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Taxonomic contribution to the knowledge of the oribatid mite family Epimerellidae (Acari, Oribatida, Oppioidea)

Sergey G. Ermilov ^a, Olga L. Makarova ^b

^a Institute of Environmental and Agricultural Biology (X-BIO), Tyumen State University, Tyumen, Russia.

^b Severtsov Institute of Ecology and Evolution, Russian Academy of Sciences, Moscow, Russia.

Original research

ABSTRACT

A new species of the genus *Epimerella* (Oribatida, Epimerellidae), *E. kalmykorum* n. sp., is described, based on materials collected from the reed debris in the bank of the salty Manych-Gudilo Lake in the Republic of Kalmykia, Russia. The morphology of gnathosoma and the identification of leg setae and solenidia are given for the first time for any representative of Epimerellidae. Besides, *Enisella turcica* Ayyildiz and Luxton, 1989 is first found in Crimea (on the shore of the saline Sivash Lake). Generic diagnoses for *Epimerella* Kulijev, 1967 and *Enisella* Ayyildiz and Luxton, 1989 are revised. An identification key, distribution and habitats of all known representatives of Epimerellidae are presented.

Keywords opioid mites; *Epimerella*; *Enisella*; taxonomy; morphology; family diagnosis; generic diagnosis; identification key; distribution; habitat; Russia

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Introduction

The oribatid mite family Epimerellidae (Acari, Oribatida, Oppioidea) was proposed by Ayyildiz and Luxton (1989), based on the following morphological traits: medial crista of anterior notogastral margin well developed and produced into prodorsum; epimeres III+IV separated medially, with broad concavity between them; 10–13 pairs of notogastral setae, with shortest seta *c*; five pairs of genital, one pair of aggenital, two pairs of anal, and three pairs of adanal setae; legs monodactylous. The family includes two genera: *Epimerella* Kulijev, 1967; and *Enisella* Ayyildiz and Luxton, 1989. Subías (2009) considered the rather specific Indonesian genus *Luxtonia* Mahunka, 2001 also the member of Epimerellidae (see Discussion section below).

Epimerella was described by Kulijev (1967), with *Oppia smirnovi* Kulijev, 1962 as type species; at present, the genus comprises eight species and one subspecies, which are distributed in the southern Palaearctic region (Subías 2022). *Enisella* was described by Ayyildiz and Luxton (1989), with *Enisella turcica* Ayyildiz and Luxton, 1989 as type species; at present, the genus comprises one (type) species, which is known only from Turkey (Subías 2022).


During the taxonomic identification of oribatid mites from salty habitats in Kalmykia, Russia (Fig. 1), we found one new species belonging to *Epimerella*. The main goals of our paper are: to describe and illustrate a new species under the name *Epimerella kalmykorum* n. sp.; to summarize generic morphological traits; and to present the renewed identification key, distribution, and habitats to known species of the family. Besides, new record of *Enisella turcica*

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Corresponding author

Sergey G. Ermilov 
ermilovacari@yandex.ru

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Figure 1 Locality and habitat of *Epimerella kalmykorum* n. sp.: A, B – general views of floodplain of the Manych-Gudilo Lake, south bank of the Left Island; C – shrubby *Tamarix ramossissima* among *Salicornia perennans* and *Bassia prostrata*; D – sampled litter (rotten reed fragments and tamarisk remnants). Kalmykia, 13.XI.2021.

Ayyildiz and Luxton, 1989 is presented based on samplings in Crimea by N.A. Kuznetsova and M.B. Potapov in 2021.

Presently, two species and one subspecies of Epimerellidae have been registered in the Russian fauna (e.g., Gordeeva and Karppinen 1988; Shtanchaeva and Subias 2010): *Epimerella puzanovi* Gordeeva and Karppinen, 1988; *Ep. smirnovi* (Kulijev, 1962); and *Ep. smirnovi longisetosa* Kulijev, 1967.

Material and methods

Specimens

Mites were collected during the special expedition organized in November 2021 for the testing the assumption about the possible occurrence of littoral halophilic species within the Kuma-Manych Depression. This area is the former ancient strait that connected the Black and Caspian Seas in the geological past. Its course is characterized by numerous salt lakes, and the Manych-Gudilo Lake is the largest from them. The climate of this hot and dry during the summer area is considered as moderately continental. The mid-July temperature in this area is 24.4 °C, the mid-January temperature is –6.8 °C, annual precipitation 360 mm (Scientifically-Applied Handbook, 1990), and the salinity of the Manych-Gudilo Lake during last years is more than 40‰ (Bulysheva *et al.* 2018). In general, 31 samples of turf, litter and soil were taken (about 6 liters) on banks of five lakes and two rivers. And only one sample included two specimens of a new species belonging to *Epimerella*.

Besides, the enough collection of mites obtained by N.A. Kuznetsova and M.B. Potapov from different saline sites of the Crimea in September 2021 was studied (27 localities, about 40

samples). Among other mites, this yielded one specimen of *Enisella turcica*.

Samples (each of volume 150–300 ml) were taken from the turf of saline lands, litter of reeds as well as from storm debris on shores of salty lakes and rivers. Mites were extracted from the cores in Moscow using laboratory eclectors by drying the samples for 10 days until their completely dry condition without additional heating or lighting. Microarthropods were fixed with 85–96% alcohol.

Observation and documentation

For measurement and illustration, specimens were mounted in lactic acid on temporary cavity slides. All measurements are in micrometers. Body length was measured in lateral view, from the tip of the rostrum to the posterior edge of the notogaster; other structures were oriented to avoid parallax errors. Notogastral width refers to the maximum in dorsal aspect. Setal lengths were measured perpendicular to their long axis, accounting for curvature. Formulas for leg solenidia are given in square brackets according to the sequence genu-tibia-tarsus. Drawings were made with a camera lucida using a Leica DM 2500 light microscope.

Terminology

Morphological terminology used in this paper follows that of F. Grandjean: see Travé and Vachon (1975) for references; Norton (1977) for leg setal nomenclature; Norton and Behan-Pelletier (2009) for overview.

Abbreviations

Prodorsum: *ro*, *le*, *in*, *bs*, *ex* = rostral, lamellar, interlamellar, bothridial, and exobothridial seta, respectively; *exv* = vestige of second exobothridial seta; *pbt* = postbothridial tubercle. *Notogaster*: *ap* = apophysis; *cr* = crista; *c*, *la*, *lm*, *lp*, *h*, *p* = setae; *ia*, *im*, *ip* = lyrifissures; *gla* = opisthotal gland opening. *Gnathosoma*: *a*, *m*, *h* = subcapitular setae; *or* = adoral seta; *sup*, *inf*, *d*, *l*, *cm*, *acm*, *ul*, *su*, *vt* = palp setae; ω = palp solenidion; *cha*, *chb* = cheliceral setae; *Tg* = Trägårdh's organ. *Epimeral and lateral podosomal regions*: *con* = concavity; *1a–1c*, *2a*, *3a–3c*, *4a–4c* = epimeral setae; *PdI* = pedotectum I; *dis* = discidium. *Anogenital region*: *g*, *ag*, *an*, *ad* = genital, aggenital, anal, and adanal seta, respectively; *iad* = adanal lyrifissure; *p.o.* = preanal organ. *Legs*: *Tr*, *Fe*, *Ge*, *Ti*, *Ta* = trochanter, femur, genu, tibia, and tarsus, respectively; ω , ϕ , σ = solenidia; ϵ = famulus; *d*, *l*, *v*, *bv*, *ev*, *ft*, *tc*, *it*, *p*, *u*, *a*, *s*, *pv*, *pl* = setae.

Taxonomy

Family diagnosis of Epimerellidae Ayyildiz and Luxton, 1989

The representatives of the family Epimerellidae are characterized within the superfamily Oppioidea by the presence of broad concavity between epimeres III+IV and strong protruding apophysis in anteromedial part of the notogaster.

Generic diagnosis of *Epimerella* Kulijev, 1967

Adult

With character states of Epimerellidae (as above). *Measurements*: Small species, length often about 300. *Integument*. Without heavy ornamentation and sculpturing. *Prodorsum*. Rostrum rounded, incised or tripartite. Costula, transcostula and lateral ridge absent. Rostral, lamellar, interlamellar, and exobothridial setae well developed, setiform; *le* inserted closer to *in* than to *ro*. Bothridial seta long, with elongate, slightly dilated and ciliate unilaterally head. Interbothridial tubercles absent; postbothridial tubercles present. *Notogaster*. Anteromedial apophysis bifurcate. Humeral region without tooth but sometimes with indistinct tubercle and

short crista. Ten pairs of setiform setae (*da*, *dm* and *dp* absent): *c* shortest; posterior setae (p_1 – p_3) medium-sized; dorsal setae long. *Gnathosoma*. Subcapitulum diarthric; adoral setae present. Palp solenidion bacilliform, entirely pressed to surface. Chelicera chelate-dentate. *Epimeral and lateral podosomal regions*. Epimeres I and II medially distinctly or slightly separated, or fused; sometimes epimere I with deep pit-like structure. Epimeral setae setiform. Pedotectum I represented by small lamina. Discidium present. *Anogenital region*. Five pairs of genital, one pair of aggenital, two pairs of anal, and three pairs of adanal setae; adanal seta ad_1 posterior, ad_2 lateral, ad_3 anterolateral to anal plate, distance ad_3 – ad_3 longer than ag – ag and ad_2 – ad_2 . Adanal lyrifissure located close and parallel to anal aperture. *Legs*. Tarsus I with 20 setae (l'' and v' present), tarsus II with 16 setae (l'' present). Tarsus II with two solenidia.

***Epimerella kalmykorum* n. sp.**

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(Figures 2–4)

Diagnosis

Body length: 315–323. Epimeres I, II, mentum, gena of subcapitulum and lateral side of prodorsum tuberculate. Rostrum with median incision. Rostral, lamellar, interlamellar, and exobothridial setae setiform, barbed; *ro* arch-like, directed anteriorly; bothridial seta with 10 ciliae unilaterally; relative length: $bs > in = le > ex > ro$. Dorsal notogastral setae long (*la*, *lm* and h_3 reaching beyond insertions of h_3 , *lp* and h_2 , respectively). Epimere I complete versus epimeres II, III+IV separated medially by large concavity. Epimeral and anogenital setae setiform, barbed; *4c* located on top of discidium.

Description

Measurements – Body length: 315 (holotype: female), 323 (one paratype: female); body width: 180 (holotype), 180 (paratype).

Integument – Body color light brown. Body surface mostly smooth but epimeres I, II, mentum and gena of subcapitulum, and lateral side of prodorsum with sparse, distinct, tubercles (diameter up to 2).

Prodorsum – Rostrum with semi-rectangular incision. Rostral (28–30), lamellar (47–49), interlamellar (49), and exobothridial (34–37) setae setiform, barbed; *ro* arch-like, directed anteriorly; head of bothridial seta (64–67) with 10 ciliae unilaterally. Postbothridial tubercle slightly developed.

Notogaster – Anterior bifurcate notogastral apophysis well-developed. Crista short, slightly visible. All notogastral setae (*c*: 18–22; p_1 – p_3 : 60–67; others: 90–96) setiform, barbed; *c* thinnest, curved backwards; dorsal setae long (*la*, *lm* and h_3 continues beyond insertions of h_3 , *lp* and h_2 , respectively); in holotype, insertions of *lp* and h_3 on right side of notogaster located close to each other. Lyrifissures *ia*, *im* and *ip* distinct versus *ih* and *ips* not observed.

Gnathosoma – Subcapitulum size: 67 × 47–49; subcapitular and adoral setae setiform, *a* (11) slightly barbed, *m*, *h* (17–19) barbed, *or* (4) smooth. Palp length: 47–49; setation: 0–2–1–3–8(+ω); solenidion medium-sized (1/2 of tarsus); postpalpal seta (4) spiniform, smooth. Chelicera length: 67; setae (*cha*: 22; *chb*: 15) setiform, barbed.

Epimeral and lateral podosomal regions – Epimere I medially fused versus epimeres II, III+IV separated medially by large concavity. Epimeral setae (*1a*, *2a*, *3a*: 15–19; *1b*, *4b*: 28–30; others: 41–49) setiform, barbed; in holotype, left side of epimere IV with extra seta between setae *4a* and *4b*. Discidium triangular, bearing insertion of seta *4c* on the top.

Anogenital region – Genital (g_1 : 19–22; others: 15–19), aggenital (19–22), adanal (34–41), and anal (19–22) setae setiform, barbed. Adanal lyrifissure distinct.

Legs – Claw of each leg smooth; claw of leg IV larger than those on legs I–III. Porose area on all segments not observed. Formulas of leg setation and solenidia: I (1–5–2–4–20) [1–2–2, II (1–5–2–4–16) [1–1–2, III (2–3–1–3–15) [1–1–0, IV (1–2–2–3–12) [0–1–0; homology of

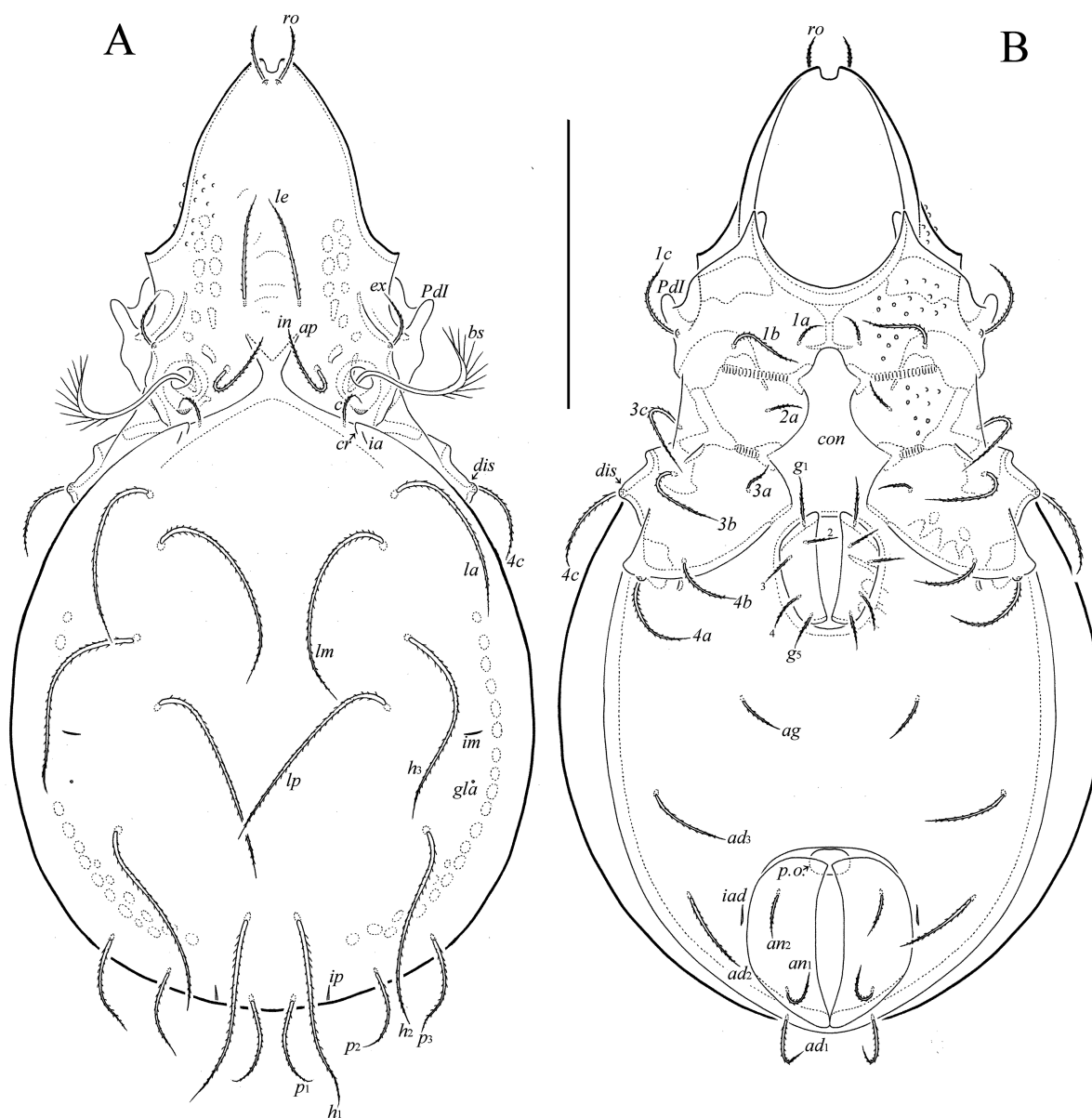


Figure 2 *Epimerella kalmykorum* n. sp., adult: A – dorsal view (legs omitted); B – ventral view (gnathosoma and legs omitted). Scale bar 100 μ m.

setae and solenidia indicated in Table 1. Setae p' and p'' setiform on tarsus I versus very short, conical on tarsi II–IV; seta s eupathidial on tarsus I; famulus short, erect, slightly swollen distally; solenidion ω_1 on tarsus I, ω_1 , ω_2 on tarsus II and σ on genu III slightly bacilliform versus other solenidia setiform.

Type material

Holotype (female) and one paratype (female): European Russia, Republic of Kalmykia, bank of salty Manych-Gudilo Lake, southern shore of the Left Island, floodplain, 45°59'N, 43°32'E, reed debris (*Fragmites australis*) under *Tamarix ramossissima* among *Salicornia perennans* and *Bassia prostrata*, 13.11.2021 (leg. O.L. Makarova) (Fig. 1).

The holotype and one paratype are deposited in the collection of the Tyumen State University

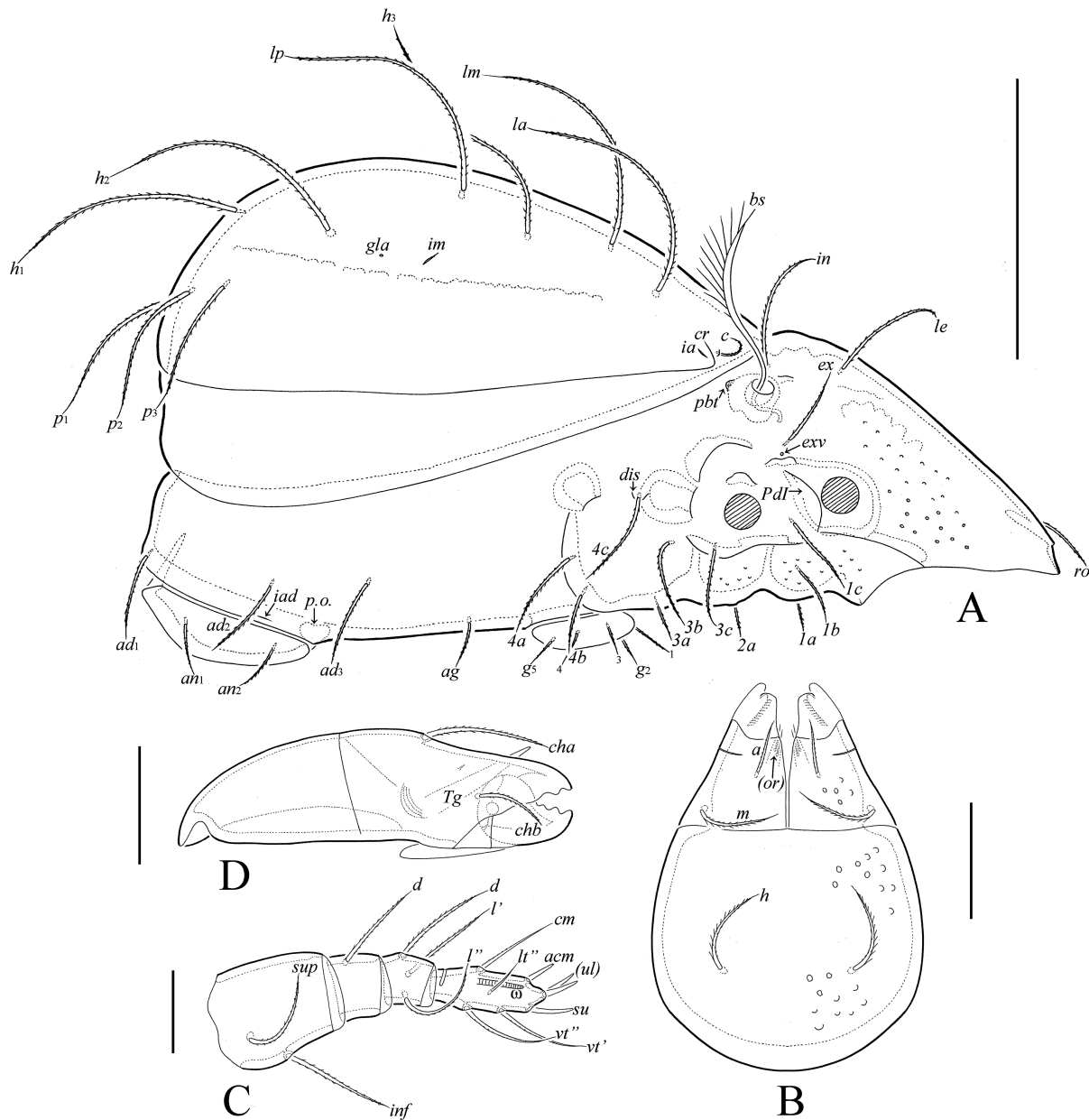


Figure 3 *Epimerella kalmykorum* n. sp., adult: A – right lateral view (gnathosoma and legs omitted); B – subcapitulum, ventral view; C – palp (trochanter omitted), right, antiaxial view; D – chelicera, right, antiaxial view. Scale bar 100 μ m (A), 20 μ m (B, D), 10 μ m (C).

Museum of Zoology, Tyumen, Russia. Both specimens are preserved in 70% solution of ethanol with a drop of glycerol.

Etymology

The species name refers to the place of origin, Republic of Kalmykia.

Remarks

Epimerella kalmykorum n. sp. is morphologically similar to *Ep. luxtoni* Toluk, Ayyildiz and Baran, 2008 in having semi-rectangular incision of the rostrum and the structure of epimeral

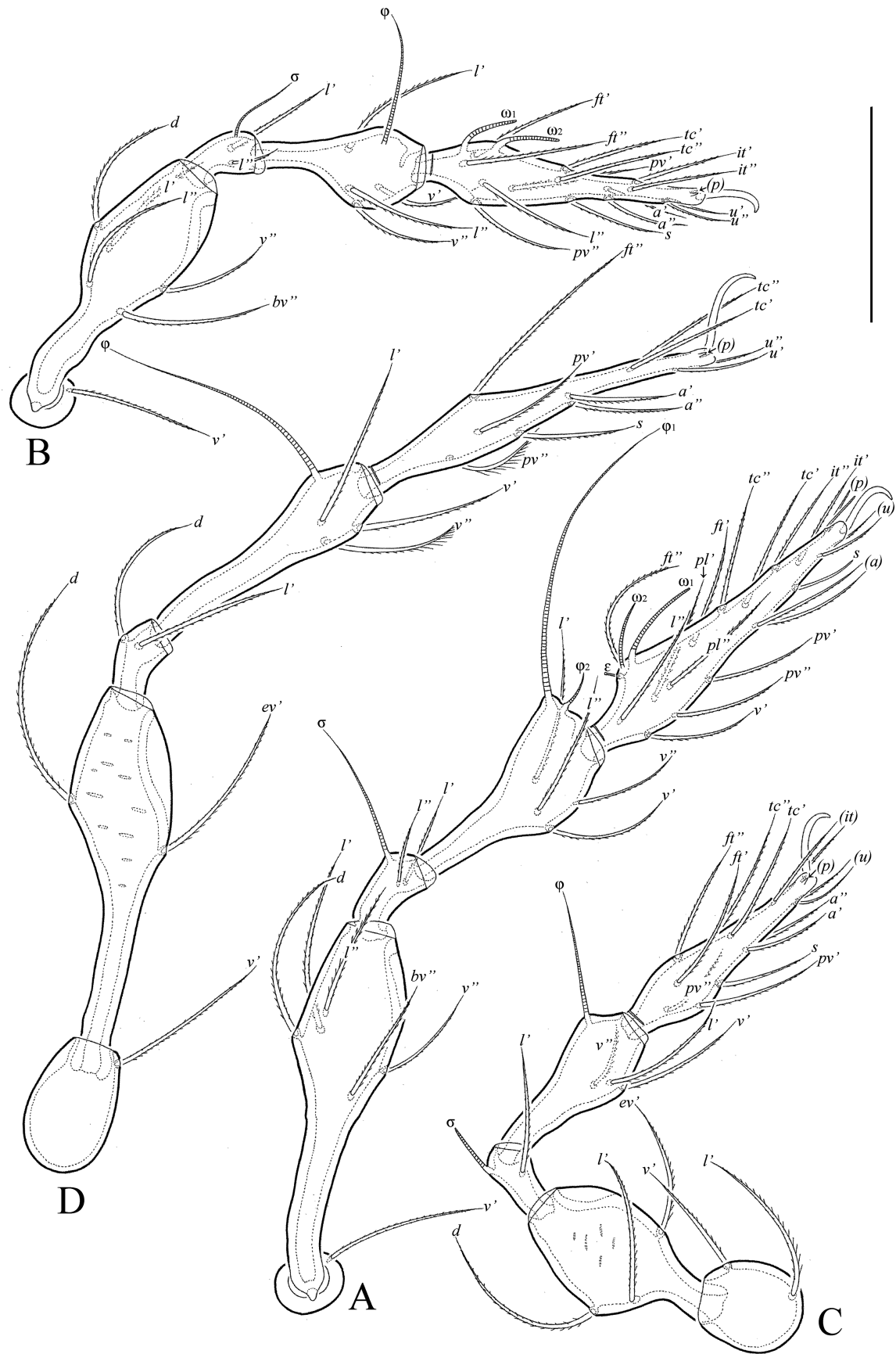


Figure 4 *Epimerella kalmykorum* n. sp., adult: A – leg I, right, antiaxial view; B – leg II right, antiaxial view; C – leg III, left, antiaxial view; D – leg IV, left, antiaxial view. Scale bar 50 μ m.

region (epimere I complete versus epimeres II–III+IV interrupted medially by large concavity). However, the new species differs from the latter by: anterior notogastral apophysis well developed reaching mid-distance between interlamellar and lamellar setae (versus hardly reaching the transversal level of interlamellar setae); rostral setae arch-like, directed anteriorly (versus straight, divergent); epimeres I, II, mentum and gena of subcapitulum, and lateral side of prodorsum sparsely tuberculate (versus not tuberculate); dorsal notogastral setae long (*la*, *lm* and *h₃* reaching beyond insertions of *h₃*, *lp*, *h₂*, respectively, versus not reaching these insertions); and notogastral setae *c* barbed (versus smooth).

Distinctive characters of the new species compared with other members of Epimerellidae can be found in the identification key below.

Generic diagnosis of *Enisella* Ayyildiz et Luxton, 1989

Adult — With character states of *Epimerella* (as above) but with 13 pairs of notogastral setae (*da*, *dm*, and *dp* present).

***Enisella turcica* Ayyildiz and Luxton, 1989**

Material — One specimen: Crimea, Leninsky district, Arabatskaya Strelka, bank of Sivash Lake, 45°18'N, 35°27'E, saline land with grasses and *Limonium* sp., 26.09.2021 (leg. N.A. Kuznetsova, M.B. Potapov). First record of the genus and species from Crimean peninsula.

Discussion

Mahunka (2001) described the genus *Luxtonia* from Borneo, with *Luxtonia hauseri* Mahunka, 2001 as type species, and he placed it in the newly described family Luxtoniidae Mahunka, 2001. Subías (2004) did not support the independence of the new family and included *Luxtonia* in Epimerellidae. Schatz *et al.* (2011) espoused the Mahunka’s opinion. *Luxtonia hauseri* does not have the specific structure of the epimeral region (epimeres III+IV separated by broad concavity), what is the main morphological trait of Epimerellidae, and also has a unique structure of posterior part of the notogaster (divided into overlapping lobes and connecting with postanal saccular structure). Therefore, we support the initial placement of *Luxtonia* within Luxtoniidae.

Key to known species of Epimerellidae

- 1. Thirteen pairs of notogastral setae (*da*, *dm*, *dp* present); body length: 320–360
 *Enisella turcica* Ayyildiz and Luxton, 1989
- Ten pairs of notogastral setae (*da*, *dm*, *dp* absent) 2

Table 1 Leg setation and solenidia of adult *Epimerella kalmykorum* n. sp.

Leg	Tr	Fe	Ge	Ti	Ta
I	v'	d, (l), bv'', v''	(l), σ	(l), (v), φ ₁ , φ ₂	(ft), (tc), (it), (p), (u), (a), s, (pv), (pl), l'', v', ε, ω ₁ , ω ₂
II	v'	d, (l), bv'', v''	(l), σ	(l), (v), φ	(ft), (tc), (it), (p), (u), (a), s, (pv), l'', ω ₁ , ω ₂
III	l', v'	d, l', ev'	l', σ	l', (v), φ	(ft), (tc), (it), (p), (u), (a), s, (pv)
IV	v'	d, ev'	d, l'	l', (v), φ	ft'', (tc), (p), (u), (a), s, (pv)

Note: Roman letters refer to normal setae (except ε = famulus); Greek letters refer to solenidia; single quotation mark (') designates seta on the anterior and double quotation mark (") seta on the posterior side of a given leg segment; parentheses refer to a pair of setae.

2. Epimere I medially with deep pit-like structure 3
 — Epimere I medially well separated or fused (pit-like structure absent) 5
3. Rostrum tripartite; insertions of rostral setae located close to each other (on the distance about their alveolus size); body length: 310
 *Epimerella puzanovi* Gordeeva and Karppinen, 1988
 — Rostrum rounded; insertions of rostral setae widely spaced (on the distance much more than their alveolus size) 4
4. Pit-like structure of epimere I posteriorly triangular; epimere II medially fully coalescent; body length: 250–328 *Epimerella marasensis* Toluk and Ayyildiz, 2013
 — Pit-like structure of epimere I posteriorly broadly rounded; epimere II medially narrowly separated; body length: 300–330 ... *Epimerella ankaraensis* Baran, Ayyildiz and Kence, 2012
5. Epimere I medially broadly separated; rostrum with semi-rectangular incision 6
 — Epimere I medially fused; rostrum tripartite or with semi-rectangular incision 7
6. Dorsal notogastral setae lm and h_3 reaching beyond insertions of h_3 and h_1 , respectively; body length: 360 *Epimerella distenta* Ayyildiz and Luxton, 1989
 — Dorsal notogastral setae lm and h_3 shorter, not reaching beyond insertions of h_3 and h_1 , respectively; body length: 284–286 *Epimerella subiasi* Toluk, Ayyildiz and Baran, 2008
7. Rostrum with semi-rectangular incision 8
 — Rostrum tripartite 9
8. Dorsal notogastral setae la , lm and h_3 reaching beyond insertions of h_3 , lp , and h_2 , respectively; rostral setae arch-like, directed anteriorly; epimeres I, II, mentum, and lateral side of prodorsum tuberculate; body length: 315–323 *Epimerella kalmykorum* n. sp.
 — Dorsal notogastral setae la , lm and h_3 shorter, not reaching beyond insertions of h_3 , lp and h_2 , respectively; rostral setae straight, divergent; epimeres I, II, mentum and lateral side of prodorsum not tuberculate; body length: 292–336 *Epimerella luxtoni* Toluk, Ayyildiz and Baran, 2008
9. Dorsal notogastral setae la and lm shorter, not reaching beyond insertions of lp and h_2 , respectively; body length: 494 *Epimerella rubeni* Khanbekyan et Gordeeva, 1991
 — Dorsal notogastral setae la and lm longer, reaching beyond insertions of lp and h_2 , respectively 10
10. Head of bothridial seta with 13 ciliae; notogastral setae p_1 – p_3 half as long as most dorsal notogastral setae; body length: 340
 *Epimerella smirnovi longisetosa* Kulijev, 1967
 — Head of bothridial seta with five ciliae; notogastral setae p_1 – p_3 fivefold shorter than most dorsal notogastral setae; body length: 340
 *Epimerella smirnovi smirnovi* Kulijev, 1962 (see also Kulijev 1967)

Distribution and habitats of Epimerellidae

At present, all 11 representatives of Epimerellidae have been recorded only in the southern Palaearctic region. Except *Epimerella smirnovi smirnovi* and *Ep. smirnovi longisetosa*, the other nine species have a highly confined geographic distribution, i.e. are conventionally endemic to a single country.

Six species are known only from Turkey: *Enisella turcica* was described from forest soil (plum grove); *Epimerella distenta* from pasture soil (Ayyildiz and Luxton 1989); all other species (*Ep. luxtoni*, *Ep. marasensis*, *Ep. subiasi*, and *Ep. ankaraensis*) were found mainly within different pine woods, rarely in other forests (Toluk *et al.* 2008; Baran *et al.* 2012; Toluk and Ayyildiz 2013; Ay and Ayyildiz 2019b).

Two species are known only from the south areas of the European Russia: *Ep. kalmykorum* is described from the reed debris nearly salty lake in Kalmykia (data of this paper); the strict habitat in Crimea (Karadag Mts.) for *Ep. puzanovi* is unknown (Gordeeva and Karppinen 1988).

One species is recorded only from Armenia: *Ep. rubeni* from litter under acacia trees (Khanbekyan and Gordeeva 1991).

Epimerella smirnovi smirnovi and *Ep. smirnovi longisetosa* are broadly distributed in the East Mediterranean: the former is known from Azerbaijan, Georgia, Iran, and south of the European Russia; the latter is known from Turkey, Ukraine and south of the European Russia; both species are found mostly in forest soil-litter and moss, as well as in meadow and urban soils (e.g., Kulijev 1962, 1967; Bocharova 1973; Mortazavi *et al.* 2011; Murvanidze and Mumladze 2016; Ay and Ayyildiz 2019a; Murvanidze *et al.* 2020).

According to the summarized data, representatives of Epimerellidae prefer mainly the soil-litter sites in forest ecosystems, however, they also occur in the other habitats, such as meadows and urban soils.

Thus, *Ep. kalmykorum* is unique among congeners dwelling in extremal conditions on the low bank of the hypersaline Many-Gudilo Lake very close to the water edge (Fig. 1). The salinity of this waterbody in last years varied in average between 40 to 56 ‰ (Bulysheva *et al.*, 2018) and wave height reaches several meters. So, one can conclude that this species is strongly halolerant. Two specimens of a new species co-habited with numerous specimens of predatory mites, *Neoseiulus tervus* (Meshkov, 1994) and *N. extricatus* (Kolodochka, 1991). These species are halotolerant judging from their records by Kolodochka (1991) and Döker *et al.* (2021). Some eurybiontic mesostigmatic species (*Arctoseius cetratus* (Sellnick, 1940), *Gaeolaelaps* spp., and *Proctolaelaps pygmaeus* Müller, 1859) were also found in this habitation. Besides, the sample in question contained also numerous specimens of oribatid mite *Zetomimus acutirostris* (Mihelčič, 1957), which has been recorded on extensive farmed crop fields with the high application of mineral fertilizers and biocides (Kulijev 1962) as well.

Enisella turcica Ayyildiz and Luxton, 1989 described from the plum litter in Turkey more than thirty years ago and was not recorded anywhere else till now. The satisfactory sampling in Crimea gave only one individual of this species from the saline soil. It is the first record from Crimean Peninsula.

Both Crimean and Kalmykian expeditions in 2021 were conducted after the hot summer period in September and November, respectively. Probably in autumn, small mites migrate upward within the soil and just this circumstance enabled us to reveal these rare species.

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ORCID

Sergey G. Ermilov  <https://orcid.org/0000-0002-0913-131X>

Olga L. Makarova  <https://orcid.org/0000-0002-1820-2511>

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