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The millipede order Chordeumatida (Diplopoda) in Kazakhstan, with descriptions of three new species

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Abstract

The order Chordeumatida is represented in Kazakhstan by five species in three genera and three families. All species are recorded in the Altai and Dzhungarskii Alatau Mountains. Three species are described here as new to science: *Altajosoma arshaty* **sp. nov.**, *Altajosoma bukhtarma* **sp. nov.** and *Tarbagataya zaisanica* **sp. nov.** The family Diplomaragnidae and the genus *Altajosoma* Gulička, 1972 are formally new to the fauna of Kazakhstan. Diagnosis of the genus *Tarbagataya* has been supplemented. All currently known Chordeumatida from Kazakhstan are keyed, including the new species. The distributions of all Kazakhstan chordeumatidan species are mapped.

Key words: Diplopods, chordeumatidans, new species, taxonomy, key, Altai, Kazakhstan, Central Asia

Introduction

The millipede order Chordeumatida has hitherto been known to be represented in Kazakhstan by two species from two genera and two families: *Tianella ornata* Golovatch, 1979 (Cleidogonidae) (Golovatch 1979) and *Tarbagataya splendida* Golovatch & Wytwer, 2003 (Kirkayakidae Özdikmen, 2008, syn. Altajellidae Mikhaljova & Golovatch, 2001 (Golovatch & Wytwer 2003). Because *Altajella* Gulička, 1972 is a homonym which has been changed to *Kirkayakus* Özdikmen, 2008, the family name Altajellidae has also been changed to Kirkayakidae (Özdikmen 2008). Also, the first species can be found in the lists of diplopods from Central Asia (Read & Golovatch 1994) and the former Soviet Union, including Kazakhstan (Lokšina and Golovatch 1979). In addition, an unidentified species of *Tianella* (represented by a female or juveniles) was recorded from the valley of the Bolshaya Alma-Atinka River, East Kazakhstan (Golovatch 1979). Up to now, our knowledge about Kazakhstan Chordeumatida was limited to this information.

The diplopod material treated herein appears to contain two new species belonging to the family Diplomaragnidae Attems, 1907 and the genus *Altajosoma* Gulička, 1972, new to the fauna of Kazakhstan. In addition, among the material a new species of *Tarbagataya* has been found. The present paper provides descriptions of the new species and a key to the families, genera and species of Chordeumatida occurring in Kazakhstan, and the distributions of all Kazakhstan chordeumatidan species are mapped (Map).

Material and methods

Material treated here has been deposited in the collections of the Institute of Biology and Soil Science, Far Eastern Branch of the Russian Academy of Sciences, Vladivostok, Russia (IBSS), Pavlodar State University, Pavlodar, Kazakhstan (PU), and Zoological Museum, State University of Moscow, Russia (ZMUM), as indicated in the text.

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Specimens were kept in 70–75% ethanol. In the process of studying the material, the gonopods and some other parts were dissected from a limited number of males and mounted in glycerin as temporary micropreparations. SEM micrographs were prepared at the Centre of Collective Use "Biotechnology and Gene Engineering" of the Institute of Biology and Soil Science, Far Eastern Branch of the Russian Academy of Sciences in Vladivostok, Russia using a Zeiss Evo 40 scanning electron microscope. Mounts for SEM were made through air-drying after transfer to acetone via 96% alcohol, mounting on stubs, and coating with gold and platinum. After examination, SEM material was removed from stubs and returned to alcohol, all such samples being kept at IBSS.

Taxonomic part

Diplomaragnidae

Altajosoma arshaty Mikhaljova sp. nov.

Figs 1–4

Material examined. *Holotype*: 1 male (IBSS), Kazakhstan, Arshaty, slope, 49°18´26´´ N, 86°32´55´´ E, 1250 m a.s.l., 2 August 2007, leg. F. Pěček. *Paratype*: 1 female (IBSS), together with holotype, 2 August 2007, leg. F. Pěček.

Diagnosis. Differs from congeners mainly by the large smooth, curved horn-shaped lateral sheath processes of the posterior gonopod colpocoxites. The new species seems to be particularly closely related to *Altajosoma corniferum* Mikhaljova, Nefediev, Nefedieva, 2008 from Republic of Altai, Siberia, Russia (Mikhaljova *et al*. 2008), but differs mainly by the shape of the lateral sheath processes of the posterior gonopod colpocoxites as large smooth, arcuate horns, by bifurcated distal parts of posterior gonopod colpocoxites, and the shape of the anterior angiocoxal processes: broadened at the base and directed at an angle to the axis of the colpocoxites.

Description. Male. Length about 15 mm, width with paraterga about 1.2 mm. Coloration in alcohol tan (probably faded by preservation). Legs pale tan. Ocellaria black. Antennae tan. Forehead with light spot.

Body with 32 segments. Head covered with relatively long setae. Eye patches subtriangular, each composed of at least 27 ocelli. Collum semi-circular. Body width gradually increasing until somite 7, body parallel-sided on somites 8–21(22), thereafter gradually tapering. Paraterga beginning on somite 2, well developed on somites 3–26, reduced on somite 27, onward missing. Paraterga of pregonopodal somites smaller. Metazonital macrochaetae in transverse row on somites 28–31, arranged in elongate (to different degrees) triangle on preceding somites. Numerous macrochaetae broken off, remaining ones in posterior part of body long, pointed apically; anterolateral macrochaetae shortest, caudolateral ones longest.

Legs long and slender. Leg pairs 3–7 somewhat enlarged, femora swollen. Legs (including leg pairs 10 and 11) with small group of funnel-shaped tarsal papillae apically near claw, however tarsal papillae gradually reduced toward middle part of body; at least legs of somite 17 and hindmost legs devoid of tarsal papillae. Claws of postgonopodal legs (including leg pairs 10 and 11) at base with two small additional claws dorsally and a long setoid filament ventrally, but small additional claws gradually missing toward posterior part of body; at least claws of hindmost legs at base devoid of such additional claws. Prefemur, femur, postfemur and tibia covered with tiny knobs ventrally, however such knobs gradually reduced toward posterior part of body.

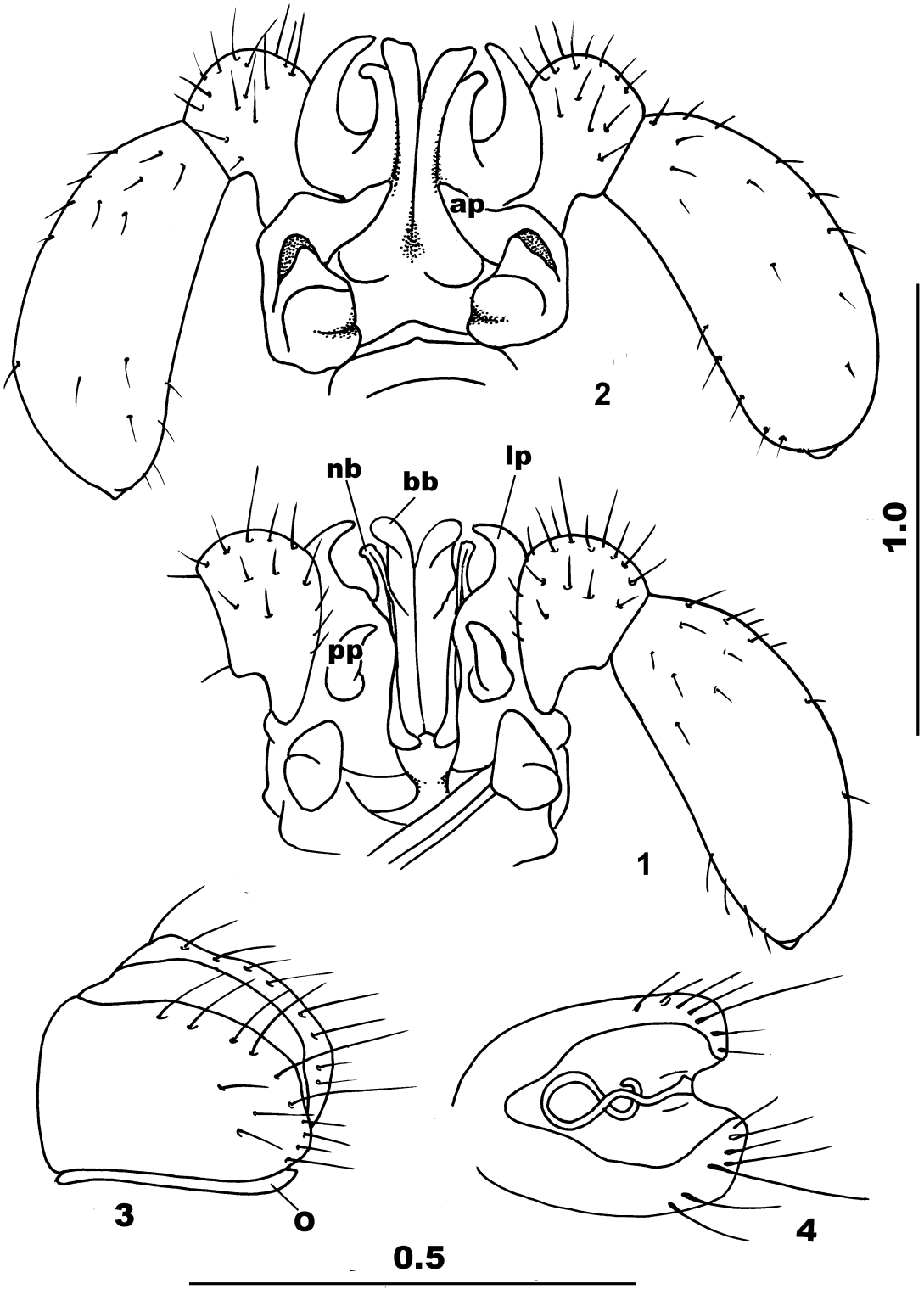
Legs 10 and 11 with coxal glands. Coxae 10 somewhat projecting ventrally.

Anterior gonopod telopodite 1-segmented, flagelliform, its distal part hidden inside narrow sheath groove (Fig. 1). Telopodite base and distal part of coxosternum attached to adjacent mesal portion of posterior gonopod. Posterior gonopod colpocoxites fused to 2/3 extent, arcuate, curved caudad. Colpocoxite with distal part of broad (**bb**) and narrow (**nb**) blades bifurcated. Lateral sheath process of colpocoxite (**lp**) as large smooth, arcuate horn. Mesal sheath processes of colpocoxite absent. Angiocoxite with a globule in posterior view. Posterior angiocoxal process (**pp**) large, curved forward, its apex pointed. Angiocoxites with depressions and ridges in anterior view, each supplied with digitiform process (**ap**) blunted apically (Fig. 2). Anterior angiocoxal process broadened at base and directed at an angle to the axis of colpocoxite. Posterior gonopod telopodite 2-segmented, setose, with a long femur and claw vestige.

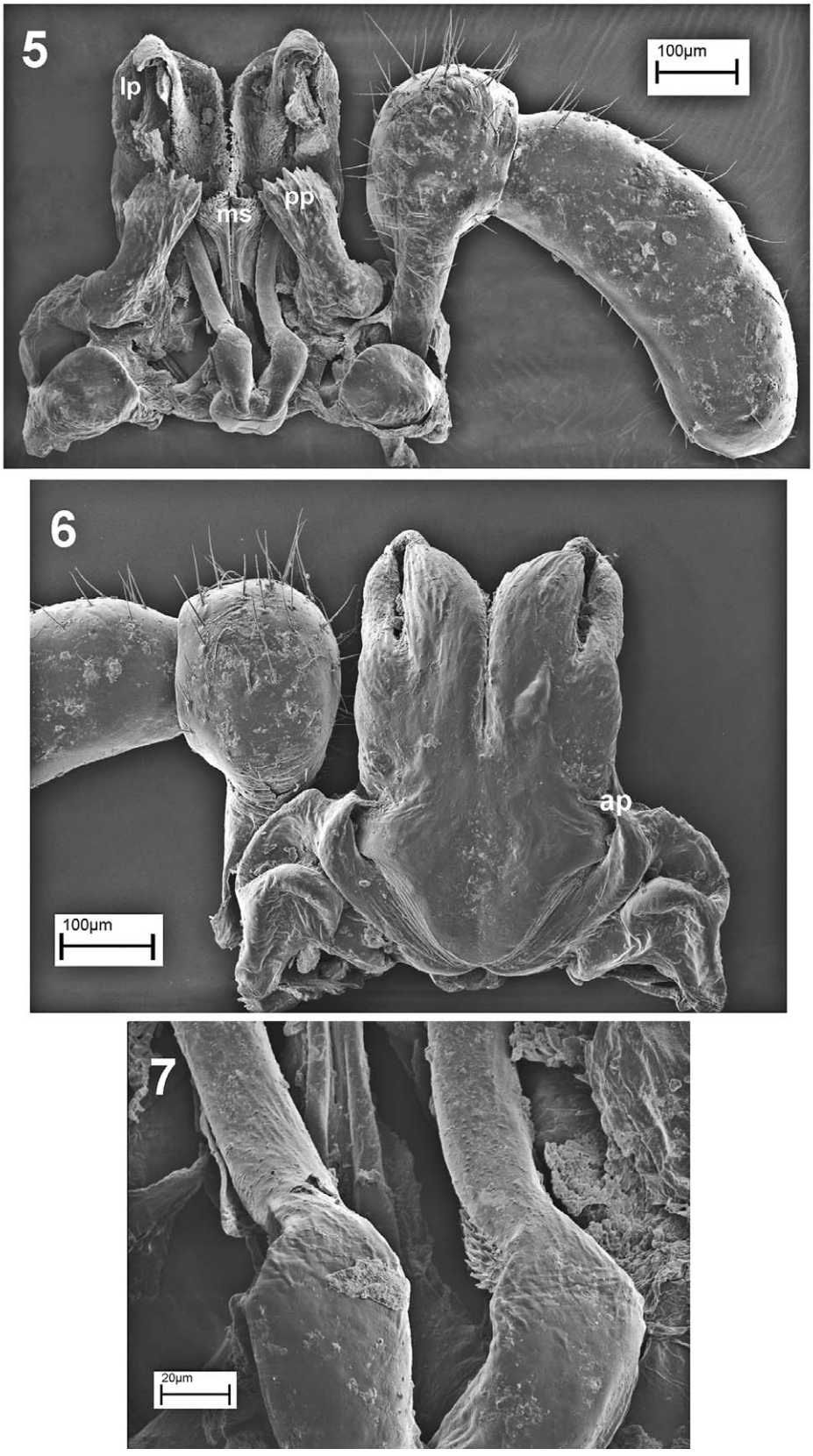
Female. Length about 15 mm, width with paraterga 1.1–1.2 mm. Body with 32 segments. Legs brown with marbled distal parts. Numerous macrochaetae broken off, remaining ones in anterior part long, pointed apically;

anterolateral macrochaetae shortest, caudolateral and medial ones subequal in length. Eye patch each composed of at least 27 ocelli. Paraterga smaller than ones in male. Other nonsexual characters as in male. Vulvae small, near ovoid (Figs 3–4). Valves with long setae in distal parts. Operculum (**o**) short devoid of setae.

Name. The specific epithet refers to the type locality, a noun in apposition.



FIGURES 1–4. *Altajosoma arshaty* **sp. nov.**, male holotype (1–2), female paratype (3–4). 1, gonopods, caudal view; 2, gonopods, front view; 3, vulva, lateral view, somewhat rotated outwards; 4, vulva, ventral view; **bb**, broad blade of posterior gonopod colpocoxite; **nb**, narrow blade of posterior gonopod colpocoxite; **lp**, lateral sheath process of posterior gonopod colpocoxite; **pp**, posterior process of posterior gonopod angiocoxite; **ap**, anterior process of posterior gonopod angiocoxite; **o**, operculum. Scales in mm.



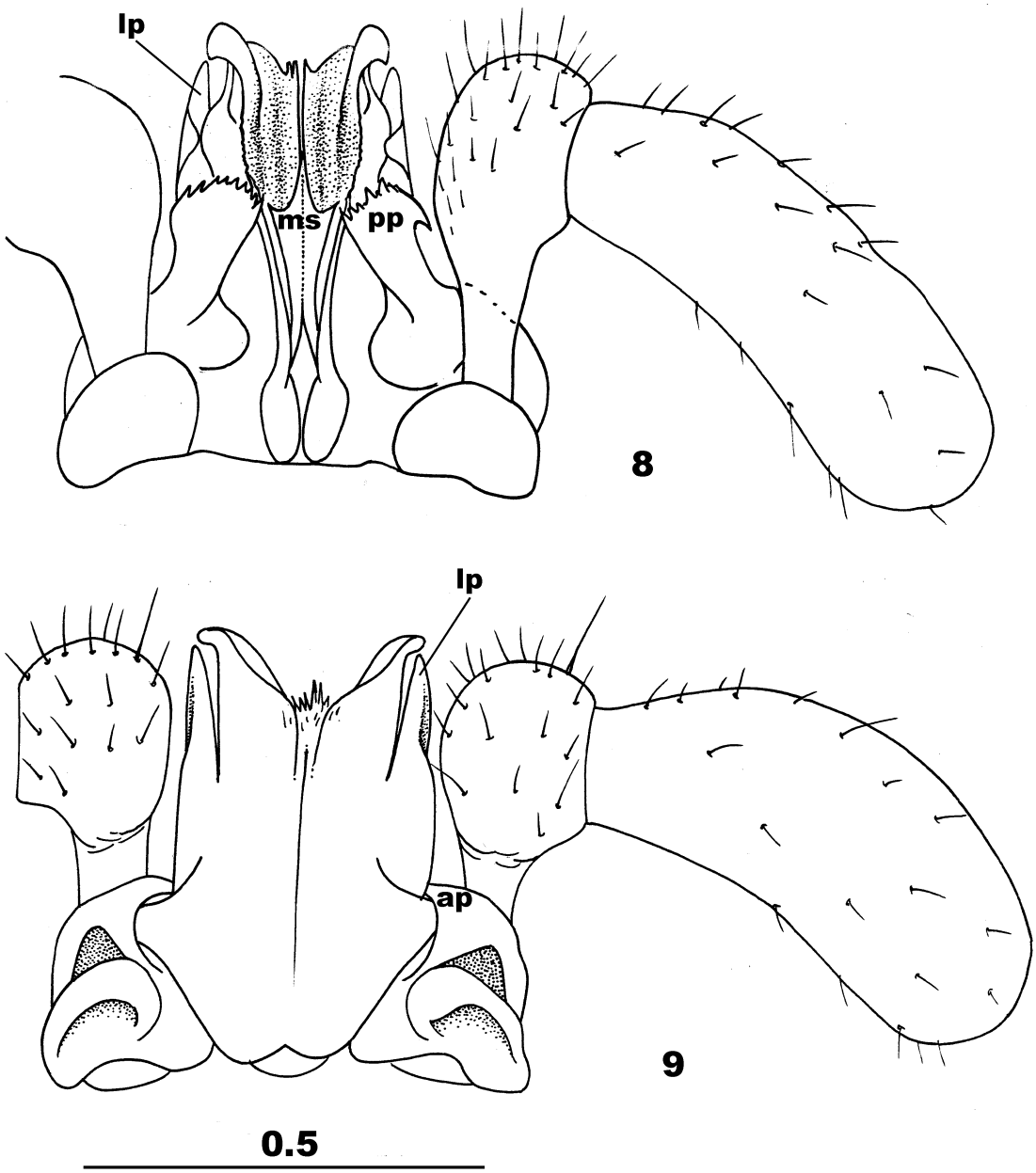
FIGURES 5–7. *Altajosoma bukhtarma* **sp. nov.**, male paratype. 5, gonopods, caudal view; 6, gonopods, front view; 7, basal parts of telopodites of anterior gonopods; **lp**, lateral sheath process of posterior gonopod colpocoxite; **pp**, posterior process of posterior gonopod angiocoxite; **ms**, mesal sheath processes of posterior gonopod colpocoxites; **ap**, anterior process of posterior gonopod angiocoxite.

***Altajosoma bukhtarma* Mikhaljova sp. nov.**
Figs 5–9

Material examined. *Holotype*: 1 male (IBSS), Kazakhstan, Vostochno Kazakhstanskaya Area, Katon-Karagaiskii District, 1390 m, 49°08´499´´ N, 085°57´670´´ E, *Larix* forest, 22 August 2010, leg. K. Ulykpan. *Paratypes*: 1 male (PU), 1 male (IBSS), together with holotype, 22 August 2010, leg. K. Ulykpan.

Diagnosis. Differs from congeners mainly by the large, straight, lateral sheath processes of the posterior gonopod colpocoxites, coupled with large posterior angiocoxal processes and small mesal sheath processes of the colpocoxite fused mesally into a single cyathiform structure.

Description. Male. Length 11–12 mm, width with paraterga 0.9–1.0 mm. Coloration in alcohol brown. Legs brown with marbled distal parts. Ocellaria black. Antennae brown. Protruding telopodites of posterior gonopods dark brown. Forehead with light spot.



FIGURES 8–9. *Altajosoma bukhtarma* **sp. nov.**, male paratype. 8, gonopods, caudal view; 9, gonopods, front view; **lp**, lateral sheath process of posterior gonopod colpocoxite; **pp**, posterior process of posterior gonopod angiocoxite; **ap**, anterior process of posterior gonopod angiocoxite; **ms**, mesal sheath processes of posterior gonopod colpocoxites. Scale in mm.

Body with 32 segments. Head covered with short and relatively long setae. Eye patches subtriangular, each composed of at least 25 ocelli. Collum semi-circular. Body width gradually increasing until somite 7, body parallel-sided on somites 8–24(25), thereafter gradually tapering.

Paraterga beginning on somite 2, well developed on somites 3–26, reduced on somite 27, onward missing. Paraterga of pregonopodal somites smaller. Metazonital macrochaetae in a transverse row on somites 30–31, like an elongate (to different degrees) triangle on preceding somites. Numerous macrochaetae broken off, remaining ones long, pointed apically; anterolateral macrochaetae shortest, caudolateral ones longest.

Legs long and slender. Leg pairs 3–7 somewhat enlarged, femora swollen. Legs (including leg pairs 10 and 11) with a small group of funnel-shaped tarsal papillae apically near claw, however tarsal papillae gradually missing toward middle part of body. Claws of pregonopodal legs at base with long setoid filament ventrally but without well-developed additional claws dorsally. Claws of postgonopodal legs (including leg pairs 10 and 11) at base with two small additional claws dorsally and long setoid filament ventrally, but small additional claws gradually missing toward middle part of body.

Legs 10 and 11 with coxal glands but without other modifications.

Anterior gonopod telopodite 1-segmented, flagelliform (Fis. 5, 7, 8). Telopodite base and distal part of coxosternum attached to adjacent mesal portion of posterior gonopod. Posterior gonopod colpocoxites fused to 2/3 extent, arcuate, curved caudad. Colpocoxite distal part narrowed, apex hook-shaped. Lateral sheath process of colpocoxite (**lp**) straight with prominence in its middle part, pointed apically. Mesal sheath processes of colpocoxite not large, fused mesally into single cyathiform structure (**ms**). Angiocoxite with a globule in posterior view. Posterior angiocoxal process (**pp**) large, curved forward with beak-shaped pointed lateral margin and teeth apically. Angiocoxites with depressions and ridges in anterior view, each supplied with small process (**ap**) (Fig. 6, 9).

Female unknown.

Name. The specific epithet refers to the type locality (Bukhtarma is the name of the river, which flows near the type locality), a noun in apposition.

Kirkayakidae Özdikmen, 2008

(syn. Altajellidae Mikhaljova & Golovatch, 2001)

Tarbagataya zaisanica Mikhaljova sp. nov.

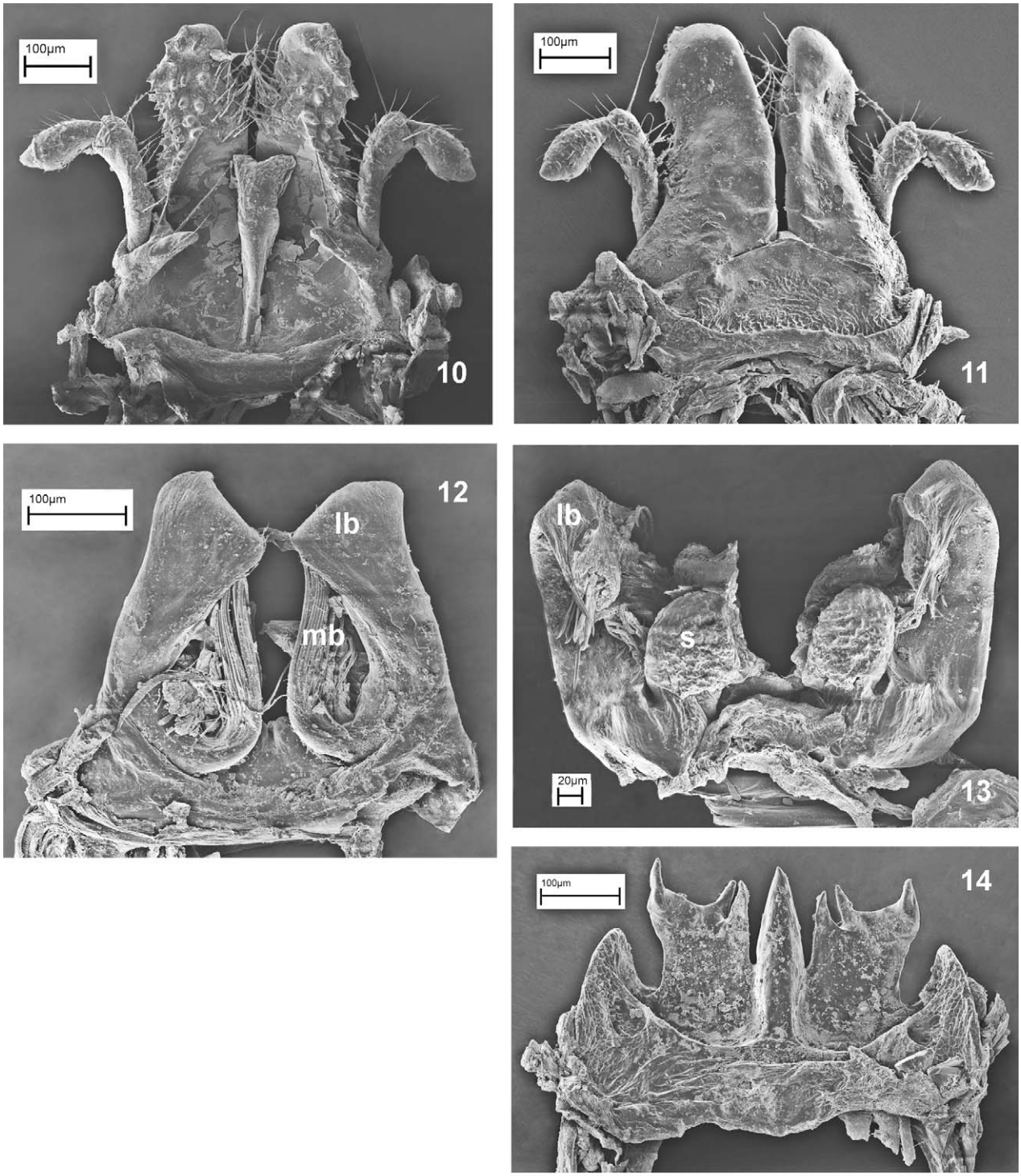
Figs 10–23

Material examined. *Holotype*: 1 male (IBSS), Kazakhstan, Vostochno-Kazakhstanskaya Area, Zaisan District, 1662 m a.s.l., 12 July 2011, leg. K. Ulykpan and U.D. Burkitbaeva. *Paratypes*: 1 male, 2 juveniles (IBSS), Kazakhstan, Vostochno-Kazakhstanskaya Area, Zaisan District, 1755 m a.s.l., 6 July 2011; 2 males, 2 females, 1 juv. (IBSS), Kazakhstan, Vostochno-Kazakhstanskaya Area, Zaisan District, forest, 8 July 2011; 1 male, 2 females, 1 juvenile (IBSS), Kazakhstan, Vostochno-Kazakhstanskaya Area, Zaisan District, 1848 m a.s.l., 8 July 2011; 1 male, 1 female (ZMUM), Kazakhstan, Vostochno-Kazakhstanskaya Area, Zaisan District, 1793 m a.s.l., 9 July 2011; 1 female, 1 juvenile (IBSS), Kazakhstan, Vostochno-Kazakhstanskaya Area, Zaisan District, 1793 m a.s.l., 11 July 2011; 1 male, 3 females (IBSS), together with holotype, 12 July 2011; 1 male, 2 females, 1 juvenile (PU), Kazakhstan, Vostochno-Kazakhstanskaya Area, Zaisan District, 1680 m a.s.l., 13 July 2011; 2 males (IBSS), Kazakhstan, Vostochno-Kazakhstanskaya Area, Zaisan District, 1662 m a.s.l., 13 July 2011; 1 male, 11 females, 4 juveniles (IBSS), Kazakhstan, Vostochno-Kazakhstanskaya Area, Zaisan District, 1735 m a.s.l., 17 July 2011; all leg. K. Ulykpan and U.D. Burkitbaeva.

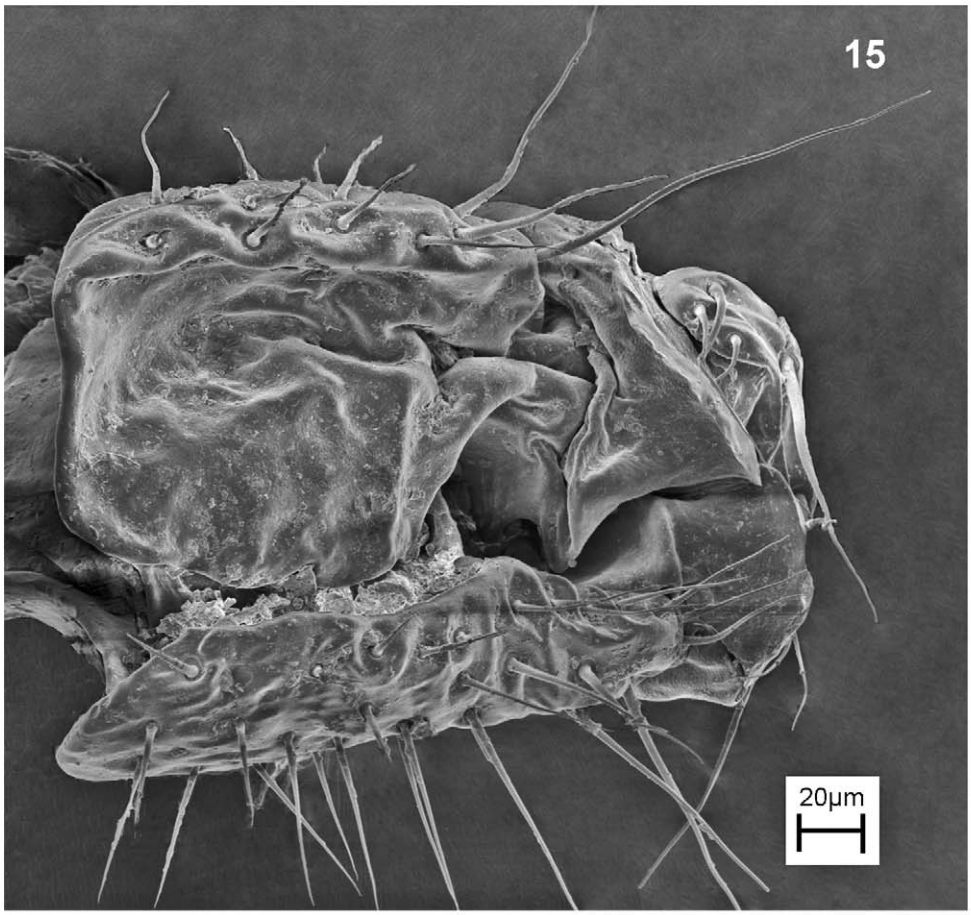
Diagnosis. Differs from its only congener *Tarbagataya splendida* Golovatch & Wytwer, 2003 mainly by the structure of the posterior gonopods, with the coxal process supplied with three teeth, the structure of leg pair 7 with tongue-shaped, long, apically bilobate sternal protuberance, the structure of the anterior gonopods as well as the presence of tarsal papillae in males.

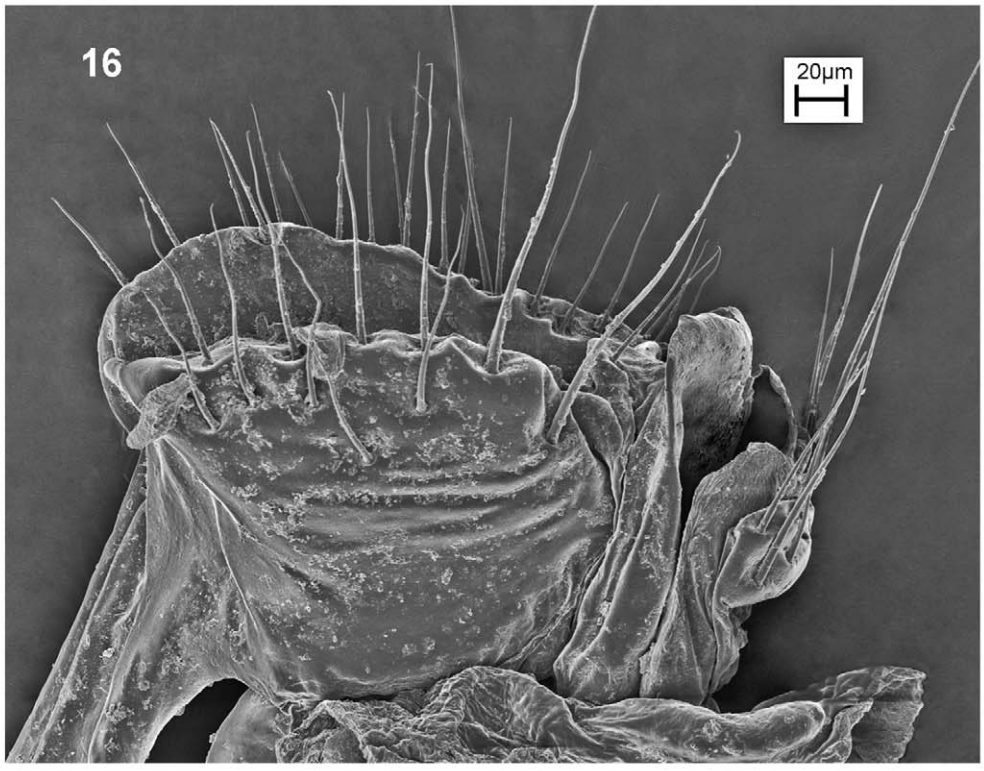
Description. Male. Length 10–11 mm, width of midbody metazona 0.7–0.8 mm. Coloration in alcohol light brown or brown with marbled, annulated pattern due to pale stricture between pro- and metazona as well as with light marbled spots on sides; this spots gradually decrease towards the telson. Ventral side pale. Clypeolabral region of head with pattern of small light spots of different shapes. Antennae brown, marbled brown distally. Legs pale with marbled light brown distal portions. Ocellaria black.

Body with 28 segments. Head covered with short and relatively long setae. Clypeolabral region slightly convex. Eye patches triangular, each composed of at least 18 ocelli. Antennae *in situ* reaching to posterior margin of body segment 4. Collum semi-circular. Body juloid, subcylindrical, somewhat moniliform. Paraterga missing. Metazona of anterior body segments with low bulges laterally. Metazonital macrochaetae in a transverse row on somites 25–27, like an elongate (to different degrees) triangle on preceding somites. Numerous macrochaetae broken off, remaining ones middle length, pointed apically.

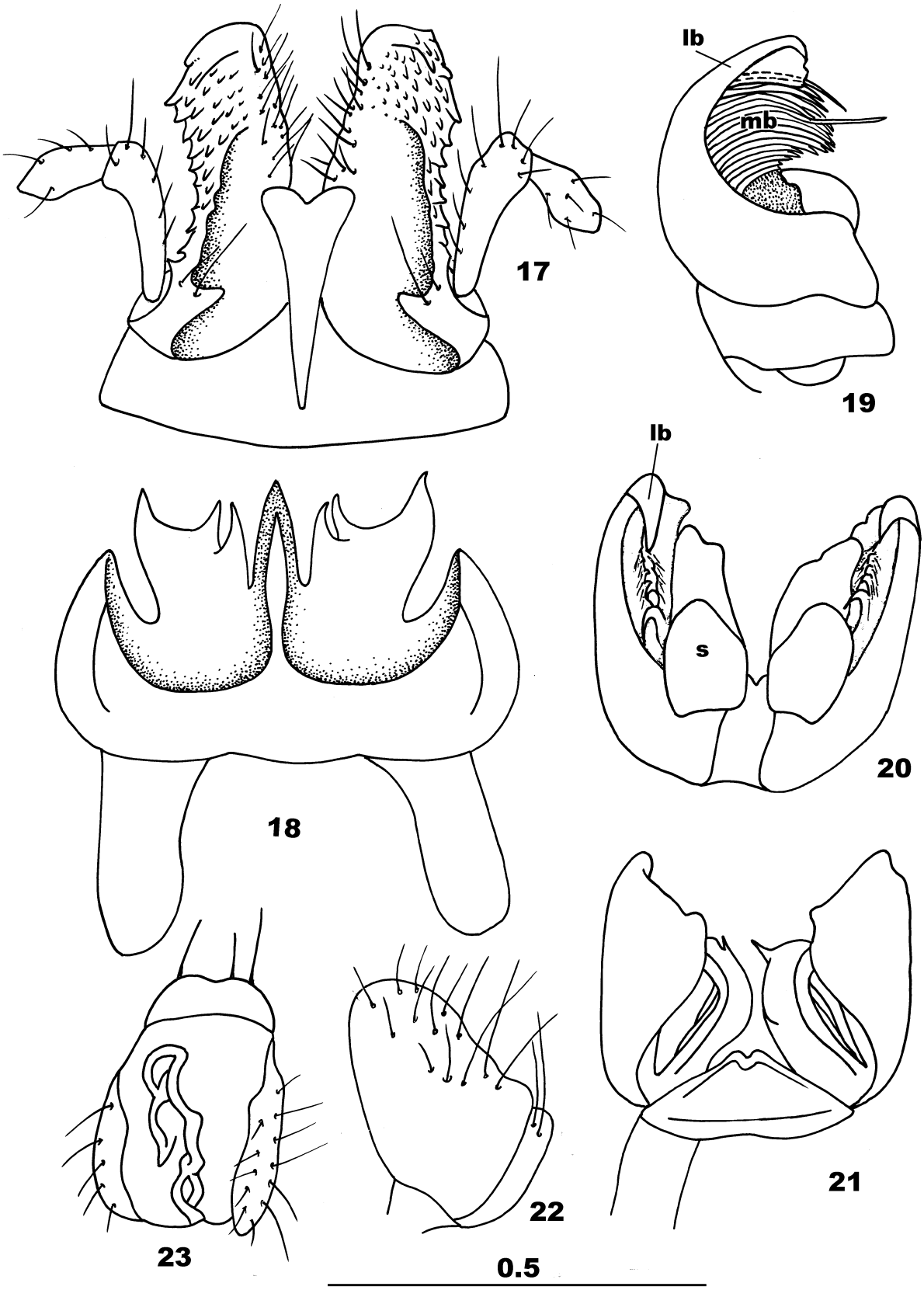


FIGURES 10–14. *Tarbagataya zaisanica* **sp. nov.**, male paratype. 10, leg pair 7, caudal view; 11, leg pair 7, front view; 12, anterior gonopods, front view; 13, anterior gonopods, caudal view; 14, posterior gonopods, front view; **mb**, mesal branch of coxite; **lb**, lateral branch of coxite; **s**, saculiform structure of anterior gonopod.





FIGURES 15–16. *Tarbagataya zaisanica* **sp. nov.**, female paratype. 15, vulva, ventral view; 16, vulva, lateral view.



FIGURES 17–23. *Tarbagataya zaisanica* **sp. nov.**, male paratype (17–21), female paratype (22–23). 17, leg pair 7, caudal view; 18, posterior gonopods, front view; 19, left anterior gonopod, lateral view; 20, anterior gonopods, caudal view; 21, anterior gonopods, front view; 22, left vulva, mesal view; 23, vulva, ventral view; **mb**, mesal branch of coxite; **lb**, lateral branch of coxite; **s**, saculiform structure of anterior gonopod. Scales in mm.

Leg pairs 3–6 slightly enlarged, with funnel-shaped tarsal papillae throughout ventrally; claw at base with two small additional claws dorsally and short setoid filament ventrally; coxae micropapillate ventrally. Postgonopodal legs (including leg pairs 10 and 11) with funnel-shaped tarsal papillae gradually missing toward end of body (tarsal papillae of leg pairs 10 and 11 occupying 2/3 length of tarsus i.e. space near claw free from papillae; tarsal papillae of midbody legs reaching to middle of tarsus i.e. distal part of tarsus free from papillae; hindmost legs without tarsal papillae); claw at base with two small additional claws dorsally and short setoid filament ventrally. In some individuals small dorsal additional claws on claws of hindmost legs missing. Claw of leg pairs 1 and 2 at base with two small additional claws dorsally and short setoid filament.

Leg 7 strongly modified (Figs 10–11, 17); each coxite ventrally elongated in tongue-shaped process covered with setae medially and papillae laterally; telopodites 2-segmented, setose ventrally; sternite with long protuberance bilobate apically.

Legs 10 with coxal glands but without other modifications. Legs 11 without coxal glands; coxae micropapillate ventrally.

Anterior gonopods (Figs 12–13, 19–21) with subtriangular, ventrally slightly bilobed sternite. Coxite with two branches. Mesal branch (**mb**) as numerous long filaments one or two of which longer than others. Lateral branch (**lb**) curved caudad, its mesal part thin fold covering **mb** frontally and enveloping **mb** mesodistally. Solenomere barely traceable on lateral branch. In posterior view (Figs 13, 20) anterior gonopods with pair of sacculiform structures (**s**) (modified coxal glands?).

Posterior gonopods (Figs 14, 18) reduced to a cupped coxosternum with normal tracheal apodemes. Coxal part with process supplied with three teeth. Sternal part with a high median process frontally.

Female. Body with 28 segments. Length 11–12 mm, width of midbody metazona 0.9–1.0 mm. Leg 2 typical, not reduced. Vulvae (Figs 15–16, 22–23) oblong with long setae ventrally. Operculum bilobate. Receptaculum seminis central in position. In some individuals small dorsal additional claws at base of claws of hindmost legs missing.

Name. The specific epithet refers to the type locality.

Remarks. Up to now *Tarbagataya* included only one species - *T. splendida* Golovatch & Wytwer, 2003, described from East Kazakhstan (Golovatch & Wytwer 2003). *T. zaisanica* **sp. nov.** is the second species of this genus. One of the distinguishing characters of *Tarbagataya* is the absence of tarsal papillae in males because they are absent in the type species *T. splendida*. However because tarsal papillae are present in *T. zaisanica* **sp. nov.**, the original diagnosis of the genus must be changed accordingly. Thus, tarsal papillae in the males of *Tarbagataya* species are absent or present.

Tarbagataya splendida Golovatch & Wytwer, 2003

Tarbagataya splendida Golovatch & Wytwer 2003: 579–584, 581: figs 1–14, 582: figs 15–20, 583: figs 21–23.

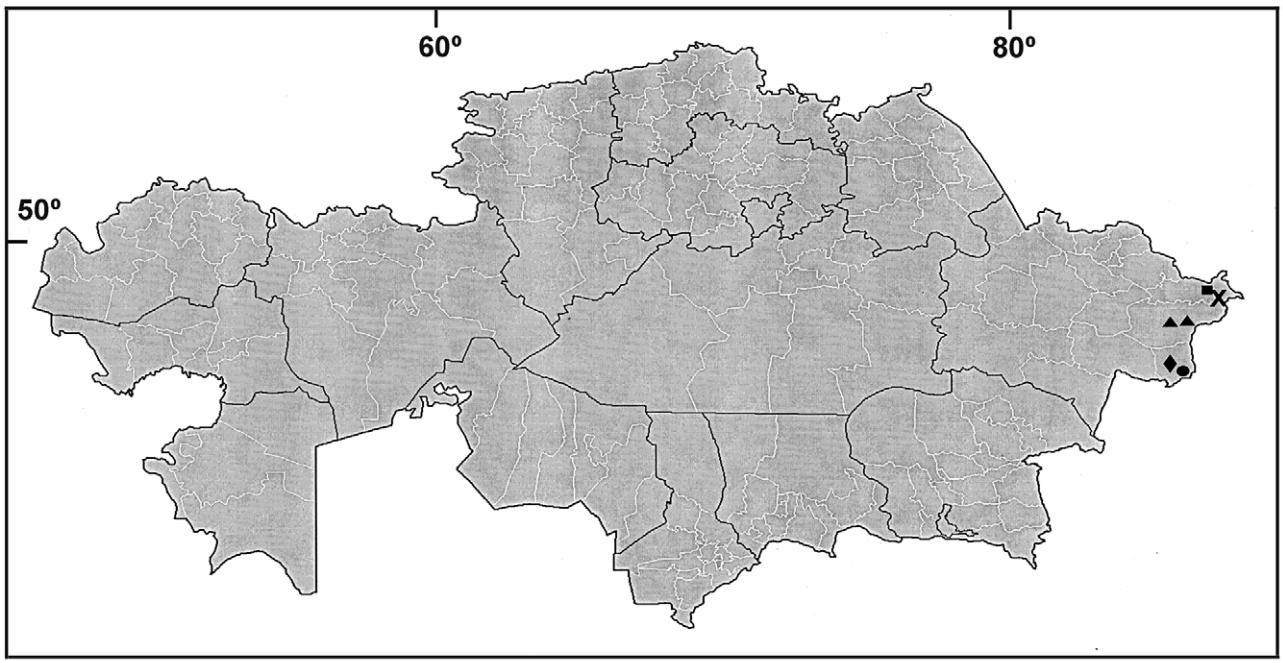
Remarks. This species is known only from its *terra typica* i.e. Tarbagatay Mountains, East Kazakhstan, Central Asia (Golovatch & Wytwer 2003).

Cleidogonidae Cook, 1896

Tianella ornata Golovatch, 1979

Tianella ornata Golovatch 1979: 987–990, 989: figs 1–12.
Tianella ornata—Lokšina and Golovatch 1979: 383.
Tianella ornata —Read & Golovatch 1994: 65, 66.

Remarks. Originally described from Dzhungarsky Alatau, East Kazakhstan (Golovatch 1979), this species has not been collected since.



Map. Distribution of Chordeumatida species in Kazakhstan. Borderlines show borders between the areas. Filled diamond: *Tianella ornata*, filled square: *Altajosoma bukhtarma* **sp. nov.**, filled triangle: *Tarbagataya splendida*, filled circle: *Tarbagataya zaisanica* **sp. nov.**, cross: *Altajosoma arshaty* **sp. nov.**

Key to Chordeumatida families, genera and species occurring in Kazakhstan

1(6) Leg pair 7 of male typical (i.e. morphologically unmodified) 2
2(5) Posterior gonopods complex and highly modified. Anterior gonopods comparatively simple with flagelliform telopodites. Paraterga well-developed . . . . . .Family Diplomaragnidae, genus *Altajosoma*
3(4) Apex of posterior angiocoxal process pointed without teeth (Fig. 1). Lateral sheath process of colpocoxite (**lp**) as large smooth, arcuate horn . . . . . *Altajosoma arshaty* **sp. nov.**
4(3) Apex of posterior angiocoxal process with teeth (Figs 5, 8). Lateral sheath process of colpocoxite (**lp**) straight with prominence in its middle part, pointed apically . . . . . *Altajosoma bukhtarma* **sp. nov.**
5(2) Posterior gonopods simple leg-liked. Anterior gonopods complex and highly modified. Paraterga absent, somites with dorso-lateral bulges . . . . . Family Cleidogonidae, genus *Tianella*, *T. ornata*
6(1) Leg pair 7 of male morphologically strongly modified (Fig. 10–11, 17) . . . .Family Kirkayakidae (syn. Altajellidae), genus *Tarbagataya*
7(8) Posterior gonopods with coxal process supplied with three teeth (Figs 14, 18) . . . . . *Tarbagataya zaisanica* **sp. nov.**
8(7) Posterior gonopods with coxal subsecuriform process without three teeth . . . . . *Tarbagataya splendida*

Acknowledgements

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