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A new fairy shrimp *Galaziella murae* (Branchiopoda: Anostraca) from Mongolia

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A new species of fairy shrimp is described from a permanent lake in western Mongolia and assigned to the genus *Galaziella*. The new species is distinguished from its congeners *G. baikalensis* Naganawa & Orgiljanova, 2000, *G. mongoliana* (Uéno, 1940) (= *Chirocephalus mongolianus* Uéno, 1940), and *G. gobisteppensis* Naganawa & Zagas, 2003 by the display of the following combination of character states: (1) a single, instead of bilamellar, dorsomedial process on the proximal segment of the male antenna; (2) ovisac (brood pouch) broadened anteriorly and protruded laterally at each side into an acute process; and (3) colourless cercopods in both sexes.

Key words: Chirocephalidae, *Galaziella baikalensis*, *Galaziella mongoliana*, *Galaziella gobisteppensis*, taxonomy.

INTRODUCTION

During a limnological expedition conducted in September-October of 2005 to the southern, central and western parts of Mongolia, a new anostracan (fairy shrimp) was collected from two mountain permanent water bodies located in the westernmost part of the Mongol Altayn nuruu (Mongolian term "nuruu" = mountains). This species appears to belong to the genus *Galaziella* Naganawa & Orgiljanova, 2000.

The genus *Galaziella* was erected by Naganawa & Orgiljanova (2000) to accommodate a new species (*G. baikalensis*) collected in two temporary water bodies at Olkhon Island (Lake Baikal, Russia). Afterwards, two additional taxa previously included in the genus *Chirocephalus* Prévost in Jurine, 1820 [i.e., an undescribed *Chirocephalus* sp. from Mongolia reported in Naganawa & Zagas (2002), and *Chirocephalus mongolianus* Uéno, 1940 from Mongolia and Inner Mongolia] were transferred by Naganawa & Zagas (2003) to the new genus as *Galaziella gobisteppensis* Naganawa and Zagas, 2003 and *Galaziella mongoliana* (Uéno, 1940), respectively.

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MATERIAL AND METHODS

Specimens were collected with a 100 μm mesh handheld plankton net, and then fixed with 4% formalin in the field. Body length measurements include cercopods (CL).

Camera lucida drawings were made with an Olympus BH-2 compound microscope provided with phase-contrast optics. Egg samples for SEM were critical-point dried and sputter-coated with gold-palladium.

Type material is deposited in the Non-insect Invertebrates Collection of Museo Nacional de Ciencias Naturales – CSIC (MNCN), Madrid, Spain.

RESULTS

Genus ***Galaziella*** Naganawa & Orgiljanova, 2000

Galaziella murae sp. nov. (Figs 1-5)

Material examined. Holotype: MNCN 20.04/7959 (male, 17.6 mm CL), Chömögt nuur, Tsengel sum., Bayan-Olgiy aimag, western Mongolia (48°25′10″N-88°53′19″E, 2242 m a.s.l.); shallow permanent water body of 14.7 ha surrounded by high mountain steppes; coll. M. Alonso, 4 October 2005; preserved in a vial in 4% formalin with glycerol. Allotype: MNCN

20.04/7960 (ovigerous female, 20.5 mm CL). Paratypes: MNCN 20.04/7961 (3 mature males and 1 ovigerous female). Collecting data for allotype and paratypes are same as for holotype. Mongolian terms: "nuur" = lake, "sum." (sumun) = village, "aimag" = province.

Etymology. Species named after Prof. Graziella Mura (University of Rome "La Sapienza", Italy), in recognition of her long and enthusiastic dedication to the taxonomy of the Anostraca.

Description. Adult male (Figs 1 and 2). Body unpigmented. Head (Fig. 1F-H) with small elliptical nuchal organ placed mid-dorsally. Antennule shorter than proximal segment of antenna (Fig. 1F, H), with three long subdistal setae and nine aesthetascs (Fig. 1K: AE). Proximal segment of antenna soft and corrugated, with patches of microtuberculate integument and sensilla distributed on dorsal and dorsolateral surface as figured (Fig. 1F-I); distinctive stalked spherical or bean-shaped apophysis (Fig. 1A, H, J: AP) covered with thin spinules placed ventromedially on segment; soft, folded fleshy lamella inserted proximally on dorsomedial surface of segment; lamella not reaching distal margin of segment, with sparsely set pointed denticles along medial surface. Distal segment rigid and chitinous, almost as long as proximal counterpart, bifid, with medial branch longer, flattened and curved inwards, ending in blunt apex (Fig. 1B-D); lateral branch (Fig. 1E) finger-like, slightly curved towards ventral, about one-third length of medial branch, with patch of microtuberculate integument placed proximally on posterior surface and at rounded tip (Fig. 1H, J).

Genital somites (Fig. 2A) swollen. Rigid part of penes short and broad, with tuberculate integument and with roughly triangular process placed on medial margin; medial margin of process covered with densely set short denticles; additional shorter, pointed smooth chitinous process (Fig. 2B: PT, arrow) placed posteromedially beside latter process. Fully-everted eversible part of penes consisting of unique boom-like process four times as long as rigid part, with posterolateral conical cirrus showing distomedial portion covered with sharp denticles directed backward (Fig. 2C, D). When partially everted, distal part of penes hidden within pouch (Fig. 2B: P).

Adult female (Figs 3-5). As male except for antennae and genital complex. Antennule with three long subdistal setae and nine aesthetascs (Fig. 3C: AE). Antenna as long as antennule, conical with sharply pointed tip (Fig. 3A, B); medial surface with small chitinized outgrowth with microtuberculate integument placed about midway (arrows in Fig. 3A, F); lateral surface with several patches of microtuberculate integument and sparsely set sensilla distributed as in Fig. 3A, B, F. Labrum (Fig. 3B, D) subquadrangular, lacking distal protuberances; short and fleshy setulose linguiform process subdistally on posterior margin; blunt setulose pad (Fig. 3D: SP) placed midway on posterior margin. Maxilla (Fig. 3E) reduced, provided with three soft setae.

First ten thoracic limbs (Figs 3G and 4A, I, I′, I″, II-X) subsimilar, each with pre-epipod (Fig. 4A: PE) subdivided into two leaf-like portions with margin clearly serrated except on first limb (Fig. 3G), where serrations are less marked. Epipod (Fig. 4A: EP) with smooth margin. Exopod (Fig. 4A: EX) broad, provided with proximal spine-like setae on lateral margin. Endopod (Fig. 4A: EN) expanded distally with proximal setae on medial margin spine-like, unequal in length (Fig. 3I). Endite 1 (Fig. 3A: 1) with three submarginal setae on anterior surface, two distalmost reduced and spine-like, placed closely together (Fig. 3H). Endite 2 (Fig. 4A: 2) with two unequal submarginal setae on anterior surface close to proximal angle. Endites 3-5 of second to tenth thoracic limbs (Fig. 4A: 3-5) with 2, 2, and 4-6 short anterior setae, and 3, 2, 2 long plumose posterior setae, respectively (Fig. 4II-X). Anterior setae of endites 3-5 of first thoracic limb more numerous and variable (5-9, 5-9, and 5-7, respectively in specimens examined) (Figs 3G and 4I, I′, I″). Eleventh thoracic limb (Fig. 4B) with pre-epipod not completely subdivided, each lobe with pointed distolateral angle. Endopod not expanded distally. Endite 1 with three anterior short, spine-like setae. Endites 2-5 globular and similar in size. Endite 2 with filtering comb reduced to three long posterior setae. Endites 3-5 with variable number of short anterior setae (3-5, 4-5, and 3-6, respectively in specimens examined) (Fig. 4XI, XI″-XI‴′). Peculiar wart-like outgrowths (Fig. 4C: WG) developed on endites 4, 5 and on proximal part of endopod.

Thoracic somites with dorsal outgrowths (Fig. 5D: DO, F: DO) on posterior margin of eleventh (= last pregenital) somite only, as pair of evenly rounded processes with microtuberculate integument. Genital somites completely fused, but retaining respective dorsolateral verrucose outgrowths (Fig. 5A, C, E: VB) about midway of composite double-somite. Genital and postgenital somites provided with verrucose outgrowths as figured (Fig. 5A, C, E); some outgrowths bearing 1-2 sensilla (not figured).

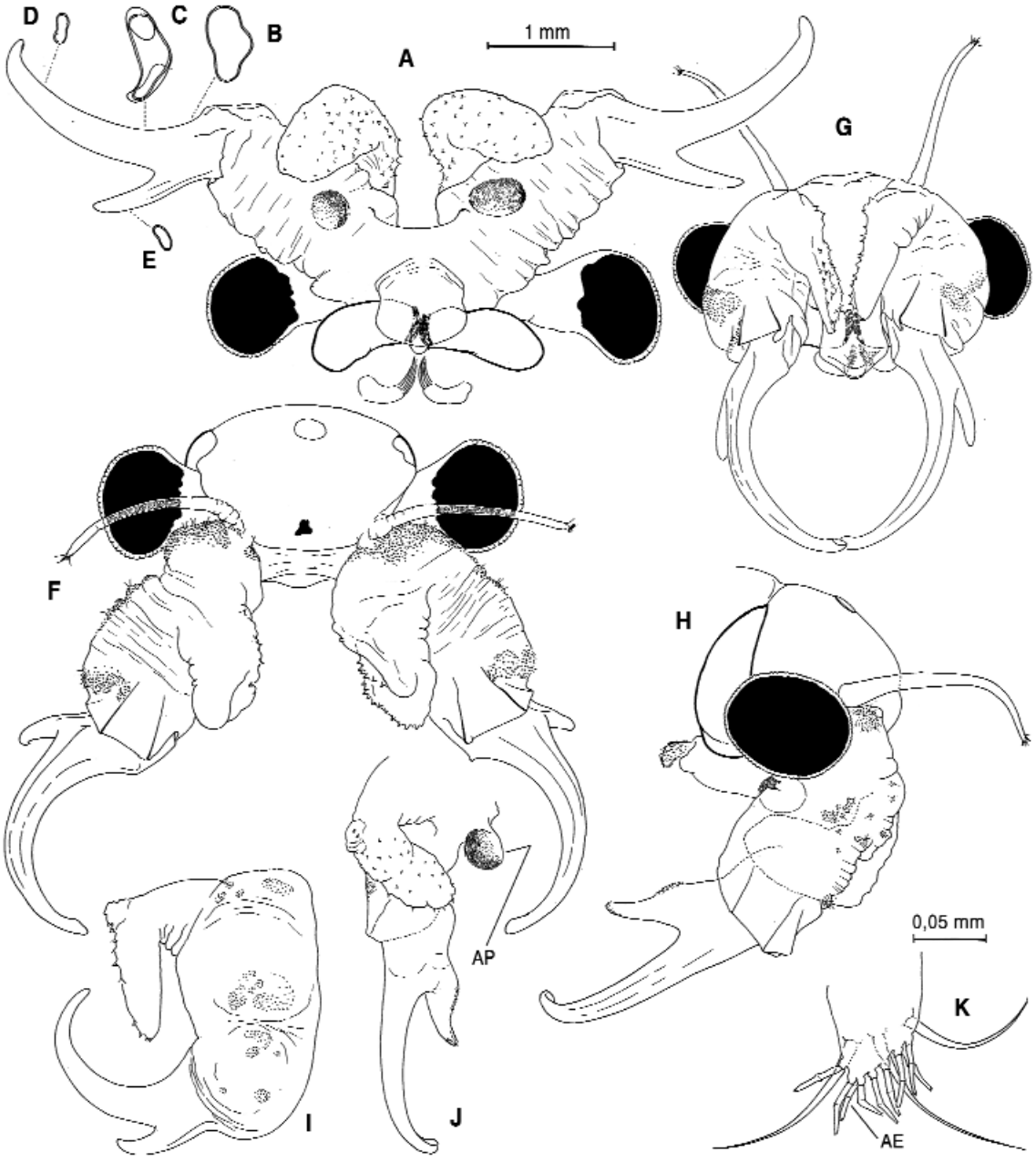

FIG. 1.
Galaziella murae sp. nov., holotype, MNCN 20.04/7959 (male, 17.6 mm CL) from Chömögt nuur (Tsengel sum., Bayan-Olgiy aimag, western Mongolia).

A: head, ventral view;
B-E: cross sections of distal segment of antenna;
F: head, dorsal; G: same, frontal;
H: same, right lateral; I: left antenna, dorsolateral;
J: right antenna, medial;
K: tip of antennule.

Abbreviations: AE, aesthetasc; AP, apophysis.

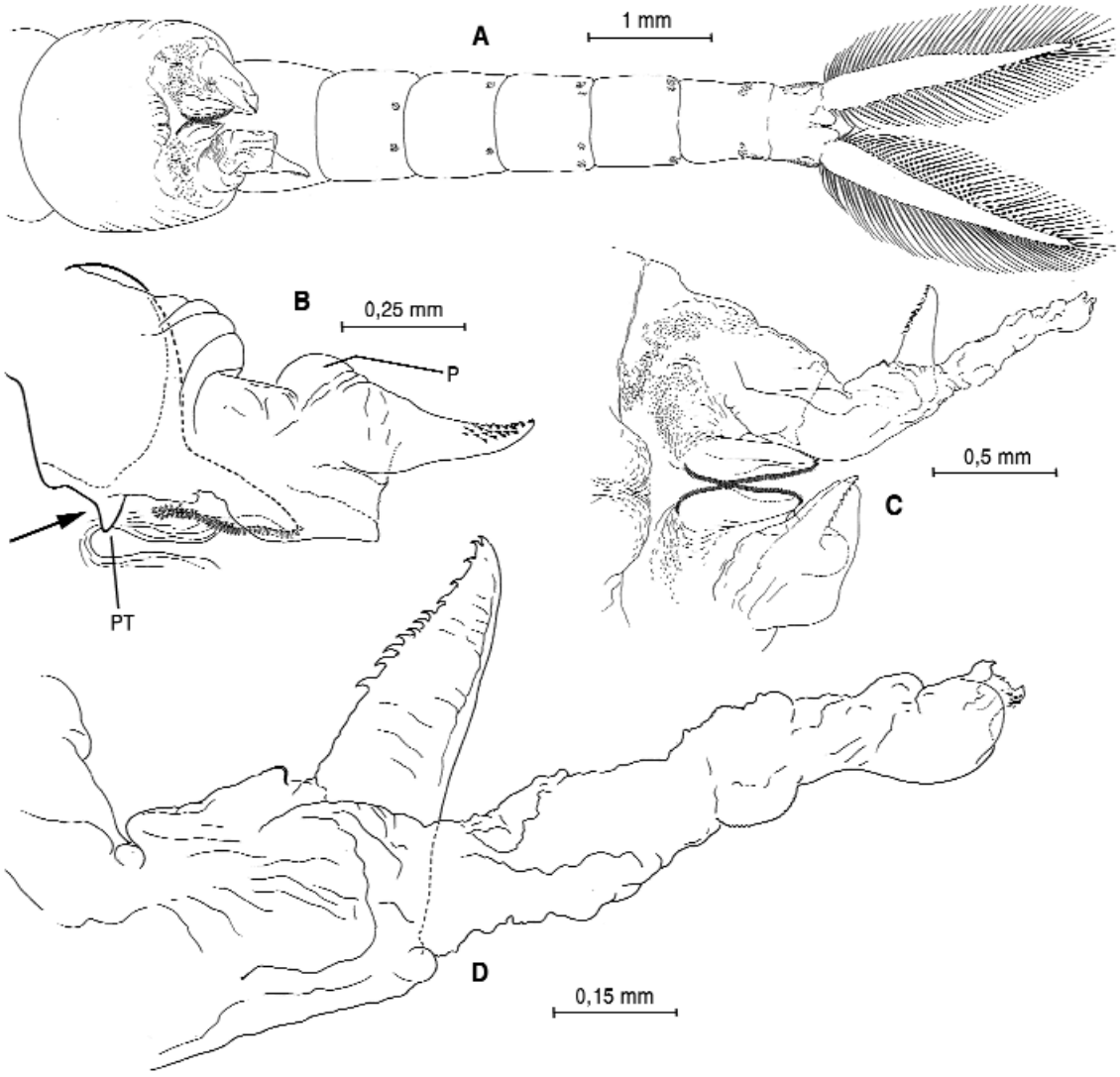

FIG. 2.
Galaziella murae sp. nov., holotype.

A: pregenital, genital and postgenital somites plus telson with cercopods, ventral view;
B: right penis partially everted, dorsal;
C: male paratype (MNCN 20.04/7961) with left penis fully-everted, ventral;
D: detail of latter.

Abbreviations: pouch (P) and posteromedial process (PT) of rigid portion of penis (arrow).

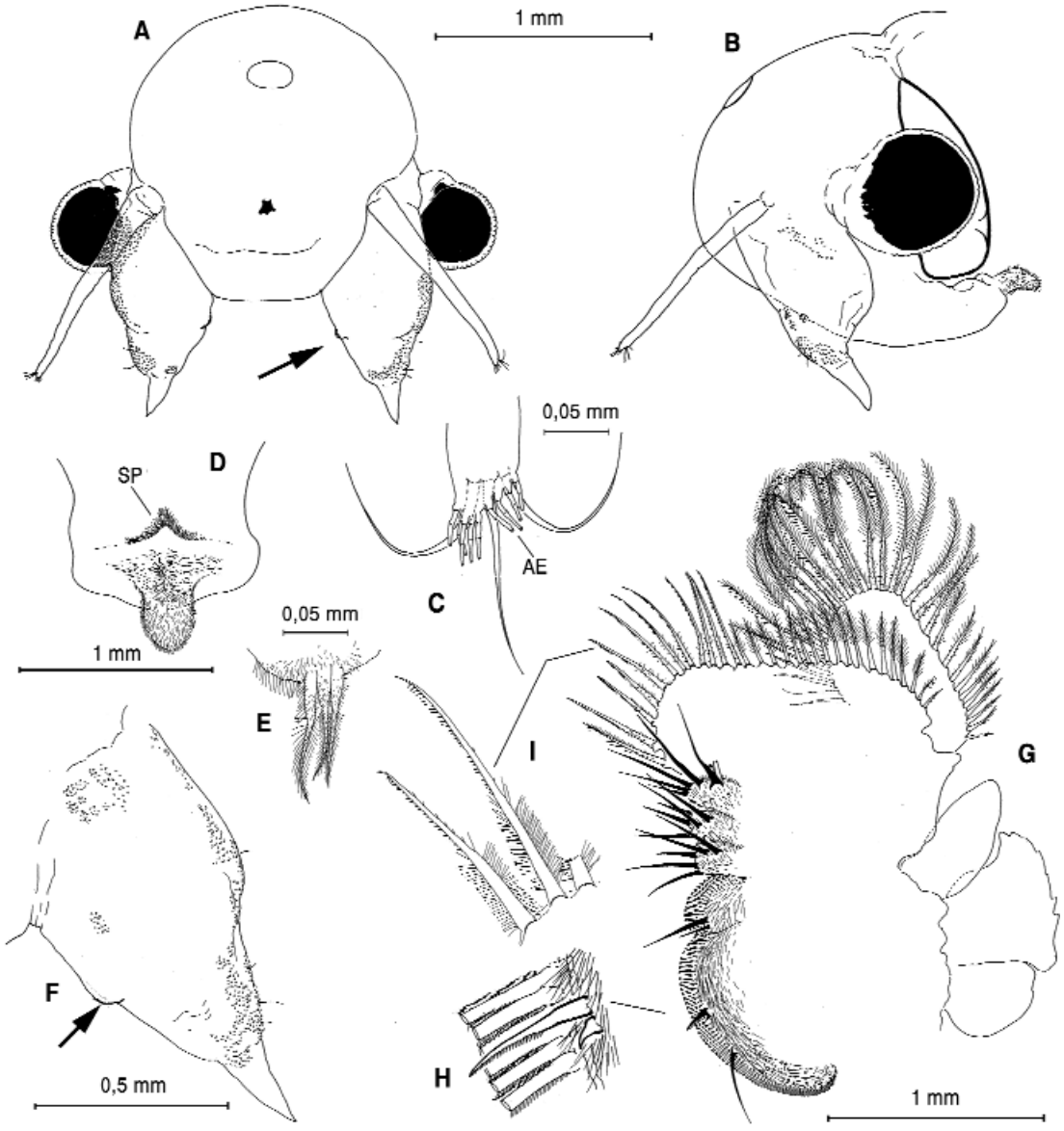

FIG. 3.
Galaziella murae sp. nov., allotype.

A: head, dorsal view;
B: same, left lateral;
C: tip of antennule;
D: labrum, posterior;
E: maxilla;
F: left antenna, dorsal;
G: right first thoracic limb, lateral;
H: detail of submarginal spine-like reduced setae on endite 1;
I: detail of proximal spine-like setae on medial margin of endopod.

Abbreviations: AE, aesthetasc; SP, setulose pad. For arrows in A and F, see text.

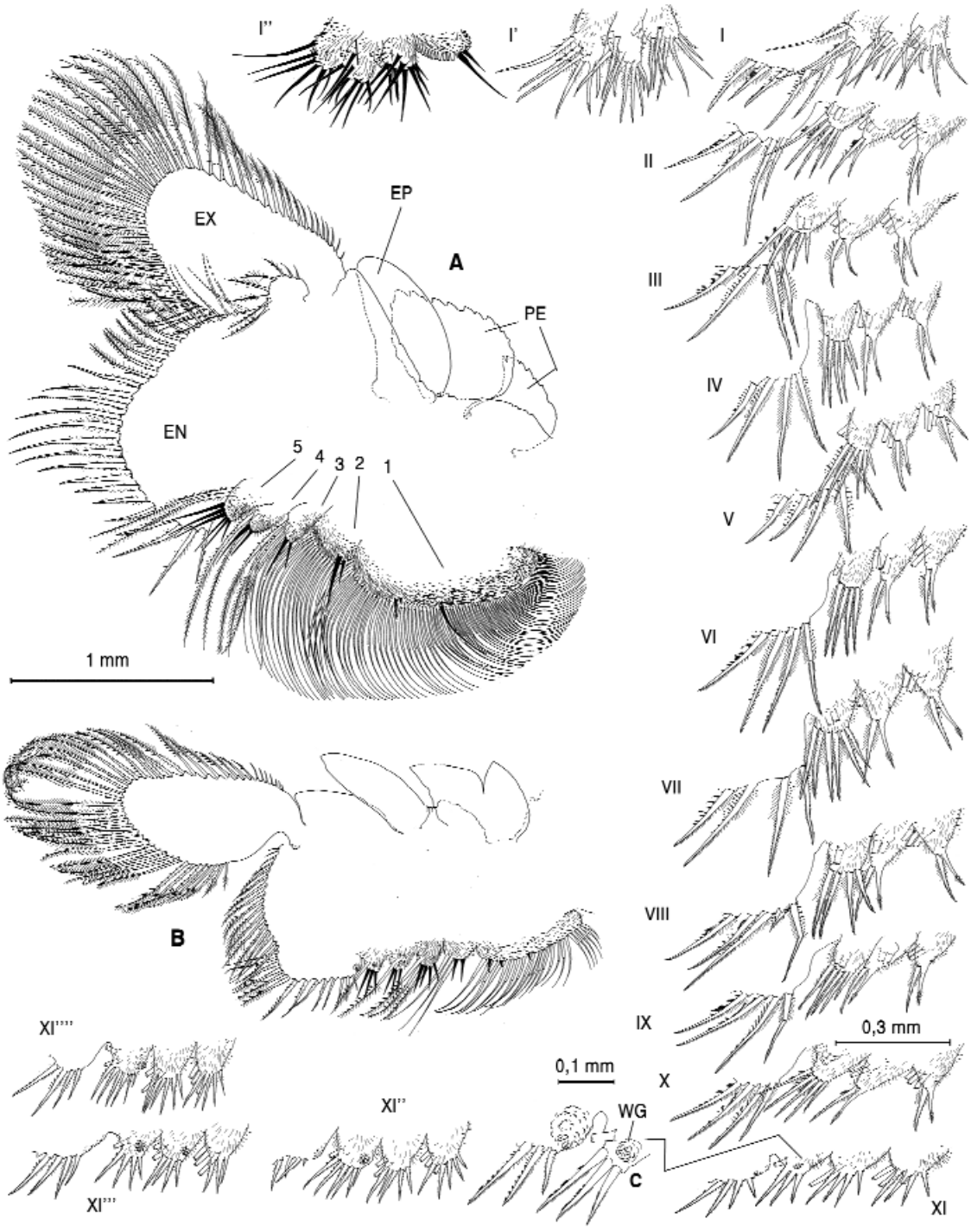

FIG. 4.
Galaziella murae sp. nov., allotype.

A: right fifth thoracic limb, lateral view;
B: right eleventh thoracic limb, lateral;
C: detail of wart-like outgrowths on endite 5 and endopod of eleventh thoracic limb.

Abbreviations: EN, endopod; EP, epipod; EX, exopod; PE, pre-epipod; WG, wart-like outgrowths. Arabic numerals 1-5 correspond to endites 1-5, respectively. Roman numerals I-XI correspond to endites 3, 4 and 5 and proximal part of endopod of first to eleventh thoracic limbs, respectively. I′ and I′′ show variability in arrangement of anterior setae of first thoracic limb; I′: endites 3, 4 and 5; I′′: endites 2, 3, 4 and 5. XI′′-XI′′′′: variability in anterior setae configuration of eleventh thoracic limb.

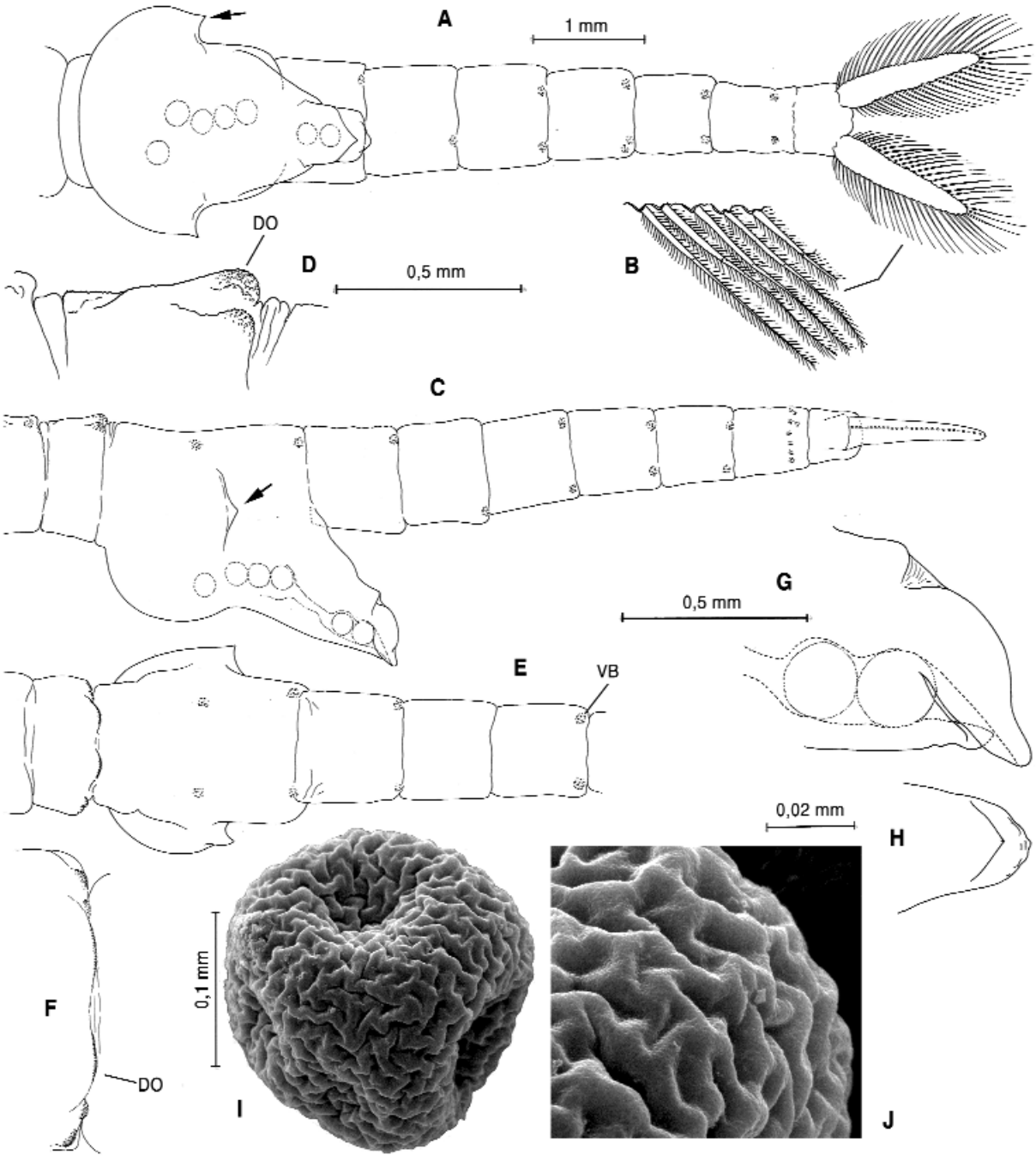

FIG. 5.
Galaziella murae sp. nov., allotype.

A: ovisac (brood pouch), pregenital, genital and postgenital somites and telson with cercopods, ventral view;
B: detail of marginal setae of cercopods;
C: same as A, left lateral;
D: detail of dorsal outgrowths on eleventh thoracic (= last pregenital) somite, dorsolateral;
E: genital composite double-somite and some neighbouring somites with verrucose bosses, dorsal;
F: detail of dorsal outgrowths on eleventh thoracic somite, dorsal;
G: detail of distal portion of ovisac, left lateral; H: outlet of ovisac, ventral;
I: resting egg;
J: detail of resting egg surface.

Abbreviations: DO, dorsal outgrowths; VB, verrucose bosses. For arrows in A and C, see text.

TABLE 1. Diagnostic characters of the four *Galaziella* species

Character	*Galaziella baikalensis*	*G. mongoliana*	*G. gobisteppensis*	*G. murae*
Male antennal processes	Two leaf-shaped processes, anterior larger	As in *G. baikalensis*	As in *G. baikalensis*	Only short, single fleshy lamella, folded ventrally
Apophysis of male antenna, outline	Pyriform	Globular	Fava(broad bean)-shaped	Spherical to bean-shaped
Female antenna	With one acute outgrowth on medial margin	As in *G. baikalensis*	With variably developed bulk on medial margin, showing small chitinized thickening	As in *G. gobisteppensis*
Female pregenital somites	Last two somites each with pair of similar obtuse processes	Last two somites with pair and 2-3 pairs of acute thorns, respectively	Only last somite displaying pair of processes	As in *G. gobisteppensis*
Ovisac (brood pouch)	Spindle-shaped, anterior lobe rounded	As in *G. baikalensis*	As in *G. baikalensis*	Anterior lobe expanded and with lateral acute process at each side
Resting eggs, outer ornamentation	Unknown (immature eggs were reported only)	Muskmelon-like netted plicae	As in *G. mongoliana*	As in *G. mongoliana*

Ovisac (brood pouch) (Fig. 5A, C, E) inflated anteroventrally, with pointed lateral process at each side (arrows in Fig. 5A, C), and extended posteroventrally into slender process reaching posterior margin of first postgenital somite (Fig. 5A, C, G, H). Resting eggs (Fig. 5I, J) spherical, with strongly wrinkled surface; outer layer densely pitted.

Cercopods (Fig. 5A, B) colourless, of variable shape, either blunt or tapering distally as those of male (Fig. 2A), fringed with finely plumose setae; length about as fifth and sixth postgenital somites plus telson combined.

Differential diagnosis. Diagnostic traits of the new species versus its three living congeners are summarized in Table 1.

Distribution. For further information and pictures of the sampling sites, see http://geodata.es/mongolian_lakes. At present, only three localities for this species are known in Mongolia: Chömögt nuur (the type locality) and a nearby small lagoon (Tsengel sum.) in the Altay region (western Mongolia; reference numbers 58 and 59 in the website), and Tagiin nuur (shallow turbid permanent lake) in Hovsgol aimag (north-central Mongolia; reference number 205). Chömögt nuur (14.7 ha) and the appendant lagoon (0.9 ha) are placed on middle Cambrian-early Ordovician stratigraphic units (ca. 500 My ago) in high mountain steppes (2242 m a.s.l.) of the Mongol Altayn nuruu (western Mongolia). Tagiin nuur (14.4 ha) is also placed on the same stratigraphic units in medium mountain steppes (1728 m a.s.l.) of the Horidol Saridag nuruu (southern slopes, 60 km south of Lake Hovsgol). All these water bodies are permanent and more than 1.5 m deep. The slowly flowing water is turbid due to suspended clay (grey in colour), whereas mineralization is medium to high, ranging between 770 μS cm^{-1} (Tagiin nuur) and 4200 μS cm^{-1} (Chömögt nuur).

Aquatic submerged vegetation is scarce: only *Enteromorpha* sp., a taxon typical of mineralized waters, and sparse stems of *Potamogeton* gr. *pectinatus* L. were recorded. Accompanying crustacean species in Chömögt nuur and its neighbour lagoon in October, 2005 were *Daphnia magna* Straus, 1820; *Daphnia* gr. *pulex* Leydig, 1860; *Simocephalus vetulus* (O.F. Müller, 1776); *Chydorus* gr. *sphaericus* (O.F. Müller, 1785); *Hemidiaptomus ignatovi* G.O. Sars, 1903; *Arctodiaptomus rectispinosus* Kikuchi, 1940; *Eucyclops dumonti* Alekseev, 2000; some ostracods and *Gammarus* sp. In Tagiin nuur the accompanying crustacean fauna (in September, 2007) was *Daphnia carinata* King, 1853; *D. magna* and *Arctodiaptomus wierzejskii* (Richard, 1888).

DISCUSSION

The genus *Galaziella* is closely similar to *Chirocephalus* Prévost in Jurine, 1820, but differs in the following features: (1) the proximal branch of the bifid distal segment of the male antenna is placed posterolaterally (versus medially in *Chirocephalus*), a feature reported also in some fossil anostracans from the Lower Cretaceous of the Eastern Transbaikal region, Russia (Trussova, 1971, 1975; Naganawa & Brtek, 2006); (2) when fully-everted, the eversible part of the penes comprises a boom-like process with pouch and a conical toothed cirrus directed outwards, a feature not reported in the other anostracans (Naganawa & Zagas, 2003); and (3) a unique resting egg morphology, found only in some extinct anostracans (Trussova, 1974; Naganawa & Brtek, 2006). The genus currently encompasses four living species: *G. baikalensis*, *G. mongoliana*, *G. gobisteppensis* and *G. murae*, usually placed in the family Chirocephalidae.

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REFERENCES

Naganawa H, Brtek J, 2006. Current prospect of the Recent large branchiopodan fauna of East Asia: 9. "Living fossil" fairy shrimps, from the viewpoint of hemoglobin evolution. *Aquabiology*, 28: 527-533.

Naganawa H, Orgiljanova TI, 2000. *Galaziella baikalensis*, a new genus and species of chirocephalid (Crustacea: Branchiopoda: Anostraca) from Russia and the zoogeography of East Asian Anostraca. *Limnology*, 1: 209-216.

Naganawa H, Zagas B, 2002. General aspects of the large branchiopod crustacean fauna of Mongolia. *Limnology*, 3: 181-188.

Naganawa H, Zagas B, 2003. Current prospect of the Recent large branchiopodan fauna of East Asia: 6. Revision of the genus *Galaziella* (Anostraca: Chirocephalidae: Galaziellinae). *Aquabiology*, 25: 387-393.

Trussova EK, 1971. On the first finding of the Mesozoic species of order Anostraca (Crustacea). *Paleontologicheskii zhurnal*, 4: 68-73.

Trussova EK, 1974. The traces of life of phyllopod crustaceans. *Paleontolologicheskii sbornik*, 10: 82-87.

Trussova EK, 1975. On the taxonomic status of Anostraca, Crustacea from the Lower Cretaceous of the Eastern Transbaikal. *Paleontologicheskii sbornik*, 12: 60-66.

Uéno M, 1940. Phyllopod Crustacea of Manchoukuo. *Bulletin of the biogeographical society of Japan*, 10: 87-102.