge **ov** ovary with oocytes **pa** posterior adductor **r** rectum **rd** right demibranch **st** stomach **tm** thickened mantle ventral to anterior adductor muscle.

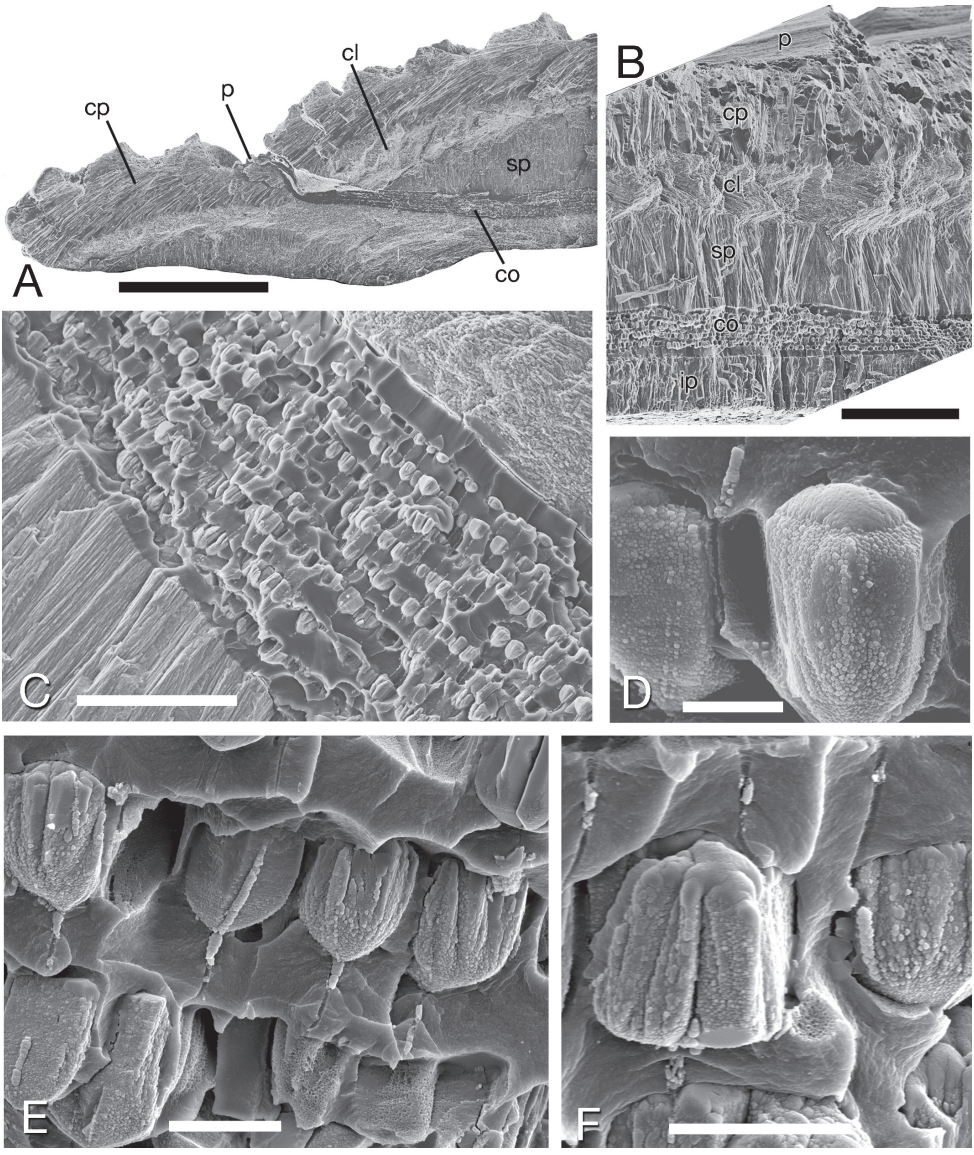

Figure 4. Shell microstructure of *Pleurolucina harperae*. **A** Fractured section of shell margin showing major notch growth halt and conchiolin layer. Scale bar = 400 μm **B** Fractured section showing succession of shell layers. Shell exterior at top. Scale bar = 100 μm **C** Conchiolin layer with regular bands of spherulites. Scale bar = 40 μm **D** Individual spherulite. Scale bar = 2 μm **E** Adjacent spherulites embedded in conchiolin with narrow channels between layers. Scale bar = 5 μm **F** Single spherulites with channels below and above. Scale bar = 5 μm. **cl** crossed lamellar layer **co** conchiolin layer **cp** composite prismatic layer **ip** irregular prismatic layer **p** periostracum **sp** spherulitic prismatic layer.

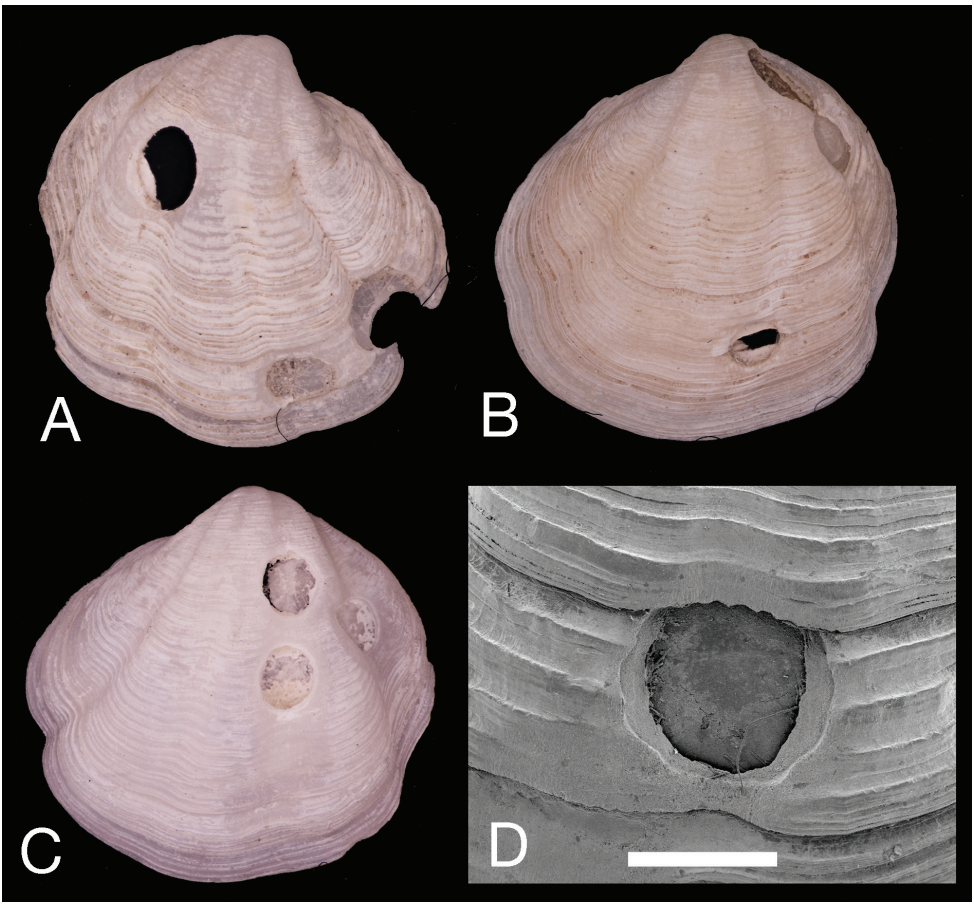

Figure 5. Failed and multiple drill holes in shells of *Pleurolucina harperae*. **A** L = 6.8 mm **B** L = 9.8 mm **C** L =7.8 mm **D** SEM of failed drill hole terminating at conchiolin layer. Scale bar = 1.0 mm.

incomplete drill holes that terminated at an internal conchiolin layer (Fig. 5). In one shell there were three failed drills and in another two failures before successful penetration. Incidences of apparent multiple completed drill holes in dead shells may have resulted from post-mortem degradation of organic layers in failed drill holes.

Similar conchiolin calcified sheets were identified in *Pleurolucina hendersoni* (Figs 6 A, B) and *P. undata* (Figs 6 C–E) but not in *P. leucocyma* (2 shells examined) or *P. sombrerensis* (2 shells examined). Also conchiolin sheets with multiple layers of calcareous spherules were observed in *Lucina pensylvanica* from the Florida Keys (Figs F,G), apparently confined to the inner shell layer within the pallial line. This is distinct from the calcified periostracum of this species (Fig. 6 H) as described by Taylor et al. (2004). No conchiolin sheets were observed in a single *Cavilinga blanda* examined. For comparison, the repeated conchiolin sheets reported in *Cardiolucina* species by Ishikawa and Kase (2007) were studied in *C. quadrata* from the Philippines. These sheets were approx. 10-15 μm thick and only lightly calcified with sporadic spherulitic crystal aggregations (Figs 6 I-K) with no multiple sub-layers.

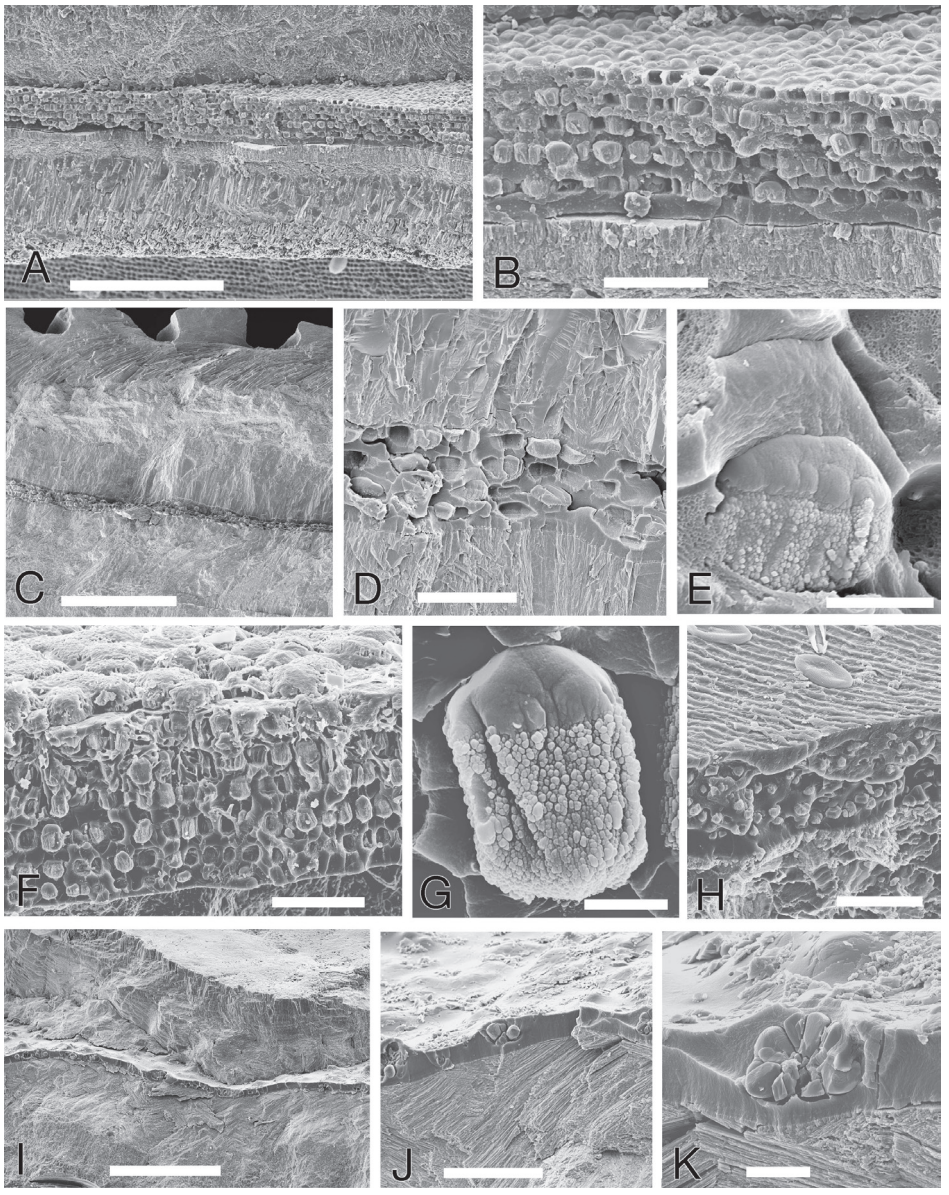

Figure 6. Shell microstructure of other species *Pleurolucina hendersoni*, *P. undata*, *Lucina pensylvanica* and *Cardiolucina quadrata*. **A** *Pleurolucina hendersoni* Guadeloupe, fractured section with prominent calcified conchiolin layer, periostracum at base. Scale bar = 20 μm **B** *P. hendersoni*, detail of conchiolin layer with lines of calcareous spherulites. Scale bar = 20 μm **C** *Pleurolucina undata* Baja California, fractured section with thin conchiolin layer Scale bar = 200 μm **D** *P. undata*, detail of conchiolin layer with spherulites. Scale bar = 20 μm **E** *P. undata*, single spherulites embedded in conchiolin. Scale bar = 3 μm **F** *Lucina pensylvanica* Florida Keys, calcified conchiolin layer. Scale bar = 20 μm **G** *L. pensylvanica*, single spherulite. Scale bar = 2 μm **H** *L. pensylvanica*, section of periostracum with calcareous granules. Shell interior to top. Scale bar = 20 μm **I** *Cardiolucina quadrata* Philippines, fractured section with conchiolin layer. Scale bar = 200 μm **J** *C. quadrata* detail of conchiolin layer with calcareous aggregates. Scale bar = 50 μm **K** *C. quadrata* detail of calcareous aggregate. Scale bar =10 μm.

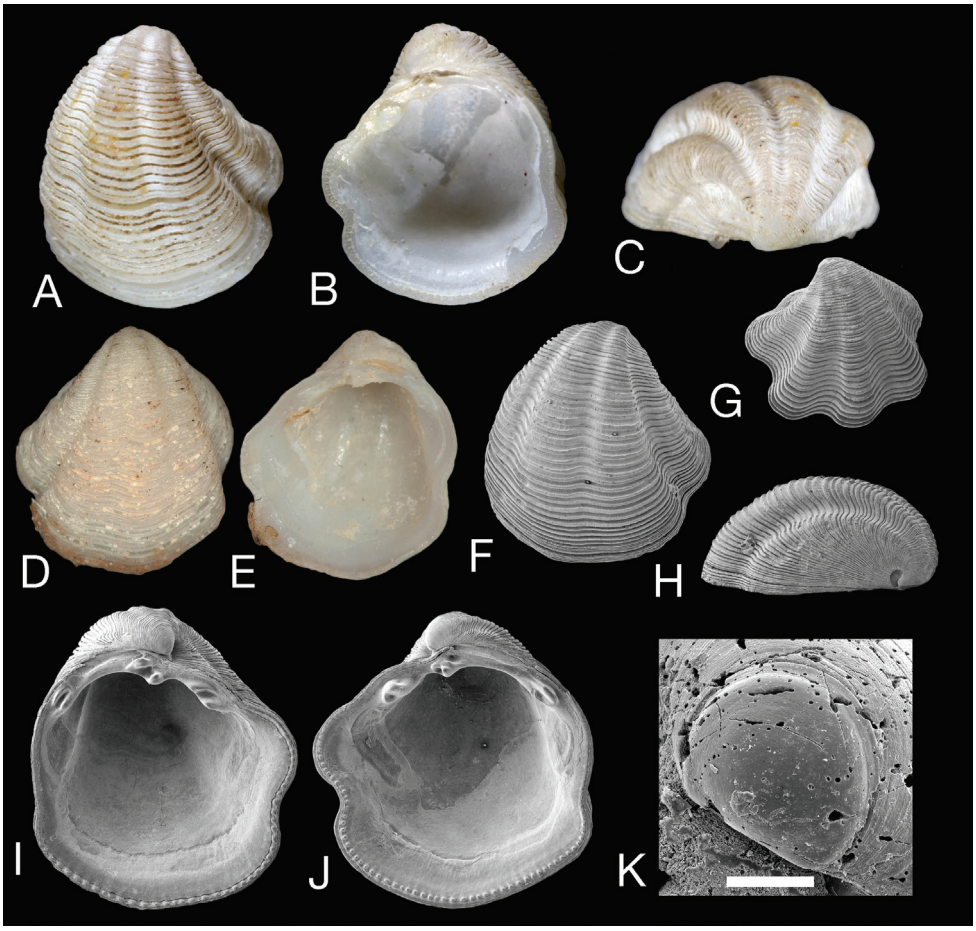

Figure 7. *Pleurolucina leucocyma.* **A–C** *Lucina leucocyma* Dall, 1881 lectotype MCZ 7986, exterior, interior and dorsal view of right valve, L 5.7 mm, H 6.6 mm **D, E** *Lucina leucocyma* paralectotype USNM 83140, exterior of left valve and interior of right valve, L 4.8 mm, H 5.5 mm **F–K**, *Pleurolucina leucocyma* USNM 446563 Eolis Station 368, off Ajax Reef, Florida **F** Exterior of left valve, L 5.1 mm **G** Left valve of juvenile shell, L 3.1 mm **H** Lateral view of left valve, L 5.1 mm. **I** Interior of left valve, L 5.5 mm **J** Interior of right valve, L 5.5 mm **K** Protoconch, scale bar = 100 μm.

Habitat. *Pleurolucina harperae* is an intertidal to shallow subtidal species collected from sand amongst seagrass rhizomes (largely *Thalassia testudinum*, *Halodule* sp.) in contrast to *P. leucocyma* that is usually recorded from deeper water, for example 30–180 m around the Florida Keys (Britton 1970). Records of *P. harperae* from Atlantic Panama (USNM below) are also from shallow water seagrass habitats. At Curaçao it co-occurred with several other lucinid species: *Clathrolucina costata* (d'Orbigny, 1845), *Ctena imbricatula* (C.B. Adams, 1845), *Anodontia alba* Link, 1807, *Codakia orbicularis* (Linnaeus, 1758), *Lucina roquesana* J. & W. Gibson-Smith, 1982 and *Divalinga quadrisulcata* (d'Orbigny, 1845).

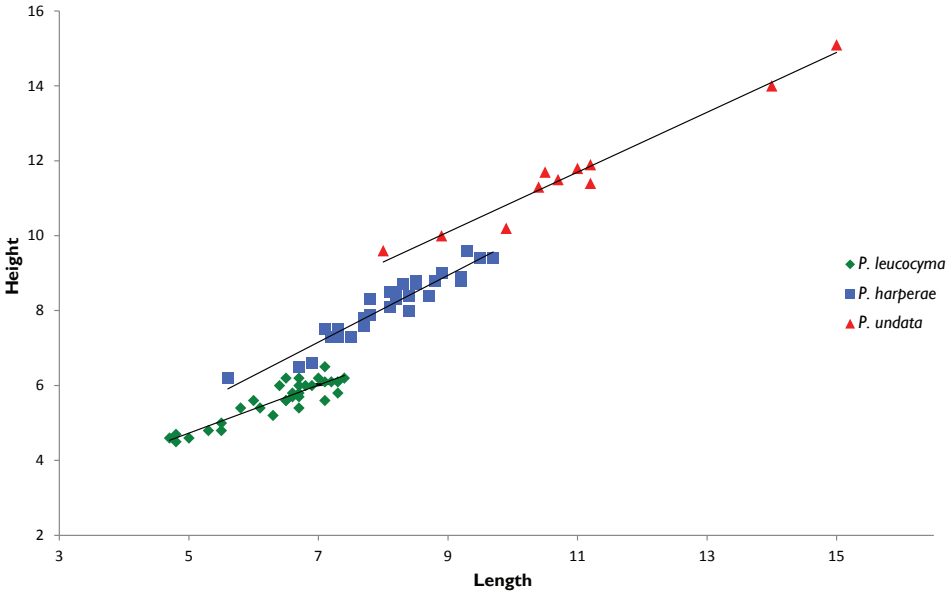

Figure 8. Bivariate height/length plots comparing *P. harperae* with *P. leucocyma*, and *P. undata.* Length and height in millimetres.

Distribution. Southern Caribbean: Panama (USNM 759784; 620716, 759825) Colombia -Taganga (Daccarett and Bossio 2011), Curaçao. The distribution of *Pleurolucina harperae* in the southern Caribbean is uncertain but it may be restricted to the southwestern area. There have been no records from the Antilles and intensive sampling of molluscs around Guadeloupe by Muséum national d'Histoire Naturelle (KARUBENTHOS 2012, 2015) recorded only *P. hendersoni* and *P. sombrerensis* (Taylor and Glover submitted). Similarly, only *P. sombrerensis* was recorded from a recent survey of the marine molluscan fauna of French Guiana (MNHN - GUYANE 2014).

Etymology. Named for Elizabeth (Liz) Harper, University of Cambridge, bivalve researcher, colleague and friend, who helped collect the new species.

Comparison with other species. *Pleurolucina leucocyma* (Fig. 7) was thought to be widespread across the tropical Western Atlantic but we now consider it to be restricted to Florida and the Gulf of Mexico with the southern Caribbean records representing *Pleurolucina harperae.* The new species differs from *P. leucocyma* (mean L 6.2 mm, H 7.4 mm, H/L 1.13) in being larger, less inflated and usually longer than high in the adult (Fig. 8). The radial folds are usually lower and the anterior adductor muscle scar is shorter and more divergent from the pallial line (Fig. 2 B). In shape and sculpture, it is most similar to the somewhat larger *Pleurolucina undata* (Figs 9 E-G) (mean L 15.1 mm, H 15 mm, H/L 0.95) from the eastern Pacific, Gulf of California, intertidal zone to 60 m (Coan and Valentich-Scott 2012).

Other less similar species are: *P. hendersoni* (Figs 9 A, B) an offshore to deep water species (to 300 m) from the southern Caribbean (Cuba, Lesser Antilles) that reaches

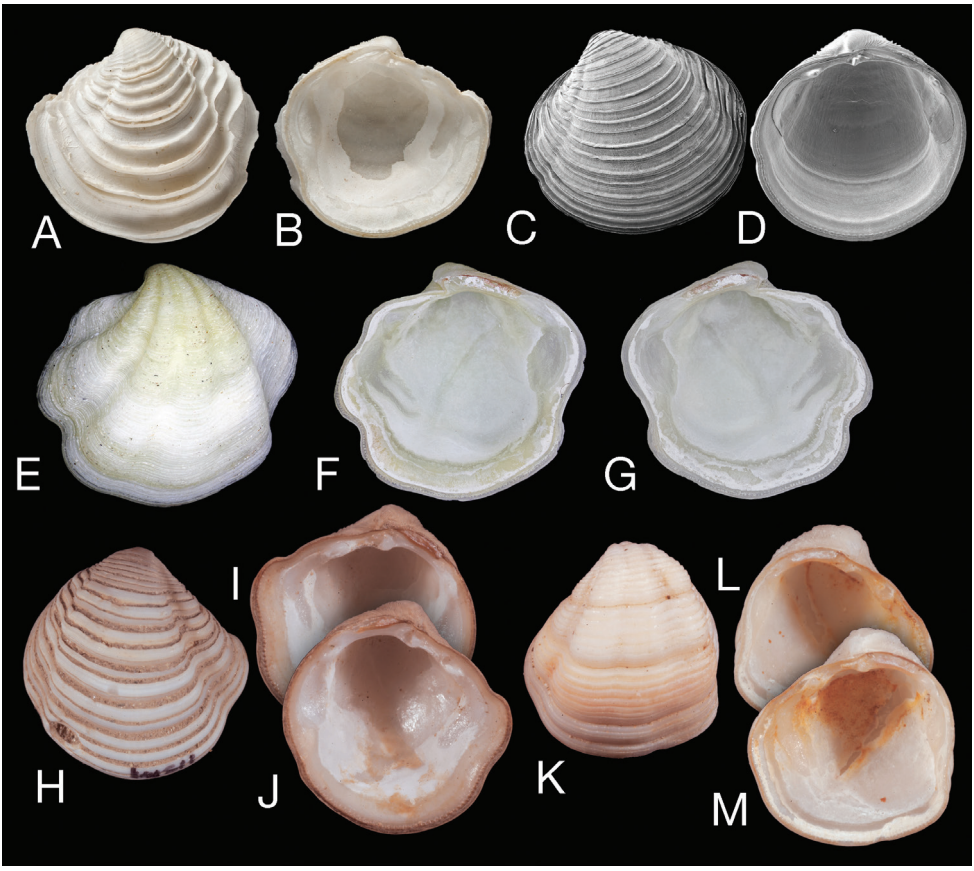

Figure 9. Other *Pleurolucina* species. **A, B** *Pleurolucina hendersoni* Britton, 1972, exterior and interior of left valve Guadeloupe station GD 69 (MNHN), L 9.1 mm **C, D** *Pleurolucina sombrerensis* (Dall, 1886) exterior of left valve (L 4.9 mm) and interior of right valve (L 5.2 mm), USNM 446178, Eolis stn 48, off Miami, Florida, 110 m **E–G** *Pleurolucina undata* (Carpenter, 1865) exterior of left valve and interiors of right and left valves, NUMUK 1915.15.273 'California', L 11.0 mm **H–J** *Pleurolucina leucocymoides* (Lowe, 1935), exterior of right valve and interiors of right and left valves SBMNH 141511, Baja California, NE of Isla Danzante, Mexico, L 11 mm **K–M** *Pleurolucina taylori* Coan & Valentich-Scott, 2012, holotype, exterior of left valve and interior of left and right valves, SBMNH 149647, Baja California, Los Frailes, Mexico, L 9.5 mm.

about 12 mm in length and resembles the eastern Pacific *P. leucocymoides*. Compared with other *Pleurolucina*, the sculpture of broad radial folds is less pronounced and the commarginal lamellae are widely spaced and prominent. *Pleurolucina sombrerensis* (Figs 9 C, D) lives in deeper water to 200 m from the Florida Keys to Brazil. The shell reaches about 6–7 mm in length and is rounded in outline, with a shallow radial anterior sulcus and prominent close commarginal lamellae, sometimes separated by deep interspaces. It does not closely resemble other *Pleurolucina* but shares some shell features including dentition and adductor scar shape. The larger *P. leucocymoides* (Figs 9 H–J) is known from shallow water to 150 m and ranges from Baja California to Ec-

uador and Galapagos Islands. The sculpture of broad prominent commarginal lamellae and absence of prominent radial folds distinguish it from other *Pleurolucina*. Lastly, *P. taylori* (Figs 9 K–M) is known from the intertidal zone to 183 m in the Gulf of California; it is distinguished by the highly inflated shell and closely spaced, low commarginal lamellae with four to five radial folds and resembles the extinct late Pliocene – mid-Pleistocene Floridian species *P. amabilis*.

Discussion

Pleurolucina is a genus of seven living species from the tropical to subtropical western Atlantic and eastern Pacific with none recognised from the eastern Atlantic or Indo-West Pacific. In that respect, it is similar to *Radiolucina* (Garfinkle 2012) and *Lucinisca* that share similar distributions. In the western Atlantic, the most similar species to the southern Caribbean *Pleurolucina harperae* is *P. leucocyma* from Gulf of Mexico and Florida. This distributional pattern of northern and southern species pairs is seen in *Ctena* (*C. orbiculata* and *C. imbricatula*), *Lucinisca* (*L. nassula* and *L. muricata*) and *Lucina* (*L. pensylvanica* and *L. roquesana*) (see Taylor and Glover submitted). Cognate pairs of bivalves have been recognised from morphology and/or molecules on either side of the central American Isthmus (Marko 2002, Marko and Moran 2009). Although molecular confirmation is lacking, *Pleurolucina harperae* is similar in shell form to *P. undata*, *P. hendersoni* resembles *P. leucocymoides* and perhaps *P. leucocyma* is a sister species to *P. taylori*.

An interesting and unusual feature of *Pleurolucina harperae* is the repeated conchiolin sheets that are calcified with layers of embedded spherules. A model of conchiolin sheet formation in another lucinid genus, *Cardiolucina*, was proposed by Ishikawa and Kase (2007 fig. 7). Periodically, normal shell secretion of outer, middle and inner shell layers stops and a conchiolin sheet is secreted across the inside of the shell from the margin and extending within the pallial line. This break in normal calcification is marked by a distinct notch at the shell surface. Calcification then resumes with secretion of normal shell layers. Conchiolin layer formation in *Pleurolucina* is essentially similar but each layer is thicker with repeated sublayers of aragonitic spherules. The narrow channels linking successive spherule layers suggest some sort of original tissue connection to the cells of the mantle surface.

Conchiolin layers within the shell have been recorded in several bivalve families but those in the Corbulidae have attracted most attention because of the supposed resistance to predation by drilling gastropods evidenced by the high incidence of failed borings that terminate at the organic layers (e.g. Lewy and Samtleben 1979, Harper 1994). Alternatively, organic layers may enhance resistance to shell dissolution, endolithic organisms or shell breakage (Anderson 1992, Harper 1994, Kardon 1998). In contrast to *Pleurolucina* where the conchiolin layers are secreted episodically, the layers in Corbulidae are secreted continuously as a sublayer of normal shell formation. In *Corbula gibba* the conchiolin layer is calcified with cone-shaped spher-

ules approx. 8 μm in diameter (Lewy and Samtleben 1979 figs 5A–F). The organic layers of *Pleurolucina harperae* are similar in position and mode of formation to those recorded for species of *Cardiolucina* (Ishikawa and Kase 2007), but are much more highly calcified. *Cardiolucina* spp also show a high incidence of multiple drill holes with many terminating at the organic layers (Ishikawa and Kase 2007). *Pleurolucina* and *Cardiolucina* are not closely related among the Lucininae and the occurrence of conchiolin layers in other lucinids seems to be sporadic and certainly absent in many genera although no comprehensive study has been made. Nonetheless, calcified conchiolin layers do occur in some individuals of *Lucina pensylvanica* that is more closely related to *Pleurolucina.* It is tempting to regard the conchiolin layers as an adaptation conferring some resistance to shell drilling predation but, as argued in the case of *Corbula* (e.g. Kardon 1998), the layers may be an exaptation having first developed with some other function such as resistance to shell dissolution or enhancement of mechanical strength.

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RESEARCH ARTICLE

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Mysidella hoshinoi, a new species from Izu-Oshima Island, Japan (Crustacea, Mysidae, Mysidellinae)

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Abstract

A new mysid, *Mysidella hoshinoi* **sp. n.** is described from Izu-Oshima Island, Sagami Sea, central Japan. This species differs from its congeners in having a posterodorsal finger-like papilla on the eyestalk, five peculiar spines terminating in plumed seta on outer margin of carpopropodus of endopod of first thoracopod, and uropodal endopod bearing 27 spines on inner margin.

Keywords

Izu-Oshima Island, Mysidae, *Mysidella*, Sagami Sea

Introduction

Mysidella G. O. Sars, 1872, is the only genus of the subfamily Mysidellinae Czerniavsky, 1882 and includes 16 species (WoRMS 2016), ranging in depth from 3 m to 738 m worldwide (Murano 2002). Among these, four species have so far been reported from Japan:

Mysidella nana Murano, 1970 at 18–80 m, Oomura Bay, Tateyama Bay, and Suruga Bay (Murano 1970a, 1970b, 2002),
M. orientalis Murano, 2002 at 347–369 m, eastern East China Sea (Murano 2002),
M. tanakai Ii, 1964 at 220–660 m, Suruga Bay, Tateyama Bay and Sagami Bays (Ii 1964; Murano 1970b, 2002), and
M. truncata Murano, 2002 at 138–141 m, Amami-Oshima Island (Murano 2002).

Our recent investigations yielded an undescribed species *Mysidella* from a marine benthic habitat of Izu-Oshima, Sagami Sea. Based on this material, a new species *Mysidella hoshinoi* sp. n. is described, and an updated identification key is provided to the known species of *Mysidella*.

Material and methods

Mysids were collected with sealable plastic bags (20 cm × 20 cm) by scooping seawater on a sea anemone beloninging to the family Haloclavidae by a local SCUBA diver. All specimens obtained were fixed and preserved in 80% ethanol. Each individual was dissected and prepared for observation by a light microscope (Nikon E600). The total length of individuals was measured from the end of the rostrum to the end of the telson excluding spines.

The terminology follows Murano (2002). The type specimens are deposited in the Kitakyushu Museum of Natural History and Human History, Japan (KMNH).

Systematics

Mysidella G. O. Sars, 1872

Mysidella G. O. Sars, 1872: 266; G. O. Sars 1879: 84–86; Zimmer 1909: 169; Illig 1930: 600; Banner 1948: 108–109; Tattersall and Tattersall 1951: 427; Ii 1964: 574; Kathman et al. 1986: 191; Fenton 1990: 437; Murano 2002: 66.

Type species. *Mysidella typica* G. O. Sars, 1879 (by original designation and monotypy).

Mysidella hoshinoi sp. n.

http://zoobank.org/F7FEE4EB-48E9-4E4A-8AAA-6329D6197FFE
Figs 2–5

Material examined. Holotype. Adult ♂ (4.0 mm) (KMNH IvR 500893), 34°47'N, 139°24'E, Akino-hama, Izu-Oshima Island, Sagami Sea, Japan, 23 August 2014, 35 m.

Paratypes. Adult ♀ (4.0 mm) (KMNH IvR 500894), immature ♀ (3.0 mm) (KMNH IvR 500895), immature ♂ (3.1 mm) (KMNH IvR500896), data same as holotype; adult ♀ (3.4 mm) (KMNH IvR 500897), immature ♀ (3.0 mm) (KMNH IvR 500898), immature ♂ (2.7 mm) (KMNH IvR 500899), 34°47'N, 139°24'E,Akino-hama, Izu-Oshima Island, Tokyo, Japan, 16 August 2014, 35 m.

Diagnosis. Eyestalk with posterodorsal finger-like papilla; carpopropodus of endopod of first thoracopod with five peculiar spines terminating in plumed seta on outer margin; terminal claw of carpopropodus of endopod of first thoracopod

Figure 1. *Mysidella hoshinoi* sp. n., sex unknown, on a tentacle of a sea anemone (family Haloclavidae), Akino-hama, Izu-Oshima Island, Sagami Sea, Japan, 25 March 2016, 35 m depth, habitus *in situ*, photographed by O. Hoshino.

with one short seta and suture distinct; uropodal endopod with 27 spines on inner margin.

Description of the holotype. *Carapace* (Fig. 2A): anterior margin produced into short rounded rostral plate and covering basal part of eyestalks; anterolateral corner produced; posterior margin emarginated, leaving last thoracic somite exposed. Eye (Fig. 2A, C) developed; cornea well-pigmented, globular, wider than eyestalk, occupying nearly half of eye; eyestalk with posterodorsal finger-like papilla.

Antennula (Fig. 2A, H): first segment of antennular peduncle longest, 1.3 times as long as third article, with anterolateral corner produced laterally and tipped with three plumose setae, and with two short projections anterodorsally bearing some plumose setae apically; second article shortest, with short projection anterodorsally bearing four plumose setae apically and one simple seta distomedially; third article slightly wider than long, small appendix masculina on ventral side, with short projection anterodorsally bearing some short stout setae and two plumose setae apically, and with six simple setae distomedially.

Antenna (Fig. 2A, J): antennal scale setose all round, extending beyond distal margin of antennular peduncle for 0.3 of its length, 3.2 times as long as width, distal suture distinct; outer margin slightly concave; inner margin convex. Antenna peduncle 3-articulate: first segment shortest; second and third segments subequal in length.

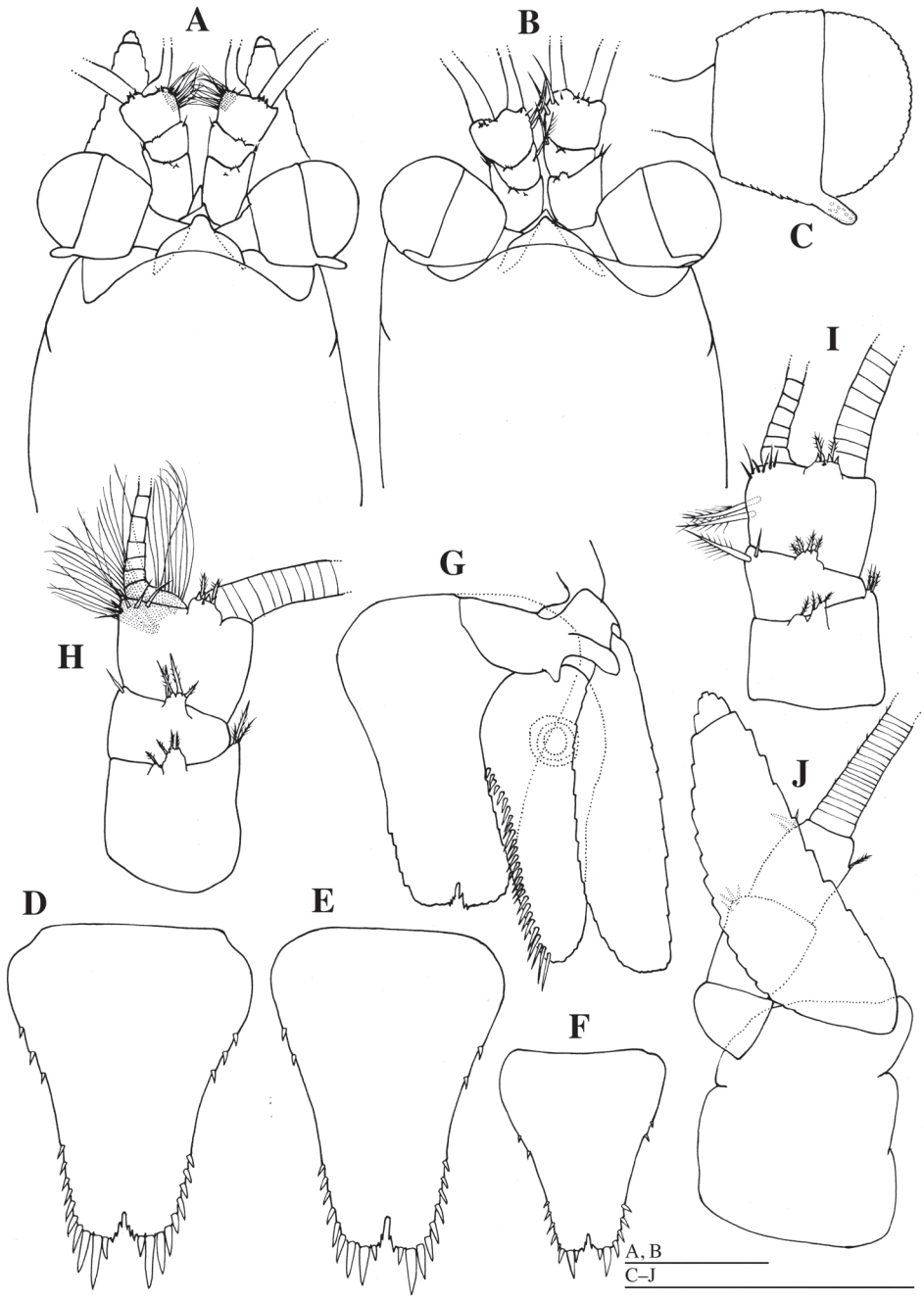

Figure 2. *Mysidella hoshinoi* sp. n., **A, C, D, G, H, J** holotype male **B, E, I** paratype female (KMNH IvR 500894) **F** paratype female (KMNH IvR 500895): **A, B** anterior part of head, dorsal **C** right eye, dorsal **D–F** telson, dorsal **G** telson and left uropod, ventral **H, I** basal part of right antennula, dorsal **J** basal part of right antenna, dorsal. Scale bars: 500 μm.

Labrum (Fig. 3A) rounded apically, produced posteriorly into two unequal lobes; right lobe broadly rounded posteriorly, with fine teeth on margin; left lobe smaller; both lobes with fine teeth on posterior margin.

Left mandible (Fig. 3B) without teeth; molar portion trapezoidal; first article of mandibular palp shortest; second article longest, with seven setulate setae distally; third article slightly curved, with several setae. Right mandible (Fig. 3C) without teeth and molar portion, slightly curved medially, mandibular palp similar in shape than the left one.

Maxillula (Fig. 3D): inner lobe broad, 2.6 times as wide as outer lobe, with three plumose and one simple setae; outer lobe with 12 stout setae distally.

Maxilla (Fig. 3E): exopod with nine plumose setae on margin; first article of endopod with two plumose setae distally; second article with many plumose and some simple setae on margin; bilobulate basal endites each with ten plumose setae distally; coxal endite with six plumose setae distally and four plumose setae medially.

Endopod of first thoracopod (Fig. 3F) robust: basis with two plumose setae; preischium triangular, with four plumose setae distally; ischium 1.1 times as long as basis, with five plumose setae distally; merus 0.6 times as long as ischium, with two plumose setae and one simple seta; carpopropodus 1.4 times as long as merus, twice as long as width, with five peculiar spines (Fig. 3G) terminating in plumed seta on outer margin; terminal claw nearly straight, 1.1 times as long as carpopropodus, with one short setae, suture distinct.

Endopod of second thoracopod (Fig. 3H): ischium 0.8 times as long as basis; merus longest, 1.6 times as long as ischium; carpopropodus 0.7 times as long as merus, with two rows of setae distally; dactylus small, with one long, setulate seta apically and several short setae. Endopod of third thoracopod (Fig. 4A): preischium trapezoidal; ischium 3.0 times as long as preischium; merus 1.1 times as long as ischium; carpopropodus divided into two subsegments, 0.8 times as long as merus; dactylus small, with strong terminal claw. Endopod of fourth thoracopod (Fig. 4B): preischium trapezoidal; ischium 3.0 times as long as preischium; merus 0.9 times as long as ischium; carpopropodus divided into two subsegments, 0.7 times as long as merus; dactylus small, with strong terminal claw. Endopod of fifth thoracopod (Fig. 4C): preischium triangular; ischium 6.1 times as long as preischium; merus half as long as ischium; carpopropodus divided into three subsegments, 0.8 times as long as merus; dactylus small, with strong terminal claw. Endopod of sixth thoracopod (Fig. 4D): preischium triangular; ischium 5.7 times as long as preischium; merus half as long as ischium; carpopropodus divided into three subsegments, 0.8 times as long as merus; dactylus small, with strong terminal claw. Endopod of seventh thoracopod (Fig. 4E): preischium triangular; ischium 4.2 times as long as preischium; merus 0.7 as long as ischium; carpopropodus divided into three subsegments, 0.8 times as long as merus; dactylus small, with strong terminal claw. Endopod of eighth thoracopod (Fig. 4F): preischium triangular; ischium 3.9 times as long as preischium; merus 0.7 as long as ischium; carpopropodus divided into three subsegments, 0.8 times as long as merus; dactylus small, with strong terminal claw.

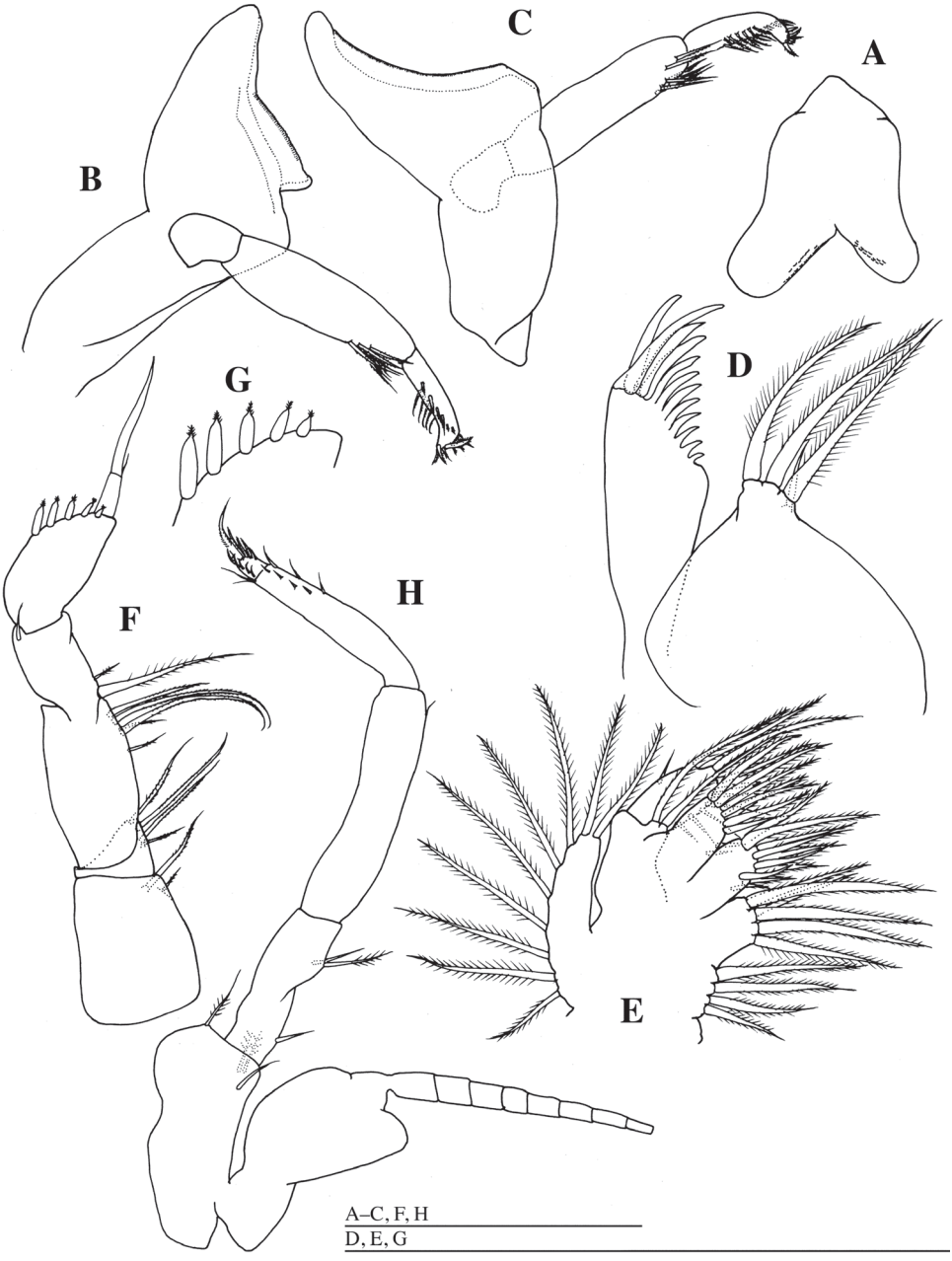

Figure 3. *Mysidella hoshinoi* sp. n., holotype male: **A** labrum ventral **B** left mandible, dorsal **C** right mandible, ventral **D** left maxillula, dorsal **E** left maxilla, dorsal **F** right first thoracopod, dorsal **G** peculiar spines on outer margin of carpopropodus of endopod of first thoracopod **H** right second thoracopod, lateral. Scale bars: 500 μm.

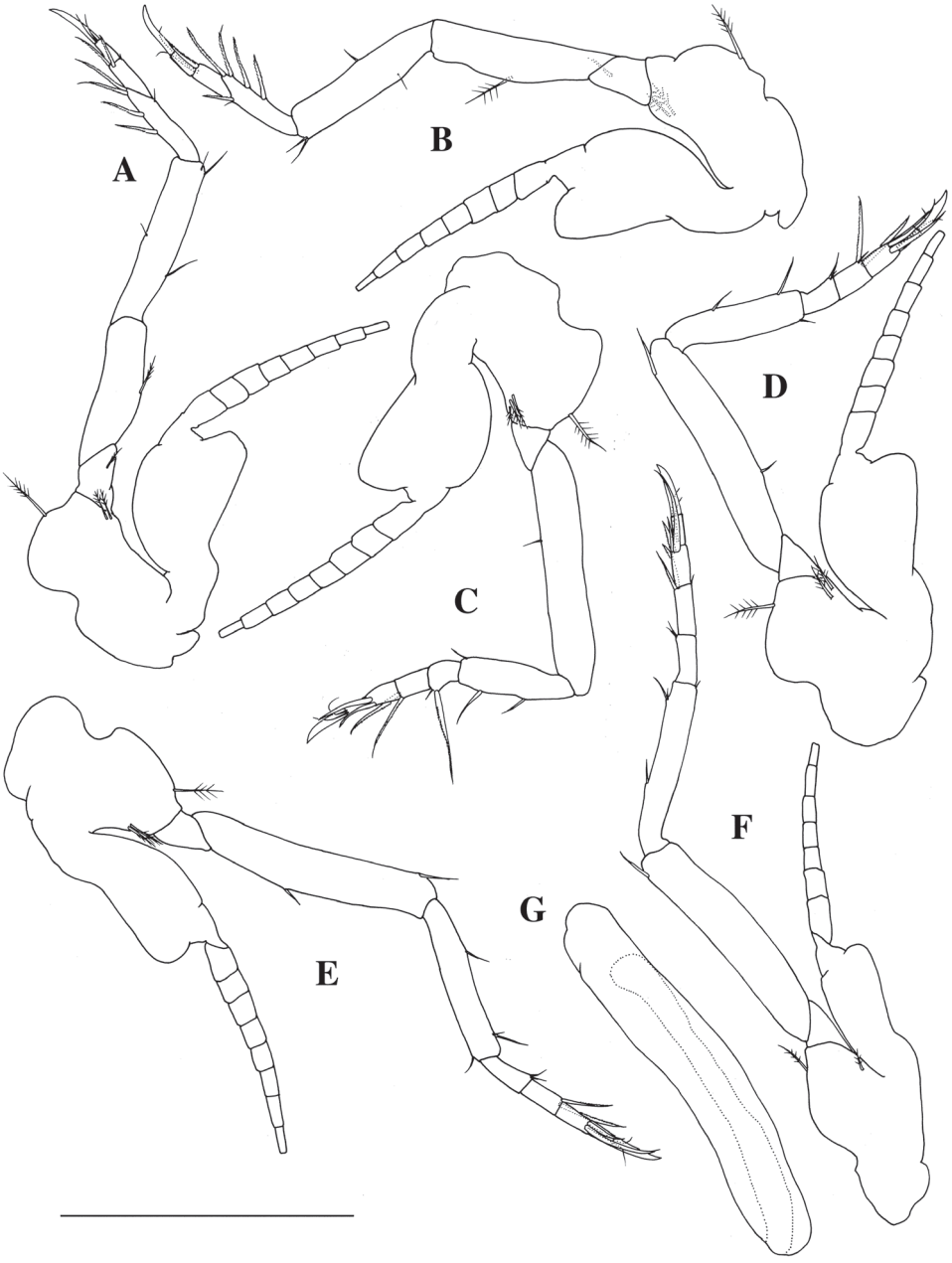

Figure 4. *Mysidella hoshinoi* sp. n., holotype male: **A** left third thoracopod, lateral **B** left fourth thoracopod **C** left fifth thoracopod, lateral **D** left sixth thoracopod, lateral **E** left seventh thoracopod, lateral **F** left eighth thoracopod, lateral **G** left penis, ventral. Scale bar: 500 μm.

Exopod of first thoracopod with 8-segmented flagellum. Exopods of second to seventh thoracopods (Figs 3H, 4A–E) similar in shape and size, with 7-segmeted flagellum; basal plate with rounded outer corner. Exopod of eighth thoracopod (Fig. 4F) with 7-segmented flagellum; basal plate narrower than those of anterior six thoracopods.

Penis (Fig. 4G) cylindrical, 6.2 times as long as width, without setae.

Abdomen: first four somites decreasing in length posteriorly; second and fifth segments subequal in length; sixth somite 1.3 times as long as fifth somite.

All pleopods (Fig. 5A–E) reduced to unsegmented lobe, not modified. First pleopod as long as second pleopod; second pleopod to fifth pleopod increasing in length; fifth pleopod 1.3 times as long as fourth pleopod.

Uropod (Fig. 2G): endopod of uropod extending to apex of apical spines of telson, 2.1 times as long as width, with large statolith and 27 spines on inner margin; exopod of uropod 3.9 times as long as width.

Telson (Fig. 2D) tapering posteriorly, 1.3 as long as maximum width; lateral margins each with three pairs of anterior spiniform setae, seven posterior spiniform setae on left side and six posterior spiniform setae on right side, and three pairs of terminal spiniform setae; cleft shallow and narrow, 0.08 times as deep as telson length, with six short spines on margin.

Description of the paratype female (KMNH IvR 500894). *Antennula* (Fig. 2B, I): first segment of antennular peduncle as long as third article, with anterolateral corner produced laterally and tipped with three plumose setae, and with two short projections anterodorsally bearing some plumose setae apically; second article shortest, with short projection anterodorsally bearing four plumose setae apically and one plumose and one simple setae distomedially; third article slightly wider than long, with short projection anterodorsally bearing some short stout setae and two plumose setae apically, and with two plumose setae medially and six simple setae distomedially.

All thoracopods and pleopods (Fig. 5F) similar to holotype male in morphology and chaetotaxy.

Telson (Fig. 2E): lateral margins each with two pairs of anterior, six pairs of posterior and three pairs of terminal spiniform setae; cleft with four spines on margin.

Marsupium composed of two pairs of developed oostegites on seventh and eighth thoracopods.

Variation. Some variations (N = 7: holotype and 6 paratypes) were recognized in the number of spiniform setae on telson (Fig. 2F). Lateral margins each with two or three pairs of anterior, four to seven pairs of posterior spiniform setae; cleft with one to four spines on margin.

Color in life. Body (Fig. 1) dark to light read, with or without light brownish marbled pattern. Cornea of eye light orange; posterodorsal finger-like papilla on the eyestalk white. Antennular flagella transparent with white and red stripes.

Distribution and habitat. The new species has so far been found only the type locality, 35 m depth, Akino-hama, Izu-Oshima Island, Sagami Sea, central Japan. According

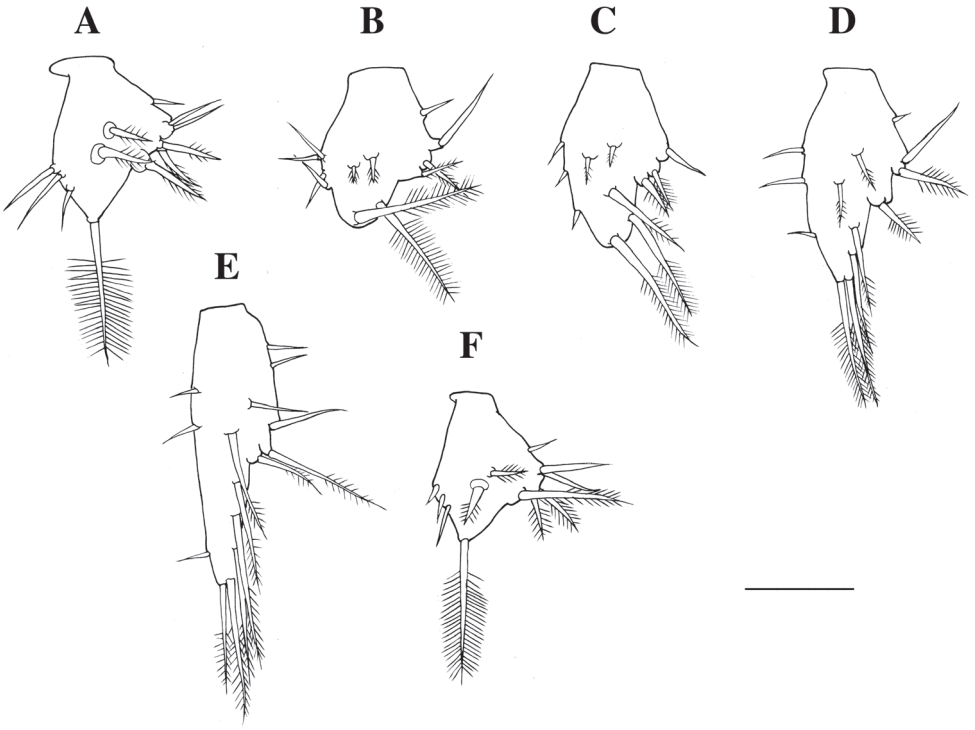

Figure 5. *Mysidella hoshinoi* sp. n., **A–E** holotype male **F** paratype female (KMNH IvR 500894): **A** left first pleopod, ventral **B** left second pleopod, ventral **C** left third pleopod, ventral **D** left fourth pleopod, ventral **E** left fifth pleopod, ventral **F** left first pleopod, ventral. Scale bar 100 μm.

to the sampling notes by Mr. O. Hoshino, a number of individuals hovered above and around oral disc and tentacles of Haloclavidae sp. at the bottom. The mysids sometimes perched on the tentacles of the sea anemone. The new species live in ectocommensal association with sea anemones of the family.

Remarks. *Mysidella hoshinoi* sp. n. differs from all the congeners in having a posterodorsal finger-like papilla on the eyestalk.

The arrangement of the spines of the telson links the new species to *Mysidella incisa* Wang, 1998, from the northern area of the South China Sea (Wang, 1998) and the Timor Sea (Murano, 2002). *Mysidella hoshinoi* is distinguished from *M. incisa* by the following characters (those of *M. incisa* in parentheses): cornea occupying nearly half of eye (nearly one third); eyestalk with posterodorsal finger-like papilla (without papilla); uropodal endopod 2.1 times as long as width (2.5–2.7 times as long as width), with 27 spines on inner margin (with 22–24 spines).

Etymology. This species is named after Mr. O. Hoshino, who gave me the present material for taxonomic study. The specific name thus is a noun in the genitive singular.

Key to the species of *Mysidella*, with the depth ranges and distributions (modified from Brattegard 1973 and Murano 2002)

1 Eye well developed, with cornea **2**
– Eye rudimentary, without cornea. 375 m depth, Norway ..... ***M. typhlops***
2 Posterodorsal finger-like papilla on the eyestalk absent..... **3**
– Posterodorsal finger-like papilla on the eyestalk present. 35 m depth, Izu-Oshima Island, Japan..... ***M. hoshinoi* sp. n.**
3 Distal cleft / total length in telson less than 5% **4**
– Distal cleft / total length in telson more than 5% **5**
4 Two or three spines on distal cleft of telson. 20–115 m depth, northern South China Sea, Timor Sea ..... ***M. incisa***
– Six spines on distal cleft of telson. 33–79 m depth, Bass Strait.... ***M. australiana***
5 Distal cleft / total length in telson less than 10% **6**
– Distal cleft / total length in telson more than 10% **8**
6 Telson 1.3 times as long as width; two to four spines on distal cleft of telson **7**
– Telson about twice as long as width; eight spines on distal cleft of telson. 25.5–260 m depth, northern South China Sea ..... ***M. rotundincisa***
7 Three peculiar spines on outer margin of carpopropodus of endopod of first thoracopod; 16 spines on inner margin of uropodal endopod; seven to nine spiniform setae along whole length of lateral margin of telson. 3 m depth, Rottnest Island, West Australia..... ***M. mukaii***
– Five peculiar spines on outer margin of carpopropodus of endopod of first thoracopod; 25 spines on inner margin of uropodal endopod; eight spiniform setae on distal half of lateral margin of telson. 138–141 m depth, Amami-Oshima Island, southwestern Japan ..... ***M. truncata***
8 Distal cleft / total length in telson less than 19% **9**
– Distal cleft / total length in telson more than 19% **13**
9 Distal cleft / total length in telson 17%. 500–600 m depth, British Columbia to S. California ..... ***M. americana***
– Distal cleft / total length in telson less than 15%. **10**
10 46 spines on inner margin of uropodal endopod..... **11**
– 24–32 spines on inner margin of uropodal endopod..... **12**
11 Telson 2.4 times as long as width. 300–720 m depth, Bay of Biscay..... ..... ***M. biscayensis***
– Telson less than twice as long as width. 415–437 m depth, northern South China Sea ..... ***M. macrophthalma***
12 Six or seven spiniform setae on distal half of lateral margin of telson; 24 or 25 spines on inner margin of uropodal endopod. 40 m depth, Caribbean coast of Colombia ..... ***M. minuta***
– 16–18 spiniform setae on distal half of lateral margin of telson; 30–32 spines on inner margin of uropodal endopod. 90–540 m depth, Norway to Bay of Biscay, Mediterranean..... ***M. typica***

13 Five peculiar spines on outer margin of carpopropodus of endopod of first thoracopod; 12–20 spines on distal cleft of telson **14**

– Three peculiar spines on outer margin of carpopropodus of endopod of first thoracopod; 24–36 spines on distal cleft of telson **15**

14 20 spiniform setae on distal half of lateral margin of telson; 35 spines on inner margin of uropodal endopod. 80 m depth, Suruga bay, Japan .... ***M. nana***

– Eleven or 12 spiniform setae on distal half of lateral margin of telson; 29 spines on inner margin of uropodal endopod. 78 m depth, northern South China Sea ..... ***M. tenuicauda***

15 16 spiniform setae on distal half of lateral margin of telson; 30 spines on inner margin of uropodal endopod. 347–369 m depth, eastern East China Sea..... ..... ***M. orientalis***

– 25–27 spiniform setae on lateral margin of telson; 47 or 48 spines on inner margin of uropodal endopod **16**

16 Deep transverse groove on rostrum present; telson 2.6 times as long as width. 535–738 m depth, Timor Sea, Sulu Sea ..... ***M. sulcata***

– Deep transverse groove on rostrum absent; telson 2.3 times as long as width. 220–660 m depth, Suruga Bay, Sagami Bay, Japan..... ***M. tanakai***

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RESEARCH ARTICLE

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Four new species of the genus *Otacilia* Thorell, 1897 from Hunan Province, China (Araneae, Phrurolithidae)

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Abstract

Four new species of the genus *Otacilia* Thorell, 1897 are reported from Hunan Province, China: *Otacilia hippocampa* **sp. n.**, *Otacilia yangmingensis* **sp. n.**, *Otacilia curvata* **sp. n.**, and *Otacilia submicrostoma* **sp. n.** All new species are described based on both sexes. In addition, the 55 known *Otacilia* species are divided into four species groups.

Keywords

Description, diagnosis, etymology, morphology, taxonomy

Introduction

Phrurolithidae Banks, 1892 was elevated to family rank by Ramírez (2014), consistent with the suggestion of Deeleman-Reinhold (2001). The family is currently represented by 211 species belonging to 14 genera worldwide. Of these, four genera and 65 species are recorded from China (World Spider Catalog 2016, Fu et al. 2015, Fu et al. 2016a, b). The Phrurolithidae are mostly ground-dwelling spiders living in leaf litter, especially bamboo leaves, woody debris or on the forest floor, very few species are found in the canopy (Deeleman-Reinhold 2001; Fu et al. 2014).

Otacilia Thorell, 1897 is one of the species-rich genera of the family comprising 55 species distributed in south-east Asia and east Asia. Among these *Otacilia* species, 35 are reported from China (Fu et al. 2015, Fu et al. 2016a, Fu et al. 2016b). The genus *Otacilia* was established by Thorell (1897) with description of *O. armatissima* based on a single female specimen from Myanmar.

The genus *Otacilia* is closely related to *Phrurolithus* C. L. Koch, 1839, comprising 74 species mostly distributed in the holarctic region. Until now, there is no clear way to differentiate between *Otacilia* and *Phrurolithus*. The diagnostic characters provided by Kamura (2005) were inaccurate (Wang et al. 2015), and the differences listed by Jäger and Wunderlich (2012) were also not distinct with the addition of more new species of these two genera.

Wang et al. (2015) listed ten Chinese *Otacilia* species in two groups. Subsequently, Fu et al. (2016b) reviewed the 31 Chinese *Otacilia* species and agreed with Wang et al.'s (2015) assignment and also established a third species group to accommodate the *Otacilia* species: the *armatissima* group, the *revoluta* group, and the *pseudostella* group.

While examining the collections from Hunan Province, China, some *Otacilia* specimens were found that differed from the currently known *Otacilia* species. They are identified as four new species, *Otacilia hippocampa* sp. n., *Otacilia yangmingensis* sp. n., *Otacilia curvata* sp. n., and *Otacilia submicrostoma* sp. n., and are described and illustrated here.

Material and methods

The terminology used follows Jäger and Wunderlich (2012). All measurements given in the text are in millimeters. Total length is the sum of the carapace and abdomen lengths, regardless of the pedicel. Eye sizes were measured as the maximum diameter in dorsal or frontal view. Leg measurements are shown as: total length (femur, patella, tibia, metatarsus, tarsus). Epigyne were removed and cleared in a warm solution of 10% potassium hydroxide (KOH), transferred to ethanol and temporarily mounted for drawing. All specimens are preserved in 75% alcohol and were examined, drawn, and measured under a Leica M205A stereomicroscope equipped with an Abbe drawing device. Photographs were taken using a Leica M205A stereomicroscope equipped with a DFC450 CCD. The specimens are deposited in the Museum of Hebei University, Baoding, China (MHBU).

Abbreviations

ALE anterior lateral eyes;
AME anterior median eyes;
a.s.l. above sea level;
B bursa;

C conductor;
CD copulatory duct;
CO copulatory opening;
CT connecting tube;
DTA dorsal tibial apophysis;
E embolus;
FA femoral apophysis;
FD fertilization duct;
GA glandular appendage;
MOA median ocular area;
MP median plate;
PLE posterior lateral eyes;
PME posterior median eyes;
RTA retrolateral tibial apophysis;
S spermatheca;
TA tegular apophysis.

Taxonomy

Phrurolithidae Banks, 1892

Otacilia Thorell, 1897

Diagnosis. Chelicerae each with two bristles (rarely with one bristle) on anterior side; leg formula: 4123 (rarely 1423); spination: femora I–II d 0–2, III–IV d 0–1, I pl 3–6, II pl 0–3; tibiae I–II usually with 6–8 pairs of ventral spines; tibia I always one more rv than pv spine and tibia II always one more pv than rv spine; metatarsi I–II usually with 3–4 pairs of ventral spines, and always one more pv than rv spine.

Male palp: femur with ventral apophysis or hump; tibia usually with single strong RTA, some species with BTA or DTA; embolus hook-shaped or needle-like, originating antero-prolaterally; tegular apophysis sclerotized or transparent, present or absent, antero-retrolaterally located; conductor membranous, well developed or absent. Female genitalia: epigynal median plate distinct or absent; vulva with pair of transparent bursae anteriorly and pair of strongly sclerotized spermathecae posteriorly.

Species groups of *Otacilia*. After reviewing 59 *Otacilia* species (including the four new Chinese species described in this paper), the grouping was revised and the current species assigned to four groups based on assessment of Fu et al. (2016b). The *revoluta* group was divided into two new groups, the *longituba* group (16 species) and the *ambon* group (two species). The *armatissima* group (29 species) and the *pseudostella* group (nine species) were preserved and updated. Three species were not assigned to any group because of their poor original description and figures or peculiar structure: *Otacilia luzonica* (Simon, 1898) (female is unknown; description and figures are not

diagnostic), *O. papilla* Dankittipakul & Singtripop, 2014 (male is unknown; epigyne medially with lobe and absence of bursae) and *O. paracymbium* Jäger & Wunderlich, 2012 (female is unknown; cymbium with paracymbium).

Here the male and female diagnostic characters are listed for each species group, followed by a list of all of the included *Otacilia* species (Table 1).

Otacilia hippocampa sp. n.

http://zoobank.org/C336230A-1FD5-435C-BA9C-13657E682F6F
Figs 1–3

Type material. Holotype ♂, China, *Hunan Province*: Dao County, Qingtang Town, Dajiangyuan Village, Mt. Jiucailing (25°27'37.678"N, 111°21'12.499"E), 448 m a.s.l., 29 September 2015, Chi Jin leg. Paratypes: 2♀2♂, same data as for holotype.

Etymology. The species name is taken from the Latin generic name of the seahorse, "*Hippocampus*", referring to the seahorse-shaped internal ducts (copulatory duct, connecting tube and spermatheca) in the female epigyne; adjective.

Diagnosis. The male can be distinguished from all other *armatissima* group species, except *O. bicolor* Jäger & Wunderlich, 2012, *O. onoi* Deeleman-Reinhold, 2001 and *O. truncata* Dankittipakul & Singtripop, 2014, by having a long DTA and can be distinguished from these three species by the absence of conductor (Figs 2A–D, 3A–C). The female of the new species can be easily distinguished from all of the other *armatissima* group species by the seahorse-shaped internal ducts (except the bursae), whereas they are S-shaped or crescent-shaped in the other congeners (Figs 2E–G, 3D–E).

Description. Male (Fig. 1A–B). Total length 2.17–2.65 (n = 3). Holotype: body 2.65 long; carapace 1.28 long, 1.12 wide; abdomen 1.37 long, 0.90 wide. Carapace yellowish brown, with black marginal bands; fovea longitudinal, brown. Eye diameters: AME 0.08, ALE 0.09, PME 0.08, PLE 0.09. Eye interdistances: AME–AME 0.02, AME–ALE 0.01, PME–PME 0.09, PME–PLE 0.05, ALE–PLE 0.07. MOA 0.19 long, front 0.17 wide, back 0.25 wide. Clypeus 0.14 high. Chelicerae with two strong anterior bristles; promargin with three well-separated teeth, and retromargin with two teeth close to each other. Labium and sternum dark yellow. Legs light yellowish brown; all femora with distal black distal annulus; patellae I–II black, patellae III–IV with distal black annulus; tibiae I–II almost all black, tibiae III–IV with black distal annulus; metatarsi I–II distal half part black, metatarsi III–IV with black distal annulus. Measurements of legs: leg I 4.95 (1.29, 0.49, 1.39, 1.23, 0.55), II 4.09 (1.11, 0.46, 1.01, 0.98, 0.53), III 3.59 (0.91, 0.44, 0.74, 0.94, 0.56), IV 5.19 (1.36, 0.45, 1.14, 1.49, 0.75). Leg formula: 4123. Femur I with two dorsal spines and three prolateral spines, femur II with one dorsal spine and two prolateral spines, femur III lacks dorsal spine, femur IV with one dorsal spine; tibia I with six proventral spines and seven retroventral spines, tibia II with six pairs of ventral spines; metatarsus I with four pairs of ventral spines, metatarsus II with four proventral spines and three retroventral spines. Femora I–III lack dorsal spines, femur IV four with one dorsal spine, femur I

Figure 1. *Otacilia hippocampa* sp. n. **A** male habitus, dorsal view **B** same, ventral view **C** Female habitus, dorsal view **D** same, ventral view.

Table 1. Definition of species groups of *Otacilia* species, together with lists of included species (species marked with an asterisk are reported from China).

Species group name	Diagnostic Character	Included Species
armatissima	1) Palpal organ with a distinct sclerotized TA or membranous conductor; embolus hook-shaped. 2) Epigyne with a distinct median plate, without concavity; CO slocated anteriorly or medially, higher than the spermathecae; CD (the left one from the ventral view) anti-clockwise from the CO; connecting tube usually crescent-shaped; spermathecae separated by more than half a spermatheca's diameter.	1) *O.armatissima* Thorell, 1897 2) *O. bawangling* Fu, Zhang & Zhu, 2010* 3) *O. biarclata* Fu, He & Zhang, 2015* 4) *O. bicolor* Jäger & Wunderlich, 2012 5) *O. florifera* Fu, He & Zhang, 2015* 6) *O. forcipata* Yang, Wang & Yang, 2013* 7) *O. foveata* (Song, 1990)* 8) *O. fujiana* Fu, Jin & Zhang, 2014* 9) *O. hengshan* (Song, 1990)* 10) *O. jianfengling* Fu, Zhang & Zhu, 2010* 11) *O. kao* Jäger & Wunderlich, 2012 12) *O. komurai* (Yaginuma, 1952)* 13) *O. limushan* Fu, Zhang & Zhu, 2010* 14) *O. liupan* Hu & Zhang, 2011* 15) *O. luna* (Kamura, 1994) 16) *O. lynx* (Kamura, 1994)* 17) *O. macrospora* Fu. Zhang & Zhang, 2016* 18) *O. obesa* Fu. Zhang & Zhang, 2016* 19) *O. onoi* Deeleman-Reinhold, 2001 20) *O. papilion* Fu, Zhang & Zhang, 2016* 21) *O. pyriformis* Fu, Zhang & Zhang, 2016* 22) *O. sinifera* Deeleman-Reinhold, 2001 23) *O. songi* Wang et al., 2015* 24) *O. subliupan* Wang et al., 2015* 25) *O. taiwanica* (Hayashi & Yoshida, 1993)* 26) *O. truncata* Dankittipakul & Singtripop, 2014 27) *O. yangi* Zhang, Fu & Zhu, 2009* 28) *O. hippocampa* sp. n.* 29) *O. yangmingensis* sp. n.*
ambon	1) Palpal organ without a distinct TA; the bulb is not pyriform but oval; embolus claw-like. 2) Epigyne without median plate and concavity; Cos located posterior, lower than the spermathecae; spermathecae well separated from each other by more than three spermatheca's diameter.	1) *O. ambon* Deeleman-Reinhold, 2001 2) *O. revoluta* (Yin et al., 2004)*
longituba	1) Palpal organ without a distinct TA; conductor well developed or degenerated; embolus needle-like. 2) Epigyne without median plate and concavity; Cos located medially, higher than the spermathecae; CD (the left one from the ventral view) straight or slightly clockwise from the CO; spermathecae close together or separated by less than half a spermatheca's diameter.	1) *O. bifurcata* Dankittipakul & Singtripop, 2014 2) *O. christae* Jäger & Wunderlich, 2012 3) *O. flexa* Fu, Zhang & Zhang, 2016* 4) *O. longituba* Wang, Zhang & Zhang, 2012* 5) *O. loriot* Jäger & Wunderlich, 2012 6) *O. microstoma* Wang et al., 2015* 7) *O. mingsheng* Yang, Wang & Yang, 2013* 8) *O. mira* Fu, Zhang & Zhang, 2016* 9) *O. mustela* Kamura, 2008

Species group name	Diagnostic Character	Included Species
longituba		10) *O. namkhan* Jäger & Wunderlich, 2012 11) *O. parva* Deeleman-Reinhold, 2001 12) *O. simianshan* Zhou, Wang & Zhang, 2013* 13) *O. vangvieng* Jäger & Wunderlich, 2012 14) *O. zebra* Deeleman-Reinhold, 2001 15) *O. curvata* sp. n.* 16) *O. submicrostoma* sp. n.*
pseudostella	1) Palpal organ without a distinct TA; an apophysis present near embolic base (PEA); embolus needle-like. 2) Epigyne without indistinct median plate, but with a pair of shallow concavities; Cos located anteriorly or medially, higher than the spermathecae; spermathecae separated by more than one spermatheca's diameter.	1) *O. acuta* Fu, Zhang & Zhang, 2016* 2) *O. aurita* Fu, Zhang & Zhang, 2016* 3) *O. digitata* Fu, Zhang & Zhang, 2016* 4) *O. leibo* Fu, Zhang & Zhang, 2016* 5) *O. ovata* Fu, Zhang & Zhang, 2016* 6) *O. pseudostella* Fu, Jin & Zhang, 2014* 7) *O. stella* Kamura, 2005 8) *O. vulpes* (Kamura, 2001) 9) *O. zhangi* Fu, Jin & Zhang, 2014*
the others		1) *O. luzonica* (Simon, 1898) 2) *O. papilla* Dankittipakul & Singtripop, 2014 3) *O. paracymbium* Jager & Wunderlich, 2012*

with three prolateral spines; tibia I with six proventral spines and seven retroventral spines, tibia II with six proventral spines and five retroventral spines; metatarsus I with four pairs of ventral spines, metatarsus II with four proventral spines and three retroventral spines. Abdomen oval, dorsum light grey, with several chevron-like black stripes, anterior half with a small dorsal scutum; venter light grey.

Palp (Figs 2A–D, 3A–C). Femur distally with an inflated hump on ventral side and a retrolateral concavity. RTA basally thick, tapering to a sharp apex, bent prolaterally. DTA shaped similarly to RTA, with one spine basally. Embolus short, needle-like. Conductor absent. Tegular apophysis triangular, sclerotized.

Female (Fig. 1C–D). Total length 2.56–2.96 (n = 2). One paratype: body 2.96 long; carapace 1.47 long, 1.22 wide; abdomen 1.49 long, 0.99 wide. Eye diameters: AME 0.07, ALE 0.09, PME 0.08, PLE 0.10. Eye interdistances: AME–AME 0.03, AME–ALE 0.01, PME–PME 0.09, PME–PLE 0.06, ALE–PLE 0.09. MOA 0.22 long, front 0.18 wide, back 0.27 wide. Clypeus 0.13 high. Leg measurements: I 5.40 (1.41, 0.58, 1.54, 1.32, 0.55); II 4.53 (1.21, 0.53, 1.16, 1.04, 0.59); III 3.96 (1.04, 0.46, 0.81, 1.02, 0.63); IV 5.63 (1.46, 0.50, 1.27, 1.60, 0.80). Leg formula: 4123. Leg spination as in male. Abdomen light grey, anterior half lacks dorsal scutum. Other characters as in male.

Epigyne (Figs 2E–F, 3D): median plate narrow, with parallel lateral margin; copulatory openings situated centrally, tiny and pore-like. Vulva (Figs 2G, 3E–F): copulatory ducts short, connected with a pair of slender tubes leading to the large, transparent ovoid bursae; spermathecae located posteriorly, small and ovoid, separated by more than one spermatheca's diameter; connecting tubes curved and sigmoid. Glandular appendages absent.

Distribution. Known only from the type locality, Hunan, China (Fig. 13).

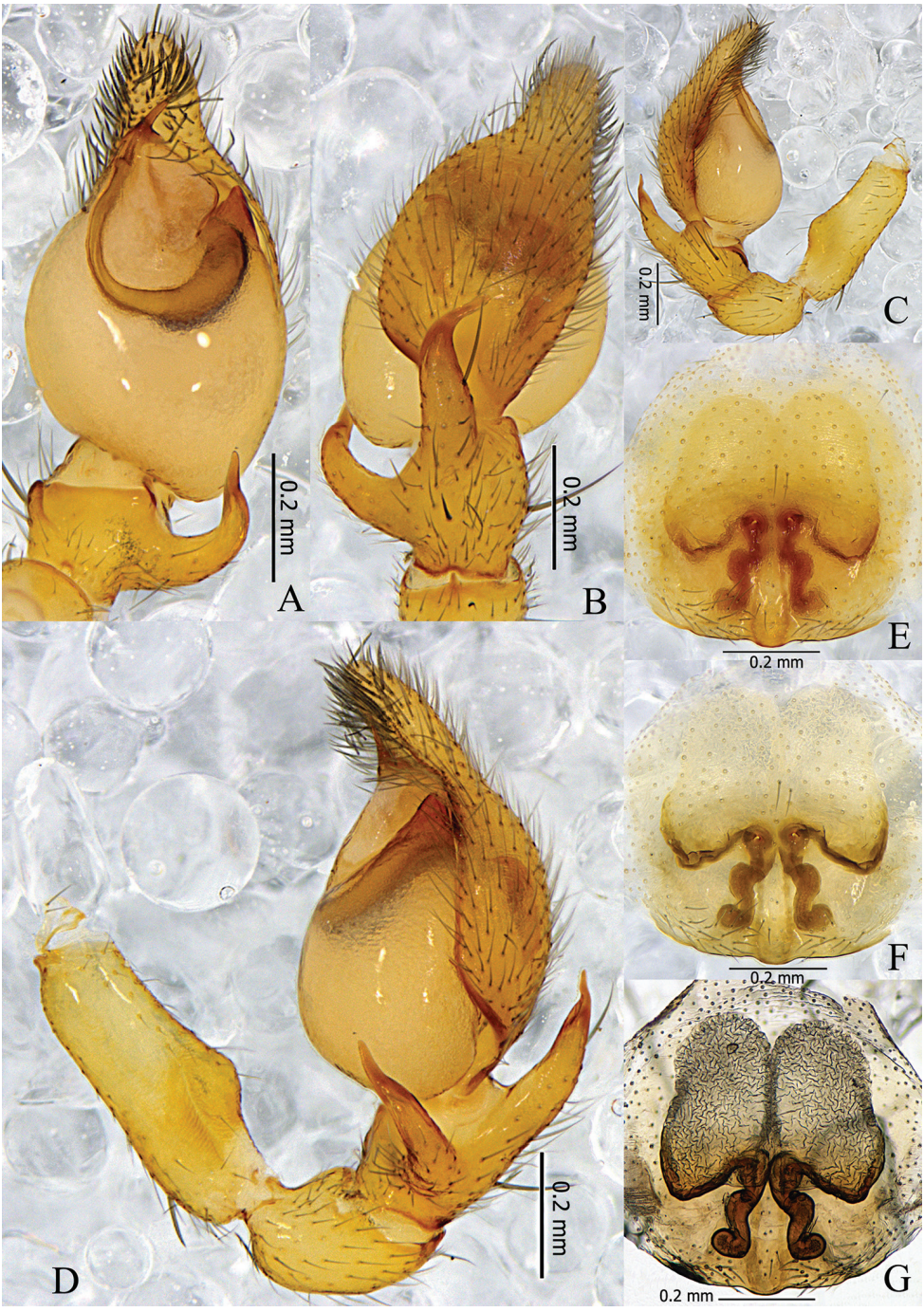

Figure 2. *Otacilia hippocampa* sp. n. **A** left male palp, ventral view **B** same, dorsal view **C** same, prolateral view **D** same, retrolateral view **E** epigyne, ventral view **F** same, cleared by potassium hydroxide, ventral view **G** vulva, dorsal view.

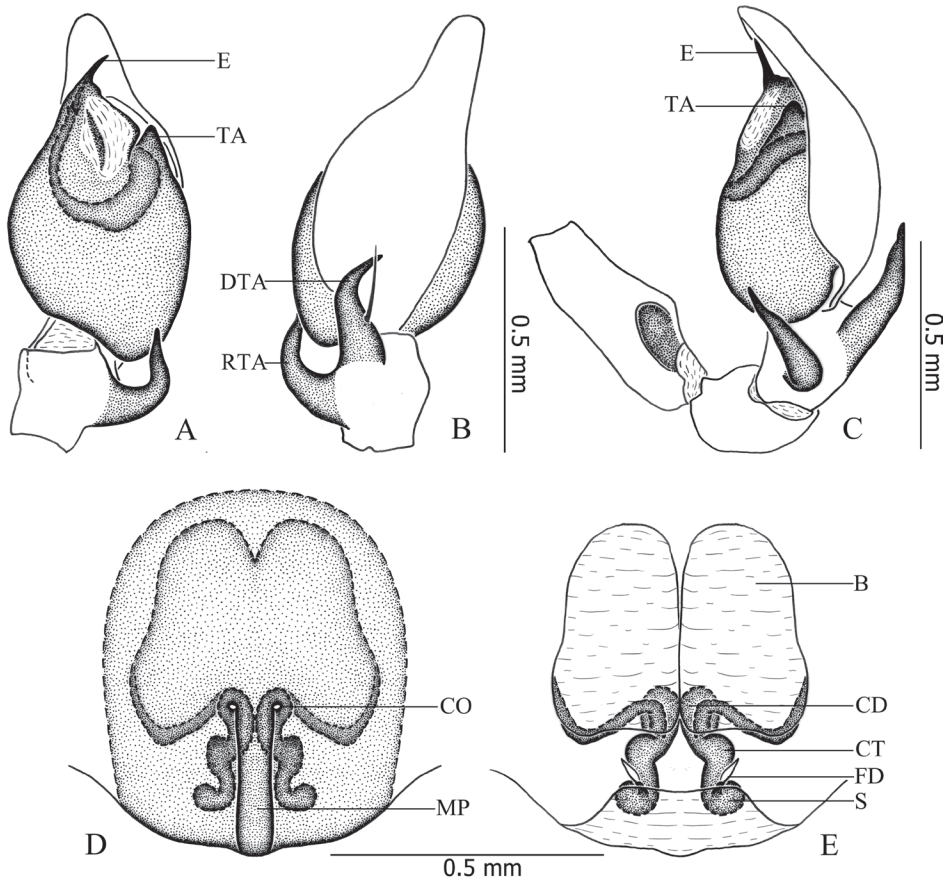

Figure 3. *Otacilia hippocampa* sp. n. **A** left male palp, ventral view **B** same, dorsal view **C** same, retrolateral view **D** epigyne, ventral view **E** vulva, dorsal view. Scale bars equal for **A** and **B**, equal for **D** and **E**.

***Otacilia yangmingensis* sp. n.**
http://zoobank.org/9FA1C1B9-0F0B-455C-B1D8-E17B2897AA68
Figs 4–6

Type material. Holotype ♂, China, *Hunan Province*: Shuangpai County, Mt. Yangming, Wanshou Temple (26°06'27.490"N, 111°55'19.186"E), 1375 m a.s.l., 26 September 2015, Chi Jin leg. Paratypes: 5♀4♂, same data as for holotype; 1♂, Shuangpai County, Mt. Yangming, Hongjun Pavilion (26°04'34.924"N, 111°56'19.223"E), 1324 m a.s.l., 27 September 2015, Xiangbo Guo leg.; 1♂, Jiangyong County, Qianjiadong Town, Daboshui (25°24'25.70"N, 111°19'04.33"E), 224 m a.s.l., 3 October 2015, Jingchao He leg.

Etymology. The species name refers to the holotype locality; adjective.

Diagnosis. The male can be distinguished from all other *armatissima* group species, except *O. macrospora* Fu. Zhang & Zhang, 2016, by the RTA base with a triangular

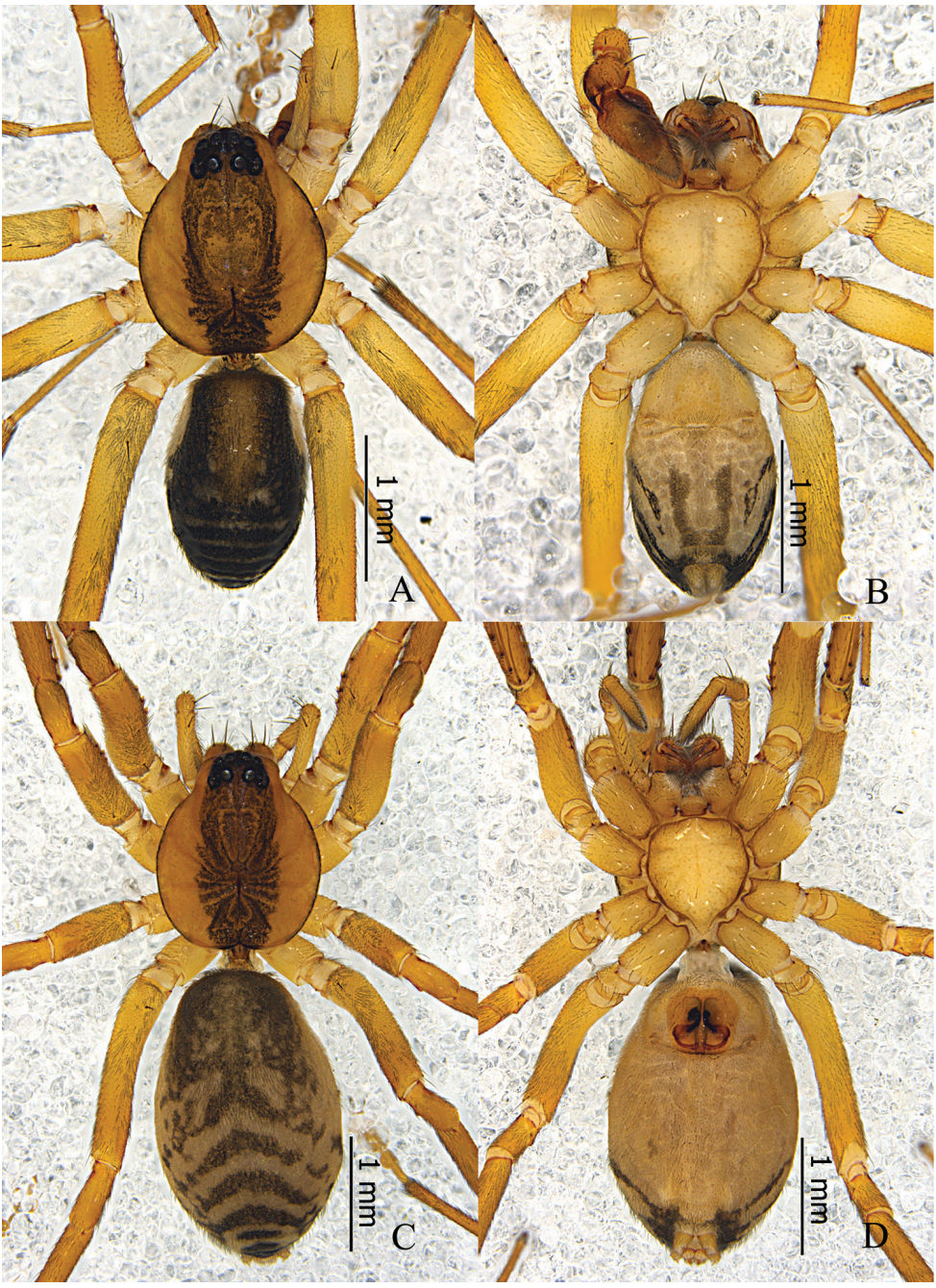

Figure 4. *Otacilia yangmingensis* sp. n. **A** male habitus, dorsal view **B** same, ventral view **C** Female habitus, dorsal view **D** same, ventral view.

process dorsally and by the absent DTA and can be distinguished from it by the long needle-like embolus (embolus stout and hook-shaped in *O. macrospora*) and the thumb-shaped tegular apophysis (tegular apophysis sickle-shaped in *O. macrospora*) (Figs 5A–B, 6A–B; Fu et al. 2016a: figs 16, 18, 22–23). The female of the new species can be distinguished from all other *armatissima* group species, except *O. macrospora* Fu, Zhang & Zhang, 2016, by the copulatory openings connected with a pair of shallow concavities anteriorly, and the concavities have distinct anterior and inner lateral margins, and can be distinguished from it by the median plate (narrower than that of *O. macrospora*) and bursae (long ovoid, whereas they are spherical in *O. macrospora*) (Figs 5E–G, 6D–E; Fu et al. 2016a: figs 20–21, 25–26).

Description. Male (Fig. 4A–B). Total length 3.04–3.16 (n = 7). Holotype: body 3.16 long; carapace 1.58 long, 1.31 wide; abdomen 1.58 long, 0.97 wide. Carapace light yellowish brown, lateral margin black, middle with broad longitudinal black stripe, from ocular area to the posterior margin of carapace; fovea longitudinal, distinct. Eye diameters: AME 0.11, ALE 0.12, PME 0.10, PLE 0.10. Eye interdistances: AME–AME 0.03, AME–ALE 0.01, PME–PME 0.10, PME–PLE 0.05, ALE–PLE 0.09. MOA 0.25 long, front 0.23 wide, back 0.27 wide. Clypeus 0.14 high. Chelicerae with two strong anterior bristles; promargin with three well separated teeth and retromargin with six denticles close to each other. Labium and sternum light yellow. Legs light yellowish brown. Leg measurements: leg I 6.65 (1.66, 0.61, 1.89, 1.65, 0.84), II 5.36 (1.42, 0.47, 1.43, 1.29, 0.75), III 4.56 (1.22, 0.49, 1.01, 1.20, 0.64), IV 7.38 (2.00, 0.58, 1.75, 2.08, 0.97). Leg formula: 4123. Femur I with two dorsal spines and four prolateral spines, femur II with one dorsal spine and two prolateral spines, femora III–IV with one dorsal spine; tibia I with seven proventral spines and eight retroventral spines, tibia II with seven pairs of ventral spines; metatarsi I–II with four pairs of ventral spines. Abdomen oval, dorsum black, anterior half with a narrow dorsal scutum, posterior half with several black transversal stripes; venter light grey, with black longitudinal stripes.

Palp (Figs 5A–D, 6A–C). Femur distally with an apophysis on ventral side anda retrolateral concavity. RTA broad, with sharp apex, base with a triangular process dorsally. Embolus slender, needle-like, slightly curved. Tegular apophysis sclerotized and thumb-shaped, situated at the apex of the bulb, separate from the embolus base.

Female (Fig. 4C–D). Total length 3.27–4.29 (n = 5). One paratype: body 4.29 long; carapace 1.72 long, 1.44 wide; abdomen 2.57 long, 1.62 wide. Carapace yellowish brown. Eye diameters: AME 0.11, ALE 0.10, PME 0.09, PLE 0.10. Eye interdistances: AME–AME 0.04, AME–ALE 0.01, PME–PME 0.11, PME–PLE 0.05, ALE–PLE 0.11. MOA 0.26 long, front 0.24 wide, back 0.31 wide. Clypeus 0.13 high. Leg measurements: I 6.63 (1.71, 0.65, 1.91, 1.56, 0.80); II 5.48 (1.44, 0.60, 1.42, 1.28, 0.74); III 4.67 (1.24, 0.56, 0.97, 1.20, 0.70); IV 7.29 (1.90, 0.63, 1.76, 2.00, 1.00). Leg formula: 4123. Femur I with two dorsal spines and four prolateral spines, femur II with one dorsal spine and three prolateral spines, femora III–IV with one dorsal spine; tibia I with eight pairs of ventral spines, tibia II with eight proventral spines and seven retroventral spines; metatarsus I with four pairs of ventral spines, metatarsus II with

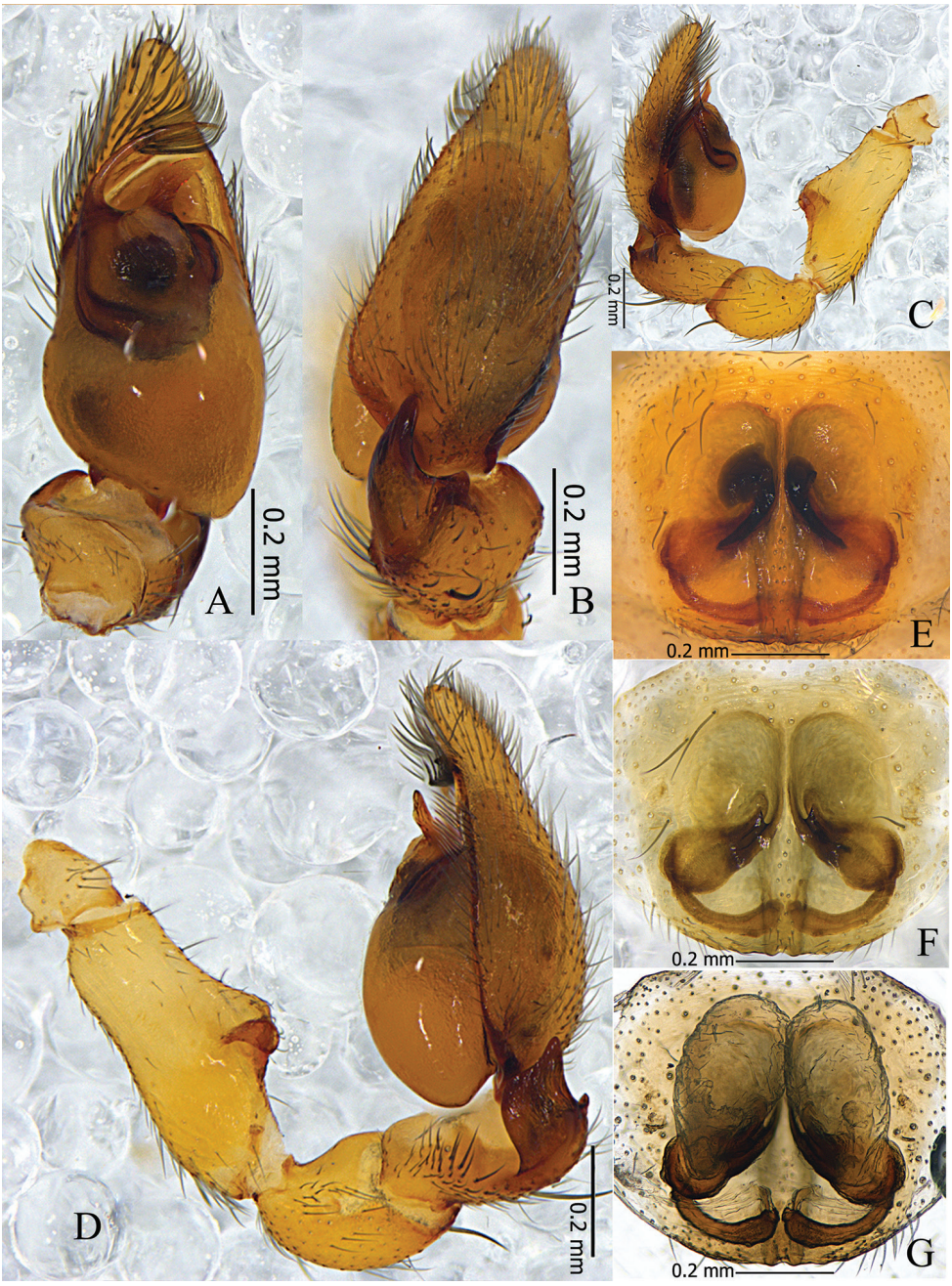

Figure 5. *Otacilia yangmingensis* sp. n. **A** left male palp, ventral view **B** same, dorsal view **C** same, prolateral view **D** same, retrolateral view **E** epigyne, ventral view **F** same, cleared by potassium hydroxide, ventral view **G** vulva, dorsal view.

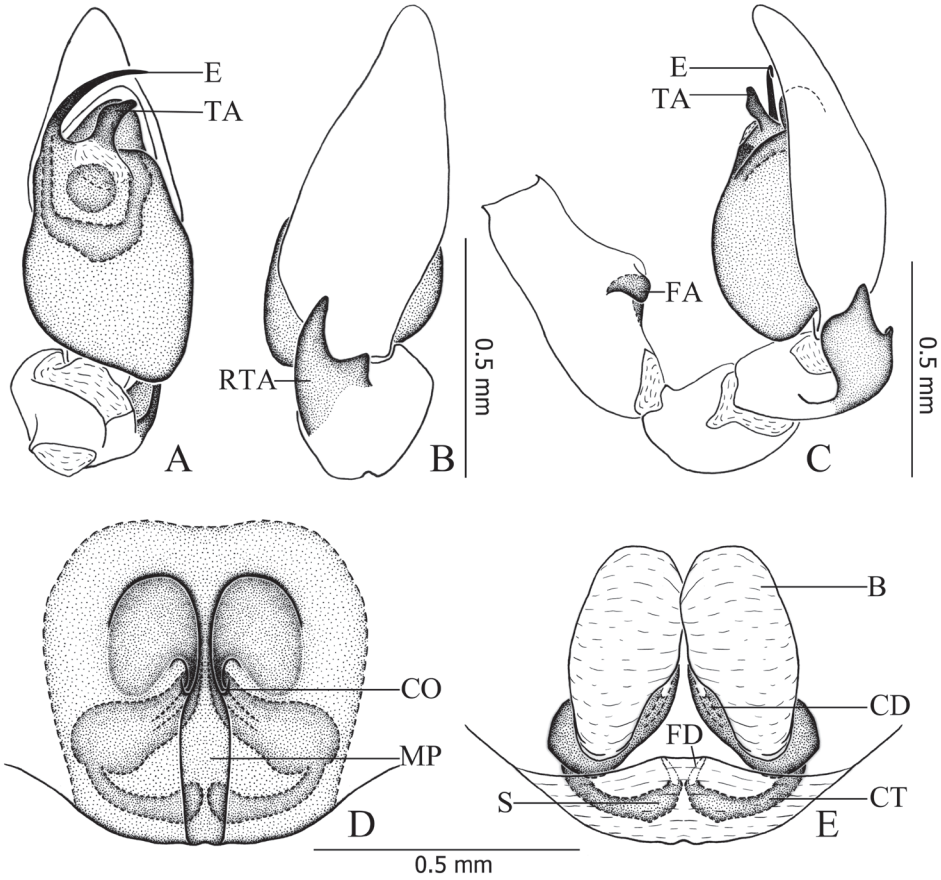

Figure 6. *Otacilia yangmingensis* sp. n. **A** left male palp, ventral view **B** same, dorsal view **C** same, retrolateral view **D** epigyne, ventral view **E** vulva, dorsal view. Scale bars equal for **A** and **B**, equal for **D** and **E**.

four proventral spines and three retroventral spines. Abdomen light grey, anterior half without dorsal scutum, posterior half dark with several indistinct chevron-like black stripes dorsally. Other characters as in male.

Epigyne (Figs 5E–F, 6D): median plate narrow, with parallel lateral margin; copulatory openings situated centrally, covered with mating plugs (Fig. 5E), connected with a pair of shallow concavities anteriorly, and the concavities have distinct anterior and inner lateral margins. Vulva (Figs 5G, 6E): copulatory ducts thick, posteriorly swollen, connected to a pair of large, transparent long ovoid bursae; spermathecae located posteriorly and small, close to each other; bursae and spermathecae connected by slender, slightly curved connecting tubes.

Distribution. Known only from the type localities, Hunan, China (Fig. 13).

***Otacilia curvata* sp. n.**
http://zoobank.org/EFCA1B66-8035-41A4-BB6F-634B4F16BB01
Figs 7–9

Type material. Holotype ♂, China, *Hunan Province*: Shuangpai County, Mt. Yangming, around the Forest Park Service (26°03'36.698"N, 111°56'12.707"E), 539 m a.s.l., 24 September 2015, Chi Jin leg. Paratypes: 5♀3♂, same data as for holotype; 2♀4♂, Shuangpai County, Mt. Yangming, Wanshou Temple (26°06'27.490"N, 111°55'19.186"E), 1375 m a.s.l., 26 September 2015, Chi Jin leg.; 2♀1♂, Shuangpai County, Mt. Yangming, Hongjun Pavilion (26°04'34.924"N, 111°56'19.223"E), 1324 m a.s.l., 27 September 2015, Xiangbo Guo and Jingchao He leg.

Etymology. The specific name is derived from the Latin "curvatus", meaning curved and refers to the shape of the DTA of the male palp; adjective.

Diagnosis. The male can be distinguished from all other *longituba* group species, except *O. bifurcata* Dankittipakul & Singtripop, 2014, *O. loriot* Jäger & Wunderlich, 2012 and *O. namkhan* Jäger & Wunderlich, 2012, by having a long RTA and a long DTA and can be distinguished from them by the needle-like embolus (embolus of these three species claw-like, knife-shaped and semicircular respectively) (Figs 8A–D, 9A–C). The female of the new species can be easily distinguished from all of the other *longituba* group species, except *O. microstoma* Wang et al., 2015, by the copulatory ducts longitudinal and close together, and it can be distinguished from *O. microstoma* by the present of glandular appendages and sigmoid connecting tubes (glandular appendages absent and connecting tubes V-shaped in *O. microstoma*) (Figs 8E–G, 9D–E; Wang et al. 2015: figs 1D–E, 2F–G).

Description. Male (Fig. 7A–B). Total length 2.51–2.80 (n = 5). Holotype: body 2.67 long; carapace 1.37 long, 1.15 wide; abdomen 1.30 long, 0.96 wide. Carapace yellowish brown, with black marginal bands; middle with broad longitudinal black stripe, from ocular area to the posterior margin of carapace; fovea longitudinal, dark brown. Diameter of eyes: AME 0.08, ALE 0.09, PME 0.06, PLE 0.10. Eye interdistances: AME–AME 0.03, AME–ALE 0.01, PME–PME 0.08, PME–PLE 0.06, ALE–PLE 0.05. MOA 0.19 long, front 0.19 wide, back 0.20 wide. Clypeus 0.12 high. Chelicerae with two strong anterior bristles; promargin with three well-separated teeth and retromargin with five denticles close to each other. Labium and sternum dark yellow. Legs light yellowish brown; all femora with distal black annulus; patellae I–II all black, patellae III–IV absenting black patches; tibia I almost all black, tibiae II–IV with black proximal and distal annulus; metatarsus I distal half part black, metatarsi II–IV with black distal annulus. Measurements of legs: leg I 4.95 (1.31, 0.51, 1.42, 1.21, 0.50), II 3.90 (1.06, 0.40, 1.02, 0.91, 0.51), III 3.36 (0.86, 0.44, 0.68, 0.86, 0.52), IV 4.90 (1.29, 0.45, 1.09, 1.41, 0.66). Leg formula: 1423. Femora I–III lack dorsal spines, femur IV with one dorsal spine, femur I with three prolateral spines; tibia I with six proventral spines and seven retroventral spines, tibia II with six proventral spines and five retroventral spines; metatarsus I with four pairs of ventral spines, metatarsus II with four proventral spines and three retroventral spines. Abdomen oval,

Figure 7. *Otacilia curvata* sp. n. **A** male habitus, dorsal view **B** same, ventral view **C** female habitus, dorsal view **D** same, ventral view.

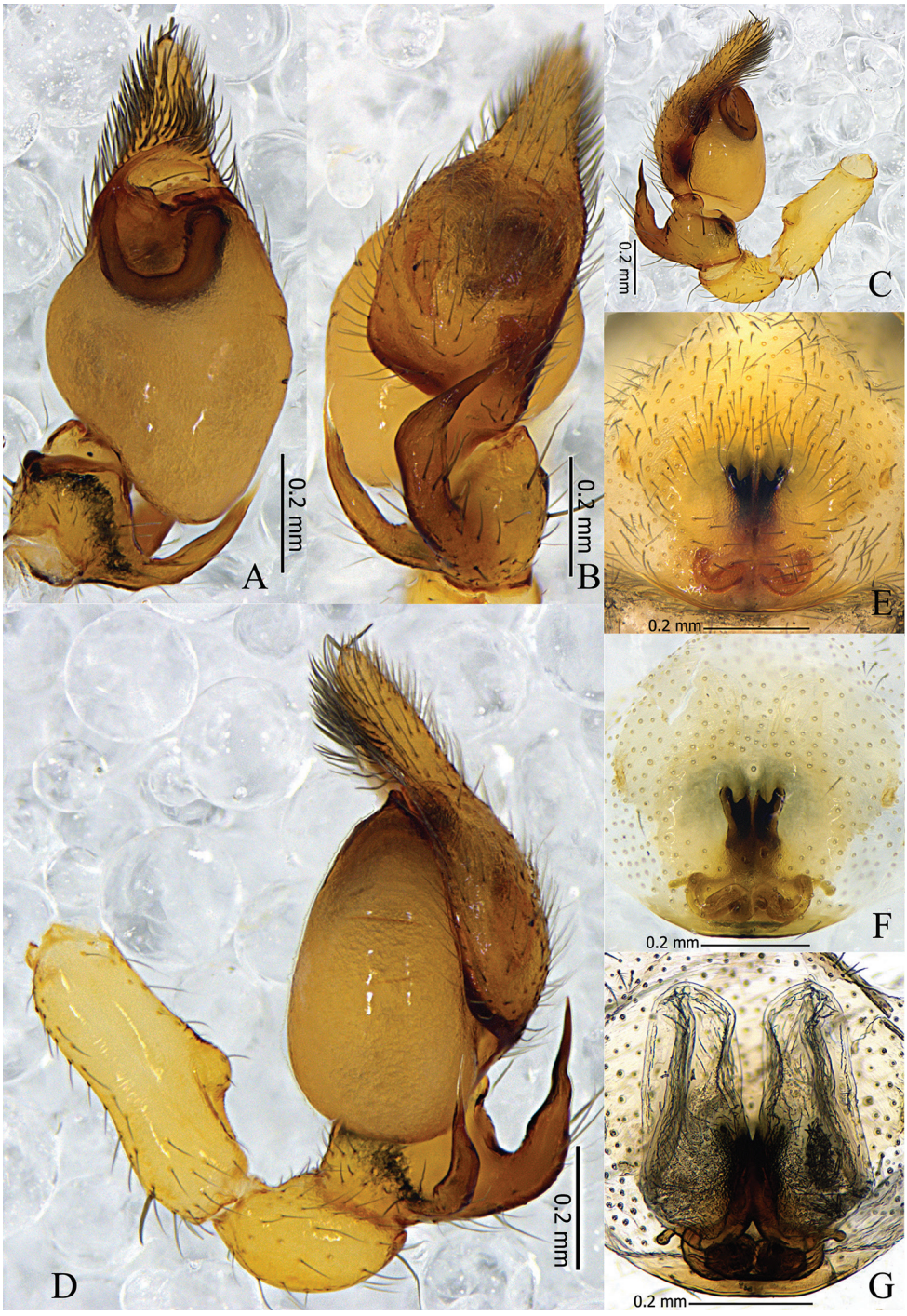

Figure 8. *Otacilia curvata* sp. n. **A** left male palp, ventral view **B** same, dorsal view **C** same, prolateral view **D** same, retrolateral view **E** epigyne, ventral view **F** same, cleared by potassium hydroxide, ventral view **G** vulva, dorsal view.

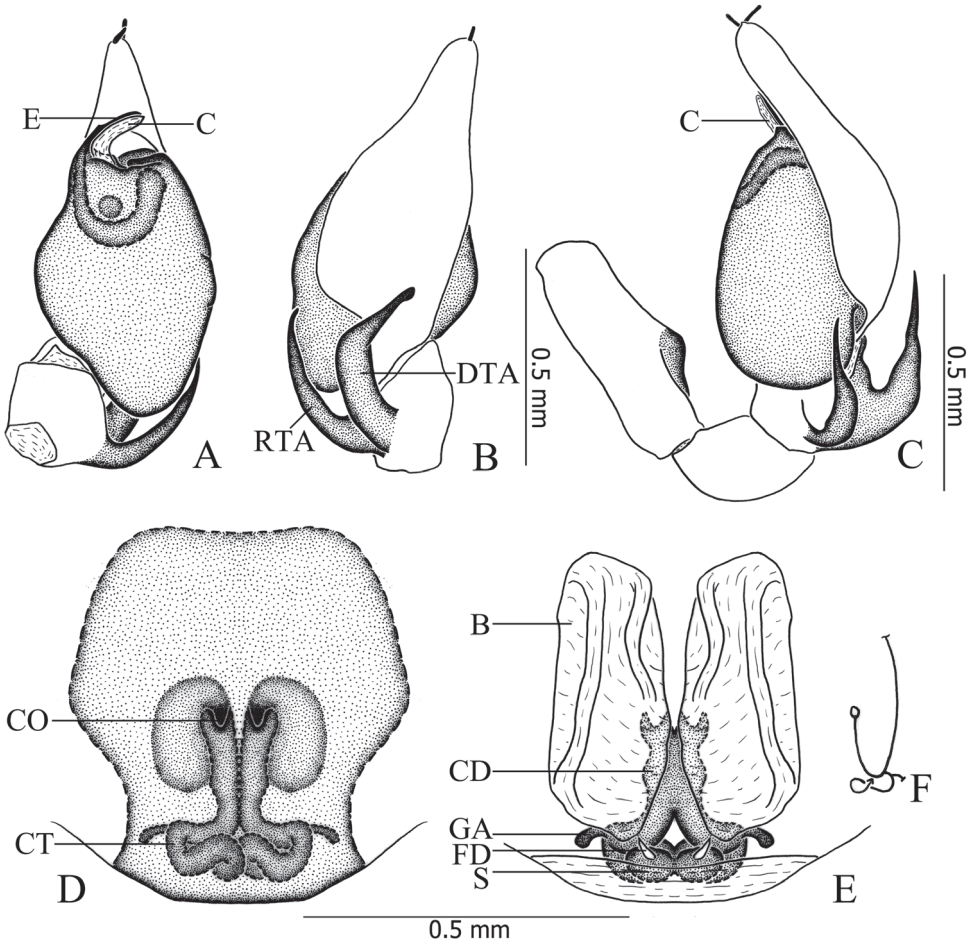

Figure 9. *Otacilia curvata* sp. n. **A** left male palp, ventral view **B** same, dorsal view **C** same, retrolateral view **D** epigyne, ventral view **E** vulva, dorsal view **F** schematic course of internal duct system. Scale bars equal for **A** and **B**, equal for **D** and **E**.

dorsum black, anterior half with a narrow dorsal scutum, posterior half with several chevron-like black stripes; venter light grey.

Palp (Figs 8A–D, 9A–C). Femur distally with an inflated hump on ventral side. RTA thick in proximal part and abruptly tapering at half of its length. DTA with anterior and posterior margins parallel in proximal part from the dorsal view, then abruptly curved to the prolateral side of bulb, tapering and with an enlarged blunt apex. Embolus short, needle-like. Conductor membranous, close to and as long as the embolus. Tegular apophysis absent but with a tegular ridge.

Female (Fig. 7C–D). Total length 2.77–2.85 (n = 7). One paratype: body 2.77 long; carapace 1.41 long, 1.20 wide; abdomen 1.36 long, 1.01 wide. Eye diameters: AME 0.08, ALE 0.09, PME 0.07, PLE 0.10. Eye interdistances: AME–AME 0.04,

AME–ALE 0.01, PME–PME 0.07, PME–PLE 0.07, ALE–PLE 0.07. MOA 0.21 long, front 0.18 wide, back 0.19 wide. Clypeus 0.11 high. Leg measurements: I 5.11 (1.31, 0.54, 1.46, 1.29, 0.51); II 4.10 (1.10, 0.49, 1.03, 0.97, 0.51); III 3.46 (0.91, 0.43, 0.73, 0.86, 0.53); IV 5.08 (1.35, 0.50, 1.12, 1.41, 0.70). Leg formula: 1423. Femur II with one dorsal spines and two prolateral spines, tarsus II with six proventral spines and five retroventral spines, other segments with the same spination as male. Abdomen light grey, anterior half lacks dorsal scutum. Other characters as in male.

Epigyne (Figs 8E–F, 9D): median plate absent; copulatory openings situated centrally, tiny. and trumpet-shaped. Vulva (Figs 8G, 9E–F): copulatory ducts longitudinal, connecting with a pair of large, transparent, long, ovoid bursae; spermathecae located posteriorly, small and ovoid, close to each other; bursae and spermathecae connected by strong, curved, sigmoid connecting tubes. Glandular appendages present, as long as the diameter of one spermatheca.

Distribution. Known only from the type localities, Hunan, China (Fig. 13).

***Otacilia submicrostoma* sp. n.**
http://zoobank.org/64BE3E6B-B7E9-40EB-A1F0-39A01D85D844
Figs 10–12

Type material. Holotype ♂, China, *Hunan Province*: Sangzhi County, Bamaoxi Town, Mt. Tianping, Watch Tower (29°47'11.854"N, 110°05'28.838"E), 1626 m a.s.l., 15 September 2015, Chi Jin leg. Paratypes: 11♀7♂, same data as for holotype; 19♀19♂, Sangzhi County, Bamaoxi Town, Mt. Tianping (29°46'07.921"N, 110°04'22.159"E), 1330 m a.s.l., 16 September 2015, Xiangbo Guo and Jingchao He leg.; 2♀6♂, Sangzhi County, Bamaoxi Town, Mt. Tianping (29°46'35.332"N, 110°05'54.474"E), 1520 m a.s.l., 17 September 2015, Chi Jin leg.

Etymology. The species is named for its similarity to *O. microstoma* Wang et al., 2015; adjectival.

Diagnosis. The male can be distinguished from all other *longituba* group species, except *O. mira* Fu, Zhang & Zhang, 2016, *O. mustela* Kamura, 2008 and *O. parva* Deeleman-Reinhold, 2001, by having only one tibial apophysis and no conductor and can be distinguished from them by the RTA base with a small triangular process (Figs 11A–D, 12A–C). The female of the new species can be easily distinguished from all of the other *longituba* group species by the long, S-shaped connecting peculiar tubes (Figs 11E–F, 12D).

Description. Male (Fig. 10A–B). Total length 2.65–2.99 (n = 33). Holotype: body 2.99 long; carapace 1.52 long, 1.29 wide; abdomen 1.47 long, 1.04 wide. Carapace yellowish brown, with black marginal bands; fovea longitudinal, brown. Eye diameters: AME 0.09, ALE 0.10, PME 0.09, PLE 0.10. Eye interdistances: AME–AME 0.04, AME–ALE 0.01, PME–PME 0.11, PME–PLE 0.05, ALE–PLE 0.08. MOA

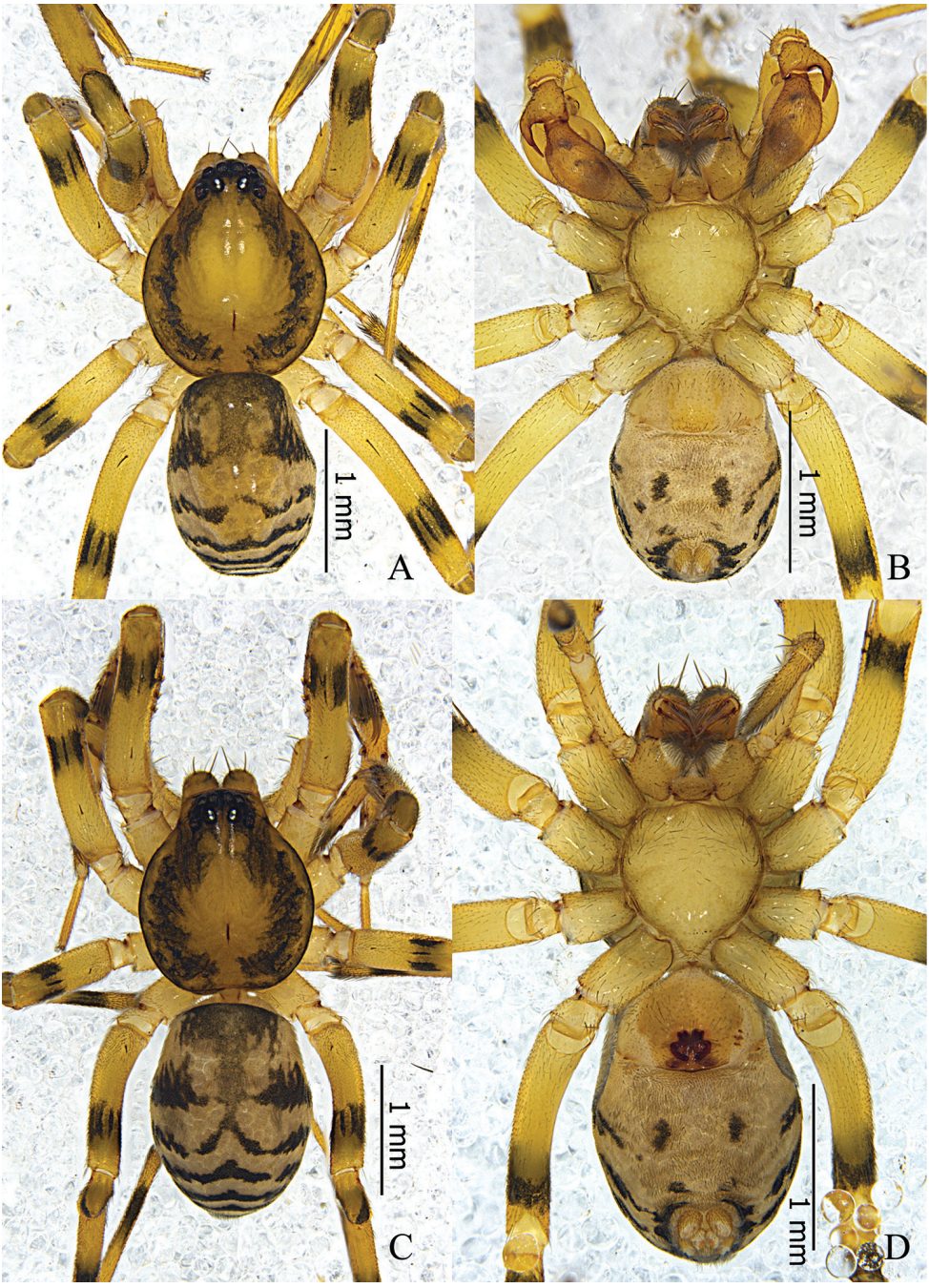

Figure 10. *Otacilia submicrostoma* sp. n. **A** male habitus, dorsal view **B** same, ventral view **C** female habitus, dorsal view **D** same, ventral view.

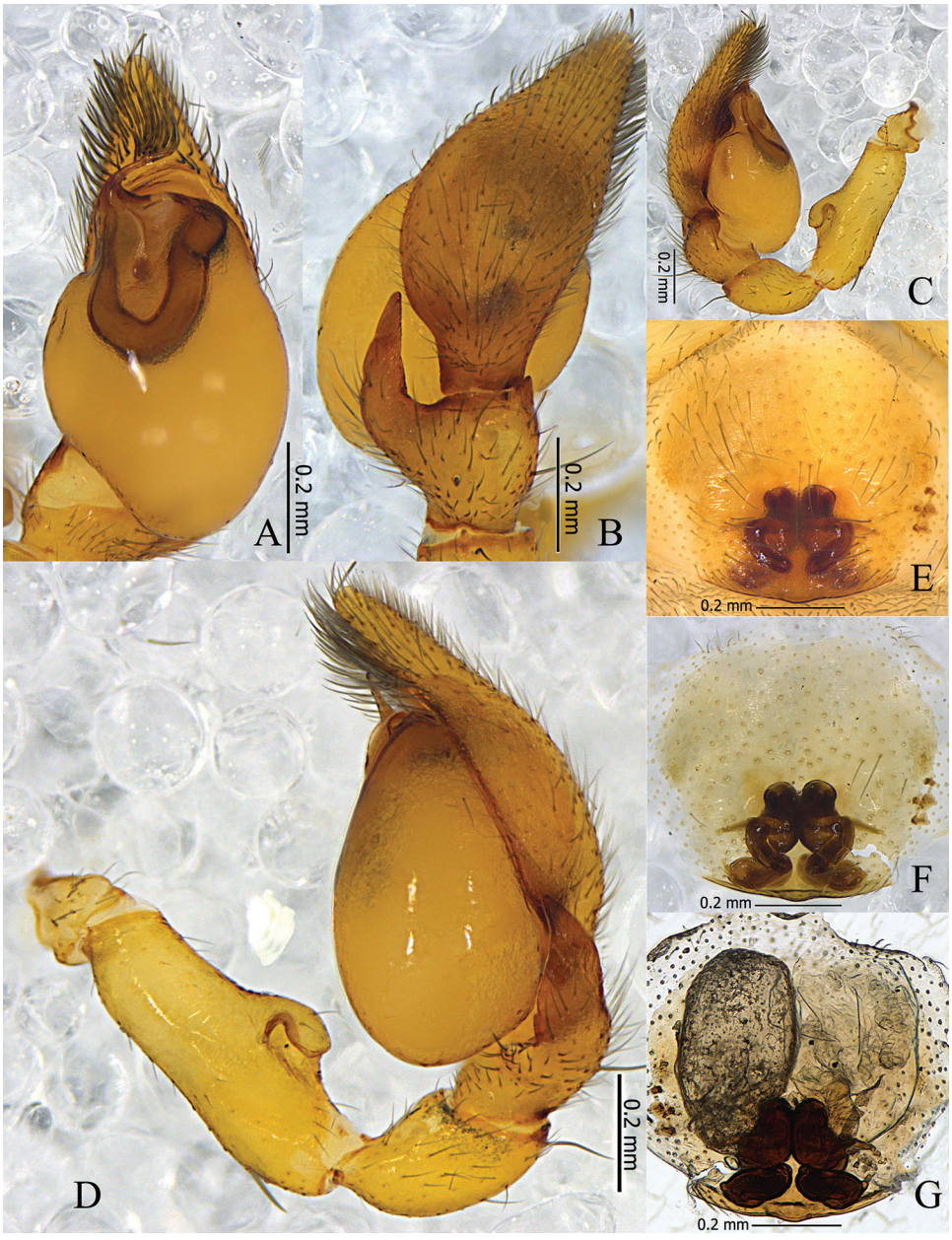

Figure 11. *Otacilia submicrostoma* sp. n. **A** left male palp, ventral view **B** same, dorsal view **C** same, prolateral view **D** same, retrolateral view **E** epigyne, ventral view **F** same, cleared by potassium hydroxide, ventral view **G** vulva, dorsal view.

0.22 long, front 0.21 wide, back 0.30 wide. Clypeus 0.15 high. Chelicerae with two strong anterior bristles; promargin with three well-separated teeth and retromargin with seven denticles close to each other. Labium and sternum dark yellow. Legs light

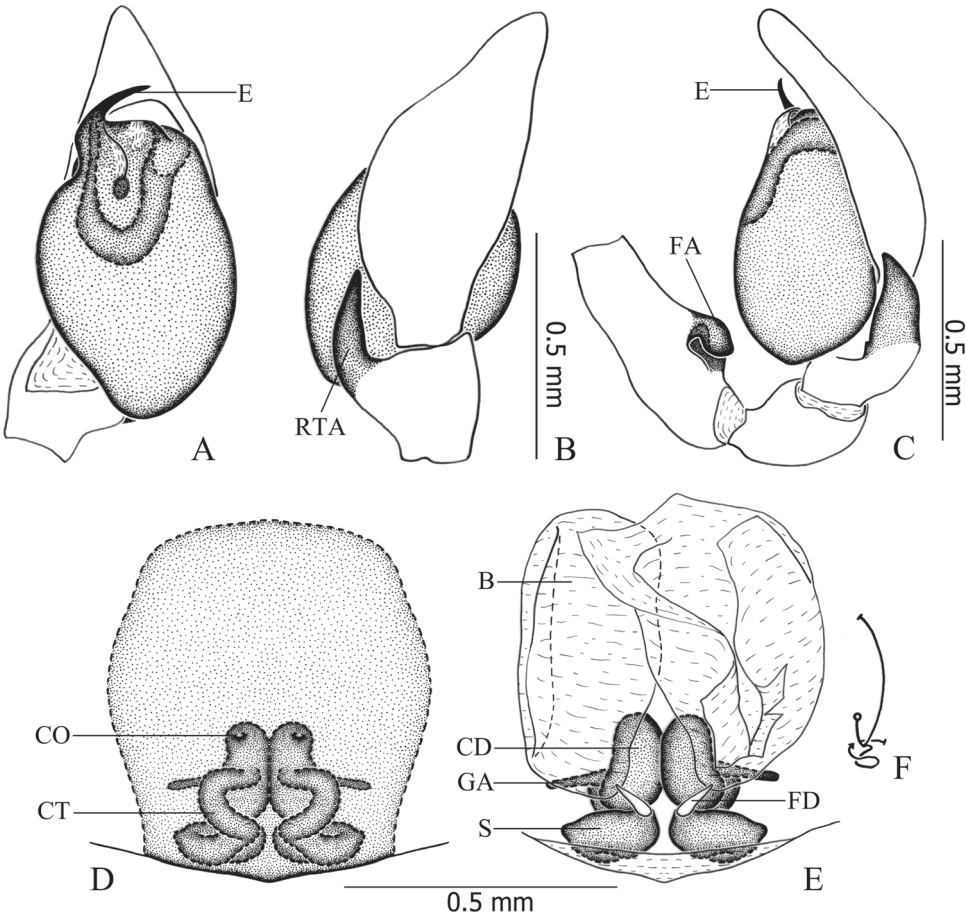

Figure 12. *Otacilia submicrostoma* sp. n. **A** left male palp, ventral view **B** same, dorsal view **C** same, retrolateral view **D** epigyne, ventral view **E** vulva, dorsal view **F** schematic course of internal duct system. Scale bars equal for **A** and **B**, equal for **D** and **E**.

yellowish brown, all femora, patellae, tibiae, metatarsi distally with black annulus. Measurements of legs: leg I 5.45 (1.42, 0.54, 1.55, 1.30, 0.64), II 4.54 (1.20, 0.47, 1.18, 1.08, 0.61), III 3.96 (1.04, 0.44, 0.83, 1.03, 0.62), IV 5.72 (1.56, 0.50, 1.26, 1.57, 0.83). Leg formula: 4123. Femur I with two dorsal spines and four prolateral spines, femur II with one dorsal spine and one prolateral spine, femora III–IV with one dorsal spine; tibia I with six proventral spines and seven retroventral spines, tibia II with six pairs of ventral spines; metatarsus I with four pairs of ventral spines, metatarsus II with four proventral spines and three retroventral spines. Abdomen oval, dorsum black, anterior half with a narrow dorsal scutum, posterior half with several black transverse stripes; venter light grey, with black scattered patches.

Palp (Figs 11A–D, 12A–C). Femur distally with an apophysis on ventral side anda retrolateral concavity. RTA broad, with relatively sharp apex extending along the cym-

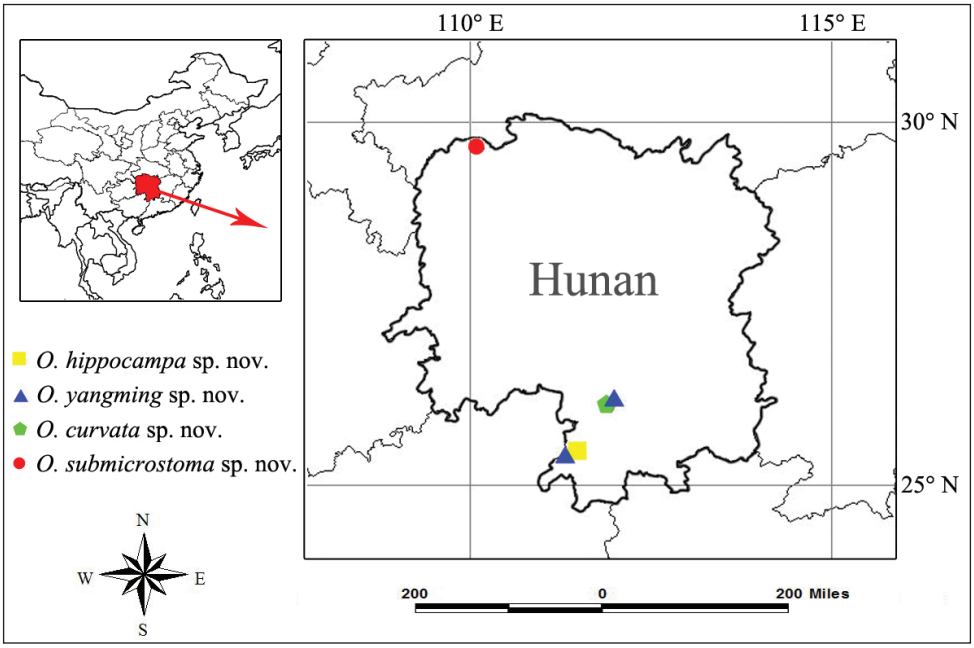

Figure 13. Distribution of new species the genus *Otacilia* from Hunan, China.

bium retrolaterally, basally with a small triangular process. Embolus slender, needle-like. Tegular apophysis and conductor absent.

Female (Fig. 10C–D). Total length 3.02–3.48 (n = 32). One paratype: body 3.48 long; carapace 1.60 long, 1.36 wide; abdomen 1.88 long, 1.25 wide. Carapace yellowish brown. Eye diameters: AME 0.09, ALE 0.09, PME 0.10, PLE 0.10. Eye interdistances: AME–AME 0.04, AME–ALE 0.01, PME–PME 0.10, PME–PLE 0.06, ALE–PLE 0.09. MOA 0.25 long, front 0.20 wide, back 0.29 wide. Clypeus 0.14 high. Leg measurements: I 5.71 (1.47, 0.59, 1.64, 1.40, 0.61); II 4.87 (1.28, 0.52, 1.20, 1.23, 0.64); III 4.11 (1.09, 0.47, 0.85, 1.04, 0.66); IV 5.98 (1.60, 0.53, 1.33, 1.64, 0.88). Leg formula: 4123. Femur I with two dorsal spines and four prolateral spines, femur II with one dorsal spine and two prolateral spines, femora III–IV with one dorsal spine; tibiae and metatarsi I and II with the same spination as male. Abdomen light grey, anterior half lacking dorsal scutum, posterior half dark with several indistinct chevron-like black stripes dorsally. Other characters as in male.

Epigyne (Figs 11E–F, 12D): median plate absent; copulatory openings situated centrally, tiny and pore-like. Vulva (Figs 11G, 12E–F): copulatory ducts thick and short, connected with a pair of large, transparent, long, ovoid bursae; spermathecae located posteriorly, large and ovoid, close to each other; bursae and spermathecae connected by strongly curved, S-shaped connecting tubes. Glandular appendages present, as long as one spermatheca's diameter.

Distribution. Known only from the type localities, Hunan, China (Fig. 13).

Acknowledgments

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RESEARCH ARTICLE

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Two new species of *Yaginumaella*, Prószyński 1976 from Yunnan, China (Araneae, Salticidae)

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Abstract

The present paper deals with two new species of *Yaginumaella*, *Yaginumaella lushuiensis* **sp. n.** (female and male) and *Yaginumaella pseudoflexa* **sp. n.** (female and male). The male of *Y. lushuiensis* **sp. n.** differs from the related species *Y. flexa* Song & Chai, 1992 in ventral view of palpal organ. The female of *Y. lushuiensis* **sp. n.** differs from the related species *Y. urbanii* Żabka, 1981 by: 1) hoods locate at the anterior area of epigynum and far away from the copulatory openings; 2) epigynum about circular; 3) copulatory openings transverse. The male of *Y. pseudoflexa* **sp. n.** differs from the related species *Y. bulbosa* Peng, Tang & Li, 2008 in ventral view of palpal organ: 1) basal portion of embolus touches the margin of genital bulb. 2) distal portion of tibial apophysis covers the posterior margin of cymbium and far away from the margin of genital bulb. The female of *Y. pseudoflexa* **sp. n.** differs from the related species *Y. urbanii* Żabka, 1981 by: epigynum about as long as wide; hoods locate at the anterior area of the epigynum, above the outside area of the copulatory openings and far away from the copulatory openings. Photos of body and copulatory organs, line drawings of copulatory organs, as well as the locality map are provided. Descriptions of morphology are given.

Keywords

Asia, description, diagnosis, jumping spider, taxonomy

Introduction

Yaginumaella was established by Prószyński in 1979 with the type species *Y. ususudi*. A total of 42 species have been described mainly from subtropical Himalayan and Eastern Palaearctic areas (World Spider Catalog 2016). Żabka (1980, 1981) revised the diagnosis of the genus and described 27 new species. Up to now, 14 species have been recorded from China (Prószyn'ski 1979; Żabka 1980; Żabka 1981; Song and Chai 1992; Xie and Peng 1995; Yang et al. 1997; Peng et al. 2002; Zhu et al. 2005; Zhang and Zhu 2007).

While examining the specimens collected in the Gaoligong Mountains (Yunnan Province, Southwest China) by the Sino-American Expeditions (1998–2008), two new species of the genus *Yaginumaella* are found and described in this paper.

Material and methods

All specimens were kept in 75% ethanol, examined, measured, and drawn with an Olympus SZX16 stereomicroscope and an Olympus BX53 compound microscope. Photos were taken with a digital camera Canon PowerShot G12 mounted on an Olympus SZX16. Compound focus images were generated using Helicon Focus software (3.10).

All measurements are given in millimeters. Leg measurements are given as: total length (femur, patella + tibia, metatarsus, tarsus). The abbreviations used in text include:

AER anterior eye row;
ALE anterior lateral eyes;
AME anterior median eyes;
CD copulatory ducts;
CO copulatory openings;
E embolus;
EFL length of eye;
H hood;
MOA median ocular area;
PER posterior eye row;
PLE posterior lateral eyes;
PME posterior median eyes;
S spermatheca;
TA tibial apophysis.

Taxonomy

Yaginumaella Prószyński, 1976

Females in *Yaginumaella* have sclerotized blind hoods on epigyne, which are far away from the posterior edge, and differ in size and location. Copulatory ducts are of different length, with an internal ridge in the majority of species. The shape and size of spermathecae differ in various species.

Palpal organ in males rather simple, with end of embolus lying in a special groove on the ventral surface of cymbium usually more or less expanded laterally. Seminal receptacle thick. Cymbium densely covered with setae. Tibial apophysis robust and heavily sclerotized. Species differ in length and shape of embolus, bulb, and cymbium.

Yaginumaella lushuiensis sp. n.

http://zoobank.org/379A5DDF-82DF-4CAA-9955-78D61F82690A
Figs 1–12

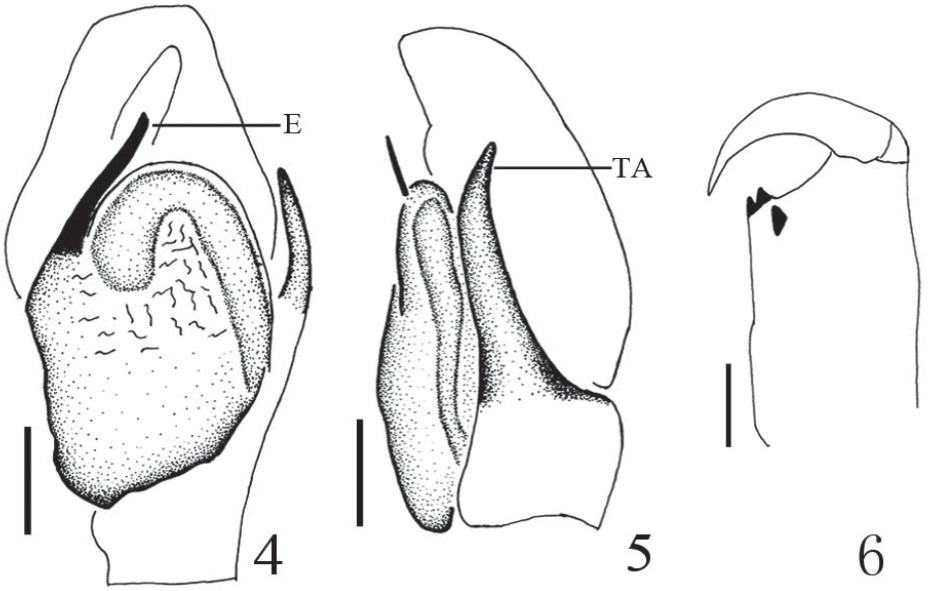
Type material. ***Holotype*****:** ♂, China: Yunnan: Lushui County: Pianma Township, 25.99363°N, 98.66651°E, 2470 m, 14 May 2005, C. Griswold. ***Paratypes*****:** 1♂,4♀, the same data as holotype.

Etymology. The specific name refers to the type locality, Lushui County.

Diagnosis. The male of the new species can be distinguished from all known congeneric species in ventral view of palpal organ by: embolus short, spatuliform; genital bulb without distinct posterior lobe; tibial apophysis extends to the top of genital bulb; embolus about 1/2 length of genital bulb. The female of the new species can be distinguished from all known congeneric species by: epigynum about circular; copulatory openings transverse.

Description. Male (holotype): Total length 4.60. Cephalothorax 2.15 long, 1.75 wide. Abdomen 2.35 long, 1.50 wide. Clypeus height 0.10. Carapace black-brown, with black margin, basal area of each eye, anterior and lateral margins of ocular area black. Thoracic region with two longitudinal dark bands. Marginal areas of carapace, anterior and lateral margins of ocular area densely covered with white hair; ocular area with thick dark brown hair; fovea short, longitudinal and black; cervical groove indistinct, radial groove dark brown. Sternum oval, covered with short brown hair, central area bulged, light yellow with gray edge. Clypeus narrow, height less than the radius of AME, light brown, promargin with white hair. Chelicerae dark brown, with brown hair, two promarginal and one retromarginal teeth (Fig. 6). Labium brown with brown hair, terminal area lightly colored. Palp and legs brown, legs with clear dark brown annuli. Eye sizes and interdistances: AER 1.50, PER 1.40, ALE 0.25, PLE 0.15, AME 0.50, EFL1.00. Measurements of legs: I 5.00 (1.50, 2.00, 1.00, 0.50), II 3.75 (1.00, 1.50, 0.75, 0.50),

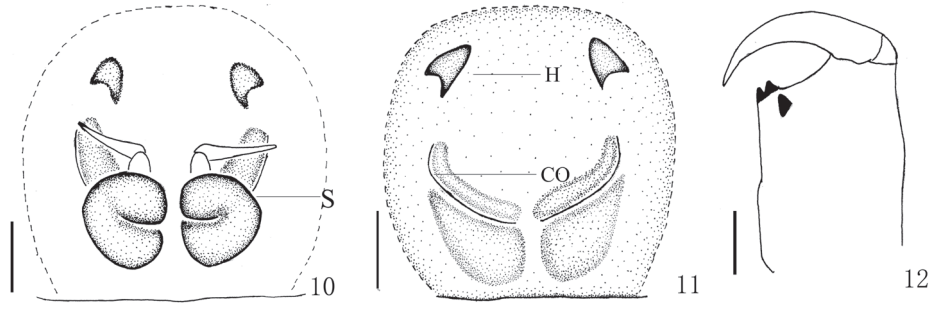
Figures 1–3. *Yaginumaella lushuiensis* sp. n. **1** male body, dorsal view **2** male palp, retrolateral view **3** male palp, ventral view. Scale bars: (**1**) 0.5 mm; (**2, 3**) 0.1 mm.



Figures 4–6. *Yaginumaella lushuiensis* sp. n. **4** male palp ventral view **5** male palp, retrolateral view **6** left chelicera, posterior view. Scale bars: 0.1 mm.

III 4.50 (1.50, 1.50, 1.00, 0.50), IV 4.25 (1.25, 1.50, 1.00, 0.50). Leg formula: 1342. Abdomen long oval, black to yellow brown, cardiac pattern long bar-shaped, muscular impressions clearly visible, posterior area of abdomen with six arc-shaped darker bands.

Figures 7–9. *Yaginumaella lushuiensis* sp. n. **7** female body, dorsal view **8** epigyne, ventral view **9** vulva, dorsal view. Scale bars: (**7**) 0.5 mm; (**8, 9**) 0.1 mm.



Figures 10–12. *Yaginumaella lushuiensis* sp. n. **10** vulva, dorsal view **11** epigynum, ventral view **12** left chelicera, posterior view. Scale bars: 0.1 mm.

Abdominal ventral: anterior area light brown, median area with one black longitudinal stripe, lateral areas with scattered grayish-black patches. Spinnerets brown.

Male palp (Figs 2–3, 4–5): tibia longer than wide in ventral view, with several long prolateral macrosetae in retrolateral view. Genital bulb with membrane structure. Embolus slender and about 1/2 length of genital bulb, originates from the position of 10:00 o'clock, its tip reaches to the position of 13:00 o'clock in ventral view. Bulb squat, median portion widest. Sperm ducts obvious, its diameter about 1/6 width of bulb.

Female: Total length 5.00. Cephalothorax 2.40 long, 2.00 wide. Abdomen 2.60 long, 2.10 wide. Clypeus 0.15 high. Eye sizes and interdistances: AME 0.50, ALE 0.25, PLE 0.15, AER 1.60, PER 1.40, EL1.00. Legs yellow. Leg spinnation the same as male. Measurements of legs: I 4.85 (1.50, 1.85, 0.75, 0.75), II 3.85 (1.30, 1.30, 0.75, 0.50), III 4.75 (1.75, 1.3, 1.00, 0.75), IV 4.5 (1.25, 1.75, 1.00, 0.50). Leg formula: 1342. Other morphological characteristics the same as male except more pale in color.

Epigyne (Figs 8–9, 10–11) longer than wide, with two distinct anterior hoods. copulatory openings almost u-shaped, far away from the hoods. Copulatory ducts indistinct. Spermathecae big, squat, close to each other.

Variation. The male length 4.60–4.80 (n = 2) and the female length 4.80–5.60 (n = 4).

Distribution. China (Yunnan).

***Yaginumaella pseudoflexa* sp. n.**

http://zoobank.org/0268AF85-0001-4F73-B2DA-D90232A13381

Figs 13–24

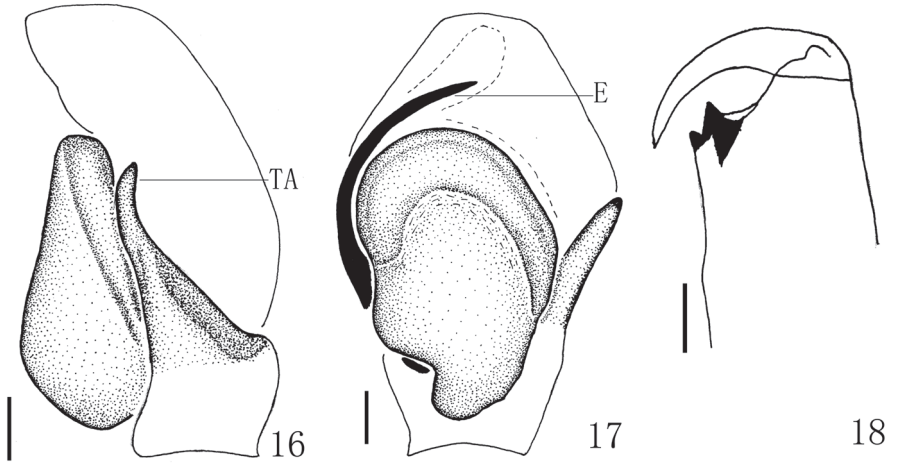
Type material. ***Holotype*:** ♂, China: Yunnan: Lushui County: Pianma Township, 25.99363°N, 98.61704°E,1780 m, along the road in town 15 May 2005, G. Tang. ***Paratypes*:** 1♂, 3♀, the same data as holotype.

Etymology. The specific name is the combination of the Latin prefix *"pseudo"* and *"flexa"*, referring to the similarity of the new species to *Y. flexa* Song and Chai, 1992.

Diagnosis. The male of this new species can be separated from all known congeneric species in ventral view of palpal organ by: basal portion of embolus touches the margin of genital bulb; distal portion of tibial apophysis covers the posterior margin of cymbium and far away from the margin of genital bulb. The female of this new species can be separated from all known congeneric species by: epigynum about as long as wide; copulatory openings almost parentheses-shaped; hoods locate above the outside area of the copulatory openings.

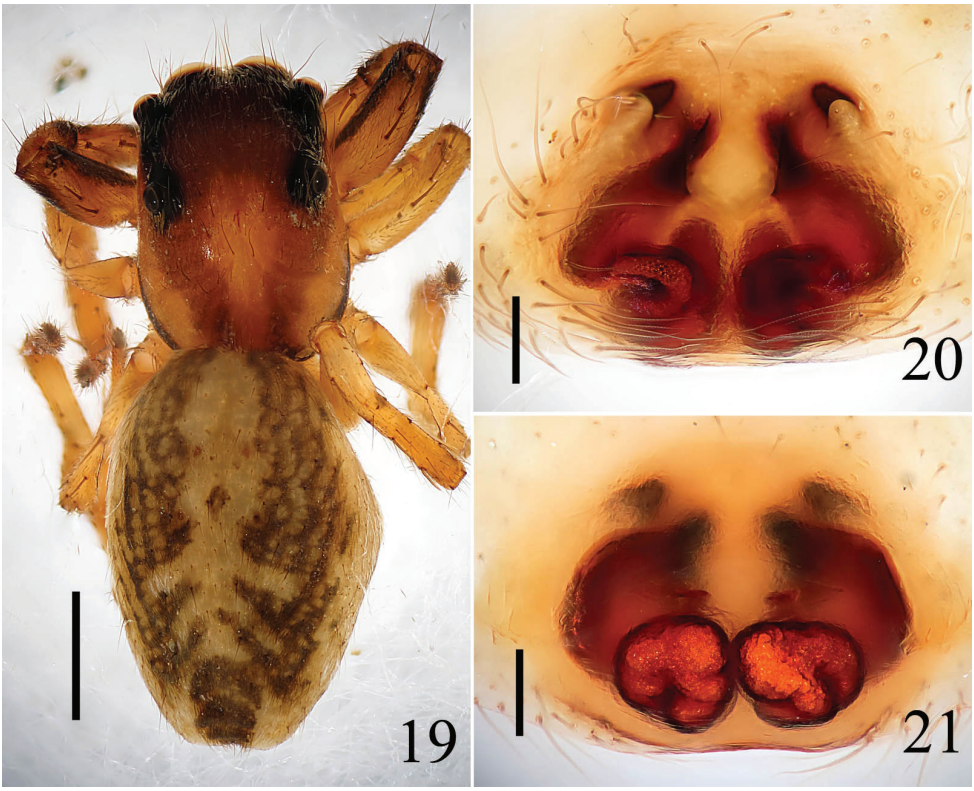
Description. Male (Holotype): Total length 5.40. Cephalothorax 2.60 long, 1.90 wide; Abdomen 2.80 long, 1.70 wide. Clypeus 0.15 high. Carapace brown, with black margin, basal area of each eye, anterior and lateral margins of ocular area black; Marginal areas of carapace and thoracic region with one longitudinal yellow brown band. Marginal areas of carapace, anterior margin of ocular area densely covered with white hair, sparsely covered with brown hairs; fovea short, longitudinal and reddish-

Figures 13–15. *Yaginumaella pseudoflexa* sp. n. **13** male body, dorsal view **14** male palp, retrolateral view **15** male palp, ventral view. Scale bars: (**13**) 0.5 mm; (**14, 15**) 0.1 mm.

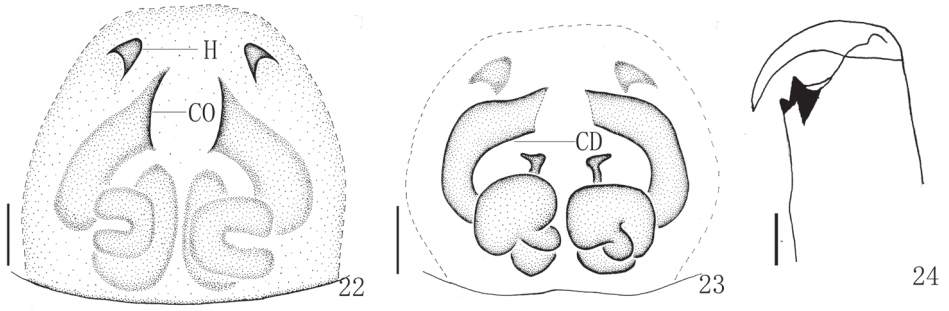


Figures 16–18. *Yaginumaella pseudoflexa* sp. n. **16** male palp, retrolateral view **17** male palp, ventral view **18** left chelicera, posterior view. Scale bars: 0.1 mm.

brown; cervical groove indistinct, radial groove dark brown. Sternum scutiform, covered with short brown hair, dark brown with gray edge. Clypeus dark brown, with long brown setae. Promargin with dense hair. Chelicerae brown to dark brown, with brown hair; 2 promarginal and 1 retromarginal teeth (Figs 18). Labium dark brown, terminal brown, with dark brown hair. Endites base brown, terminal yellow brown, with dense dark brown hair. Legs yellow brown to dark brown; leg I dark brown, I and II spina-

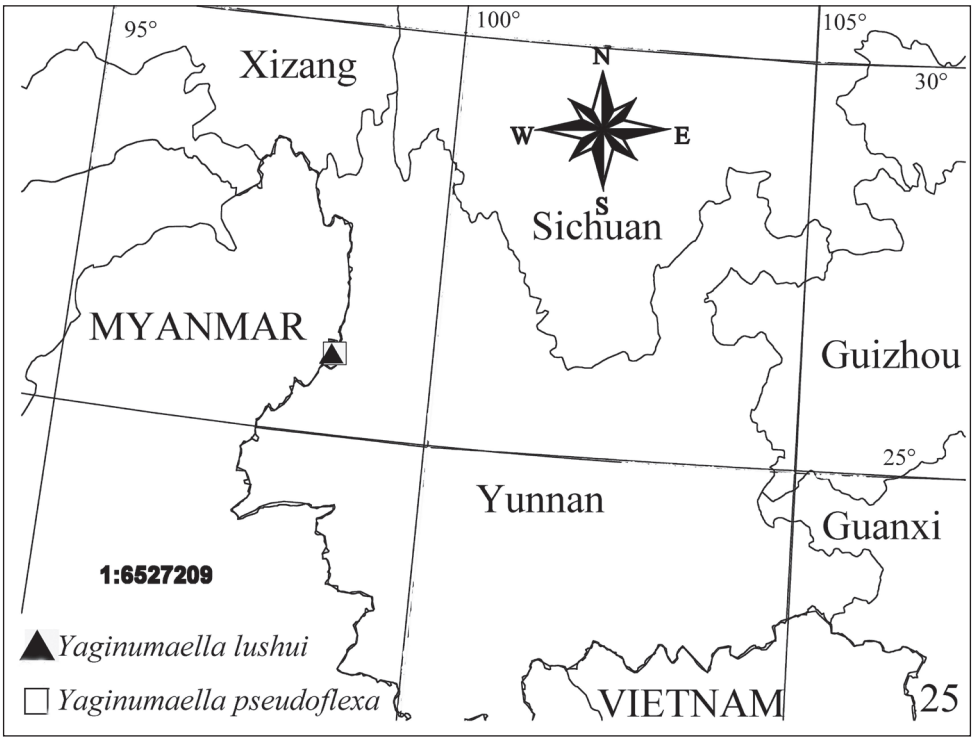


Figures 19–21. *Yaginumaella pseudoflexa* sp. n. **19** female body, dorsal view **20** epigynum, ventral view **21** vulva, dorsal view. Scale bars: 0.1 mm.



Figures 22–24. *Yaginumaella pseudoflexa* sp. n. **22** epigynum, ventral view **23** vulva, dorsal view **24** left chelicerae, posterior view. Scale bars: 0.1 mm.

tion v 2-2-2, I and II spination v 2-2. Measurements of legs: I 4.55 (1.65, 2.20, 1.00, 0.70), II 4.80 (1.60, 1.80, 0.80, 0.60), III 4.90 (1.60, 1.60, 1.00, 0.70), IV 5.40 (1.75, 1.75, 1.20, 0.70). Leg formula: 4321. Abdomen oval, yellow brown, with 6 muscular impressions; lateral areas with two grayish-black longitudinal stripes and scattered black diagonal patches. Posterior area of abdomen with arc-shaped and dentiform dark



Figures 25. Localities of new *Yaginumaella* species from China.

bands; ventral yellowish-white, with scattered grayish-black patches; median area with one black longitudinal stripe, lateral areas with scattered black diagonal patches. Spinnerets black-brown.

Male palp (Figs 14–15, 16–17): tibia longer than wide in ventral view, with several long prolateral macrosetae in retrolateral view. Genital bulb with membrane structure. Embolus slender and sinuous, nearly as long as genital bulb, originates from the position of 9:00 o'clock, its tip reaches to the position of 14:00 o'clock in ventral view. Bulb squat, median portion widest. Sperm ducts obvious, its diameter about 1/3 width of bulb.

Female: Total length 5.40, Cephalothorax 2.40 long, 1.85 wide. Abdomen 3.00 long, 1.90 wide. Clypeus 0.15 high. Eye sizes and interdistances: AME 0.50, ALE 0.30, PLE 0.25, AER 1.65, PER 1.55, EFL1.00. Measurements of legs: I 4.30 (1.40, 1.70, 0.70, 0.50), II 3.90 (1.30, 1.05, 0.06, 0.50), III 4.80 (1.40, 1.70, 0.90, 0.80), IV 5.20 (1.60, 1.90, 1.00, 0.70). Leg formula: 4312. Other morphological characteristics the same as male, but lightly colored.

Epigyne (Figs 20–21, 22–23) as long as wide, with two distinct anterior hoods. Copulatory openings almost parentheses-shaped, far away from the hoods. Copulatory ducts thick and sinuous. Spermathecae big, squat, close to each other.

Variation. The male length 4.30–5.40 (n = 2) and the female length 4.80–5.80. (n = 3).

Distribution. China (Yunnan).

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An annotated catalogue of the mayfly fauna of Turkey (Insecta, Ephemeroptera)

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Abstract

The mayfly fauna of Turkey was reviewed including all hitherto known distribution records together with references and a few new records. Additionally, comments on taxonomy, identification and nomenclature are provided. Two species are new for the Turkish fauna: *Ephemera romantzovi* Kluge, 1988 and *Thraulus thraker* Jacob, 1988. A list of taxa including their recorded distribution in Turkey (according to provinces) is provided in the annotated catalogue. The type locality is also given for each species originally described from Turkey. According to the literature and the new records, 157 mayfly taxa representing 33 genera and 14 families were described from Turkey. Among them, 24 species are considered endemic to Anatolia.

Keywords

Annotated catalogue, bibliography, Ephemeroptera, Turkey

Introduction

Turkey is located among three continents geographically and covers a region also known as Asia Minor and Anatolia. Ulmer (1920) was the first author who described

a new mayfly taxon from Turkey, whereas Verrier (1955) and Puthz (1972) provided the first faunistic records. Puthz (1978) already listed 17 species from Turkey but earnest faunistic research commenced with Kazancı (1984)[1], who contributed so far more than 30 papers, followed by Tanatmış (from 1995 onwards)[2] and others. A total of more than 70 scientific papers and books have been published on Ephemeroptera in Turkey until the year 2015 by Turkish and foreign researchers.

The websites www.faunaturkey.com and www.faunaturkey.org (established in 2013) aim to contribute more information on researchs about the fauna of Turkey. The data provided will be also added to the websites after publication. Our hope is to keep this list up-to-date with further additions and some corrections periodically, so we welcome information on any omissions, errors, and updates.

Material and methods

Data in this review have been based on a detailed study of literature on Ephemeroptera in Turkey as well as on hitherto unpublished material housed in the Natural History Museum, Vienna (NMW, Austria). Unpublished theses have not been considered, nor have all records above the species level. Distribution of species-group taxa in Turkey has been listed and referenced according to publication dates. National distribution records (without specific data at least on province level) have been listed under 'Turkey'. Type locality of species were only provided if the taxon had originally been based on material from Turkey. Additionally, taxa considered endemic to Turkey have been specifically mentioned under '*note*'. Remarks on different taxonomic opinions and nomenclature have been added under '*Comment*' whenever appropriate. Nomenclature and arrangement of families are given according to Bauernfeind and Soldán (2012).

Figure 1. Provinces of Turkey

[1] Prof. Dr. Nilgün Kazancı, Hacettepe University, Turkey

[2] Dr. Mustafa Tanatmış, Anadolu University, Turkey

Annotated catalogue of the Turkish mayfly fauna

157 species-group taxa (153 species and 4 subspecies) of mayflies representing 33 genera and 14 families have been recorded from Turkey. Among them, 24 species (15.3%) are presently considered endemic to Turkey. Three species have been excluded from the Turkish checklist.

Family AMELETIDAE McCafferty, 1991
Genus *Ameletus* Eaton, 1885

***Ameletus inopinatus* Eaton, 1887**

Distribution in Turkey. Ankara, Eskişehir (Tanatmış 1995); Kırklareli, Tekirdağ (Tanatmış 1997); Samsun, Zonguldak (Kazancı 2001b); listed from Turkey: Tanatmış (1999); Kazancı and Türkmen (2012).

Genus *Metreletus* Demoulin, 1951

***Metreletus balcanicus* (Ulmer, 1920)**

Distribution in Turkey. Kırklareli (Kazancı 1998a); listed from Turkey: Kazancı (2001b); Kazancı and Türkmen (2012).

Family SIPHLONURIDAE Ulmer, 1920
Genus *Siphlonurus* Eaton, 1868

***Siphlonurus aestivalis* Eaton, 1903**

Distribution in Turkey. Kırklareli, Tekirdağ (Tanatmış 1997); Balıkesir, Kütahya (Tanatmış 2000); Kütahya (Tanatmış 2002); Bolu (Tanatmış 2004a); Balıkesir (Narin and Tanatmış 2004); Konya (Kazancı 2011); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Comment. Considering the difficulties in identification of *Siphlonurus* taxa at the larval stage, records based on male imagines would be desirable.

Siphlonurus lacustris Eaton, 1870

Distribution in Turkey. Aydın (Kazancı 2001b); listed from Turkey: Kazancı and Türkmen (2012).

Siphlonurus muchei Braasch, 1983

Type country and locality. Turkey, approximately 170-180 km south-east Amasia, Reşadiye district, the province of Tokat (Braasch 1983a).

Distribution in Turkey. Tokat (Braasch 1983a); listed from Turkey: Tanatmış (1999); Kazancı and Türkmen (2012).

Comment. Larva not described.

Note. Endemic to Turkey.

Family BAETIDAE Leach, 1815
Genus *Baetis* Leach, 1815

Subgenus *Acentrella* Bengtsson, 1912

Comment. *Acentrella* is either considered of generic rank (Barber-James et al. 2013) or a subgenus of *Baetis* (Novikova and Kluge 1987; Bauernfeind and Soldán 2011); see also Kluge and Novikova (2011).

Baetis (*Acentrella*) *inexpectatus* (Tshernova, 1928)

Distribution in Turkey. Elazığ (Berker 1981); Ağrı, Kars (Kazancı 1986a); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Baetis (*Acentrella*) *lapponicus* (Bengtsson, 1912)

Distribution in Turkey. Bolu (Kazancı 2001b); Bolu (Kazancı and Türkmen 2008a); Bolu (Kazancı and Türkmen 2008b); listed from Turkey: Kazancı and Türkmen (2012).

Comment. Occurrence of *B.* (*A.*) *lapponicus* in Turkey [syntopic with *B.* (*A.*) *sinaicus*] seems rather doubtful and a re-examination of voucher specimens would be useful.

***Baetis* (*Acentrella*) *sinaicus* (Bogoescu, 1931)**

Distribution in Turkey. Bolu (Kazancı 1984); Balıkesir (Tanatmış 2000); Karabük (Tanatmış 2004a); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Subgenus *Baetis* Leach, 1815

***Baetis* (*Baetis*) *alpinus* (Pictet, 1843)**

Distribution in Turkey. Ankara, Ağrı, Antalya, Bayburt, Erzurum, Kars, Konya (Kazancı 1984); Çankırı, Erzincan, Hakkari (Kazancı 2009); listed from Turkey: Puthz (1973); Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Comment. Taxonomy of the *Baetis alpinus* species-group *sensu* Müller-Liebenau (1969) is rather complicated and several taxa are known from the near vicinity of Turkey. Tabular summaries of diagnostic characters for all species of the *B. alpinus* species-group described so far have been provided by Peru and Thomas (2003, Ephemera 3, 2: 75) for larvae and by Righetti and Thomas (2001, Ephemera 2, 2: 77) for male imagines.

***Baetis* (*Baetis*) *buceratus* Eaton, 1870**

Distribution in Turkey. Ankara, Antalya, Balıkesir, Bayburt, Bingöl, Bolu, Elazığ, Erzurum, Eskişehir, Isparta, Kırşehir, Konya, Sivas, Van (Kazancı 1985a); Hatay, Şanlıurfa (Koch 1988); Muğla (Kazancı et al. 1992); Balıkesir (Tanatmış 2000); Balıkesir, Bursa, Kütahya (Tanatmış 2002); Bolu, Karabük, Kastamonu, Zonguldak (Tanatmış 2004a); Kastamonu (Tanatmış 2004b); Balıkesir, Çanakkale (Narin and Tanatmış 2004); Sinop (Ertorun and Tanatmış 2004); Bartın (Tanatmış and Ertorun 2006); Düzce, Zonguldak (Tanatmış 2007); Ankara (Kazancı and Girgin 2008); Adıyaman, Erzurum, Kars (Kazancı 2009); Afyon, Konya (Özyurt and Tanatmış 2011); Malatya (Aydınlı 2013); İzmir, Kütahya, Manisa, Uşak (Aydınlı and Ertorun 2015); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

***Baetis* (*Baetis*) *elazigi* Berker, 1981**

Type country and locality. Turkey, Keban Deresi (the type locality is located in the province of Elazığ) (Berker 1981).

Distribution in Turkey. Elazığ (Berker 1981); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Note. Endemic to Turkey

Comment. Description and drawings do not allow identification without some doubt. A re-examination of type material (not specified) is necessary to ascertain the taxonomic status of this species.

Baetis (*Baetis*) *fuscatus* (Linnaeus, 1761)

Distribution in Turkey. Hatay [as *Baetis bioculatus* Linnaeus, 1758 (Verrier 1955)]; Ankara, Ağrı, Balıkesir, Bayburt, Bingöl, Erzurum, Erzincan, Hatay, Kars, Muş, Tekirdağ (Kazancı 1985a); Tekirdağ (Tanatmış 1997); Afyon (Kazancı 1998b); Balıkesir (Tanatmış 2000); Erzincan, Erzurum, Gümüşhane, Kars (Kazancı 2001a); Bursa, Kütahya (Tanatmış 2002); Bolu, Karabük, Zonguldak (Tanatmış 2004a); Kastamonu, Sinop (Tanatmış 2004b); Balıkesir, Çanakkale (Narin and Tanatmış 2004); Sinop (Ertorun and Tanatmış 2004); Bartın (Tanatmış and Ertorun 2006); Düzce, Zonguldak (Tanatmış 2007); Ankara (Kazancı and Girgin 2008); Bolu (Kazancı and Türkmen 2008a); Bolu (Kazancı and Türkmen 2008b); Giresun, Gümüşhane, Rize, Trabzon (Türkmen and Kazancı 2015); İzmir, Manisa (Aydınlı and Ertorun 2015); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012); Eastern Black Sea Basin (Türkmen and Kazancı 2013).

Baetis (*Baetis*) *lutheri* Müller-Liebenau, 1967

Distribution in Turkey. Muş (Kazancı 1985a); Sivas (Koch 1985); Hatay (Koch 1988); Muğla (Kazancı et al. 1992); Balıkesir (Tanatmış 2000); Ankara (Kazancı 2001b); Bursa (Tanatmış 2002); Bolu, Karabük, Kastamonu, Zonguldak (Tanatmış 2004a); Kastamonu, Sinop (Tanatmış 2004b); Balıkesir (Narin and Tanatmış 2004); Sinop (Ertorun and Tanatmış 2004); Bartın (Tanatmış and Ertorun 2006); Düzce (Tanatmış 2007); Ankara (Kazancı and Girgin 2008); Bolu (Kazancı and Türkmen 2008a); Bolu (Kazancı and Türkmen 2008b); Sinop (Tanatmış and Ertorun 2008); Adıyaman (Kazancı 2009); Afyon, Konya (Özyurt and Tanatmış 2011); Tokat (Kazancı et al. 2012); Malatya (Aydınlı 2013); Giresun, Gümüşhane, Rize, Trabzon (Türkmen and Kazancı 2015); Kütahya, Manisa, Uşak (Aydınlı and Ertorun 2015); listed from Turkey: Tanatmış (1999); Kazancı and Türkmen (2012); Eastern Black Sea Basin (Türkmen and Kazancı 2013).

Comment. Subspecific identity of records as *Baetis lutheri* (*as above*) is not clear.

Baetis (*Baetis*) *lutheri georgiensis* Zimmermann, 1981

Distribution in Turkey. Artvin, Erzincan, Tunceli (Kazancı 2009); listed from Turkey: Kazancı and Türkmen (2012).

Comment. Larval characters of *Baetis lutheri georgensis* Zimmermann have so far not been described. Identification and separation of subspecies *Baetis lutheri lutheri*

Müller-Liebenau and *Baetis lutheri georgensis* Zimmermann in the larval stage remain therefore doubtful at present.

Baetis (*Baetis*) *macani* Kimmins, 1957

Distribution in Turkey. Elazığ (Berker 1981); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Comment. Taxonomy and identification of *B. macani* and related taxa is rather complicated (see Savolainen et al. 2007; Savolainen 2009). *Baetis macani* is considered to represent a tundral or boreo-tundral faunistic element distributed north of 54° northern latitude and occurrence in Turkey is rather unlikely. A re-examination of voucher material would be useful.

Baetis (*Baetis*) *melanonyx* (Pictet, 1843)

Distribution in Turkey. Hatay (Koch 1988); Ankara (Kazancı 2001b); listed from Turkey: Kazancı and Türkmen (2012).

Baetis (*Baetis*) *meridionalis* Ikonomov, 1954

Distribution in Turkey. Ankara, Muş, Sivas (Kazancı 1984); Balıkesir, Bursa, Kütahya (Tanatmış 2000); Balıkesir, Bursa, Kütahya (Tanatmış 2002); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Baetis (*Baetis*) *pavidus* Grandi, 1951

Distribution in Turkey. Elazığ (Berker 1981); Bilecik, Bursa, Eskişehir, Kütahya (Tanatmış 1995); Balıkesir, (Tanatmış 2000); Bursa, Kütahya (Tanatmış 2002); Bolu (Kazancı and Türkmen 2008a); Bolu (Kazancı and Türkmen 2008b); Tokat (Kazancı et al. 2012); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Baetis (*Baetis*) *nexus* Navás, 1918

Distribution in Turkey (as *Baetis pentaphlebodes* Ujhelyi, 1966). Kars, Erzurum (Kazancı 1984); Kütahya (Tanatmış 2000, 2002); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Comment. *Baetis pentaphlebodes* Ujhelyi, 1966 is usually considered to represent a junior subjective synonym of *Baetis nexus* Navás, 1918 (International Commission on Zoological Nomenclature 2007. Opinion 2171, Case 3322. Bulletin of Zoological Nomenclature 64 (2): 131 [*Baetis nexus* Navás, 1918 placed on the Official List of Specific Names in Zoology]. See also Sziráki (2005).

Baetis (*Baetis*) *samochai* Koch, 1981

Distribution in Turkey. Diyarbakır (Koch 1985); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Baetis (*Baetis*) *scambus* Eaton, 1870

Distribution in Turkey. Ankara (Kazancı 1984); Muğla (Kazancı et al. 1992); Ankara, Bursa, Eskişehir, Kütahya (Tanatmış 1995); Bolu, Çankırı, Kırşehir (Kazancı 2001b); Bolu (Taşdemir et al. 2008); listed from Turkey: Tanatmış (1999); Kazancı and Türkmen (2012).

Comment. Larvae are very similar to *B. fuscatus*, not always reliably separated. Identification is comparatively easy if larvae and male imagines are associated.

Baetis (*Baetis*) *vardarensis caucasicus* Zimmermann, 1981

Distribution in Turkey. Trabzon (Kazancı 2009); listed from Turkey: Kazancı and Türkmen (2012).

Baetis (*Baetis*) *vernus* Curtis, 1834

Distribution in Turkey. Elazığ (Berker 1981); Ankara, Erzincan (Kazancı 1984); Sivas (Koch 1985); Ankara, Bolu, Eskişehir, Kütahya (Tanatmış 1995); Edirne, İstanbul, Kırklareli, Tekirdağ (Tanatmış 1997); Balıkesir, Bursa, Kütahya (Tanatmış 2000); Erzincan, Erzurum (Kazancı 2001a); Kırşehir, Konya (Kazancı 2001b); Bursa, Kütahya (Tanatmış 2002); Bolu, Karabük, Kastamonu, Zonguldak (Tanatmış 2004a); Kastamonu, Sinop (Tanatmış 2004b); Balıkesir (Narin and Tanatmış 2004); Sinop (Ertorun and Tanatmış 2004); Bartın (Tanatmış and Ertorun 2006); Düzce (Tanatmış 2007); Sinop (Tanatmış and Ertorun 2008); Afyon, Konya (Özyurt and Tanatmış 2011); Malatya (Aydınlı 2013); İzmir, Kütahya, Manisa, Uşak (Aydınlı and Ertorun 2015); listed from Turkey: Tanatmış (1999); Kazancı and Türkmen (2012).

Subgenus *Labiobaetis* Novikova & Kluge, 1987

Comment. *Labiobaetis* is either considered of generic rank (Barber-James et al. 2013) or a subgenus of *Baetis* (Novikova and Kluge 1987, Bauernfeind and Soldán 2011); see also the interesting discussion in Kluge (2015) [accessed October 15th 2015].

***Baetis* (*Labiobaetis*) *atrebatinus* Eaton, 1870**

Distribution in Turkey. Manisa, Uşak (Aydınlı and Ertorun 2015).

***Baetis* (*Labiobaetis*) *balcanicus* Müller-Liebenau & Soldán, 1981**

Distribution in Turkey. Balıkesir (Kazancı 1998a); listed from Turkey: Kazancı (2001b); Kazancı and Türkmen (2012).

***Baetis* (*Labiobaetis*) *tricolor* Tshernova, 1928**

Distribution in Turkey. Diyarbakır (Koch 1985); Hatay (Koch 1988); Sivas (Kazancı 1998a); Balıkesir (Tanatmış 2000); Artvin, Erzurum, Sivas (Kazancı 2001a); Bursa (Tanatmış 2002); Erzincan, Tunceli (Kazancı 2009); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Comment. Occurrence of potamalic *B. tricolor* in high mountain streams (Erzincan, Tunceli at between 1000–1500 m a.s.l.) is rather doubtful. In the larval stage, usually not separable from *B. calcaratus* Keffermüller, 1972. A re-examination of voucher specimens would be desirable.

Subgenus *Rhodobaetis* Jacob, 2003

***Baetis* (*Rhodobaetis*) *bisri* Thomas & Dia, 1983**

Distribution in Turkey. Hakkari, Dicle River Basin, 1500 m, 10. 7. 1986, 3 larvae (Kazancı 2009).

Comment. Novikova (1987: 79) suggested the possible synonymy of *B. bisri* with *B. stipposus* Kluge, 1982 [presently considered a junior subjective synonym of *B. braaschi* Zimmermann, 1980]. However, Godunko et al. (2004: 165) considered *B. bisri* a well-characterized taxon easily separated from *B. braaschi* in the nymph stage by several morphological characters. No information was provided by Kazancı (2009) on characters for identification and several closely related taxa have subsequently been described from the neighbouring (adjacent) Taurus region. Occurrence of *B. bisri* in

Turkey is not very likely and the record may in fact be based on any taxon of the subgenus *Baetis* (*Rhodobaetis*). The record from Hakkari has obviously been listed subsequently by Kazancı and Türkmen (2012) as *B. braaschi* (see below).

Baetis (*Rhodobaetis*) *braaschi* Zimmermann, 1980

Distribution in Turkey. Probably Hakkari (as *B. bisri;* Kazancı, 2009). Listed from Turkey: Kazancı and Türkmen (2012).

Comment. For diagnostic characters and their variability see Sroka et al. (2012).

Baetis (*Rhodobaetis*) *gemellus* Eaton, 1885

Distribution in Turkey. Ankara, Bingöl, Erzurum, Yozgat (Kazancı 1984); Muğla (Kazancı et al. 1992); Bolu (Kazancı and Türkmen 2008a); Bolu (Kazancı and Türkmen 2008b); Giresun, Gümüşhane, Rize, Trabzon (Türkmen and Kazancı 2015); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012); Eastern Black Sea Basin (Türkmen and Kazancı 2013).

Comment. *Baetis gemellus* Eaton is considered an insufficiently known taxon, at present represented by the male lectotype (Kimmins 1960) only. Larval characters and distribution not known, probably restricted to Switzerland. According to Godunko et al. (2015) all previous records as *B. gemellus* from Turkey refer in fact to *Baetis vadimi* Godunko, Palatov and Martynov, 2015.

Baetis (*Rhodobaetis*) *macrospinosus* Koch, 1985

Type country and locality. Turkey, Dicle river, 100 m upstream Dicle Bridge (at Gözlü Köprü), province of Diyarbakır (Koch 1985).

Distribution in Turkey. Diyarbakır (Koch 1985); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Note. Endemic to Turkey.

Baetis (*Rhodobaetis*) *milani* Godunko, Prokopov & Soldán, 2004

Distribution in Turkey. Balıkesir (Türkmen and Özkan 2011); Gümüşhane, Rize, Trabzon (Türkmen and Kazancı 2015); listed from Turkey: Kazancı and Türkmen (2012); Eastern Black Sea Basin (Türkmen and Kazancı 2013).

Comment. According to Godunko et al. (2015: 196) the record from Balıkesir is doubtful and distribution in Anatolia needs confirmation.

Baetis (*Rhodobaetis*) *pseudogemellus* Soldán, 1977

Distribution in Turkey. Siirt (Kazancı 2009); listed from Turkey: Kazancı and Türkmen (2012).

Comment. Occurrence of *B. pseudogemellus* in Turkey is extremely unlikely (Godunko et al. 2015: 196), but several rather similar taxa of the subgenus *Rhodobaetis* occur in this region. A re-examination of voucher specimens from Siirt would be desirable.

Baetis (*Rhodobaetis*) *rhodani* (Pictet, 1843)

Distribution in Turkey. Antalya, Osmaniye (Puthz 1972); Elazığ (Berker 1981); Ankara, Balıkesir, Bayburt, Bingöl, Erzurum, Hakkari, Kars, Muş, Van (Kazancı 1984); Hatay (Koch 1988); Ankara, Bilecik, Bolu, Bursa, Eskişehir, Kütahya, Sakarya (Tanatmış 1995); Çanakkale, Edirne, İstanbul, Kırklareli, Tekirdağ (Tanatmış 1997); Balıkesir, Kütahya (Tanatmış 2000); Konya (Kazancı 2001b); Bursa, Kütahya (Tanatmış 2002); Bolu, Karabük, Kastamonu, Zonguldak (Tanatmış 2004a); Kastamonu, Sinop (Tanatmış 2004b); Balıkesir, Çanakkale (Narin and Tanatmış 2004); Sinop (Ertorun and Tanatmış 2004); Bartın (Tanatmış and Ertorun 2006); Düzce, Zonguldak (Tanatmış 2007); Ankara (Kazancı and Girgin 2008); Bolu (Kazancı and Türkmen 2008a); Bolu (Kazancı and Türkmen 2008b); Sinop (Tanatmış and Ertorun, 2008); Çankırı (Kazancı 2009); Balıkesir (Türkmen and Özkan 2011); Afyon, Konya (Özyurt and Tanatmış 2011); Tokat (Kazancı et al. 2012); Malatya (Aydınlı 2013); Giresun, Gümüşhane, Rize, Trabzon (Türkmen and Kazancı 2015); İzmir, Kütahya, Manisa, Uşak (Aydınlı and Ertorun 2015); listed from Turkey: Tanatmış (1999); Kazancı and Türkmen (2012); Eastern Black Sea Basin (Türkmen and Kazancı 2013).

Comment. Taxonomy of the *Baetis rhodani* species-group *sensu* Müller-Liebenau (1969) is rather complicated and numerous new species have been described in the more recent past. For a redescription and designation of neotype see Gattolliat and Sartori (2008).

Baetis (*Rhodobaetis*) *vadimi* Godunko, Palatov & Martynov, 2015

Type country and locality. Turkey, Unnamed brook, small right-side tributary of upper part of Fırtına Deresi (Kaçkar Mountains), district of Ardeşen, Rize province (Godunko et al. 2015).

Distribution in Turkey. Rize (Godunko et al. 2015).

Comment. Various earlier records as *Baetis gemellus* may in fact represent *Baetis* (*Rhodobaetis*) *vadimi* (see *Comment* above).

Subgenus *Nigrobaetis* Novikova & Kluge, 1987

Comment. *Nigrobaetis* is either considered of generic rank (Barber-James et al. 2013) or a subgenus of *Baetis* (Novikova and Kluge 1987, Bauernfeind and Soldán 2011). It is not clear, whether *Alainites* Waltz and McCafferty, 1994, should be treated as a distinct genus-group taxon (e.g. Barber-James et al. 2013) or included in *Labiobaetis* (e.g. Kluge 2015; accessed October 15th 2015).

Baetis (*Nigrobaetis*) *digitatus* Bengtsson, 1912

Distribution in Turkey. Bolu, Muş, Sivas (Kazancı 1984); Bolu, Zonguldak (Tanatmış 2004a); Kastamonu, Sinop (Tanatmış 2004b); Balıkesir (Narin and Tanatmış 2004); Sinop (Ertorun and Tanatmış 2004); Bartın (Tanatmış and Ertorun 2006); Düzce, Zonguldak (Tanatmış 2007); listed from Turkey (Tanatmış 1999; Kazancı 2001b; Kazancı and Türkmen 2012).

Comment. Taxonomy of *B. digitatus* is insufficiently known and specific identity of southern (Mediterranean) and southeastern (Turkey, Caucasus region) representatives probably questionable. A series of reared material from Turkey would be especially interesting towards solving this question.

Baetis (*Nigrobaetis*) *gracilis* Bogoescu & Tabacaru, 1957

Distribution in Turkey. Balıkesir (Tanatmış 2000); Balıkesir (Kazancı 2001b); Balıkesir, Bursa (Tanatmış 2002); Karabük, Zonguldak (Tanatmış 2004a); listed from Turkey: Kazancı and Türkmen (2012).

Baetis (*Nigrobaetis*) *kars* Thomas & Kazancı, 1989

Type country and locality. Turkey, Kızılsu (the type locality is a stream and is located in the province of Şırnak) (Kazancı and Thomas 1989).
Distribution in Turkey. Hakkari, Kars, Şırnak (Kazancı and Thomas 1989); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Baetis (*Nigrobaetis*) *muticus* (Linnaeus, 1758)

Distribution in Turkey. Bingöl, Van (Kazancı 1984); Muğla (Kazancı et al. 1992); Ankara, Bilecik, Bolu, Bursa, Eskişehir, Kütahya, Sakarya (Tanatmış 1995); İstanbul, Kırklareli, Tekirdağ (Tanatmış 1997); Balıkesir, Kütahya (Tanatmış 2000); Artvin, Erzincan, Erzurum, Kars (Kazancı 2001a); Kütahya (Tanatmış 2002); Bolu, Karabük,

Kastamonu, Zonguldak (Tanatmış 2004a); Kastamonu, Sinop (Tanatmış 2004b); Sinop (Ertorun and Tanatmış 2004); Bartın (Tanatmış and Ertorun 2006); Düzce, Zonguldak (Tanatmış 2007); Bolu (Kazancı and Türkmen 2008a); Bolu (Kazancı and Türkmen 2008b); Sinop (Tanatmış and Ertorun 2008); Balıkesir (Türkmen and Özkan 2011); Afyon, Konya (Özyurt and Tanatmış 2011); Giresun, Rize, Trabzon (as *A. muticus*) (Türkmen and Kazancı 2015); Kütahya, Manisa (Aydınlı and Ertorun 2015); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012); Eastern Black Sea Basin (Türkmen and Kazancı 2013).

***Baetis* (*Nigrobaetis*) *niger* (Linnaeus, 1761)**

Distribution in Turkey. Samsun (Kazancı 1984); Sivas (Koch 1985); Ankara (Kazancı 2001b); Manisa (Aydınlı and Ertorun 2015); listed from Turkey: Tanatmış (1999); Kazancı and Türkmen (2012).

Genus *Centroptilum* Eaton, 1869

***Centroptilum luteolum* (O.F. Müller, 1776)**

Distribution in Turkey. Ankara (Kazancı 1984); Sivas (Koch 1985); Ankara, Eskişehir (Tanatmış 1995); Çanakkale (Tanatmış 1997); Kütahya (Tanatmış 2000); Kütahya (Tanatmış 2002); Bolu, Karabük, Kastamonu, Zonguldak (Tanatmış 2004a); Kastamonu, Sinop (Tanatmış 2004b); Balıkesir (Narin and Tanatmış 2004); Sinop (Ertorun and Tanatmış 2004); Bartın (Tanatmış and Ertorun 2006); Zonguldak (Tanatmış 2007); Balıkesir (Türkmen and Özkan 2011); Afyon, Konya (Özyurt and Tanatmış 2011); Kütahya, Manisa (Aydınlı and Ertorun 2015); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Genus *Cloeon* Leach, 1815

***Cloeon dipterum* (Linnaeus, 1761)**

Distribution in Turkey. Zonguldak (Verrier 1955); Afyon, Ankara, Ardahan, Erzurum, Nevşehir (Kazancı 1984); Ankara (Koch 1985); Hatay, Şanlıurfa (Koch 1988); Eskişehir, Kütahya, Sakarya (Tanatmış 1995); Edirne, İstanbul, Kırklareli, Tekirdağ (Tanatmış 1997); Balıkesir (Tanatmış 2000); Balıkesir, Bursa, Kütahya (Tanatmış 2002); Bolu, Karabük, Zonguldak (Tanatmış 2004a); Kastamonu (Tanatmış 2004b); Balıkesir, Çanakkale (Narin and Tanatmış 2004); Sinop (Ertorun and Tanatmış, 2004); Bartın (Tanatmış and Ertorun 2006); Düzce, Zonguldak (Tanatmış 2007); Bolu, Sakarya (Taşdemir et al. 2008); Konya (Topkara et al. 2009); Balıkesir (Türk-

men and Özkan 2011); Afyon, Konya (Özyurt and Tanatmış 2011); Malatya (Aydınlı 2013); İzmir, Manisa, Uşak (Aydınlı and Ertorun 2015); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Cloeon simile Eaton, 1870

Distribution in Turkey. Ankara, Erzincan, Kırşehir (Kazancı 1984); Bursa (Tanatmış 1995); Balıkesir (Tanatmış 2000); Bolu, Kırşehir (Kazancı 2001b); Kütahya (Tanatmış 2002); Balıkesir (Narin and Tanatmış 2004); Malatya (Aydınlı 2013); Manisa (Aydınlı and Ertorun 2015); listed from Turkey: Tanatmış (1999); Kazancı and Türkmen (2012).

Genus *Procloeon* Bengtsson, 1915

Procloeon bifidum (Bengtsson, 1912)

Distribution in Turkey. Eskişehir (Kazancı 1984); Kırklareli, Tekirdağ (Tanatmış 1997); Balıkesir (Tanatmış 2000); Kütahya (Tanatmış 2002); Bolu, Zonguldak (Tanatmış 2004a); Sinop (Tanatmış 2004b); Balıkesir (Narin and Tanatmış 2004); Sinop (Ertorun and Tanatmış 2004); Bartın (Tanatmış and Ertorun 2006); Düzce, Zonguldak (Tanatmış 2007); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Procloeon nana (Bogoescu, 1951)

Distribution in Turkey. Ağrı (as *Centroptilum nanum*; Kazancı 1984); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Comment. Frequently placed in the subgenus (originally genus) *Pseudocentroptilum* Bogoescu, 1947. Very similar to (or conspecific with) *P. macronyx* (Kluge and Novikova, 1992), see discussion in Bauernfeind and Soldán (2012: 212) and Kluge (2015).

Procloeon pennulatum (Eaton, 1870)

Distribution in Turkey. Ağrı, Ankara, Erzurum (as *Centroptilum pennulatum*; Kazancı 1984); Şanlıurfa (as *Centroptilum pennulatum*; Koch 1988); Çanakkale, Kırklareli (Tanatmış 1997); Balıkesir, Bursa, Kütahya (Tanatmış 2000); Balıkesir, Kütahya (Tanatmış 2000); Erzurum (Kazancı 2001a); Ankara, Çankırı (Kazancı 2001b); Balıkesir, Bursa, Kütahya (Tanatmış 2002); Bolu, Karabük, Zonguldak (Tanatmış 2004a); Kastamonu (Tanatmış 2004b); Bartın (Tanatmış and Ertorun 2006); Düzce, Zonguldak (Tanatmış 2007); Afyon, Konya (Özyurt and Tanatmış 2011); Manisa

(Aydınlı and Ertorun 2015); listed from Turkey: Tanatmış (1999); Kazancı and Türkmen (2012).

Comment. Frequently placed in the subgenus (originally genus) *Pseudocentroptilum* Bogoescu, 1947.

***Procloeon pulchrum* (Eaton, 1885)**

Distribution in Turkey. Bingöl, Kars (as *Centroptilum pulchrum*; Kazancı 1984); Diyarbakır (as *Centroptilum* ? *pulchrum*: Koch 1985); Şanlıurfa (as *Centroptilum* ? *pulchrum*: Koch 1988); Zonguldak (Tanatmış 2004a); Kastamonu, Sinop (Tanatmış 2004b); Sinop (Ertorun and Tanatmış 2004); Düzce (Tanatmış 2007); Sinop (Tanatmış and Ertorun 2008); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Comment. Frequently placed in the subgenus (originally genus) *Pseudocentroptilum* Bogoescu, 1947.

Genus *Pseudocentroptiloides* Jacob, 1986

***Pseudocentroptiloides shadini* (Kazlauskas, 1964)**

Distribution in Turkey. Çankırı, Kırşehir (Kazancı 2001b); listed from Turkey: Kazancı and Türkmen (2012).

Comment. Has been placed in *Psammonella* Glazaczow (in Jacob and Glazaczow), 1986 by Kluge and Novikova (1992), but see discussion in Kluge (2015; accessed October 15th 2015).

Family ISONYCHIIDAE Burks, 1953
Genus *Isonychia* Albarda, 1878

***Isonychia ignota* Walker, 1853**

Material. Yalova, brook I Köseler, Koruköy, male imago, female imago, 30.5.1992, H. Malicky leg., 38°50'N, 27°10'E (NMW).

Distribution in Turkey. Samsun, Zonguldak (Kazancı 1986a); Eskişehir (Tanatmış 1995); İstanbul (Tanatmış 1997); Balıkesir (Tanatmış 2000); Erzincan (Kazancı 2001a); Ankara, Balıkesir, Muğla (Kazancı 2001b); Balıkesir (Tanatmış 2002); Karabük, Zonguldak (Tanatmış 2004a); Kastamonu (Tanatmış 2004b); Balıkesir, Çanakkale (Narin and Tanatmış 2004); Sinop (Ertorun and Tanatmış 2004); Bartın (Tanatmış and Ertorun 2006); Zonguldak (Tanatmış 2007); listed from Turkey: Tanatmış (1999); Kazancı and Türkmen (2012).

Family OLIGONEURIIDAE Ulmer, 1914
Genus *Oligoneuriella* Ulmer, 1924

***Oligoneuriella magna* Bojková & Soldán in Sroka et al., 2015**

Type country and locality. Turkey, Kayseri, Zamantı Irmağı River, Eşelik (near Taşçı); 38°12'42.7"N / 35°50'31.1"E.
Distribution in Turkey. Kayseri (Sroka et al. 2015).
Note. Endemic to Turkey.
Comment. Imago not described.

***Oligoneuriella orontensis* Koch, 1980**

Distribution in Turkey. Hatay (Koch 1980); Diyarbakır (Koch 1985); Hatay (Koch 1988); Erzincan, Erzurum, Tunceli (Kazancı 2001a); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).
Comment. Imago not described.

***Oligoneuriella pallida* (Hagen, 1855)**

Distribution in Turkey. Amasya (as *Oligoneuriella mikulskii* Sowa, 1961; Kazancı 1986a); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

***Oligoneuriella paulopilosa* Sroka in Sroka et al., 2015**

Type country and locality. Turkey, Adıyaman, Sürgü Çayı river near Gölbaşı; 37°50'10.2"N / 37°41'06.9"E (Sroka et al. 2015).
Distribution in Turkey. Adıyaman (Sroka et al. 2015).
Note. Endemic to Turkey.
Comment. Imago not described.

***Oligoneuriella pectinata* Bojková & Soldán in Sroka et al., 2015**

Type country and locality. Turkey, Adıyaman, right tributary of Göksu Çayı, Taşlıyazı (near Besni); 37°42'36.9"N / 37°56'16.0"E (Sroka et al. 2015).
Distribution in Turkey. Adıyaman (Sroka et al. 2015).
Note. Endemic to Turkey.

Oligoneuriella rhenana (Imhoff, 1852)

Distribution in Turkey. Kırklareli (Kazancı 1986a); Bilecik, Bolu, Eskişehir (Tanatmış 1995); Kırklareli (Tanatmış 1997); Balıkesir, Kütahya (Tanatmış 2000); Balıkesir, Muğla, Kırklareli (Kazancı 2001b); Balıkesir, Bursa, Kütahya (Tanatmış 2002); Bolu, Karabük, Zonguldak (Tanatmış 2004a); Kastamonu, Sinop (Tanatmış 2004b); Balıkesir (Narin and Tanatmış 2004); Sinop (Ertorun and Tanatmış 2004); Bartın (Tanatmış and Ertorun 2006); Sinop (Tanatmış and Ertorun 2008); Bolu (Kazancı and Türkmen 2008a); Bolu (Kazancı and Türkmen 2008b); Tokat (Kazancı et al. 2012); listed from Turkey: Tanatmış (1999); Kazancı and Türkmen (2012).

Oligoneuriella tskhomelidzei Sowa & Zosidze, 1973

Distribution in Turkey. Van (as *Oligoneuriella baskale* Soldán and Landa 1977; Soldan and Landa 1977); Artvin, Erzincan (as *Oligoneuriella zanga* Soldán and Landa; Kazancı 2001a); Kars, Van (as *O. baskale* Soldán and Landa; Kazancı 2009); listed from Turkey: Kazancı (2001b); Kazancı and Türkmen (2012).

Comment. Imago of *O. tskhomelidzei* not described. Both, *Oligoneuriella baskale* Soldán and Landa, 1977 and *Oligoneuriella zanga* Soldán and Landa, 1977 have been considered to represent junior subjective synonyms of *Oligoneuriella tskhomelidzei* Sowa and Zosidze, 1973 by Kluge (2004).

Family HEPTAGENIIDAE Needham in Needham & Betten, 1901

Genus *Ecdyonurus* Eaton, 1865

Comment. For use of the name *Ecdyonurus* see Bauernfeind and Haybach (2012) and ICZN (2015).

Ecdyonurus bimaculatus Tanatmış & Haybach, 2010

Type country and locality. Turkey, Emet Stream (Emet Stream is located in the Harmancık – Dursunbey Road 24.km, Hopanlar village, the province of Balıkesir) (Tanatmış and Haybach 2010).

Distribution in Turkey. Balıkesir, Bursa, Karabük, Kütahya, Sinop, Zonguldak (Tanatmış and Haybach 2010).

Note. Endemic to Turkey.

Comment. Tentatively placed in *Ecdyonurus* by Tanatmış and Haybach (2010), very similar to *Afghanurus vicinus* Demoulin, 1964 (larva not described) and *Afronurus*? sp. 1 of Demoulin (1963: p. 37, imago not described). For a discussion of taxo-

nomic concepts for *Ecdyonurus* Eaton see Bauernfeind and Soldán (2012: 251) and Bauernfeind and Haybach (2012).

Subgenus *Ecdyonurus* Eaton, 1865

***Ecdyonurus* (*Ecdyonurus*) *aurantiacus* (Burmeister, 1839)**

Distribution in Turkey. Erzurum (Kazancı 2009); listed from Turkey: Kazancı and Türkmen (2012).

***Ecdyonurus* (*Ecdyonurus*) *autumnalis* Braasch, 1980**

Distribution in Turkey. Artvin (Kazancı 2001b); Artvin (Kazancı 2001a); listed from Turkey: Tanatmış (1999); Kazancı and Türkmen (2012).

Comment. Larva not described.

***Ecdyonurus* (*Ecdyonurus*) *dispar* (Curtis, 1834)**

Distribution in Turkey. Ankara (as *Ecdyonurus fluminum* Pictet, 1843; Geldiay 1949); Erzurum, Hakkari, Kars (Kazancı 2001b); Kütahya (Tanatmış 2002); Karabük, Zonguldak (Tanatmış 2004a); Kastamonu (Tanatmış 2004b); Balıkesir (Narin and Tanatmış 2004); Sinop (Ertorun and Tanatmış 2004); Bartın (Tanatmış and Ertorun 2006); Hakkari (Kazancı 2009); Manisa (Aydınlı and Ertorun 2015); listed from Turkey: Tanatmış (1999); Kazancı and Türkmen (2012).

***Ecdyonurus* (*Ecdyonurus*) *insignis* (Eaton, 1870)**

Distribution in Turkey. İstanbul, Kırklareli, Tekirdağ (Tanatmış 1997); Balıkesir, Kütahya (Tanatmış, 2000); Sivas (Kazancı 2001b); Kütahya (Tanatmış 2002); Bolu, Karabük, Zonguldak (Tanatmış 2004a); Kastamonu, Sinop (Tanatmış 2004b); Bartın (Tanatmış and Ertorun 2006); Düzce, Zonguldak (Tanatmış 2007); Bolu (Kazancı and Türkmen 2008a); Bolu (Kazancı and Türkmen 2008b); listed from Turkey: Tanatmış (1999); Kazancı and Türkmen (2012).

***Ecdyonurus* (*Ecdyonurus*) *macani* Thomas & Sowa, 1970**

Distribution in Turkey. Giresun (Türkmen and Kazancı 2015); listed from Turkey: Eastern Black Sea Basin (Türkmen and Kazancı 2013).

Comment. Occurrence of *E. macani* Thomas and Sowa in Turkey is probably doubtful and a re-examination of material would be advisable.

Ecdyonurus (*Ecdyonurus*) *ornatipennis* Tshernova, 1938

Distribution in Turkey. Muş (Braasch 1981); Amasya (Kazancı and Braasch 1988); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Ecdyonurus (*Ecdyonurus*) *russevi* Braasch & Soldán, 1985

Distribution in Turkey. Balıkesir (Kazancı 2001b); listed from Turkey: Kazancı and Türkmen (2012).

Comment. First larval description (and redescription of imaginal stages) was given by Godunko et al. (2015).

Ecdyonurus (*Ecdyonurus*) *submontanus* Landa, 1969

Distribution in Turkey. Ardahan (Kazancı 2009); listed from Turkey: Kazancı and Türkmen (2012).

Comment. Occurrence of *E. submontanus* Landa in Turkey rather questionable, a re-examination of voucher specimens would be advisable.

Ecdyonurus (*Ecdyonurus*) *starmachi* Sowa, 1971

Distribution in Turkey. Bolu (Kazancı and Türkmen 2008a); Bolu (Kazancı and Türkmen 2008b); Giresun, Rize, (Türkmen and Kazancı 2015); listed from Turkey: Kazancı and Türkmen (2012); Eastern Black Sea Basin (Türkmen and Kazancı 2013).

Ecdyonurus (*Ecdyonurus*) *venosus* (Fabricius, 1775)

Distribution in Turkey. Bolu, Bursa, Eskişehir, Kütahya (Tanatmış 1995); Çanakkale, Kırklareli, Tekirdağ (Tanatmış 1997); Balıkesir (Tanatmış 2000); Ankara, Çankırı, Eskişehir, Konya (Kazancı 2001b); Ankara (Kazancı and Girgin 2008); Bolu (Kazancı and Türkmen 2008a); Bolu (Kazancı and Türkmen 2008b); Erzincan (Kazancı 2009); listed from Turkey: Tanatmış (1999); Kazancı and Türkmen (2012).

Comment. Occurrence in Turkey rather doubtful, probably based on misidentification. A re-examination of voucher specimens would be advisable.

Subgenus *Helvetoraeticus* Bauernfeind & Soldán, 2012

Ecdyonurus (*Helvetoraeticus*) *helveticus* Eaton, 1883

Distribution in Turkey. Ankara, Bolu, Eskişehir (Kazancı 2001b); Bolu (Tanatmış 2004a); Düzce (Tanatmış 2007); Giresun, Rize (Türkmen and Kazancı 2015); Kütahya (Aydınlı and Ertorun 2015); listed from Turkey: Kazancı and Türkmen (2012); Eastern Black Sea Basin (Türkmen and Kazancı 2013).

Comment. Occurrence of the alpine taxon *E. helveticus* Eaton in Turkey is rather doubtful and most probably based on misidentification. A re-examination of material would be advisable.

Ecdyonurus (*Helvetoraeticus*) *picteti* (Meyer-Dür, 1864)

Distribution in Turkey. Giresun, Rize (Türkmen and Kazancı 2015); listed from Turkey: Eastern Black Sea Basin (Türkmen and Kazancı 2013).

Comment. Occurrence of the alpine taxon *E. picteti* (Meyer-Dür) in Turkey is rather doubtful and most probably based on misidentification. A re-examination of material would be advisable.

Genus *Electrogena* Zurwerra & Tomka, 1985

Electrogena affinis (Eaton, 1883)

Distribution in Turkey. Balıkesir (Türkmen and Özkan 2011); Giresun, Rize, Trabzon (Türkmen and Kazancı 2015); listed for Turkey: Eastern Black Sea Basin (Türkmen and Kazancı 2013).

Electrogena anatolica (Kazanci & Braasch, 1986)

Type country and locality. Turkey, Ardahan (Kazancı and Braasch 1986).

Distribution in Turkey. Ankara, Ardahan, Bingöl, Bolu, Kars (as *Ecdyonurus anatolicus*; Kazancı and Braasch 1986); Ankara, Ardahan, Erzurum, Hakkari (Kazancı 1990b); Ardahan, Kars (Kazancı 2001a); Kars (Kazancı 2009); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Note. Endemic to Turkey.

Comment. Larva not described.

***Electrogena antalyensis* (Braasch & Kazanci in Kazancı & Braasch, 1986)**

Type country and locality. Turkey, Burçak Village (the type locality is located in the province of Ankara) (Kazancı and Braasch 1986).

Material. Samsun, Sahinkaya, male imago, 6.6.1992, Malicky leg., 40°11'N, 25°46'E (NMW).

Distribution in Turkey. Ankara, Antalya, Çorum, Yozgat (as *Ecdyonurus antalyensis*; Kazancı and Braasch 1986); Ankara, Bolu (Kazancı 1990b); Ankara, Antalya, Eskişehir, Kütahya (Belfiore et al. 2000); Kırklareli (Kazancı 2001b); Kütahya (Tanatmış 2002); Bolu (Tanatmış 2004a); Manisa (Aydınlı and Ertorun 2015); listed from Turkey: Tanatmış (1999); Kazancı and Türkmen (2012).

Comment. For description of larva (and redescription of imaginal stages) see Belfiore et al. (2000).

***Electrogena boluensis* Kazanci, 1990b**

Type country and locality. Turkey, Bolu-Gerede road, 10 km to Gerede (the type locality is located in the province of Bolu) (Kazancı 1990b).

Distribution in Turkey. Bolu (Kazancı 1990b); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Note. Endemic to Turkey.

Comment. Larva not described.

***Electrogena dirmil* Kazanci, 1990b**

Type country and locality. Turkey, Dirmil Pass (the type locality is located in the district of Fethiye, the province of Muğla) (Kazancı 1990b).

Distribution in Turkey. Muğla (Kazancı 1990b); Muğla (Kazancı et al. 1992); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Note. Endemic to Turkey.

Comment. Larva not described.

***Electrogena hakkarica* (Kazanci, 1986b)**

Type country and locality. Turkey, Güzereş Köyü (Güzereş Köyü is a village and is located in the district of Çukurca, the province of Hakkari) (Kazancı 1986b).

Distribution in Turkey. Hakkari (as *Ecdyonurus hakkaricus*; Kazancı 1986b); Rize (Kazancı 2001b); listed from Turkey: Tanatmış (1999); Kazancı and Türkmen (2012).

Note. Endemic to Turkey.

Comment. Larva not described.

Electrogena lateralis (Curtis, 1834)

Distribution in Turkey. Ankara (as *Ecdyonurus lateralis*; Kazancı 1985a); Ankara, Bilecik, Bolu, Eskişehir, Kütahya (Tanatmış 1995); İstanbul, Kırklareli, Tekirdağ (Tanatmış 1997); Balıkesir, Bursa (Tanatmış 2000); Çorum, Yozgat (Kazancı 2001b); listed from Turkey: Tanatmış (1999); Kazancı and Türkmen (2012).

Electrogena monticola (Braasch, 1980)

Distribution in Turkey. Tunceli (Kazancı 1990b); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Comment. Originally as *Ecdyonurus monticolus*. Larva not described.

Electrogena necatii (Kazanci, 1987a)

Type country and locality. Turkey, Akyarma Pass (Akyarma Geçidi is a pass and is located between Bolu-Ankara Road; Kazancı 1987a).

Distribution in Turkey. Ankara, Bolu (as *Ecdyonurus necatii*; Kazancı 1987a); Ankara (Kazancı and Girgin 2008); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Note. Endemic to Turkey

Comment. Larva not described.

Electrogena pseudaffinis (Braasch, 1980)

Distribution in Turkey. Trabzon (as *Ecdyonurus pseudaffinis*; Kazancı and Braasch 1988); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Electrogena quadrilineata (Landa, 1969)

Distribution in Turkey. Giresun, Rize, Trabzon (Türkmen and Kazancı 2015); listed from Turkey: eastern Black Sea Basin (Türkmen and Kazancı 2013).

Comment. *Electrogena quadrilineata* has so far only been recorded from a few localities in Central Europe and occurrence in Turkey is rather questionable. For confusing taxa see Bauernfeind and Soldán (2012), a redescription from type material has been provided by Kłonowska-Olejnik (2004).

Electrogena ressli (Braasch, 1981)

Type country and locality. Turkey, Van Gölü (the type locality is located in the province of Muş) (Braasch 1981).

Distribution in Turkey. Muş (as *Ecdyonurus ressli*; Braasch 1981); Erzincan, Erzurum, Muş, Tunceli (Kazancı 2009); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Comment. Larva not described.

Genus *Afronurus* Lestage, 1924

Afronurus kugleri Demoulin, 1973

Material. Yalova, brook I Köseler, Koruköy, male subimago, 30.5.1992, H. Malicky leg., 38°50'N, / 27°14'E (NMW).

Distribution in Turkey. Hatay (Koch 1988); Ankara, Bingöl, Bolu, Elazığ, Muş (Kazancı and Braasch 1988); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Comment. Taxonomic position of palaearctic representatives of *Afronurus* (*A. kugleri*, *A. madli* and *A. zebratus*) remains uncertain and rather provisional (included in *Electrogena* by Kluge 2004, Phyl. Syst. Eph., 184), not considered in Webb and McCafferty 2008 (Can. J. Arthropod Identif. 7: 2-3). For generic placement in a new genus see Yanai et al. (2016).

Afronurus madli Kazanci, 1992

Type country and locality. Turkey, Karacadağ (the type locality is located in the province of Diyarbakır) (Kazancı 1992).

Distribution in Turkey. Diyarbakır (Kazancı 1992); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Comment. Larva not described. Taxonomic position of palaearctic representatives of *Afronurus* (*A. kugleri*, *A. madli* and *A. zebratus*) remains uncertain and rather provisional (included in *Electrogena* by Kluge 2004, Phyl. Syst. Eph., 184), not considered in Webb and McCafferty 2008 (Can. J. Arthropod Identif. 7: 2–3). For generic placement see Yanai et al. (2016).

Note. Endemic to Turkey.

Genus *Epeorus* Eaton, 1881
Subgenus *Caucasiron* Kluge, 1997

***Epeorus* (*Caucasiron*) *alpestris* (Braasch, 1979)**

Distribution in Turkey. Artvin, Kars (as *Iron alpestris*; Kazancı 1986a); Artvin, Kars (as *Iron alpestris*; Kazancı 2001a); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Comment. Taxonomy follows Kluge (1997a). Webb and McCafferty (2008, Can. J. Arthropod Ident. 7: 1-55) did not recognize subgenera or species-groups within *Epeorus*.

***Epeorus* (*Caucasiron*) *caucasicus* (Tshernova, 1938)**

Distribution in Turkey. Van (as *Iron caucasicus*; Braasch 1981); Artvin, Erzincan, Erzurum (Kazancı 1986a); Adıyaman (as *Iron caucasicus*; Koch 1988); Artvin, Erzincan, Erzurum (Kazancı 2001a); Erzincan, Erzurum, Hakkari, Tunceli (Kazancı 2009); Giresun, Gümüşhane, Rize, Trabzon (Türkmen and Kazancı 2015); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen 2012); Eastern Black Sea Basin (Türkmen and Kazancı 2013).

Comment. Taxonomy follows Kluge (1997a). *Cinygma caucasica* Tshernova, 1938 has been designated type species of the subgenus *Caucasiron* Kluge, 1997.

***Epeorus* (*Caucasiron*) *fuscus* (Sinitshenkova, 1976)**

Distribution in Turkey. Erzincan (Kazancı 2009).

***Epeorus* (*Caucasiron*) *longimaculatus* (Braasch, 1980)**

Distribution in Turkey. Bursa (as *Iron longimaculatus*; Kazancı and Braasch 1988); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

***Epeorus* (*Caucasiron*) *magnus* (Braasch, 1978)**

Distribution in Turkey. Rize (as *Iron magnus*; Kazancı 2009); listed from Turkey: Kazancı and Türkmen (2012).

***Epeorus* (*Caucasiron*) *nigripilosus* (Sinitshenkova, 1976)**

Distribution in Turkey. Hakkari (as *Iron nigripilosus*; Kazancı 2001b); Erzincan, Şırnak (Kazancı 2009); listed from Turkey: Kazancı and Türkmen (2012).

***Epeorus* (*Caucasiron*) *znojkoi* (Tshernova, 1938 [sub *Iron znojkoi*])**

Distribution in Turkey. Van (as *Iron znojkoi*; Braasch, 1981); Giresun, Rize, Trabzon (Türkmen and Kazancı 2015); listed from Turkey: Eastern Black Sea Basin (Türkmen and Kazancı 2013).

Comment. Not to be confused with *Ecdyonurus znojkoi* Tshernova, 1938 (presently placed in *Rhithrogena*). For the generic placement see Kluge (1997a: 233). *Epeorus znojkoi sensu* Braasch (1978; larva) nec Tshernova (1938) represents in fact *Epeorus zaitzevi* Tshernova, 1981 (see Sartori 1992).

Subgenus *Epeorus* Eaton, 1881

***Epeorus* (*Epeorus*) *assimilis* Eaton, 1885**

Distribution in Turkey. Kırklareli (as *Epeorus sylvicola*; Tanatmış 1997); Ankara (sub *Epeorus sylvicola*; Kazancı 2001b); Ankara (as *Epeorus sylvicola*; Kazancı and Girgin 2008); Giresun, Gümüşhane, Rize, Trabzon (as *Epeorus sylvicola*; Türkmen and Kazancı 2015); listed from Turkey: Tanatmış (1999); Kazancı and Türkmen (2012); Eastern Black Sea Basin (Türkmen and Kazancı 2013).

Comment. Frequently considered a junior subjective synonym of *Epeorus* (*Epeorus*) *sylvicola* (Pictet, 1865), but see Thomas et al. (1999: 85).

***Epeorus* (*Epeorus*) *zaitzevi* Tshernova, 1981**

Distribution in Turkey. Şanlıurfa (as *Epeorus zaitcevi* [injustified emendation (see Sartori 1992)]; Koch 1988); Ardahan, Bayburt, Erzurum, Hakkari (as *Epeorus zaitcevi* [injustified emendation (see Sartori 1992)]; Kazancı and Braasch 1988); Erzurum, Hakkari, Kars, Şırnak, Tunceli (Kazancı 2009); Giresun, Gümüşhane (Türkmen and Kazancı 2015); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012); Eastern Black Sea Basin (Türkmen and Kazancı 2013).

Comment. Larval characters of *Epeorus znojkoi sensu* Braasch (1978) refer in fact to *Epeorus* (*Epeorus*) *zaitzevi* Tshernova, 1981 (see Sartori 1992).

Subgenus *Ironopsis* Traver, 1935

***Epeorus* (*Ironopsis*) *alpicola* (Eaton, 1871)**

Distribution in Turkey. Bursa, Eskişehir, Kütahya (Tanatmış 1995); Kütahya (Tanatmış 2000); Kütahya (Tanatmış 2002); Sinop (Ertorun and Tanatmış 2004); Giresun, Rize, Trabzon (Türkmen and Kazancı 2015); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012); Eastern Black Sea Basin (Türkmen and Kazancı 2013).

Comment. Taxonomy follows Kluge (1997a). Braasch (2006) proposed the new subgenus *Alpiron* Braasch for the European representatives of the subgenus *Ironopsis* Traver. Occurrence in Turkey somewhat doubtful, a re-examination of voucher specimens would be advisable.

Genus *Rhithrogena* Eaton, 1881

***Rhithrogena amseli* (Demoulin, 1964) [sub *Epeiron*]**

Distribution in Turkey. Hakkari, Muş (Kazancı 2009); listed from Turkey: Kazancı and Türkmen (2012).

Comment. By most authors *Epeiron* Demoulin is currently considered to represent a junior synonym of *Rhithrogena* Eaton [cf. Kluge (1988: 304)]. Recently Kluge (2004: 195) reconsidered the generic status of *Epeiron*. Wang and McCafferty (2004) placed the taxon in the genus *Cinygmula* Mcdunnough, 1933. Occurrence in Turkey rather questionable, a re-examination of voucher specimens would be desirable.

***Rhithrogena anatolica* Kazancı, 1985b**

Type country and locality. Turkey, Kızılırmak River in Kırıkkale Province (Kazancı 1985b).

Distribution in Turkey. Erzurum, Kırıkkale, Siirt, Sivas (Kazancı 1985b); Erzurum (Kazancı 2001a); Ankara (Kazancı 2001b); listed from Turkey: Tanatmış (1999); Kazancı and Türkmen (2012).

Note. Endemic to Turkey.

Comment. Larva not described. Placed in *Epeiron* Demoulin 1964 by Kluge (2004).

***Rhithrogena beskidensis* Alba-Tercedor & Sowa, 1987**

Distribution in Turkey. Rize (Türkmen and Kazancı 2015); listed from Turkey: Eastern Black Sea Basin (Türkmen and Kazancı 2013).

Comment. So far considered to represent rather a west Palaearctic taxon, distribution on the Balkans and in Turkey probably questionable (Bauernfeind and Soldán 2012: 336).

Rhithrogena braaschi Jacob, 1974

Material. Elazığ, Soğukpınar, E-Anatolia, male imago, female imago, 4.6.1992, H. Malicky leg., 38°25'N, / 39°15'E (NMW).

Distribution in Turkey. Bolu (Kazancı and Braasch 1988); Bolu (Tanatmış 2004a); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Rhithrogena caucasica Braasch, 1979

Distribution in Turkey. Hakkari (Kazancı and Braasch 1988); Erzincan, Erzurum (Kazancı 2001a); Bingöl (Kazancı 2009); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Rhithrogena expectata Braasch, 1979

Distribution in Turkey. Erzurum (Kazancı and Braasch 1988); Erzurum (Kazancı 2001a); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Rhithrogena germanica Eaton, 1885

Distribution in Turkey. Giresun, Rize, Trabzon (Türkmen and Kazancı 2015); listed from Turkey: Eastern Black Sea Basin (Türkmen and Kazancı, 2013).

Comment. Larvae are very difficult to separate from several representatives of the *R. semicolorata* species-group and occurrence in Turkey probably doubtful (Bauernfeind and Soldán 2012: 344).

Rhithrogena iranica Braasch, 1983

Distribution in Turkey. Muş (Kazancı and Braasch 1988); Erzurum (Kazancı 2001a); Van (Kazancı 2009); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen, 2012).

Comment. Larva not described.

Rhithrogena iridina kownackorum Sowa & Zimmermann, 1975

Distribution in Turkey. Gümüşhane (Kazancı and Braasch 1988); Erzincan, Kars (Kazancı 2009); Giresun, Rize, Trabzon (as *Rhithrogena iridina*; Türkmen and Kazancı 2015); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012); Eastern Black Sea Basin (Türkmen and Kazancı, 2013).

Comment. Larvae are very difficult to separate from several representatives of the *R. semicolorata* species-group.

Rhithrogena loyolaea Navás, 1922

Distribution in Turkey. Artvin (Kazancı 1985a); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Comment. So far considered to represent a west-central Palaearctic taxon, distribution on the Balkans and in Turkey probably questionable (Bauernfeind and Soldán 2012: 368). For taxonomic characters see Kłonowska-Olejnik and Godunko (2003).

Rhithrogena pontica Sowa, Soldán & Kazanci, 1986

Type country and locality. Turkey, stream 30 km south of Tortum (the type locality is located in the district of Tortum, the province of Erzurum) (Sowa et al. 1986).

Distribution in Turkey. Erzurum (Sowa et al. 1986); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Note. Endemic to Turkey.

Comment. Larva not described.

Rhithrogena potamalis Braasch, 1979

Distribution in Turkey. Kahramanmaraş (Kazancı 1986a); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Comment. Imago not described.

Rhithrogena puytoraci Sowa & Degrange, 1987

Distribution in Turkey. Giresun, Rize, Trabzon (Türkmen and Kazancı 2015); listed from Turkey: Eastern Black Sea Basin (Türkmen and Kazancı 2013).

Comment. So far considered to represent rather a central Palaearctic taxon, distribution in Turkey is probably questionable (Bauernfeind and Soldán 2012: 378).

***Rhithrogena semicolorata* (Curtis, 1834)**

Distribution in Turkey. Bayburt, Çankırı (Kazancı 1985a); Bilecik, Bursa, Eskişehir (Tanatmış 1995); Kırklareli, Tekirdağ (Tanatmış 1997); Giresun, Rize, Trabzon (Türkmen and Kazancı 2015); Kütahya (Aydınlı and Ertorun 2015); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012); Eastern Black Sea Basin (Türkmen and Kazancı 2013).

***Rhithrogena sublineata* Kazanci & Braasch, 1988**

Type country and locality. Turkey, Otluca (Otluca is a village and is located in the province of Hakkari) (Kazancı and Braasch 1988).

Distribution in Turkey. Hakkari (Kazancı and Braasch 1988); listed from Turkey: Tanatmış (1999); Kazancı, (2001b); Kazancı and Türkmen (2012).

Note. Endemic to Turkey.

Comment. The taxon was described from a male subimago, larvae and imagines not known so far and generic placement doubtful.

***Rhithrogena tibialis* (Ulmer, 1920)**

Type country and locality. Turkey, Brussa [i.e. immediate surroundings of the city of Bursa (Mann 1864: 173)].

Distribution in Turkey. Bursa (as *Cinygma tibiale*; Ulmer 1920); Bursa (Tshernova and Belov 1982); Bolu, Erzurum, Hakkari (Kazancı and Braasch 1988); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Note. Endemic to Turkey.

Comment. Generic placement is not clear, placed in genus *Epeiron* Demoulin, 1964 by Kluge (2004). The 'paratype' in Museum Hamburg discussed by Tshernova and Belov (1982) represents in fact a syntype, two other syntypes in Natural History Museum Vienna. Larva is not known. The collector Josef Johann Mann (1804-1889) worked since 1837 in the k. k. Zoologisches Hofkabinett in Vienna.

***Rhithrogena theischingeri* Braasch, 1981**

Type country and locality. Turkey, Van Gölü (the type locality is the located in the district of the Tatvan, the province of Van) (Braasch 1981).

Distribution in Turkey. Van (Braasch 1981); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Note. Endemic to Turkey.

Comment. Larva not described.

Rhithrogena zelinkai Sowa & Soldán, 1984

Distribution in Turkey. Giresun, Rize, Trabzon (Türkmen and Kazancı 2015); listed from Turkey: Eastern Black Sea Basin (Türkmen and Kazancı, 2013).

Comment. So far considered to represent a central Palaearctic taxon, distribution in Turkey is probably questionable (Bauernfeind and Soldán 2012: 378). Imago was not described, for a detailed redescription of larva see Kłonowska-Olejnik and Godunko (2003).

Rhithrogena znojkoi (Tshernova, 1938) [sub *Ecdyonurus* ? *znojkoi*]

Distribution in Turkey. Erzurum (as *Epeiron znojkoi*; Braasch 1983b); Ardahan, Bayburt, Hakkari (as *Epeiron znojkoi;* Kazancı 1985a); Hatay (as *Rhithrogena znojkoi*; Koch 1988); Antalya, Ankara, Artvin, Bingöl, Erzincan, İçel, Kahramanmaraş, Tunceli (as *Rhithrogena znojkoi*; Kazancı and Braasch 1988); Erzincan, Hakkari, Şırnak (Kazancı 2009); listed from Turkey: Kazancı (2001b); Kazancı and Türkmen (2012).

Comment. Not to be confused with *Iron znojkoi* Tshernova, 1938 (presently placed in *Epeorus*). For the generic placement and redescriptions see Thomas and Dia (1982: 297) and Sartori and Sowa (1992: 32).

Genus *Heptagenia* Walsh, 1862
Subgenus *Dacnogenia* Kluge, 1988

Heptagenia (*Dacnogenia*) *coerulans* Rostock, 1878

Distribution in Turkey. Ankara (Kazancı 1986a); Şanlıurfa (Koch 1988); Balıkesir (Tanatmış 2000); Erzincan, Erzurum (Kazancı 2001a); Aydın, Çankırı, Yozgat (Kazancı 2001b); Balıkesir, Bursa (Tanatmış 2002); Balıkesir (Tanatmış 2005); Hakkari (Kazancı 2009); listed from Turkey: Tanatmış (1999); Kazancı and Türkmen (2012).

Comment. *Dacnogenia* Kluge, 1988 (originally proposed as a subgenus of *Heptagenia*) is considered of generic rank by various authors.

Heptagenia (*Dacnogenia*) *coerulans micracantha* Kluge, 1989

Distribution in Turkey. Zonguldak (as *Heptagenia coerulans*; Tanatmış 2004a); Karabük, Zonguldak (Tanatmış 2005); listed from Turkey: Kazancı and Türkmen (2012).

Subgenus *Heptagenia* Walsh, 1862

***Heptagenia* (*Heptagenia*) *longicauda* (Stephens, 1836)**

Distribution in Turkey. Eskişehir (Kazancı 1986a); Balıkesir (Tanatmış 2000); Ankara (Kazancı 2001b); Balıkesir, Bursa, Kütahya (Tanatmış 2002); Bolu, Karabük, Zonguldak (Tanatmış 2004a); Çanakkale (Narin and Tanatmış 2004); Sinop (Ertorun and Tanatmış 2004); listed from Turkey: Tanatmış (1999); Kazancı and Türkmen (2012).

***Heptagenia* (*Heptagenia*) *perflava* Brodsky, 1930**

Distribution in Turkey. Siirt (Kazancı 2009); listed from Turkey: Kazancı and Türkmen (2012).

Comment. Sometimes placed in the genus *Sigmoneuria* Demoulin, 1964, considered to represent a junior subjectiv synonym of *Sigmoneuria amseli* Demoulin, 1964 (see Kluge 1997b: 176). Sometimes confused with *Heptagenia samochai* Demoulin, 1973.

***Heptagenia* (*Heptagenia*) *sulphurea* (O.F. Müller, 1776)**

Distribution in Turkey. Eskişehir (Tanatmış 1995); Ankara, Muğla (Kazancı 2001b); listed from Turkey: Tanatmış (1999), Kazancı and Türkmen (2012).

Genus *Thalerosphyrus* Eaton, 1881

***Thalerosphyrus determinatus* (Walker, 1853)**

Distribution in Turkey. Ankara (as *Thalerosphyrus* (?); Demoulin 1965); Elazığ (Berker 1981); listed from Turkey: Kazancı (2001b), Kazancı and Türkmen (2012).

Comment. Usually considered to represent an exclusively Oriental taxon, occurrence in Turkey is rather unlikely. Association of imaginal stages are somewhat doubtful, for a redescription of larvae see Sartori (2014). A careful re-evaluation of Turkish records based on a re-examination of voucher specimens seems necessary.

Family LEPTOPHLEBIIDAE Banks, 1900
Genus *Calliarcys* Eaton, 1881

***Calliarcys van* Godunko & Bauernfeind in Godunko, Sroka, Soldán & Bojková, 2015**

Type country and locality. Turkey, Bitlis Province, Kavuşşahap Dağları mountain range, Pınarca Çayı [river] and its small unnamed right tributary above Kuşlu village, 38°22'32"N, 42°15'31"E, 1720 m a.s.l., about 20 km S of Tatvan town (western shore of the Van Lake) (Godunko et al. 2015).

Distribution in Turkey. Bitlis, İzmir (Godunko et al. 2015).

Note. Endemic to Turkey.

Genus *Choroterpes* Eaton, 1881

Subgenus *Choroterpes* Eaton, 1881

Comment. Frequently considered of generic rank (Kluge 2004; Barber-James et al. 2013).

***Choroterpes* (*Choroterpes*) *picteti* Eaton, 1871**

Distribution in Turkey. Ankara, Bingöl (Kazancı 1985a); Diyarbakır (Koch 1985); İstanbul (Tanatmış 1997); Balıkesir, Kütahya (Tanatmış 2000); Balıkesir, Bursa (Tanatmış 2002); Zonguldak (Tanatmış 2004a); Kastamonu, Sinop (Tanatmış 2004b); Balıkesir, Çanakkale (Narin and Tanatmış 2004); Sinop (Ertorun and Tanatmış 2004); Bartın (Tanatmış and Ertorun 2006); Düzce, Zonguldak (Tanatmış 2007); Ankara (Kazancı and Girgin 2008); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Subgenus *Euthraulus* Barnard, 1932

Comment. Frequently considered of generic rank (Kluge 2004; Barber-James et al. 2013).

***Choroterpes* (*Euthraulus*) *balcanica* (Ikonomov, 1961)**

Distribution in Turkey. Trakya (Kazancı 2001b); listed from Turkey: Kazancı and Türkmen (2012).

Comment. Imago not described.

Genus *Paraleptophlebia* Lestage, 1917

Comment. Sometimes considered to represent a subgenus of *Leptophlebia* (see Kluge 1997a).

***Paraleptophlebia submarginata* (Stephens, 1836)**

Distribution in Turkey. Erzincan (Kazancı 1986a); Eskişehir (Tanatmış 1995); Kırklareli (Tanatmış 1997); Balıkesir, Kütahya (Tanatmış 2000); Erzurum (Kazancı 2001a); Eskişehir, Muğla (Kazancı 2001b); Kütahya (Tanatmış 2002); Bolu, Kastamonu (Tanatmış 2004a); Kastamonu (Tanatmış 2004b); Bolu (Kazancı and Türkmen 2008a); Bolu (Kazancı and Türkmen 2008b); listed from Turkey: Tanatmış (1999); Kazancı and Türkmen (2012).

***Paraleptophlebia cincta* (Retzius, 1783)**

Material. İzmir, Kamberler, male subimago, female subimago, 21.5.1992, H. Malicky leg., 38°21'N, / 27°36'E (NMW).

Distribution in Turkey. Bolu (Kazancı and Türkmen 2008a); Bolu (Kazancı and Türkmen 2008b); listed from Turkey: Kazancı and Türkmen (2012).

***Paraleptophlebia werneri* Ulmer, 1920**

Distribution in Turkey. Edirne, İstanbul, Kırklareli, Tekirdağ (Tanatmış 1997); Eskişehir (Kazancı 2001b); Zonguldak (Tanatmış 2004a); Kastamonu (Tanatmış 2004b); Sinop (Ertorun and Tanatmış 2004); Sinop (Tanatmış and Ertorun 2008); Bolu (Kazancı and Türkmen 2008a); Bolu (Kazancı and Türkmen 2008b); Kütahya (Aydınlı and Ertorun 2015); listed from Turkey: Tanatmış (1999); Kazancı and Türkmen (2012).

Genus *Habroleptoides* Schoenemund, 1929

***Habroleptoides caucasica* Tshernova, 1931**

Distribution in Turkey. Bolu (Kazancı 2001b); listed from Turkey: Kazancı and Türkmen (2012).

Comment. Larvae is rather similar to *Habroleptoides pontica* Kluge, 1994 and other related taxa.

Habroleptoides confusa Sartori & Jacob, 1986

Distribution in Turkey. Bolu, Çankırı (as *Habroleptoides modesta* Hagen, 1864; Kazancı 1985a); Tekirdağ (Tanatmış 1997); Balıkesir (Tanatmış 2000); Kütahya (as *Habroleptoides confuse*; Tanatmış 2002); Bolu, Kastamonu (Tanatmış 2004a); Kastamonu, Sinop (Tanatmış 2004b); Bartın (Tanatmış and Ertorun 2006); Zonguldak (Tanatmış 2007); Sinop (Tanatmış and Ertorun 2008); Konya (Özyurt and Tanatmış 2011); Giresun, Rize, Trabzon (as *Habroleptoides confuse*; Türkmen and Kazancı 2015); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012); Eastern Black Sea Basin (Türkmen and Kazancı 2013).

Comment. Prior to the paper by Sartori and Jacob (1986) authors had confused *Habroleptoides modesta* Hagen, 1864 [endemic to Corsica and Sardinia] with central European taxa.

Habroleptoides kavron Kazancı & Türkmen, 2011

Type country and locality. Turkey The stream that is inflowing Büyük Deniz Lake (the type locality is located in the Kaçkar Mountains, Upper Kavron Highland, the province of Rize) (Kazancı and Türkmen 2011).

Distribution in Turkey. Rize (Kazancı and Türkmen 2011); listed from Turkey: Kazancı and Türkmen (2012).

Note. Endemic to Turkey.

Comment. Larva not described. Imagines very similar to *Habroleptoides confusa* Sartori and Jacob, 1986 and other related taxa, hardly separable without doubt.

Habroleptoides umbratilis Eaton, 1884

Distribution in Turkey. Bursa, Eskişehir, Kütahya (Tanatmış 1995); listed from Turkey: (Tanatmış 1999); Kazancı and Türkmen (2012).

Comment. Larva is similar to *Habroleptoides confusa* and related taxa; discriminating characters provided by Biancheri (1957) most probably insufficient for reliable separation.

Genus *Habrophlebia* Eaton, 1881

Habrophlebia fusca (Curtis, 1834)

Distribution in Turkey. Antalya, İçel (Puthz 1972); Artvin, Elazığ (Kazancı 1985a); İstanbul, Kırklareli (Tanatmış 1997); Artvin (Kazancı 2001a); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Comment. Occurrence in Turkey is rather questionable, probably based on misidentification or confused with mediterranean *Habrophlebia eldae* Jacob and Sartori, 1984.

Habrophlebia lauta Eaton, 1884

Distribution in Turkey. Ankara, Bolu, Giresun, Trabzon (Kazancı 1985a); Bursa, Eskişehir (Tanatmış 1995); İstanbul, Kırklareli, Tekirdağ (Tanatmış 1997); Kütahya (Tanatmış 2000); Çankırı (Kazancı 2001b); Bursa, Kütahya (Tanatmış 2002); Bolu, Kastamonu, Karabük, Zonguldak (Tanatmış 2004a); Kastamonu, Sinop (Tanatmış 2004b); Balıkesir (Narin and Tanatmış 2004); Sinop (Ertorun and Tanatmış 2004); Bartın (Tanatmış and Ertorun 2006); Düzce, Zonguldak (Tanatmış 2007); Bolu (Kazancı and Türkmen 2008a); Bolu (Kazancı and Türkmen 2008b); Sinop (Tanatmış and Ertorun 2008); Balıkesir (Türkmen and Özkan 2011); Afyon (Özyurt and Tanatmış 2011); Kütahya, Manisa (Aydınlı and Ertorun 2015); listed from Turkey: Tanatmış (1999); Kazancı and Türkmen (2012).

Genus *Thraulus* Eaton, 1881

Thraulus bellus Eaton, 1881

Distribution in Turkey. Sinop (Tanatmış 2004b); listed from Turkey: Kazancı and Türkmen (2012).

Comment. Occurrence in Turkey is rather questionable, probably based on misidentification (confusion with *T. thraker*).

Thraulus thraker Jacob, 1988

First record from Turkey. Material. Yalova, rivulet I Köseler, Koruköy, ♀SI, 38°50'N, 27°10'E, 200 m a.s.l., 30.5.1992, H. Malicky leg. (NMW).

Comment. Larva is not described. Imagines are rather similar to *T. bellus* Eaton, but easily separable by colouration of extreme wing roots (sooty black) and egg chorionic structures (figured in Bauernfeind and Soldán 2012).

Family EPHEMERIDAE Latreille, 1810
Genus *Ephemera* Linnaeus, 1758

Ephemera danica Müller, 1764

Distribution in Turkey. Bolu (Kazancı 1984); Bursa, Eskişehir, Kütahya (Tanatmış 1995); İstanbul, Kırklareli (Tanatmış 1997); Kütahya (Tanatmış 2000); Ankara, Balıkesir, Bolu

(Kazancı 2001b); Kütahya (Tanatmış 2002); Bolu (Tanatmış 2004a); Kastamonu (Tanatmış 2004b); Zonguldak (Tanatmış 2007); Ankara (Kazancı and Girgin 2008); Bolu (Kazancı and Türkmen 2008a); Bolu (Kazancı and Türkmen 2008b); Sinop (Tanatmış and Ertorun 2008); Balıkesir (Türkmen and Özkan 2011); Afyon, Konya (Özyurt and Tanatmış 2011); Giresun (Türkmen and Kazancı 2015); listed from Turkey: Tanatmış (1999); Kazancı and Türkmen (2012); Eastern Black Sea Basin (Türkmen and Kazancı 2013).

Ephemera glaucops Pictet, 1843

Distribution in Turkey. Eskişehir (Kazancı 2001b); listed from Turkey: Kazancı and Türkmen (2012).

Comment. Frequently placed in subgenus *Sinephemera* Kluge, 2004 which is especially well characterized in male imagines (shape of titillator).

Ephemera lineata Eaton, 1870

Distribution in Turkey. Bolu (Kazancı 2001b); listed from Turkey: Kazancı and Türkmen (2012).

Ephemera romantzovi Kluge, 1988

First record from Turkey. Material. İzmir, Kozak, W Anatolia, 39°17'N, 26°59'E, 250 m a.s.l., female imago, 31.5.1992, Malicky and Sipahiler leg., (NMW).

Ephemera vulgata Linnaeus, 1758

Distribution in Turkey. Muş (Braasch 1981); Bolu, Eskişehir (Kazancı 1984); Bolu, Bursa, Eskişehir, Kütahya (Tanatmış 1995); Balıkesir (Tanatmış 2000); Erzurum, Kars (Kazancı 2001a); Bolu, Denizli, Eskişehir (Kazancı 2001b); Bolu, Karabük, Zonguldak (Tanatmış 2004a); Kastamonu, Sinop (Tanatmış 2004b); Sinop (Ertorun and Tanatmış, 2004); Bartın (Tanatmış and Ertorun 2006); Düzce, Zonguldak (Tanatmış 2007); Bolu (Kazancı and Türkmen 2008a); Bolu (Kazancı and Türkmen 2008b); Hakkari, Kars (Kazancı 2009); Malatya (Aydınlı 2013); listed from Turkey: Tanatmış (1999); Kazancı and Türkmen (2012).

Ephemera zettana Kimmins, 1937

Distribution in Turkey. Kütahya (Kazancı 1986a); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Family PALINGENIIDAE Albarda in Selys-Longchamps, 1888
Genus *Palingenia* Burmeister, 1839

***Palingenia anatolica* Jacob, 1977**

Type country and locality. Turkey, immediate vicinity of Silifke, Göksu River (the type locality is located in the district of Silifke, the province of İçel) (Jacob 1977).
Distribution in Turkey. İçel (Jacob 1977); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Note. Endemic to Turkey.

Comment. Larva is not described.

Family POLYMITARCYIDAE Banks, 1900
Genus *Ephoron* Williamson, 1802

***Ephoron virgo* (Olivier, 1791)**

Distribution in Turkey. Bingöl (Kazancı 1984); Balıkesir, Bursa (Tanatmış 2000); Erzurum (Kazancı 2001a); Ankara (Kazancı 2001b); Balıkesir (Tanatmış 2002); Bolu, Karabük, Zonguldak (Tanatmış 2004a); Çanakkale (Narin and Tanatmış 2004); Sakarya (Kazancı 2013); Ardahan (Kazancı and Türkmen, 2015); listed from Turkey: Tanatmış (1999); Kazancı and Türkmen (2012).

Family POTAMANTHIDAE Albarda in Selys-Longchamps, 1888
Genus *Potamanthus* Pictet, 1843

***Potamanthus luteus* (Linné, 1767)**

Distribution in Turkey. Ankara, Bolu, Çankırı (Kazancı 1984); Ankara, Bolu, Bursa, Eskişehir, Kütahya (Tanatmış 1995); Edirne (Tanatmış 1997); Balıkesir, Bursa (Tanatmış 2000); Erzincan, Erzurum (Kazancı 2001a); Ankara, Aydın, Bolu, Çankırı, Denizli, Muğla (Kazancı 2001b); Balıkesir, Bursa, Kütahya (Tanatmış 2002); Bolu, Karabük, Zonguldak (Tanatmış 2004a); Kastamonu, Sinop (Tanatmış 2004b); Sinop (Ertorun and Tanatmış 2004); Bartın (Tanatmış and Ertorun 2006); Düzce, Zonguldak (Tanatmış 2007); Ankara (Kazancı and Girgin 2008); Bolu (Kazancı and Türkmen 2008a); Bolu (Kazancı and Türkmen 2008b); Sinop (Tanatmış and Ertorun 2008); Erzurum, Kars (Kazancı 2009); Malatya (Aydınlı 2013); Giresun (Türkmen and Kazancı 2015); listed from Turkey: Tanatmış (1999); Kazancı and Türkmen (2012); Eastern Black Sea Basin (Türkmen and Kazancı 2013).

Family EPHEMERELLIDAE Klapálek, 1909
Genus *Ephemerella* Walsh, 1862

***Ephemerella mucronata* (Bengtsson, 1909)**

Distribution in Turkey. Sivas (Kazancı, 2001b); listed from Turkey: Kazancı and Türkmen (2012).

***Ephemerella notata* Eaton, 1887**

Distribution in Turkey. Ankara, Bolu, Muğla (Kazancı 2001b); Tokat (Kazancı et al. 2012); listed from Turkey: Kazancı and Türkmen (2012).

***Ephemerella ignita* (Poda, 1761)**

Distribution in Turkey. Antalya, İzmir (Puthz 1972); Bolu (Braasch 1981); Ankara, Ardahan, Bingöl, Bolu, Erzincan, Erzurum, Kars, Muş, Sivas, Tunceli, Van (Kazancı 1984); Şanlıurfa (Koch 1988); Bilecik, Bolu, Bursa, Eskişehir, Kütahya (Tanatmış 1995); Çanakkale, İstanbul, Kırklareli Tekirdağ (Tanatmış 1997); Balıkesir, Kütahya (Tanatmış 2000); Erzincan, Erzurum (Kazancı 2001a); Aydın, Bilecik, Muğla (Kazancı 2001b); Balıkesir, Bursa, Kütahya (Tanatmış 2002); Konya (Kazancı et al. 2003); Bolu, Kastamonu, Karabük, Zonguldak (Tanatmış 2004a); Kastamonu, Sinop (Tanatmış 2004b); Balıkesir, Çanakkale (Narin and Tanatmış 2004); Sinop (Ertorun and Tanatmış 2004); Bartın (Tanatmış and Ertorun 2006); Düzce, Zonguldak (Tanatmış 2007); Ankara (Kazancı and Girgin 2008); Sinop (Tanatmış and Ertorun 2008); Bolu (Kazancı and Türkmen 2008b); Afyon (Özyurt and Tanatmış 2011); Malatya (Aydınlı 2013); Giresun, Rize, (Türkmen and Kazancı 2015); Kütahya, Manisa, Uşak (Aydınlı and Ertorun 2015); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012); Eastern Black Sea Basin (Türkmen and Kazancı 2013).

Comment. Placed in *Serratella* Edmunds, 1959 by some authors (e.g. Jacobus and McCafferty 2008) but generic concept for *Serratella* is in discussion.

***Ephemerella mesoleuca* (Brauer, 1857)**

Distribution in Turkey. Karabük (Tanatmış 2004a); listed from Turkey: Kazancı and Türkmen (2012).

Comment. Placed in *Teloganopsis* Ulmer, 1939 by Jacobus and McCafferty (2008) and Kluge (2004), but their concepts for *Teloganopsis* differ considerably (e.g., *sensu* Kluge restricted to the Oriental realm).

Genus *Drunella* Needham, 1905

***Drunella karia* Kazanci, 199**0

Type country and locality. Turkey, Çırpı Köyü (Çırpı Köyü is a village and is located in the province of Muğla (Kazancı 1990a).

Distribution in Turkey. Muğla (Kazancı 1990a); Antalya, Muğla (Kazancı 1991); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Note. Endemic to Turkey.

Comment. Placed in *Serratella* Edmunds, 1959 by some authors (e.g. Jacobus and McCafferty 2008) but generic concept for *Serratella* in discussion.

***Drunella euphratica* Kazanci, 1987**

Type country and locality. Turkey, Yuva Köyü (Yuva Köyü is a village and is located in the district of Kemaliye, the province of Erzincan) (Kazancı 1987b).

Distribution in Turkey. Erzincan, Hakkari, Malatya, Tunceli (Kazancı 1987b); Ardahan, Erzincan, Hakkari, Malatya, Tunceli (Kazancı 1991); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Note. Endemic to Turkey.

Comment. Placed in *Quatica* Jacobus and McCafferty, 2008 by some authors or in *Torleya* Lestage, 1917 following Kluge (2015). Concept for *Quatica* is still in discussion and probably polyphyletic.

Genus *Torleya* Lestage, 1917

***Torleya major* (Klapálek, 1905)**

Distribution in Turkey. Ankara, Bolu, Erzincan (Kazancı 1984); Bolu, Kırklareli (Kazancı 2001b); Ankara (Kazancı and Girgin 2008); Bolu (Kazancı and Türkmen 2008a); Bolu (Kazancı and Türkmen 2008b); Ardahan, Erzincan (Kazancı 2009); listed from Turkey: (Tanatmış (1999); Kazancı and Türkmen (2012).

Family CAENIDAE Newman, 1853
Genus *Brachycercus* Curtis, 1834

***Brachycercus harrisellus* Curtis, 1834**

Distribution in Turkey. Balıkesir (Tanatmış 2002); listed from Turkey: Kazancı and Türkmen (2012).

Genus *Caenis* Stephens, 1835

***Caenis horaria* (Linnaeus, 1758)**

Distribution in Turkey. Ankara (Kazancı 2001b); Bolu (Tanatmış 2004a); İzmir (Aydınlı and Ertorun 2015); listed from Turkey: Kazancı and Türkmen (2012).

***Caenis luctuosa* (Burmeister, 1839)**

Distribution in Turkey. Ankara, Bolu, Bursa, Eskişehir, Kütahya (Tanatmış 1995); Çanakkale, Edirne, İstanbul, Kırklareli, Tekirdağ (Tanatmış 1997); Muğla (Kazancı 1998a); Balıkesir, Bursa, Kütahya (Tanatmış 2000); Ankara (Kazancı 2001b); Balıkesir, Bursa (Tanatmış 2002); Ankara (Kazancı and Girgin 2008); Bolu (Kazancı and Türkmen 2008a); Bolu (Kazancı and Türkmen 2008b); Giresun (Türkmen and Kazancı 2015); listed from Turkey: Tanatmış (1999); Kazancı and Türkmen (2012); Eastern Black Sea Basin (Türkmen and Kazancı 2013).

***Caenis macrura* Stephens, 1836**

Distribution in Turkey. Kocaeli (Verrier 1955); Sivas (Koch 1985); Hatay, Şanlıurfa (Koch 1988); Erzincan, Erzurum (Kazancı 2001a); Ankara, Aydın, Eskişehir, Konya, Muğla (Kazancı 2001b); Balıkesir, Bursa, Kütahya (Tanatmış 2002); Bolu, Karabük, Kastamonu, Zonguldak (Tanatmış 2004a); Kastamonu, Sinop (Tanatmış 2004b); Balıkesir, Çanakkale (Narin and Tanatmış 2004); Sinop (Ertorun and Tanatmış 2004); Bartın (Tanatmış and Ertorun 2006); Düzce, Zonguldak (Tanatmış 2007); Sinop (Tanatmış and Ertorun 2008); Afyon, Konya (Özyurt and Tanatmış 2011); Tokat (Kazancı et al. 2012); Malatya (Aydınlı 2013); Giresun (Türkmen and Kazancı 2015); İzmir, Kütahya, Manisa, Uşak (Aydınlı and Ertorun 2015); listed from Turkey: Tanatmış (1999); Kazancı and Türkmen (2012) Eastern Black Sea Basin (Türkmen and Kazancı 2013).

Comment. Discrimination of larvae is frequently difficult. Two subspecies from the Mediterranean have been described by Malzacher (1986).

***Caenis martae* Belfiore, 1984**

Distribution in Turkey. Bolu (Kazancı and Türkmen 2008a); Bolu (Kazancı and Türkmen 2008b); Balıkesir (Türkmen and Özkan 2011); Giresun (Türkmen and Kazancı 2015); listed from Turkey: Kazancı and Türkmen (2012); Eastern Black Sea Basin (Türkmen and Kazancı 2013).

Comment. Discrimination of larvae is frequently difficult. For micrographs of discriminating characters see Bauernfeind and Lechthaler (2014).

***Caenis pseudorivulorum* Keffermüller, 1960**

Distribution in Turkey. Ankara (Kazancı 1986a); Zonguldak (Tanatmış 2007); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

***Caenis rivulorum* Eaton, 1884**

Distribution in Turkey. Elazığ (Berker 1981); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Kazancı and Türkmen (2012).

Comment. Correct identification of *Caenis* taxa in all stages has been greatly improved by Malzacher (1982, 1984, 1986). Earlier records remain usually doubtful and should be checked.

***Caenis robusta* Eaton, 1884**

Distribution in Turkey. Antalya, İzmir (Puthz 1972); Antalya (Malzacher 1986); Bursa (Tanatmış 2002); listed from Turkey: Tanatmış (1999); Kazancı and Türkmen (2012).

Family PROSOPISTOMATIDAE Laméere, 1917
Genus *Prosopistoma* Latreille, 1833

***Prosopistoma orhanelicum* Dalkiran, 2009**

Type country and locality. Turkey, Deliballılar site (Deliballılar is located in the district of Orhaneli in Orhaneli stream, the province of Bursa) (Dalkıran 2009).

Distribution in Turkey. Bursa (Dalkıran 2009); listed for Turkey: Kazancı and Türkmen (2012).

Note. Endemic to Turkey.

Comment. Differences between larvae of *P. orhanelicum* and *P. pennigerum* are, however, rather slight, and discrimination may sometimes be doubtful. Manifestations of morphological characters are age dependent (Dalkıran 2009; Schletterer et al. 2015), imagines of *P. orhanelicum* have not been described so far. Discriminating characters for east Palaearctic taxa (larvae) have been summarized by Bojková and Soldán (2015).

***Prosopistoma pennigerum* (O.F. Müller, 1785)**

Distribution in Turkey. Diyarbakır (sub *Prosopistoma foliaceum* (Fourcroy, 1785); Koch 1985); listed from Turkey: Tanatmış (1999); Kazancı (2001b); Dalkıran (2009); Kazancı and Türkmen (2012).

Comment. Differences between larvae of *P. orhanelicum* and *P. pennigerum* are, however, rather slight, and discrimination doubtful. Manifestations of morphological characters are age-dependent (Schletterer et al. 2015). Discriminating characters for east Palaearctic taxa (larvae) have been summarized by Bojková and Soldán (2015).

Ephemeroptera species excluded from the catalogue

Pseudocloeon inopinum Gillies 1949

Distribution in Turkey. Elazığ (Berker 1981); listed from Turkey: Tanatmış (1999).

Comment. Occurrence of this Oriental taxon in Turkey has most probably been based on misidentified material as already stated by Kazancı (2001b).

Pseudocloeon rubellum Navás, 1931

Distribution in Turkey. Elazığ (Berker 1981); listed from Turkey: Tanatmış (1999).

Comment. Occurrence of this Oriental taxon in Turkey has most probably been based on misidentified material as already stated by Kazancı (2001b).

Rhithrogena pellucida Daggy, 1945

Distribution in Turkey. Elazığ (Berker 1981).

Comment. Occurrence of this Nearctic taxon in Turkey has most probably been based on misidentified material as already stated by Kazancı (2001b).

Results

1. Ephemeroptera fauna of some provinces is remarkable and comparatively well-investigated, whereas some provinces have so far been not or insufficiently studied. Best known provinces are Ankara, Balıkesir Bartın, Bingöl, Bolu, Bursa, Çanakkale, Çankırı, Düzce, Erzincan, Erzurum, Eskişehir, Hakkari, Kars, Kastamonu, Karabük, Kırklareli, Kütahya, Muğla, Muş, Sinop, Tekirdağ, and Zonguldak provinces while Adana, Aksaray, Batman, Burdur, Gaziantep, Karaman, Kilis, Mardin, Niğde, Ordu there was not a single record observed. For faunistic research on Ephemeroptera, priority should be given to Adana, Aksaray, Batman, Burdur, Gaziantep, Karaman, Kilis, Mardin, Niğde, Ordu provinces.
2. Some taxa are known so far only from a single locality or from early records that are in need of updating and a careful re-examination based on modern taxonomic

standards. Additionally, it would be advisable to revise discriminating characters for some problematic taxa.

3. Areas which have endemic species and their protection status should eventually be reconsidered due to their expected high endemism ratio.

We hope, however, there will be young scientists who will critically evaluate the present data, confirm or correct taxonomically doubtful records, and complete the missing parts in the taxonomic and faunistic knowledge about Ephemeroptera in Turkey.

Turkish mayfly diversity

As shown in Table 1, the two most diversified families are the Heptageniidae (62 spp., 39.50% of total), followed by the Baetidae (42 spp., 26.75%). On the other hand, the highest level of endemism (12 spp., 50.00%) is in the Heptageniidae followed by the Oligoneuriidae (3 spp., 12.5%).

As shown in Table 2, the two most diversified genera in Turkey are *Baetis* (34 spp., 21.66%) and *Rhithrogena* (19 spp., 12.10%), followed by *Ecdyonurus* (13 spp., 8.28%). Concerning the level of endemism, *Electrogena* and *Rhithrogena* are also in first position (5 spp., 20.83%), followed by *Oligoneuriella* (3 spp., 12.5%). It has to be considered, however, that taxonomy of many taxa, especially of Heptageniidae, recorded from Turkey is but poorly understood at present.

Table 1. Diversity among the different families occurring in Turkey (Nb = number, % Total = % of total species number, % Fam. = % only within the family).

	Diversity		Endemism		
Family	**Nb**	**% Total**	**Nb**	**% Total**	**% Fam.**
Ameletidae	2	1.27	0	0	0
Siphlonuridae	3	1.91	1	4.17	33.33
Baetidae	42	26.75	2	8.33	4.76
Isonychiidae	1	0.64	0	0	0
Oligoneuriidae	7	4.46	3	12.5	42.86
Heptageniidae	62	39.50	12	50	19.35
Leptophlebiidae	14	8.92	2	8.33	14.28
Ephemeridae	6	3.82	0	0	0
Palingeniidae	1	0.64	1	4.17	100
Polymitarcyidae	1	0.64	0	0	0
Potamanthidae	1	0.64	0	0	0
Ephemerellidae	7	4.46	2	8.33	28.57
Caenidae	8	5.10	0	0	0
Prosopistomatidae	2	1.27	1	4.17	50
Total	**157**	**100**	**24**	**100**	

Table 2. Diversity among the different genera occurring in Turkey (Nb = number, % Total = % of total species number, % Genus = % only within the genus).

	Diversity		Endemism		
Genus	**Nb**	**% Total**	**Nb**	**% Total**	**% Genus**
Ameletus	1	0.64	0	0	0
Metreletus	1	0.64	0	0	0
Siphlonurus	3	1.91	1	4.17	33.33
Baetis	34	21.66	2	8.33	5.88
Centroptilum	1	0.64	0	0	0
Cloeon	2	1.27	0	0	0
Procloeon	4	2.55	0	0	0
Pseudocentroptiloides	1	0.64	0	0	0
Isonychia	1	0.64	0	0	0
Oligoneuriella	7	4.46	3	12.5	42.86
Ecdyonurus	13	8.28	1	4.17	7.69
Electrogena	12	7.64	5	20.83	41.66
Afronurus	2	1.27	1	4.17	50
Epeorus	10	6.37	0	0	0
Rhithrogena	19	12.10	5	20.83	26.31
Heptagenia	5	3.18	0	0	0
Thalerosphyrus	1	0.64	0	0	0
Calliarcys	1	0.64	1	4.17	100
Choroterpes	2	1.27	0	0	0
Paraleptophlebia	3	1.91	0	0	0
Habroleptoides	4	2.55	1	4.17	25.00
Habrophlebia	2	1.27	0	0	0
Thraulus	2	1.27	0	0	0
Ephemera	6	3.82	0	0	0
Palingenia	1	0.64	1	4.17	100
Ephoron	1	0.64	0	0	0
Potamanthus	1	0.64	0	0	0
Ephemerella	4	2.55	0	0	0
Drunella	2	1.27	2	8.33	100
Torleya	1	0.64	0	0	0
Brachycercus	1	0.64	0	0	0
Caenis	7	4.46	0	0	0
Prosopistoma	2	1.27	1	4.17	50
Total	**157**	**100**	**24**	**100**	

Endemic species

The endemic species are separated into two groups, those having a wide distribution in Anatolia (macro-endemic species) and those only occurring in a small mountainous massif or in a narrow part of the Taurus or Pontus (micro-endemic species). There are

seven macro-endemic species: *E. bimaculatus*, *E. anatolica*, *E. hakkarica*, *R. anatolica*, *R. tibialis*, *C. van*, and *D. euphratica* and 17 micro-endemic species: *S.muchei*, *B. elazigi*, *B. macrospinosus*, *O. magna*, *O. paulopilosa*, *O. pectinata*, *E. boluensis*, *E. dirmil*, *E. necatii*, *A. madli*, *R. pontica*, *R. sublineata*, *R. theischingeri*, *H. kavron*, *P. anatolica*, *D. karia*, and *P. orhanelicum.*

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Collembola of the genus *Protaphorura* Absolon, 1901 (Onychiuridae) in the Eastern Palearctic: morphology, distribution, identification key

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Abstract

Seven new species, *Protaphorura jernika* **sp. n.**, *Protaphorura abscondita* **sp. n.**, *Protaphorura tuvinica* **sp. n.**, *Protaphorura vasilinae* **sp. n.**, *Protaphorura sayanica* **sp. n.**, *Protaphorura oligopseudocellata* **sp. n.** and *Protaphorura nikolai* **sp. n.** from different habitats of the southern Siberia and Far East of Russia, are described. *Protaphorura ombrophila* (Stach, 1960) is redescribed based on the type specimens. These species differ one from other and from all known species by dorsal and ventral pseudocellar formulae, number of pseudocelli on subcoxae 1 of legs I–III, parapseudocellar formula, chaetotaxy of body, structure of claw, size of postantennal organ and body length. Geographical distribution of all known *Protaphorura* species of Eastern Palearctic was analysed and an identification key to 50 species was provided.

Keywords

Protaphorurini, taxonomy, chaetotaxy, new species, redescription, Siberia, Far East

Introduction

The genus *Protaphorura* Absolon, 1901, widespread throughout Holarctic, is the most diverse taxon with almost 140 species described to date (Bellinger et al. 2016, Parimuchová and Kováč 2016), forty three of which is known from the Eastern Palearctic (Martynova 1976, Pomorski and Kaprus' 2007, Kaprus' and Pomorski 2008, Kaprus' et al. 2014, Gulgenova and Potapov 2013, Sun, Wu and Gao 2013, Sun, Zhang and Wu 2013, Babenko and Kaprus' 2014, Sun, Chang and Wu 2015 etc.). The boundaries of the Eastern Palearctic region we determined conventionally from the Ural Mountains and Caspian Sea to Japan Islands and Bering Strait. Siberia, which occupies most of the Eastern Palearctic, continues to be one of the poorly studied geographical regions. The results of this study allow to discover seven new species of *Protaphorura*. Additionally, *Protaphorura ombrophila* (Stach, 1960) is redescribed from Afghanistan, using the type material deposited in the Institute of Systematics and Evolution of Animals, Polish Academy of Sciences in Kraków (Poland). The present paper aims to provide a critical evaluation of all known *Protaphorura* species of the Eastern Palearctic.

Material and methods

Material of *Protaphorura* species was collected by the soil samples method. Samples were extracted using Berlese–Tullgren funnels. Specimens of new species were collected by Dr. Sophya Stebaeva (Severtsov Institute of Ecology and Evolution, Russian Academy of Sciences, Moscow) in southern Siberia from 1972 to 1994, Dr. Elena Sleptsova (North eastern Federal University in Yakutsk, Russia) in the north eastern Altai in 2002 and Dr. Nikolay Ryabinin (Institute of Water and Ecological Problems, Far Eastern Branch of Russian Academy of Sciences, Khabarovsk) in the Far East of Russia in 2011. Specimens were mounted in Faure's medium, after clearing in lactophenol, and were studied using Olympus and Leica microscopes. Material is housed in the State Museum of Natural History, Ukrainian National Academy of Sciences, L'viv, Ukraine (**SNHM**), Institute of Systematics and Evolution of Animals, Polish Academy of Sciences, Kraków, Poland (**ISEA**) and Moscow Pedagogical State University, Russia (**MPSU**).

The studied type materials of *Protaphorura ombrophila* (Stach, 1960) are deposited in the Institute of Systematics and Evolution of Animals, Polish Academy of Sciences (Kraków).

Morphological terms. Labial types are named after Fjellberg (1999). Labium areas and chaetal nomenclature follow Massoud (1967) and D'Haese (2003). Tibiotarsal formula is presented after Deharveng (1983). Chaetae on furcal area are notated after Weiner (1996). Chaetae on anal valves are named following Yoshii (1996). Chaetae formula on thoracic tergum I is notated after Gisin (1952).

Abbreviations used in descriptions:

Abd. abdominal segments,
Ant. antennal segments,
AIIIO sensory organ of Ant. III,

AS anal spines,
pso pseudocellus,
ms s-microchaeta,
MVO male ventral organ,
PAO postantennal organ,
psp pseudopore,
psx parapseudocellus,
Th. thoracic segments,
VT ventral tube,
1^m single psx or psp in medial position.

Species descriptions

***Protaphorura abscondita* sp. n.**
http://zoobank.org/BC9EAE06-D98C-4A03-964D-2C6035DA71B6
Figs 1–9, 58

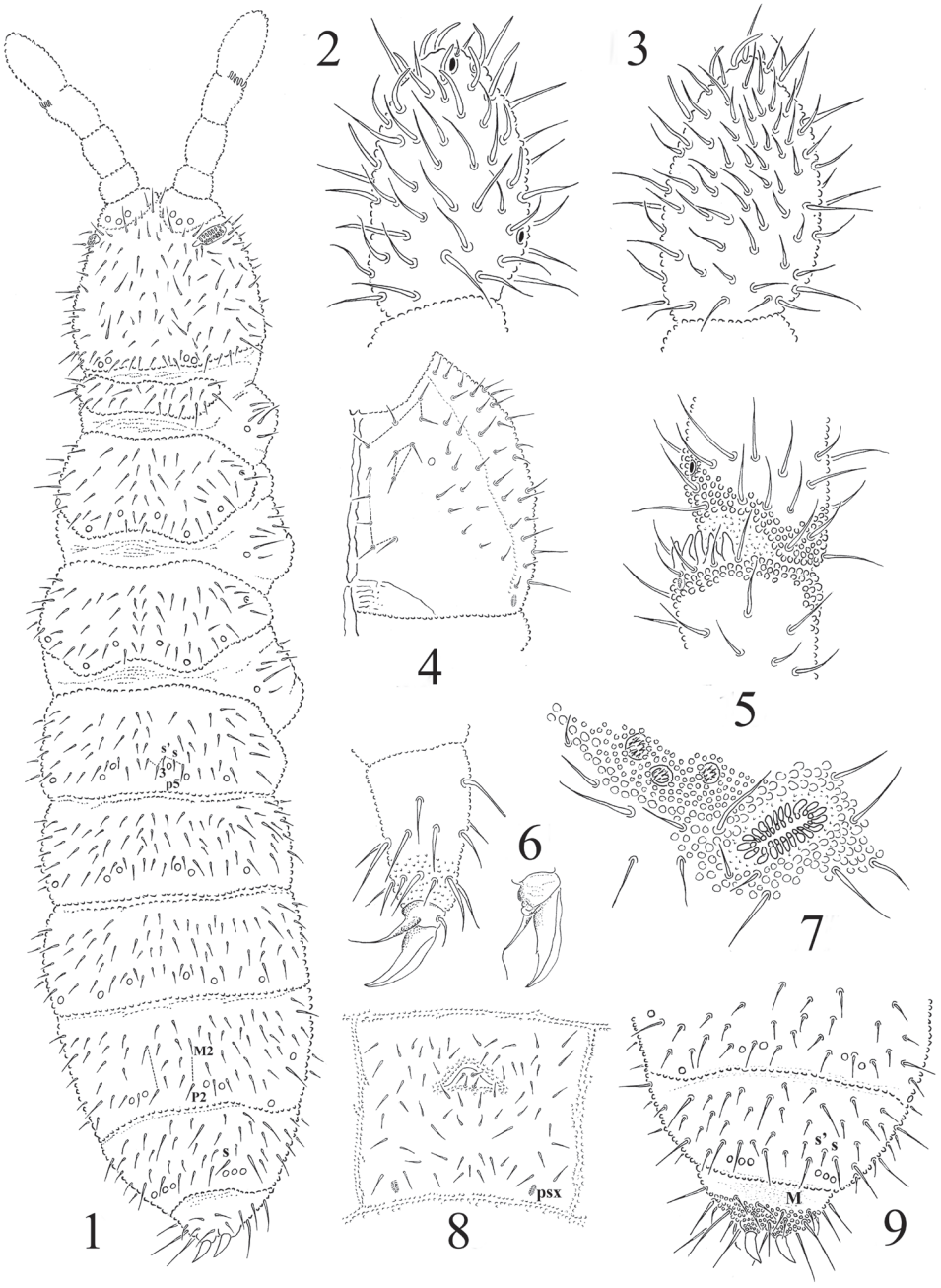
Type material. Holotype (female): Russia, Siberia, Krasnoyarsk Territory, Achinsk Province, 7 km from Nazarovo, steppe meadow, soil, ca 400 m alt., 57°02'N, 90°39'E, 14.VII.1987, leg. S.K. Stebaeva (SNHM). Paratypes: 8 males and 10 females, same data as holotype (SNHM – 7 paratypes: 1 male and 6 females, ISEA – 6 paratypes: 5 males and 1 female, MSPU – 5 paratypes: 2 males and 3 females).

Diagnosis. PAO with 20–23 simple vesicles. Pso formula dorsally 32/033/33343, ventrally 1/000/0000, subcoxae 1 of I–III legs with 1,1,1 pso respectively. Submedial pso a and b on Abd. terga I–II located close together. Psx formula on Abd. sterna: 111100. Th. tergum I with 12–15+12–15 chaetae, chaeta m present. Chaetae s' present on Abd. terga I–III. Manubrial field with 12 chaetae in 3 rows. Claw without lateral denticles.

Description. Holotype (female) length 1.2 mm, length of paratypes: 0.9–1.1 mm (males) and 1.0–1.3 mm (females). Shape of body typical of the genus: cylindrical with strong AS on distinct papillae (Fig. 1). Colour in alcohol yellowish-white. Granulation more or less uniform, distinct. Usually 10–11 grains around each pso.

Antennae approximately as long as head, their base well marked. Ant. I with 10–11 chaetae, Ant. II with 17–18 chaetae. AIIIO consisting of 5 guard chaetae, 5 papillae, 2 smooth sensory rods, 2 straight and granulated sensory clubs, ventro-lateral microsensillum present (Fig. 5). Ant. IV with subapical organite in unprotected cavity without clear cuticular papilla. Microsensillum on Ant. IV in usual position above second proximal row of chaetae (Fig. 2). Ventrally Ant. IV with numerous chaetae (ca. 58–65) (Fig. 3). Ant. IV with 9–11 well-differentiated sensilla (Fig. 2, 3).

PAO of small length with 20–23 simple vesicles (Fig. 7). Labral formula of chaetae: 4/342. Maxillary outer lobe with simple palp, basal chaeta and with two sublobal hairs. Labial palp of type A. Labium with 6 proximal, 4 basomedian (E, F, G, and f), and 6 basolateral chaetae (a, b, c, d, e, e'). Papillae A-E with 1, 4, 0, 3, 3 guard chaetae respectively.



Figures 1–9. *Protaphorura abscondita*: **1** habitus and dorsal chaetotaxy **2** dorsal side of Ant. IV **3** ventral side of Ant. IV **4** right part of head ventrally **5** AIIIO **6** tibiotarsal chaetotaxy and claw of leg III **7** PAO and anterior cephalic pseudocelli **8** chaetotaxy of Abd. sternum IV **9** chaetotaxy of Abd. terga IV-VI.

Pso formula dorsally 32/033/33343, ventrally 1/000/0000. Subcoxae 1 of I–III legs with one pso and one psx each. Submedial pso a and b on Abd. terga I–II located close together, i.e. closer than on Abd. tergum III, both set posteriorly to macrochaeta p5. Psx present on Abd. sterna I–IV (psx formula 0/000/111100). Psp formula dorsally 0/011/1111, ventrally $0/111/01^m1^m1^m$, coxae with 1 psp each.

Dorsal chaetotaxy rather symmetrical, as in Fig. 1, 4 and 9. Dorsal chaetae poorly differentiated into macrochaetae and microchaetae. Sensory chaetae s distinct on body. On head p2 chaetae on the same level as p1 and p3. Chaetae p6 on head located anterior to pso b. Th. tergum I with 12–15+12–15 chaetae, chaeta m present (chaetotaxy type i2–3m). Both Th. terga II and III with lateral microsensilla and with 5+5 or 6+6 axial microchaetae. Chaetae s' present on Abd. terga I–III, on Abd. tergum V present or absent. On Abd. tergum IV in axial area between M2 and P2 macrochaetae located 7– 8 chaetae, medial chaeta m0 present (rarely absent) (Fig. 1). Abd. tergum V usually with 1–2 unpaired microchaeta m0 and p0 (sometimes m0 absent) (Fig. 1). Abd. tergum VI with 1–2 medial chaetae a0 and m0 (often a0 absent). Relative position of prespinal microchaetae usually of subparallel type (Fig. 9). M/s ratio on Abd. tergum V as 10.5–11.4/9.0–9.5, (AS = 10). AS 1.2–1.3 times longer than inner edge of claw and 2.9–3.0 times longer than their basal diameter.

Chaetotaxy of ventral side of head as in Fig. 4. Perilabial area with 4+4 a-chaetae (Fig. 4). Postlabial chaetae 5+5 along ventral groove. Th. sterna I–III with 1+1, 2+2, 2+2 chaetae respectively. VT with ca. 7–9+7–9 chaetae, and 2 chaetae at base. Chaetotaxy of Abd. sternum IV as in Fig. 8. Furcal rudiment: cuticular fold (located near the middle of sternum) with 2+2 dental microchaetae in 2 rows. Chaetotaxy of manubrial field rather stable: 4 chaetae present in ma-row, 4 chaetae in mm-row and 4 chaetae in mp-row (Fig. 8). MVO absent. Each lateral anal valves with a0, 2a1 and 1-2a2; upper anal valve with chaetae a0, 2a2, 2b1, 2b2, c0, 2c1 and 2c2 (as in *P. jernika*, Fig. 58).

Subcoxae 1 of I, II and III legs with 5, 7, 6 chaetae, subcoxae 2 with 1, 5, 5, coxae with 3, 10, 14, trochanters with 11, 11, 10, femora with 17 each, tibiotarsi with four rows of chaetae (distal whorl (A+T)+B+C): 11+8+3, 11+8+3, 11+8+4 chaetae respectively. Claw with very small (rarely without) denticle in 1/2 of inner edge of claw (Fig. 6). Empodial appendage of same length as inner edge of claw, without basal lamella (Fig. 6).

Etymology. The name of the new species refers to the Latin *absconditus* (hidden, concealed).

Discussion. *P. abscondita* sp. n. is characterized by a unique formula of dorsal pso: 2+2 posterior cephalic pso, 3+3 pso on Th. terga II and III and Abd. tergum V. Among seven known species with 3+3 pso on Th. terga II and III, the new species is most similar to the siberian *P. tundricola* (Martynova, 1976), *P. submersa* Kaprus' & Pomorski, 2008 and *P. merita* Kaprus' & Pomorski, 2008 due to number of pso on Abd. terga. *P. abscondita* sp. n. differs from all these species by the 9-11 well differentiated sensilla on Ant. IV. Additionally, it differs from *P. merita* by the absence of cauliflower like papilla on the tip of antenna and 1+1 ventral pso in posterolateral position on head. From *P. submersa,* the new species differs by having 3 pso on the base of antennae (4(5) pso in *P. submersa*) and from *P. tundricola* by relative position of prespinal microchaetae on Abd.6 (distinctly convergent type in *P. tundricola* and subparallel type in *P. abscondita*).

***Protaphorura jernika* sp. n.**
http://zoobank.org/A4590F99-71B6-4923-8178-696819C5AD5F
Figs 10–17, 58

Type material. Holotype (female): Russia, N-E Altai, Turochak Region, Altyn-Tu Mt. Ridge, Archa Mt, mountain shrub tundra (=jernik tundra) with *Betula rotundifolia*, moss, 1700–1800 m alt., 51°31'N, 87 °27'E, 9.VIII.2002, leg. E.V. Sleptsova (ISEA). Paratypes: 2 males, same data as holotype (SNHM).

Diagnosis. PAO with 39–44 simple vesicles. Pso formula dorsally 32/033/33342, ventrally 2/000/0001, subcoxae 1 of I–III legs with 1,1,1 pso respectively. Submedial pso a and b on Abd. terga I–II located far from each other. Psx formula on Abd. sterna: 111000. Th. tergum I with 12–15+12–15 chaetae, chaeta m present. Chaetae s' absent on Abd. terga I–III and V. Manubrial field with 16–17 chaetae in 4 rows. Claw without lateral denticles.

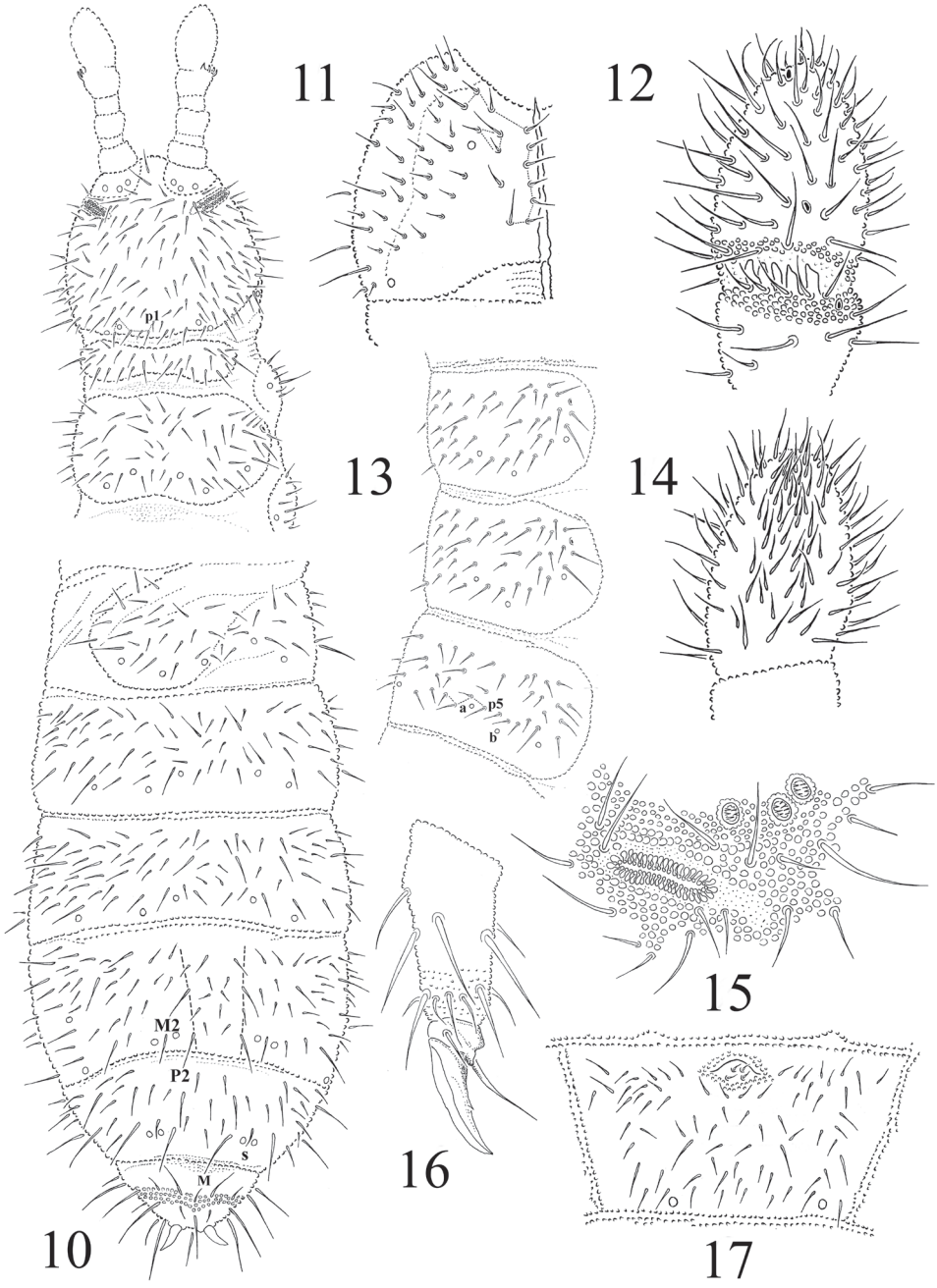
Description. Holotype (female) length 1.8 mm, length of paratypes: 1.4 mm (males). Shape of body typical for the genus: cylindrical with strong AS on distinct papillae (Fig. 10). Colour in alcohol yellowish-white. Granulation distinct, usually slightly coarser on head, Abd. tergum VI and around pso. Usually 9–11 grains around each pso.

Antennae slightly shorter than head, their base well marked. Ant. I with 10 chaetae, Ant. II with 18 chaetae. AIIIO consisting of 5 guard chaetae, 5 papillae, 2 smooth sensory rods, 2 straight and granulated sensory clubs, ventro-lateral microsensillum present (Fig. 12). Ant. IV with subapical organite in unprotected cavity without clear cuticular papilla. Microsensillum on Ant. IV in usual position on the level of second proximal row of chaetae. Ant. IV ventrally with very numerous chaetae (ca. 70–75) (Fig. 14). Sensilla indistinct on Ant. IV.

PAO of middle length with 39–44 simple vesicles (Fig. 15). Labral formula of chaetae: 4/342. Maxillary outer lobe with simple palp, basal chaeta and with two sublobal hairs. Labial palp of type A. Labium with 6 proximal, 4 basomedian (E, F, G, and f), and 6 basolateral chaetae (a, b, c, d, e, e'). Papillae A-E with 1, 4, 0, 3, 3 guard chaetae respectively.

Pso formula dorsally 32/033/33342, ventrally 2/000/0001 (Figs 10, 11, 13, 17). Subcoxae 1 of I–III legs with one pso and one psx each. Submedial pso a and b on Abd. terga I–II located far apart, i.e. on similar distance as on Abd. tergum III (Fig. 13). Psx present on Abd. sterna I–III (psx formula 0/000/111000). Psp formula dorsally 0/011/1111, ventrally $0/111/01^m1^m1^m$, coxae with 1 psp each.

Dorsal chaetotaxy, slightly asymmetrical and rather plurichaetotic, as in Figs 10 and 13. Dorsal chaetae rather well differentiated into macrochaetae and microchaetae. Sensory chaetae s indistinct on body. On head p1 chaetae are displaced forward in relation to p2–p4 (Fig. 10). Chaetae p6 on head located between pso a and b. Th. tergum I with 12–15+12–15 chaetae, chaeta m present (chaetotaxy type i2–3m). Both Th. terga II and III with lateral microsensilla and with 5+5 or 6+6 axial microchaetae. Chaetae



Figures 10–17. *Protaphorura jernika*: **10** habitus and dorsal chaetotaxy **11** left part of head ventrally **12** dorsal side of Ant. III–IV **13** chaetotaxy of Th. terga I-II aand Abd. tergum I **14** ventral side of Ant. IV **15** PAO and anterior cephalic pseudocelli **16** tibiotarsal chaetotaxy and claw of leg III **17** chaetotaxy of Abd. sternum IV.

s' absent on Abd. terga I–III and V. On Abd. tergum IV in axial area between M2 and P2 macrochaetae located 8–12 chaetae, medial chaeta m0 present (rarely absent) (Fig. 10). Abd. tergum V usually with 1–2 unpaired microchaeta m0 and p0 (sometimes m0 absent) (Fig. 10). Abd. tergum VI with 1–2 medial chaetae a0 and m0 (rarely a0 absent). Relative position of prespinal microchaetae usually of parallel type (Fig. 10). M/s ratio on Abd. tergum V as 13.6–17.6/5.6–6.9 (AS = 10). AS 1.1 times longer then inner edge of claw and 2.6 times longer then their basal diameter.

Chaetotaxy of ventral side of head as in Fig. 11. Perilabial area with 4+4 a-chaetae (Fig. 11). Postlabial chaetae 5-6+5-6 along ventral groove. Th. sterna I–III with 0+0, 1+1, 1+1 chaetae respectively. VT with ca. 8–9+8–10 chaetae and 1+2 chaetae at base. Furcal rudiment: cuticular fold (located on the anterior edge of sternum) with 2+2 dental microchaetae in 2 rows. Chaetotaxy of manubrial field: 4 chaetae present in ma-row, 4 chaetae in mm'-row, 4 chaetae in mm-row and 4–5 chaetae in mp-row (Fig. 17). MVO absent. Each lateral anal valves with a0, 2a1 and 2a2; upper anal valve with chaetae a0, 2a2, 2b1, 2b2, c0, 2c1 and 2c2 (Fig. 58).

Subcoxae 1 of I, II and III legs with 5–7, 6–8, 5–6 chaetae, subcoxae 2 with 1, 5, 5, coxae with 3, 8, 14, trochanters with 11, 11, 10, femora with 19 each, tibiotarsi with four rows of chaetae (distal whorl (A+T)+B+C): 11+8+3, 11+8+3, 11+8+4 chaetae respectively. Claw with strong denticle in 1/2 of inner edge of claw (Fig. 16). Empodial appendage of same length as inner edge of claw, without basal lamella (Fig. 16).

Etymology. The name of the new species refers to the Russian "jernik" (= shrub tundra or tundra with dwarf birch).

Discussion. *Protaphorura jernika* sp. n. belongs to the group of *Protaphorura* species with pseudocelli on subcoxa 1 of all legs and 2+2 pso ventrally on head. By the presence of 1+1 pso on Abd. sternum IV, the new species is similar to the *P. vasilinae* sp. n. Both species differ only in the formula of dorsal pso and ventral psx on Abd. sterna: the former has 32/033/33342 pso and 111000 psx whereas the latter 32/022/33332 pso and 110001^{m} psx (see also diagnosis of *P. vasilinae* sp. n.). *P. jernika* sp. n. differs from other two Eastern Palearctic representatives of this group, *P. merita* Kaprus' & Pomorski, 2008 and *P. buryatica* Gulgenova & Potapov, 2013 by dorsal pso formula (32/033/33342 in the new species vs 32(3)/012/33342 in *buryatica* and 43/02(3)2(3)/3335(4,6)3(4) in *merita*), by the presence of 1+1 pso on abd. sternum IV in the new species and lack in the both other, by the number of vesicles in PAO (39-44 in the new species, 12-13 in *buryatica* and 16-22 in *buryatica*).

Protaphorura nikolai sp. n.

http://zoobank.org/AA913DC8-EE15-44C5-AD7E-5092B2F8F207
Figs 18–25, 58

Type material. Holotype (male): Russia, Primorsky Krai, Khasansky district, Barabash village, mixed forest with *Quercus*, *Acer* and *Juglans*, in soil and leave litter, 9.VII.2011,

leg. N.A. Ryabinin (SNHM). Paratypes: 6 males and 6 females, same data as holotype (SNHM – 9 paratypes: 5 male and 4 females, ISEA – 3 paratypes: 1 male and 2 females).

Diagnosis. PAO with 29–36 simple vesicles. Pso formula dorsally 33/022/33342, ventrally 1/000/0000, subcoxae 1 of I–III legs with 1,0,0 pso respectively. Submedial pso a and b on Abd. terga I–II located close together. Psx formula on Abd. sterna: 100000. Th. tergum I with 11–12+11–12 chaetae, chaeta m present. Chaetae s' absent on Abd. terga I–III and V. Manubrial field with 14–15 chaetae in 3 rows. Claw without lateral denticles.

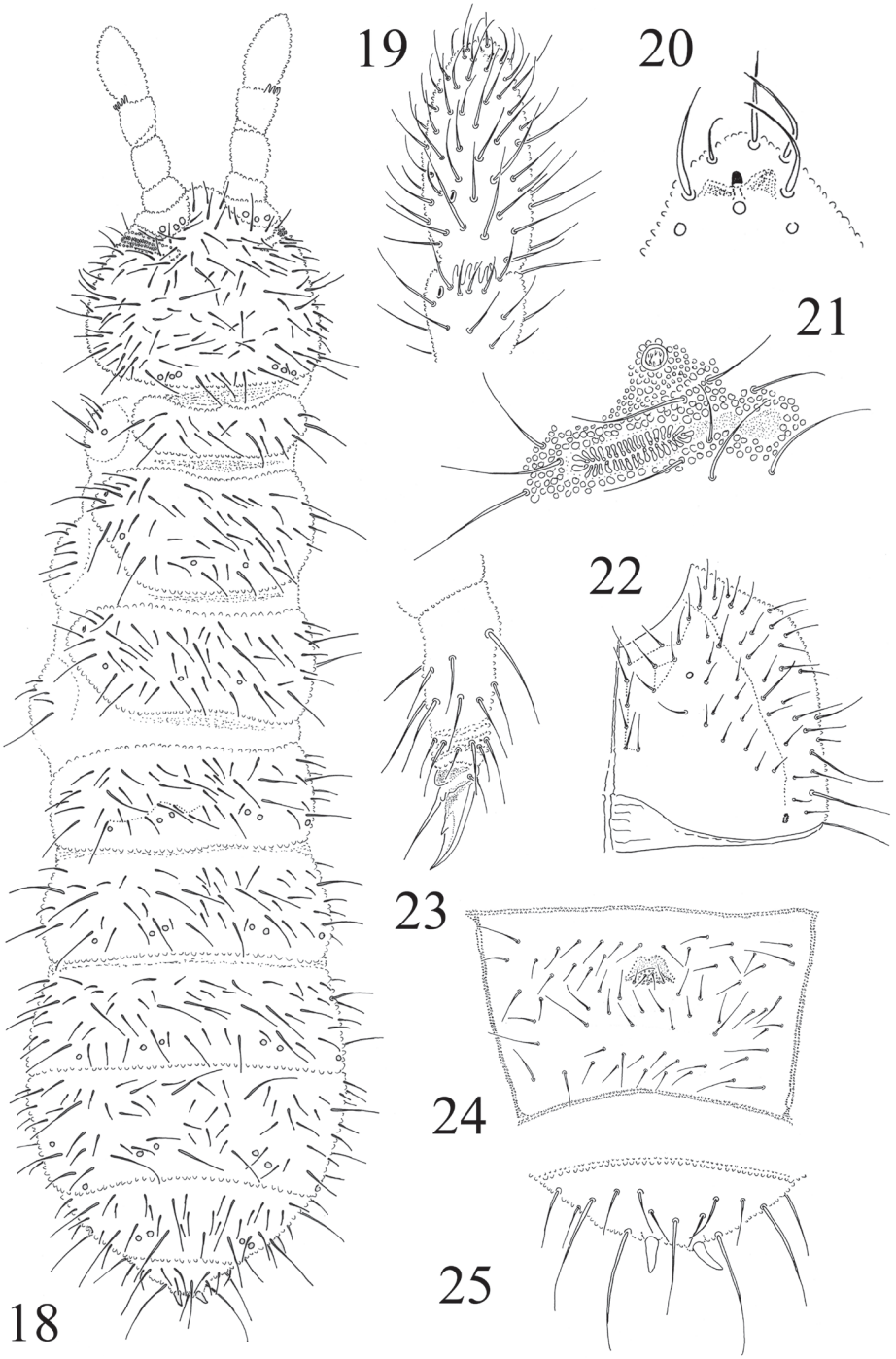
Description. Holotype (male) length 1.5 mm, length of paratypes: 1.45–1.55 mm (males) and 1.58–1.72 mm (females). Shape of body typical for the genus: cylindrical with strong AS on distinct papillae (Fig. 18). Colour in alcohol yellowish-white. Granulation more or less uniform, distinct. Usually 12–14 grains around each pso.

Antennae approximately as long as head, their base well marked. Ant. I with 11–12 chaetae, Ant. II with 17–18 chaetae. AIIIO consisting of 5 guard chaetae, 5 papillae, 2 smooth sensory rods, 2 straight and granulated sensory clubs, ventro-lateral microsensillum present (Fig. 19). Ant. IV with subapical organite in cavity protected by cuticular papillae (Fig. 20). Microsensillum on Ant. IV situated on level or below of second proximal row of chaetae. Ventrally Ant. IV with numerous chaetae (ca. 68–72). Ant. IV without differentiated sensilla (Fig. 19).

PAO is relatively small with 29–36 simple vesicles (Fig. 21). Labral formula of chaetae: 4/342. Maxillary outer lobe with simple palp, basal chaeta and with two sublobal hairs. Labial palp of type A. Labium with 7 proximal, 4 basomedian (E, F, G, and f), and 6 basolateral chaetae (a, b, c, d, e, e'). Papillae A-E with 1, 4, 0, 3, 3 guard chaetae respectively.

Pso formula dorsally 33/022/33342, ventrally 1/000/0000 (Figs 18, 22, 24). Subcoxae1 of legs I, II and III with 1,0,0 pso respectively. Psx on subcoxae1 of legs I, II and III absent. Submedial pso a and b on Abd. terga I–II located close together, i.e. much closer than on Abd. tergum III, both set posteriorly to macrochaeta p5 (Fig. 18). Ventral psx formula 1/000/100000). Psp formula dorsally 0/011/1111, ventrally $0/111/01^{m}1^{m}1^{m}$, coxae with 1 psp each.

Dorsal chaetotaxy slightly asymmerical, chaetae well differentiated into macrochaetae, mesochaetae and microchaetae as in Fig. 18. Sensory chaetae s indistinct on body. On head p2 chaetae on same level as p1 and p3. Chaetae p6 on head located anterior to pso b (Fig. 18). Th. tergum I with 11–12+11–12 chaetae, chaeta m present (chaetotaxy type i2–3m). Both Th. terga II and III with lateral microsensilla and with 4+4 or 5+5 axial microchaetae. Chaetae s' absent on Abd. terga I–III and V. On Abd. tergum IV in axial area between M2 and P2 macrochaetae located 9–11 chaetae, medial chaeta m0 present or absent, p0 present or absent (Fig. 18). Abd. tergum V usually with 1 unpaired microchaeta p0 (m0 absent) (Fig. 18). Abd. tergum VI with 1 medial chaetae m0. Relative position of prespinal microchaetae of distinctly divergent type (Fig. 25). M/s ratio on Abd. tergum V as 33–40/20–22, (AS = 10). AS 0.6–0.7 times as long as inner edge of claw and 2.0 times longer than their basal diameter.



Figures 18–25. *Protaphorura nikolai*: **18** habitus and dorsal chaetotaxy **19** dorsal side of Ant. III–IV **20** tip of Ant. IV **21** PAO and anterior cephalic pseudocelli **22** right part of head ventrally **23** tibiotarsal chaetotaxy and claw of leg III **24** chaetotaxy of Abd. sternum IV **25** chaetotaxy of Abd. tergum VI.

Chaetotaxy of ventral side of head as in Fig. 22. Perilabial area with 4+4 a-chaetae. Postlabial chaetae 5+5 along ventral groove. Th. sterna I–III with 1+1, 2+2, 2+2 chaetae respectively. VT with ca. 8–9+8–9 chaetae, and 2(1)+2(1) chaetae at base. Chaetotaxy of Abd. sternum IV as in Fig. 22. Furcal rudiment: cuticular fold (located near the middle of sternum) with 2+2 dental microchaetae in 2 rows. Chaetotaxy of manubrial field: 4 chaetae present in ma-row, 6-7 chaetae in mm-row and 4 chaetae in mp-row (Fig. 24). MVO absent. Each lateral anal valves with a0, 2a1 and 2a2; upper anal valve with chaetae a0, 2a2, 2b1, 2b2, c0, 2c1 and 2c2 (as in *P. jernika*, Fig. 58).

Subcoxae 1 of I, II and III legs with 5–6, 6–7 and 5–6 chaetae respectively, subcoxae 2 with 1, 5, 5, coxae with 3, 11, 13, trochanters with 11, 11, 10, femora with 21, 21, 18, tibiotarsi with four rows of chaetae (distal whorl (A+T)+B+C): 11+8+4, 11+8+4, 11+8+4–5 chaetae respectively. Claw with very strong denticle in the 1/2 of inner edge of claw (Fig. 23). Empodial appendage 0,9–1,0 times as long as inner edge of claw, without basal lamella (Fig. 23).

Etymology. The species is cordially dedicated to Russian oribatologist Dr. Nikolay Ryabinin, who collected the type material of new species in Primorsky Krai of Russia.

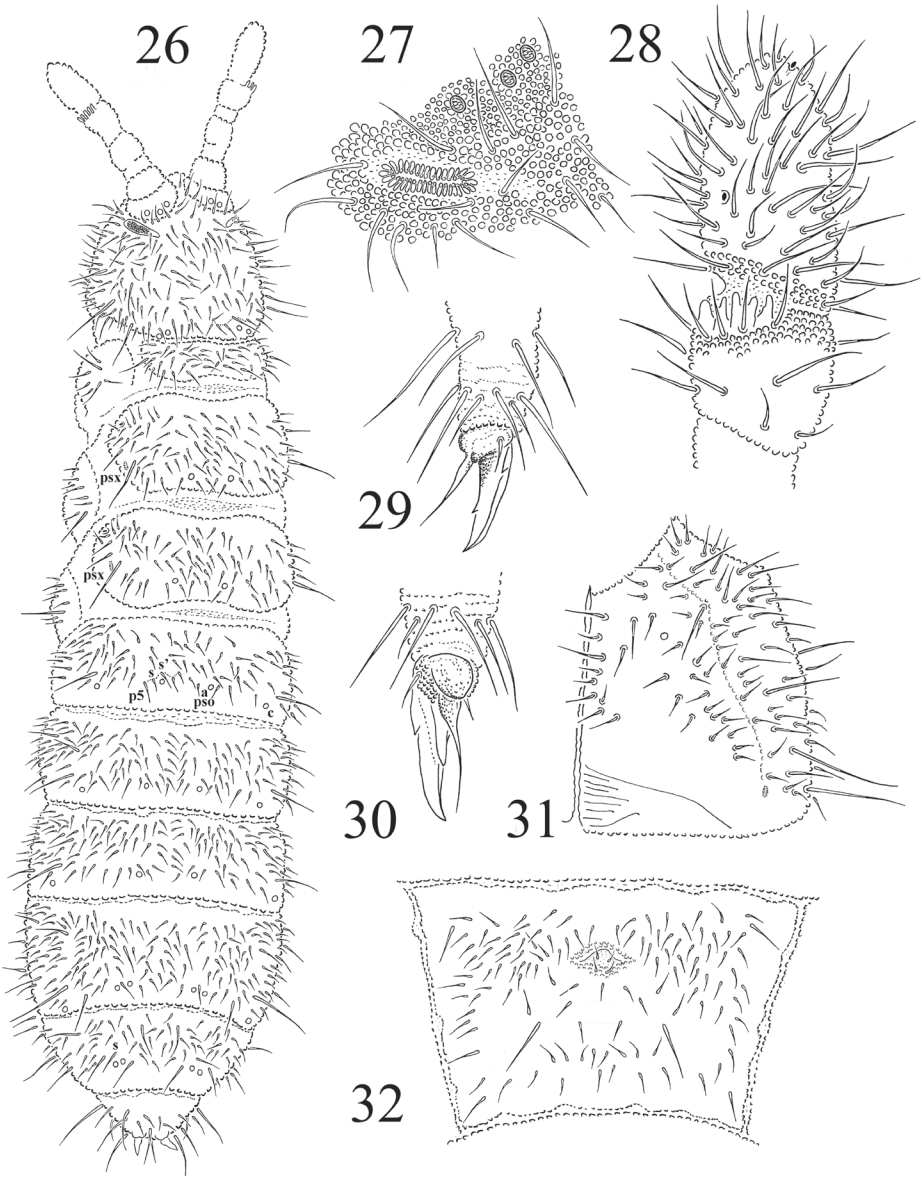
Discussion. *Protaphorura nikolai* sp. n. belongs to the group of *Protaphorura* species with 1,0,0 pseudocelli on subcoxa 1 of I, II and III legs and 1+1 pso on head ventrally. Among Asiatic species this group includes *P. zori* (Martynova, 1975 in Martynova & Chelnokov, 1975)(although Martynova did not mention subcoxal pso, the examined by us type has 1,0,0 pso on subcoxae), *P. brevispinata* (Yosii, 1966), *P. changbaiensis* Sun, Zhang & Wu, 2013, *P. mongolica* (Martynova, 1975 in Martynova & Chelnokov, 1975), *P. sakatoi* (Yosii, 1966) and *P. maoerensis* Sun, Wu & Gao, 2013. Within this group, it shares dorsal pso formula with *P. zori* but differs from the latter by the presence of inner denticle on claw, the absence of chaeta a0 on Abd. tergum VI (in *P. zori* inner denticle absent and chaeta a0 present) and by arrangement of prespinal chaetae (placed divergently in *P. nikolai* and convergently in *P. zori*). Perhaps there are other differences in the morphology of these two species, but *P. zori* is not well described and needs more detailed study.

***Protaphorura oligopseudocellata* sp. n.**

http://zoobank.org/3FC95D7C-4065-4C63-989F-FBD2B1635E9F
Figs 26–32, 58

Type material. Holotype (female): Russia, Siberia, Western Sayan, Oiskii Mt. Range, vicinity of weather station Olenya Rechka, mountain tundra with *Betula rotundifolia*, *Salix* sp, *Sphagnum* sp., 1800 m alt., in moss and soil, 52°48'N, 93°13'E, 27.VI.1990, leg. S.K. Stebaeva (SNHM). Paratypes: 3 females and juvenile, same data as holotype (ISEA – 1 paratype, MSPU – 1 paratype and juvenile).

Diagnosis. PAO with 32–34 simple vesicles. Pso formula dorsally 32/011/22232, ventrally 1/000/0000, subcoxae 1 of I–III legs without pso. Psx formula on Abd. sterna: 111000. Th. tergum I with 23–25+23–25 chaetae, one, two or three chaetae m present.



Figures 26–32. *Protaphorura oligopseudocellata*: **26** habitus and dorsal chaetotaxy **27** PAO and anterior cephalic pseudocelli **28** dorsal side of Ant. III-IV **29** and **30** distal part of leg III **31** right part of head ventrally **32** chaetotaxy of Abd. sternum IV.

Chaetae s' present on Abd. terga I–III and absent or present on Abd. tergum V. Manubrial field with 12–13 chaetae in three rows. Claw with pair of lateral denticles.

Description. Holotype (female) length 2.2 mm, length of paratypes: 2.0–2.3 mm (females). Shape of body typical of the genus: cylindrical with strong AS on distinct pa-

pillae (Fig. 26). Colour in alcohol yellowish-white. Granulation more or less uniform, distinct. Usually 7–10 grains around each pso.

Antennae as long as the head, their base well marked. Ant. I with 11–12 chaetae, Ant. II with 18 chaetae. AIIIO consisting of 5 guard chaetae, 5 papillae, 2 smooth sensory rods, 2 straight and granulated sensory clubs, ventro-lateral microsensillum present (Fig. 28). Ant. IV with subapical organite in unprotected cavity without clear cuticular papilla. Microsensillum on Ant. IV in usual position above second proximal row of chaetae. Ventrally Ant. IV with numerous chaetae (ca. 74–78). Sensilla indistinct on antennal segment IV (Fig. 28).

PAO relatively small, consisting of 32-34 simple vesicles (Fig. 27). Labral formula of chaetae: 4/342. Maxillary outer lobe with simple palp, basal chaeta and with two sublobal hairs. Labial palp of type A. Labium with 7 proximal, 4 basomedian (E, F, G, and f), and 6 basolateral chaetae (a, b, c, d, e, e'). Papillae A-E with 1, 4, 0, 3, 3 guard chaetae respectively.

Pso formula dorsally 32/011/22232, ventrally 1/000/0000 (Figs 26, 31, 32). Subcoxae 1 of I–III legs without pso and with one psx each. Psx formula 1/000/111000. Th. terga II and III with 1+1, 1+1 psx in lateral position (Fig. 26). Psp formula dorsally 0/011/1111, ventrally $0/111/01^m1^m1^m$, coxae with 1 psp.

Dorsal chaetotaxy plurichaetotic, usually with some asymmetry, all dorsal chaetae rather short (except macrochaetae), well differentiated into macro- meso- and microchaetae, as in Fig. 26. Sensory chaetae s indistinct on body. On head p2 chaetae are displaced forward in relation to p1 and p3. Chaetae p6 on head located anterior to pseudocelli b (Fig. 26). Th. tergum I with 23–25+23–25 chaetae, 1–3 chaetae m and 1–2 chaetae i present (chaetotaxy type i(1–2)3–4m(1–3)). Both Th. terga II and III with lateral microsensilla and with 6+6 or 7+7 axial microchaetae. Chaetae s' present on Abd. terga I–III and absent or present on Abd. tergum V (Fig. 26). On Abd. tergum IV in axial area between M2 and P2 macrochaetae located 23–24 chaetae, medial chaetae p0 and m0 present (sometimes these chaetae absent). Abd. tergum V with one unpaired microchaeta p0 (Fig. 26). Abd. tergum VI with medial chaetae m0. Relative position of prespinal microchaetae of convergent type (Fig. 26). M/s ratio on Abd. tergum V as 23.5–23.9/15 (AS = 10). AS 0.7–0.8 times as long as inner edge of claw and 2.3 times longer than their basal diameter.

Chaetotaxy of ventral side of head as in Fig. 31. Perilabial area with 4–5+4–5 achaetae. Postlabial chaetae 4-5+4-5 along ventral groove. Thoracic sterna I–III with 1+1, 2–3+2–3, 2–3+2–3 chaetae respectively. VT with ca. 10+10 chaetae, and 2–3 chaetae at base. Chaetotaxy of Abd. sternum IV as in Fig. 32. Furcal rudiment: cuticular fold (located near the middle of sternum) with 2+2 dental microchaetae in 2 rows. Chaetotaxy of manubrial field: 4–5 chaetae present in ma-row, 4 chaetae in mm-row, 4 chaetae in mp-row (in adult specimens) (Fig. 32). Each lateral anal valves with a0, 2a1 and 2a2; upper anal valve with chaetae a0, 2a2, 2b1, 2b2, c0, 2c1 and 2c2 (as in *P. jernika*, Fig. 58).

Subcoxae 1 of I, II and III legs with 6–8, 7–8, 7–9 chaetae, subcoxae 2 with 1, 5, 5, coxae with 4, 10, 15, trochanters with 13, 15, 15, femora with 21, 23, 22–23,

tibiotarsi with four rows of chaetae (distal whorl (A+T)+B+C): 11+8+3–4, 11+8+5–6, 11+8+5 chaetae respectively. Claw with strong denticle in 1/2 of inner edge of claw and pair of lateral denticles (Figs 29, 30). Empodial appendage 0.9 times as long as inner edge of claw, without basal lamella (Fig. 29).

Etymology. The name of the new species refers to the Latin *oligo* (a few) and *pseudocellus* (false ocellus) − characteristic structure in Onychiuroidea.

Discussion. *Protaphorura oligopseudocellata* sp. n. is characterized by the reduced number of pso on body dorsally – 32/011/22232. Only four species with 1+1 pso on Th. tergum III is currently known: *P. januarii* (Weiner, 1977), *P. stiriaca* (Stach, 1946), *P. pseudostyriaca* (Loksa, 1964) and *P. pseudarmata* (Folsom, 1917). The first three species are described from Europe and the last one from North America. Among these species *P. oligopseudocellata* sp. n. is probably the most similar to *P. januarii* and *P. stiriaca* due to the absence of pso on subcoxa 1 of all legs and some similarity of dorsal pso formulae. The new species can be easily distinguished from these species by the number of pso on Abd. terga I–V (22232 in *P. oligopseudocellata* sp. n., 23232 in *P. januarii* and 33232 in *P. stiriaca*), the plurichaetotic chaetotaxy and by the presence of strong lateral denticles on claws and 1+1 pso on head ventrally (lateral denticles and pso absent in *P. januarii* and *P. stiriaca*).

Protaphorura ombrophila (Stach, 1960)

Figs 33–36, 59

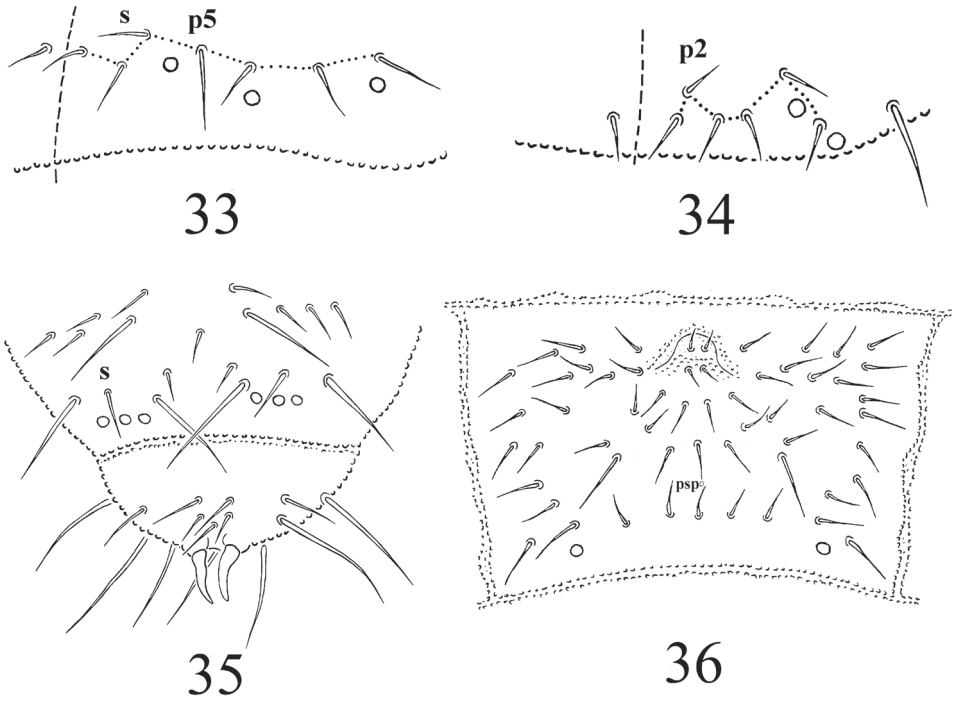
Onychiurus ombrophilus Stach, 1960: 509 – 514, pl. LXV

Type material. Lectotype (female) (by present designation): Afghanistan, "Tchehel Sotoun" Cave near Jalrayz, W Kabul, with the original label: "Tchehel Sotoun-Höhle (nahe Djalrez), 20.III.1959", leg. Dr. K. Lindberg. Paralectotypes: 1 male and 8 females, same data as lectotype.

Redescription. Lectotype (female) length 1.9 mm, length of paralectotypes: 1.8 mm (male) and 1.8–2.2 mm (females). Shape of body typical of the genus: cylindrical with strong AS on distinct papillae. Colour in alcohol white. Granulation more or less uniform, distinct. Usually 11–13 grains around each pso.

Antennae slightly shorter than head, their base well marked. Ant. I with 10 chaetae, Ant. II with 16–18 chaetae. AIIIO consisting of 5 guard chaetae, 5 papillae, 2 smooth sensory rods, 2 straight and granulated sensory clubs, ventro-lateral microsensillum present. Ant. IV with subapical organite in unprotected cavity without clear cuticular papilla. Microsensillum on Ant. IV in usual position above second proximal row of chaetae. Sensilla indistinct on Ant. IV.

PAO of middle length, consisting of 24–38 simple vesicles. Labral formula of chaetae: 4/342. Maxillary outer lobe with simple palp, basal chaeta and with two sublobal hairs. Labial palp of type A. Chaetotaxy of labium invisible.



Figures 33–36. *Protaphorura ombrophila*: **33** position of pso and p-chaetae in midsection of Abd. tergum I **34** position of p-chaetae on posterior margin of head **35** chaetotaxy of Abd. terga V–VI **36** chaetotaxy of Abd. sternum IV.

Pso formula dorsally 32/022(3)/33(2)3(2)43, ventrally 2/000/0001 (Figs 33–36). Subcoxae 1 of I–III legs without pso. Submedial pseudocelli a and b on Abd. terga I–II located far apart, i.e. on similar distance as on Abd. tergum III (Fig. 33). Psx formula 0/000/11?00?.

Dorsal chaetotaxy rather symmetrical. Dorsal chaetae well differentiated into macrochaetae and microchaetae. On head p2 chaetae are displaced forward in relation to p1 and p3 (Fig. 34). Chaetae p6 on head located between pseudocelli a and b. Th. tergum I with 8–10+8–10 chaetae, chaeta m absent (chaetotaxy type i2-). Both Th. terga II and III with lateral microsensilla. Chaetae s' absent on Abd. terga I–III and V (Fig. 35). On Abd. tergum IV in axial area between M2 and P2 macrochaetae located 6–7 chaetae, medial chaeta m0 present. Abd. tergum V usually with 1 unpaired microchaeta m0 (p0 absent) (Fig. 35). Abd. tergum VI with 1 medial chaetae m0. Relative position of prespinal microchaetae usually divergent or parallel type (Fig. 35). M/s ratio on Abd. tergum V as 18.2/8.8 (AS = 10). AS 0.8–0.9 times as long as inner edge of claw and 2.8-3.4 times longer then their basal diameter.

Perilabial area with 4+4 a-chaetae. Th. sterna I–III without chaetae. VT with ca. 8–9+8–9 chaetae, and 1 chaetae at base. Furcal rudiment: cuticular fold (located on

the anterior edge of the sternum) with 2+2 dental microchaetae in 2 rows. Chaetotaxy of manubrial field: 4 chaetae present in ma-row, 2 chaetae in mm' -row, 4 chaetae in mm-row and 5 chaetae in mp-row (Fig. 36). MVO absent. Each lateral anal valves with a0 and 2a1 (a2 absent); upper anal valve with chaetae a0, 2a2, 2b1, 2b2, c0, 2c1 and 2c2 (as in *P. vasilinae*, Fig. 59).

Subcoxae 1 of I, II and III legs with 5, 6, 5–6 chaetae, tibiotarsi with four rows of chaetae (distal whorl (A+T)+B+C): 11+8+3, 11+8+3, 11+8+4 chaetae respectively. Claw with very small denticle in 1/2 of inner edge of claw. Empodial appendage 0.7–0.8 times as long as inner edge of claw, without basal lamella.

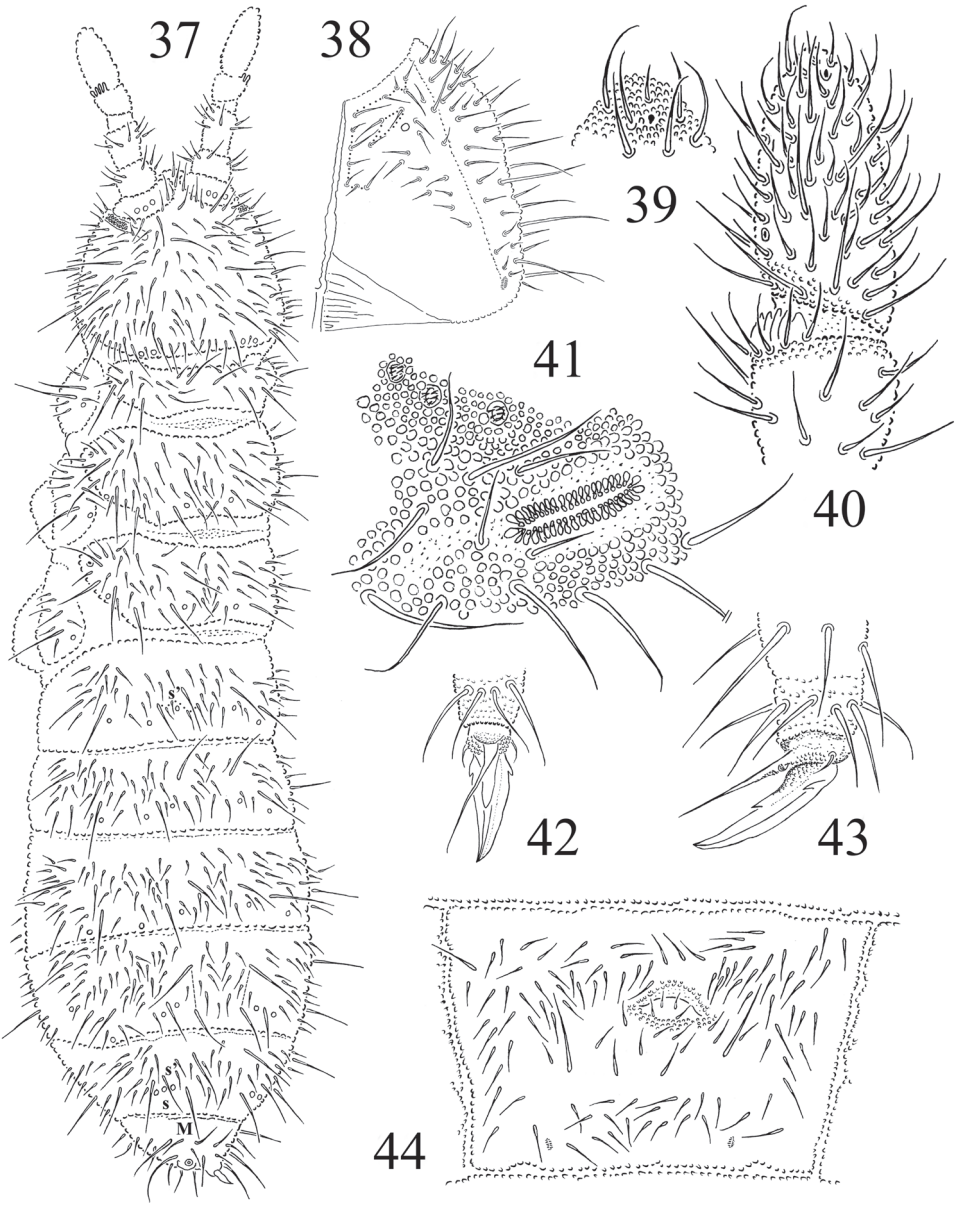
Remarks. *Protaphorura ombrophila* has been described by Stach (1960) from Afghanistan about 55 years ago, when many important diagnostic characters remained unknown. Latter Yosii (1966), during his research on some Collembola of Afghanistan, India and Ceylon, discovered three females of the species in Afghanistan and wrote: "They (i.e. *P. ombrophila*) coincide fairly well with the detailed description of Stach. However, the posterior margin of head has 3+3, 3+2 and 2+2 pseudocelli. In other respects no difference is to be found". Parimuchová and Kováč in their recent publication (2016) devoted to the critical analysis of Palearctic species of the genus *Protaphorura* and assigned this species to the group "species dubia". Here we present first redescription of *P. ombrophila* based on characters currently used in taxonomy of *Protaphorura.* See also the discussion in *P. tuvinica* sp. n.

***Protaphorura sayanica* sp. n.**

http://zoobank.org/6F4A0F37-3673-4C0F-BB2D-95B05B6799E2
Figs 37–44, 58

Type material. Holotype (male): Russia, Siberia, Western Sayan, Oiskii Mt. Range, vicinity of weather station Olenya Rechka, mountain tundra, 1800 m alt., in moss and soil, 52°48'N, 93°13'E, 10.VII.1990, leg. S.K. Stebaeva (SNHM). Paratypes: 2 females and 2 juveniles, same data as holotype (SNHM – 1 paratype female, ISEA – 1 paratype female and 2 juveniles); 2 females: Russia, Krasnoyarsk Territory, Khakasia, Kuznetskii Alatau Mt. Range, ca 5 km NW of settl. Kommunar, mountain tundra with *Dryas oxyodontha*, 1500 m alt., 54°20'N, 89°17'E, 24.VII.1990, leg. S.K. Stebaeva (ISEA); 2 males, female and 2 juveniles: Russia, Kuznetskii Alatau Mt. Range, Kemerovo Prov., 10 km NW of Mezhdurechensk, mixed taiga with rich herbaceous cover, under *Abies sibirica*, soil, 500-600 m alt., 53°45'N, 88°00'E, 1.VII.1982, leg. S.K. Stebaeva (SNHM); male: Russia, Salair Range, 130 km SE of Novosibirsk, 11 km N of Mirnyi, chern forest, 500 m alt., soil, 54°38'N, 84°45'E, 7.VI.1972, leg. S.K. Stebaeva (MPSU); female subadult: Russia, West Siberia, 25 km S of Novosibirsk, Akademgorodok, glade in birch forest, soil, 400 m alt., 54°49'N, 83°08'E, 7.X.1994, leg. S.K. Stebaeva (SNHM).

Diagnosis. PAO with 41–48 simple vesicles. Pso formula dorsally 32/022/33343, ventrally 1/000/0000, subcoxae 1 of I–III legs with 1,1,1 pso respectively. Submedial



Figures 37–44. *Protaphorura sayanica*: **37** habitus and dorsal chaetotaxy **38** right part of head ventrally **39** tip of Ant. IV **40** dorsal side of Ant. III-IV **41** PAO and anterior cephalic pseudocelli **42** and **43** distal part of leg III **44** chaetotaxy of Abd. sternum IV.

pso a and b on Abd. terga I–II located far apart. Psx formula on Abd. sterna: 111101^{m}. Th. tergum I with 18–21+18–21 chaetae, one or two chaetae m present. Chaetae s' present on Abd. terga I–III and V. Manubrial field with 14 chaetae in three rows. Claw with pair of lateral denticles.

Description. Holotype (male) length 2.7 mm, length of paratypes: 2.7–2.9 mm (females). Other specimens length: 2.6-2.7 mm males and 2.8 mm female. Shape of body typical of the genus: cylindrical with strong AS on distinct papillae (Fig. 37). Colour in alcohol yellowish-white. Granulation more or less uniform, distinct. Usually 7–9 grains around each pso.

Antennae as long as the head, their base well marked. Ant. I with 11 chaetae, Ant. II with 16–19 chaetae. AIIIO consisting of 5 guard chaetae, 5 papillae, 2 smooth sensory rods, 2 straight and granulated sensory clubs, ventro-lateral microsensillum present (Fig. 40). Ant. IV with subapical organite in unprotected cavity without clear cuticular papilla (Fig. 39). Microsensillum on Ant. IV in usual position above second proximal row of chaetae. Ventrally Ant. IV with numerous chaetae (ca. 65–70) (Fig. 40). Sensilla indistinct on Ant. IV (Fig. 40).

PAO large, consisting of 41–48 simple vesicles (Fig. 41). Labral formula of chaetae: 4/342. Maxillary outer lobe with simple palp, basal chaeta and with two sublobal hairs. Labial palp of type A. Labium with 7 proximal, 4 basomedian (E, F, G, and f), and 6 basolateral chaetae (a, b, c, d, e, e'). Papillae A-E with 1, 4, 0, 3, 3 guard chaetae respectively.

Pso formula dorsally 32/022/33343, ventrally 1/000/0000 (Figs 37, 38, 44). Subcoxae 1 of I–III legs with one pso and one psx each. Submedial pso a and b on Abd. terga I–II located far apart, i.e. on similar distance as on Abd. tergum III (Fig. 37). Psx formula 1/000/111101^{m}. Psp formula dorsally 0/011/1111, ventrally 0/111/01^{m}1^{m}1^{m}, coxae with 1 psp each.

Dorsal chaetotaxy, usually slightly asymmetrical, all dorsal chaetae rather long, well differentiated into macro- meso- and microchaetae, as in Fig. 37. Sensory chaetae s indistinct on body. On head p2 chaetae on the same level as p1 and p3. Chaetae p6 located anterior to pso b on head (Fig. 37). Th. tergum I with 18–21+18–21 chaetae, 1–2 chaetae m and 1–2 chaetae i present (chaetotaxy type i(1–2)2–4m(1–2)). Both Th. terga II and III with lateral microsensilla and with 5+5 or 6+6 axial microchaetae. Chaetae s' present on Abd. terga I–III and V. On Abd. tergum IV in axial area between M2 and P2 macrochaetae located 15–18 chaetae, medial chaeta p0 present (sometimes p0 absent). Abd. tergum V with one unpaired microchaeta p0 (Fig. 37). Abd. tergum VI with medial chaetae m0. Relative position of prespinal microchaetae of convergent type (Fig. 37). M/s ratio on abdominal tergum V as 18.9–26.6/15.7–20.6 (AS = 10). AS 0.8–1.1 times as long as inner edge of claw and 2.9 times longer than their basal diameter.

Chaetotaxy of ventral side of head as in Fig. 38. Perilabial area with 5(4)+5(4) achaetae. Postlabial chaetae 4-5+4-5 along ventral groove. Th. sterna I–III with 1–2+1–2, 2–3+2–3, 2–3+2–3 chaetae respectively. VT with ca. 11–12+11–12 chaetae, and 2–3 chaetae at base. Furcal rudiment: cuticular fold (located near middle of sternum) with 2+2 dental microchaetae in 2 rows. Chaetotaxy of manubrial field: 4 chaetae present in ma-row, 6 chaetae in mm-row, 4 chaetae in mp-row (in adult specimens) (Fig. 44). MVO absent. Each lateral anal valves with a0, 2a1 and 2a2; upper anal valve with chaetae a0, 2a2, 2b1, 2b2, c0, 2c1 and 2c2 (as in *P. jernika*, Fig. 58).

Subcoxae 1 of I, II and III legs with 7–9, 8–9, 7–8 chaetae, subcoxae 2 with 1, 5, 5, coxae with 4, 10, 12-15, trochanters with 11, 13, 13, femora with 20–21, 20–23, 20–23, tibiotarsi with four rows of chaetae (distal whorl (A+T)+B+C): 11+8+3, 11+8+4–5, 11+8+4–5 chaetae respectively. Claw with strong denticle in 1/2 of inner edge of claw and pair of lateral denticles (Figs 42, 43). Empodial appendage as long as the claw, without basal lamella. (Fig. 43).

Etymology. The name of the new species refers to the Sayan Mountains in Southern Siberia, an area where the type specimens were collected.

Discussion. *Protaphorura sayanica* sp. n. is probably the most similar to such Asiatic *Protaphorura* species as *P. pjasinae* (Martynova, 1976), *P. microtica* (Dunger, 1978) and *P. subarctica* (Martynova, 1976) due to the presence of the same number of pso on subcoxae 1 of all legs, ventral and dorsal side of head, Th. terga I–II and Abd. terga I–IV. However, *P. sayanica* sp. n. may easily be distinguished from these species by the number of pso on Abd. tergum V (3+3 pso in the new species and 2+2 pso all other species presented above) and presence of pair of lateral denticles on claw (absent in other four species).

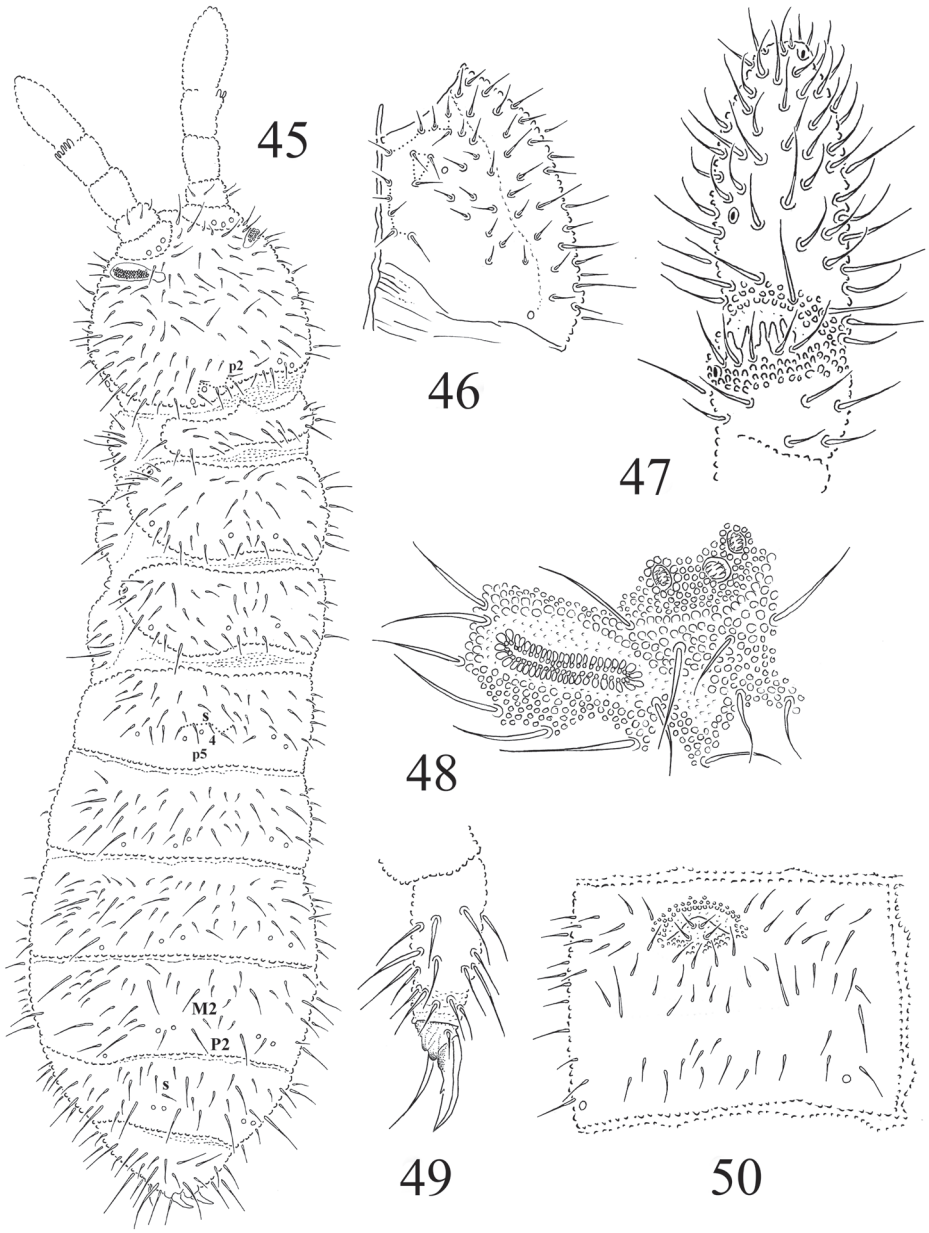
***Protaphorura tuvinica* sp. n.**
http://zoobank.org/9A1C9947-6CD2-4FB3-A88C-514A0A819CD3
Figs 45–50, 59

Type material. Holotype (male): Russia, S-W Tuva, ca 30 km SW of Mugur-Aksy, upper reaches of Mugur River, Mongun-Taiga Mts, mountain tundra, moss under *Betula rotundifolia*, 2700 m alt., 50°22'N, 90°05'E, 23.VII.1993, leg. S.K. Stebaeva (SNHM). Paratypes: 10 males, 3 females and 7 juveniles, same data as holotype (SNHM – 6 paratypes: 5 males and 1 female, ISEA – 4 paratypes: 3 males and 1 female, MSPU – 4paratypes: 3 males and 1 female, and 7 juveniles).

Diagnosis. PAO with 37–45 simple vesicles. Pso formula dorsally 32/022/33332, ventrally 2/000/0001, subcoxae 1 of I–III legs without pso. Submedial pso a and b on Abd. terga I–II located far apart. Psx formula on Abd. sterna: 110–1001 ^{m}. Th. tergum I with 9–11+9–11 chaetae, chaeta m absent. Chaetae s' absent on abdominal terga I–III and V. Manubrial field with 19 chaetae in 4 rows. Claw without lateral denticles.

Description. Holotype (male) length 1.9 mm, length of paratypes: 1.7–1.8 mm (males) and 1.9–2.2 mm (females). Shape of body typical for the genus: cylindrical with strong AS on distinct papillae (Fig. 45). Colour in alcohol yellowish-white. Granulation more or less uniform, distinct. Usually 11–12 grains around each pso.

Antennae slightly shorter than head, their base well marked. Ant. I with 9–10 chaetae, Ant. II with 17 chaetae. AIIIO consisting of 5 guard chaetae, 5 papillae, 2 smooth sensory rods, 2 straight and granulated sensory clubs, ventro-lateral microsensillum present (Fig. 47). Ant. IV with subapical organite in unprotected cavity



Figures 45–50. *Protaphorura tuvinica*: **45** habitus and dorsal chaetotaxy **46** right part of head ventrally **47** dorsal side of Ant. III-IV **48** PAO and anterior cephalic pseudocelli **49** tibiotarsal chaetotaxy and claw of leg III **50** chaetotaxy of Abd. sternum IV.

without clear cuticular papilla. Microsensillum on Ant. IV in usual position above second proximal row of chaetae. Ventrally Ant. IV with numerous chaetae (ca. 68–70). Sensilla indistinct on Ant. IV (Fig. 47).

PAO of middle length, consisting of 37–45 simple vesicles (Fig. 48). Labral formula of chaetae: 4/342. Maxillary outer lobe with simple palp, basal chaeta and with two sublobal hairs. Labial palp of type A. Labium with 7 proximal, 4 basomedian (E, F, G, and f), and 6 basolateral chaetae (a, b, c, d, e, e'). Papillae A-E with 1, 4, 0, 3, 3 guard chaetae respectively.

Pso formula dorsally 32/022/33332, ventrally 2/000/0001 (Figs 45, 46, 50). Subcoxae 1 of I–III legs without pso and with one psx each. Submedial pso a and b on Abd. terga I–II located rather far apart, i.e. on similar distance as on Abd. tergum III (Fig. 45). Psx formula 0/000/110(1)01. Psp formula dorsally 0/011/1111, ventrally $0/111/01^{m}1^{m}1^{m}$, coxae with 1 psp each.

Dorsal chaetotaxy rather symmetrical and plurichaetotic, chaetae well differentiated into macrochaetae and microchaetae (fig. 45). Sensory chaetae s indistinct on body. On head p2 chaetae displaced forward in relation to p1 and p3. Chaetae p6 on head located between pso a and b (Fig. 45). Th. tergum I with 9–11+9–11 chaetae, chaeta m absent (chaetotaxy type i2-). Both Th. terga II and III with lateral microsensilla and with 5+5 or 6+6 axial microchaetae. Chaetae s' absent on Abd. terga I–III and V. On Abd. tergum IV in axial area between M2 and P2 macrochaetae located 7–8 chaetae, medial chaeta m0 present (Fig. 45). Abd. tergum V usually with 1–2 unpaired microchaeta m0 and p0 (often m0 absent) (Fig. 45). Abd. tergum VI with medial chaetae m0. Relative position of prespinal microchaetae of parallel type (Fig. 45). M/s ratio on Abd. tergum V as 14.6–17.2/4.6–6.2 (AS = 10). AS 0.9–1.0 as long as inner edge of claw and 3.1 times longer than their basal diameter.

Chaetotaxy of ventral side of head as in Fig. 46. Perilabial area with 5+5 a-chaetae (Fig. 46). Postlabial chaetae 5-6+5-6 along ventral groove. Th. sterna I–III without chaetae. VT with ca. 8–9+8–9 chaetae and 2 chaetae at base. Furcal rudiment: cuticular fold (located on the anterior edge of the sternum) with 2+2 dental microchaetae in 2 rows. Chaetotaxy of manubrial field: 5 chaetae present in ma-row, 4 chaetae in mm'-row, 6 chaetae in mm-row and 4 chaetae in mp-row (Fig. 50). MVO absent. Each lateral anal valves with a0 and 2a1 (a2 absent); upper anal valve with chaetae a0, 2a2, 2b1, 2b2, c0, 2c1 and 2c2 (as in *P. vasilinae*, Fig. 59).

Subcoxae 1 of I, II and III legs with 5–6, 6, 5 chaetae, subcoxae 2 with 1, 5, 5, coxae with 3, 10, 13, trochanters with 11, 12, 10, femora with 20, 20, 19–20, tibiotarsi with four rows of chaetae (distal whorl (A+T)+B+C): 11+8+3, 11+8+3, 11+8+3-4 chaetae respectively. Claw with strong denticle in 1/2 of inner edge of claw (Fig. 49). Empodial appendage of the same length as inner edge of claw, without basal lamella. (Fig. 49).

Etymology. The name of the new species refers to the Tuva Republic (Russian Federation), the place where the type specimens were collected.

Discussion. *Protaphorura tuvinica* sp. n. belongs to the group of *Protaphorura* species without pseudocelli on subcoxa 1 of all legs and with 2+2 pso ventrally on head: *P. ombrophila* (Stach, 1960), *P. kopetdagi* Pomorski, 1994, *P. salsa* Kaprus', Paśnik & Weiner, 2014, *P. bakhchisaraica* Kaprus', Paśnik & Weiner, 2014 and *P. ajudagi* Pomorski, Skarżyński & Kaprus', 1998. All these species inhabit the territory of southern Palearctic from Crimean Peninsula to central Asia and southern Siberia.

The new species has the pseudocellar formula the same as in *kopetdagi* (32/022/33332) when the other posses the different number of pseudocelli. The males of *P. kopetdagi*, *P. salsa*, *P. bakhchisaraica* and *P. ajudagi* are armed with the male ventral organ whereas the new species and *P. ombrophila* have males devoided of the organ. *P. tuvinica* differs also from the latter species by the number of pso on Abd. terga IV-V (3,2 in the new species and 4,2 in *P. ombrophila*).

***Protaphorura vasilinae* sp. n.**
http://zoobank.org/80C4CF4F-0711-488A-AB00-5EEFAEA30B20
Figs 51–57, 59

Type material. Holotype (female): Russia, West Siberia, 25 km S of Novosibirsk, Akademgorodok, lawn, soil, 400 m alt., 54°49'N, 83°08'E, 2.X.1994, leg. S.K. Stebaeva (SNHM). Paratypes: 7 females and 6 juveniles, same data as holotype (SNHM – 3 paratype females and 3 juveniles, ISEA – 4 paratype females and 3 juveniles); 2 females and 3 juveniles: Russia, N-E Altai, Turochak Region, meadow, soil, 11.VI.2002, leg. E. Sleptsova (SNHM).

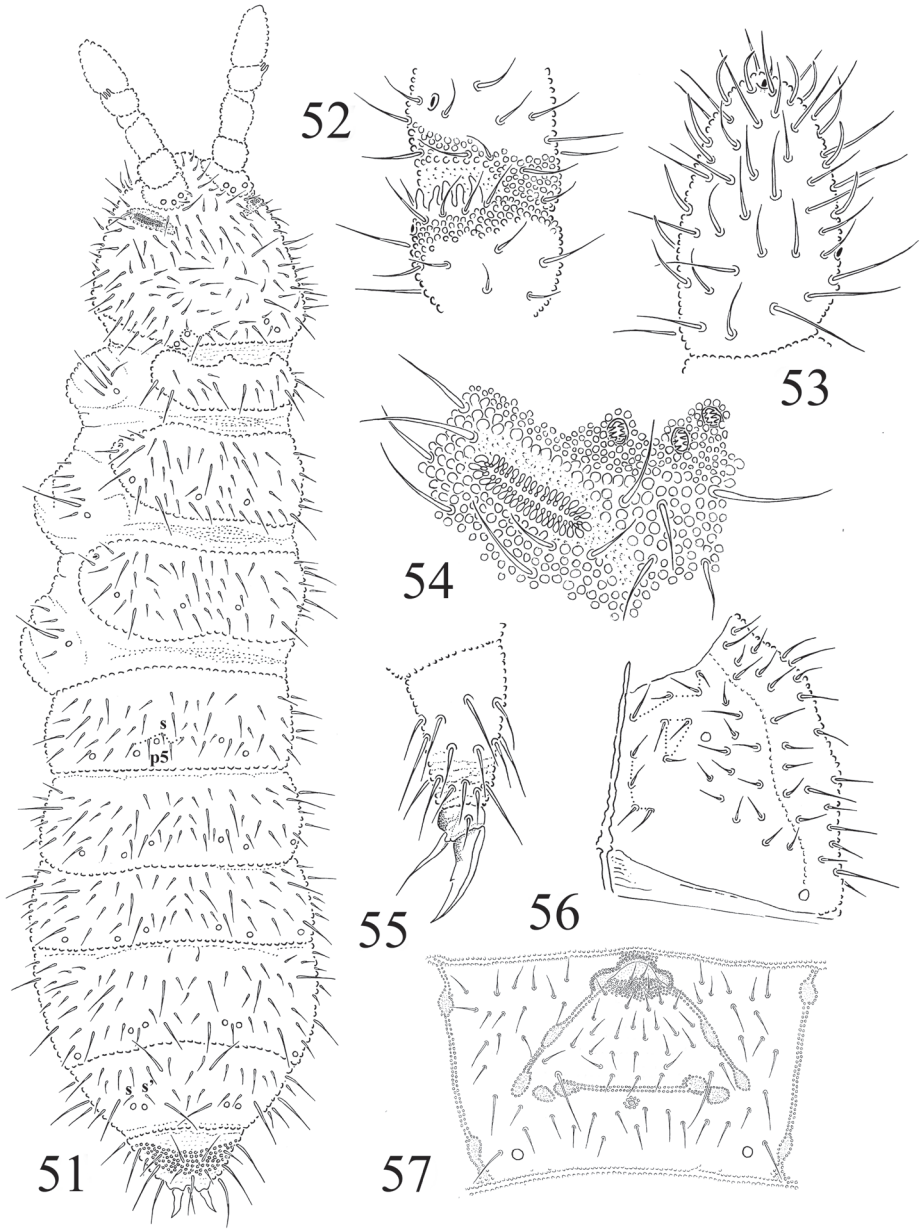
Diagnosis. PAO with 32–36 simple vesicles. Pso formula dorsally 32/022/33332, ventrally 2/000/0001, subcoxae 1 of I–III legs with 1,1,1 pso respectively. Submedial pso a and b on Abd. terga I–II located far apart. Psx formula on Abd. sterna: 110001^{m}. Th. tergum I with 10–11+10– 11 chaetae, chaeta m absent. Chaetae s' absent on Abd. terga I–III and present on Abd. tergum V. Manubrial field with 25–28 chaetae in 6 rows. Claw without lateral denticles.

Description. Holotype (female) length 1.5 mm, length of paratypes: 1.4–1.7 mm (females). Shape of body typical of the genus: cylindrical with strong AS on distinct papillae (Fig. 51). Colour in alcohol yellowish-white. Granulation more or less uniform, distinct. Usually 10–12 grains around each pso.

Antennae slightly shorter than the head, their base well marked. Ant. I with 10 chaetae, Ant. II with 16 chaetae. AIIIO consisting of 5 guard chaetae, 5 papillae, 2 smooth sensory rods, 2 straight and granulated sensory clubs, ventro-lateral microsensillum present (Fig. 52). Ant. IV with subapical organite in unprotected cavity without clear cuticular papilla (Fig. 53). Microsensillum on antennal segment IV in usual position above second proximal row of chaetae. Ventrally Ant. IV with numerous chaetae (ca. 50–55). Ant. IV with 8–11 slightly differentiated sensilla (Fig. 53).

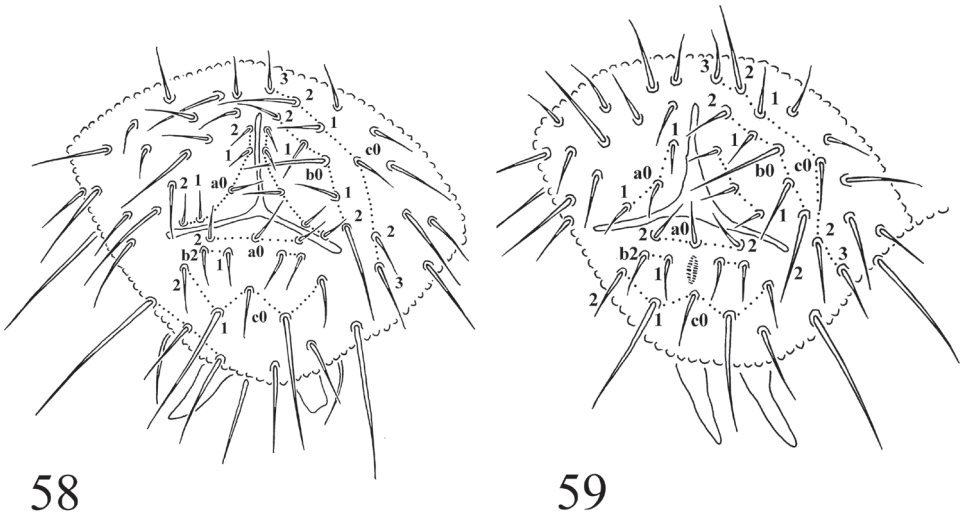
PAO of middle length, consisting of 32–36 simple vesicles (Fig. 54). Labral formula of chaetae: 4/342. Maxillary outer lobe with simple palp, basal chaeta and with two sublobal hairs. Labial palp of type A. Labium with 7 proximal, 4 basomedian (E, F, G, and f), and 6 basolateral chaetae (a, b, c, d, e, e'). Papillae A-E with 1, 4, 0, 3, 3 guard chaetae respectively.

Pso formula dorsally 32/022/33332, ventrally 2/000/0001 (Figs 51, 56, 57). Subcoxae 1 of I– III legs with one pso and one psx each. Submedial pso a and b on Abd.



Figures 51–57. *Protaphorura vasilinae*: **51** habitus and dorsal chaetotaxy **52** AIIIO **53** ventral side of Ant. IV **54** PAO and anterior cephalic pseudocelli **55** tibiotarsal chaetotaxy and claw of leg III **56** right part of head ventrally **57** chaetotaxy of Abd. sternum IV.

terga I–II located far apart, i.e. on similar distance as on Abd. tergum III (Fig. 51). Psx present on Abd. sterna I–II and VI (psx formula 0/000/110001^{m}). Psp formula dorsally 0/011/1111, ventrally: 0/111/01^{m}1^{m}1^{m}, coxae with 1 psp each.



Figures 58–59. Chaetotaxy of anal valves: **58** *Protaphorura jernika* **59** *Protaphorura vasilinae*.

Dorsal chaetotaxy rather symmetrical, as in Fig. 51. Dorsal chaetae well differentiated into macrochaetae and microchaetae. Sensory chaetae s indistinct on body. On head p2 chaetae are displaced forward in relation to p1 and p3. Chaetae p6 located between pseudocelli a and b on head. Th. tergum I with 10–11+10–11 chaetae, chaeta m absent (chaetotaxy type i2–3-). Both Th. terga II and III with lateral microsensilla and with 5+5 or 6+6 axial microchaetae. Chaetae s' absent on Abd. terga I–III and present on Abd. tergum V. On Abd. tergum IV in axial area between M2 and P2 macrochaetae located 7–8 chaetae, medial chaeta m0 present (Fig. 51). Abd. tergum V usually with 2 unpaired microchaeta m0 and p0 (sometimes m0 absent) (Fig. 51). Abd. tergum VI with medial chaetae m0. Relative position of prespinal microchaetae of subparallel type (Fig. 51). M/s ratio on abdominal tergum V as 14.9–16/5.6–5.2 (AS = 10). AS 1.1 times longer than inner edge of claw and 3.1 times longer than their basal diameter.

Chaetotaxy of ventral side of head as in Fig. 56. Perilabial area with 4+4 a-chaetae. Postlabial chaetae 4–5+4–5 along ventral groove. Th. sterna I–III without chaetae. VT with ca. 8–9+8–9 chaetae, and 2 chaetae at base. Chaetotaxy of Abd. sternum IV as in Fig. 57. Furcal rudiment: cuticular fold (located on the anterior edge of the sternum) with 2+2 dental microchaetae in 2 rows. Chaetotaxy of manubrial field: 4 chaetae present in ma-row, 4 chaetae in ma'-row, 4–5 chaetae in mm''-row, 5–6 chaetae in mm'-row, 4 chaetae in mm-row and 4–5 chaetae in mp-row (in adult specimens) (Fig. 56). MVO absent. Each lateral anal valves with a0 and 2a1 (a2 absent); upper anal valve with chaetae a0, 2a2, 2b1, 2b2, c0, 2c1 and 2c2 (Fig. 59).

Subcoxae 1 of I, II and III legs with 5, 6–7, 6 chaetae, subcoxae 2 with 1, 5, 4, coxae with 3, 10–11, 13, trochanters with 11, 11, 10, femora with 18, 18, 18, tibiotarsi with four rows of chaetae (distal whorl (A+T)+B+C): 11+8+3, 11+8+3, 11+8+4 chaetae respectively. Claw with strong denticle in the 1/2 of inner edge of claw (Fig.

55). Empodial appendage of the same length as inner edge of claw, without basal lamella. (Fig. 55).

Etymology. The species is cordially dedicated to Vasilina, a granddaughter of Dr. Sophya Stebaeva.

Discussion. The same number of pso on body ventrally (2+2 on head and 1+1 on Abd. sternum V), the presence of pseudocelli on subcoxae 1 of all legs, 2+2 posterior cephalic pso and 2+2 pso on Abd. tergum V allow suggesting a close similarity between *P. vasilinae* sp. n. and *P. jernika* sp. n. (see also discussion of *P. jernika* sp. n.). These species distinctly differ in the number of pso on Th. terga II–III and Abd. tergum IV (2+2,2+2 and 3+3 in *P. vasilinae* vs 3+3,3+3 and 4+4 in *P. jernica* respectively), in the formula of psx on Abd. sterna (110001m in *P. vasilinae* vs 111000 in *P. jernica*) and in the chaetotaxy of Th. tergum I (chaetotaxy type i2–3- in *P. vasilinae* vs i2–3m in *P. jernica*) and Abd. tergum V (s' present in *P. vasilinae* vs s' absent in *P. jernica*).

Key to *Protaphorura* species of the Eastern Palearctic

For the species with high variability in the pseudocellar formula we used in the key the most common type.

1 AIIIO with four papillae **2**
– AIIIO with five papillae **5**
2 Th. terga II and III with 3+3 pso each (formula of dorsal pso: 33/033/33333) ..... ***P. matsumotoi*** **(Kinoshita, 1923)** (Japan)
– Th. terga II and III with 1+1 and 2+2 pso respectively **3**
3 Ventrally on head 1+1 pso present in posterolateral position, formula of dorsal pso: 33/012/33342 ..... ***P. dzherga*** **Gulgenova & Potapov, 2013** (Russia: Transbaikal)
– Ventral pso on head absent **4**
4 Formula of dorsal pso: 33/012/33332, furcal area with two pairs of dental microchaetae..... ***P. dorzhievi*** **Gulgenova & Potapov, 2013** (Russia: Transbaikal)
– Formula of dorsal pso:43/012/33353, furcal area with one pair of dental microchaetae..... ***P. uniparis*** **Gulgenova & Potapov, 2013** (Russia: Transbaikal)
5 AIIIO with two slender, long sensory rods: one inserted dorsal to the papillae, secod between papillae **6**
– AIIIO with two normal sensory rods inserted behind the papillae , between the sensory cluba..... **8**
6 Antennal base with four pso (formula of dorsal pso: 43(4)/022/3(4)3(4)3(4) 5(6)3(4)), PAO with 42-46 vesicles ..... ***P. nutak*** **(Yosii, 1972)** (Russia: Far East, Kunashir Island and Eastern Siberia, Japan)
– Antennal base with three pso **7**
7 Formula of dorsal pso: 33/022/33343, PAO with about 45 vesicles..... ..... ***P. longisensillata*** **(Yosii, 1969)** (Japan)

– Formula of dorsal pso: 32/022/33342, PAO with 36-40 vesicles .... ***P. diplosensillata* (Dunger, 1978)*** (Mongolia)
8 Subcoxae1 of legs I, II and III without pso **9**
– Subcoxae1 of legs I, II and III with 1,0,0 pso respectively **21**
– Subcoxae1 of legs I, II and III with 1,1,1 pso respectively **27**
9 Ventral pso on head absent **10**
– Ventrally on head 1+1 or 2+2 pso present **11**
10 Formula of dorsal pso: 32/022/33333, PAO with 40-65 vesicles, MVO absent ..... ***P. borealis* (Martynova, 1973 in Martynova, Gorodkov & Chelnokov, 1973)** (Eastern Palearctic)
– Formula of dorsal pso: 33/012/33332, PAO with 21-26 vesicles, MVO in a form of two brush-shape chaetae on each anal valve..... ..... ***P. minima* Sun, Zhang & Wu, 2013** (North Eastern China)
11 Ventrally on head 2+2 pso present, Abd. sternum IV with 1+1 pso **12**
– Ventrally on head 1+1 pso present in anteromedial position, Abd. sternum IV without pso..... **15**
12 Abd. tergum V with 3+3 pso **13**
– Abd. tergum V with 2+2 pso **14**
13 Anterolateral pso on Abd. tergum IV present, formula of dorsal pso: 32(3)/022(3)/33(2)3(2)43, MVO absent..... ..... ***P. ombrophila* (Stach, 1960)** (Afghanistan)
– Anterolateral pso on Abd. tergum IV absent, formula of dorsal pso: 33/022/3324(3)3, MVO present on Abd. sterna II-III with 2+2 and 1+1 modified chaetae respectively .... ***P. salsa* Kaprus', Paśnik & Weiner, 2014** (Russia: southern Siberia)
14 PAO with 37-45 vesicles, formula of dorsal pso: 32/022/33332, MVO absent..... ***P. tuvinica* sp.n.** (Russia: southern Siberia)
– PAO with 26-36 vesicles, formula of dorsal pso: 32/022/33332, MVO present on Abd. sterna II-III with 2+2 and 2+2 modified chaetae respectively ... . ***P. kopetdagi* Pomorski, 1994** (Turkmenistan: Kopetdag Mts.)
15 Antennal base with four or more pso **16**
– Antennal base with three pso **17**
16 Dorsomedial pso on Th. tergum II and anterolateral pso on Abd. tergum IV present (formula of dorsal pso: 4(5,6)3(4)/022/3335(4)3(4,5))..... ..... ***P. octopunctata* (Tullberg, 1876)** (Russia: central Siberia)
– Dorsomedial pso on Th. tergum II and anterolateral pso on Abd. tergum IV absent (formula of dorsal pso: 43/012/333(2)43)..... ..... ***P. tolae* Pomorski & Kaprus', 2007** (Russia: eastern Siberia)
17 Posterior cephalic pso 2+2, claws with pair lateral denticles **18**
– Posterior cephalic pso 3+3, claws without lateral denticles **20**
18 Th. tergum I in adult specimens with 11+11 chaetae, claws with strong lateral denticles, formula of dorsal pso: 32/022/33232 .... ***P. microcellata* (Dunger, 1978)** (Mongolia)

– Th. tergum I in adult specimens with 17-25+17-25 chaetae.....**19**
19 Th. tergum I with 17-20+17-20 chaetae, formula of dorsal pso: 32/022/33332, claws with very small lateral denticles.....***P.* cf. *microcellata* (Dunger, 1978)** (Russia: central Siberia after Babenko & Kaprus', 2014)
– Th. tergum I with 23-25+23-25 chaetae, formula of dorsal pso: 32/011/22232, claws with strong lateral denticles ..... ***oligopseudocellata* sp. n.** (Russia: southern Siberia)
20 Formula of dorsal pso: 33/022/33332, ventral psx formula: 01/000/111100, chaetae s' present on Abd. terga I-III and V..... .....***P. bicampata* (Gisin 1956)** (Northern Europe, Eastern Palearctic)
– Formula of dorsal pso: 33/01(2)2/3334(3)2, ventral psx formula: 01/000/100000, chaetae s' absent on Abd. terga I-III and V..... ..... ***P. jacutica* (Martynova, 1976)** (north eastern Europe, eastern Asia)
21 Antennal base with four pso.....**22**
– Antennal base with three pso **24**
22 Abd. tergum IV with 5+5 pso (formula of dorsal pso: 43/022/33353), PAO with 40-42 vesicles.....***P. maoerensis* Sun, Wu & Gao, 2013** (noth eastern China)
– Abd. tergum IV with 4+4 pso **23**
23 Formula of dorsal pso: 43/022/33342, claws always with strong inner denticle, PAO with 26-27 vesicles.....***P. mongolica* (Martynova, 1975)** (Mongolia)
– Formula of dorsal pso: 43/022/33343, claws without or rarely with very small inner denticle (in Asian populations), PAO with 30-35 vesicles..... ..... ***P. sakatoi* (Yosii, 1966)** (central and south-eastern Europe, Russia: Caucasus Mts and southern Siberia, Afghanistan, Kazakhstan, Tajikistan)
24 Abd. sternum IV with 1+1 pso, formula of dorsal pso: 32/012/33132..... .....***P. brevispinata* (Yosii, 1966)** (southern Korea)
– Abd. sternum IV without pso **25**
25 Posterior cephalic pso 2+2 (formula of dorsal pso: 32/012/33232), psx formula on Abd. sterna I-VI: 100000..... .....***P. changbaiensis* Sun, Zhang & Wu, 2013** (north eastern China)
– Posterior cephalic pso 3+3 (formula of dorsal pso: 33/022/33342) **26**
26 Claws without inner denticle, chaeta a0 present on Abd. tergum VI, prespinal chaetae placed convergently .....***P. zori* (Martynova, 1975 in Martynova & Chelnokov, 1975)** (Tajikistan: eastern Pamir)
– Claws with strong inner denticle, chaeta a0 absent on Abd. tergum VI, prespinal chaetae placed divergently.....***P. nikolai* sp. n.** (Russia: Far East)
27 Ventrally on head 2+2 pso present.....**28**
– Ventrally on head 1+1 pso present in anteromedial position.....**31**
28 Abd. sternum IV without pso **29**
– Abd. sternum IV with 1+1 pso **30**
29 Formula of dorsal pso: 32(3)/012/33342, claws with inner denticle, PAO with 12-13 vesicles..... ..... ***P. buryatica* Gulgenova & Potapov, 2013** (Russia: Transbaikal)

– Formula of dorsal pso: 43/02(3)2(3)/3335(4,6)3(4), claws without inner denticle, PAO with 16-22 vesicles..... .....***P. merita*** **Kaprus' & Pomorski, 2008** (Russia: southern Siberia)

30 Formula of dorsal pso: 32/033/33342, psx formula on Abd. sterna I-VI: 111000..... ***P. jernika*** **sp. n.** (Russia: southern Siberia)

– Formula of dorsal pso: 32/022/33332, psx formula on Abd. sterna I-VI: 110001^{m} .....***P. vasilinae*** **sp. n.** (Russia: southern Siberia)

31 Antennal base with four or more pso **32**

– Antennal base with three pso **36**

32 Th. tergum III with 2+2 pso (formula of dorsal pso: 43/022/33342), psx formula $1/000/110001^{m}$..... ..... ***P. licheniphila*** **Kaprus' & Pomorski, 2008** (Russia: central Siberia)

– Th. tergum III with 3+3 pso **33**

33 Abd. tergum V with 2+2 pso (formula of dorsal pso: 43/023/33342), PAO with 18-22 vesicles..... .....***P. nazarovensis*** **Kaprus' & Pomorski, 2008** (Russia: south Siberia)

– Abd. tergum V with 3+3 or more pso **34**

34 Abd.terga I–III and V without chaetae s', formula of dorsal pso: 43/023/33353, PAO with 16-22 vesicles, psx formula on Abd. sterna I-VI: 111101^{m} .... ***P. jiamusiensis*** **Sun, Wu & Gao, 2013** (north eastern China)

– Abd.terga I–III and V with chaetae s'.....35

35 PAO with 18-26 vesicles, psx formula on Abd. sterna I-VI: 111101^{m}, formula of dorsal pso: 4(5)3(4,5)/033/4(3)4(3)4(3)5(6)3(4)..... ..... ***P. submersa*** **Kaprus' & Pomorski, 2008** (Russia: southern Siberia)

– PAO with 36-40 vesicles, psx formula on Abd. sterna I-VI: $100001?^{m}$, formula of dorsal pso: 4(5,6)4/03(2)3(2)/4(3)4(3)4(3,5)5(6)4(3) .... ***P. elenae*** **Kaprus' & Pomorski, 2008** (Russia: eastern Siberia)

36 Posterior cephalic pso 2+2 .....**37**

– Posterior cephalic pso 3+3 .....**42**

37 Th. terga II and III with 3+3 pso each (formula of dorsal pso: 32/033/33343) .....***P. abscondita*** **sp. n.** (Russia: southern Siberia)

– Th. Terga II and III with 2+2 pso **38**

38 Abd. terga I-III without chaetae s'.....**39**

– Abd. terga I-III with chaetae s'.....**40**

39 Subapical organite on Ant. IV in cavity protected by cuticular papillae, PAO with 30–42 simple vesicles, most common formula of dorsal pso: 32/022/33343, but some specimens may have 3+3 posterior pso on head and 2+2 pso on Abd. tergum V..... .....***P. tschernovi*** **(Martynova, 1976)** (Russia: western Taimyr, central Siberia)

– Subapical organite on Ant. IV in unprotected cavity, PAO with 25–40 simple vesicles, formula of dorsal pso: 32/022/3333(4)2 ....***P. subarctica*** **(Martynova, 1976)** (Northern Palearctic)

40 Abd. tergum V with chaetae s' PAO with about 41–48 vesicles, formula of dorsal pso: 32/022/33343 and ventral pso: 1/000/0000..... ..... ***P. sayanica* sp. n.** (Russia: southern Siberia)

– Abd. tergum V without chaetae s'.....**41**

41 Submedial pso a and b on Abd. terga I-II in nearby position and both these pso set medially to macrochaetae p5, formula of dorsal pso: 32/022/3334(3)2, PAO with 24–40 simple vesicles..... ..... ***P. pjasinae* (Martynova, 1976)** (northern Asia, western Siberia)

– Submedial pso a and b on Abd. terga I-II set far apart and pso b set laterally to macrochaetae p5, formula of dorsal pso: 32/022/33342, PAO with 22 simple vesicles.....***P. microtica* (Dunger, 1978)** (Mongolia)

42 Th. tergum II with 1+1 pso (formula of dorsal pso: 33/012/33342), psx formula on Abd. sterna I-VI: 111101^{m}, PAO with 24-32 vesicles..... ..... ***P. genheensis* Sun, Chang & Wu, 2015** (north eastern China)

– Th. tergum II with 2+2 or more pso **43**

43 Abd. tergum IV with 3 +3 pso (formula of dorsal pso: 33/022/33333), claws without inner denticle.....***P. fimata* (Gisin, 1952)** (Kyrgyzstan, Iran)

– Abd. tergum IV with 4 +4 or more pso.....**44**

44 Chaetae s' present on Abd. terga I-III or V **45**

– Chaetae s' absent on Abd. terga I-III or V.....**48**

45 AS less than 0.5 length of claws III, formula of dorsal pso: 33/022/33343.... ..... ***P. ussurica* (Martynova, 1981)** (Russia: Far East)

– AS 0.7–1.0 length of claws III **46**

46 Relative position of prespinal microchaetae on Abd. tergumVI parallel type, formula of dorsal pso: 33(2)/022/33342(3), psx formula on Abd. sterna I-VI: 110001^{m} .... ***P. boedvarssoni* Pomorski, 1993** (Russia: western and central Siberia)

– Relative position of prespinal microchaetae on Abd. tergumVI distinctly convergent type **47**

47 Formula of dorsal pso highly variable: 33(2)/03(2)3(2)/4(3,5)4(3,5)4(3,5,6)5(4,6)3(2,4), chaetae s on Abd. tergum V 1.0-1.1 times longer than AS.....***P. tundricola* (Martynova, 1976)** (north eastern Europe, western and central Siberia)

– Formula of dorsal pso: 33/022(3)/3334(5,6)2(3), chaetae s on Abd. tergum V 1.5 times longer than AS..... ..... ***P. neriensis* (Martynova, 1976)** (Russia: eastern Siberia)

48 Th. tergum II with 3+3 pso (formula of dorsal pso: 3(4)3/033/33342), claws with hardly noticeable inner denticle .... ***P. kaszabi* (Dunger, 1978)** (Mongolia, north eastern China)

– Th. tergum II with 2+2 or rarely 1+1 pso (formula of dorsal pso: 33/02(1)2(3)/33342(3), claws with clear inner denticle .... ***P. taimyrica* (Martynova, 1976)** (northern Asia)

Species insufficient described which are not included in the key

P. aksuensis (Martynova, 1972), formula of dorsal pso: 33/022/33333, (Kyrgyzstan)
P. tridentata (Stebaeva, 1982), formula of dorsal pso: 32/022/33342, (southern Siberia)
P. teres (Yosii, 1956), formula of dorsal pso: 32/022/33333, (Japan)
P. yagii (Miyoshi, 1923), formula of dorsal pso: 32/022/33232, (Japan)

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On p. 81 the header for the new species reads *Megastigmus pistaciae* Roques & Copeland sp. n.

The CORRECT species name is *Megastigmus ozoroae* Roques & Copeland sp. n. The name was misspelled when the PDF file was generated.