

## Contribution to the knowledge of soil mite genera *Zygoribatula* and *Peloribates* (Acari: Oribatida: Oripodoidea) in Central Asia

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### Abstract

The present paper deals with the members of oribatid mites of the genera *Zygoribatula* and *Peloribates* from Central Asia. Two new species, *Zygoribatula semicirculata* sp. nov. and *Z. mongolica* sp. nov., collected from dry steppe and mountain-steppe habitats in eastern Kazakhstan and eastern Mongolia, are described on the basis of adults. In addition, supplementary descriptions and illustrations of four known species, *Zygoribatula glabra* (Michael, 1890), *Z. propinqua* (Oudemans, 1902), *Peloribates robustus* Grishina, 1981 and *P. pilosus* Hammer, 1952 collected from southern Russia and different regions of Mongolia are given. Data on ecology and biogeography of all studied species as well as other species of *Zygoribatula* and *Peloribates* recorded in the Central Asian region are discussed.

**Keywords:** Oribatulidae, Haplozetidae, Kazakhstan, Mongolia, Russia

### Zusammenfassung

Neue Erkenntnisse über Hornmilben der Gattungen *Zygoribatula* und *Peloribates* aus Zentralasien werden dargestellt. Zwei neue Arten, *Zygoribatula semicirculata* sp. nov. und *Z. mongolica* sp. nov. aus trockenen bzw. montanen Steppen in Ost-Kazakhstan und der östlichen Mongolei sind auf der Grundlage der adulten Stadien beschrieben. Ergänzende Beschreibungen und Abbildungen von vier weiteren, bereits bekannten, Arten (*Zygoribatula glabra* (Michael, 1890), *Z. propinqua* (Oudemans, 1902), *Peloribates robustus* Grishina, 1981 und *P. pilosus* Hammer, 1952) werden gegeben. Ökologische und biogeographische Daten zu allen untersuchten Arten sowie weiteren Arten aus Mittelasien werden diskutiert.

### 1. Introduction

The genus *Zygoribatula* is one of the largest genera of oribatid mites, which was proposed by Berlese (1916) as a subgenus of *Oribatula* with *Oribatula connexa* Berlese, 1904 as the type species. He considered the presence of a chitinous ribbon-shaped band connecting the lamellae distally as main diagnostic character of *Zygoribatula*, which is called now as translamella or translamellar ridge. At the same time Berlese (1916) combined nine species in his newly proposed subgenus.

Later, Balogh (1943), Buitendijk (1945), van der Hammen (1952), Travé (1961), Bulanova-Zachvatkina (1967) and many other authors elevated or accepted *Zygoribatula* as an independent genus within the family Oribatulidae.

Subías (2004) recently considered *Zygoribatula* again to be a subgenus of the cosmopolitan genus *Oribatula*. He gave no specific rationale or explanation, but we presume this was primarily based on the shared characters of notogaster, ventral plate and leg setation. However, subsequently Weigmann (2006) accepted the validity of the generic status of *Zygoribatula*, and in this paper we followed his concept for the following reason.

Indeed, these two taxa seem closely related to each other sharing the dorsal and ventral setations of the body, structure and setation of the legs, chelicera and palps. Also, the immature stages of most species of both the genera are not described and still remain unknown. Further studies on phylogenetic relationships and comparative morphology are necessary for definition of the systematic status of these and other closely related genera of Oribatulidae.

The genus has cosmopolitan distribution and comprises more than 90 species. *Zygoribatula* is a taxonomically difficult group due to the large number of known species and the absence of clearly defined diagnostic characters in many of the older descriptions, often resulting in the misidentification of species. Most of the species of *Zygoribatula* show the same characters of ventral plate, structure and setation of legs, palps and chelicera, but they distinguish from one another by the characters of prodorsal and notogastral setae, structure or shape of lamellae, translamella and sensilli. Therefore, in this work we made a detailed description and illustration for only one of the species, and for other species only supplementary characterisations are given.

The genus *Peloribates* was established also by Berlese (1908) with *Oribates peloptoides* Berlese, 1888 as the type species. *Peloribates* is also one of the species-rich genera of the family Haplozetidae, and world-wide about eighty species are assigned to this genus, which were previously known from widely scattered areas of the most of biogeographical regions of the world. All re-described species herein are recorded for the first time in Mongolia.

## 2. Materials and methods

The morphological terminology used below is mostly that developed over many years by Grandjean (e.g. 1935). All measurements are given as a range, with the mean in brackets. Body length was measured in lateral view, from the tip of the rostrum to the posterior edge of the ventral plate, to avoid discrepancies caused by different degrees of notogastral distension. Notogastral length was also measured in lateral aspect, from the anterior to the posterior edge; notogastral width refers to the maximum width in dorsal aspect. Setal formulas of the legs are given as numbers per segment for appendages (from trochanter to tarsus) and as number per podosomal segment (I-IV) for epimeres.

All examined materials and data on their localities are given in the respective 'material examined' section. Species studied here are represented as adults.

### 3. Descriptions of species

#### *Zygoribatula semicirculata* sp. nov.

(Figs 1 – 3)

**Diagnosis:** Medium-sized species with general characters of *Zygoribatula*. Rostrum conspicuously projected anteroventrad in lateral view, but broadly rounded in dorsal view; lamellae narrow; translamella thin, arched and distinctly protruding anteriorly; all prodorsal setae moderately long, thin, finely barbed, sub-equal in length; sensilli with minutely barbed club shaped head; hysterosoma relatively flat in lateral view, its ventral plate foveolate; 13 pairs of notogastral setae medium long, thin, finely barbed, posterior setae  $p_3$  smooth, shorter and thinner than others.

**Measurements:** Holotype: body length 378  $\mu\text{m}$ , length of notogaster 290  $\mu\text{m}$ , width of notogaster 207  $\mu\text{m}$ ; paratypes: body length 376 – 457 (436)  $\mu\text{m}$ ; length of notogaster 290 – 363 (337)  $\mu\text{m}$ ; width of notogaster 207 – 250 (231)  $\mu\text{m}$ . A total of eight specimens was measured.

**Integument:** Light yellowish to yellowish-brown in colour. Surface of body and leg segments with thin cerotegument having granules on lateral part of prodorsum. Ventral plate of hysterosoma foveolate.

**Prodorsum:** Rostrum conspicuously projected anteroventrad in lateral view, but broadly rounded in dorsal view. Rostral setae (*ro*) fairly long, thin, finely barbed, inserted laterally. Lamellar setae (*le*) slightly longer than setae *ro*, finely barbed and extending well beyond tip of rostrum. Interlamellar setae (*in*) very slightly shorter than setae *le*, thin, finely barbed. Exobothridial setae (*ex*) weakly barbed, approximately half as long as lamellar setae. Lamellae narrow, slightly widened posteriorly. Translamella narrow, arched and distinctly protruding anteriorly, its shape somewhat variable (Figs 1a, 2a & g). Sensilli (*ss*) with minutely barbed club shaped head and short, narrow stalk. Bothridia irregular funnel shaped, with large openings, its posterior part concealed under anterior margin of notogaster. Porose areas *Ad* oval, situated anteromedial of each bothridium (Figs 1a, c, 2a, b).

**Notogaster:** Elongate oval in dorsal aspect, about 1.5 times as long as width. Dorsosejugal suture complete, conspicuously arched anteriorly; humeral projection weakly developed. Thirteen pairs of notogastral setae (one seta of *p* series absent, probably  $p_2$ ). Most of notogastral setae medium in length, nearly equal to one another, finely barbed, but setae  $p_1$  and  $p_3$  slightly shorter and thinner than others. Porose areas *Aa* and  $A_1$  elongate oval, while  $A_2$  and  $A_3$  oval in shape; *Aa* situated anteromedial of seta *la*;  $A_1$  posterolateral to seta *lp*,  $A_2$  between setae  $h_2$  and  $h_3$ , and  $A_3$  situated between setae  $h_1$  and  $h_2$ . Lyrifissures *ia*, *ih*, *im*, *ip* and *ips* well visible in lateral view. Opisthosomal gland opening (*gla*) situated posterolateral to lyrifissure *im* (Figs 1a, c, 2a & d).

**Gnathosoma:** Infracapitular mentum conspicuously wider than long, without noticeable microtubercles. Hypostomal setae thin, smooth, setae *h* longer than *a* and *m*, (Fig. 1b). Chelicerae chelate, moderately strong, with a few small teeth; setae *cha* and *chb* moderately long, barbed; Trägårdh's organ well developed (Fig. 2c). Palp normal for genus, setae *d* of tibia and genus, *l* and *v* of femur conspicuously barbed, other setae smooth; anteroculminal euphathidium *acm* completely fused to tarsal solenidion  $\omega$ ; palpal setation: 0-2-1-3-9 including solenidion  $\omega$  (Fig. 2e).

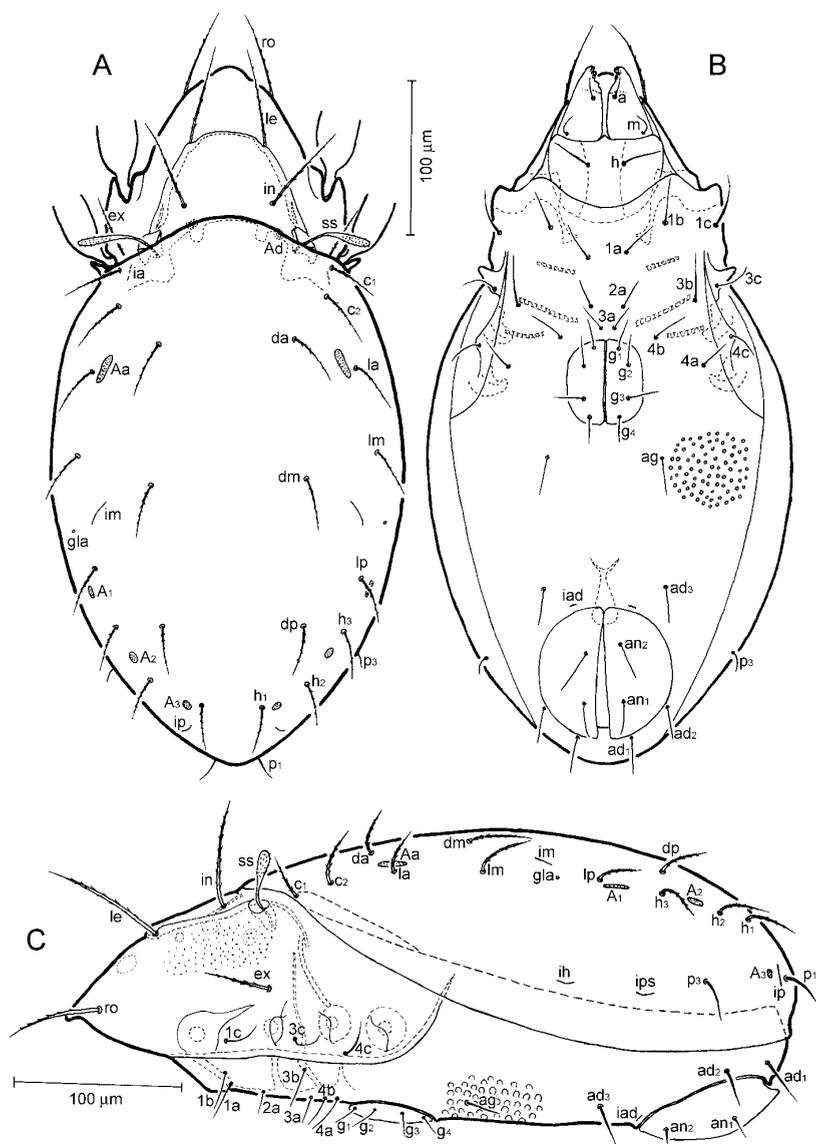


Fig. 1 *Zyoribatula semicircularata* sp. nov. A – Dorsal view; B – Ventral view; C – Lateral view (legs removed).

**Epimeral region:** Apodemes *apo.1*, *apo.2*, *apo.sj* and *apo.3* fairly long, but thin, obliquely oriented. All epimeral setae moderately long, but thin, smooth; epimeral setal formula: 3-1-3-3. Discidium well developed, on which epimeral seta 4c is inserted. Circumpedal carina reaching to the lateral border of ventral plate. Pedotectum I large, its surface smooth; pedotectum II scale-like, relatively small (Figs 1b & c).

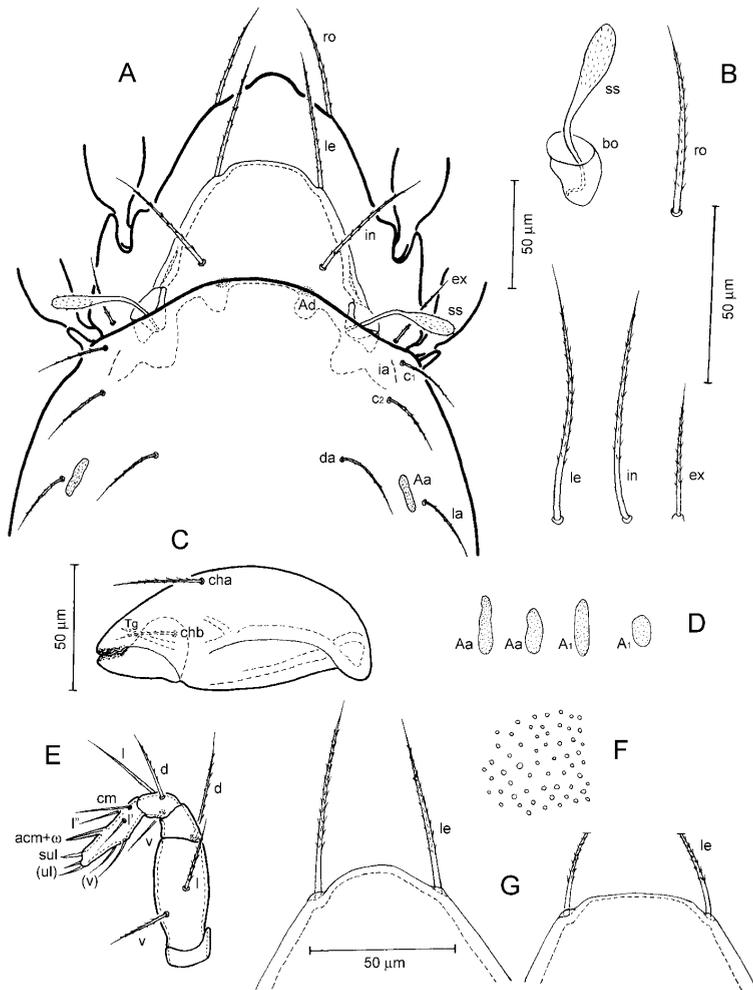


Fig. 2 *Zygoribatula semicirculata* sp. nov. A – Prodorsum and anterior part of notogaster; B – Sensillus, bothridium and prodorsal setae; C – Chelicera (left, antiaxial view); D – Variation of porose areas Aa and A1; E – Palp (left, antiaxial view); F – Anterior part of lamellae showing the variation of translamella.

**Ano-genital region:** Surface of ventral plate foveolate, while both anal and genital plates smooth. Anal aperture distinctly larger than genital one. Four pairs of genital, one pair of aggenital, two pairs of anal and three pairs of adanal setae long, thin, smooth. Distance between bases of aggenital setae nearly equal with that between setae  $ad_3$ - $ad_3$ . Seta  $ad_3$  and adanal lyrifissure  $iad$  situated in preanal position. (Figs 1b & c).

**Legs:** All tarsi heterotridactylous, with lateral claws much thinner than empodial claw. Femora I-IV and trochanters III and IV with large porose areas. Trochanter IV with distinct anteroventral projection in front of seta  $l'$ . All leg setae distinctly barbed, except only paired

setae  $p$  of tarsus. On tarsus I solenidia  $\omega_1$  conspicuously shorter than  $\omega_2$ ; famulus  $\varepsilon$  very short and slender. Tibia I with a distinctly projected apophysis for solenidia;  $\varphi_1$  much longer and thicker than  $\varphi_2$ . Genu I with fairly thick and long solenidion  $\sigma$ . Solenidia  $\omega_1$  and  $\omega_2$  on tarsus II subequal in size, setiform. Tibia II without crispin for solenidion, and tibial solenidion  $\varphi$  slightly shorter than  $\varphi_1$  of tibia I. Formula of leg setation (including famulus): I (1-5-3-4-21); II (1-4-2-4-16); III (2-3-1-3-15); IV (1-2-2-3-12); formula of solenidia: I (1-2-2); II (1-1-2); III (1-1-0); IV (0-1-0). Setation of legs I-IV as shown in Fig. 3.

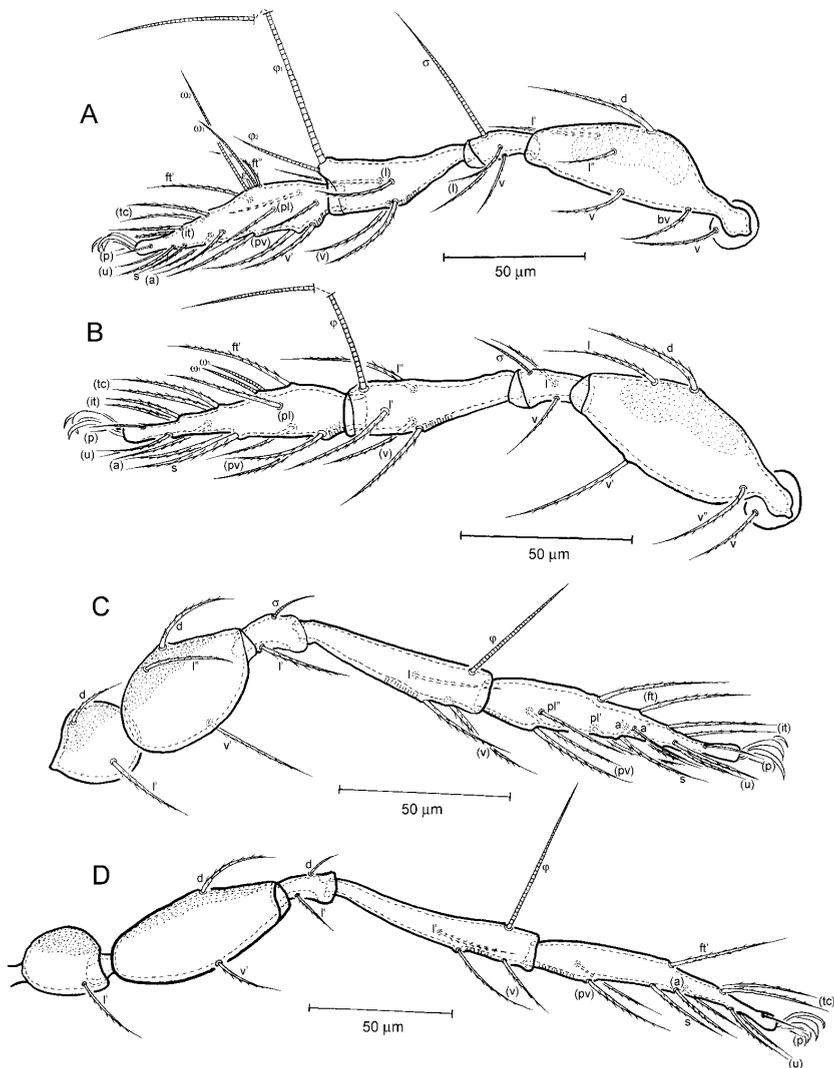


Fig. 3 *Zygorbitatula semicircularata* sp. nov. A – Leg I; B – Leg II; C – Leg III; D – Leg IV (all left, antiaxial view).

**Material examined:** Holotype (male): Coastal plain of Aral Sea near northern end of Tuschybas Bay, 150 km south of the town Chelkar, Kzyl-Orda Province, Kazakhstan, brackish sands covered with *Limonium suffruticosum* and *Salsola arbuscula*; organic debris accumulated on the soil and mineral soils of 0 – 5 cm depth under *Limonium suffruticosum* bunch. Coll. I. E. Smelyansky, 07 May 1999. Eight paratypes (five males and three females): same data as holotype. The holotype and four paratypes are deposited in the collection of the Zoological Museum, Institute of Systematics and Ecology of Animals, Siberian Branch of the Russian Academy of Sciences, Novosibirsk, Russia, and four paratypes in the collection of the Department of Zoology, National University of Mongolia, Ulaanbaatar, Mongolia.

**Remarks:** The new species can readily be distinguished from most of the known species of *Zygoribatula* by the shape of translamella, which is semi-circularly arched and distinctly protruding anteriorly. Most of the known species of *Zygoribatula* do not have such a peculiar character of translamella, but either straight or slightly convex translamella.

Among the known *Zygoribatula*, only three species, namely *Z. arcuatissima* (Berlese, 1916), *Z. exarata* (Berlese, 1916) and *Z. thalassophila* Grandjean, 1935 are somewhat similar to the present new species in the arched translamella.

The southern European species, *Z. arcuatissima*, described by Berlese (1916) and re-described by Mahunka (1994), is easily distinguishable from *Z. semicirculata* sp. nov. by the wider lamellae and translamella as opposed to the very narrow lamellae and translamella in the new species; presence of the longitudinal striations on notogastral surface in contrast to the smooth notogaster in the new species, and relatively longer notogastral setae, of which anteriorly situated setae ( $c_2$ ,  $da$ ,  $dm$ ,  $dp$ ,  $h_1$ ) extend well the insertion of the next row of setae. Mahunka (1980) described the species, *Z. gozmanyi* from Tunisia, which is similar to Berlese's species by the slightly arched translamella, longitudinal striations on the notogaster and long notogastral setae. Recently, Subías (2004) considered *Z. gozmanyi* as a junior synonym of *Z. arcuatissima*.

Another European species, *Z. exarata*, described by Berlese (1916), and later re-described by Schuster (1958), Bernini (1969) and Pérez-Iñigo (1974), is different from the present new species in the very wide lamellae as opposed to narrow lamellae in *Z. semicirculata* sp. nov., presence of strongly developed longitudinal ridges on the prodorsum rather than smooth prodorsum in *Z. semicirculata* sp. nov., and the presence of the longitudinal striations on notogastral surface in contrast to the smooth notogaster in the new species.

The southern European species, *Z. thalassophila*, described by Grandjean (1935), can be differentiated from *Z. semicirculata* sp. nov. in the narrowly prominent rostrum as opposed to the broadly rounded rostrum in the latter species, very short interlamellar and notogastral setae in contrast to relatively long and conspicuously barbed setae in the new species, short and capitate sensilli rather than relatively long and weakly swollen sensilli in the new species, and the presence of 14 pairs of notogastral setae as opposed to the only 13 pairs in the present new species, which lacks  $p_2$ , probably.

**Etymology:** The specific epithet, '*semicirculata*' refers to the semi-circularly arched shape of translamella.

**Distribution:** All known localities of the present species are situated along the northern coast of Aral Sea. The type locality of this species is given in the 'material examined' section. There are 6 more specimens found from another core of the same site. Three other specimens

were collected in May 2003, of which two specimens were collected at Northern Cliff (Tchink) of Ustyurt Plateau, watershed of Shomishtikol salt-marsh, 50 km east-north-east from Turush village, Mangystau Province, Kazakhstan, under salt desert vegetation, coll. A. S. Pazhenkov; one specimen was collected at the gullied country on the left bank of the Irgiz river, the upper course of Tekeli spring-stream in head of Zhabysai valley, 50 km north-east from Chelkar town, Aktyubinsk Province, Kazakhstan, coll. A. S. Pazhenkov.

**Ecology:** This species inhabits the organic debris accumulated on the soil and the upper layer of soil in brackish sands and sandy soil covered with salt desert vegetation (predominantly perennial saltwort).

***Zygoribatula mongolica* sp. nov.**

(Fig. 4)

**Diagnosis:** Medium-sized species with general characters of *Zygoribatula*. Rostrum slightly projected anteroventrad in lateral view, but rounded in dorsal view; lamellae medium in width, conspicuously narrowed anteriorly; translamella moderately wide, nearly straight or very slightly convex, lamellar cusps absent; all prodorsal setae moderately long and roughly barbed, setae *ro* and *le* slightly longer than *in*; sensilli with minutely barbed clavate head; hysterosoma relatively robust in lateral view, its dorsal plate nearly smooth, but ventral plate and anal plates foveolate; notogaster with lenticulus-like light spot; 14 pairs of notogastral setae moderately long and thick, roughly barbed; most of ventral setae except only genital, anal and hypostomal setae *a* barbed.

**Measurements:** Body length 337 – 391 (362)  $\mu\text{m}$ ; width of notogaster 218 – 235 (225)  $\mu\text{m}$ . A total of four specimens was measured.

**Integument:** Yellowish-brown in colour. Surface of body and leg segments with relatively thick cerotegument having small granules on lateral part of prodorsum and around leg acetabula. Ventral plate and anal plates foveolate.

**Prodorsum:** Rostrum slightly projected anteroventrad in lateral view, but rounded anteriorly or blunt triangular in dorsal view. Rostral setae moderately long and thick, barbed, inserted dorso-laterally on rostrum. Lamellar setae nearly as long as *ro*, barbed, inserted at the lateral ends of translamellar ridge. Interlamellar setae slightly shorter, but slightly thicker than *le*, barbed. Exobothridial setae shorter and thinner than other prodorsal setae, finely barbed. Lamellae medium in width, conspicuously narrowed anteriorly, without cusps. Translamella moderately wide, nearly straight or very slightly convex. Sensilli with minutely barbed clavate head and short stalk. Bothridia irregularly funnel-shaped, with large opening, its posterior part concealed under anterior margin of notogaster (Fig. 4a).

**Notogaster:** Oval in dorsal aspect, with lenticulus-like light spot on anteromedian part. Dorsosejugal suture broadly rounded, slightly protruding anteriorly; humeral projection poorly developed. Fourteen pairs of moderately long, thick and roughly barbed notogastral setae subequal in length. Porose areas medium in size, oval in shape,  $A_1$  and  $A_3$  slightly larger than  $A_2$  and  $A_4$ . Lyrifissures *ia*, *ih*, *im*, *ip* and *ips* well developed. Opisthosomal gland opening (*gla*) situated posterolateral to lyrifissure *im* (Fig. 4a).

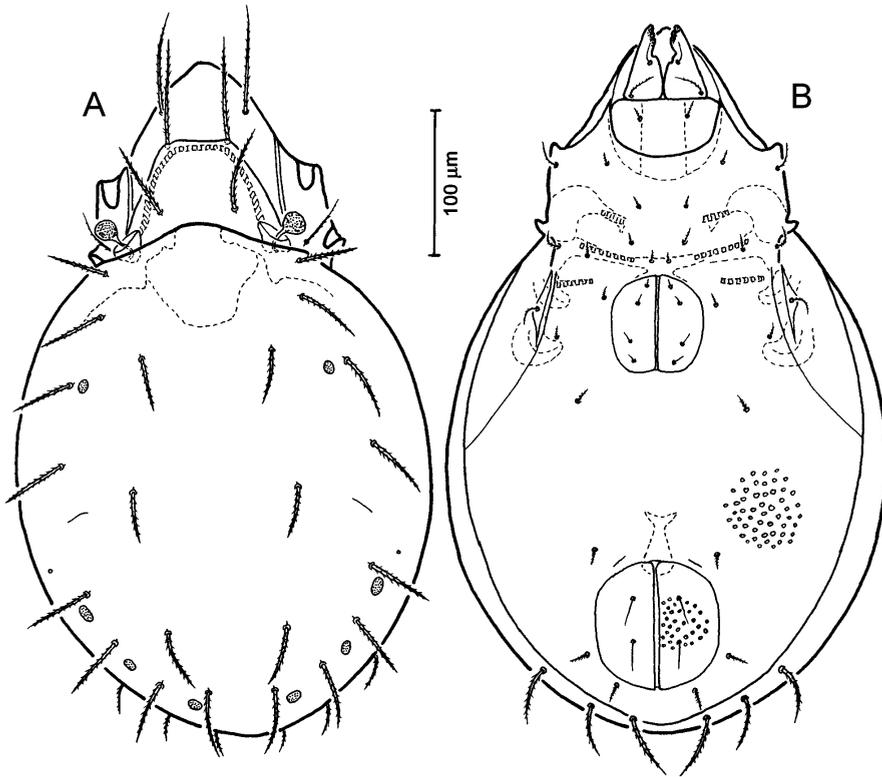


Fig. 4 *Zygoribatula mongolica* sp. nov. A – Dorsal view; B – Ventral view (legs removed).

**Gnathosoma:** Infracapitular mentum conspicuously wider than long, without noticeable microtubercles. Hypostomal setae *h* and *m* barbed, seta *a* thin, smooth; setae *m* distinctly longer than two others (Fig. 4b). Chelicerae and palp normal for genus, similar to those of the former species.

**Epimeral region:** Apodemes *apo.2*, *apo.sj* obliquely situated, while *apo.3* transversely oriented. Epimeral setae short, all of them barbed; setae *1c*, *3c* and *4c* conspicuously longer than others; setal formula: 3-1-3-3. Discidium well developed, on which epimeral seta *4c* is inserted. Circumpedal carina reaching to the lateral border of ventral plate (Fig. 4b).

**Ano-genital region:** Surface of ventral plate and anal plates foveolate, but genital plates smooth. Anal aperture distinctly larger than genital one. Genital and anal setae thin, smooth, anal setae twice as long as genital setae; aggenital and adanal setae barbed, sub-equal in length. Distance between bases of aggenital setae greater than that between setae *ad<sub>1</sub>-ad<sub>2</sub>*. Seta *ad<sub>3</sub>* and adanal lyrifissure *iad* situated in preanal position (Fig. 4b).

**Legs:** Setation of legs typical for genus as in *Z. semicirculata* sp. nov. Formula of leg setation (including famulus): I (1-5-3-4-21); II (1-4-2-4-16); III (2-3-1-3-15); IV (1-2-2-3-12); formula of solenidia: I (1-2-2); II (1-1-2); III (1-1-0); IV (0-1-0).

**Material examined:** Holotype (female): District Erdenetsagaan, Province Sukhbaatar, Mongolia, 46°12'58"N, 116°21'57"E, 1368 m a.s.l., upper layer of soils of the mountain steppe, 31 May 2003, coll. B. Bayartogtokh. Three paratypes (females): same data as holotype. The holotype and two paratypes will be deposited in the collection of the Department of Zoology, National University of Mongolia, Ulaanbaatar, Mongolia, and one paratype is in the collection of the Zoological Museum, Institute of Systematics and Ecology of Animals, Siberian Branch of the Russian Academy of Sciences, Novosibirsk, Russia.

**Remarks:** *Zygoribatula mongolica* sp. nov. differs from most other species of the genus *Zygoribatula* in the presence of lenticulus-like light spot on the anteromedian part of notogaster, the long, thick and roughly barbed notogastral setae, the foveolate ventral plate and the distinctly barbed ventral setae. The combination of these characters can be considered as diagnostic feature of this species.

Among the known species of this genus, only the Mediterranean species, *Z. lenticulata*, described by Minguez and Subías (1986), has a lenticulus-like structure, long, thick, barbed notogastral setae and foveolate ventral plate. However, the lamellae and translamella in *Z. lenticulata* are much narrower and the notogastral setae much longer than those in the new species, respectively. Also *Z. lenticulata* is distinguishable from *Z. mongolica* sp. nov. by the distally pointed rostrum as opposed to the rounded rostrum in the new species, and far larger body size, 406 – 516 µm in length according to Minguez and Subías (1986) and Pérez-Iñigo (1993).

There are several other species of *Zygoribatula*, such as *Z. arcuatissima* Berlese, 1916, *Z. excavata* Berlese, 1916, *Z. schauenbergi* Mahunka, 1978, *Z. setosa* Evans, 1953, which show long and roughly barbed notogastral setae, but the lamellar-translamellar complexes of these species are different than that in *Z. mongolica* sp. nov., and moreover, none of them has a lenticulus-like structure on the notogaster.

**Etymology:** The specific epithet, 'mongolica' refers to the name of the country encompassing the type locality of this species.

**Distribution:** This species is known only from the type locality.

**Ecology:** This is an inhabitant of the upper layer of soils in dry mountain steppe.

### ***Zygoribatula glabra* (Michael, 1890)**

(Fig. 5)

*Notaspis glabra* (Michael 1890), p. 419.

*Zygoribatula hortobagyensis* (Mahunka 1983), p. 389, Figs 21 – 24.

*Oribatula* (*Zygoribatula*) *glabra*: (Subías 2004), p. 189.

*Zygoribatula glabra*: (Bernini et al. 1987), p. 447; (Mahunka & Mahunka-Papp 1995), p. 167; 1999, p. 646, Fig. 32; (Weigmann 2006), p. 438, Fig. 234d.

**Diagnosis:** Medium-sized species with general characters of *Zygoribatula*. Rostrum slightly projected anteroventrad in lateral view, but broadly rounded in dorsal view; lamellae wide, widened anteriorly; translamella variable, wide or thin, straight to slightly convex in the middle; all prodorsal setae except *ex* moderately long and thick, roughly barbed, setae *le* longer than others, positioned in the middle of the broad, but very short cusps; sensilli with densely barbed club-shaped head; hysterosoma relatively robust in lateral view, its dorsal and ventral plates nearly smooth; 13 pairs of notogastral setae short, thin, smooth.

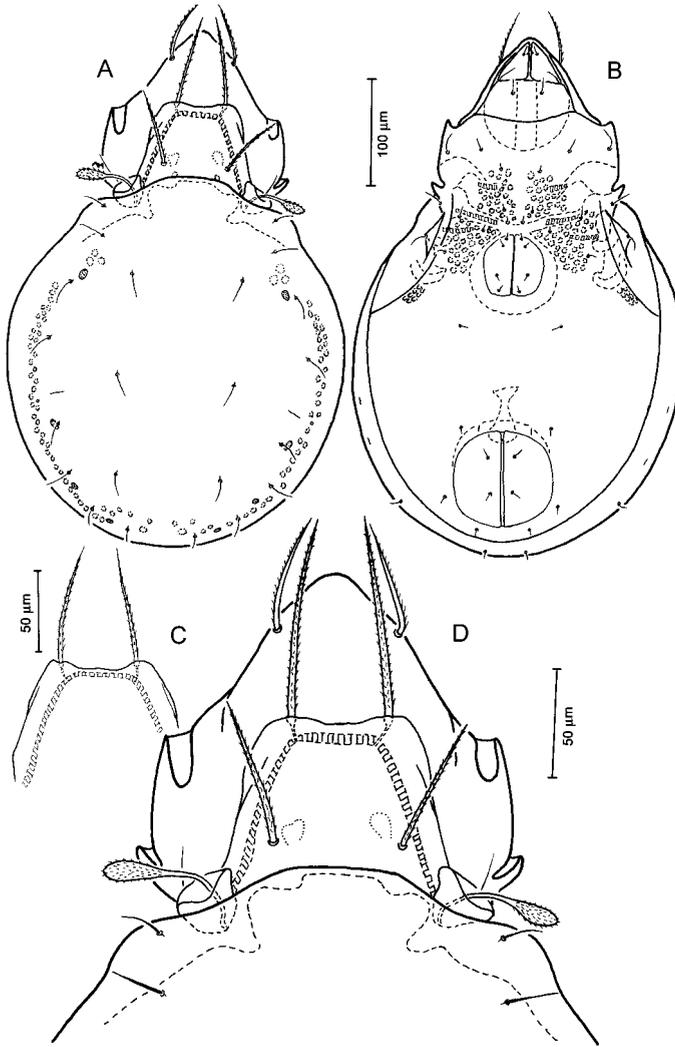


Fig. 5 *Zygoribatula glabra* (Michael 1890). A – Dorsal view; B – Ventral view (legs removed); C – Variation of translamella; D – Prodorsum and anterior part of notogaster.

**Measurements:** Body length 443 – 471 (456)  $\mu\text{m}$ ; width of notogaster 258 – 274 (264)  $\mu\text{m}$ . A total of 16 specimens was measured.

**Integument:** Yellowish-brown in colour. Surface of body and leg segments with relatively thick cerotegument having small granules on lateral part of prodorsum and around leg acetabula.

**Prodorsum:** Rostrum slightly projected anteroventrad in lateral view, but broadly rounded in dorsal view. Rostral setae moderately long and thick, unilaterally barbed, inserted dorso-laterally on rostrum. Lamellar setae longer than setae *ro*, densely barbed and positioned in the

middle of the broad, but very short cusps in a distance to the lateral edge of the cusps. Interlamellar setae shorter than *le*, but slightly longer than *ro*, barbed. Exobothridial setae (*ex*) thin, smooth, approximately half as long as interlamellar setae. Lamellae wide, conspicuously widened anteriorly. Translamella variable, wide or thin, straight to slightly convex in the middle (Figs 5a, c & d). Sensilli with densely barbed club-shaped head and relatively long stalk. Bothridia irregularly funnel-shaped, with large openings, its posterior part concealed under anterior margin of notogaster (Figs 5a & d).

**Notogaster:** Oval or almost circular in dorsal aspect, about 1.1 times as long as wide. Dorsosejugal suture slightly arched anteriorly; humeral projection conspicuously developed. Thirteen pairs of short, thin, smooth notogastral setae; posterior setae *p*<sub>1</sub> and *p*<sub>3</sub> slightly shorter than other notogastral setae. Porose areas small, oval in shape, *A*<sub>2</sub> and *A*<sub>3</sub> slightly larger than *A*<sub>1</sub>. Lyrifissures *ia*, *ih*, *im*, *ip* and *ips* well developed. Opisthosomal gland opening (*gla*) situated posterolateral to lyrifissure *im* (Fig. 5a).

**Gnathosoma:** Infracapitular mentum conspicuously wider than long, without noticeable microtubercles. Hypostomal setae *h* and *m* slightly longer than *a*, but all of them thin, smooth (Fig. 5b). Chelicerae and palp normal for the genus, similar to those of the former species.

**Epimeral region:** Apodemes *apo.2* and *apo.sj* obliquely situated, *apo.3* nearly transversely oriented. Epimeral setae medium long, thin, smooth; setal formula: 3-1-3-3. Discidium well developed, on which epimeral seta *4c* is inserted. Circumpedal carina reaching to the lateral border of ventral plate (Fig. 5b).

**Ano-genital region:** Surface of ventral plate and anal, genital plates smooth. Anal aperture distinctly larger than genital one. Four pairs of genital, one pair of aggenital, two pairs of anal and three pairs of adanal setae short, thin, smooth. Distance between bases of aggenital setae nearly equal with that between setae *ad*<sub>1</sub>-*ad*<sub>2</sub>. Setae *ad*<sub>3</sub> and adanal lyrifissures *iad* situated in preanal position (Fig. 5b).

**Legs:** Setation of legs typical for genus as in the previous species. Formula of leg setation (including famulus): I (1-5-3-4-21); II (1-4-2-4-16); III (2-3-1-3-15); IV (1-2-2-3-12); formula of solenidia: I (1-2-2); II (1-1-2); III (1-1-0); IV (0-1-0).

**Material examined:** Twenty-six specimens (16 males and 10 females): Mt Lkhachinvandad, District Erdenetsagaan, Province Sukhbaatar, Mongolia, 45°40'54"N, 116°07'57"E, 1242 m a.s.l., organic debris accumulated between rocks and soils of the mountain steppe, 01 June 2003, coll. B. Bayartogtokh.

**Remarks:** The most important diagnostic character of the species is the shape of the lamellar and translamellar complex with the seta *le* clearly distant from lateral edge of the very short, but broad cusps. Morphological characters of the present material are similar to those of specimens from Hungary as described for *Z. hortobagyensis* Mahunka, 1983, which has been declared as junior synonym of *Z. glabra* (Michael, 1890) by Mahunka & Mahunka-Papp (1999). The Mongolian specimens are larger in body size than European specimens, which measure 365 – 425 µm in length according to Mahunka (1983) and Weigmann (2006). Another slight difference is that the lamellae of Mongolian specimens are slightly widened anteriorly rather than sub-equal width of lamellae in European specimens, but we considered this character as inter-specific variation.

Subías (2004) considered *Z. propinqua* (Oudemans, 1902) as a junior synonym of *Z. glabra*, but Weigmann (2006) did not accept the synonymy. We suggest that these are

different taxa, and determined two independent species based on the materials from Mongolia (see below).

**Distribution:** Palaearctic Region: Central, southern and eastern Europe (Italy, Spain, Germany, Hungary, Albania); Asia: Russia (Siberia), Kazakhstan and Mongolia.

**Ecology:** In Mongolia, this species inhabits the organic debris accumulated on the soil, and the upper layer of soils in dry mountain steppe habitats.

### *Zygoribatula propinqua* (Oudemans, 1902)

(Fig. 6)

*Eremaeus propinquus* (Oudemans 1902), p. 54.

*Eremaeus brauni* (Sellnick 1908), p. 338, Fig. 1.

*Oribatula* (*Zygoribatula*) *propinquus*: (Willmann 1931), p. 155, Fig. 227.

*Zygoribatula laubieri* (Travé 1961), p. 329, Fig. 5a.

*Zygoribatula laubieri meridionalis* (Travé 1961), p. 332, Fig. 5b.

*Zygoribatula matritensis* (Mihelčič 1966), p. 462, Fig. 2.

*Oribatula* (*Zygoribatula*) *glabra*: sensu (Subías 2004), p. 189.

*Zygoribatula propinqua*: (Bulanova-Zachvatkina 1975), p. 260; (Pérez-Iñigo 1993), p. 226, Fig. 80c; (Mahunka & Mahunka-Papp), 2002, p. 223, Figs 19 – 22; (Weigmann 2006), p. 439, Fig. 234b.

**Diagnosis:** Medium-sized species with general characters of *Zygoribatula*. Rostrum sharply projected anteroventrad in lateral view, but rounded in dorsal view; lamellae narrow, very slightly widened anteriorly; translamella thin, nearly straight; lamellar cusps short, but conspicuously developed, narrowed distally; all prodorsal setae except *ex* moderately long and slightly barbed; setae *ro* and *le* longer than *in*; sensilli with minutely barbed clavate head; hysterosoma relatively robust in lateral view, its dorsal and ventral plates nearly smooth; 13 pairs of notogastral setae medium in length, thin, smooth.

**Measurements:** Body length 340 – 360 (352)  $\mu\text{m}$ ; width of hysterosoma 216 – 228 (224)  $\mu\text{m}$ ; length of notogaster 264 – 269 (266)  $\mu\text{m}$ . A total of four specimens was measured.

**Integument:** Yellowish-brown in colour. Surface of body and leg segments with relatively thick cerotegument having small granules on lateral part of prodorsum and around leg acetabula.

**Prodorsum:** Rostrum sharply projected anteroventrad in lateral view, but rounded anteriorly in dorsal view. Rostral setae moderately long and thick, finely barbed, inserted dorso-laterally on rostrum. Lamellar setae nearly as long as setae *ro*, barbed, inserted underneath distal end of cusps. Interlamellar setae shorter than *le*, barbed, inserted between lamellar ridges. Exobothridial setae thin, smooth, approximately half as long as lamellar setae. Lamellae narrow, very slightly widened anteriorly. Lamellar cusps short, but well developed, conspicuously narrowed distally. Translamella thin, nearly straight (Figs 6a & c). Sensilli (*ss*) with minutely barbed clavate head and relatively short stalk. Bothridia irregularly funnel-shaped, with large opening, its posterior part concealed under anterior margin of notogaster (Figs 6a & d).

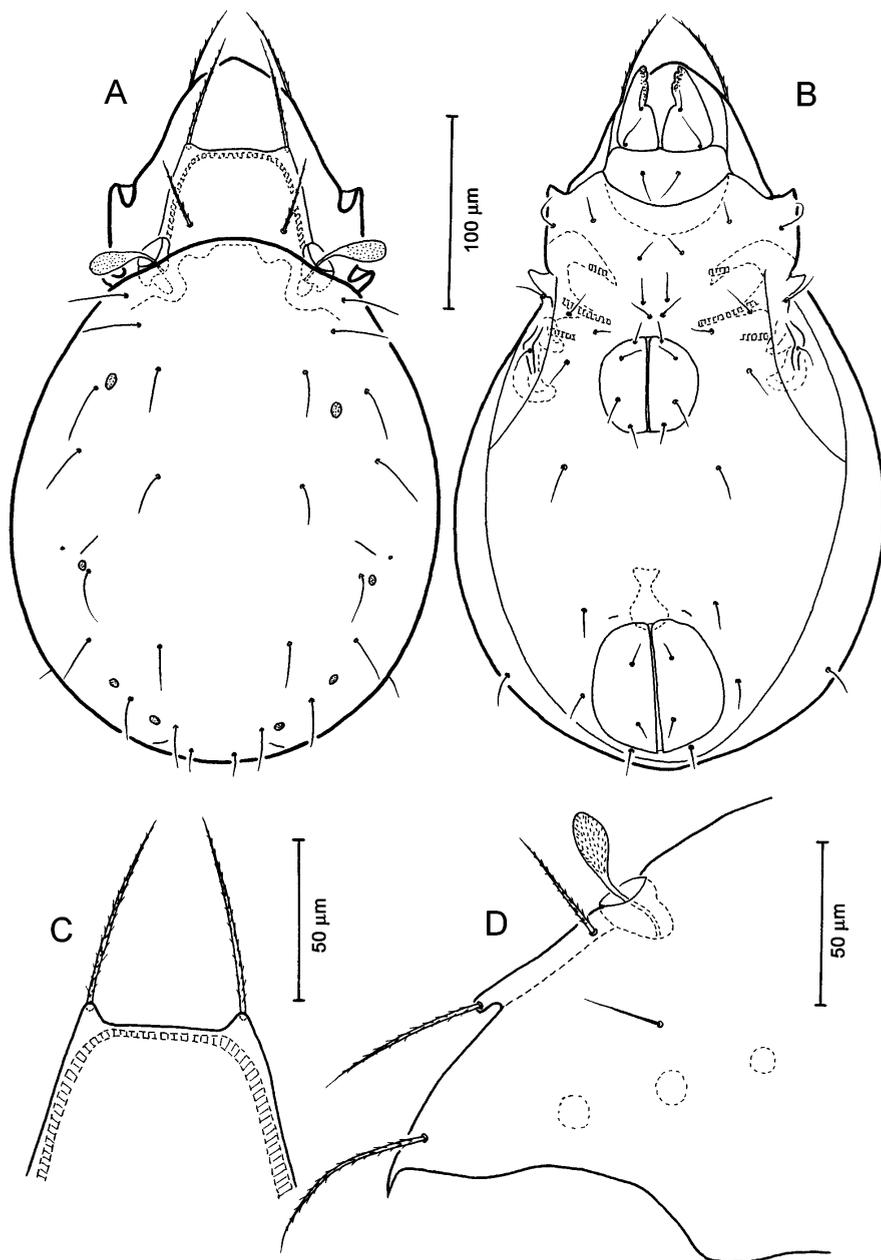


Fig. 6 *Zyoribatula propinqua* (Oudemans, 1902). A – Dorsal view; B – Ventral view (legs removed); C – Lamellae; D – Lateral view of proterosoma.

**Notogaster:** Oval in dorsal aspect, longer than wide. Dorsosejugal suture complete, broadly rounded; humeral projection weakly developed. Thirteen pairs of medium long, thin, smooth notogastral setae; posterior setae  $p_1$  and  $p_3$  slightly shorter than other notogastral setae. Porose areas small, oval in shape,  $Aa$  slightly larger than others. Lyrifissures  $ia$ ,  $ih$ ,  $im$ ,  $ip$  and  $ips$  well developed. Opisthosomal gland opening ( $gla$ ) situated posterolateral to lyrifissure  $im$  (Fig. 6a).

**Gnathosoma:** Infracapitular mentum conspicuously wider than long, without noticeable microtubercles. Hypostomal setae  $h$  and  $m$  distinctly longer than  $a$ , all of them thin, smooth (Fig. 6b). Chelicerae and palp normal for the genus, similar to those of *Z. semicirculata* sp. nov.

**Epimeral region:** Apodemes  $apo.2$ ,  $apo.sj$  and  $apo.3$  well developed, two former apodemes obliquely situated, while latter apodeme nearly transversely oriented. Epimeral setae medium long, thin, smooth; setal formula: 3-1-3-3. Discidium well developed, on which epimeral seta  $4c$  is inserted. Circumpedal carina well developed, reaching to the lateral border of ventral plate (Fig. 6b).

**Ano-genital region:** Surface of ventral plate, anal and genital plates smooth. Anal aperture distinctly larger than genital one. Ano-genital setae medium in length, thin, smooth. Distance between bases of aggenital setae nearly equal with that between setae  $ad_2$ - $ad_2$ . Seta  $ad_3$  and adanal lyrifissure  $iad$  situated in preanal position (Fig. 6b).

**Legs:** Setation of legs typical for the genus as in *Z. semicirculata* sp. nov. Formula of leg setation (including famulus): I (1-5-3-4-21); II (1-4-2-4-16); III (2-3-1-3-15); IV (1-2-2-3-12); formula of solenidia: I (1-2-2); II (1-1-2); III (1-1-0); IV (0-1-0).

**Material examined:** Four specimens (one male and three females): Khonin Nuga area, Basin river Eruu, District Mandal, Province Selenge, Mongolia, 49°20'15"N, 107°40'36"E, 1720 m a.s.l., soils of the mountain steppe, 23 May 2002, coll. B. Bayartogtokh.

**Remarks:** This species is very similar to *Z. frisiae* (Oudemans, 1916), but it differs from the latter species in having distinct lamellar cusps. Mongolian specimens show the distinctly developed lamellar cusps, and therefore, we assign our specimens to *Z. propinqua*. However, it is necessary to mention that Mahunka (1987) illustrated the variation of the lamellae of *Z. frisiae* with distinct cusps.

It should be noted that most of the characters of our studied specimens accord well with those of the European specimens re-described or illustrated by Willmann (1931), Travé (1961), Bulanova-Zachvatkina (1975), Pérez-Iñigo (1993), Mahunka & Mahunka-Papp (2002) and Weigmann (2006). However, we observed some slight differences between Mongolian and European materials. Thus, the materials studied by Sellnick (1908) and Willmann (1931) show relatively narrow and elongate notogaster compared to our material. The rostrum of the specimens studied by Travé (1961) under the name of *Z. laubieri*, and *Z. propinqua* sensu Pérez-Iñigo (1993) have sharply pointed tips as seen in dorsal view. However, the Oudemans' type specimen examined by Weigmann (2006) and the Hungarian material illustrated by Mahunka & Mahunka-Papp (2002) show rounded or blunt-triangular tip of rostrum as that in the Mongolian material.

**Distribution:** Palaearctic Region: Europe (common); Asia: Russia (Siberia), Kazakhstan and Mongolia.

**Ecology:** This is an inhabitant of the litter of larch and birch forests, and soils of the mountain steppes in northern Mongolia.

***Peloribates robustus* Grishina, 1981**

(Figs 7 – 9)

*Peloribates robustus* (Grishina 1981), p. 26, Figs 3 – 5.

*Peloribates robustus*: (Subías 2004), p. 210; (Bayartogtokh 2007), p. 249, Fig. 188.

**Diagnosis:** Medium in size, with typical characters of *Peloribates*. Rostrum slightly projected in lateral view, but broadly rounded in dorsal view; lamellae relatively wide, but distinctly narrowed distally; all prodorsal setae, except *ex* moderately long and distinctly barbed; sensilli with minutely barbed club-shaped head and short, narrow stalk. Notogaster and anal plates with longitudinal, but interrupted striations; notogastral setae conspicuously barbed; sacculi small, round in shape; pteromorphae small, fully hinged. Ventral plate with foveolae; five pairs of genital setae, legs tridactylous.

**Integument:** Yellowish brown to deep reddish brown in colour. Surface of body and leg segments with relatively thick cerotegument having small granules on lateral part of prodorsum and around leg acetabula. Notogaster and anal plates with longitudinal striations.

**Measurements:** Body length 436 – 485 (455)  $\mu\text{m}$ ; width of notogaster 256 – 308 (268)  $\mu\text{m}$ ; length of notogaster 326 – 372 (352)  $\mu\text{m}$ . A total of five specimens was measured.

**Prodorsum:** Rostrum broadly rounded anteriorly in dorsal view, but projected in lateral view. Rostral setae moderately long, densely barbed, inserted laterally and extending well beyond tip of rostrum. Lamellae relatively wide, but distinctly narrowed distally; length of lamellae nearly half of the total length of prodorsum as seen in dorsal view (Figs 7a, c & 8a). Tutoria well developed, moderately long, but narrow, setae *ro* inserted on its distal end (Fig. 7c). Lamellar setae slightly longer than *ro*, distinctly barbed and extending beyond the tip of rostrum. Interlamellar setae nearly as long as *le*, conspicuously barbed throughout their length. Sensilli short, with minutely barbed club-shape head and narrow stalk (Figs 7a, c, 8a & c). Bothridia directed anterolaterally, with large opening, its posterior part concealed under anterior margin of notogaster.

**Notogaster:** Oval, about 1.3 – 1.4 times as long as wide, its anterior margin slightly arched, while posterior margin circularly rounded. Surface of notogaster with interrupted longitudinal striations. Pteromorphae relatively small, fully hinged, curved downwards. Notogastral setae medium long, densely barbed, nearly equal in length to one another. Sacculi small, round in shape. Lyrifissures *ia*, *im* and *ih* well developed; other lyrifissures not evident. Opisthosomal gland opening (*gla*) situated anterolaterad of seta *h*<sub>3</sub> (Fig. 7a, c).

**Gnathosoma:** Infracapitular mentum wider than long, without noticeable microtubercles. Hypostomal setae *a*, *m* and *h* short, thin, smooth. Chelicera chelate, moderately strong, fixed and movable digits with a few blunt teeth; setae *cha* and *chb* barbed (Fig. 9d). Palp normal for the genus, anteroculminial euphathidium *acm* completely fused to tarsal solenidion w; palpal setation: 0-2-1-3-9 (Fig. 8e).

**Epimeral region:** Nearly smooth, apodemes *apo.1*, *apo.sj* and *apo.3* aligned obliquely. Epimeral setae short, thin, smooth, setal formula: 3-1-3-3. Circumpedal carina well developed, reaching to the lateral border of ventral plate. Discidium well developed, on which epimeral seta *4c* inserted. Custodium well developed, projected anteriorly. Pedotecta I and II small, their surface smooth (Fig. 7b).

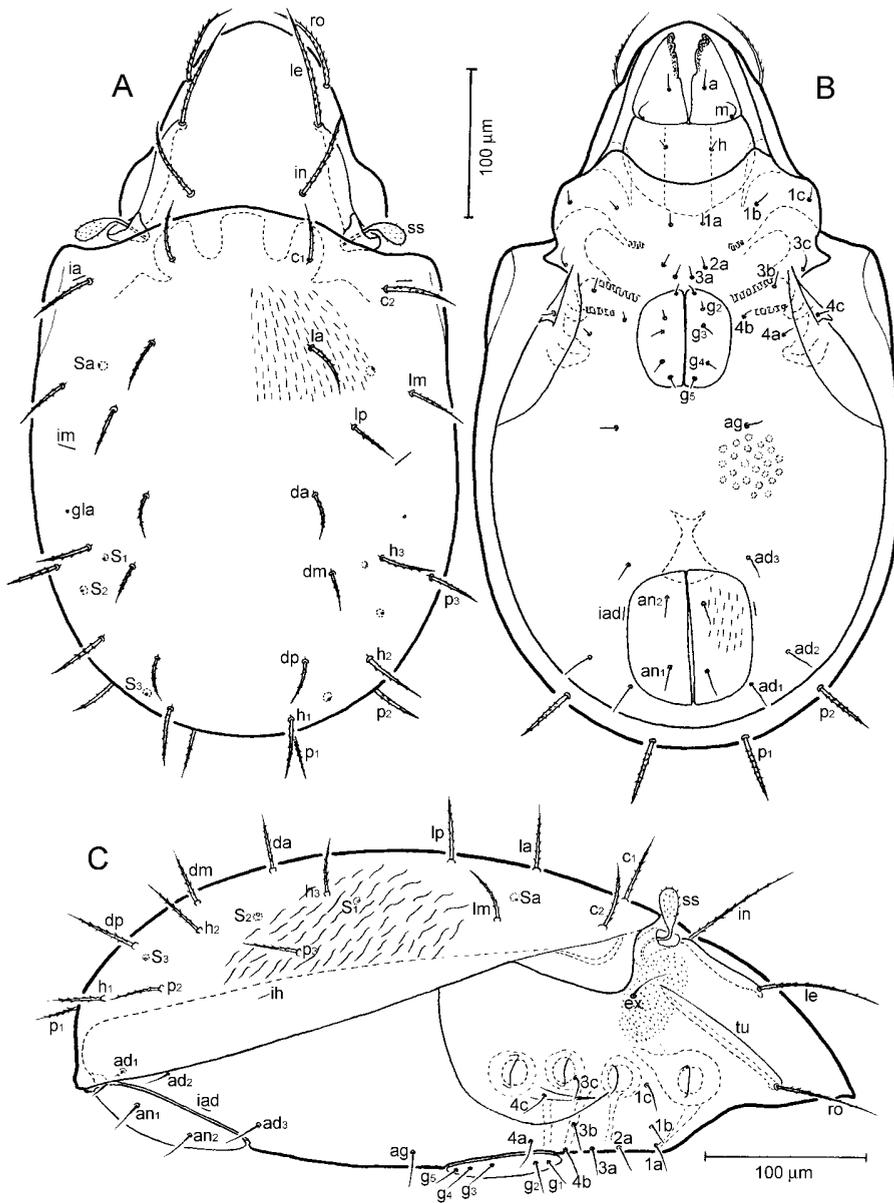


Fig. 7 *Peloribates robustus* Grishina, 1981. A – Dorsal view; B – Ventral view; C – Lateral view (legs removed).

**Ano-genital region:** Ventral plate foveolate; anal plates with longitudinal striations, while genital plates smooth. Five pairs of genital, one pair of aggenital, two pairs of anal and three pairs of adanal setae; anal seta  $an_1$  and adanal setae  $ad_1$ ,  $ad_2$  finely barbed, other ano-genital setae smooth; seta  $ad_3$  in preanal position. Adanal lyrifissures  $iad$  situated at the level of setae  $an_2$  adjacent and parallel to lateral margins of anal aperture (Figs 7b, 8b & d).



Fig. 8 *Peloribates robustus* Grishina, 1981. A – Prodorsum and anterior part of notogaster; B – Anal region; C – Sensillum and bothridium; D – Genital region; E – Palp (right, antiaxial view); F – Striations on the notogaster; G – Leg I (right, antiaxial view).

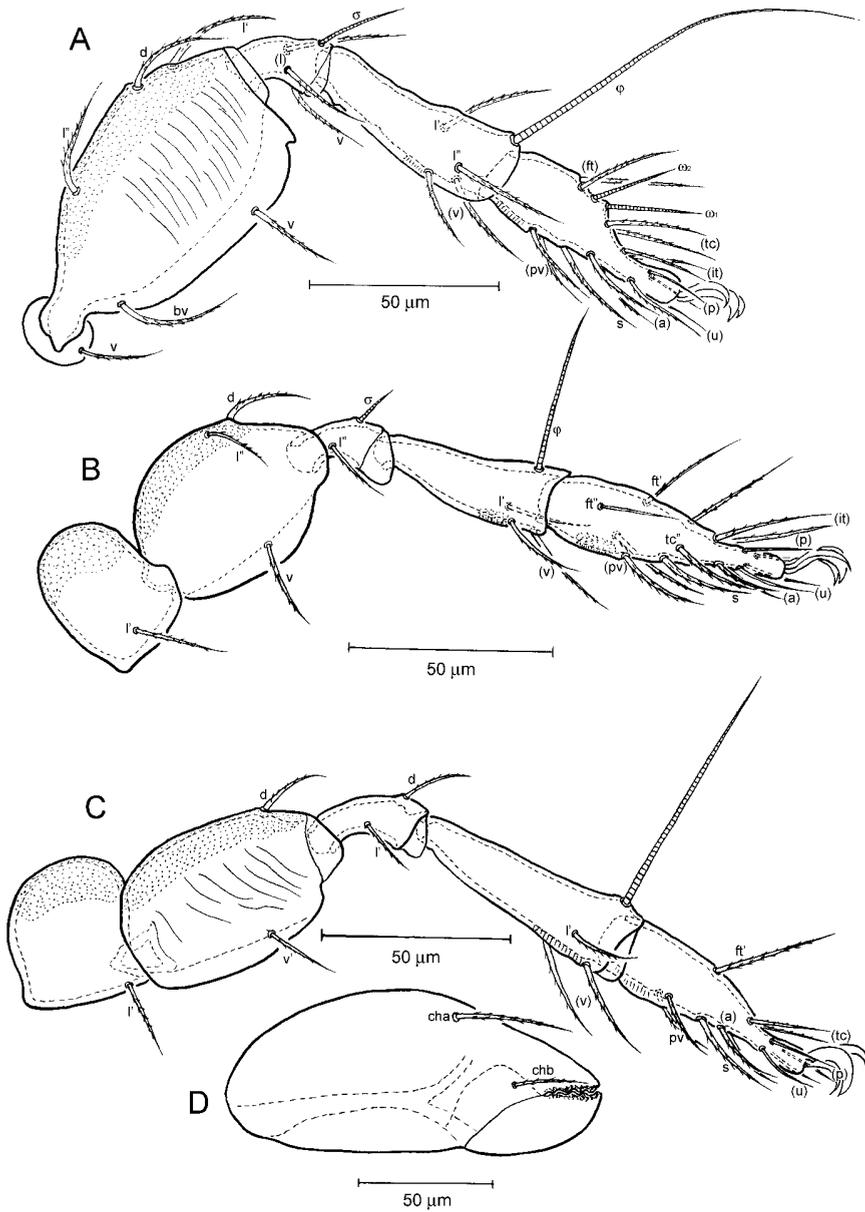


Fig. 9 *Peloribates robustus* Grishina, 1981. A – Leg II (right, antiaxial view); B – Leg III (left, antiaxial view); C – Leg IV (left, antiaxial view); D – Chelicera (right, antiaxial view).

**Legs:** All tarsi heterotridactylous, with the lateral claws much thinner than empodial claw. Femora II-IV with distinct, complete ventral keels or blades. Femur I with a short, relatively small keel in its proximal part. Femora I – IV and trochanters III, IV with large porose areas. All setae on the leg segments, except for setae  $v$  of femur I,  $p$  of all tarsi and  $u$  of tarsi I, III and IV distinctly barbed. On tarsus I solenidion  $\omega_2$  almost twice as long as  $\omega_1$ ; famulus  $\varepsilon$  short and slender, situated between two solenidia. Solenidia  $\phi$  of tibia I and II much longer than those on tibia III and IV. Formula of leg setation including famulus: I (1-5-3-4-21); II (1-5-3-4-15); III (1-3-1-3-15); IV (1-2-2-3-12) and formula of solenidia: I (1-2-2); II (1-1-2); III (1-1-0); IV (0-1-0). Setation of legs I-IV as shown in Figs 8g, 9a – c.

**Material examined:** Two specimens (females): 15 km south-east from the centre of District Erdene, Central Province, Mongolia, 47°35'58"N, 107°58'02"E, 1470 m a.s.l., litter of birch trees growing in the mountain-steppe, 04 June 2003, coll. B. Bayartogtokh; three specimens (two males and one female): Onchalaan rocks, District Erzin, Tyva Republic, Russia, litter under *Caragana bungei* in the shrub steppe covered the plain at the bottom of the rocks, 10 June 1995, coll. S. K. Stebaeva.

**Remarks:** After the original description by Grishina (1981), the present species has not been reported anymore. Main features of the specimens studied here are well in accordance with those of the type specimens. However, the original description was restricted mainly by the characterisation and illustration of dorsal and part of ventral aspects of the body, but the structure of the lateral side of the body, details of the gnathosomal and epimeral regions as well as leg setation were lacking. Grishina (1981) described that the lamellae being with complicated structure and its anterior and posterior parts are bifurcated. However, we did not find such a structure in the examined specimens here.

**Distribution:** Palaearctic region: Asia: Russia (Krasnoyarsk Province, Khakasiya and Tyva Republics) and Mongolia.

**Ecology:** This species was reported as inhabitant of the bark and mosses on the decaying birch trees in the Middle Siberia. In Mongolia, it inhabits the litter of birch trees growing in the mountain steppe landscape as well as temperate taiga forests and soils of mountain steppes in northern part of the country. The species also found in the litter under steppe shrubs in Tyva Republic.

### ***Peloribates pilosus* Hammer, 1952**

(Fig. 10)

*Peloribates pilosus* (Hammer 1952), p. 44, Fig. 69.

*Peloribates pilosus*: (Pérez-Iñigo 1974), p. 401, Fig. 16; (Shaldybina 1975), p. 270, Fig. 638; (Marshall et al. 1987), p. 264; (Subías 2004), p. 210.

**Diagnosis:** Medium in size, with typical characters of *Peloribates*. Rostrum broadly rounded in dorsal view; lamellae relatively wide, but distinctly narrowed distally; all prodorsal setae, except *ex* moderately long, distinctly barbed; sensilli with a minutely barbed fusiform head and narrow stalk. Notogastral setae conspicuously barbed; sacculi small, round in shape; pteromorphae large, almost fully hinged; four pairs of genital setae.

**Integument:** Yellowish brown to deep reddish brown in colour. Surface of body and leg segments with relatively thick cerotegument having small granules on lateral part of prodorsum and around leg acetabula.

**Measurements:** Body length 479 – 490 (485)  $\mu\text{m}$ ; width of hysterosoma 329 – 348 (336)  $\mu\text{m}$ . A total of eight specimens was measured.

**Prodorsum:** Rostrum slightly projected in lateral view, but broadly rounded in dorsal view. Rostral setae moderately long and thick, densely barbed, inserted laterally. Lamellae relatively wide, but distinctly narrowed distally; length of lamellae nearly half of the total length of prodorsum as seen in dorsal view. Turtoria moderately long, but narrow, setae *ro* inserted on its distal end. Lamellar setae longer than *ro*, barbed, extending beyond the tip of rostrum. Interlamellar setae slightly shorter than *le*, conspicuously barbed throughout their length. Sensilli medium in length, with minutely barbed elongate oval head and narrow stalk. Bothridia directed anterolaterally, with large openings, its posterior part concealed under anterior margin of notogaster (Fig. 10a).

**Notogaster:** Oval, about 1.1 times as long as wide, its anterior margin broadly rounded. Surface of notogaster smooth, pteromorphae well developed, almost fully hinged, slightly curved downwards. Notogastral setae medium long, setae *lp*, *dm* and *dp* slightly shorter than other setae, all of them barbed. Sacculi small, round in shape. Lyrifissures *ia*, *im* and *ih* well developed, other lyrifissures not evident. Opisthosomal gland opening (*gla*) situated posterior to lyrifissure *im* (Fig. 10a).

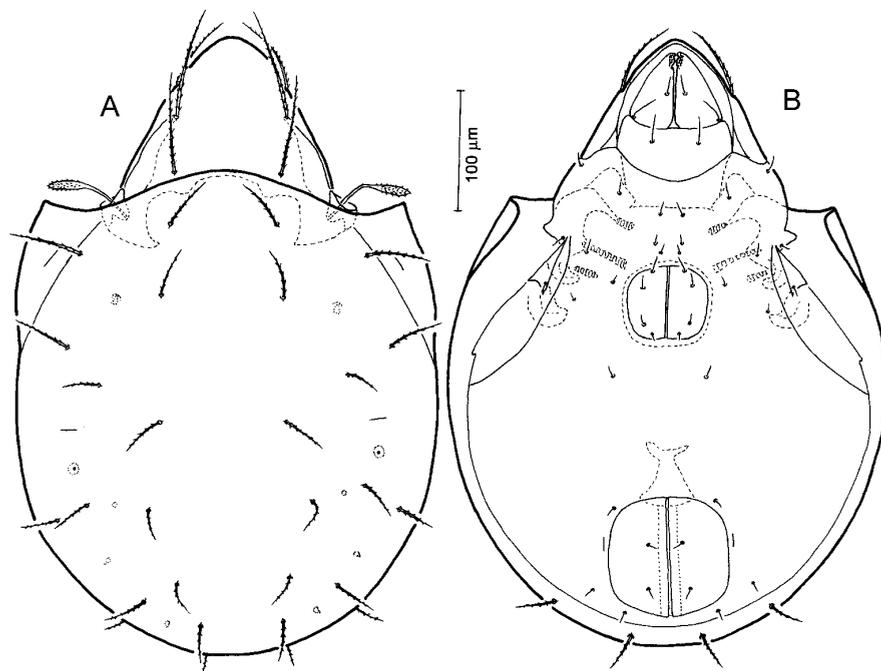


Fig. 10 *Peloribates pilosus* Hammer, 1952. A – Dorsal view; B – Ventral view (legs removed)

**Gnathosoma:** Infracapitular mentum wider than long, without noticeable microtubercles. Hypostomal setae *a*, *m* and *h* thin, smooth, sub-equal in length (Fig. 10b). Chelicera and palp normal for the genus as in the previous species; palpal setation: 0-2-1-3-9.

**Epimeral region:** Nearly smooth, apodemes *apo.2*, *apo.sj* and *apo.3* aligned obliquely. Epimeral setae short, thin, smooth; setal formula: 3-1-3-3. Circumpedial carina reaching to the lateral border of ventral plate. Discidium projected laterally, on which epimeral seta *4c* is inserted. Custodium short, slightly projected anteriorly. Pedotecta I and II small, their surface smooth (Fig. 10b).

**Ano-genital region:** Ventral plate of opisthosoma, anal and genital plates smooth. Four pairs of genital, one pair of aggenital, two pairs of anal and three pairs of adanal setae short, thin, smooth; seta *ad*<sub>3</sub> in preanal position. Adanal lyrifissures *iad* situated at the level of setae *an*<sub>2</sub>, adjacent and parallel to lateral margins of anal aperture (Fig. 10b).

**Legs:** Tidactylous, setation of legs typical for genus as in the previous species. Formula of leg setation including famulus: I (1-5-3-4-21); II (1-5-3-4-15); III (1-3-1-3-14); IV (1-2-2-2-12) and formula of solenidia: I (1-2-2); II (1-1-2); III (1-1-0); IV (0-1-0).

**Material examined:** Eight specimens (three males and five females): Mt Altai Tavan Bogd, Mts Mongol Altai, District Tsengel, Province Bayan-Ulgii, Mongolia, 48°50'26"N, 88°50'34"E, 3860 m a.s.l, soils of the high mountain alpine meadow, 24 July 2004, coll. B. Bayartogtokh.

**Remarks:** Main features of the specimens studied here are well in accordance with those of the materials described by Hammer (1952) and also re-described or characterised from Europe by Pérez-Iñigo (1974) and Shaladybina (1975). The North American specimens are slightly larger in body size (520 µm long, 380 µm wide, according to Hammer 1952) than Mongolian specimens.

**Distribution:** Holarctic region: North America (Canada, USA: Alaska); Europe: Poland, Spain, Russia (Caucasus: Daghestan), Greenland; Asia: Russia (Siberia, Far East), Kazakhstan, Kyrgyzstan and Mongolia.

**Ecology:** In Mongolia, this species inhabits the wet soils of the high mountain alpine meadows.

#### 4. Discussion

Although the genus *Zygoribatula* encompasses itself many species, most of them have rather restricted distributions, though the given species may inhabit multiple types of habitats. At the moment, a total of 15 species of *Zygoribatula* has been recorded in the Central Asian region (Bulanova-Zachvatkina 1967, Vtorov & Krivolutsky 1968; Zlotin & Krivolutsky 1969; Karppinen et al. 1986, Krivolutsky 1995, Rakhimbaeva 1995, Andrievsky et al. 2002, Wang et al. 2003, Bayartogtokh 2007).

The Kazakhstan fauna contains more diverse species than other areas of Central Asia, and in spite of two species re-described here, seven more species (*Z. connexa* (Berlese, 1904), *Z. exarata* Berlese, 1916, *Z. microporosa* Bulanova-Zachvatkina, 1967, *Z. ruchljadevi*

Bulanova-Zachvatkina, 1967, *Z. skrjabini* Bulanova-Zachvatkina, 1967, *Z. trigonella* Bulanova-Zachvatkina, 1967 and *Z. vulgaris* Bulanova-Zachvatkina, 1967) have been recorded there.

Only one of the studied species here (*Z. glabra*) has been recorded before in Tyva Republic, and a single species (*Z. frisiae*) has also been found in Khakasiya Republic, but four species (*Z. exilis* Nicolet, 1855, *Z. exarata*, *Z. glabra* and *Z. frisiae*) are known in the Altai Province of Russia.

Three other Central Asian republics of the former Soviet Union have only three known species each. Thus, the faunas of Kyrgyzstan and Tajikistan contain the same species, namely *Z. frisiae*, *Z. cognata* (Oudemans, 1902) and *Z. skrjabini*. In addition to the latter mentioned species, two more species have been recorded in the fauna of Turkmenistan, namely *Z. exilis* and *Z. undulata* Berlese, 1916.

As for the Mongolian fauna, besides the species recorded here, three more species have been found before (*Z. connexa*, *Z. truncata* Aoki, 1961, *Z. andrianovae* Bulanova-Zachvatkina, 1967), but the status of the latter species is problematic. The study on type material of *Z. andrianovae* and other species described by Bulanova-Zachvatkina (1967) is necessary, but unfortunately, the type deposition is unclear, and in the original description she did not designate the type specimens.

Up to now, only a single species, *Z. levigata*, is known from the Central Asian part of China (Xingjian autonomous region).

Among the Central Asian species, *Z. connexa* and *Z. exilis* have the widest distribution, being reported from many areas of the Holarctic region as well as some parts of the Australian and Afrotropical regions. Three other species, *Z. cognata*, *Z. frisiae* and *Z. glabra*, also show a rather wide range of distribution and are known from the majority of the areas of the Palaearctic region, while *Z. exarata*, *Z. microporosa*, *Z. ruchljadevi*, *Z. skrjabini*, *Z. vulgaris* and *Z. andrianovae* are known to be distributed in the western part of Palaearctic region, especially commonly reported from the various areas of southern and eastern Europe.

The other species have restricted distributions, like *Z. trigonella*, found only in some parts of Central Asia, while *Z. undulata* was recorded in some areas of the Afrotropical region; a record of this species from Turkmenistan must be considered to be doubtful and is likely to be a misidentification. *Z. truncata* is mostly distributed in the Eastern Palaearctic region, and *Z. levigata* is only known from northern China.

In Central Asia, most species of *Zygoribatula* are typical inhabitants of the various forest litter, mosses, lichens or decaying wood as well as soils of arid steppes, mountain meadows, high mountain alpine zones etc. Thus, the species of this genus are often found in organic soil layers of forested regions in Central Asia, but some of them are more characteristic for litter and soils of xeric habitats.

Concerning the genus *Peloribates* in Central Asian region, there are four more species besides the two taxa re-described here. These are *P. angulatus* Bayartogtokh, 2000, *P. curtipilis* Jacot, 1937, *P. europaeus* Willmann, 1935 and *P. longipilosus* Csiszar, 1962. Two of them, *P. angulatus* and *P. curtipilis*, have been recorded in Mongolia, but the finding of the latter species in Mongolia is uncertain (might be a misidentification of *P. pilosus*). Two other species, *P. longipilosus* and *P. europaeus* were found in Siberia and the Far East of Russia, and in eastern Kazakhstan.

Among the Central Asian species of *Peloribates*, two Holarctic species *P. europaeus* and *P. pilosus* have a wider distribution in Eurasia and North America. Other species are distributed mainly in some areas of Europe, Asia or North America.

Most of the *Peloribates* species in Central Asia inhabit the litter, mosses and other organic layers accumulated on the soils of various types of forests, but some species are often found in the litter and soils of non-forested landscapes such as mountain steppe, plain steppe, meadows etc. Especially the species, *P. europaeus*, *P. longipilosus* and *P. pilosus* are characteristic for the steppe habitats.

Since the oribatid mite faunas of many regions in Central Asia are incompletely known, further species of these two genera certainly remain to be discovered.

### 5. Acknowledgements

We would like to thank Dr S. K. Stebaeva, Institute of Ecology and Evolution, Russian Academy of Sciences, Moscow, for collecting material used in this work. Thanks also to the anonymous reviewers for their critical reading of the manuscript with useful comments. The present research was partly supported by the Asia Research Centre at the National University of Mongolia.

### 6. References

- Andrievsky, V. S., B. Bayartogtokh, L. G. Grishina & I. E. Smelyansky (2002): Oribatids of steppe ecosystems of Inner Asia and adjacent areas. – In: Khmelev, V. A. (ed.): Steppes of Inner Asia. – Siberian Branch of RAS Press, Novosibirsk: 201 – 221 [in Russian]
- Balogh, J. (1943): Magyarország Pancselosatkai (Conspectus Oribateorum Hungariae). – Matematikai és Természettudományi Közlemények, Akadémia Kiadása, Budapest: 1 – 202
- Bayartogtokh, B. (2007): Fauna and communities of oribatid mites of Mongolia (Acari: Oribatida). Dissertation submitted for the degree of doctor of science in biology. – Institute of Ecology and Evolution, RAS, Moscow: Vol. 1: 572 pp, Vol. 2: 288 pp. [in Russian]
- Berlese, A. (1908): Elenco di generi e specie nuove di Acari. – Redia **5**: 1 – 15
- Berlese, A. (1916): Centuria terza di Acari nuovi. – Redia **12**: 283 – 338
- Bernini, F. (1969): Notulae Oribatologicae I. Contributo alla conoscenza degli Oribatei (Acarida) della Pineta di S. Vitale (Ravenna). – Redia **51**: 329 – 375
- Bernini, F., A. M. Avanzati & S. Bernini (1987): Notulae Oribatologicae XXXVII. Gli Acari Oribatei del Massiccio del Pollino (Italia Meridionale): Aspetti faunistici e biogeografici. – Lavori della Società Italiana di Biogeografia **10**: 379 – 488
- Buitendijk, A. M. (1945): Voorloopige Catalogus van de Acari in de Collectie Oudemans. – Zoologische Mededeelingen **24**: 281 – 391
- Bulanova-Zachvatkina, E. M. (1967): Armored mites – Oribatids. – Higher School Press, Moscow: 254 pp. [in Russian]
- Bulanova-Zachvatkina, E. M. (1975): Family Oribatulidae. – In: Gilyarov, M. S. (ed.): A Key to the Soil Inhabiting Mites. – Nauka Press, Moscow: 255 – 260 [in Russian]
- Grandjean, F. (1935): Observations sur les Oribates (9e série). – Bulletin du Muséum National D'Histoire Naturelle **7**: 280 – 287
- Grishina, L. G. (1981): New species of oribatid mites (Sarcoptiformes, Oribatei) from south regions of Siberia. – In: Cherepanov, A. I. (ed.): Insects and Mites of Siberia. – Nauka Press, Novosibirsk: 23 – 32

- Hammen, L. van der (1952): The Oribatei (Acari) of the Netherlands (Acari). – *Zoologische Verhandelingen* **17**: 1 – 139
- Hammer, M. (1952): Investigations on the microfauna of Northern Canada, Part I. Oribatidae. – *Acta Arctica* **4**: 1 – 108
- Karppinen, E., D. A. Krivolutsky & M. P. Poltavskaja (1986): List of Oribatid mites (Acarina, Oribatei) of northern Palaearctic region. III. Arid lands. – *Annales Entomologici Fennici* **52**: 81 – 94
- Krivolutsky, D. A. (1995): Oribatid mites. – Nauka Press, Moscow: 223 pp.
- Mahunka, S. (1980): Oribatids from Tunesian soils (Acari: Oribatida). I. – *Folia Entomologica Hungarica* **41**: 123 – 134
- Mahunka, S. (1983): The Oribatids (Acari: Oribatida) of the Hortobágy National Park. – In Mahunka, S. (ed.): Fauna of the Hortobagy National Park. Hungarian Natural History Museum, Budapest, Vol. **2**: 377 – 397
- Mahunka, S. (1987): A survey of the oribatids of Kiskunsag National Park (Acari: Oribatida). – In Mahunka, S. (ed.): Fauna of Kiskunsag National Park. Hungarian Natural History Museum, Budapest, Vol. **2**: 346 – 397
- Mahunka, S. (1994): Further notes, additions and redescriptions of the Oribatid species preserved in the Berlese Collection (Acari, Oribatida) I. – *Acta Zoologica Academia Scientiarum Hungaricae* **40**: 29 – 49
- Mahunka, S. & L. Mahunka-Papp (1995): The Oribatid species described by Berlese (Acari). – Hungarian Natural History Museum, Budapest: 325 pp.
- Mahunka, S. & L. Mahunka-Papp (1999): Oribatids (Acari: Oribatida) from the Aggtelek National Park (NE Hungary). – In Mahunka, S. (ed.): The Fauna of the Aggtelek National Park, Hungarian Natural History Museum, Budapest: 619 – 651
- Mahunka, S. & L. Mahunka-Papp (2002): Oribatids (Acari: Oribatida) from the Fertő-Hanság National Park (NW Hungary). – In Mahunka, S. (ed.): The Fauna of the Fertő-Hanság National Park, Hungarian Natural History Museum, Budapest: 199 – 229
- Marshall, V. G., R. M. Reeves & R. A. Norton (1987): Catalogue of the Oribatida (Acari) of Continental United States and Canada. – *Memoirs of the Entomological Society of Canada* **139**: 3 – 418
- Michael, A. D. (1890): On a collection of Acarina found in Algeria. – *Proceedings of the Zoological Society of London* **29**: 414 – 425
- Mihelčič, F. (1966) Zur Kenntnis der Milbenfauna Zentralspaniens (Acarina). – *Revista Española de Entomología* **41**: 458 – 470
- Mínguez M. E. & L. S. Subías (1986): Nuevos Oribátidos (Acari, Oribatei) de las Islas Columbretes (España). – *Cuadernos de Investigación Biológica* **9**: 75 – 88
- Oudemans, A.C. (1902): New list of Dutch Acari. 2nd part. – *Tijdschrift voor Entomologie* **45**: 50 – 64
- Pérez-Iñigo, C. (1974) Acaros oribátidos de suelos de España peninsular e islas Baleares (Acari, Oribatei). Parte V. – *Revista Española de Entomología* **48**: 367 – 475
- Pérez-Iñigo, C. (1993): Fauna Iberica. Vol. 9. Acari, Oribatei, Poronata. – Museo Nacional de Ciencias Naturales, Madrid: 320 pp.
- Rakhimbaeva, A. K. (1995): To the fauna of oribatid mites of Kazakhstan. – Kustanay University Press, Kustanay: 40 pp. [in Russian]
- Schuster, R. (1958): Beitrag zur Kenntnis der Milbenfauna (Oribatei) in pannonischen Trockenböden. – *Sitzungsberichten der Österreichischen Akademie der Wissenschaften* **167**: 221 – 235
- Sellnick, M. (1908): Die Tardigraden und Oribatiden der ostpreussischen Moorsrasen. – *Schriften Physikalisch-ökonomischen Gesellschaft* **49**: 317 – 350

- Shaldybina, Å. S. (1975): Family Haplozetidae. – In: Gilyarov, M. S. (ed.): A Key to the Soil Inhabiting Mites. – Nauka Press, Moscow: 268 – 275 [in Russian]
- Subías L. S. (2004): Listado sistemático, sinonímico y biogeográfico de los Ácaros Oribátidos (Acarifomes, Oribatida) del mundo (1748-2002). – *Graellsia* **60**: 3 – 305
- Travé, J. (1961): Contribution a l'étude des Oribatulidae (Oribates, Acariens). – *Vie et Milieu* **12**: 315 – 351
- Vtorov, I. I. & D. A. Krivolutsky (1968): Oribatid mites in eastern Kirgizia. – *Pedobiologia* **8**: 123 – 133 [in Russian]
- Wang, H. F., Z. Wen & J. Chen (2003): A checklist of oribatid mites of China (II). (Acari: Oribatida). – *Acta Arachnologica Sinica* **12**: 42 – 63
- Weigmann, G. (2006): Hornmilben (Oribatida). Die Tierwelt Deutschlands, Teil 76. – Goecke & Evers, Keltern: 520 pp.
- Willmann, C. (1931): Moosmilben oder Oribatiden (Cryptostigmata). – In: Dahl, F. (ed.): Die Tierwelt Deutschlands, 22 – Gustav Fischer, Jena: 79 – 200
- Zlotin, R. I. & D. A. Krivolutsky (1969): Fauna and landscape distribution of oribatid mites (Oribatei) in high mountains of inner Than-Shan. – *Pedobiologia* **9**: 254 – 270 [in Russian]

Accepted 10 June 2008