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“SEXUALLY ARMED” SPECIES OF THE GENUS PROTAPHORURA
(COLLEMBOLA: ONYCHIURIDAE)

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ABSTRACT

Species possessing mvo: Protaphorura bakhchisaraica sp. nov. and P. salsa sp. nov. from 
two peculiar habitats: xerothermic bushes in Ukraine (Crimea) and a salt lake shore in Rus-
sia (South Siberia) are described. Two other species with this organ, Protaphorura ianstas-
tchia Yosii, 1972 and P. stiriaca (Stach, 1946), are redescribed, discussed and their lectotypes 
designed. An identification key to all known Protaphorura species having mvo is given. The structure and arrangement of the organ is applied as a sharp diagnostic character at the 
species level.

Key Words: Protaphorurini, taxonomy, chaetotaxy, abdominal sterna, identification key

RESUMEN

Se describen como nuevas especies para la ciencia Protaphorura bakhchisaraica sp. nov. y P. salsa sp. nov., especies que poseen machos con órgano ventral y que proceden de la maquia 
de Ucrania (Crimea) y de la costa de un lago salado de Rusia (Siberia). Se redescriben tam-
bien dos especies mas con este órgano: Protaphorura ianstachia Yosii, 1972 y P. stiriaca 
(Stach, 1946), se designan los lectotipos de ambas. En este trabajo se da una clave mundial 
para todas las especies de Protaphorura con órgano ventral en los machos. La estructura y 
disposición en diferentes esternitos de las quetas del órgano ventral se utiliza como un buen 
caracter para la distincion entre las especies.

Palabras Clave: Protaphorurini, taxonomía, quetotaxía, esternitos abdominales, clave de 36 identificación

In Onychiuridae s. str., (= Onychiurinae sensu Deharveng 2004) the male ventral organ (mvo) 
so far has been found in all tribes, although only in one species for the tribe Oligaphorurini. Origi-
nally, the organ was discovered and described by Stach (1934) as the “male ventral organ” (in Ger-
man – “Bauchorgan eines Männchens”) in the following species: Onychiurotoides granulosus 
(Stach, 1930), Onychiurotoides postumicus (Bonet, 1931), Onychiurus rectospinatus Stach, 1922, Onychi-
urus stillicidii (Schiodte, 1849) and Protaphorura ianstachi (Yosii 1972).

The function of mvo is not known until now. However, Stach (1934) and Pomorski (1998) be-
lieved that the structure of the organ provides a good diagnostic character at the species level.

The mvo consists of modified chaetae (the mod-
ifications are sometimes very considerable ) and it is situated on different abdominal sterna: Abd. 
I (on ventral tube), II, II–III, II–IV and VI (anal valves) depending on the species. Snider (1977), 
and Weiner & Stomp (1995) showed that the mvo undergoes changes from instar to instar, modi-
ifying the shape of chaetae, but preserving their number and position.

Even within the genus Protaphorura Absolon, 
1901 the mvo seems to be a convergent character 
since it occurs in species which are very differ-
ent in the pseudocellar formula and other essen-
tial characters. Thus, the species with “sexually 
armed” males compose an artificial, although well 
defined, group.

The presence of modified chaetae in mature 
males is not a common phenomenon for the ge-
nus Protaphorura. Up to now only 10 species 
equipped with such an organ were known. In our 
materials from Ukraine and Russia we found 2 
species new to science. The identification key to 
the Protaphorura-species with the mvo provided 
herein can facilitate their determination.

MATERIAL AND METHODS

Specimens were mounted in Marc Andre II 
and Faur solution, 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, Lviv, Ukraine (SNHM), Institute of Systematics and Evolution of Animals, Polish Academy of Sciences, Kraków, Poland (ISEA) and Moscow Pedagogical State University, Moscow, Russia (MPSU).


Abbreviations used in descriptions: Abd. – abdominal segments, th. – thoracic segments, mvo – male ventral organ, Ant. – antennal segments, AiiiO – sensory organ of Ant. iii, p AO – postantennal organ, pso – pseudocell, psx – parapseudocell, psp – pseudopore, 1\textsuperscript{m} – single psx or psp in medial position.

Taxonomy

Onychiuridae: Onychiurinae: Protaphorurini

List of Protaphorura species with MVO:

- **P. ajudagi** Pomorski, Skarżyński and Kaprus’ 1998 – Ukraine, Crimea;
- **P. bakhchisaraica** sp. nov. – Ukraine, Crimea;
- **P. christiani** Pomorski, Leithner and Bruckner 2003 – Austria, Kolmberg;
- **P. eichhorni** (Gisin 1954) – Luxembourg, Klepešch, Neuwies etc.;
- **P. ianstachi** (Yosii 1972) – Georgia, Caucasus, Tbilisi;
- **P. januarii** (Weiner 1977) – Poland, Pieniny Mts.;
- **P. kopetdagi** Pomorski 1994 – Turkmenia, Kopdag Mts.;
- **P. minima** Sun, Zhang and Wu 2013 – China, Heilongjiang, Tongjiang;
- **P. salsa** sp. nov. – Russia, South-West Siberia.
- **P. stiriaca** (Stach 1946) – Austria, Upper Stiria, Admont;
- **P. stogovi** Pomorski 1993 – North of European Russia (Babenko, pers. com.);
- **P. tricampata** (Gisin 1956) – Europe (after Bellinger et al. 2006-2013);

**Protaphorura Bakhchisarai** sp. nov.

(Figs. 1–8, 31, 34)

Type Material


Other material. 3 males and 2 females, Ukraine, Crimea, Rybachy village, 9-IX-1997, maquis, under stones, leg. I. Kaprus’, D. Skarżyński and R.J. Pomorski.

Diagnosis

PAO with 24–30 simple vesicles. Pso formula: 32/01(2)/2/311(2)/32 dorsally, 2/000/0000 ventrally, subcoxae without pso. Submedial pso a and b on Abd. terga I–II located far apart. Psx formula on Abd. sterna: 110001\textsuperscript{m}. Th. tergum I with 7–9+7–9 chaetae, chaeta m absent. Chaetae s’ absent on Abd. terga I–III and V. Mvo on Abd. sterna II and III with 2+2 and 2+2 modified chaetae, and 4+4 thickened chaetae on ventral tube.

Description

Holotype (male) length 1.17 mm, length of paratypes: 1.14–1.47 mm (females). Shape of body typical of the genus: cylindrical with strong anal spines on papillae (Fig. 1). Colour in alcohol white. Granulation more or less uniform, distinct. Base of antennae well marked. Usually 11–12 grains around each pso.

Antennae shorter than head. Ant. I with 10 chaetae, Ant. II with 17–18 chaetae. AIIIIO with five guard chaetae, five papillae, two smooth sensory rods, two straight and granulated sensory clubs, ventro-lateral microsensillum present (Fig. 3). Ant. IV with subapical organite, without clear cuticular papillae. Microsensillum on Ant. IV in usual position above second proximal row of chaetae (Fig. 3). Ventrally Ant. IV with numerous chaetae (ca. 65). Sensilla on Ant. IV indistinct.

PAO with 24–30 simple vesicles (Fig. 2). Labral formula of chaetae: 4/342. Maxillary outer lobe with simple palp, basal chaeta and with two sublobal hairs. Labial palp of type A.

Pso formula dorsally: 32/01(2)/2/331(2)/32; ventrally: 2/000/0000. Subcoxae 1 of I–III legs without pso. Submedial pso a and b on Abd. terga I–II located far apart, i.e. pso b laterally from chaetae p5. Psx present on Abd. sterna I, II and on upper anal valve (0/000/110001\textsuperscript{m}) (Figs. 4 and 7). Formula psp (size almost as 1/4 of pso) dorsally: 0/011/011, ventrally: 0?1//111, ventrally: 0?1//111.

Dorsal chaetotaxy, usually asymmetrical, as in Fig. 1, well differentiated into macrochaetae and microchaetae. Sensory chaetae s’ indistinct. On head p2 chaetae displaced forward in relation to p1 and p3. Chaetae p6 on head between pso a and b. Th. tergum I with 7–9+7–9 chaetae, chaeta m absent (i2–, –1–). Th. terga II and III with lateral microsensilla. Chaetae s’ absent on Abd. terga I–III and V. Abd. tergum IV with me-
Figs. 1–8. Protaphorura bakhchisaraiaca sp. nov. (1) habitus and dorsal chaetotaxy; (2) PAO and anterior cephalic pseudocell; (3) antennal III sense organ; (4) chaetotaxy of Abd. sterna I–VI (female); (5) distal part of ventral tube; (6) tibiotarsal chaetotaxy and claw of leg III; (7) chaetotaxy of Abd. sterna II–V (male); (8) modified chaetae of mvo.
diad chaeta m, Abd. tergum V with medial chaetae p, and m (sometimes m absent). Abd. tergum VI with 1 medial chaeta m. Base of chaetae in front of anal spines in subconvergent forward arrangement (Fig. 1). M/s ratio on Abd. tergum V as 10.5–11.4/9.0–9.5 (anal spines = 10). Anal spines 0.95–1.07 times longer than inner edge of claw and 2.7–2.8 times longer than their basal diameter.

Ventral chaetotaxy. Th. sternum I–III without chaetae. Ventral chaetotaxy of Abd. sternum I–VI as in Figs. 4 and 7. Ventral tube with ca. 7–8+7–8 chaetae (4+4 thickened) (Fig. 5), and 2+2 chaetae at base. Furcal rudiment: cuticular fold (on the anterior edge of the sternum) with 1+1 microchaetae and 1+1 microchaetae at the base (i.e., 2+2 dental microchaetae in 2 rows). Chaetotaxy of manubrial field variable: 4 chaetae present in ma-row, 2–3 chaetae in mm-row and 6–7 chaetae in mp-row (Figs. 4 and 7). In adult males mvo present as 2+2 and 2+2 modified chaetae developed on Abd. sternum II and III (Figs. 7, 8 and 31) and additionally ventral tube with 4+4 thickened chaetae (Fig. 5). Male genital plate as in Fig. 34.

Legs. Subcoxae 1 of I, II and III legs with 5, 6–7, 6–7 chaetae, subcoxae 2 with 1, 4, 4, coxae with 4, 10, 14, trochanters with 11, 10, 9, femora with 18, 18, 17, tibiotarsi with four rows of chaetae (A+T)(=distal whorl)+B+C: 11+8+3, 11+8+3, 11+8+4 chaetae respectively (fig. 6). Femur papillae. Microsensillum on Ant. iV in usual position above second proximal row of chaetae. AiiiO with five guard chaetae, five papillae, two smooth sensory rods, two straight and subapical organite in cavity, without cuticular granulated sensory clubs, ventro-lateral microsensillum present (Figs. 11 and 27). Ant. iV with 9–12 chaetae, Ant. ii with 17–18 chaetae. Antennae of almost the same length as head. Ant. I with 9–12 chaetae, Ant. II with 17–18 chaetae. Antennae with five guard chaetae, five papillae, two smooth sensory rods, two straight and granulated sensory clubs, ventro-lateral microsensillum present (Figs. 11 and 27). Ant. IV with subapical organite in cavity, without cuticular papillae. Microsensillum on Ant. IV in usual position above second proximal row of chaetae. Ant. IV with very numerous ventral chaetae (ca. 85) (Fig. 10). Sensilla on Ant. IV indistinct.

Etymology

The name of the new species refers to Bakhchisarai, the former capital of Crimean Tatars and the place where the type specimens originated.

Discussion

The new species seems to be the most similar in the structure of mvo to P. kopetdagii from the Central Asia desert. Both species have the modified chaetae on Abd. sternum II and III (2+2 and 2+2) and are characterized by lacking the pso on all subcoxae 1’s, but can be easily distinguished by different pso formulas (32/01(2)/2/3312/32 dorsally and 2/000/0001 ventrally in the new species, 32/0223/33232 dorsally and 2/000/0001 ventrally in P. kopetdagii), by the shape of chaetae on ventral tube (4+4 thickened chaetae in the new species and absent these chaetae in P. kopetdagii) and also shape of mvo chaetae.

The new species is also similar to the Siberian P. salsa sp. nov. by lacking the pso on all subcoxae 1, chaetae on Abd. terga I–III, and V, and by the presence 2 + 2 pso on the head ventrally. They differ in the dorsal pso formula and also by the number of modified chaetae in mvo on Abd. sternum III (see also description of P. salsa).

Among the Protaphorura species with the mvo, the only sympatric one is P. ajudagi. Specimens of the both species have the same number of dorsal and ventral pso. However, they clearly differ by the number and the shape of mvo modified chaetae and their locations (see the key).

Protaphorura salsa sp. nov.
(Figs. 9–15, 27–30, 33)

Type Material


Diagnosis

PAO with 28–35 simple vesicles. Pso formula: 33/022/3324(3)3 dorsally, 2/000/0001 ventrally, subcoxae without pso. Mvo on Abd. sternum II and III with 2+2 and 1+1 modified chaetae. Submedi- pso a and b on Abd. terga i and ii located close together. Pso formula on Abd. sternum: 110001”. Th. tergum I with 8–9+8–9 chaetae, chaeta m absent. Chaetae s’ absent on Abd. terga I–III and V.

Description

Holotype (preadult male) length 1.94 mm, length of paratypes: 2.0–2.31 mm (females), 1.72–2.32 mm (males). Shape of body typical for the genus: cylindrical with strong anal spines on distinct papillae (Fig. 9). Colour in alcohol white. Granulation distinct more or less uniform. Base of antennae well marked. Usually 11–13 grains around each pso.

Antennae of almost the same length as head. Ant. I with 9–12 chaetae, Ant. II with 17–18 chaetae. Antennae with five guard chaetae, five papillae, two smooth sensory rods, two straight and granulated sensory clubs, ventro-lateral microsensillum present (Figs. 11 and 27). Ant. IV with subapical organite in cavity, without cuticular papillae. Microsensillum on Ant. IV in usual position above second proximal row of chaetae. Ant. IV with very numerous ventral chaetae (ca. 85) (Fig. 10). Sensilla on Ant. IV indistinct.

PAO with 28–35 simple vesicles (Figs. 12 and 28). Labral formula of chaetae: 4/342. Maxil-
Figs. 9–15. *Protaphorura salsa* sp. nov. (9) habitus and dorsal chaetotaxy; (10) ventral side of Ant. IV; (11) dorsal side of Ant. III–IV; (12) PAO and anterior cephalic pseudocelli; (13) tibiotarsal chaetotaxy and claw of leg III; (14) modified chaetae of mvo; (15) chaetotaxy of Abd. sterna I–V.
lary outer lobe with simple palp, basal chaeta and with two sublobal hairs. Labial palp of type A. PsO formula dorsally: 33/022/3324(3)3 (Abd. IV with 3(2) psO in medial and one in dorsolateral positions, lateral psO absent); ventrally: 2/000/0001 (Figs. 9 and 15). Subcoxae 1 of I–III legs without psO. Submedial psO a and b on Abd. terga I–II placed close together. PsO present on Abd. sterna I, II and on upper anal valve (psx formula 0/000/110001) (Fig. 15). PsO (size almost as 2/3 of psO) formula dorsally: 0/011/1111, ventrally: 0/011/0111*11* (-= single psO in medial position: Abd. II in anterior part, in Abd. III in posterior part, in Abd. IV at base of manubrial area), coxae with 1 psO each.

Dorsal chaetotaxy, not fully symmetrical, as in Fig. 9, well differentiated into macrochaetae and microchaetae. Sensory chaetae s indistinct. On head p2 chaetae displaced forward in relation to p1 and p3. Chaetae p6 on head between psO a and b. Th. tergum I with 8–9+8–9 chaetae, chaeta m absent on i(2). Th. terga II and III with lateral microsensilla. Chaetae s’ absent on Abd. terga I–III and V. Abd. tergum IV with medial chaeta m, rarely absent). Abd. tergum V with medial chaetae p, and m, rarely absent m,. Abd. tergum VI with 1 medial chaeta (m). Base of chaetae in front of anal spines in subconvergent forward arrangement. M/s ratio on Abd. tergum V as 21.6 /8.6 (anal spines = 10). Anal spines 1.4–1.56 times longer than inner edge of claw and 2–2.5 times longer than their basal diameter.

Ventral chaetotaxy. Th. sterna I–III without chaetae. Chaetotaxy of Abd. sterna I–VI as in Fig. 15. Ventral tube with ca. 9+9 chaetae, and 2+3 chaetae at base (Fig. 15). Furcal rudiment: cuticular fold (on the anterior edge of the sternum) with 2+2 dental microchaetae. Chaetotaxy of manubrial field variable: 4 chaetae present in ma-row, 2–4 chaetae in mm-row and 6–7 chaetae in mp-row (Figs. 15 and 29). Mvo present: in preadult males on Abd. sterna II and III as 2+2 and 1+1 modified chaetae respectively (Figs. 14, 15 and 30). Adult male not found in the material (Fig. 33).

Legs. Subcoxae 1 of I, II and III legs with 5–6, 6–7, 6–7 chaetae, subcoxae 2 with 1, 5, 4–3, coxae with 4, 10–11, 14–13), trochanteris with 11, 11, 10, femora with 19 each, tibiotarsi with four rows of chaetae (A+T=M=distal whorl)+B+C: 11+8+3, 11+8+3, 11+8+4 chaetae respectively. Claw narrow and long, always with strong denticle in the 1/2 of inner edge of claw (Fig. 13). Empodial appendage almost equal in length to inner edge of claw, without basal lamella. (Fig. 13).

Etymology

The name of the new species refers to the salty (in Latin: salsus) type of locality.

DISCUSSION

The shape of mvo in a new species is similar to P. christianseni and P. stiriaca. All three species possess modified chaetae on Abd. sterna II (2+2) and III (1+1), but they differ in the dorsal and ventral psO formula: 33/022/3324(3)3 and 2/000/0001 in the new species, 33/012/33333 and 1/000/0000 in P. christianseni, 32/001/23232 and ventrally lack psO in P. stiriaca. The new species and P. stiriaca have no psO on subcoxae 1 (vs. 1,1,1 in P. christianseni). See also the discussion of P. bakchisaraiaca sp. nov.

ProtaPhorura Ianstachi (Yosii, 1972) (Figs. 16–20)

Onychiurus octopunctatus (Tullberg, 1876) sensu Stach (1934): 134–138, partim

Type Material

Lectotype (by present designation): male Georgia: Mt. Mtsheta, Armazi Gorge NW Tbilisi, with the original label: “Caucasus, Mechet, Wąwóz armarski, 28-IV-1918, leg. Roszkowski; Onychiurus octopunctatus, det. J. Stach”. The only one preserved specimen is not in good condition and for that only some details are given.

Redescription

Lectotype (male) length 1.1 mm. Shape of body typical for the genus: cylindrical with strong anal spines on distinct papillae (Fig. 16). Granulation more or less uniform, distinct. Base of antennae well marked.

Antennae of almost the same length as head. AIIO with five guard chaetae, five papillae, two smooth sensory rods, two straight and granulated sensory clubs, ventro-lateral microsensillum present. Ant. IV with subapical organite in cavity, without cuticular papillae. Microsensillum on Ant. IV in usual position above second proximal row of chaetae. Ventrally Ant. IV with numerous chaetae. Sensilla indistinct on Ant. IV.

PAO with about 28 simple vesicles. Maxillary outer lobe with simple palp, basal chaeta and with two sublobal hairs. Labial palp of type A.

PsO formula dorsally: 42/022/33332, ventrally: 2/000/0000. Subcoxae 1 of I–III legs with 1,1,1 psO. Submedial psO a and b on Abd. terga I–II located far apart (Fig. 19), almost the same distance as on Abd. tergum III. PsO invisible.

Dorsal chaetotaxy well differentiated into macrochaetae and microchaetae. On head p2 chaetae displaced forward in relation to p1 and p3 (Fig. 18). Chaetae p6 between psO a and b on head. Th. tergum I with 7+8 chaetae, chaeta
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m absent Fig. 17). Th. terga II and III with lateral microsensilla. Chaetaes’ absent on Abd. terga I–III and V (Fig. 16). Abd. tergum V with medial chaeta p1. Abd. tergum VI with medial chaeta m1 (Fig. 16). Base of chaetae in front of anal spines in parallel arrangement. M/s ratio on Abd. tergum V as 16/10 (anal spines = 10). Anal spines slightly shorter than inner edge of claw (0.9:1) and 3.3 times longer than their basal diameter.

Ventral chaetotaxy. Th. sterna I–III without chaetae. Ventral tube with ca. 7+7 chaetae, and 1+1 chaetae at base. Chaetotaxy of medial part of Abd. sterna II–III as in Fig. 20. Mvo present on posterior edge of Abd. sternum II and anterior edge of Abd. sternum III with 2+2 (join chaetal socket on each side) and 1+1 modified chaetae respectively (Fig. 20). Furcal rudiment: cuticular fold (on the anterior edge of the sternum).

Distal whorl (A+T) of tibiotarsi with 11 chaetae. Claw with small denticle in the 1/2 of inner edge of claw. Empodial appendage of almost the same length as the inner edge of the claw, without basal lamella.

Remarks

Stach (1934: p. 135–136) partly redescribed P. octopunctata using the specimens from Caucasus. He had handled (after Stach 1954) 8 specimens from which only 2 have been found by us in his collection. One of Stach’s slides contains a male, the second one shows a fragmented female belonging to another species – P. sakatoi (Yosii, 1966), and the third one does not contain any animal. Yosii (1972) during his research of the alpine fauna of Mt. Poroshi (Hokkaido) at the occasion of the description specimens of O. (Protaphoruta) octopunctatus pronounced: “... Accordingly, the species determined by Stach as O. octopunctatus, which has distinct male ventral organ, must be regarded as an independent species, for which the name O. ianstachi sp. nov. is given herewith. ...”.

After examining the male of the Stach’s collection we confirm the decision of R. Yosii.

Later additional Protaphorura species with 4 and more pseudocelli at antennal base were erected by Pomorski & Kaprus’ (2007) as the oc-
topunctata group. In the same paper they redescribed the most known *P. quadriocellata* (Gisin, 1947) and *P. octopunctata* (Tullberg, 1876) and described two new species. It was found that *P. octopunctata* was distributed only in North and Middle Siberia, whereas 15 other species from this Colembola group inhabit Europe and the Caucasus (Kaprus’ & Pomorski 2005). Among them only 2 species have the mvo *P. ianstachi* and *P. eichhorni* (Gisin 1954). However, they clearly differ by the dorsal pseudocellar formula, details of chaetotaxy and location of the mvo (see key below).

Two other above mentioned species, *P. octopunctata* and *P. sakatoi*, clearly differ one from another and from *P. ianstachi* by presence/absence of mvo (present only in *P. ianstachi*) and the pseudocellar formula (42/022/33332 dorsally and 2/000/0000 ventrally, subcoxae 1 of i–iii legs with 1,1,1 pso in *P. ianstachi*, 4(5,6)3(4)/022/3335(4)3(4,5) dorsally and 1/000/0000 ventrally, subcoxae 1 of I–III legs with 0,0,0 pso in *P. octopunctata*, 43/022/33343 dorsally and 0/000/0000 ventrally, subcoxae 1 of I–III legs with 1,0,0 pso in *P. sakatoi*).

**Protaphorura stiriaca** (Stach, 1946)  
(Figs. 21–26, 32)

**Onychiurus stiriacus** Stach, 1946: 13–17, pl. V

**Type Material**

Lectotype (by present designation): male Austria: Upper Styria, Enns river valley near Admont, direction to Frauen mountain, 31111940, gap of wildbrook, from leaves of hazels, oaks, willows, leg. H. Franz. Paralectotypes: 2 males and 2 females, data same as Lectotype.

**Redescription**

Lectotype (male) length 1.9 mm, paralectotypes: females 1.7–1.9 mm, males 1.8 mm. Shape of body typical of the genus: cylindrical, but with very small anal spines on very low papillae (Fig. 25). Granulation more or less uniform, distinct. Base of antennae slightly marked.

Antennae of almost the same length as head. AIIIO with five guard chaetae, five papillae, two smooth sensory rods, two sensory clubs different in size: one greater, ovoid, morel-like, the other one smaller, round, sponge-like, ventro-lateral microsensillum present. Ant. IV with subapical organite in cavity, without cuticular papillae. Microsensillum on Ant. IV in usual position above second proximal row of chaetae. Sensilla indistinct on Ant. IV, ventrally Ant. IV with about 75 chaetae. PAO with about 38–41 simple vesicles. Maxillary outer lobe with simple palp, basal chaeta and with two subglobal hairs. Labral formula: 4/342. Labial palp of type A.

Pso formula dorsally: 32/001/33232, ventrally without pso. Subcoxae 1 of I–III legs without pso. Submedial pso a and b on Abd. terga I–II placed close together (Fig. 23). Psp visible only on Abd. sternum IV below manubrial area.

Dorsal chaetotaxy well differentiated into macrochaetae and microchaetae. On head the p2 chaetae displaced forward in relation to p1 and p3 (Fig. 22). Chaetae p6 on head above pso b. Th. tergum I with 9–11+9–11 chaetae, chaeta m absent (i2(3)) (Fig. 21). Th. terga II and III with lateral microsensilla. Chaetaes’ absent on Abd. terga I–III and V (Figs. 23 and 25). Abd. tergum IV with one medial chaeta m, Abd. tergum V with medial chaeta p, m, present or absent. Abd. tergum VI with one medial chaeta p (Fig. 25). Base of chaetae in front of anal spines in parallel arrangement. M/s ratio on Abd. tergum V as 54/42 (anal spines = 10). Anal spines shorter than half of inner edge of claw (0.33:1) and 2.4 times longer than their basal diameter.

Ventral chaetotaxy. Th. sterna I–III with 1,1,1 chaetae. Ventral tube with ca. 8–9+8–9 chaetae, and 1+1 chaetae at base. Mvo present on posterior edge of Abd. sternum II and III (in p-row chaetae) with 2+2 and 1+1 modified chaetae respectively (Figs. 24 and 32). Chaetotaxy of Abd. sternum IV as in Fig. 26. Furcal rudiment below one row of chaetae: cuticular fold with 2+2 dental chaetae, three manubrial rows with 4 ma, 2 mm and 6 mp chaetae.

Legs. Subcoxae 1 of I, II and III legs with 5, 6–7, 5 chaetae, subcoxae 2 with 1, 5, 5, coxae with 3, 11, 15, trochanters with 10, 11, 11, femora with 20 each, tibiotarsi with four rows of chaetae (A+T (=distal whorl)+B+C: 11+8+5) each. Claw with strong denticle in middle of inner edge of claw. Empodial appendage almost the same length as inner edge of claw, without basal lamella.

**Remarks**

*Protaphorura stiriaca* has been described by Stach about 70 years ago (in 1946), when many important diagnostic characters remained unknown, but the status of this species was discussed by Pomorski et al. (2003). However, the species was never redescribed and we do so based on type specimens.

**Key to Males of Protaphorura Species With the Ventral Organ**

1. Subcoxa 1 of legs I–III with 1,1,1 or 1,0,0 pso. ........................................... 2

2. Subcoxa 1 of legs I–III without pso .......................................................... 6
2. Subcoxa 1 of legs I–III with 1,1,1 pso .......................... 3
   —. Subcoxa 1 of legs I–III with 1,0,0 pso, dorsal pso formula: 3(4)3(2)/022/33(4):3432(3), ventral tube with 6-8+6-8 modified chaetae .......................... P. stogovi Pomorski

3. Base of antennae with 4 pso. ................................................. 4
   —. Base of antennae with 3 pso ............................................. 5

4. Mvo on Abd. sternum II (posterior edge) and III (anterior edge) as 2+2 and 1+1 modified chaetae, dorsal pso formula: 42/022/33332 ............................................. P. ianstachi (Yosii)
   —. Mvo on Abd. sternum II (posterior edge) and III (anterior edge) as modified chaetae 3 and 6 respectively, dorsal pso formula: 43(4)/022/3335(6):34(4) ...................... P. eichhorni (Gisin)

Figs. 21–26. Protaphorura stiriaca (Stach, 1946), type specimens. (21) chaetotaxy of Th. terga I–II; (22) position of p-chaetae on posterior margin of head; (23) chaetotaxy of Abd. tergum II; (24) mvo; (25) chaetotaxy of Abd. terga V–VI; (26) chaetotaxy of Abd. sternum IV.
Figs. 27–32. *Protaphorura salsa* sp. nov.: (27) AIII O; (28) PAO; (29) Furcal area; (30) Abd. sterna II and III with mvo, preadult male; *Protaphorura bakhchisaraica* sp. nov.: (31) Abd. sterna II and III with mvo, adult male; *P. stiriaca* (Stach, 1946): (32) Abd. sterna II and III with mvo, adult male. Arrows show the modified chaetae.
5. Mvo on ventral tube with 6+6 modified chaetae, dorsal pso formula: 33/023/33343

—. Mvo on Abd. sternum II and III (posterior edge) as 2+2 and 1+1 modified chaetae, dorsal pso formula: 33/012/33333

6. Mvo with two modified brush-shaped chaetae on each anal valves, dorsal pso formula: 33/012/33332

—. Mvo with modified chaetae on different abdominal sterna

7. Modified chaetae of mvo on Abd. sterna II–IV

—. Modified chaetae of mvo on Abd. sterna II–III

8. Mvo on Abd. sterna II–IV with modified chaetae 4,10–12, 16 respectively, dorsal pso formula: 32(3)/011/23232. Anal spines very small

—. Mvo on Abd. sterna II–IV with modified chaetae: 7, 12, 11 respectively, dorsal pso formula: 32/022/33332. Anal spines normal

9. Mvo on Abd. sterna II–III with modified chaetae 2+2 and 1+1 respectively

—. Mvo on Abd. sterna II–III with modified chaetae 2+2 and 2+2 respectively

10. Dorsal pso formula: 32/001/23232, ventrally without pso

—. Dorsal pso formula: 33/022/3324(3)3, ventrally: 2/000/0001

11. Dorsal pso formula: 32/022/33332, ventrally: 2/000/0001, thickened chaetae on ventral tube absent

—. Dorsal pso formula: 32/01(2)/331(2)/32, ventrally: 2/000/0000, ventral tube with 4+4 thickened chaetae

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