

## Contributions to the Tardigrada of the Canadian High-Arctic

### 1. Freshwater Tardigrades from Devon Island, Northwest Territories

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A list of thirteen species of Tardigrada from freshwater habitats on Devon Island (75°30'N) is given. The most frequently occurring species were *Isohypsibius granulifer*, *I. papillifer bulbosus* and *Hypsibius dujardini*.

Key Words: Tardigrada, High Arctic, Devon Island, Northwest Territories, Canada, freshwater.

In contrast to the European High Arctic and the Antarctic, Canadian High Arctic biota have hardly been investigated for their tardigrade fauna. Weglarska (1970) and Weglarska and Kuc (1980) studied moss-dwelling tardigrades sampled on Axel Heiberg Island, Northwest Territories (latitude 79°30'N) and listed 12 species and one forma of Heterotardigrada, and one species of Eutardigrada. The only other data available are by Ryan (1977) who reported *Pseudechiniscus* sp. and *Macrobiotus* sp. from Truelove Lowland on Devon Island.

It is clear from this limited number of studies that the primary question at the present stage of our knowledge is a basic one: which tardigrade species are living in the Canadian High Arctic and what is the composition of their assemblages as a function of environmental parameters.

The present paper deals with the tardigrade species found in a small number of samples from freshwater habitats, collected on Truelove and Sparbo-Hardy Lowlands, Devon Island.

#### Materials and Methods

Devon Island (75°30'N, 86°00'W) is part of the Canadian eastern High Arctic. Following Aleksandrova (1980), the island belongs to the north-eastern Canadian-northwestern Greenland sub-province of the arctic tundras. It has a tundra climate with mean annual temperature below freezing (–15°C to –18°C). The mean minimum and maximum temperatures for July are respectively 1.7°C and 7.2°C. The number of frost-free days varies from 30 to 40; mean annual precipitation ranges from 127 mm to 254 mm (Fletcher and Young s.d.). Microclimatological stud-

ies (Courtin and Labine 1977) show that the lowlands form some kind of a thermal oasis due to a higher summer radiation, the proximity of large bodies of water, föhn winds, etc. The physiographic controls give rise to a variety of microclimates.

Truelove and Sparbo-Hardy Lowland are situated on the northeastern coast (approximately 75°45'N and 84°00'W). According to Bliss (1977), these coastal lowlands result from postglacial rebound following deglaciation. During uplift, lagoons were cut off by raised beaches, resulting in the formation of shallow lakes. Some of the shallower lakes became infilled with lacustrine sediments to form meadows. There is an abundance of surface water resulting from blocked drainage by the raised beaches. This blockage gives rise to well developed sedge-moss meadows.

Sampling was carried out during the month of July 1987. Mosses were squeezed; plankton was taken with a plankton net. The tardigrades were fixed and preserved in 4% formalin. Tardigrades were found only in 6 of the 9 samples (4 moss, 1 epilithic-benthic, 4 plankton) examined.

List of tardigrade positive samples, site of collection and habitat description:

Truelove Lowland

Sample M 175: Pool, 25 × 30 m, depth 8 cm, water temperature 11.0°C, pH 8.07, conductivity 275 µS cm<sup>-1</sup>, transparency (Weigelt) 20 cm, total hardness > 7°d < 14°d. 09.07.1987. Nature of sample : moss (*Drepanocladus lycopodioides* (Brid.) Warnst).

Sample M 185: Pool, water temperature 8.0°C, pH 7.28, conductivity 145 µS cm<sup>-1</sup>, transparency



32.5 cm, total hardness  $> 4^{\circ}\text{d} < 7^{\circ}\text{d}$ . 11.07.1987. Nature of sample: moss (*Calliergon richardsonii* (Mitt.) Kindb).

Sample M 191: See M 175. Nature of sample: epilithic-benthic material.

Sample M 198: Pool, moderately large, depth 10-20 cm, pH 6.91, conductivity  $42 \mu\text{S cm}^{-1}$ . 10.07.1987. Nature of sample: submerged mosses.

Sample W 203: Pool, moderately large, depth 20 cm, water temperature  $12.0^{\circ}\text{C}$ , pH 8.15, conductivity  $205 \mu\text{S cm}^{-1}$ , transparency 21.5 cm, total hardness  $> 7^{\circ}\text{d} < 14^{\circ}\text{d}$ . 12.07.1987. Nature of sample: plankton.

Sparbo-Hardy Lowland

Sample M 235: Lakelet, depth 0.5 m+, water temperature  $8.0^{\circ}\text{C}$ , pH 8.30, conductivity  $190 \mu\text{S cm}^{-1}$ , total hardness  $> 4^{\circ}\text{d} < 7^{\circ}\text{d}$ . 16.07.1987. Nature of sample: moss (*Scorpidium scorpioides* (Hedw.) Limpr.).

### List of species

Nomenclature follows Ramazzotti and Maucci (1983) with minor modifications. General zoogeographical and ecological remarks were taken from Ramazzotti and Maucci (1983) and Dastych (1988). The number of specimens found is bracketed.

#### HETEROTARDIGRADA

##### Family Echiniscidae

*Echiniscus spitsbergensis* Scourfield, 1897 (Figure 1. 1a-g)

A series of two clawed larvae, juvenile stages with four claws on each leg, and sexually mature animals with one or two eggs.

The cuticle is characteristically sculptured and consists of penta- or hexagonal depressions surrounded by an irregular wrinkled wall. Our specimens show two dorsal appendages, a filiform  $\text{C}^{\text{d}}$  and a long jag or spine at  $\text{D}^{\text{d}}$ ; lateral filiform appendages present at A, C and D; between dorsal and lateral appendages a small jag at  $\text{C}'$  and at  $\text{D}'$ ; B is lacking and E consists of a row of spines with up to 4 or 5 jags. All specimens, even the larvae, have spine E developed and all specimens lack appendage B, even the sexually mature ones (*spinuloides* type). The absence of specimens with filiform appendage B developed could be due to the fact that most of them had not yet reached full morphological adult stage. For specimens from Greenland, Petersen (1951) also noted that this feature was lacking even in the very large ( $320 \mu\text{m}$ ) and the sexually mature ones, which demonstrates that this character may be absent altogether. According to Dastych (1988) this species is a boreal-mountain subelement with holarctic range. The species was reported in large numbers by Weglarska and Kuc (1980) from 57 stations, and among different mosses on Axel Heiberg Island.

Dimensions: body length:  $227\text{--}393 \mu\text{m}$ ; egg:  $46 \times 61 \mu\text{m}$ .

Samples: M 191 (4), M 198 (10).

*Pseudechiniscus suillus* (Ehrenberg, 1853) (Figure 1. 2)

All features of the specimen conform with the description of the forma *facetialis* Petersen, 1951. Small animal, cuticle with a fine regular granulation. The head plate and the terminal plate show distinct facetting. In addition to the lateral facetting of the terminal plate, there is a weakly faceted triangle in the middle. Cosmopolitan. *P. suillus* f. *facetialis* has been reported in large numbers from six localities on Axel Heiberg Island by Weglarska and Kuc (1980).

Dimensions: body length:  $123\text{--}177 \mu\text{m}$ .

Samples: M 198 (5), M 235 (2).

#### EUTARDIGRADA

##### Family Amphibolidae

*Amphibolus weglarskae* (Dastych, 1972) (Figure 1. 3a-d)

Robust animals with yellow-brownish pigment and two eye spots. Mouth cavity with 14 lamellae. Pharyngeal tube broad and straight; oval bulbus with three macroplacoids, the two first so closely fused together, as to resemble one long macroplacoid with a distinct incision in the middle; the top ends narrowing and almost reaching the apophyses. The third macroplacoid frequently with a flat broadening at the end. Doubleclaws of the *Amphibolus* type with distinct lunulae which are largest and mostly crenulated in external claw of leg IV. Cold-stenothermic and hygrophilous. Distribution still insufficiently known (British Columbia (Canada), Tatra Mountains in Poland, Italy, Norway, Greenland, Svalbard). On the basis of the present findings we are inclined to consider *A. weglarskae* as an arctic-boreo-alpine element.

Dimensions: body length:  $386 \mu\text{m}$ ; bulbus length:  $55 \mu\text{m}$ , diameter:  $49 \mu\text{m}$ ; pharyngeal tube length:  $68 \mu\text{m}$ , diameter:  $8 \mu\text{m}$ .

Sample: M 235 (1).

##### Family Hypsibiidae

*Diphascon recamieri* Richters, 1911 (Figure 2. 1a-e).

Animals of medium size. Very long pharyngeal tube; the drop-like structure on the buccopharyngeal tube was absent in the specimens studied. Elongated bulbus with 2 macroplacoids; the first (almost twice as long as the second) is divided in two, the first halves somewhat smaller and thinner. Microplacoid and distinct septulum present (cf. Weglarska 1959). Petersen (1951) and Kathman (1990) did not find specimens with septula in Greenland. An arctic-alpine subelement with holarctic distribution.

Dimensions: body length:  $163\text{--}299 \mu\text{m}$ ; bulbus (specimen of  $299 \mu\text{m}$ ) length:  $37 \mu\text{m}$ , diameter:  $19 \mu\text{m}$ ; pharyngeal tube (specimen of  $299 \mu\text{m}$ ) length:  $77 \mu\text{m}$ , diameter:  $1 \mu\text{m}$ .

Sample: M 185 (2).



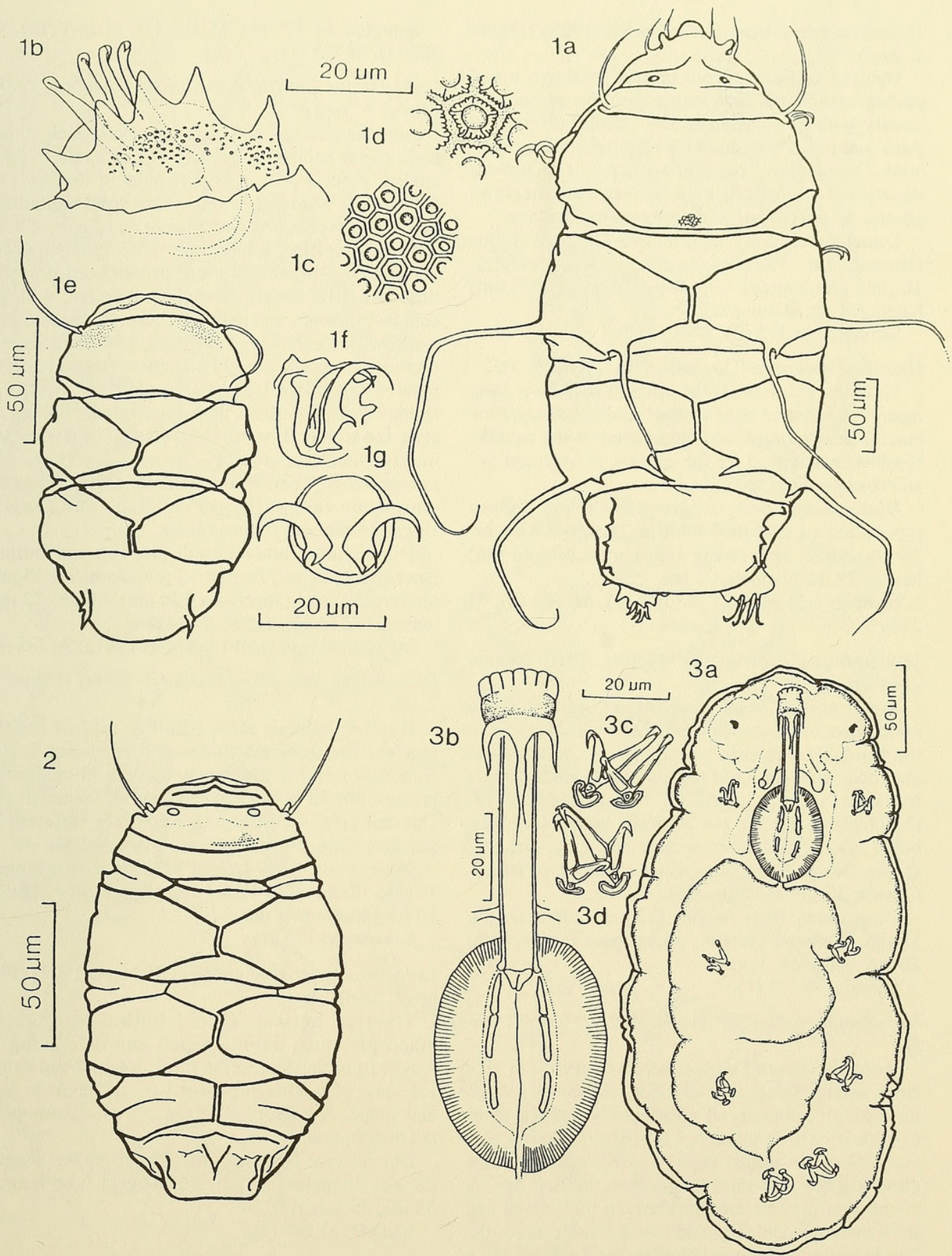


FIGURE 1. 1 *Echiniscus spitsbergensis*: a general view, b claws of leg IV, c cuticle, d detail of cuticle, e juvenile stage, f claws of juvenile leg III, g claws of juvenile leg IV; 2 *Pseudechiniscus suillus*: general view; 3 *Amphibolus weglarskae*: a general view, b buccal apparatus, c, d claws of leg IV.



*Hypsibius convergens* (Urbanowicz, 1925) (Figure 2. 2a-c)

Hyaline animals. Ovoid bulbus with two broad macroplacoids, the first longer than the second and mostly with an incision in the middle; the second thick and broad with rounded corners. No microplacoid. Doubleclaws resembling those of *Hypsibius dujardini*; sclerotized bars between doubleclaws absent. An euryhygric and cosmopolitan species.

Dimensions: body length: 115-213  $\mu\text{m}$ ; bulbus (specimen of 200  $\mu\text{m}$ ) length: 22  $\mu\text{m}$ , diameter: 18  $\mu\text{m}$ ; pharyngeal tube (specimen of 200  $\mu\text{m}$ ) length: 31  $\mu\text{m}$ , diameter: 2  $\mu\text{m}$ .

Samples : M 175 (2), M 191 (10).

*Hypsibius dujardini* (Doyère, 1840) (Figure 2. 3).

Hyaline animals. Oval bulbus with two long macroplacoids and large distinct microplacoids. First macroplacoid longer and constricted in the middle. Doubleclaws typical for the species. A hygrophilous and cosmopolitan species.

Dimensions : body length: 109-269  $\mu\text{m}$ ; bulbus (specimen of 194  $\mu\text{m}$ ) length: 26  $\mu\text{m}$ , diameter: 20  $\mu\text{m}$ ; pharyngeal tube (specimen of 194  $\mu\text{m}$ ) length: 29  $\mu\text{m}$ , diameter: 2  $\mu\text{m}$ .

Samples : M 185 (4), M 191 (5), M 198 (6), M 235 (1).

*Isohypsibius cf. canadensis* (Murray, 1910) (Figure 2. 4a-b)

Small animal. Almost spherical bulbus. Three macroplacoids, increasing in size from the first to the third. At one side of the bulbus the two first macroplacoids are fused together, showing a distinct incision in the middle. No microplacoid. Doubleclaws slender, the branches united near their basis; interior and exterior claw not much different in size. North American species (Vancouver Island, Canada; Virginia; California).

Dimensions: body length: 112  $\mu\text{m}$ ; bulbus length: 15  $\mu\text{m}$ , diameter: 12  $\mu\text{m}$ ; pharyngeal tube length: 20  $\mu\text{m}$ , diameter: 3  $\mu\text{m}$ .

Sample: M 175 (1).

*Isohypsibius granulifer* Thulin, 1928 (Figure 2. 5a-f).

Animals covered with tubercles varying in size from small granules to distinct rounded papillae, increasingly pronounced posteriorly. Bulbus short oval with three macroplacoids; the first two macroplacoids almost equal in size, in most cases close together, the third longer than the first two. A connection may be present between the second and third macroplacoid. Big and strong doubleclaws; the two branches of each doubleclaw can be moved to a nearly horizontal position. Hydropophilous and cosmopolitan.

Dimensions: body length: 116-191  $\mu\text{m}$ ; bulbus (specimen 139  $\mu\text{m}$ ) length: 20  $\mu\text{m}$ , diameter: 15  $\mu\text{m}$ ; pharyngeal tube (specimen 139  $\mu\text{m}$ ) length: 26  $\mu\text{m}$ , diameter: 1  $\mu\text{m}$ .

Samples: M 175 (1), M 191 (7), M 198 (10), W 203 (1), M 235 (1).

*Isohypsibius papillifer bulbosus* (Marcus, 1928) (Figure 3. 1a-d)

Animals covered with large papillae, each showing a broad hemispherical swelling at its base and a conical process with c. 4 stiff hairs at its top. The papillae are arranged in transverse and longitudinal rows. Transverse rows anterior to third pair of legs with six papillae, posteriorly with four papillae. Swellings of processes more pronounced dorsally than laterally. Small, rounded tubercles, without conical processes and hairs, between the bases of the papillae. At each side of the head, two small, lateral processes, placed closely together. Base of fourth pair of legs with large hemispherical swelling. Bulbus oval with three macroplacoids increasing in size from the first to the third. The first two macroplacoids mostly closely together. No microplacoid. Internal and external claw of doubleclaws not very different in shape and length. Hygrophilous and cosmopolitan.

Dimensions: body length: 96-146  $\mu\text{m}$ ; bulbus (specimen 146  $\mu\text{m}$ ) length: 19  $\mu\text{m}$ , diameter: 14  $\mu\text{m}$ ; pharyngeal tube (specimen 146  $\mu\text{m}$ ) length: 22  $\mu\text{m}$ , diameter: 1  $\mu\text{m}$ . Eggs: 38  $\times$  24  $\mu\text{m}$ .

Samples: M 175 (1), M 185 (3), M 191 (2), M 235 (4).

*Isohypsibius schaudinni* (Richters, 1909) (Figure 3. 2a-b)

Hyaline animals with a bulbus typical for the species. The three macroplacoids increasing in size from first to third and evenly spaced. Microplacoid present. Mouth cavity situated ventrally. Internal and external claw of doubleclaw not very different in size and shape. Euryhygric and cosmopolitan.

Dimensions: body length: 111  $\mu\text{m}$ ; bulbus length: 16  $\mu\text{m}$ , diameter: 14  $\mu\text{m}$ ; pharyngeal tube length: 18  $\mu\text{m}$ , diameter: 1  $\mu\text{m}$ .

Sample: M 175 (1).

*Isohypsibius tetradactyloides* (Richters, 1907) (Figure 3. 3a-d)

Hyaline animal. Ovoid bulbus with three macroplacoids, baton-shaped and increasing in length from the first to the third. Internal and external claw of doubleclaws not very different in size and shape. A hygrophilous species with cosmopolitan distribution.

Dimensions: body length: 175  $\mu\text{m}$ ; bulbus length: 28  $\mu\text{m}$ , diameter: 25  $\mu\text{m}$ ; pharyngeal tube length: 35  $\mu\text{m}$ , diameter: 3  $\mu\text{m}$ .

Sample: M 185 (1).

### Family Macrobiotidae

*Macrobiotus dianeae* Kristensen, 1982 (Figure 3. 4a-d)

Hyaline animals showing the typical features of the species. Mouth cavity with 10-12 lamellae. Oval bulbus with three macroplacoids, the first two closely together and the third with a typical broadening at its



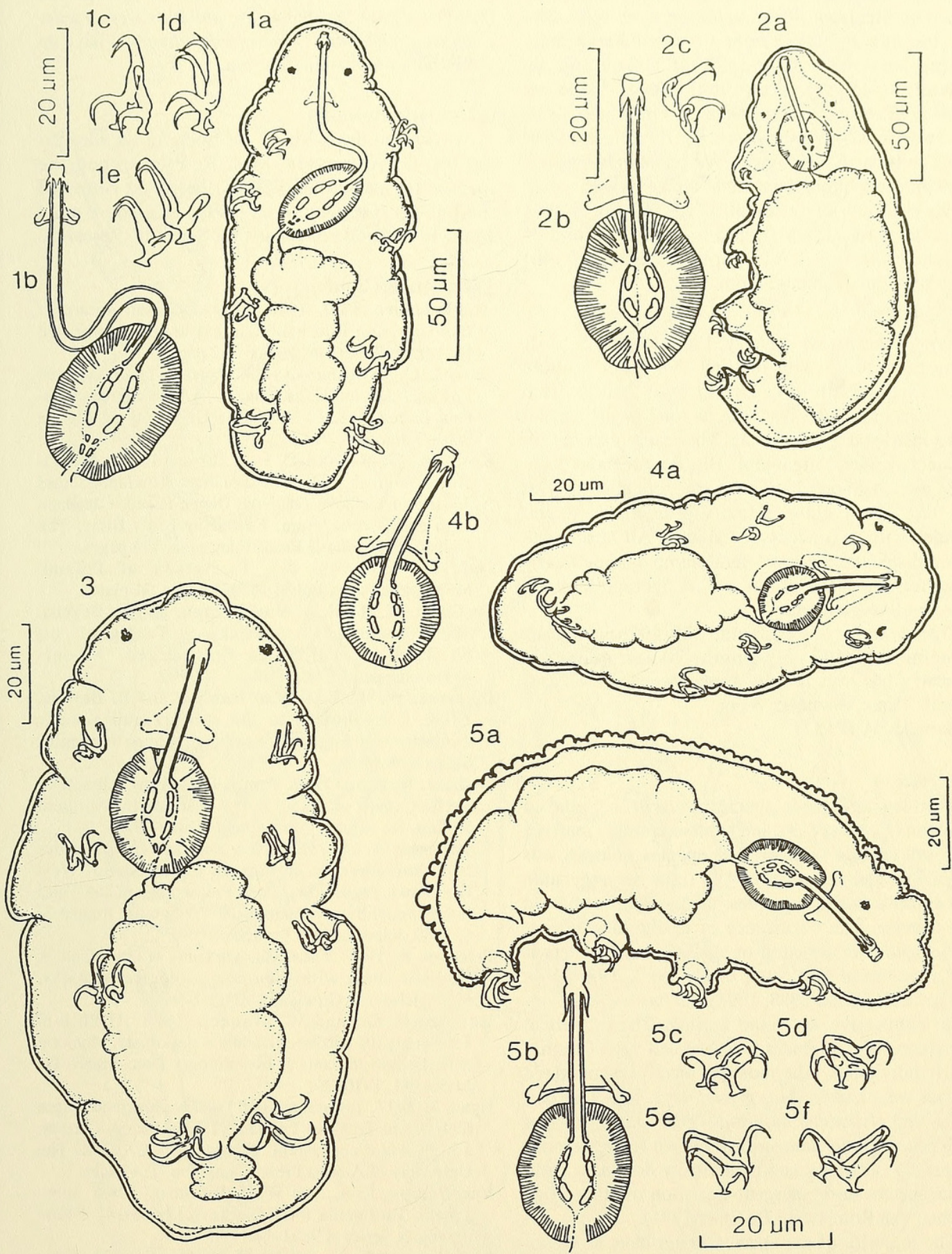


FIGURE 2. 1 *Diphascon recamieri*: a general view, b buccal apparatus, c claws of leg II, d claws of leg III, e claws of leg IV; 2 *Hypsibius convergens*: a general view, b buccal apparatus, c claws of leg IV; 3 *Hypsibius dujardini*: general view; 4 *Isohypsibius* cf. *canadensis*: a general view, b buccal apparatus; 5 *Isohypsibius granulifer*: a general view, b buccal apparatus, c claws of leg I, d claws of leg II, e claws of leg III, f claws of leg IV.



posterior extremity; the third  $2/3$  length of the first two. Doubleclaws of the *echinogenitus* type. The species was described from a warm homothermic spring on Disko Island, West Greenland by Kristensen (1982). We (unpublished) found *M. dianeae* in aquatic habitats from W. Greenland, Little Cornwallis Island (Northwest Territories, Canada) and Tanzania (Kilimanjaro). We tentatively place it amongst the hydrophilous arctic-alpine elements.

Dimensions: body length: 210–340  $\mu\text{m}$ ; bulbus (specimen of 319  $\mu\text{m}$ ) length: 46  $\mu\text{m}$ , diameter: 36  $\mu\text{m}$ ; pharyngeal tube (specimen of 319  $\mu\text{m}$ ) length: 56  $\mu\text{m}$ , diameter: 6  $\mu\text{m}$ .

Samples: M 185 (1), M 235 (7).

*Dactylobiotus dispar* (Murray, 1907) (Figure 3. 5a-d)

Large animals with distinct eye spots. Cuticle with fine granulation. Broad oval bulbus; two macroplacoids, the first twice as long as the second and constricted in the middle. The macroplacoids are connected with a ligament. Big doubleclaws each with two chitinous bars between, touching only at the base of the claw. Primary branches long and slender with two accessory spines. All specimens found displayed a dorso-lateral hump symmetrically on either side of the middle line. A hydrophilous and cosmopolitan element.

Dimensions: body length: 329–497  $\mu\text{m}$ ; bulbus (specimen of 497  $\mu\text{m}$ ) length: 70  $\mu\text{m}$ , diameter: 47  $\mu\text{m}$ ; pharyngeal tube (specimen of 497  $\mu\text{m}$ ) length: 73  $\mu\text{m}$ , diameter: 8  $\mu\text{m}$ .

Sample: M 185 (3).

## Discussion

Thirteen tardigrade species have been found in plankton (1), moss (13), and benthic-epilithic material (5) from aquatic habitats. The species richness was rather low and varied from 4 to 6 for the vegetation and epilithic-benthic samples; the plankton contained one species. The occurrence of tardigrades at very low densities in plankton of shallow arctic waters is not uncommon (De Smet et al. 1987, 1988; Van Rompu & De Smet 1988, 1991) and has been attributed to convective and wind mixing. The numerical abundance of tardigrades was low and varied from 1 to 31 individuals. The most frequently encountered species were *Isohypsibius granulifer*, *I. papillifer bulbosus* and *Hypsibius dujardini*. These taxa, together with *Macrobiotus dianeae*, are known to be the most frequently occurring and numerically dominant tardigrade species in submerged vegetation from the High Arctic (Van Rompu and De Smet 1991).

The majority of the species found have a cosmopolitan (Dastych 1988) distribution (*Echiniscus suillus*, *Hypsibius convergens*, *H. dujardini*, *Isohypsibius granulifer*, *I. papillifer bulbosus*, *I. schaudinni*, *I. tetradactyloides*, *Dactylobiotus dispar*). *Isohypsibius canadensis* appears to be a North

American element. The remainder of the species (*Echiniscus spitsbergensis*, *Amphibolus weglarskae*, *Diphascon recamieri*, *Macrobiotus dianeae*) have an arctic-boreo-alpine distribution.

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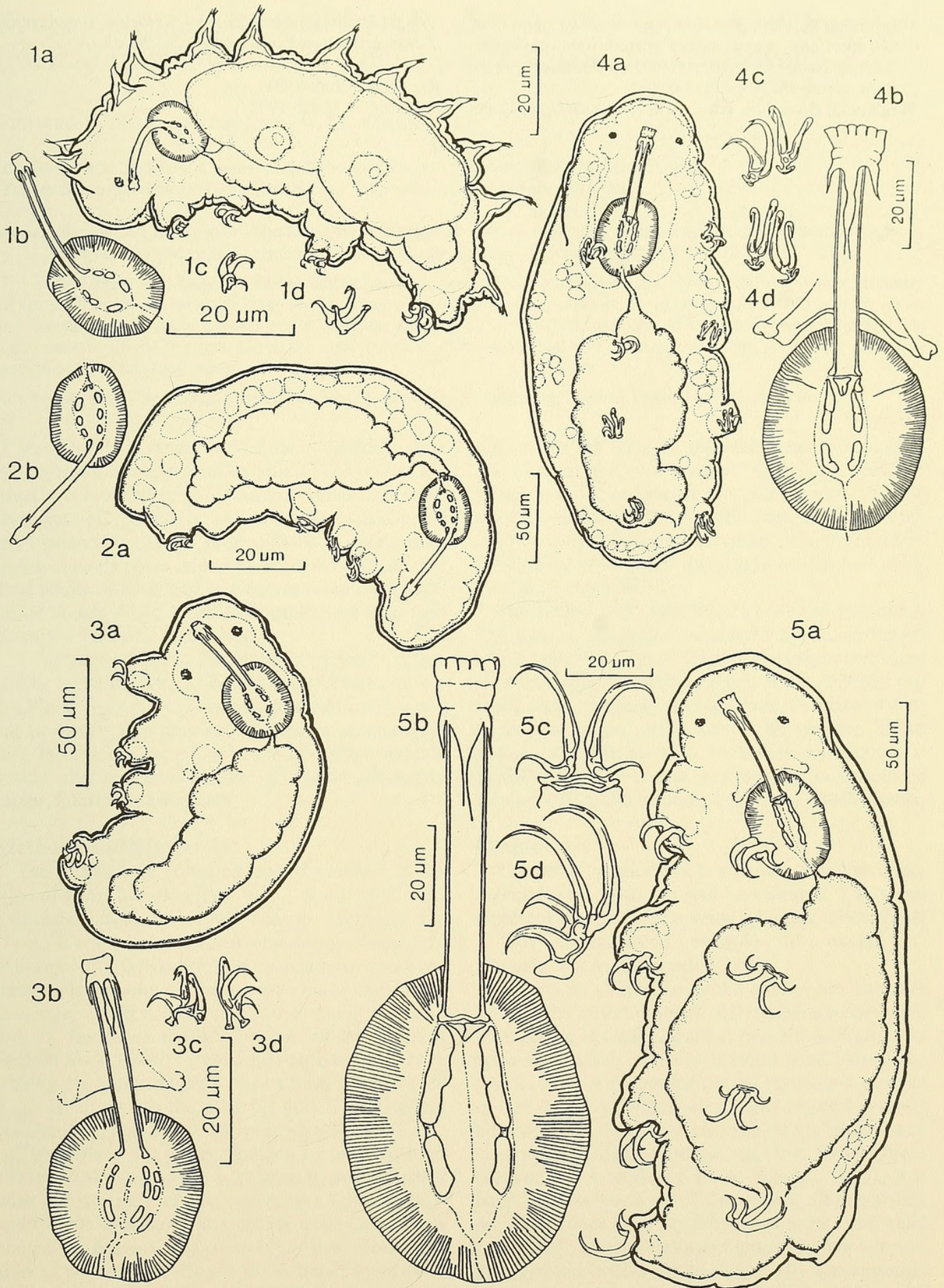


FIGURE 3. 1 *Isohypsibius papillifer bulbosus*: a general view, b buccal apparatus, c claws of leg III, d claws of leg IV; 2 *Isohypsibius schaudinni*: a general view, b buccal apparatus; 3 *Isohypsibius tetradactyloides*: a general view, b buccal apparatus, c claws of leg III, d claws of leg IV; 4 *Macrobiotus dianaeae*: a general view, b buccal apparatus, c claws of leg III, d claws of leg IV; 5 *Dactylobiotus dispar*: a general view, b buccal apparatus, c claws of leg II, d claws of leg IV.



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