Tardigrades of the Taimyr peninsula with descriptions of two new species

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This is the first report on tardigrades from the Taimyr peninsula. Seventy-one species of tardigrades were recorded, new to Russian fauna and two of which are new to science. Diphascon boreale sp. nov. is closely related to D. brevipes (Marcus, 1936) but easily distinguished from it by claw structure and the absence of cuticular bars on the legs. Isohypsibius roberti sp. nov. belongs to the elegans group of the genus Isohypsibius; it differs from other species in the group by having a long and thin buccal tube and large lunulae with small teeth on leg IV. The eggs of Ramazzottius montivagus are here described for the first time. The almost complete absence of tardigrades in and around Norilsk is noted. This is related to the heavy industrial pollution from a local nickel-copper plant.

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ADDITIONAL KEY WORDS: — Tardigrada — systematics — Russia — Siberia — pollution.

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INTRODUCTION

Few data exist about the tardigrades of the Taimyr peninsula (and Siberia as a whole). This paper is based on samples taken from mosses, lichens, litter and water, collected from Taimyr during an expedition in July 1991. Some terrestrial samples (from near Lake Taimyr and the lower Taimyra river) were kindly supplied by L. Malinin and M. Basarov, Institute of Inland Water Biology.

Taimyr is the northernmost peninsula of Siberia. The areas investigated comprise forest tundra (Norilsk and Dudinka) open tundra (Putoran Mts, Lake Taimyr and the lower reaches of the River Taimyra) and arctic tundra (Dikson Island and mainland). Mosses and lichens are very abundant and often grow in dense aggregations.
Terrestrial samples (Fig. 1) were collected from the following areas (numbers of samples in brackets): 1. Polar station on lake Taimyr (4); 2. Gelmersen Island, the Lower Taimyra (1); 3. Dikson Island (44, 39 with tardigrades); 4. Area around the Dikson settlement (39, 34 with tardigrades); 5. Area around Norilsk, to a radius of 6 km (15, none with tardigrades); 6. Area further away from Norilsk, including Ambarnaya river, Kayerkan, Alykel (16 samples, 3 with tardigrades); 7. Area around Dudinka (16, 11 with tardigrades); 8. Putoran Mts, near the Cholochit river, 500 m above sea level (3).

Samples were collected from the following seas, lakes and rivers: 1. Kara Sea (5, none with tardigrades); 2. Lake Taimyr (1); 3. Lakes on Dikson Island (3); 4. Lakes on the mainland at Dikson (4, 1 with tardigrades); 5. Lakes near Norilsk (3, 1 with tardigrades); 6. Yenisey river (3, 1 with tardigrades); 6. Lakes near Dudinka (7, 6 with tardigrades).

Overall, 164 samples from the Taimyr peninsula and from the Norilsk and

Figure 1. Map of the Taimyr Peninsula showing locations of sampling (▲).
Dudinka regions and the Putoran Mts. were examined. Ninety-five of the 138 terrestrial samples, 13 of the 21 samples from freshwater biotopes, and none of the 5 marine samples contained tardigrades.

The terrestrial specimens were fixed and stained with acetic carmin; freshwater species were fixed with acetic acid, postfixed with formaldehyde and stained with acetic carmin. Both were mounted in Faure fluid and examined using phase contrast microscopy. KOH was sometimes used instead of acetic carmin.

The specimens extracted for scanning electron microscopy were mounted, air-dried, coated with gold and photographed with a JSM-25S scanning electron microscope. New species holotypes and paratypes are preserved in Biserov’s collection at the Institute of Inland Water Biology, Borok, Russia.

LIST OF SPECIES FOUND

Class Heterotardigrada
Family Echiniscidae

_Bryodelphax parvulus_ Thulin, 1928
  Typical specimens. One moss sample, Dikson Is. (6).

_Bryodelphax tatrensis_ (Weglarzka, 1959
  Typical specimens. Two samples, moss/lichen aggregations, Dikson mainland (3).

_Echiniscus arctomys_ Echrenberg, 1853
  Typical specimens. Two samples, lichens and moss/lichen aggregations, Dikson mainland (5).

_Echiniscus merokensis_ Richters, 1904
  Typically developed specimens and others with reduced dorsal appendages. As three samples contain _E. merokensis_ and _E. merokensis_ forma _suecicus_ Thulin, 1911, I think the latter has no taxonomic status. The sculpture of the larvae and adults differs significantly in from adult animals, as it does in _E. quadrispinosus_, Richters, 1902 (Lattes, 1975). Twenty-nine samples (11 mosses, 8 lichens, 10 aggregations), Dikson Is. and mainland (306).

_Echiniscus reticulatus_ Murray, 1905
  Typical specimens. Five samples (2 mosses, 3 aggregations), Dikson Island and mainland (10).

_Echiniscus wendti_ Richters, 1903
  These specimens presented a confusing picture; 980 specimens from 20 samples (12 lichens, 3 mosses, 4 aggregations, 1 litter) from Lake Taimyr, Dikson Is. and mainland and remote environs of Norilsk, were typically developed, with long appendages A, without the third median plate, sculptured with regularly distributed dots consisting of very tiny granules. Often these granules are only just or visible in some places only, usually at the margins of scapular or terminal plates, as in the specimen from Iceland collected by W. Maucci. Most of the specimens were faceted
on the terminal plate, as described by Dastych (1988) but contrary to Maucci’s (1986) findings. Numbers of teeth on the spine fringe vary slightly (15–20). Smaller specimens have some differences in type of sculpture, with smaller and more widely spaced dots (max. diameter 1 μm) (Fig. 2C–E).

One hundred and forty-nine specimens from 12 samples (5 lichens, 3 mosses and 4 aggregations) from Dikson Is. and mainland are very similar to those mentioned above except for one feature — the absence or invisibility of any tiny granules forming dots (Fig. 2F).

Finally, 8 specimens from 3 samples (2 lichens, 1 aggregation), from Dikson Is. and mainland, are similar to those mentioned above, but differ from them in their sculpture. The dots are absent and any other details are invisible. In one sample with 4 specimens two individuals had sculpture without dots and two had an intermediate type of sculpture, in which some regions of plates had dots and others had none.

The type of sculpture is the most important character of the genus *Echiniscus* at the specific level. In our study three types of sculpture were found: (1) dots with tiny granules (*wendti* type); (2) dots without granules; (3) no dots at all. There were no other differences between these specimens. In my opinion, all belong to one species: *E. wendti*, and the variations in type of sculpture are related to the age of the specimen, as indicated by its size (as was noted for other *Echiniscus*, e.g. *E. quadrirspinosus*, see Lattes, 1975). Other variations may be due to the physical condition of some specimens. Unfortunately, our knowledge of the biology of Echiniscidae is very poor.

*Testechiniscus laterculus* (Schuster, Grigarick & Toffner, 1980)

The specimens agree well with the description of Schuster et al. (as *E. oihonae*, 1974 and 1980). The sculpture is *blumi*-type, but more delicate than in *T. spitsbergensis* and species of the ‘blumi complex’ (Fig. 2A,B). The species is new to Russian fauna. Six samples were collected (2 mosses, 3 aggregations, 1 litter), from Dikson Is., near Lake Taimyr (142).

*Testechiniscus spitsbergensis* (Scourfield, 1897)

All specimens belong to *T. spitsbergensis* — sensu stricto — which is to say, no species synonym (e.g. *T. melanophtalmus* (Bartos, 1936) etc.) has been found. Twenty-one samples were collected (16 mosses, 5 aggregations), from Dikson Is. and mainland, and the Ambarnaya (213).

*Pseudechiniscus suillus* (Ehrenberg, 1853)

Typical specimens. Two moss samples, Dikson Is., the Ambarnaya (4).

*Pseudechiniscus facetalis* (Petersen, 1951)

Typical specimens with poorly developed ventral sculpture (compare with Maucci, 1986). First recorded occurrence in Russia. Twelve samples (10 mosses, 2 aggregations), Dikson Is. and mainland (75).

Figure 2. The sculpture of Heterotardigrada. A, *Testechiniscus laterculus*, scapular plate; B, *Testechiniscus spitsbergensis*, scapular plate; C–F: the sculpture of *Echiniscus wendti*. C, small individual, scapular plate; D, large individual, scapular plate; E, large individual, terminal plate; F, animal from the other sample, scapular plate. Scale bars: C = 5 μm; D,F = 1 μm; A,B,E = 10 μm.
Class Eutardigrada  
Order Parachela  
Family Calohypsibiidae

*Calohypsibius coelatus* (Marcus, 1928)  
The specimens accord with Pilato *et al.*'s redescription (1989). Three samples, Dikson Is. and Dudinka, mosses (3).

*Calohypsibius ornatus* (Richters, 1900)  
Typical specimens, with tubercles on the hind pair of legs (var. *carpaticus* Bartos, 1940). Nineteen samples (5 lichens, 4 mosses, 10 aggregations), Dikson Is. and mainland (61).

*Microhypsibius truncatus* Thulin, 1928  
Typical specimens. Six samples (3 lichens, 3 aggregations), Dikson Is. and mainland (8).

Family Eohypsibiidae

(?) *Amphibolus mahunkai* (Iharos, 1971)  
I identified one specimen of genus *Amphibolus* as belonging to *A. mahunkai*, on the basis of comparison with my photographs of type material of the latter species from Iharos collection. Dudinka, aggregation.

*Amphibolus nebulosus* (Dastych, 1983)  
One specimen and four eggs, one with embryo, have been found in three moss samples from Dikson Is.

*Amphibolus cf. smreczinskii* (Weglarska, 1970)  
The eggs are identical to those of *A. smreczinskii*. Adults are very similar to the latter species but differ from it in body colour (ranging from light to dark brown), the absence of eyes, the division of the medio-dorsal and medio-ventral ridges into two or more parts (as by Dastych (1983) for some individuals of *A. smreczinskii*), and in having a narrower buccal tube, usually measuring 8–11 μm. I was able to compare my specimens with Weglarska's type material. On current evidence these features could possibly be included in the range of variability of *Am. smreczinskii*, but comparisons with specimens from other Holarctic territories (Svalbard, De Smet *et al.*, 1988) and possibly from Chukotka are necessary before a final conclusion can be reached. Two samples from the lakes on Dikson Is. (17 + 7 eggs).

*Eohypsibius ndjae* (Kristensen, 1982)  
One specimen, laterally situated on the slides and with poorly visible claws (but undoubtedly *Amphibolus*-type) was classified as belonging to this species. The structure of buccal apparatus corresponds to that of *Eo. ndjae* but spiral thickness is not visible. The specimen was found in Moss from Dikson Is.
Diphascon boreale sp. nov.


*Paratypes.* Slides numbers 1838 (1); (2); (5); (7); (9), four specimens and an exuvium with 3 eggs (with embryos).

*Type locality.* Five km north of Dudinka, Krasnoyarsk kraj, along the Yenisey, 15 m above sea level, moss on the soil. Jointly with *D. pingue, D. prorsirostre, D. scoticum, Plisticrissa angustata, Hypsibius convergens, H. dujardini, H. pallidus, Isohypsibius antonovae, Macrobiotus crenulatus, M. harmsworthi, M. hufelandi.*

*Etymology.* The name of the new species is derivated from ‘boreios’ (Greek) = northern.

*Diagnosis.* Diphascon with smooth cuticle, eyes, a relatively short pharyngeal tube, two macroplacoids and a small septula, short claws and no cuticular bars on the legs.

*Description.* Body long, widest at leg III (Fig. 3A), white or colourless. Eyes diffuse. Mouth opening lacks lamellae, papillae etc., detail of buccal armature not visible. Structure drop-shaped. Pharyngeal tube relatively short with spiral thickening. Pharynx oval (18.5 × 22 μm, holotype, ratio from 1.19 to 1.33) with well developed apophysis; two macroplacoids, first longer than second and slightly constricted in its rostral one-third (Fig. 3B), the second slightly constricted caudally. Septula small.

*Claws.* Small, thick, with short base and very small accessory points on the primary branches (Figs 3C & E, 4F). No cuticular bars on legs. Eggs oval, laid in an exuvium. Males not found.

*Remarks.* The new species is closely related to *D. brevipes* (Marcus, 1936), but clearly differs from it in claw structure (Fig. 3, C–F). The claws of *D. brevipes* are longer, with thinner and longer branches (when compared with *D. brevipes* samples from the

![Figure 3. Diphascon boreale sp. nov.: A, habitus; B, bucco-pharyngeal apparatus; C, claws of legs III; E, claws of hind legs; Diphascon brevipes: D, claws of legs III; F, claws of hind legs.](https://academic.oup.com/zoolinnean/article/116/1-2/215/2684386)
TABLE 1. Morphometric data (in μm, except pt) for *Diphascon boreale* sp. nov. and *D. brevispes* (from Crimea)

<table>
<thead>
<tr>
<th>Character</th>
<th>Holotype</th>
<th>Paratype 1</th>
<th>Paratype 2 in KOH</th>
<th>Paratype 3</th>
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<th>2</th>
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<td>Body length</td>
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<td>197</td>
<td>178</td>
<td>300</td>
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<tr>
<td>Buccal tube length</td>
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<td>15</td>
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<tr>
<td>Pharyngeal tube length</td>
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<td>23</td>
<td>31</td>
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<td>Stylet supports</td>
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<td>1st macroplacoid</td>
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<td>3</td>
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<tr>
<td>2nd macroplacoid</td>
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<td>2</td>
<td>3</td>
<td>4</td>
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<td>Macropl. and septulum</td>
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<td>8</td>
<td>9.5</td>
<td>12</td>
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<td>Outer claw, 1st pair of legs</td>
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<td>—</td>
<td>7</td>
<td>9</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Length of its base</td>
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<td>—</td>
<td>3</td>
<td>3.5</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Inner claw, 1st pair of legs</td>
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<td>—</td>
<td>5</td>
<td>5</td>
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<td>—</td>
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<tr>
<td>Length of its base</td>
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<td>—</td>
<td>2.5</td>
<td>2.5</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Outer claw, 4th pair of legs</td>
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<td>—</td>
<td>6</td>
<td>7.5</td>
<td>12.5</td>
<td>12</td>
</tr>
<tr>
<td>Lenth of its base</td>
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<td>—</td>
<td>3</td>
<td>3</td>
<td>3.5</td>
<td>5</td>
</tr>
<tr>
<td>Inner claws, 4th pair of legs</td>
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<td>—</td>
<td>5</td>
<td>5</td>
<td>9.3</td>
<td>—</td>
</tr>
<tr>
<td>Length of its base</td>
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<td>2</td>
<td>2.5</td>
<td>3</td>
<td>—</td>
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<tr>
<td>Pt outer claws, 4th pair of legs</td>
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<td>—</td>
<td>42.86</td>
<td>44.12</td>
<td>52.08</td>
<td>48.0</td>
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Ust-Lena National Park, Crimea, and Italy (G. Pilato’s slide), which were identical), and there are no cuticular bars on the legs.

For character size see Table 1.


Typically developed specimens usually with 3 macroplacoids; only two animals had 2 macroplacoids. Individuals with 3 macroplacoids easily distinguished from *D. scoticum* by their thinner buccal and pharyngeal tubes and by the division of each claw into three parts (Biserov, 1989). This division is not the same as in species of the family Eohypsibiidae (i.e. the claws of *D. belgicae* can hardly be considered as Amphibolus type), because in Eohypsibiidae the three parts of the claw are fully separated whereas in *D. belgicae* the separation is only apparent (Fig. 4E). For this reason, I consider the establishment by M. Ito (1991) of a new genus *Fujiscon* (and new species also) for *D. belgicae* is unjustified. Eighteen samples (4 lichens, 6 mosses, 2 litter, 6 aggregations), Dikson Island and mainland, Dudinka, the Putoran Mts., Lake Taimyr (57).

*Diphascon bullatum* Murray, 1905

The specimens are similar in body ornament to those illustrated by Argue (1974), but differ in the presence in some individuals of tubercles. These may result from the fusion of adjacent dorsal tubercles, because the number of tubercles in this species varies widely. One specimen had eight rows of tubercles but no sculpture. I think, at the present time, there is great confusion in the systematics and sculpture of many species of *Diphascon*. For example, Maucci (1986) notes for *D. bullatum* the presence of septula and microplacoids, while other authors note only the presence of septula. Dastych (1988) has written that *D. bullatum* of Argue is more similar to *D. patanei*.
Binda et Pilato, 1971 (but Binda & Pilato, 1987, indicate that *D. patanei* have polygonal granules of sculpture, not round as in the illustration of Argue), although it is possible that *D. bullatum*, judging from published photographs, corresponds to *D. bisbullatum* (Iharos, 1964) rather than *D. bullatum*. If this is the case a redescription of *D. bullatum* with establishment of a neotype would be required, since the type material is not available (Van der Land, 1966).

Two moss samples, the Putoran Mts. and Alykel.

*Diphascon behanae* Dastych, 1987

Two specimens were found in a moss sample from the mainland around Dikson. They agree with a description by Dastych (1985, 1987); one specimen showed a slightly oblique position of the second macroplacoid, with well developed constrictions on all three macroplacoids, and with tiny granulation on the cuticle. The other specimen showed normally situated macroplacoids without constriction and with poorly defined sculpture. The species is new to the Russian fauna.

*Diphascon higginsi* Binda, 1971

Typical specimen. One moss sample, Dudnika (3).

*Diphascon iltisi* (Shuster and Grigarick, 1965)

Typical specimens, but with shorter pharyngeal tube (length of the latter approximately corresponds to pharyngeal length). This species is new to the Russian fauna. One sample, from the Putoran Mts., moss (4 + 2 cuticle).

*Diphascon oculatum* Murray, 1906

In this species there is some confusion. It seems likely that different species were described under the name *D. oculatum*. The specimens from Taimyr (and from European Russia) showed well developed sculpture on the dorsal and lateral sides of all body parts. There is a peculiar feature which makes it possible to distinguish *D. oculatum* from similar species — the presence of pore-like structures on the end of the body (see Biserov, 1991, Dastych, 1988, photograph VII and, possibly, McInnes, 1991). These do not resemble the “three slightly sculptured, isolated areas” of *D. opistogliptum* (Maucci, 1987). Using this character, specimens from Taimyr correspond with those described by Dastych (1988) and specimen from Norway (presented by W. Maucci), although this feature is not mentioned in their descriptions. There are contradictions in that some species show microplacoids. Ramazzotti & Maucci (1983) have noted “microplacoidi assente”; Maucci (1986) notes: “sono presenti microplacoidi e septula”, but in his paper (1987) he writes that *D. opistogliptum* differs from *D. oculatum* and similar species by “the presence of septula in addition to the microplacoids”. In fact, *D. oculatum* has the septula only. Nine samples (5 lichens, 1 moss, 3 aggregations), Dikson Is. and cont. (53).

*Diphascon ongulense* Morikawa, 1962

One typically developed specimen, but with septula situated a long way from macroplacoids found in a small lake on Dickson Is.

*Diphascon pingue* (Marcus, 1936)

The taxonomic status of this species is among the most confused of the genus. At the same time, this species is the most common *Diphascon* in the world fauna of
Tardigrada. So, as I have not studied the problems associated with this species, I tentatively assigned specimens with a long and thin (about 1 μm) buccopharyngeal tube, three macroplacoids, increasing in length from the first to the third microplacoids and septula to *D. pingue*, in accordance with Pilato & Binda (1977). I disagree with the opinion of W. Maucci that *D. pingue* (sensu Pilato & Binda) is equal to *D. chilinense*. I have observed the latter species from New Zealand (slide of D. Nelson) with equal macroplacoids but have never seen the same individuals in Russia (although Maucci, 1986 writes: "oppure quasi uguali fra loro", he did not indicate where these specimens were found); it is possible that the distribution of *D. chilinense* is limited to the Southern Hemisphere. The fine structure of buccal armature, invisible at the light microscopic level, is illustrated in Figure 5F. Thirty-six samples (7 lichens, 15 mosses, 14 aggregations), Lake Taimyr, Putoran Mts, Dudinka, Dikson Is. and mainland (380).

*Diphascon pingue* (Variety ‘B’ according to Dastych, 1984)

The specimens differ from *D. pingue* mentioned above, largely due to their longer and thinner microplacoids, but they are similar to *D. pingue* var. ‘B’, except in dimensions. In my case variety ‘B’ was larger than *D. pingue*. One sample with *D. pingue* and *D. pingue* var. ‘B’ was found. Three samples (1 lichens, 2 mosses), Dikson Is. and mainland (4).

*Diphascon prorsirostre* (Thulin, 1928)

Typical specimens. Seven samples (2 lichens, 5 mosses), Putoran Mts., Dudinka, Dikson Is. (19).

*Diphascon ramazzotti* (Robotti, 1970)

Typical specimens, but not all individuals have eyes. Three samples (2 lichens, 1 lichen and a little moss), Dikson Is. and mainland (21).

*Diphascon recamieri* Richters, 1911

The specimens agree well with the description of Dastych (1988). The species is new for Russia. Five samples (4 mosses, 1 small lake), Dikson Is. and mainland (12).

*Diphascon rugosum* (Bartos, 1935)

The sculpture of this species is more lightly developed than in *D. ramazzotti* and the pharyngeal tube is shorter (length approximately equal the same of pharynx). One moss sample from Dikson Is. (7).

*Diphascon scoticum* Murray, 1905

Typical specimens; one individual with two macroplacoids. Eight samples (7 mosses, 1 lichen), Dudinka and Putoran Mts. (48).

*Diphascon tenue* Thulin, 1928

Typical specimens. The species is new to the Russia fauna. Five samples (2 lichens, 3 aggregations), Dikson Is. and mainland (25).
Hebesuncus conjungens (Thulin, 1911)

Typically developed animals and eggs. Eight samples (5 Liohens, 1 moss, 2 aggregations), Dikson Is. and mainland (51 + 4 eggs).

Itaquascun bartosi Weglarska, 1959

One specimen without cuticular bars on the legs has been found from Alykel, in a moss sample. This is the first record of its presence in Russia.

Mesocrista spitzbergense (Richters, 1903)

Typical specimens. Six samples (4 mosses, 1 lichen, 1 aggregation), Dudinka and Dikson Is. (36).

Platicrista angustata (Murray, 1906)

Typical specimens, length up to 825 μm. Seven samples (1 lichen, 2 mosses, 1 litter, 3 aggregations), Dikson Is. and mainland, Dudinka, Lake Taimyr (20).

Subfamily Hypsibiinae

Hypsibius convergens Urbanowicz, 1925

The specimens agree well with Bertolani’s (1982) description, but in rare cases a very small microplacoid-like structure can be seen. Many (but not all) individuals have the cuticular bar in legs IV. Nineteen samples (2 lichens, 11 mosses, 1 litter, 3 aggregations, 2 freshwater, including 1 form lake near Norilsk), all investigated regions (79).

Hypsibius dujardini (Doyere, 1840)

The specimens agree with Bertolani’s (1982) description. Forty samples (2 lichens, 21 mosses, 7 aggregations, 2 litter, 8 freshwater, including the Yenisey), Dickson Is. and mainland, Lake Taimyr, Dudinka.

Hypsibius microps Thulin, 1928

The specimens conform with the description and photograph of Dastych (1988), but do not correspond to H. microps in my paper (Biserov, 1991). Unfortunately, a mistake crept into this paper, I confused H. microps and H. pallidus. The data concerning H. microps really pertain to H. pallidus. One moss sample from Dikson Is. (6).

Hypsibius pallidus Thulin, 1911

Typical specimens (but see H. microps). 39 samples (13 lichens, 7 mosses, 17 aggregations, 2 litter), near Lake Taimyr, Dudinka, Dikson Is. and mainland (208).

Hypsibius zetlandicus (Murray, 1907)

Typical specimens. Four freshwater samples from Dudinka, Dikson Is., near Norilsk, lakes and small water body (5).

Mixibius cf. saracenus (Pilato, 1973)

The specimens from Taimyr undoubtedly belong to the new genus described by
Pilato (1992) because they have the outer claws of the Isohypsibius type and the apophyses for the insertion of the muscles of the stylets are hook-like. These individuals are very similar to M. saracenus, but some animals have lunulae on legs IV. For a final conclusion it would be necessary to make comparisons with the type material. One sample from Dikson Is., backwater in the brook (10).

*Ramazzottius montivagus* (Dastych, 1983)

Adult animals agree well with the description of Dastych (1983) and can be reliably distinguished from other species of the genus by its stumpy claws. Eggs were unknown but I have found 4 examples.

The eggs (Figs 4A–D, 5) are round or slightly oval (70.6–74.5 μm in diameter), yellow or yellow-brown in colour. Processes of the eggs have various shapes: bulbous, conical, truncated conical, filamentous pointed and filamentous truncated, with apical disc-like processes etc. Every egg has a peculiarity: on the one side of the egg there is a region with filamentous processes only; moreover, they do not project but both ends contact the surface of the egg. Other regions are covered with processes of varied shape. Height of processes from 3 to 15 μm, its base 2–15 μm. The surfaces of the eggs are smooth or with irregular dots.

Four samples (3 lichens, including Xanthoria parietina, 1 aggregation), Dikson Is. (83 + 4 eggs).

*Ramazzottius cf. thulini* (Pilato, 1970)

Adults are very similar to R. thulini, frequently with very well developed sculpture extended to the first pair of legs. They differ only by slightly longer claws. The eggs have wide conical processes but quite often semispherical examples can be seen. Aberrant processes were present, similar to those of R. oberhaeuseri (Doyere, 1840). At the present time the taxonomical status of R. thulini is not clear. Four samples (3 lichens, 1 moss), Dikson Is. and mainland (51 + 13 eggs).

*Ramazzottius* sp. nov?

The specimens with smooth cuticles are similar to R. oberhaeuseri. The eggs with small conical-filamentous processes are impossible to classify to described species of Ramazzottius. Unfortunately, this species was found in a mixed population with R. cf. thulini, which makes this species more difficult to study. Having obtained material from all areas of Russia containing species of Ramazzottius which are undoubtedly unknown at present, I will not here describe the new species. One sample, lichen from Dikson mainland (12 + 2 eggs).

Isohypsibius antonovae Biserov, 1990

Typical specimens. Four samples (2 mosses, 1 lichen, 1 aggregation), Dudinka (8).

Isohypsibius granulifer Thulin, 1928

Typical specimens. Three samples from three small lakes on Dikson Is. (56 + 1 cuticle).

Figure 4. A–D, eggs of Ramazzottius montivagus; A, general view; B–D, diverse fragments of egg; E, Diphascon belgisae, internal claw of the hind leg; F, Diphascon boreale sp. nov., claws of leg II. Scale bars: A–E = 10 μm; F = 5 μm.
**Isohypsisibius lunulatus** (Ibaros, 1966)

Typical specimens, seven samples (6 mosses, 1 lichens), Dikson Is. and mainland, Alykel (8).

**Isohypsisibius macrodactylus** Maucci, 1978

The specimens from Taimyr belong to *I. macrodactylus* rather than *I. zierhofferi* Dastych, 1979 as indicated by their dimensions and claw structure (Binda & Pilato, 1987). One moss sample near the Ambarnaya river (123 + 7 cuticles).

**Isohypsisibius prosostomus** Thulin, 1928

Typical specimens. The species can be reliably distinguished from *I. macrodactylus* and *I. zierhofferi*, if only by their shorter claws (16–20 μm on legs IV in our case against 25–30 μm for *I. macrodactylus*). Five samples (3 mosses, 1 lichen, 1 aggregation), Dikson Is. and mainland (25).

**Isohypsisibius roberti** sp. nov.

_Holotype._ Adult animal, slide number 1636(4), collected by V. Biserov, 12 July 1991 on Dikson Is.

_Paratypes._ Slide numbers 1636(2)–1636 (7); 11 specimens + 2 cuticles.

_Type locality._ Dikson Is. (the Kara Sea), moss on the soil, 10 m above sea-level. Jointly with *M. crenulatus*, *M. harmsworthi* and *H. dujardini*.

_Etymology._ The species is dedicated to Roberto Bertolani, my colleague and friend, who kindly made it possible to compare the species of the _elegans_-group with the type material.

_Diagnosis._ The _Isohypsisibius_ group _elegans_, with sculpture of _elegans_ type, narrow and long buccal tube, pharynx with two thick macroplocoids, without microplacoids, with lunulae at the bases of all claws, ones at legs IV with teeth.
Description. Body long, slightly plump (Fig. 6A), transparent or slightly brown in colour. Dorsally and laterally the cuticle has sculpture of elegans type extending to the head (Fig 8E). It seems that in some individuals this sculpture is absent. One paratype had two (or four?) caudal tubercles. Eyes present. The mouth opening is located subventrally, without lamellae, lobes etc. The buccal armature is similar to other species of the group and is represented by medio-dorsal and medio-ventral ridges and a short band of very thin teeth, which in some cases can be fused. Long and thin buccal tube terminates in a well developed apophysis. Oval pharynx (36 × 45 μm) contains two thick macroplacoids; the first is longer than the second and with slightly developed constriction (Figure 6B). No microplacoids.

Well developed robust claws are of the Isohypsibius type, their primary branches with accessory points (Figs 6C,D, 7F). With lunulae. The latter at the internal claws on legs I–III are considerably smaller than external ones. Lunulae of legs IV are large with small thick teeth. Cuticular bars occur on legs I–III.

The males have not been found.

Two cuticles were found, each containing 4 oval (98 × 80 μm) eggs.

Allometric growth was noted for this species: pt stylet supports juveniles and differs considerably from that of adult animals.

For character size see Table 2.

Remarks. The new species belongs to the elegans-group, but differs from all known species of the group by long, thin buccal tube and large lunulae with small teeth on the claws of legs IV.

Isohypsibius sattleri (Richters, 1902)

Typical specimens. Earlier this species was noted as I. bakonyiensis (Iharos, 1964) in accordance with Pilato's opinion (1973) but after redescription of I. sattleri by Dastych (1991) it is considered best to use the old name. Five moss samples, Dikson Is., Alykel, Dudinka (9 + 1 cuticle).
Table 2. Summary morphometric data (in μm, except pt) for *Isohypsysibius roberti* sp. nov.

<table>
<thead>
<tr>
<th>Character</th>
<th>Holotype</th>
<th>Mean</th>
<th>SE</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body length</td>
<td>393.75</td>
<td>382.60</td>
<td>9.50</td>
<td>356.00-431.00</td>
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<tr>
<td>Buccal tube length</td>
<td>40.60</td>
<td>41.50</td>
<td>0.80</td>
<td>36.80-45.50</td>
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<td>Stylet supports</td>
<td>27.10</td>
<td>28.50</td>
<td>0.60</td>
<td>25.60-30.97</td>
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<tr>
<td>Pt Stylet supports</td>
<td>66.75</td>
<td>68.71</td>
<td>0.33</td>
<td>66.75-69.99</td>
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<tr>
<td>Outer buccal tube width</td>
<td>3.50</td>
<td>3.70</td>
<td>0.10</td>
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<tr>
<td>Inner buccal tube width</td>
<td>2.00</td>
<td>1.90</td>
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<tr>
<td>1st macroplacoid</td>
<td>7.20</td>
<td>7.80</td>
<td>0.20</td>
<td>7.00-9.00</td>
</tr>
<tr>
<td>2nd macroplacoid</td>
<td>5.20</td>
<td>5.20</td>
<td>0.10</td>
<td>4.80-5.80</td>
</tr>
<tr>
<td>1st + 2nd macroplacoids</td>
<td>14.00</td>
<td>14.60</td>
<td>0.30</td>
<td>13.00-16.00</td>
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<tr>
<td>Outer claw, 4 pair of legs</td>
<td>20.30</td>
<td>20.80</td>
<td>0.60</td>
<td>19.00-24.50</td>
</tr>
<tr>
<td>Length of its base</td>
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<td>7.20</td>
<td>0.30</td>
<td>6.50-9.00</td>
</tr>
<tr>
<td>Inner claw, 4th pair of legs</td>
<td>14.50</td>
<td>15.30</td>
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<td>14.00-18.00</td>
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<tr>
<td>Length of its base</td>
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<td>5.00-8.00</td>
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<tr>
<td>Pt outer claw, 4th pair of legs</td>
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<td>Pt inner claws, 4th pair of legs</td>
<td>35.71</td>
<td>36.92</td>
<td>0.81</td>
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</table>

*Isohypsysibius tetracycloides* (Richters, 1909)

Typical specimens. The head and claws I and III are shown in Figure 8E,F. Five samples (I, lake on Dikson mainland and 4, the Yenisey; 146 + 34 cuticles).

*Pseudobiots augusti* (Murray, 1907)

Typical specimens. One sample from small lake, Dikson mainland (305).

*Thulina rufuoi* Bertolani, 1981

Typical specimens. Two samples from two lakes near Dudinka (4).

Family Macrobiotidae

*Dactyllobiots ambiguus* (Murray, 1907)

Typical specimen. A small pond in Dikson Is. (16 + 1 egg).

*Dactyllobiots dispar* (Murray, 1907)

Typical specimens. Five samples, freshwater, Dikson Is., Dudinka, near Norilsk (45 + 2).

*Macrobiots bondavallii* Manicardi, 1989

The specimens and eggs are similar to the type material. Dorsal cuticle with tiny (Fig. 8A) well developed sculpture on the legs (Fig. 8B) sculpture. The process of the egg is shown in Figure 8C. Twenty-two samples (2 litter, 10 mosses, 10 aggregations), Dikson Is. and mainland, near Lake Taimyr (93 + 37 eggs).

*Macrobiots crenulatus* Richters, 1904

The specimens and eggs agree with the redescription of Binda (1988); some eggs had almost invisible reticulation of processes. Twenty-four samples (15 mosses, 3

Figure 7. A-D, *Macrobiots joannae*, eggs; A, from Lake Taimyr; B-D, from Dikson; C, apical disc of process; E,F, *Isohypsysibius roberti* sp. nov.; E, dorsal cuticle, F, claws of leg III. Scale: C = 1 μm.
TARDIGRades of taimyr

lichens, 6 aggregations), Dikson Is. and mainland, Dudinka, Alykel (109 + 31 eggs).

Macrobiotus harmsworthi Murray, 1907

Typical specimens and eggs, populations from diverse regions from Taimyr are very similar. Forty-three samples (8 lichens, 18 mosses, 1 litter, 16 aggregations), everywhere on Taimyr (394 + 173 eggs).

Macrobiotus hibernicus Murray, 1911

The specimens and eggs agree with the description of Argue (1972). Adult animals differ little from M. dianeae, Kristensen, 1982, apart from the narrower buccal tube. Dorsal sculpture is illustrated in Figure 8D. Sixteen samples (3 lichens, 5 mosses, 8 aggregations), Putoran Mts., Dikson Is. and mainland (78 + egg).

Macrobiotus hufelandi Schultze, 1834

Typical specimens. Adult animals are similar in different populations, but eggs differ. Typically developed eggs, with round and long meshes of the peribasal ring and with only two rows of mesh between processes have been found (Fig. 9A–E). The most common Eutardigrada of the peninsula; 58 samples (14 lichens, 19 mosses, 25 aggregations), everywhere within the area (935 + 220 eggs).

Macrobiotus islandicus Richters, 1904

Typical specimens; one animal with tiny microplacoids was noted. The males are common. Thirty samples (2 lichens, 15 mosses, 12 aggregations, 1 litter), near Lake Taimyr, Dikson Is. and mainland (107 + 106 eggs).

Macrobiotus cf. joannae Pilato et Binda, 1983

The specimens are very similar to M. joannae, with typically developed buccal armature. Other animals are characterized by small different buccal armature; anterior band in posterior part of buccal tube in the form of teeth. Also typical and atypical eggs were found, the latter with very small meshes on the surface of the eggs (Figs 6A–D, 9. Ten samples (1 lichen, 14 mosses, 1 litter, 4 aggregations), near Lake Taimyr, Putoran Mts., Dudinka, Dikson Is. and mainland (29 + 34 eggs).

Macrobiotus montanus Murray, 1910

Typical specimens. Four samples (2 mosses and 2 aggregations); Putoran Mts., Dikson mainland (12 + 3 eggs).

Macrobiotus richtersi Murray, 1911

The adult animals are typically developed, but eggs showed truncation of the processes, which were almost conical. Three samples (2 litter, 1 moss), near Lake Taimyr and Putoran Mts. (10 + 7 eggs).

Figure 8. A–C, Macrobiotus bondoalitis: A, dorsal sculpture of cuticle; B, sculpture of the hind leg and lunula; C, process of egg; D, Macrobiotus hibernicus, dorsal sculpture of the head; E,F, Isohypsibius tetractyloides: E, head and first leg; F, first leg and claws of the other specimen. Scale bars: A,D = 1 μm;
**Macrobiotus sp.** Bertolani, Biserov, Rebecchi (in preparation)

The specimens differ from our description by well developed lunulae on legs I–III only. Two samples (1 moss, 1 lichen), Dikson Is. and mainland (12 + 10 eggs).

**Minibiotus intermedius** (Plate, 1888)

Two specimens and an egg in two samples from Dikson Is. and from near Lake Taimyr (litter and aggregation) were found.

**Murrayon pullari** (Murray, 1907)

63 specimens and 3 typical eggs have been found in a lake near Norilsk. Yet 10 specimens from two lakes near Dudinka and 9 specimens from three lakes on Dikson Is. cannot be identified precisely, because the eggs, which are necessary for reliable identification, were not found.

**Order Apochela**

**Milnesium tardigradum** Doyere, 1840

Typical specimens. Eleven samples (6 lichens, 2 mosses, 2 aggregations, 1 litter), near Lake Taimyr, Dikson Is. and mainland (94 + 3 cuticles).

Some species of Tardigrades, which cannot be identified precisely are not included in this account. For example, some specimens belonging to the ‘hufelandi’ group of the genus *Macrobiotus* had eggs similar to *M. macrocalix*, Bertolani and Rebecchi, 1993, but undoubtedly belong to other species which are as yet undescribed.

**CONCLUSION**

The Taimyr tardigrade fauna is cosmopolitan, with arcto-alpian and boreal-mountain species being the most common. For Heterotardigrada these are *E. merakensis, E. wendti, T. spitsbergensis* and *Ps. facetalis*. For the genus *Diphascon* these are *D. pingue* and *D. belgicae*; for *Hypsibius*: *H. dujardini, H. pallidus* and *H. convergens*; for *Macrobiotus*: *M. hufelandi, M. harmsworthi, M. islandicus, M. crenulatus* and *M. hibernicus.* *M. bondavallii* and *T. laterculus*, so far known in Nearctic environments only are frequent in the investigated area.

At the same time the following very rare species have been found: *Mic. truncatus, Am. mahunkai (?), Eo. nadjae, D. ongulense, D. behanae, Mix. aff. saracenus* and *M. trunovae*. The following are common in European Russia — *I. prosostomus, I. sattleri, M. richtersii* and *Min. intermedius* — but are rare in the study areas.

A total of 71 different species were identified, 11 of which were new to Russia — *Ps. facetalis, T. laterculus, Am. nebulosus, M. bondavallii, Eohypsibius nadjae (?), D. behanae, D. iltisi, D. recamieri, D. tenue, Mix. aff. saracenus* and *R. montivagus* — and 2 new to science — *Diphascon boreale sp. nov.* and *Isohypsibius robertoi sp. nov.*

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**Figure 9.** A–E, *Macrobiotus hufelandi*; eggs of various types and from diverse regions. **A, B,** Dikson; **C, D,** Dudinka; **E,** Putoran Mts.; **F,** *Diphascon pingue*, buccal armature. Scale bars: **D, F = 1 µm,** **A, B, C, E = 10 µm.**
Tardigrades have not been found in terrestrial samples from Norilsk and the neighbouring territory; only one freshwater sample contained tardigrades. In my opinion this is related to the heavy industrial pollution by sulphuric compounds (e.g. SO₄) originating from a local nickel-copper plant. The same absence of tardigrades was noted by the author at Monchegorsk (Murmans District); probably also related to industrial pollution by a local copper-nickel plant.

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