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A new species of the springtail genus *Hypogastrura* (Collembola: Hypogastruridae) from southern Kazakhstan, Middle Asia

Новый вид коллембол рода *Hypogastrura* (Collembola: Hypogastruridae) из южного Казахстана, Средняя Азия

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КЛЮЧЕВЫЕ СЛОВА: группа manubrialis, «Центральная Азия», пустыня.

ABSTRACT: *Hypogastrura crinigera* **sp.n.**, a new species of the *manubrialis*-group, is described from the Kyzylkum sandy desert, southern Kazakhstan. The species is easily distinguished from all other described species of the group by a small number of differentiated sensilla on Ant. IV, a peculiar maxillary head, the long, thick and clearly serrate setae covering the entire body, as well as the relatively large size of the anal spines.

РЕЗЮМЕ: Из песчаной пустыни Кызылкум (Южный Казахстан) описан новый вид группы *manubrialis*: *Hypogastrura crinigera* **sp.n.** Вид легко отличается от всех других описанных представителей группы небольшим числом дифференцированных сенсилл на Ant. IV, своеобразной максиллярной головкой, длинными, утолщенными и четко зазубренными хетами, покрывающими все тело, а также относительно крупными размерами анальных шипов.

Introduction

The first information on the springtail fauna of the Middle Asian republics of the former USSR, i.e. Kazakhstan, Uzbekistan, Turkmenistan, Tajikistan and Kyrgyzstan, have only appeared relatively recently, in the middle of the last century. Thus, in the catalogue of springtails by Grinbergs [1960], only one species was listed from that entire very vast territory: *Isotoma turkestanica* Stach, 1947, currently treated as a junior synonym of *I. spinicauda* Bonet, 1930, recorded from the vicinity of Tashkent, Uzbekistan. Intense research on the soil fauna of the region started only at the turn of the 1960s and 1970s [Martynova, 1967–1972, 1975; Martynova, Chikatunov, 1968; Vtorov, Martynova, 1975, 1976, 1977]. Then, numerous new forms were described, including two new species of the genus *Hypogastrura* Börner, 1906: *H. tianshanica* Martynova, 1970 and *H. rangkuli* Martynova, 1975. Further Middle Asian species from the same genus were published later [Babenko *et al*., 1994; Skarżyński, 2010], almost all of them belonging to the *manubrialis*-group, like the new species described below.

The springtail fauna of Kazakhstan, a country occupying the northernmost part of the Middle Asian region, has been studied not only insufficiently, but also highly patchily. The available literature data are limited either to the northernmost steppe regions of Kazakhstan [Tereshkova, 1976a, b; Tereshkova, Smelova, 1977; Stebaeva, 1984, 2005; Stebaeva, Shestopalova, 1985; Babenko *et al*., 1994; Bretfeld, 1996] or are based on material from its southern, mountainous part [Bretfeld, 2000]. There is no information on the Collembola from the desert regions of the republic. It seems noteworthy that most species of *Hypogastrura*, including representatives of the *manubrialis*-group, are rather hygrophilous forms, usually associated with humid habitats [Chernova, 1994]. In this regard, the discovery of a new species in a typical desert patch with sparse vegetation (Fig. 1), together with representatives of such xerophilous genera as *Axenyllodes* Stach, 1949, *Folsomides* Stach, 1922 etc. appears to be remarkable, the more so that this species was found abundant. Yet, according to the collector, during field work the study area was subject to frequent rains, and fog with dew was not uncommon in the morning.

ABBREVIATIONS:

Abd. I–VI — abdominal segments; Ant. I–IV — antennal segments; alt. — altitude; AO — antennal organ on Ant. III; A–E papillae — papillae on labial palp; a-, m- and p-setae — setae of anterior, median and posterior rows on terga, respectively; a1, b1, b2, d2, e2 — guards of corresponding labial

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papillae; L.1–6 — maxillary lamellae; leg. — legit (collector); lp — lateral process on labium; ms — microsensillum(a); MSPU — Zoology and Ecology Department of the Moscow State Pedagogical University; or — antennal organite; PAO — postantennal organ; Th. I–III — thoracic segments; S1–9 — sensilla on Ant. IV; v-setae — setae on *area verticalis* of head; VT — ventral tube.

Taxonomy

Hypogastrura crinigera sp.n.

Figs 1–20.

TYPE MATERIAL: Holotype female, Kazakhstan, Turkistan Region, East Kyzylkum sandy desert, basin of Syr Darya River, 85 km W of Arys, 42.2325°N 67.8128°E, 230 m alt., pitfall-traps, 14–16 October 2023, L. Kim leg. Deposited in MSPU.

Paratypes, 11 female, 11 males on slides, 8 slides with head parts, same data and deposition. 1 female, 3 males and 1 slide with mouthparts kept in the author's collection.

OTHER MATERIAL: ca 100 specimens in alcohol from other 8 places located from 200 meters to 7 kilometers from the type locality.

DIAGNOSIS. A species of the *manubrialis*-group that differs from other members of the group by the following characters: the long, thick and strongly serrate setae covering the whole body, including a few basal antennomeres; the quite large anal spines; only four clearly differentiated sensilla on Ant. IV; the characteristic maxillary head with a short L.1 with a slightly broadened tip covered with two rows of filaments (apical and subapical), and several stiff spines in addition to small denticles at the base; and some peculiarities of chaetotaxy, for instance, the absence of setae m2 from both Th. II–III and of an m-row on Abd. V.

DESCRIPTION. Body length of holotype discarding antennae —1.5 mm, sizes of males and females barely varying: female — 1.3 (1.09–1.61) mm, male — 1.16 (1.00–1.26) mm. Habitus typical of the genus. Body colour in alcohol dark blue (Fig. 2), ventral side slightly paler, especially in furcal area (Fig. 3). Integument granulation moderate to quite coarse, usually with 5–9 conical granules between setae p1 on Abd. V.

Antennae subequal in length to head. Ant. IV usually with a simple apical bulb (Figs 7, 16), sometimes with an outgrowth (Fig. 17); common setae smooth or slightly jagged, sensilla (three on outer lateral side, S7, S8, S9 and one dorsal, S?) cylindrical, elongate and more strongly curved than common setae (Figs 7–8), seta i not identified; subapical organite (or) and microsensillum (ms) present, as usual. Ant. III with a typical AO, composed of two short, inner, roundish sensilla, two elongated guard sensilla and one ms on outer side, common setae on Ant. III usually serrate (Figs 7–8). Ant. I–II with 7 (seta p' absent) and 13 serrate setae, respectively, those on ventral side somewhat more smooth.

Head with 8+8 subequal eyes. PAO 1–1.3 as long as adjacent ocellus, consisting of four bean-shaped lobes subequal in size, sometimes with minor outgrowths, an accessory boss invisible (Fig. 19). Papillae on distal edge of labrum hardly expressed (Fig. 20), setal formula: 4/554. Labial palp with a full set of papillae (A–E), 14 usual guards (among them a1, b1, b2, d2, and e2 shorter and borne by low papillae) and six proximal setae, a lateral process (lp) invisible. Basomedial field on labium (submentum) with four setae, basolateral field (mentum) with five setae, as usual.

Head with 3+3 postlabial setae along ventral line. Maxillary head with three teeth on main part and six lamellae (Figs 6, 18): L.1 not extending past tip of maxillary teeth, barely broadened, with an apical and a subapical row of filaments, also with a few bristles in basal part; L.2 and L.3 with short marginal filaments, all other lamellae beset with fine denticles. Outer maxillary lobe simple, with two sublobal hairs, as typical of the genus.

Head chaetotaxy typical, with 2+2 v-setae (Fig. 13). Dorsal setae on head and body poorly differentiated, long, thick and distinctly serrate, on last abdominal segments slightly longer (Fig. 4). Sensorial setae well-discernible, smooth, twice as thin and 0.2–0.8 times as long as common ones (Fig. 5). Tergal chaetotaxy complete and typical of the group, with p4 and m7 on Th. II–III, p5 on Abd. I–IV and p3 on Abd. V being sensorial setae. The only notable characters are the absence of setae m2 from Th. II and of an m-row from Abd. V (Figs 13–15).

Chaetotaxy of legs 1–3 as follows: upper subcoxae — 1, 2, 3 (all macrosetae); lower subcoxae — 0, 3, 3 (one macroseta, two microsetae); coxae — 3, 7(8), 6(7); trochanters — 7, 7, 7; femora — 13, 13, 12; tibiotarsi — 19, 19, 18 setae, respectively. Tibiotarsal tenent setae (1–1–1) weakly clavate, about as long as 1.2–1.4 inner unguis edge (Fig. 11). Unguis with a clear inner tooth slightly shifted towards apical part, lateral teeth invisible. Unguiculus slightly exceeding the middle of unguis inner edge, basal lamella narrow (Fig. 11).

Ventral tube with 4+4 distal setae. Retinaculum with 4+4 teeth. Furca well-developed. Dorsal side of dens with roundish coarse granulations and seven mostly smooth setae (sometimes bearing a few serrations visible under high magnification); outer basal seta as long as 0.6 dens (Fig. 9). Mucro approximately 0.3–0.4 as long as dens, curved ventrally to varying degrees. Outer lamella rather high, with a subapical excavation in lateral view (Fig. 10).

Abdominal tip with high, clearly defined papillae bearing the anal spines. Spines rather variable in length: from equal to papillae to 2 times larger (Fig. 12). Inner edge of unguis to anal spines length ratio as 1 : 0.60–0.86.

VARIABILITY. The following aberrations have been revealed in the type material: three anal spines on Abd. VI, absence of PAO from one of the sides of the head, asymmetric absence of m4 on Th. II, and split tergal setae.

NAME DERIVATION. The species is named for its unusually long dorsal setae. The epithet "*crinigera*" is the feminine singular of the Latin adjective "*criniger*" (meaning "having long hair").

DISTRIBUTION AND ECOLOGY. Known only from the type locality: East Kyzylkum sandy desert, Kazakhstan.

AFFINITIES. The most noticeable distinguishing feature of *H. crinigera* **sp.n.** is undoubtedly its dorsal chaetom formed by long, thickened and strongly serrate setae, which taper only slightly towards their tips. Nothing similar is known for the described species of the genus. Hardly surprisingly, during the initial sorting the material it was considered a representative of the genus *Ceratophysella* Börner, 1932 rather than *Hypogastrura*. However, in fact it turned out to be a fairly typical species of the *manubrialis*-group, characterized by all usual features of the group: maxillary head with a modified L.1; weakly distinguished sensilla on Ant. IV; labrum without or with unclear distal papillae; unguiculus with a narrow basal lamella; not more than 1–1–1 tibiotarsal tenent setae; VT with 4+4 setae; retinaculum with 3+3 or 4+4 teeth; dens with seven setae, and comparatively coarse granulations on dens and body [Yosii, 1960; Christiansen, Bellinger, 1980; Babenko *et al*., 1994; Skarżyński, 2009].

Fig. 1–3. *Hypogastrura crinigera* **sp.n.**: 1 — the type locality; 2, 3 — *H. crinigera* **sp.n.**, non-type, in alcohol, dorsal and lateral views, respectively.
Рис. 1–3. *Hypogastrura crinigera* **sp.n.**: 1 — типовое местообитание; 2, 3 — *H. crinigera* **sp.n.**, нетиповой образец, в спирте, дорсальный и латеральный виды, соответственно.

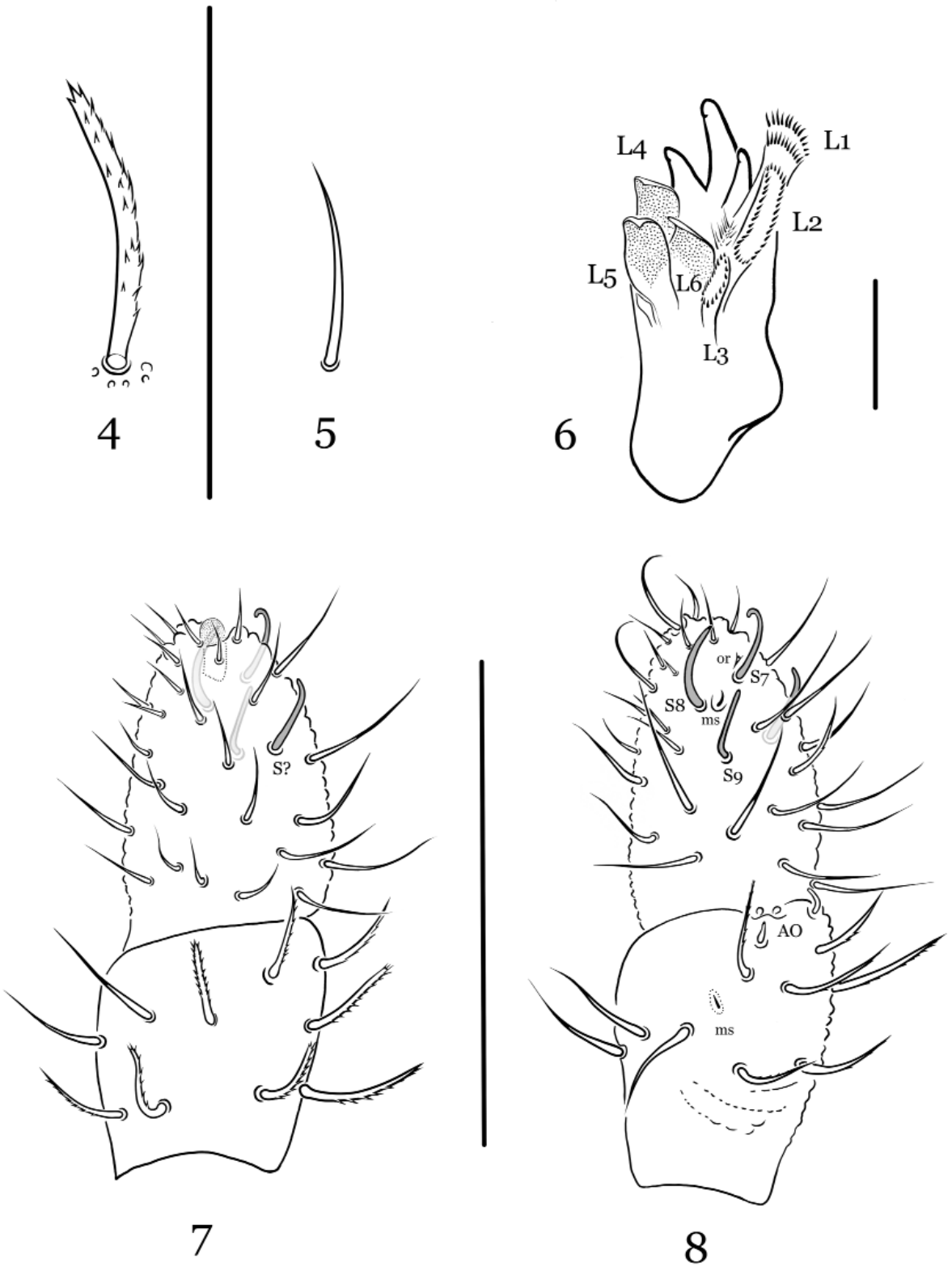


Fig. 4–8. *Hypogastrura crinigera* **sp.n.**: 4 — common seta of Abd. II; 5 — sensilla of Th. II; 6 — maxillary head; 7 — chaetotaxy of Ant. III–IV (dorsal side); 8 — chaetotaxy of Ant. III–IV (outer lateral side). Scales: 0.1 mm (4, 5, 7, 8) and 0.01 mm (6).
Рис. 4–8. *Hypogastrura crinigera* **sp.n.**: 4 — обычная хета Abd. II; 5 — сенсилла Th. II; 6 — максиллярная головка; 7 — хетотаксия Ant. III–IV (дорсальная сторона); 8 — хетотаксия Ant. III–IV (внешняя латеральная сторона). Масштаб: 0,1 мм (4, 5, 7, 8) и 0,01 мм (6).

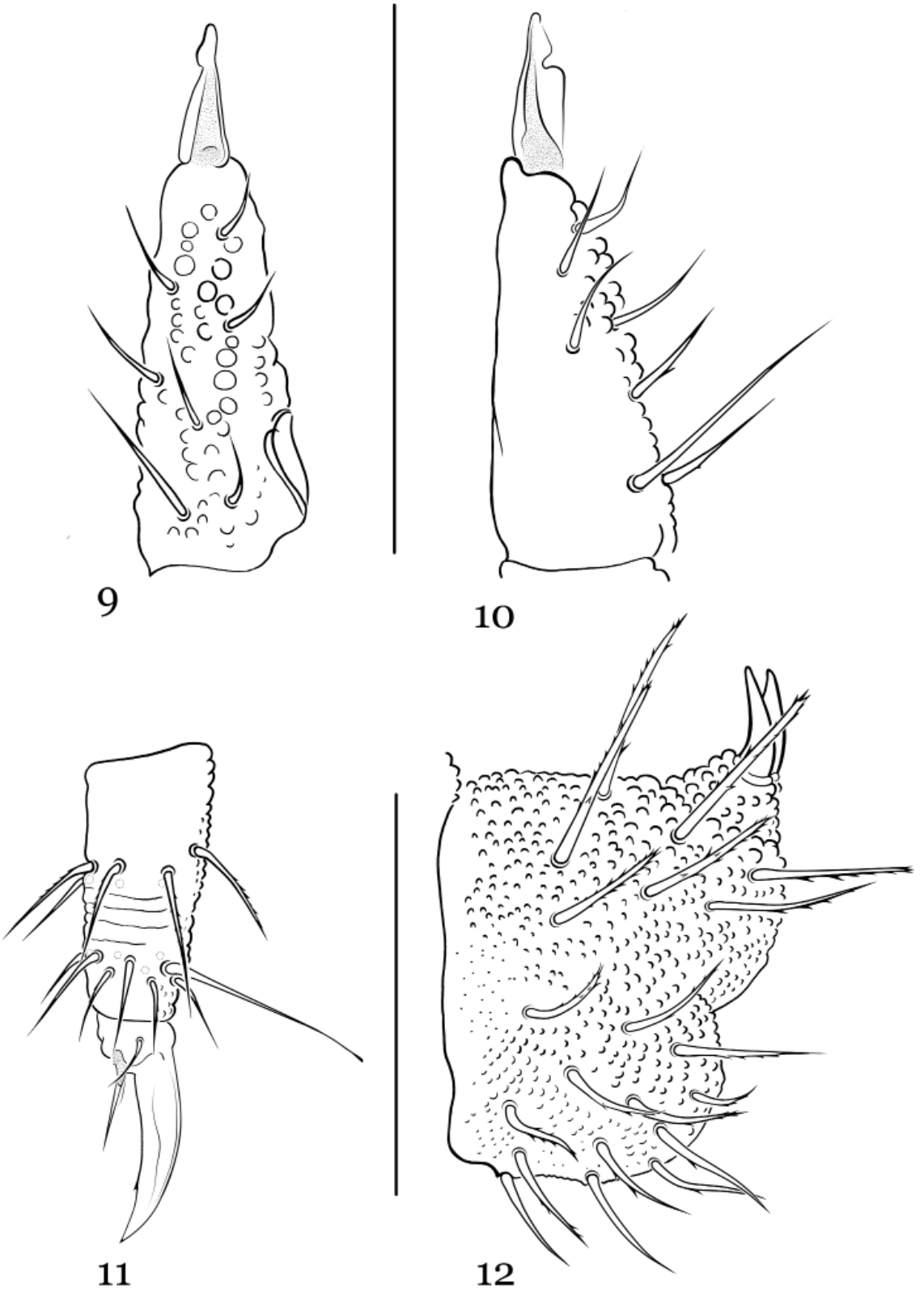
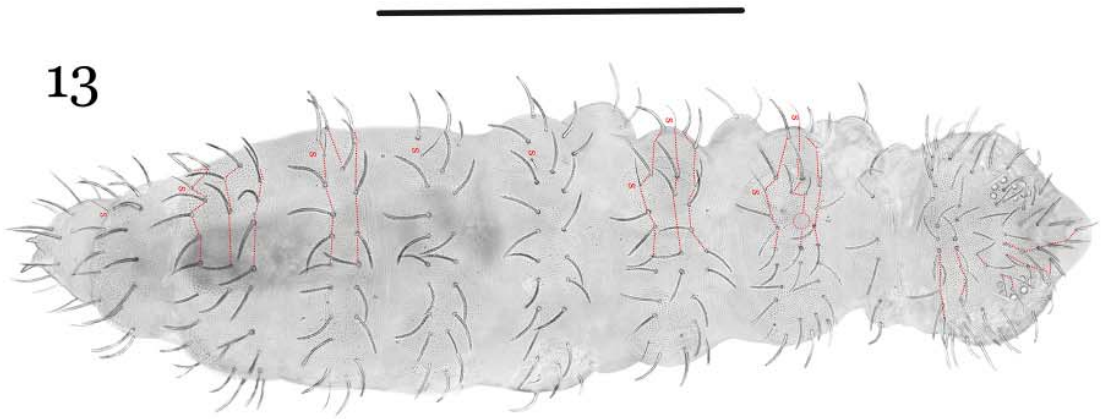
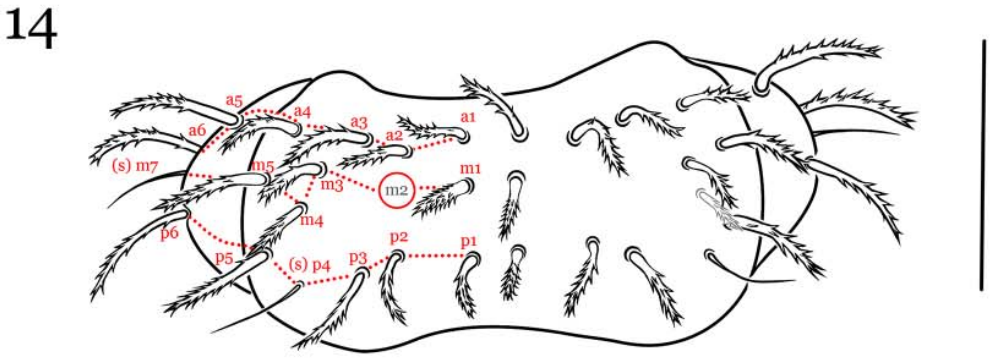


Fig. 9–12. *Hypogastrura crinigera* **sp.n.**: 9 — dorsal view of furca; 10 — lateral view of furca; 11 — claw and tibiotarsus with tenent seta; 12 — tip of Abd. VI with anal spines (lateral view). Scale: 0.1 mm.
Рис. 9–12. *Hypogastrura crinigera* **sp.n.**: 9 — дорсальная сторона фурки; 10 — латеральная сторона фурки; 11 — коготок и тибиотарзус с головчатой хетой; 12 — анальные шипы на конце Abd. VI (вид сбоку). Масштаб: 0,1 мм.





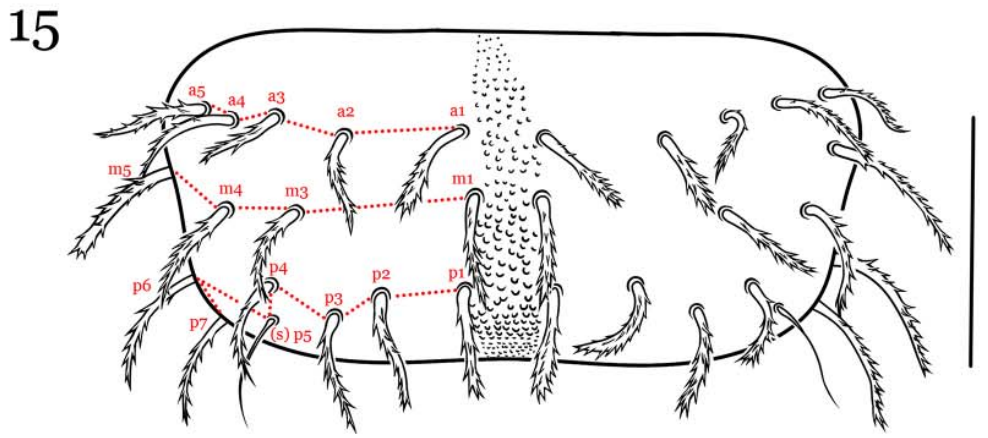


Fig. 13–15. *Hypogastrura crinigera* **sp.n.**: 13 — dorsal general view and chaetotaxy; 14 — dorsal chaetotaxy of Th. II; 15 — dorsal chaetotaxy of Abd. IV. Scale: 1 mm (13), 0.1 mm (14–15).
Рис. 13–15. *Hypogastrura crinigera* **sp.n.**: 13 — общий дорсальный вид и хетотаксия; 14 — дорсальная хетотаксия Th. II; 15 — дорсальная хетотаксия Abd. IV. Масштаб: 1 мм (13), 0,1 мм (14–15).

According to Bellinger *et al*. [1996–2024], the *manubrialis*-group is currently represented by 28 named species. *Hypogastrura crinigera* **sp.n.** shows notable differences from all known species within the group, characterized, as it was mentioned above, by the presence of unusually thick, long and strongly serrate setae that cover the entire body, extending from the antennae to the furca. Clearly serrate setae have been documented only in a few species of the group, for instance, *H. serrata* (Ågren, 1904) (Scandinavia), *H. pityusica* Ellis, 1974 (Mediterranean) and *H. tianshanica* (Tien Shan), but the degree of seta modifications in these species is hardly comparable with that of *H. crinigera* **sp.n.** Apart from this, all above species are clearly distinguishable from the new one by a number of other characters described below (see also Suppl. Table).

The chaetom in some representatives of the genus *Hypogastrura* is well known to be able of variation as a result of ecomorphosis associated with adaptations to a changing environment [Cassagnau 1955, 1956a, b; Bonfanti, 2023]. Our material was collected during only one season (autumn) and it is probably impossible to exclude a potential connection between the structure of the setae and their seasonal modification under the influence of external conditions, given the arid habitat so very atypical of the taxon. However, the combination of a number of other subtle morphological features still does not allow us to relate *H. crinigera* **sp.n.** to any of the already known species.

Up to now only one congener, *H. deserti* Babenko, 1994, appears to be known from comparable arid habitats

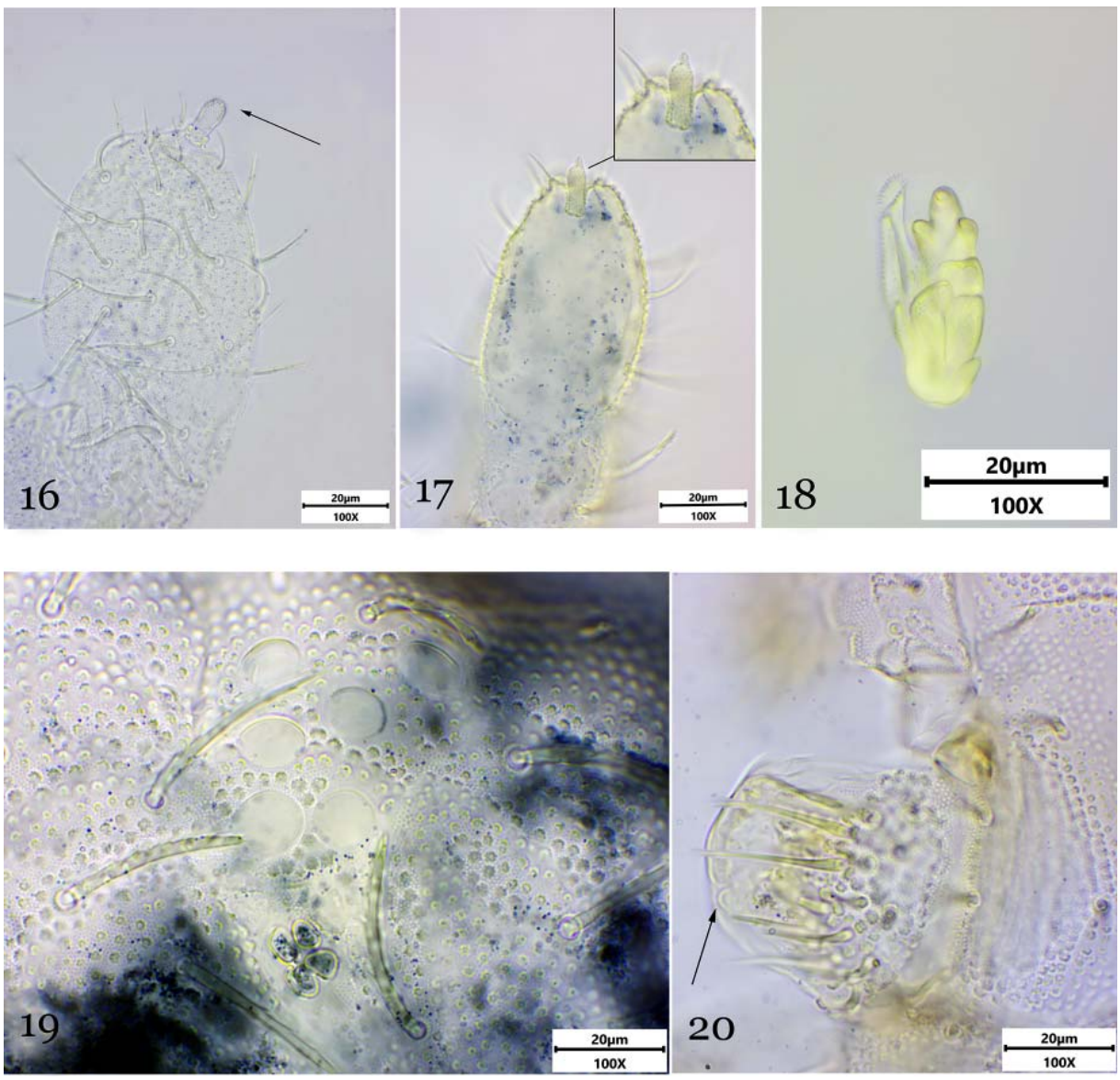


Fig. 16–20. *Hypogastrura crinigera* **sp.n.**: 16 — Ant. IV with a simple apical bulb; 17 — finger–like outgrowth on the apical bulb of Ant IV; 18 — Maxillary head; 19 — PAO and nearest ocelli; 20 — Labral edge.
Рис. 16–20. *Hypogastrura crinigera* **sp.n.**: 16 — апикальная папилла Ant. IV; 17 — пальцевидный вырост апикальной папиллы Ant. IV; 18 — головка максиллы; 19 — ПАО и окружающие глазки; 20 — край верхней губы.

(wormwood desert, Uzbekistan and the bank of a salty lake, Novosibirsk Region, Russia). This species shows a number of unique morphological characters easily distinguishing it from *H. crinigera* **sp.n.**: ventral setae on Th. II–III (absent from *H. crinigera* **sp.n.** as in all other known species of the genus), the absence of sublobal hairs (present in *H. crinigera* **sp.n.** as in the majority of other congeners), peculiar chaetotaxy of labrum (2/454, *vs* 4/554 in *H. crinigera* **sp.n.**), slightly reduced dorsal chaetotaxy, retinaculum with 3+3 teeth (*vs* 4+4 teeth in *H. crinigera* **sp.n.**), the absence of inner teeth from the unguis, different shape of mucro, fine cuticular granulations etc.

Hypogastrura crinigera **sp.n.** is significantly more similar to *H. tianshanica*, a species described from Issyk-Kul Region of Kirgizia and from a comparable habitat (dry riverbed, litter under *Perowskia*) located ~680 air-km east of the type locality of the new species. *Hypogastrura tianshanica* has similarly serrate dorsal setae, relatively long anal spines that are twice the size of papillae, and it is also characterized by the absence of p'-seta from Ant. I. However, it can be easily distinguished from *H. crinigera* **sp.n.** due to its distinctive pale coloration, the presence of setae m2 on Th. II and of m-setae on Abd. V, dorsal sensorial setae being distinctly longer than common setae, pointed tenent setae on the tibiotarsi, retinaculum with 3+3 teeth, a relatively shorter mucro and the shape of the maxillary head with a wide L.1 clearly protruding beyond the teeth.

The presence of serrate setae on the dorsal side of the body also brings the new species closer to the Holarctic *H. serrata*. Fjellberg [1998] synonymized this species with *H. ripperi* Gisin, 1952*,* suggesting this serration could be related to infections by Sporozoa, which had been noted during the species redescription by Ellis [1974]. Even without taking this into account, *H. serrata* differs from *H. crinigera* **sp.n.** quite significantly, primarily in having the *tullbergi*-type of the maxillary head and the distinctly pointed tenent setae on the tibiotarsi. Two more species, *H. tigridis* (Brown, 1926) (Iraq) and *H. pityusica*, (Mediterranean) also show ciliate dorsal setae, yet both are distinguished by having 6 instead of 7 setae on the dens.

Despite the rather incompletely studied springtail fauna of Middle Asia, a fairly large number of other species of the *manubrialis*-group have also been recorded from the region and adjacent territories. Among them, there are not only such widespread species as *H. assimilis* (Krausbauer, 1898), *H. vernalis* (Carl, 1901) and *H. manubrialis* (Tullberg, 1869), but also those known only from a limited number of habitats, in particular *H. yosii* Stach, 1964 (China and Russian Far East), *H. rangkuli* (Pamir, and also Taimyr, Alaska & India), *H. turkmenica* Babenko, 1994 (Turkmenia), *H. druki* Babenko, 1994 (Mongolia) and *H. ubsunurensis* Babenko, 1999 (Siberia).

Only three of the above widespread species, i.e. *H. assimilis*, *H. vernalis* and *H. manubrialis*, apart from the shape of the setae, differ from *H. crinigera* **sp.n.** in the length of L.1 in the maxillary head and in more than five (often up to 10) sensilla on Ant IV. Other distinguishing features are presented in Table.

Hypogastrura rangkuli was originally described from the Pamir region, located approximately 500 air-km southeast of the type locality of the newly described species. The most apparent distinguishing features are the *tullbergi*-type of the maxillary head [according to Fjellberg, 1984] and the increased number of sensilla on Ant. IV (up to 10, *vs* only 4 in *H. crinigera* **sp.n.**). *Hypogastrura turkmenica* (~1000 air-km southwest of the type locality of *H. crinigera* **sp.n.**) also differs in the peculiar structure of the maxillary capitulum [Babenko *et al*., 1994: 53] and by the presence of m-setae on Abd. V and seven sensilla on Ant. IV.

The other two Asian species, *H. yosii* and *H. druki*, both of which share with *H. crinigera* **sp.n.** coarse granulations on the cuticle and the number of teeth on the retinaculum (4+4). In addition, the former also lacks m2 setae on Th. II and setae of m-row on Abd. V, and it has weakly clavate tenent setae. *Hypogastrura yosii* may be distinguished from *H. crinigera* **sp.n.** by an increased number of sensilla on Ant. IV (9–10, *vs* 4 in *H. crinigera* **sp.n.**), rather large PAO (1.5–2.5, *vs* 1.0–1.3 times as large as adjacent ocellus in *H. crinigera* **sp.n.**), structure of the mucro, the shape of the maxillary head, and the absence of small labial guard a1 (see Babenko *et al*. [2020]) (present in *H. crinigera* **sp.n.**). *Hypogastrura druki* is also very different from *H. crinigera* **sp.n.** in having both setae m2 on Th. II and m-setae on Abd. V, as well as pointed tibiotarsal setae and long maxillary L.1.

The most characteristic feature of H. *ubsunurensis*, which makes it distinguished from *H. crinigera* **sp.n.**, is the presence of only 3+3 teeth on the retinaculum, this being not very common in the group, yet observed, for example, in *H. gisini* Strenzke 1954, *H. breviempodialis* (Stach, 1949), *H. tianshanica* and *H. cretensis* Skarżyński et Gwiazdowicz 2022. Apart from this, the dorsal setae of *H. ubsunurensis* are short and thin, only slightly thickened at the end of the abdomen, and L.1 on the maxillary head is strongly elongated and broadened at the apex.

Supplementary data. The following materials are available online.

Supplementary Table. Main morphological differences between the most similar members of the *manubrialis*-group of the genus *Hypogastrura* and *H. crinigera* **sp.n.**

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