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The millipede family Diplomaragnidae Attems, 1907 confirmed for mainland China, with descriptions of a new genus and new species (Diplopoda, Chordeumatida)

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Abstract

The family Diplomaragnidae Attems, 1907 (Chordeumatida) is confirmed for mainland China due to the discovery of the new genus and species: *Liaoninosoma* **gen. nov.** and *Liaoninosoma marusiki* **sp. nov.** The descriptions and taxonomic notes are given for the new taxa.

Key words: new taxa, North-East China

Introduction

The Diplomaragnidae is one of the larger chordeumatidan families, containing no less than 95 species from 14 genera distributed in the Asian part of Russia, Kazakhstan, Mongolia, Japan, Korea and Taiwan Island. The majority of species and genera (at the moment, 60 species from 11 genera) are known to occur in the Asian part of Russia (Mikhaljova 2021).

Mainland China has not actually been studied as regards its diplomaragnid fauna. Two dubious species: *Syntelopodeuma gracilipes* Verhoeff, 1914, recorded from Taiwan (Wang 1958) and *Syntelopodeuma formosanum* Verhoeff, 1936, deficiency described from Taiwan too (Verhoeff 1936), were registered in the checklist of the millipede fauna of China without information that they were recorded only in Taiwan (Wang & Mauriès 1996). The first of these species was described from Hokkaido Island, Japan (Verhoeff 1914). Therefore, the record of this species in Taiwan and, accordingly, its inclusion in the general list of Chinese fauna seems doubtful because of the geographical distance between the type locality and this record (Mikhaljova *et al*. 2010). The second species still remains an enigma due to the inaccurate locality on the label and scanty type material containing only a small fragment of the male gonopod (Shear 1999).

In addition, Shear (1999) informed that Verhoeff had seen a chordeumatid from China in 1933, but did not name or describe it. Also, one female of *Craspedosoma* sp. was mentioned among a cargo from China (Chamberlin & Wang 1953). However, the heterogeneous genus *Craspedosoma*, Leach, 1814 included in the 19th century many diverse chordeumatidans now placed in other families and genera. Therefore, the familial and generic affiliation of this female remains unclear to this day.

The diplopod material treated herein appears to contain the new genus and species belonging to the family Diplomaragnidae. The present paper provides descriptions of these new taxa.

Material and methods

Most of the type material treated below is kept in the collection of the Federal Scientific Center of the East Asia Terrestrial Biodiversity, Far Eastern Branch of the Russian Academy of Sciences, Vladivostok, Russia (FSCB), while several duplicates have been deposited in the Zoological Museum of the State University of Moscow, Russia (ZMUM) as indicated hereafter.

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Specimens are kept in 70–75% ethanol. In the process of studying the material, the gonopods and some other parts were dissected from the males and females and mounted in glycerin as temporary micropreparations. Scanning electrone microscope (SEM) micrographs were prepared at the Centre of Collective Use "Biotechnology and Gene Engineering" of the FSCB using a Merlin 62–15 scanning electron microscope. Mounts for SEM were made through air-drying after the transfer to acetone via 96% alcohol, mounting on stubs, and coating with carbon. After the examination, SEM material was removed from stubs and returned to alcohol.

Taxonomic part

Order Chordeumatida Pocock, 1895

Family Diplomaragnidae Attems, 1907

Liaoninosoma gen. nov.

Type and only species: *Liaoninosoma marusiki* **sp. nov.,** by present designation.

Diagnosis. The genus differs from other genera of the family mainly by the posterior gonopod colpocoxite, which has an independent (separate), broad, longitudinal structure ("pad") (**cp**), covered with dense spikes (Fig. 16), with a shallow, partly open-edged sheath groove for the anterior gonopod telopodite together with a rectangular laterally and slightly caudally curved distal part, in combination with a large posterior angiocoxal process.

A structure similar to the above-mentioned "pad" is not observed among all known genera of the family.

Description. Body with 30 rings (including telson). Ommatidia present, fields triangular. Medium-sized paraterga well-developed, horizontal. Male legs 3 and 4 not enlarged. Male legs 5–7 enlarged, coxae with low subconical outgrowths, femora swollen and curved, tarsi very long, sabre-shaped. Male legs 10 and 11 with coxal glands.

Telopodites of anterior gonopods flagelliform, 1-segmented, sheathed. Posterior gonopod colpocoxite with an independent (separate), broad, longitudinal spiky structure ("pad") (**cp**) with a shallow, partly open-edged sheath groove for the anterior gonopod telopodite (Figs 15, 16). Colpocoxites fused medially in its basal half; their distal parts curved laterally. Each colpocoxite entire, undivided. Angiocoxites with a subglobule (**sg**) strongly protruding caudad in posterior view (Figs 15, 18). Angiocoxites (**a**) in anterior view strongly elongated ventrally, centrally convex along their length, however, they do not form independent, separate processes, but are fused with to colpocoxites (Fig. 21). Anterior angiocoxal processes absent. Posterior angiocoxal processes present. Posterior gonopod telopodites 2-segmented, setose, telopoditomere 1 with a thin stem, telopoditomere 2 of medium length.

Etymology. The generic name refers to the type locality, Liaoning Province. The name is a neuter noun.

Distribution. China: Liaoning Province.

Liaoninosoma marusiki sp. nov.

Figs 1–27

Material examined. Holotype: 1 male (FSCB), China, Liaoning Prov., Fengcheng City, Mt. Phoenix, ca 40˚23′ N, 124˚05′ E, 280–550 m, 16–18.10.2017, leg. Yu.M. Marusik; Paratypes: 7 males, 5 females (FSCB), 4 males, 4 females (ZMUM), same data as for holotype.

Diagnosis. Same as for the genus.

Description. *Male*. Length 7.0–8.0 mm, width about 1.0 mm with paraterga.

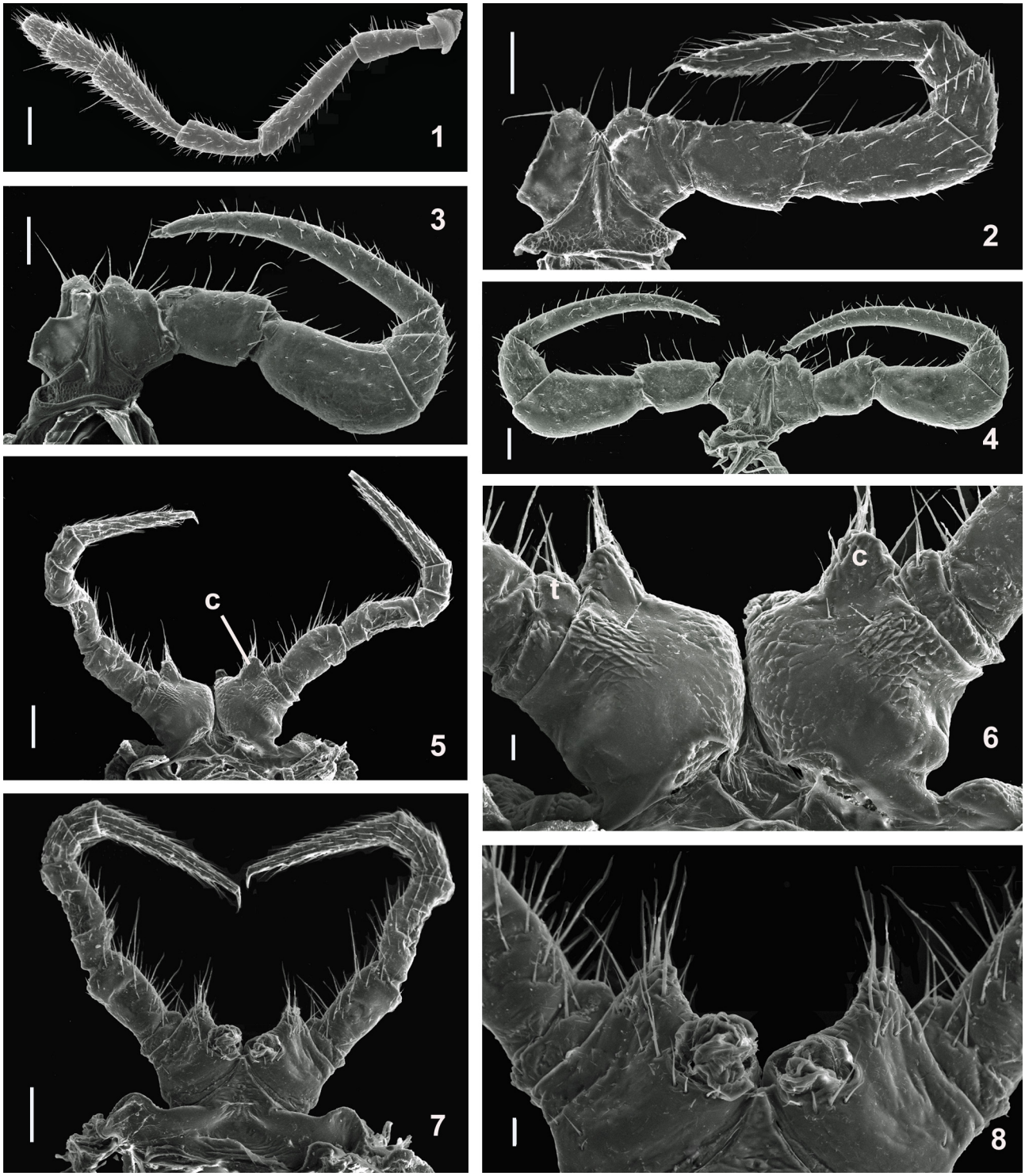
Coloration in alcohol light beige. Antennae light beige. Legs beige-white. Eye patches black.

Body with 30 rings (including telson).

Head anterior part setose. Antennae long and slender (Fig. 1). Antennae in one male paratypes deformed, short, antennomeres almost globular. Eye patches triangular, with about 23 ommatidia.

Collum semicircular. Both collum and ring 2 narrower than head with genae. Ring 2 somewhat wider than collum.

Body width gradually increasing until ring 7, body parallel-sided on rings 7–21(22), thereafter gradually tapering. Paraterga beginning on ring 3, well developed on rings 6(7)–23, poorly developed on rings 24–26, onward missing. Paraterga of the ring 7 larger and broader. Metazonital macrochaetae in a transverse row on rings 27–29, like an extended (to different degrees) triangle on preceding rings. Anterolateral (median after Spelda 2001) macrochaetae shortest, caudolateral (exterior after Spelda 2001) and medial (interior after Spelda 2001) ones subequal in length. All macrochaetae pointed, but not very sharply so. Axial suture poorly-developed.

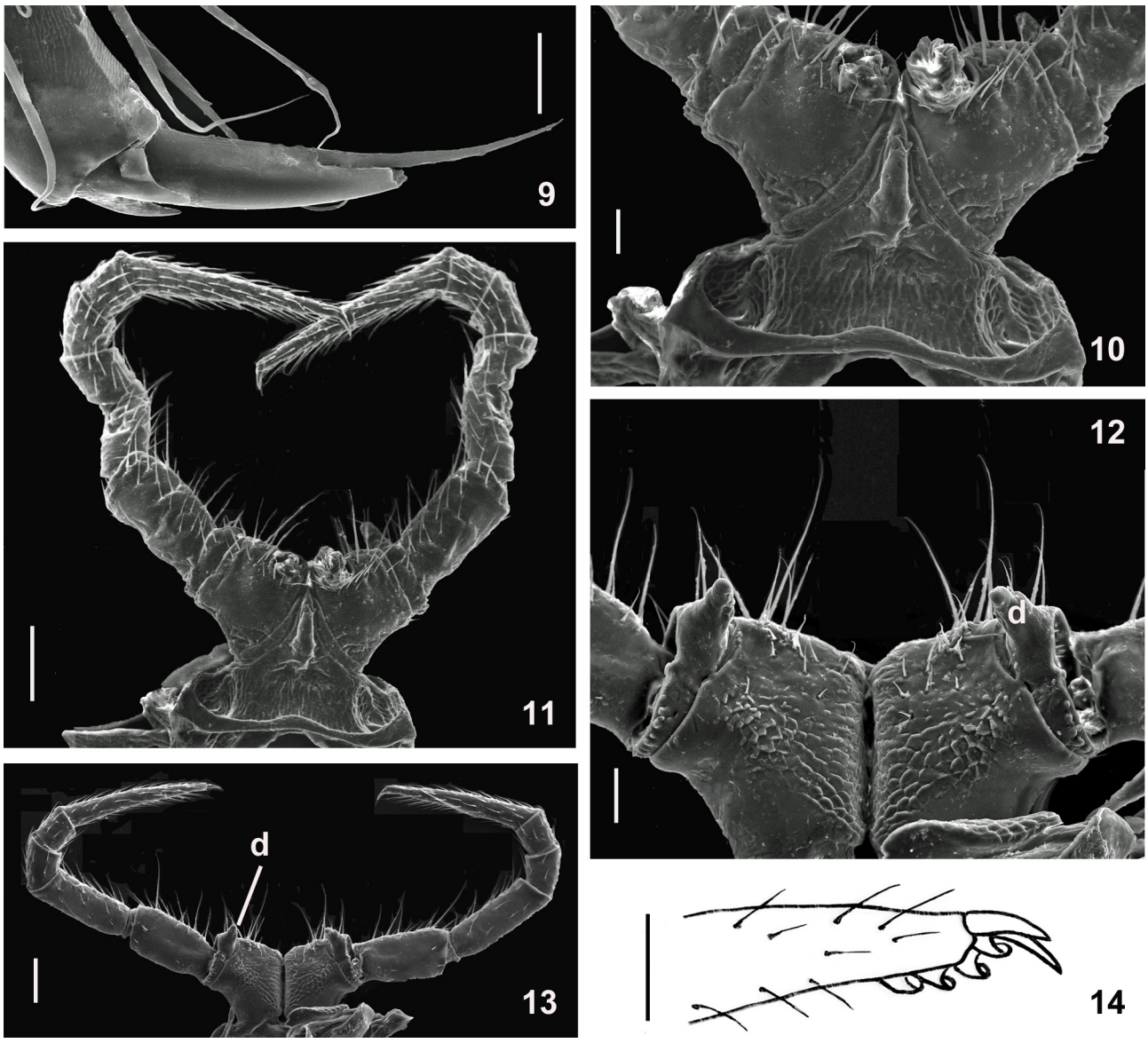


FIGURES 1–8. *Liaoninosoma marusiki* **sp. nov.**, male paratypes (FSCB). **1.** Right antenna, anterior view. **2.** Leg and sternum 3, anterior view. **3.** Leg and sternum 5, anterior view. **4.** Leg pair 6, anterior view. **5.** Leg pair 10, posterior view. **6.** Coxae and trochanters 10, posterior view. **7.** Leg pair 10, anterior view. **8.** Coxae and trochanters 10, anterior view. **Abbreviations: c**, coxal process; **t**, knob. **Scales:** 20 μm (Figs 6, 8), 100 μm (Figs 1–5, 7).

Legs long and slender. Leg pairs 1 and 2 typically reduced in size, with usual tarsal brushes. Legs 3 and 4 not enlarged. Legs 5–7 enlarged, coxae with low subconical outgrowths, femora swollen and curved, tarsi very long, sabre-shaped (Figs 3 and 4). Sternites 3–7 frontally with a longitudinal roller (Figs 2–4).

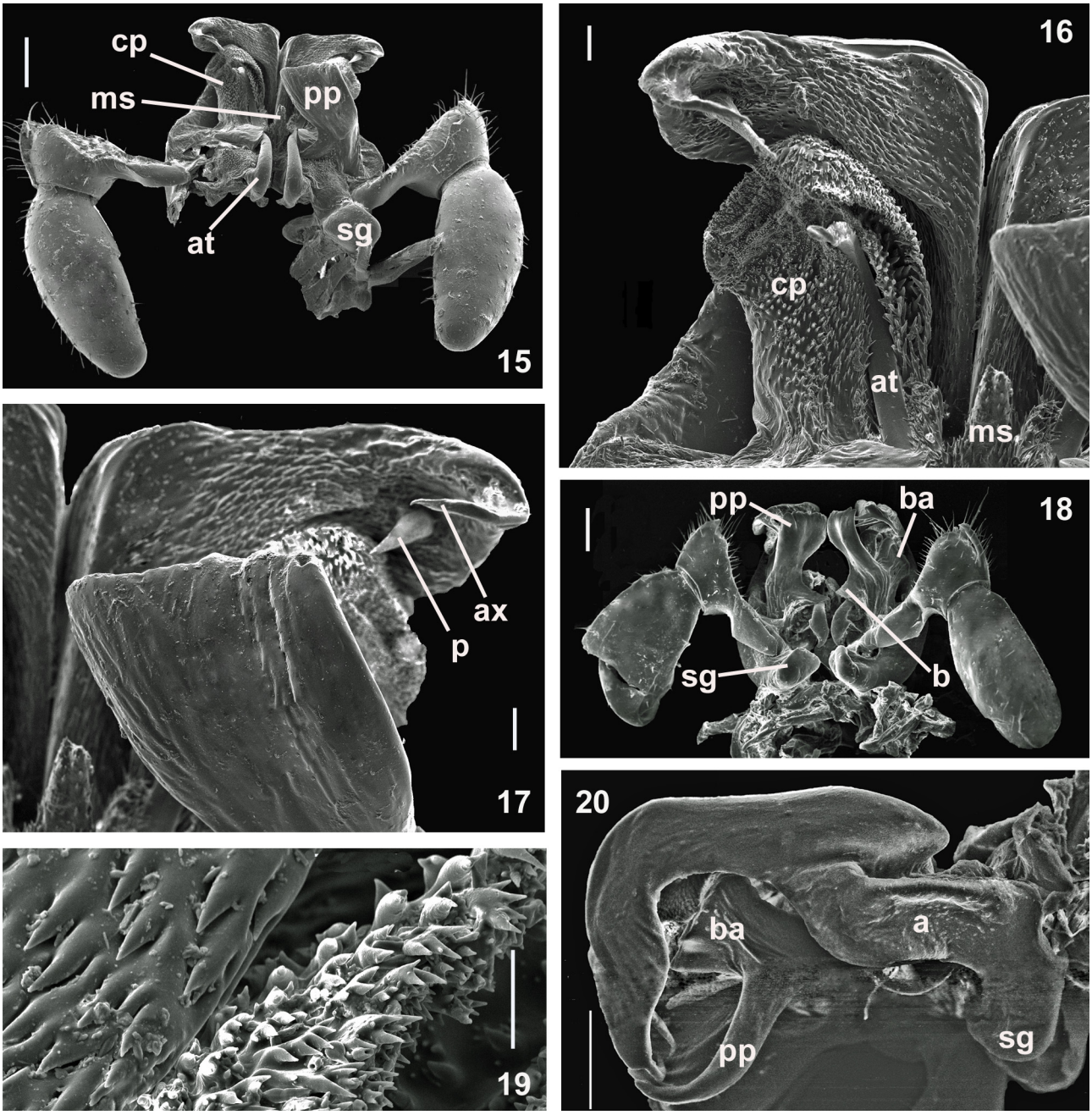
Legs 3–7 with tarsal papillae occupying about 1/3rd of the tarsus length distally (near claw) on leg pairs 3 and 4 (Fig. 2), while legs 5–7 with several (3–5) tarsal papillae near claw only (Fig. 14). Postgonopodal legs (including legs 10 and 11) without tarsal papillae.

Claws of medium length. Claws of legs 1–4 at base with two small additional claws dorsally and a long setoid outgrowth ventrally. Claws of legs 5–7 at base with an outgrowth ventrally only (Fig. 14). Claws of postgonopodal legs (including legs 10 and 11) at base with a long setoid outgrowth ventrally and two small additional claws dorsally. Two additional claws gradually disappear toward the end of the body. Claws of hindmost legs at base without additional claws dorsally.



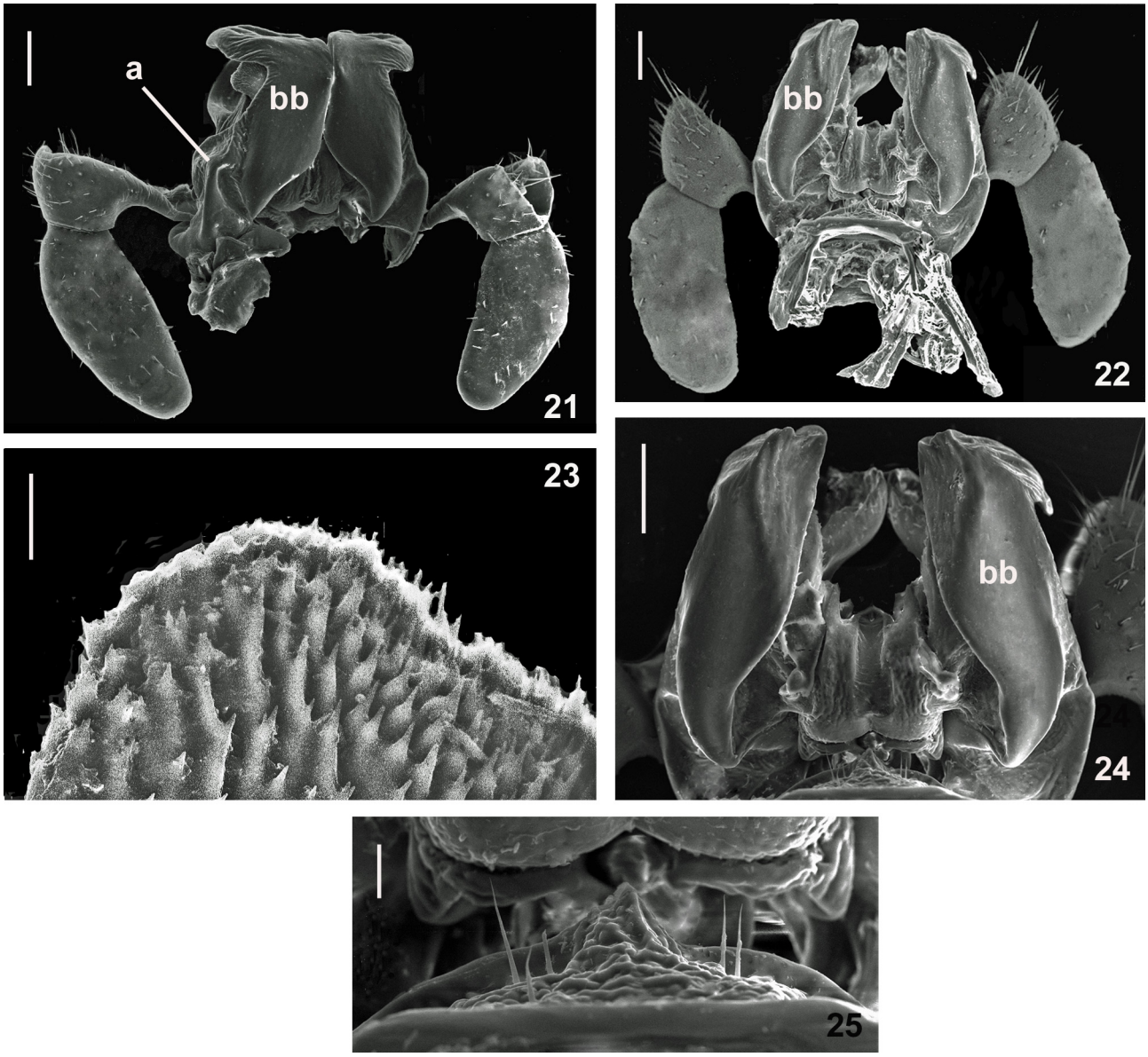
FIGURES 9–14. *Liaoninosoma marusiki* **sp. nov.**, male paratypes (FSCB). **9.** Claw 11, posterior view. **10.** Coxae, trochanters and sternum 11, anterior view. **11.** Leg pair 11, anterior view. **12.** Coxae and trochanters 11, posterior view. **13.** Leg pair 11, posterior view. **14.** Distal part of leg 5, posterior view. **Abbreviation: d,** finger-shaped process. **Scales:** 10 μm (Fig. 9), 40 μm (Figs 10, 12), 100 μm (Figs 11, 13), 0.05 mm (Fig. 14).

Legs 10 and 11 with coxal glands (Figs 7, 8, 10, 11). Coxa 10 with a subconical process (**c**) setose apically (Figs 5–8). Trochanter 10 with low knob (**t**) setose apically (Fig. 6). Trochanter 11 with a caudoventral setose finger-shaped process (**d**) rounded apically (Figs 10–13). Sternum 11 frontally with a longitudinal roller (Figs 10 and 11).



FIGURES 15–20. *Liaoninosoma marusiki* **sp. nov.**, two male paratypes (FSCB). **15.** Gonopods, posterior view (posterior angiocoxal process on the left removed). **16.** Colpocoxite distal part without posterior angiocoxal process, posterior view. **17.** Colpocoxite distal part, posterior view. **18.** Gonopods, posterior view. **19.** Spikes. **20.** Gonopods without posterior gonopod telopodites, lateral view. **Abbreviations: a**, angiocoxite; **at**, anterior gonopod telopodite; **ax**, apex; **b**, mesal blade; **ba**, frontal blade; **cp**, colpocoxite "pad"; **ms**, spear-shaped structure; **p**, conical process; **pp**, posterior angiocoxal process; **sg**, subglobule. **Scales:** 10 μm (Fig. 19), 20 μm (Figs 16, 17), 100 μm (Figs 15, 18, 20).

Anterior gonopod coxosternum in anterior view with a central, small, conical papillate outgrowth and several setae (Fig. 25). Anterior gonopod telopodites (**at**) 1-segmented, relatively short (reaching middle of colpocoxite), flagelliform (ribbon-shaped in distal part), each positioned on posterior surface of posterior gonopod colpocoxite inside a shallow, partly open-edged sheath groove positioned on a broad, longitudinal structure (colpocoxite "pad" (**cp**) - a possible homologue of the lateral and mesal processes of the sheath groove) covered throughout with dense, forked and undivided spikes (Figs 15, 16, 19, 23) (the posterior angiocoxal process on the left is removed in Figs 15 and 16). Colpocoxite "pads" at base with the spear-shaped processes forming single structure (**ms**) (homologue of fused mesal processes of sheath groove).

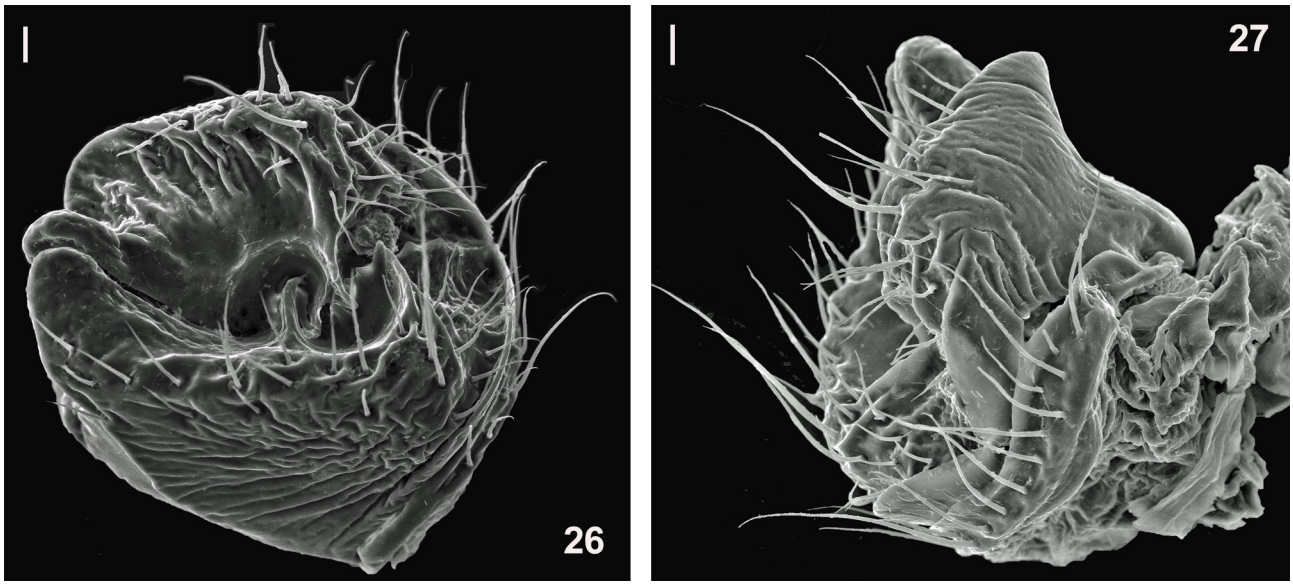


FIGURES 21–25. *Liaoninosoma marusiki* **sp. nov.**, two male paratypes (FSCB). **21.** Gonopods, anterior view (slightly turned to the right). **22.** Gonopods, anterior view **(**slightly skewed backwards). **23.** Anterior part of colpocoxite "pad". **24.** Posterior gonopod colpocoxites, anterior view (slightly skewed backwards). **25.** Central part of coxosternum of anterior gonopods, anterior view. **Abbreviations: a**, angiocoxite; **bb**, blade. **Scales:** 10 μm (Fig. 23), 20 μm (Fig. 25), 100 μm (Figs 21, 22, 24).

Posterior gonopod colpocoxites fused medially in basal half; their distal parts rectangular curved laterad and slightly caudad, posterior surface covered with tilted spikes. Colpocoxite apex (**ax**) as thin hook (Fig. 17). Subapically colpocoxite with a conical process (**p**). Each colpocoxite entire, undivided. Posterior angiocoxal process (**pp)** large, wide, curved c-shaped, with two basal blades: blade **ba** curved anteriad and blade **b** curved mesad, tightly clasping anterior gonopod (Figs 15, 18, 20) (the posterior angiocoxal process on the left is removed in Fig. 15). Angiocoxite (**a**) in posterior face with subglobule (**sg**) strongly protruding caudad and the proximal part covered with papillae and spikes (Figs 15, 18, 20). In anterior view the colpocoxite with an apically convex blade (**bb**) along its length (Figs 21, 22, 24). Two **bb** can be closed (Fig. 21) or located at some distance from each other (Figs 22, 24). Angiocoxite (**a**) in anterior face strongly elongated ventrally, convex centrally along its length (Fig. 21), however, it does not form an independent separate process (here I adhere to Shear's (1990) opinion, see Discussion). Posterior gonopod telopodite 2-segmented, setose, located almost on the posterior surface of the gonopods; telopoditomere 1 with a very thin stem, telopoditomere 2 middle length.

Female. Length 7.0–8.0 mm, width about 1.0 mm with paraterga. Claws of hindmost legs at base with two small additional claw-shaped knobs very closely pressed to main claw. Vulva as in Figs 26, 27.

Etymology. The species is named in honor of the collector Dr. Yu. M. Marusik, a well-known Russian arachnologist. A noun in genitive.



FIGURES 26–27. *Liaoninosoma marusiki* **sp. nov.**, female paratype (FSCB). **26,** Right vulva, ventral view. **27.** Right vulva, mesal view. **Scales:** 20 μm.

Discussion

Shear (1990) in his revision of Diplomaragnidae has provided a diagnosis of the family and a detailed description of the gonopods. In addition, the main distinguishing characters of this family including the gonopod structure can be found in the surveys of the diplopod fauna of the Asian part of Russia (Mikhaljova 2004; 2017) as well as in the review of Diplomaragnidae of this region (Mikhaljova 2021).

According to Shear (1990), the positioning of the anterior gonopod telopodites in sheath grooves on the posterior surfaces of the posterior gonopod colpocoxites is one of the main distinguishing characters of Diplomaragnidae. Telopodites of anterior gonopods of almost all genera are located either in the concave colpocoxites or inside simple sheath grooves sometimes with elevated and closed edges. The telopodites are freely positioned regardless of the colpocoxites in *Alineuma* Mikhaljova, 2021 only.

In contrast, sheath grooves for anterior gonopod telopodites are placed on independent, separate structures ("pads") in a new genus. This structure is unique within the family Diplomaragnidae. The character should be included in the description and diagnosis of the family.

The new genus seems more closely related to some North-East Asian *Pacifiosoma* Mikhaljova, 2000 and the South Korean *Koreagna* Mikhaljova & Lim, 2008 judged from the sheath grooves with high elevated edges covered with tiny papillae/spikes structures (only distal parts of sheath grooves is covered with tiny papillae/spikes structures in *Koreagna*). In addition, many species of *Pacifiosoma* have a large posterior angiocoxal processes of the posterior gonopods and papillate posterior surface of colpocoxites like the ones of *Liaoninosoma* **gen. nov.** However, the new genus differs from not only these two genera but also all other Diplomaragnidae by the posterior colpocoxite surface with an independent (separate), spiky structure ("pad") with a shallow sheath groove for the anterior gonopod telopodite.

In addition, distal parts of the posterior gonopod colpocoxites are rectangular, curved laterally and slightly caudally in *Liaoninosoma* **gen. nov.** (in contrast to smoothly curved caudally colpocoxites in *Pacifiosoma* and *Koreagna*).

Also, the posterior gonopods of the new genus are equipped with posterior angiocoxal processes only, while the anterior angiocoxal processes are absent (in contrast to the presence of anterior and posterior angiocoxal processes

in *Pacifiosoma*, except in some species with ventrally projecting anterior angiocoxites, as well as only anterior angiocoxal processes in *Koreagna*). However, the anterior angiocoxites are very elongated ventrally but without the formation of independent processes. Shear (1990), in his review of Diplomaragnidae, considered the shape (rounded or angular/projecting) of the mesal or mesodistal part of the anterior angiocoxite of the posterior gonopod as well as a separate anterior angiocoxal process as two independent distinguishing characters within this family. Moreover, even the strongly elongated mesodistal angle of the anterior angiocoxite was not considered a separate process. Here I hold the same opinion. The elongated ventral protrusion of the posterior gonopod angiocoxite in the anterior face in *Liaoninosoma marusiki* **sp. nov.** is not considered as a separate anterior angiocoxal process, as evidenced also by the fusion of this protrusion with colpocoxite.

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