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# West Spitsbergen *Tardigrada*

[With pls. I—XIV and 27 text-figs.]

**Niesporczaki *(Tardigrada)* Zachodniego Spitsbergenu**

Abstract. Fourty nine taxons of non-marine *Tardigrada* were found in West Spitsbergen area. Among them, twelve species were not previously recorded from that territory. Four species and one subspecies were new and most of them has been described in other papers. They are: *Amphibolus nebulosus* (DASTYCH, 1983), *Hypsibius montivagus* DASTYCH, 1983, *Doryphoribius macrodon* BINDA, PILATO & DASTYCH, 1981, *Macrobiotus harmsworthi obscurus* ssp. nov. and *Isohybsibius dastychi* PILATO, BERTOLANI & BINDA, 1982. Some quantitative characteristics are given and influence of the kind of rock-substratum and the altitude a.s.l. on *Tardigrada*-fauna are discussed. These two factors seems to be of great importance for the water-bear species composition.

CONTENTS



## I. INTRODUCTION

Spitsbergen and rather West Spitsbergen is the greatest island of Svalbard archipelago and it belongs to the best though still unsufficiently investigated areas of Arctic Region regarding the species composition of *Tardigrada*. We owe our present knowledge of this fauna to SCOURFIELD's (1897), RICHTERS' (1903, 1904, 1911 a, b), MURRAY's (1907), WĘGLARSKA's (1965), and MIHELČIČ (1971) studies.

In spite of numerous investigations on the invertebrate fauna of the Arctic Region, there are no quantitative data referring to *Tardigrada*, and in the eco-

logical elaborations mentioning water-bears, the applied methodics does not authorize to make any generalizations in reference to these animals (comp. e. g. BENGTSON et al., 1974). Water-bears are a rather important component of tundra and high mountain biocoenoses and due to this fact they deserve a much greater attention in future elaborations of these ecosystems.

## II. MATERIAL AND METHODS

Sample were supplied mainly by members of Polish mountaineering expeditions*, acting in West Spitsbergen in the years 1973—1980, and they originate

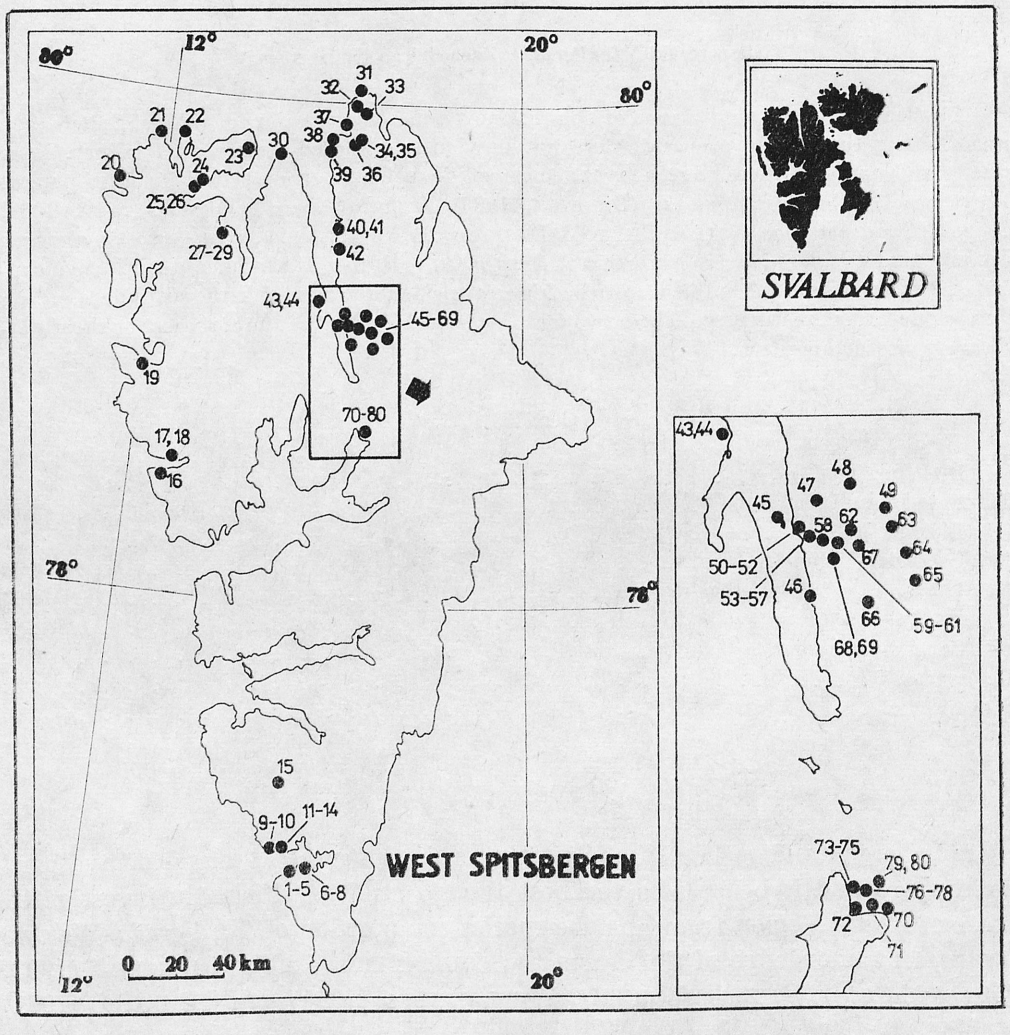



Fig. 1. Distribution of localities within West Spitsbergen

* The leader of the majority of these expeditions was Prof. Dr. R. W. SCHRAMM.

from 80 localities lying mostly in the northern regions of the island (Fig. 1). The samples were collected from soil, rocks, stones unstable soil of middle moraines, crevices in the patterned arctic soil, mouldy bones etc., both in the coastal tundra and in high mountains. The majority of samples consisted of mosses, furthermore there were lichens, grass-tussocks, saxifrages and tussocks of *Dryas octopetala*. In some cases also the sediment from the surface of glaciers was collected which is found in recesses filled with water (cryoconites, "Kriokonitlöcher"). Totally 544 samples were collected, i. e. 140 qualitative samples and 404 quantitative ones. The quantitative samples were cut out from the substrate with the help of a steel ring with sharp edges, measuring 10.1 $cm^2$ (the inner diameter of the ring was 3.6 cm). After collection, the samples were packed into paper bags, dried and then the material was elaborated in Poland. Sediment from cryoconites was preserved in 75′% ethanol.

In the laboratory each sample was placed for a few hours into a 250 ml breaker with tap water. Then the plants were thoroughly shaken off with the help of pincers and the sample was put aside for determination. Sediment with water containing water-bears and their eggs, pieces of plants etc. was poured into high, narrow cylinders and put aside for 30 minutes. After sedimentation of deposit on the bottom of vessel, the upper part of water was cautiously poured out and the rest of water (about 1/4 of original volume) was strongly mixed and gradually poured on a PETRI's dish which was placed under a stereo-microscope (magnif. 20—40 x). When the suspension precipitated on the bottom of the dish, the water-bears and their eggs were taken out with a micropipette and mounted in FAURE's fluid (according to RAMAZZOTTI, 1972). Measurements were made on the prepared material. All drawings and photogtaphs are made by author.

From all samples more than 9 thousand specimens of water-bears were taken out and they belonged to 49 taxons. Among them 4 species and one subspecies are new for science. A list of the collected species is presented in Table I.

In the ecological considerations some coefficients used in zoocoenology were employed. It was the constancy ($C$: considered here as frequency), i. e. the proportional ratio of the number of samples with the investigated species to the number of all samples collected in the given habitat, and the individual dominance ($D$), which is the proportional ratio of the number of specimens of the investigated species to all collected specimens in the given habitat (comp. BALOGH, 1958). For these coefficients the same numerical values were accepted in the distinguished classes ($C_1 — C_5$ and $D_1 — D_5$) as in the studies on that group of animals in Tatra Mts (DASTYCH, 1980a). Furthermore the characteristic of the investigated material is supplemented by the number of specimens and species per sample (Tables II, III), the percentage of positive samples of *Tardigrada* (TPS) and the average specimens number per $m^2$ ($A/m^2$).

The samples were collected by the following persons: Piotr BITTNER (PB), Hieronim DASTYCH (HD), Czesław JAKIEL (CJ), Piotr KŁYSZ (PK), Mirosław KURAŚ (MK), Piotr LEGEŻYNSKI (PL), Ryszard W. SCHRAMM (RWS). The in-

Table I

Frequency and dominance *(C, D)* of *Tardigrada* species in distinguished altitude zones of West Spitsbergen

| Species | altitude m a.s.l. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0—100 m | | 101—300 m | | 301—700 m | | 701—1100 m | | 1101—1600 m | |
| | *C* | *D* | *C* | *D* | *C* | *D* | *C* | *D* | *C* | *D* |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| *E. (E.) sinensis* | 0,4 | 0,2 | — | — | — | — | — | — | — | — |
| *E. wendti* | 3,7 | 1,7 | 2,7 | 0,1 | 2,3 | 0,2 | 36,6 | 34,7 | 20,8 | 27,0 |
| *E. capillatus* | — | — | 4,5 | 0,3 | — | — | — | — | — | — |
| *E. granulatus* | 3,0 | 0,3 | 19,8 | 10,5 | 5,7 | 7,3 | — | — | — | — |
| *E. blumi* | 1,5 | 8,6 | 3,6 | 4,1 | 1,1 | 0,9 | — | — | — | — |
| *E. spitsbergensis* | 33,4 | 18,0 | 47,7 | 21,5 | 6,8 | 1,2 | 13,6 | 2,8 | — | — |
| *E. testudo* | — | — | 4,5 | 1,6 | 1,1 | 5,0 | — | — | — | — |
| *E. merokensis* | 8,2 | 3,8 | 1,8 | 0,3 | 1,1 | 0,1 | 4,5 | 1,3 | — | — |
| *Ps. suillus* | 1,5 | 0,2 | 5,4 | 0,3 | — | — | 13,6 | 2,8 | — | — |
| *Ps. victor* | 2,6 | 1,1 | 11,7 | 3,3 | 3,4 | 0,9 | 4,5 | 0,3 | 1,9 | 1,0 |
| *M. hufelandi* | 0,3 | 7,6 | 14,4 | 11,9 | 5,7 | 10,7 | — | — | 1,9 | 0,2 |
| *M. echinogenitus* | 7,4 | 2,4 | 1,1 | 0,2 | 1,1 | 0.2 | 4,5 | 0.3 | 3,8 | 0.5 |
| *M. ariekammensis* | 2.2 | 2.3 | 5,4 | 0,5 | 2.3 | 6,5 | 27,7 | 7.2 | — | — |
| *M. willardi* | 10.8 | 1.8 | 23.4 | 1.8 | 10.2 | 5.8 | — | — | — | — |
| *M. islandicus* | 13.0 | 2.6 | 27.3 | 4.9 | 3.4 | 1.3 | 22.7 | 29.0 | 7.5 | 1.2 |
| *M. richtersi* | 3.7 | 0.5 | 5.4 | 0.2 | — | — | — | — | — | — |
| *M. areolatus* | 2.2 | 3.5 | 8.1 | 2.3 | 5.7 | 2.9 | 4.5 | 0.5 | — | — |
| *M. h. harmsworthi* | 10.8 | 6.3 | 2.7 | 0.1 | 2.3 | 2.9 | 9.1 | 5.6 | — | — |
| *M. h. obscurus* | 4.5 | 4.1 | 3.6 | 0.2 | 1.1 | 0.1 | 4.5 | 2.8 | 43.4 | 47.1 |
| *M. hibernicus* | 0.4 | 0.2 | — | — | — | — | — | — | — | — |
| *Min. intermedius* | 3.0 | 1.4 | — | — | 2.3 | 0.2 | 4.5 | 2.0 | 11.3 | 4.2 |
| *Ad. coronifer* | 6.3 | 11.2 | 15.3 | 13.7 | 6.8 | 16.1 | 9.1 | 2.3 | 1.9 | 4.0 |
| *Dor.macrodon* | — | — | 0.9 | 0.1 | | | | | | |
| *Cal. ornatus* | 0,4 | <0,1 | — | — | — | — | — | — | 5.7 | 0.1 |
| *Am. nebulosus* | 1.5 | 0.1 | 3.6 | 0.3 | — | — | — | — | — | — |
| *I. prosostomus* | 3.7 | 3.5 | 0.9 | 0.1 | 3.4 | 2.3 | — | — | — | — |
| *I. dastychi* | 1.5 | 0.2 | — | — | 1.1 | 0.1 | — | — | — | — |
| *I. elegans* | 3.7 | 0.5 | 0.9 | <0.1 | — | — | — | — | — | — |
| *I. ? granulifer* | 0.4 | <0.1 | — | — | — | — | — | — | — | — |
| *I. bakonyiensis* | 1.1 | 0.1 | 0.9 | <0.1 | — | — | — | — | — | — |
| *H. dujardini* | 6.7 | 4.3 | 5.4 | 0.3 | 6.8 | 3.6 | — | — | — | — |
| *H. convergens* | 4.5 | 1.9 | 0.9 | 0.1 | 3.4 | 2.8 | 9.1 | 1.5 | 1.9 | 0.5 |
| *H. pallidus* | 1.1 | 0.1 | 1.8 | 0.1 | 1.1 | 0.2 | — | — | — | — |
| *H. oberhaeuseri* | 2.6 | 1.8 | 7.2 | 0.1 | 5.7 | 1.4 | 4.5 | 0.3 | — | — |
| *H. cataphractus* | 2.6 | 4.1 | — | — | — | — | — | — | — | — |
| *H. montivagus* | — | — | — | — | 1.1 | 0.1 | 4.5 | 0.5 | — | — |
| *H. ? arcticus* | — | — | — | — | 4.5 | 0.6 | — | — | — | — |
| *D. conjungens* | — | — | — | — | — | — | — | — | 1.9 | 0.5 |
| *D. oculatum* | — | — | — | — | — | — | — | — | 1.9 | 1.0 |
| *D. recamieri* | 5.6 | 1.9 | 4.5 | 15.1 | 14.8 | 15.0 | 4.5 | 0.3 | — | — |
| *D. angustatum* | 0.7 | <0.1 | 2.7 | 0.1 | 1.1 | 0.1 | — | — | — | — |

Table 1, continued

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| *D. belgicae* | 0.4 | <0.1 | — | — | 1.1 | 0.1 | — | — | — | — |
| *D. spitsbergense* | — | — | — | — | 2.3 | 1.5 | — | — | — | — |
| *D. pingue* | 0.7 | 0.3 | — | — | 3.4 | 1.4 | — | — | 5.7 | 1.2 |
| *D. scoticum* | 0.7 | <0.1 | 1.8 | 0.1 | 3.4 | 0.9 | — | — | — | — |
| *D. tenue* | 0.7 | <0.1 | 0.9 | <0.1 | 2.3 | 1.3 | — | — | 9.4 | 6.0 |
| *D. arduifrons* | 0.7 | 0.1 | 1.8 | 0.1 | — | — | — | — | — | — |
| *D.* sp. nov. (?) | — | — | 0.9 | <0.1 | — | — | — | — | — | — |
| *Mil. tardigradum* | 3.0 | 3.4 | 10.8 | 4.9 | 12.5 | 6.4 | 31.8 | 6.4 | 13.2 | 3.5 |

dicated directions "left" and "right" are orographic ones. The number of samples is given in brackets. The view of some localities is illustrated in Plates I, II.

## Hornsund

1. Wurmbrandega range, mosses from calcareous rocks. 70 m a.s.l., W slope, 17 IX 1978. Leg. Piotr Kłysz PK (1 sample).
2. Vicinity of Gulliksonfjellet, 200 m N of Hevika, mosses from calcareous rocks. N, 15 m a.s.l., 17 IX 1978, PK (1).
3. Tsjebysjovfjellet Mt, mosses from dolomitic scree, 300 m a.s.l., W, 17 IX 1978, PK (1).
4. Tsjebysjovfjellet Mt, mosses from dolomitic scree, 200 m a.s.l., W, 17 IX 1978, PK (1).
5. Rasstupet range, vicinity of lateral moraine of Körberbreen glacier, 50 m a.s.l., mosses from calcareous rocks. 26 VIII 1978, PK (1).
6. Gruspynten cape at the Adriabukta. Moraine of Körberbreen glacier, N, 50 m a.s.l. Mosses from moraine and dried stream stones, 15 VII 1973, CJ (10).
7. As above, base of Reischacht Mt. Mosses from rocks, 16 VII 1973, CJ (9).
8. Reischachtpynten cape at adriabukta, vicinity of moraine of Petersbreen glacier. Mosses from rocks, 10 m a.s.l., 16 VII 1973, CJ (8).
9. Isbjörnhamna bay. Mosses from rocks in stony tundra, 10 m a.s.l., S, 25 VII 1973, RWS (1)
10. Isbjörnhamna bay, Wilczekodden; mosses from rocks, 10 m a.s.l., 17 VI 1973, PL (1)
11. Ariekammen Mt rocky ridge, N, 200 m a.s.l. Mosses from stones, 5 IX 1973, CJ (2).
12. Rocky ridge between Ariekammen and Fugleberget, 300 m a.s.l., S. Mosses from rocks. 5 IX 1973, ŻJ (7).
13. Ariekammen Mt summit, 350 m a.s.l., W. Mosses from rocks, 5 IX 1973, ŻJ (4).
14. Rocky ridge below the summit and this one of Fugleberget Mt. Mosses from rocks, 700—800 m a.s.l., 19 VI 1973, VL (5).

## Wedel Jarlsberg Land

15. Kopernikusfjellet Mt, SE rocky ridge. 970 m a.s.l. Mosses from rock (schists), 15 VII 1973, RWS (1).

## Oscar II Land

16. St. Jonsfjorden, bay at the head of Bullbreen glacier, base of Thorkemanfjellesta. E, mosses from scree, about 700 m a.s.l., 20 VII 1980, RWS (3).
17. St. Jonsfjorden, Gjertsenodden. SE crest of Lowzowfjella, about 70 km from the sea. Mosses from rocks, 300 m a.s.l., 18 VII 1980, PB (3).

Table II

The number of investigated samples (SA), *Tardigrada specimens* (SP), the *C* and *D* index on carbonate and non-carbonate bed-rock

| Species | SA | SP | non-carbonate rocks | | carbonate rocks | |
|---|---|---|---|---|---|---|
| | | | *C* | *D* | *C* | *D* |
| *E. capillatus* | 4 | 12 | — | — | 4.5 | 0.4 |
| *E. wendti* | 15 | 119 | 24.1 | 10.1 | 1.1 | 0.1 |
| *E. merokensis* | 12 | 149 | 15.5 | 3.6 | 3.4 | 3.3 |
| *E. testudo* | 6 | 111 | — | — | 6.8 | 3.4 |
| *E. blumi* | 5 | 163 | — | — | 5.7 | 5.0 |
| *E. spitsbergensis* | 46 | 293 | 6.9 | 2.1 | 47.7 | 8.2 |
| *E. granulatus* | 25 | 413 | 1.7 | 0.4 | 27.2 | 12.5 |
| *Ps. suillus* | 1 | 3 | 1.7 | 0.3 | — | — |
| *Ps. victor* | 17 | 172 | 5.1 | 0.5 | 16.0 | 5.1 |
| *M. willardi* | 25 | 75 | — | — | 28.4 | 2.3 |
| *M. ariekammensis* | 10 | 128 | — | — | 11.3 | 4.0 |
| *M. areolatus* | 12 | 114 | — | — | 13.6 | 3.5 |
| *M. hufelandi* | 12 | 487 | 1.7 | 0.1 | 12.5 | 14.8 |
| *M. hibernicus* | 1 | 9 | 1.7 | 0.1 | — | — |
| *M. islandicus* | 29 | 189 | 3.4 | 1.7 | 30.7 | 5.2 |
| *M. echinogenitus* | 8 | 30 | 13.7 | 2.6 | — | — |
| *M. h. harmsworthi* | 12 | 76 | 20.0 | 6.6 | — | — |
| *M. h. obscurus* | 14 | 99 | 17.2 | 5.6 | 4.5 | 1.0 |
| *Min. intermedius* | 9 | 37 | 12.6 | 3.0 | 2.3 | 0.1 |
| *Ad. coronifer* | 23 | 793 | 3.4 | 10.1 | 23.7 | 20.6 |
| *I. prosostomus* | 12 | 132 | 17.2 | 10.7 | 2.3 | 0.2 |
| *I. ? granulifer* | 1 | 1 | 1.7 | 0.1 | — | — |
| *I. elegans* | 2 | 3 | — | — | 2.3 | 0.1 |
| *I. dastychi* | 2 | 2 | — | — | 2.3 | 0.1 |
| *I. bakonyiensis* | 1 | 1 | — | — | 1.1 | 0.1 |
| *H. oberhaeuseri* | 9 | 62 | 3.4 | 2.6 | 8.0 | 1.0 |
| *H. montivagus* | 2 | 2 | 3.4 | 0.2 | — | — |
| *H. pallidus* | 3 | 7 | 1.7 | 0.3 | 2.3 | 0.1 |
| *H. convergens* | 9 | 62 | 10.3 | 4.6 | 3.4 | 0.2 |
| *H. dujardini* | 10 | 218 | 17.2 | 18.9 | — | — |
| *D. recamieri* | 12 | 146 | 15.5 | 10.9 | 3.4 | 0.6 |
| *D. conjungens* | 2 | 2 | 3.4 | 0.2 | — | |
| *D. tenue* | 2 | 3 | 1.7 | 0.2 | 1.1 | 0.1 |
| *D. pingue* | 2 | 2 | 3.4 | 0.2 | — | — |
| *D. belgicae* | 1 | 1 | 1.7 | 0.1 | — | |
| *D. spitsbergense* | 1 | 1 | 3.4 | 1.3 | — | — |
| *D. arduifrons* | 3 | 7 | — | — | 3.4 | 0.2 |
| *D. scoticum* | 5 | 11 | 5.1 | 0.8 | 2.3 | 0.1 |
| *D. angustatum* | 3 | 3 | 1.7 | 0.1 | 2.3 | 0.1 |
| *D.* sp. nov. (?) | 1 | 1 | — | — | 1.1 | 0.1 |
| *Mil. tardigradum* | 24 | 277 | 13.7 | 1.0 | 18.2 | 8.1 |

Table III

Quantitative distribution of investigated material and some characteristics of *Tardigrada* fauna of distinguished altitude zones in West Spitsbergen (TPS — *Tardigrada* positive samples)

| Altitude zones in m a.s.l. | The number of samples | The number of specimens | TPS in % | The number of species | Specimens per m² |
|---|---|---|---|---|---|
| 0—100 m | 265 | 4344 | 73.2 | 40 | 24910 |
| 101—300 m | 111 | 3730 | 79.3 | 35 | 39875 |
| 301—700 m | 88 | 1026 | 56.8 | 33 | 23703 |
| 701—1100 m | 22 | 389 | 72.2 | 18 | 8000 |
| 1101—1600 m | 53 | 403 | 71.7 | 15 | 6606 |

**18.** As above, mosses from rock, 630 m a.s.l., 18 VII 1980, PB (3).
**19.** Ny Ålesund, cliff in the harbour. Mosses from calciferous schists, 8 m a.s.l., 22. VII 1980, PB (3).

Albert I Land

**20.** Björnbukta; slope of Sörgattet, mosses from rock. About 600 m a.s.l., 28 VII 1980, PB (5).
**21.** Vasahalvöya, E slope of Flathukfjellet, 10 m a.s.l. Mosses from rocks, 2 VII 1973, EWS (1).
**22.** Biskayerhuken cape, 10 m a.s.l. Mosses from Devonian sanstones, 31 VII 1980, RWS (3).
**23.** Reinsdyrflya, summit of Reinsdyrwarden Mt, 96 m a.s.l. Mosses from Devonian sandstones, 3 VIII 1980, RWS (3).
**24.** Liefdefjorden, base of Siktefjellet Mt, 30 m a.s.l. Mosses from quartzites and mouldy bones, 4 VIII 1980, RWS (2).
**25.** Liefdefjorden, vicinity of the SW ridge of Hannabreen glacier, 40 m a.s.l. Mosses from dolomitic rocks. 7 VIII 1980, RWS (3).
**26.** As above, 400 m a.s.l., slope of Wulffberget. Mosses from rocks, 7 VIII 1980, RWS (3).
**27.** Bockfjorden, Trollkjeldane. Warm springs, mosses from calcite rocks, 50 m a.s.l., 7 VIII 1980, RWS (6).
**28.** Bockfjorden, Jotunkjeldane. Mosses from quartzitic scree, 50—70 m a.s.l., 7 VIII 1980, RWS (3).
**29.** Bockfjorden, Jotunkjeldane. Mosses from stones near stream, 50—70 m a.s.l., 7 VIII 1980, RWS (6).

Andrée Land

**30.** Gråhuken, mosses from sandstones and schists. 50 m a.s.l., 10 VIII 1980, RWS (6).

Ny Friesland

**31.** Verlegenhuken, about 50 m from the sea, 5—10 m a.s.l. Mosses from rocks, 5 VIII 1977, RWS (2).
**32.** Verlegenhukenflya, about 3 km from the sea, 30 m a.s.l. Mosses from stones, 5 VIII 1977, RWS (3).
**33.** Flåen, 100 m a.s.l. Mosses from tundra stones, about 5 km from the sea. 5 VIII 1977, RWS (3).
**34.** Small valley between Heikollen, Rodahfjellet and Rosenfjella. Mosses from rocks, 250 m a.s.l. Mosses from wet soil, 5 VIII 1977, RWS (2).

**35.** Rosenfjella; W slope, 150 m a.s.l. Mosses from wet soil, 5 VIII 1977, RWS (2).
**36.** Tåabreen glacier, middle moraine. 100 m a.s.l., 5 VIII 1977, RWS (2).
**37.** Mosselhalvöya, vicinity of Polheimhytta. Mosses from rocks (metamorphic schists), 5—20 m a.s.l., 24 VIII 1980, RWS (6).
**38.** Vicinity of Bangenhuk cape. Mosses from rocks, 20 m a.s.l., 22 VIII 1980, RWS (3).
**39.** Summit and slopes of Gunvervatnet at the Wijdefjorden. Mosses from rocks, 50—100 m a.s.l. 26 VIII 1980, RWS (3).
**40.** Sörbreen glacier, Åsryggen slope; about 7—8 km from the sea. Mosses from rocks, 500 m a.s.l., 31 VIII 1980, RWS (3).
**41.** Sörbreen glacier, sediment from cryoconites. 31 VII 1980, RWS (2 samples: first one collected about 2 km from the sea, 150 m a.s.l., the second one — 6 km from the sea, about 500 m a.s.l.).
**42.** Daghögda at the Wijdefjorden, mosses from rocks. 30—40 m a.s.l. 20 VIII 1980, RWS (3).
**43.** Vestfjorden, Errol Whitefjellet. Mosses from red Devonian rocks, 150 m a.s.l., 19 VIII 1980, RWS (3).
**44.** As above, 600 m a.s.l. (3).

Atomfjella

**45.** Björnnesholmen insel; mosses from amphibolits, 5—10 m a.s.l., 8 IX 1980, RWS (3).
**46.** Einsteinodden at the Austfjorden. Mosses from stones, 10—20 m a.s.l., 10 IX 1980, RWS (4).
**47.** Rutherfordfjellet Mt slope at the Schrödingerbreen glacier. Mosses from stone, 1150 m a.s.l., 21 VII 1977, RWS (1).
**48.** Curiefjellet Mt, slope S. Mosses from rocks, 1390 m a.s.l., 26 VII 1977, RWS (13).
**49.** Perriertoppen Mt, slope S. Mosses from rocks, 1600 m a.s.l., 26 VII 1977, RWS (9).
**50.** Austfjordnes hill slope; mosses from scree, between stones. 80 m a.s.l., 21 VII 1977, HD (10 samples, including one sample from mouldy bone).
**51.** As above. Mosses from soil, between tussocks of grass and *Dryas octopetala* (10).
**52.** As above. Tussocks of *Dryas octopetala* and *Silene acaulis* (10).
**53.** Vicinity of Austfjordneshytta, 100 m N from the shelter-home; broad, stony couloir in the lowest fjord terrace, 3—10 m a.s.l., about 10 m from the sea. Mosses and saxifrages from soil, 21 VII 1977, HD (10).
**54.** As above. Mosses from non-calcareous stones in small stream (10).
**55.** As above. Mosses and saxifrages from stony soil (10).
**56.** Vicinity of Austfjordneshytta, moss from mouldy bone. 10 m a.s.l., 22 VII 1977, leg. T. Szulc (1).
**57.** Tundra at the base of Grössfjell Mt, 100 m a.s.l., about 1,5 km from the sea. Mosses between tussocks of grasses and *Dryas octopetala,* 21 VII 1977, HD (15).
**58.** Tundra at the Grössfjell Mt slope, 200 m a.s.l., about 2 km from the sea. Right side of the head moraine of Tryggvebreen glacier. Mosses from thufurs and between them, wet; 21 VII 1977, HD (15).
**59.** Lateral moraine of Tryggvebreen glacier, at the slope of Grössfjell Mt; 250 m a.s.l., about 3 km from the sea. Mosses between moraine stones, 21 VII 1977, HD (15).
**60.** As above. 400 m a.s.l., about 4,5 km from the sea. Mosses from stony soil, HD (15).
**61.** Tryggvebreen glacier; about 100 m from the lateral moraine, 5 km from the sea. Sediment from cryoconites (their diameter 15—30 cm, depth 15—20 cm), 21 VII 1977, HD (5).
**62.** Tryggvebreen glacier, middle moraine at the Tannkrona. 500 m a.s.l., about 8 km from the sea. Mosses from unstable soil, 23 VII 1977, HD (15).
**63.** Lateral moraine of Tryggvebreen glacier, under S wall of Perriertoppen Mt; 700 m a.s.l., about 11 km from the sea. Mosses from stones and thin, unstable soil, 23 VII 1977, HD (15).
**64.** Vestafjellet Mt, WN wall base at the Gallerbreen glacier, 1100 m a.s.l. Mosses from rocks, 30 VII 1977, HD (15).
**65.** Plutofjellet Mt, N crest; 1300—1400 m a.s.l. Mosses from rocks, 26 VII 1977, HD (14).

**66.** Störmefjellet Mt, 1295 m a.s.l. Mosses from summit stones, 27 VII 1977, HD (15).
**67.** Thomsonryggen; SW slope, 1200 m a.s.l. Mosses from stones, 5 IX 1980, RWS (2).
**68.** Einsteinfjellet Mt, E slope. Couloir under the pass, about 1000 m a.s.l. Mosses from stones, 7 IX 1980, PB (3).
**69.** Einstenfjellet Mt, NW slope. Mosses from stones, about 900 m a.s.l., 7 IX 1980, RWS (3).

Bünsow Land

**70.** Billefjorden, mouttons of the ground moraine of the Nordenskjöldbbreen glacier, 30—50 m from the sea. Mosses from stones, 2—3 m a.s.l., 7 VIII 1977, HD (16).
**71.** Sea-coast at the Adolfbukta. Border between tundra-vegetation and stony shire, about 20 m from the sea. Mosses from soil between drift-wood, *Dryas octopetala* and *Silene acaulis*-tussocks, 7 VIII 1977, HD (15).
**72.** Rudmosepynten cape, between Petunia and Adolfbukta bay. Mosses from crevices in the patterned arctic soil, among *Dryas octopetala* tussocks; about 40 m from the sea. 7 VIII 1977, HD (15).
**73.** Ebbadalen Valley, 100 m from the sea, about 200 m from the Ebbaelva river. Mosses at the bank of shallow pool, 60 m a.s.l., 10 VIII 1977, HD (16) (Plate I a).
**74.** As above, 200 m from the sea, 60 m a.s.l. Mosses from wet thufurs, 10 VIII 1977, HD (15).
**75.** As above, 1 km from the sea, 100 m a.s.l. Mosses from the bank of periodically dried stream, 9 VIII 1977, HD (15) (Plate I b).
**76.** Wordiekammen slope, Ebbadalen Valley; 150 m a.s.l. Mosses from soil in the periodic stream, between saxifrages tussocks. 9 VIII 1977, HD (15).
**77.** As above, 200 m a.s.l. Mosses from crevices in the patterned arctic soil, 9 VIII 1977, HD (15).
**78.** As above; 300 m a.s.l., about 1 km from the sea. Mosses from scree, 100—150 m above the slope base, W, 9 VIII 1977, HD (15), (Plate II a).
**79.** Rock wall at the head moraine of Ebbabrean glacier, 300 m a.s.l. Mosses from stones, 9 VIII 1977, HD (15).
**80.** Ebbabreen glacier; mouttons at the head moraine, 30 m a.s.l. Mosses between stones, 9 VIII 1977, HD (15), (Plate II b).

## III. LIST OF SPECIES

Species new for the Svalbard fauna are marked by asterisk (*). The number of specimens is given in parentheses. The degree of attachment of the particular species to the type of substrate is given only in these cases in which it was possible to determined exactly the type of rock from which the mosses and lichens were collected (see also chapter IV. 1). The division into samples originating from carbonate and non-carbonate rocks was made on the basis of themaction of 10 % muriatic acid on rock pieces collected from some investigated localities or on tiny rock scraps occurring in the majority of investigated mosses.

### * *Echiniscus (Bryodelphax) sinensis* Pilato, 1974 (Pl. III a—c)

Length 130—170 μ. The specimens differ from the original description (Pilato, 1974b) by longer body, a little longer appendages *A*, weakly marked faceting of the end plate and by poorly developed pair of ventral plates, situated between the legs of the first pair.

Locality: Atomfjella **46** (7).

This rare species (see Table VIII) was found in the moss sample from rock collected at the height of 10—20 m a. s. l. It is known from China (l. c.) and Caucasus (DASTYCH, 1980b).

### *Echiniscus (Echiniscus) wendti* RICHTERS, **1903** (Pls. III d, IV a—c)

Length up to 270 μm, usually about 180 μm. The diameter of granules 0.5—1.5 μm; on the end plates of some specimens the granules were bigger (2.0—2.5 μm).

Localities: Hornsund **8** (7); Wedel Harlsberg Land **15** (46); Oscar II Land **18** (1); Albert I Land **23** (7), **24** (14); Andrée Land **30** (9); Ny Friesland **33** (7), **34** (3), **38** (3); Atomfjella **47** (1), **48** (6), **49** (1), **50** (8), **60** (1), **64** (52), **65** (35), **66** (5), **67** (61), **68** (16), **69** (21).

Species rather frequent and rather numerous, collected in mosses from rocks and stones, at the height of 10—1600 m a. s. l. Oligocalciphil (Fig. 24), i. e. is strongly associated with non-carbonate rocks, with neutral or acidic reaction. The optimum of its occurrence lies in the higher or the highest parts of the mountains, above 700 m a. s. l.

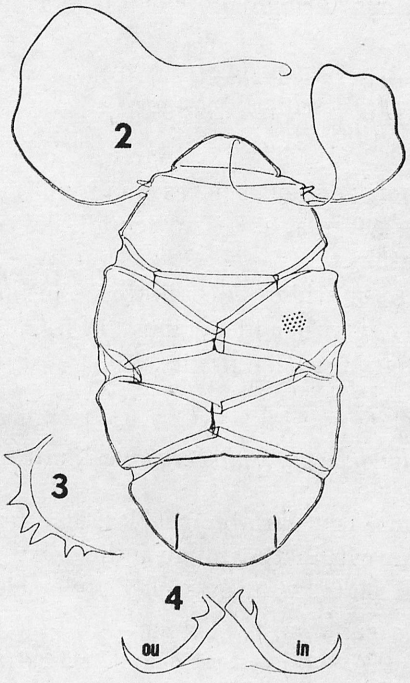
*E.* (*E.*) *wendti* RICHT. is widely distributed in the northern and mountain regions of Holarctics. In the light of systematic obscurities in the group of species most related to this one ("*arctomys*-group"), its localities in the Southern Hemisphere requires now a confirmation (see DASTYCH, 1984). This species was already recorded several times from West Spitsbergen (MARCUS, 1936; WĘGLARSKA, 1965). In Tatra Mts it belongs to the characteristic species for subnival zone (DASTYCH, 1980a).

### **Echiniscus (Echiniscus) capillatus* RAMAZZOTTI, **1956** (Figs. 2—4, Pl. IV d—g)

Length 190—250 μm. The body and the eyes are dark-red. Dorsum is covered with small (1.0—2.0 μm) spots, regularly distributed but irregular in shape (Pl. IV e, g). Between them occurs very minute (about 0.2 μm) and dense granulation. The third median plate well developed. The end plate with long incisions and not faceted. Length of cirri interni 14 μm; cirri externi 28 μm long (dimensions in the specimen 250 μm long). Papilla cephalica elongated, 7 μm in length; its width at the base 4 μm. Appendages *A* strongly developed, longer than the body (380 μm). Clava 7 μm long. Spine fringe with 6—7 large spines, irregular in shape. The claws are long. Inner claws of all legs with spine being bent downwards. Outer claws of IVth pair of legs with spine pointed upwards (Fig. 4, Pl. IV f); these claws of Ist-IIIrd pair of legs without spine. The claws of IVth pair 27 μm long.

Localities: Oscar II Land 17 (1); Bünsow Land 78 (12).

Species rare and not numerous, collected in mosses from calcareous rocks at the height of 300 m a. s. l.




Figs. 2—4. *Echiniscus (E.) capillatus* RAMAZZOTTI: 2 — habitus, dorsal view; 3 — spine fringe; 4 — fragment of the IVth pair of legs: ou — outer claw, in — inner claw

*E. (E.) capillatus* RAMAZZOTTI was quoted from the Alps (RAMAZZOTTI, 1956a), Tatra Mts (Dastych, 1980a) and South Shetland Islands (JENNINGS, 1976). In this last case other related and new species was recorded instead of *E. (E.) capillatus* RAM. (DASTYCH, 1984).

### **Echiniscus (Echiniscus) granulatus* (DOYÈRE, 1840)

Length up to 260 μm. Diameter of granules 1.5—3.0 μm. Third median plate is developed. A few specimens with the appendages *B*, some specimens with small (2—3 μm) spines *E*. Very variable species, especially in shape and size of granulation and the length and the width of $C_2$ and $D_2$ appendages.

Localities: Hornsund **7** (1); Oscar II Land **16** (1); Haakon VII Land **27** (2); Atomfjella **46** (5), **57** (1), **59** (334), **60** (34); Bünsow Land **70** (1), **72** (1), **77** (4), **78** (37) **80** (50).

Species rather frequent and rather numerous, found in mosses from rocks and soil in the zone 2—400 m a. s. l. Polycalciphil, strongly associated with calcareous (carbonate) bed-rock. In Tatra Mts it belongs to leading species for calcareous rock (there eucalciphil: DASTYCH, 1980a).

*E. (E.) granulatus* (DOY.) has a Holarctic distribution.

### *Echiniscus (Echiniscus) blumi* Richters, 1903

Length up to 390 μm. Five specimens with small spines (2—3 μm) in the place *E*; these spines were distinctly longer (12 μm) in one specimen.

Localities: Hornsund **8** (6); Atomfjella **50** (464), **59** (65), **60** (98).

That numerous but not frequent species was found in mosses from rocks and soil at the height of 10—400 m a. s. l. Eucalciphil, collected exclusively on bed-rock with alcaline reaction.

*E.* (*E.*) *blumi* Richt. is widely distributed; besides Holarctics is known from the mountains in a few other biogeographic Regions. In West Spitsbergen quoted from Klaas Billen Bay (Richters, 1904).

### *Echiniscus (Echiniscus) spitsbergensis* Scourfield, 1897

Length up to 400 μm. Very variable species. The features variability of the investigated specimens is within the range indicated by Petersen (1951) and Dastych (1973). Ventral plates usually well developed.

Localities: Hornsund **3** (3), **6** (3), **7** (8), **8** (36); Albert I Land **21** (26); Andrée Land **30** (7); Ny Friesland **32** (1), **38** (14), **42** (17); Atomfjella **46** (1), **50** (182), **51** (91), **56** (2), **57** (134), **58** (275), **59** (6), **60** (8), **64** (8); Bünsow Land **71** (50), **72** (69), **73** (36), **74** (80), **75** (3), **77** (340), **78** (93), **79** (86), **80** (6).

Among all investigated water-bears, *E.* (*E.*) *spitsbergensis* Scourf. belongs to the most frequent and very numerous species. It is strongly associated with alcaline bed-rock (polycalciphil) and was collected in a wide zone between 1—1100 m a. s. l. However, it dominated in the lower parts, i. e. in the belt up to 300 m a. s. l. and was not found on the summits of the highest mountains of that island.

Species with Holarctic distribution. It was described from West Spitsbergen (Scourfield, 1897) and afterwards was recorded a few times from there (Richters, 1903, 1904, 1911a; Węglarska, 1965).

### *Echiniscus (Echiniscus) testudo* (Doyère, 1840)

Length up to 320 μm. Investigated specimens belong to the forms trifilis and quadrifilis.

Localities: Atomfjella **59** (48), **60** (63).

Species rather numerous but not frequent. It was found exclusively in the mosses collected from alcaline bed-rock (eucalciphil), at the height of 250—400 m a. s. l.

*Echiniscus* (*E.*) *testudo* (Doyère) is widely distributed and also known from outside of Holarctics. In West Spitsbergen was recorded by Schaudinn (1901: cit. after Richters, 1904).

### *Echiniscus (Echiniscus) merokensis* RICHTERS, 1904

Length up to 230 μm. Specimens in accordance with description of MARCUS (1936), PETERSEN (1951) and LATTES (1975). Very variable species, especially in the length of $C_2$ and $D_2$ dorsal appendages.

Localities: Hornsund **8** (1); Albert I Land **24** (4); Haakon VII Land **28** (16), **29** (94); Andrée Land **30** (8); Ny Friesland **33** (5), **38** (8); Atomfjella **46** (5), **50** (4), **51** (24), **52** (1), **55** (4), **60** (13), **63** (1), **64** (5).

Species rather numerous but not frequent. It was found in mosses from rocks and soil, in the wide zone 10—1100 m a. s. l., and was a little more frequent in the highest parst of the mountains.

*E.* (*E.*) *merokensis* RICHT. in known besides Holarctics also from the mountains of Ethiopian Region (CUNHA and RIBEIRO, 1964). From West Spitsbergen was quoted by RICHTERS (1904) and maybe by WĘGLARSKA (1965), as *Echiniscus* (*E.*) *columinis* MURRAY.

### *Pseudechiniscus suillus* (EHRENBERG, 1854) (Pl. IV h)

Length up to 200 μm. Most specimens with distinctly developed net on ventral side (Pl. IV h), consisted of minute granules (comp. DASTYCH, in print).

Localities: Ny Friesland **34** (1), **42** (3); Atomfjella **51** (3), **57** (1), **58** (9), **64** (8).

Species not numerous and not frequent, found in mosses from rocks and soil, exclusively on the non-calcareous bed-rock (acalciphil) and at the height of 30—1100 m a. s. l. It is noteworthy that in Tatra Mts this species is more associated with calcareous substratum (DASTYCH, 1980a).

A cosmopolitan species, recorded from West Spitsbergen by RICHTERS (1911a) and WĘGLARSKA (1965). MURRAY (1907) quoted this species from Prince Charles Foreland, as *E. mutabilis* MUR.

### *Pseudechiniscus victor* (EHRENBERG, 1853)

Length up to 310 μm. Very variable species. One specimen without appendage $C_2$ and with strongly reduced appendages *E* (only 10 μm in length). The variability of other specimens agree with the description of SCHUSTER and GRIGARICK (1965) and the redescription of DASTYCH (1980a).

Localities: Hornsund **4** (1), **7** (2), **8** (2), **11** (1); Kaakon VII Land **28** (1), **29** (40); Ny Fiesland **44** (6); Atomfjella **48** (4), **59** (82), **60** (19), **68** (1); Bünsow Land **70** (2), **78** (19), **80** (3).

Species rather numerous but not frequent. Polycalciphil: it was collected mostly in mosses from rocks and soil on calcareous bed-rock. It occurred both in the coastal tundra and in the summit parts of the mountains, at the height of 2—1390 m a. s. l.

The Arctic-alpine species with Holarctic distribution, recorded from West Spitsbergen by RICHTERS (1911 a: cit. after MARCUS, 1936) and WĘGLARSKA (1965).

### *Macrobiotus hufelandi* SCHULTZE, 1834

Length up to 560 μm. The chorion processes and surface between them agree with the description of TOFTNER et al. (1975: Fig. 6); some eggs (locality No. **58**) were very similar to those described from California (l. c.: Fig. 13).

Localities: Atomfjella **46** (1), **50** (330), **51** (1), **58** (24), **59** (408), **60** (70), **63** (40), **66** (1); Bünsow Land **78** (7), **79** (1).

Species rather frequent and numerous. Polycalciphil, collected at the height of 10—1295 m a. s. l.; however it was more frequent in the higher parts of the island.

A cosmopolitan species, already recorded from Svalbard (MARCUS, 1936; WĘGLARSKA, 1965).

### *Macrobiotus echinogenitus* RICHTERS, 1904

Length up to 440 μm. Specimens and eggs typical (ARGUE, 1971). Chorion processes covered by very delicate net, sometimes poorly developed, with small meshes (diameter about 0.5 μm).

Localities: Hornsund **6** (1), **8** (2), **11** (1), **14** (1); Albert I Land **20** (2); Ny Friesland **31** (30), **33** (9), **37** (2), **38** (16), **39** (14), **42** (12); Atomfjella **45** (3), **46** (1), **49** (egg), **51** (12), **54** (1), **64** (1), **66** (1).

Species rather numerous but not frequent. It was found only on the non-calcareous bed-rock (acalciphil), in very wide zone 5—1600 m a. s. l. However, it was more frequent in the coastal tundra.

A cosmopolitan species, several times quoted also from Svalbard (MARCUS, 1936; WĘGLARSKA, 1965).

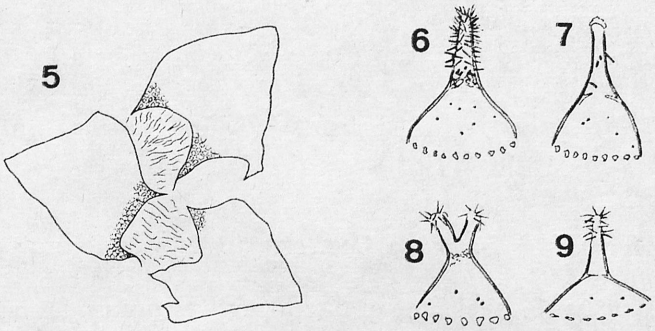
### *Macrobiotus ariekammensis* WĘGLARSKA, 1965 (Figs. 6—9, Pls. V, VI)

*Macrobiotus adelges* DASTYCH, 1977 (syn. nov.)

Length up to 780 μm. Investigated specimens and their eggs are nearly identical with description and type-material of *Macrobiotus adelges* DASTYCH 1977. However, the arctic eggs were more variable, especially in the spines number at processes tops (Figs. 6—9, Pl. VI). On the circumference of eggs occur 22—32 process. Claws lunules of the IVth pair of legs with 5—15 spines. The back of the body and legs, particularly the IV the pair, were covered with tiny granulation (Pl. V e), also observed in the type-material of *M. adelges* DASTYCH (phase contrast, immersion). Buccal cavity without the bands of anterior and posterior teeth and transversal ridges (named after PILATO, 1972).

All compared specimens had very small accessory spines on the main branches of the claws. These spines were sometimes scarcely visible.

The features of *M. adelges* DASTYCH fit perfectly to the description of *M. ariekammensis* WĘGLARSKA, 1965, which is known only from West Spitsbergen and was described only on the ground of the specimens, with excluding the egg




Figs. 5—9. *Macrobiotus harmsworthi obscurus* ssp. nov.: 5 — processes of egg; *Macrobiotus ariekammensis* WĘGLARSKA: 6—9 — variability of egg processes

structure. According to the description of *M. ariekammensis* WĘGLARSKA, this species does not have any accessory spines on the claws main branches* which occur at *M. adelges* DASTYCH. These spines I have found in the specimens collected in neighbourhood of the locus typicus of *M. ariekammensis* (localities No. 1, 5, 7).

Taking into consideration great similarity of the buccal apparatus and especially the claws in these both species, I am of the opinion that *M. adelges* DASTYCH is a synonym of insufficiently described *M. ariekammensis* WĘGLARSKA. Therefore that latter species, apart from the characteristic claws (Pl. V c-e), especially on the IVth pair leg, also has distinctive chorion processes (see DASTYCH, 1977; comp. also Figs. 6—9, Pls. V f, VI a—g).

Localities: Hornsund **1** (63), **5** (35), **7** (1); Oscar II Land **16** (1), **19** (1); Atomfjella **59** (4), **60** (73), **64** (24), **69** (3); Bünsow Land **70** (1), **78** (6).

Species rather numerous but not frequent. It belongs to the species characteristic for calcareous bed-rock (eucalciphil), from which it was found exclusively. It occurred both in the coastal tundra and high in the mountains (2—1100 m a.s.l.), but it was more frequent in the area above 100 m a.s.l.

*M. ariekammensis* WĘGLARSKA is known from West Spitsbergen (WĘGLARSKA, 1965), Poland and Caucasus (DASTYCH, 1977; 1980 a).

### ***Macrobiotus willardi* PILATO, 1976 (Pls. VII, VIII)**

Length up to 710 μm. Specimens and eggs developed typically (PILATO, 1976; DASTYCH, 1979). Most individuals with well formed two macroplacoids, from which the first one was strongly narrowed in its middle (Pl. VII a—c).

* Unfortunately I have not seen the type-material of this species.

That narrowing, the placoids size and shape and the size of chorion processes (Pl. VIII g, h) were rather variable.

Localities: Hornsund **3** (3), **8** (8), **12** (2), **13** (25), **14** (6); Kaakon VII Land **27** (1); Ny Friesland **44** (19); Atomfjella **50** (4), **51** (4), **57** (8); Bünsow Land **71** (18), **72** (11), **73** (2), **74** (26), **77** (31), **78** (30), **79** (8), **80** (5).

Species numerous and rather frequent, characteristic for "carbonate association" (eucalciphil). It was found in mosses from rocks and soil collected at the height of 1—600 a.s.l.

*M. willardi* PIL. was recorded from Canada (PILATO, l.c.), Poland and Caucasus (DASTYCH, 1979; 1980 b).

### *Macrobiotus islandicus* RICHTERS, 1904 (Pl. IX a—f)

Length up to 830 μm. Armature of buccal cavity conforming with description of PILATO (1972), hovewer, investigated specimens are characterized by greater variability in the number and size of the teeth (Pl. IX a, b). Between apophyses and the Ist macroplacoid occur two delicate rods, alike as in *Adorybiotus coronifer* (RICHTERS). Most specimens with very small microplacoid (?), 1—2 μm in length, about 0,5 μm in width (immersion!). Claw lunules of the Ist—IIIrd pair legs smooth (Pl. IX c, d); on the IVth pair with delicate and small spines (Pl. IX e, f). Lunules of the IVth pair of legs are twice bigger than at remaining legs. The surface of egg processes is covered with dense and irregular granulation. No wreaths without ganulation occurred at the bases of egg processes. Other features well agree with PETERSEN'S (1951) description.

Localities: Hornsund **3** (egg), **6** (1), **8** (20); Albert I Land **25** (9); Andrée Land **30** (19); Ny Friesland **42** (1); Atomfjella **49** (1), **57** (16), **58** (44), **60** (84), **64** (109), **66** (3), **69** (4); Bünsow Land **71** (2), **72** (6), **73** (2), **74** (25), **77** (10), **78** (42), **79** (10), **80** (1).

Species frequent and rather numerous, strongly associated with calcareous bed-rock (polycalciphil). It was found almost on the whole investigated area, both in the coastal tundra and in the summit parts on the mountains (1—1600 m a.s.l.).

Holarctic species, known also from Svalbard (MURRAY, 1907; WĘGLARSKA, 1965).

### *Macrobiotus richtersi* MURRAY, 1911

Length up to 660 μm.

Localities: Albert I Land **25** (4); Atomfjella **57** (1), **58** (8); Bünsow Land **73** (3), **74** (9).

Species not frequent and not numerous; it was found in the lower parts of the island.

*M. richtersi* is a cosmopolitan species, recorded from West Spitsbergen by WĘGLARSKA (1965) and MIHELČIČ (1971).

### *Macrobiotus areolatus* MURRAY, 1907

Length up to 830 μm. The legs are covered with tiny and regularly distributed granulation, especially on the IVth pair.

Localities: Hornsund **4** (egg), **14** (20), Atomfjella **50** (150), **57** (egg), **59** (21), **60** (87), **63** (1), **69** (2); Bünsow Land **78** (5).

Species not frequent but rather numerous, collected exclusively in the samples from calcareous bed-rock (eucalciphil). It occurred in the belt 80—900 m a.s.l., but was more frequent in the mountainous parts of the island.

A cosmopolitan species, several times quoted from West Spitsbergen (MARCUS, 1936; WĘGLARSKA, 1965).

### *Macrobiotus harmsworthi harmsworthi* MURRAY, 1907 (Pl. X e, f)

Length up to 540 μm. Specimens and eggs typical (ARGUE, 1971). Buccal armature well agree with PILATO's description (1972).

Localities: Hornsund **6** (2), **7** (2), **10** (9), **14** (3); Albert I Land **20** (21), **22** (3), **24** (7); Ny Friesland **31** (119), **33** (18), **34** (3), **35** (1), **38** (6), **40** (9), **42** (6); Atomfjella **45** (8), **51** (44), **52** (7), **53** (3), **54** (4), **68** (22).

Species rather numerous and rather frequent, found in a wide zone between 5 and 1000 m a.s.l. Acalciphil, collected exclusively in the samples from non-calcareous bed-rock. It is noteworthy that *M. h. harmsworthi* MURR. belongs to polycalciphilous species in Tatra Mts (DASTYCH, 1980 a).

A cosmopolitan species, also recorded from Svalbard (MARCUS, 1936; WĘGLARSKA, 1965).

### *Macrobiotus harmsworthi obscurus* ssp. nov. (Pls. IX g—k, X a—d)

Length up to 460 μm. Cuticle is smooth, "anterior" eyes present. Buccal apparatus of "*harmsworthi*-type", pharynx with 3 macroplacoids and big microplacoid (Pl. IX h). In the buccal cavity, between dorsal crown of the teeth and transversal ridges sometimes occur a few granules. Ventral crown of the teeth is a little displaced in comparison with the nominative subspecies and between that crown and transversal ridges always occur small granules, from a few to a dozen or so ones (supplementary teeth: PILATO, 1972). The length of the mouth tube 52 μm, its diameter 7 μm (dimensions in holotype 455 μm long). The pharynx is 41 μm long, 34 μm wide. The Ist macroplacoid 7 μm, IInd 6 μm, IIIrd 7 μm long. The legth of microplacoid 3 μm.

Claws of "*harmsworthi*-type" (comp. PETERSEN, 1951), but with characteristically formed accessory spines on the claws main branches. These spines are strikingly big and pointed upwards, especially on the IVth pair of the legs (Pl. IX g, h) and they are 14—19% of the total IVth claw length (e.g. 2,2 and 3.0 μm each spine, whereas the IVth claw length, including these spines amounts to 15 and 16 μm). Lunules on the Ist—IIIrd pair of legs are smooth; at the claws

of IVth pair they are delicately curled and twice bigger. The claws of the IVth pair of legs are 15 μm long (dimensions without lunules).

The eggs white, usually spherical and covered with conical processes (Pls. IX j, k; X a—d). The processe bases with small appendices (Fig. 5; Pls. IX k, X d) which sometimes are joined with the neighbouring appendices, forming there poorly marked areolation (Pl. X a—c). Chorion processes covered with network having very small meshes, similar to those at *M. harmsworthi harmsworthi* MURRAY. The chorion surface between processes with very delicate and irregular stripes (Fig. 5, Pl. X a, b); their width is less than 0.5 μm. Diameter of eggs with processes 90—125 μm, without them 70—82 μm. Length of processes 15—25 μm, diameter of their bases 15—18 μm. On the circumference of eggs are 9—13 processes, usually 10—12.

The new subspecies is very similar to the nominative one and differs from it by slightly different armature of buccal cavity, shape and size of accessory spines on claw main branches and by occurrence of appendices at the chorion processes bases. In *M. harmsworthi obscurus* ssp. nov. between the crown of teeth on ventral side of the mouth cavity occurs granulation, which is extremely rare at *M. harmsworthi* MURR. Moreover the new subspecies has that crown a little more distant from the transversal ridges. In *M. h. harmsworthi* MURR. accessory spines are considerably smaller and their length is only 5—7% of total length of the IVth claws (e.g. spines 0.7 μm long; the claws including these spines are 14 μm long). Furthermore, the spines are not so strongly pointed upwards, as in the new subspecies. The chorion processes in the nominative subspecies are without the appendices at their bases and sometimes occur there very tiny thickenings (comp. Pl. X e, f and X a—d).

Localities: Hornsund **5** (29), **8** (82), **9** (11); Albert I Land **20** (1), **23** (18); Andrée Land **30** (41); Atomfjella **47** (11), **48** (3), **49** (5), **58** (egg), **65** (10), **66** (162+eggs), **69** (11); Bünsow Land **79** (5).

Oligocalciphil, rather numerous and rather frequent. It was collected in the very wide zone at the height of 10—1600 m a.s.l., but its optimum occurrence is in the highest parts of the island.

Type material: 389 specimens, numerous eggs. Holotype and 376 paratypes in the collection of Department of Animal Morphology, A. MICKIEWICZ University in Poznań; 12 paratypes and 4 eggs in the collection of Prof. PILATO (Catania).

### **Macrobiotus hibernicus* MURRAY, 1907

Length 235 μm. Specimens agree with description of ARGUE (1972). Recently was described very similar species from Greenland, *M. dianeae* KRISTENSEN, 1982.

Locality: Andrée Land **30** (9).

All specimens were found in the sample from non-carbonate rock, at the height of 50 m a.s.l.

Holarctic species.

### *Minibiotus intermedius* (PLATE, 1888)

Length up to 180 μm. The eggs were not found.

Localities: Hornsund **8** (1); Albert I Land **23** (9), **24** (18); Atomfjella **48** (17), **50** (31), **60** (2), **64** (1), **69** (8).

Species not numerous and not frequent, strongly associated with non-calcareous bed-rock (oligocalciphil). It occurred at the height of 10—1390 m a.s.l., however, was more frequent in the higher parts of the mountains.

A cosmopolitan species.

### *Adorybiotus coronifer* (RICHTERS 1903)

Length up to 1040 μm. Specimens and eggs typical (MARCUS, 1936; PETERSEN, 1951). In the pharynx, between apophyses and the Ist macroplacoid are developed two delicate rods, 5—7 μm long and about 0.5 μm wide. Due to the great separateness of the buccal apparatus and claws, this species has been recently placed in a new genus (MAUCCI and RAMAZZOTTI, 1981).

Localities: Hornsund **6** (10), **8** (25), **12** (1), **14** (13); Albert I Land **24** (98); Ny Friesland **42** (19); Atomfjella **50** (318), **59** (278), **60** (191), **63** (1), **66** (16), **69** (9); Bünsow Land **78** (194), **79** (10).

Species rather frequent and numerous, strongly connected with calcareous bed-rock (polycalciphil). Frequent in mosses from rocks and soil in the lower parts of the island, in spite of its occurrence in a wide belt between 10 and 1295 m a.s.l.

*A. coronifer* (RICHT.) is known from Holarctics, moreover was recorded from Neotropical Region (HEINIS, 1914). In West Spitsbergen was quoted by RICHTERS (1903, 1904) and WĘGLARSKA (1965).

### *Doryphoribius macrodon* BINDA, PILATO & DASTYCH, 1980 (Figs. 10—12, Pl. X g—i)

Length 560—590 μm. Cuticle in the rear of the body with irregular thickenings. One specimen with well developed buccal apparatus, two other in "simplex" stage.

Locality: Atomfjella **58** (3).

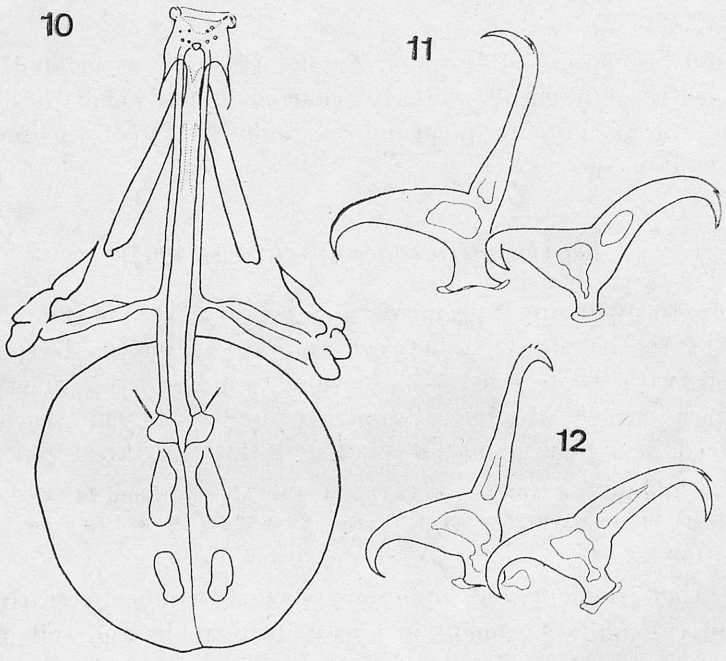
This species was described basing on specimens from Sicily, West Spitsbergen (Locality No. 58) and Australia (BINDA et al., 1980). Recently it was found also in other Norway sites (Dovrefjell, Adegnes: Mr. MEJER, in litt.).

### *Calohybsibius ornatus carpaticus* (BARTOŠ, 1939)

Length up to 160 μm. Four specimens had dorsum with spines being up to 14 μm long (comp. BARTOŠ, 1967: Fig. 3 k and 1); two individuals with small

papillae only (comp. l.c.: Fig. 3 T). On the IVth pair of legs occurred 2—3 tiny papillae (1.5—2.0 μm long; their width at the base 2 μm).

Localities: Atomfjella **57** (2 specimens with papillae); **64** (4 specimens with spines).




Figs. 10—12. *Doryphoribius macrodon* BINDA, PILATO & DASTYCH: 10 — buccal apparatus; 11 — claws of IInd pair of legs; 12 — claws of IVth pair of legs

*C. ornatus carpaticus* (BART.) was found at the height of 100 and 1295 m a.s.l. In Tatra Mts it belongs to the characteristic species for subnival zone (DASTYCH, 1980).

Nominative subspecies *C. o. ornatus* (RICHT.) is cosmopolitan, several times recorded also from Svalbard (West Spitsbergen, Bear Island; MARCUS, 1936).

### *Amphibolus nebulosus* (DASTYCH, 1983)

Length 260—580 μm. This species distinguish itself by areolation between the egg processes (DASTYCH, 1983) and belongs to the "*smreczynskii*-group", recently described as a new genus (BERTOLANI, 1981).

Localities (terra typica): Atomfjella **57** (eggs); **58** (9+eggs); Bünsow Land **73** (1), **75** (1).

Species not frequent and not numerous, probably hydrophilous one. It was found in the lower parts of the island.

*A. nebulosus* (DAST.) has been found lately in another Norway site (Dovrefjell) and in Italia (Mr. MEJER and Dr. BERTOLANI, in litt.).

### *Isohypsibius prosostomus* THULIN, 1928

Length up to 270 μm. Typical specimens (RAMAZZOTTI, 1972). All claws with small lunules.

Localities: Hornsund **12** (4); Oscar II Land **19** (30); Haakon II Land **29** (5); Ny Friesland **40** (5); Atomfjella **46** (10), **54** (107).

Species not frequent but rather numerous, collected in the lower part of the island (8—500 m a.s.l.). Oligocalciphil, but in Tatra Mts belongs to the polycalciphilous species (DASTYCH, 1980 a).

A subcosmopolitan species, already recorded from Svalbard (MARCUS 1936; WĘGLARSKA, 1965).

### *Isohypsibius dastychi* PILATO, BERTOLANI & BINDA, 1982

Length 260—420 μm. Specimens of this species are very similar to *I. marcellinoi* BINDA & PILATO.

Localities: Oscar II Land **19** (1); Atomfjella **60** (1); Bünsow Land **71** (8).

Species rare and not numerous, collected exclusively from carbonate bed-rock (eucalciphil) and at the height up to 400 m a.s.l.

### **Isohypsibius elegans* BINDA & PILATO, 1971 (Figs. 13, 14; Pl. XI c—h)

Length 250—450 μm. Dorsum and legs covered with rather irregular, multiangular granulation (diameter 0.5—1.5 μm). Dorsal protuberances poorly developed. Cuticular swellings at the inner claw bases of I—III pair of legs of characteristic shape (Fig. 14, Pl. XI h). Between the apophyses and the first macroplacoid occur two delicate rods pointed forward (Fig. 13). Variable species.

Localities: Oscar II Land **19** (2); Atomfjella **51** (2), **55** (5), **59** (1); Bünsow Land **70** (2), **71** (1), **73** (2), **74** (2), **75** (6).

Eucalciphil, not numerous and not frequent, collected in the lower parts of the island (1—250 m a.s.l.).

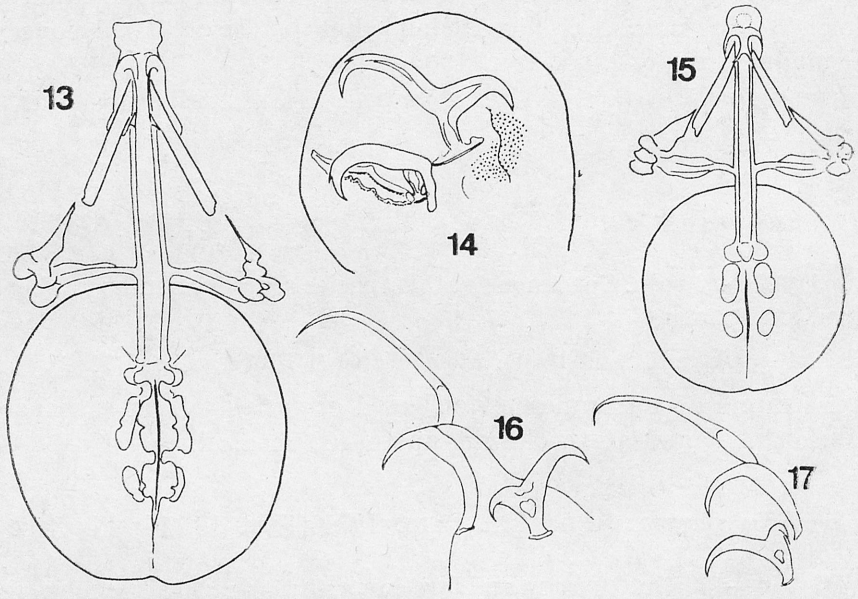
*I. elegans* BINDA & PIL. is known from Italy, Africa, Australia (BINDA & PILATO, 1971; PILATO & SPERLINGA, 1975; PILATO & PENNISI, 1976; PILATO & D'URSO, 1976) and Poland (unpublished).

### **Isohypsibius* ? *granulifer* THULIN, 1982 (Pl. XI a, b)

Length 408 μm. The eyes are big. Dorsum and legs covered with irregular granulation (up to 1.5 μm). Buccal cavity without granulation. Buccal tube 37 μm long, its outer diameter 3 μm. Pharynx spherical (34 μm), with two macroplacoids (Pl. XI a). The first macroplacoid strongly constricted in its middle, 9 μm long; the second one is 4 μm long. Claws large and slender, with

distinctly elongated main branches (Pl. XI b). Very small accessory spines were observed only on the claws of IVth pair of legs. Inner claws with small lunueles (?) at their bases. Length of outer claws of IInd pair of legs 30 μm; claws of IVth pair 38 μm long.

This species is similar to *I. granulifer* THUL., but differs from it distinctly by a little bigger dorsal granulation, placoids shape, longer claws and by lack




Figs. 13—17. *Isohypsibius elegans* BINDA & PILATO: 13 — buccal apparatus; 14 — claws of IInd pair of legs; *Hypsibius cataphractus* MAUCCI: 15 — buccal apparatus; 16, 17 — claws of IVth pair of legs

of granulation in the buccal cavity. Unfortunately only one and not well preserved specimen made impossible accurate determination.

Locality: Haakon VII Land **29** (1).

It was found in the mosses from non-carbonate rock, at the height of 50—70 m a.s.l.

### **Isohypsibius bakonyiensis* (IHAROS, 1964)

Length up to 160 μm. Typical specimens (ARGUE, 1971; PILATO, 1973). Before the redescription of this species (*I. sattleri* RICHTERS = nom. nudum: PILATO, l.c.) it was considered as a subcosmopolitan taxon.

Localities: Albert I Land **22** (2); Atomfjella **51** (3), **52** (1); Bünsow Land **79** (1).

Species rare, collected exclusively from mosses on calcareous rocks, in the lower parts of the island (10—300 m a.s.l.).

### *Hypsibius dujardini* (Doyère, 1840)

Length up to 320 μm. Typical specimens (Ramazzotti, 1972; Argue, 1974).

Localities: Hornsund **14** (18); Ny Friesland **40** (6); Atomfjella **51** (24), **53** (5), **54** (207), **57** (2), **58** (12), **61** (13); Bünsow Land **70** (1), **75** (3).

Species rather frequent and rather numerous. Acalciphil, collected exclusively in the mosses from non-carbonate bed-rock, at the height of 2—500 m a.s.l. It belongs to species found in cryoconites.

A subcosmopolitan species, also recorded from Svalbard (Richters, 1904; Murray, 1907; Węglarska, 1965).

### *Hypsibius convergens* (Urbanowicz, 1925)

Length up to 310 μm. Specimens developed typically (Argue, 1971; Maucci, 1973—1974).

Localities: Hornsund **10** (17); Oscar II Land **19** (4); Albert I Land **20** (1), **22** (12), **23** (7); Andrée Land **30** (18); Ny Friesland **32** (1), **36** (16), **38** (2), **40** (28); Atomfjella **54** (8), **64** (6), **66** (2); Bünsow Land **79** (3).

Species rather frequent and rather numerous, strongly connected with non-carbonate bed-rock (oligocalciphil). It was found in a wide belt between 8 and 1295 m a.s.l.

A subcosmopolitan species, recorded from West Spitsbergen by Węglarska (1965).

### *Hypsibius pallidus* Thulin, 1911

Length up to 190 μm. Typical specimens (Argue, 1971; Maucci, 1973—1974).

Localities: Hornsund **14** (2); Atomfjella **52** (1), **54** (4), **57** (1), **58** (1), **59** (1), **60** (2).

Species not frequent and not numerous, mesocalciphil. It was found in a zone at the height of 80—500 m a.s.l.

A subcosmopolitan species, quoted from West Spitsbergen by Węglarska (1965).

### *Hypsibius oberhaeuseri* (Doyère, 1840)

Length up to 350 μm. Specimens typically developed (Ramazzotti, 1972).

Localities: Hornsund **11** (1); Oscar II Land **17** (1); Albert I Land **22** (3); Haakon VII Land **29** (16); Ny Friesland **39** (1), **43** (1); Atomfjella **45** (2), **46** (29), **52** (4), **58** (1), **59** (28), **63** (14), **64** (1).

Species rather numerous and rather frequent, found at the height of 5—1100 m a.s.l. Mesocalciphil.

A cosmopolitan species, several times recorded from Svalbard (Marcus, 1936; Węglarska, 1965).

### *Hypsibius cataphractus* MAUCCI, 1974 (Figs. 15—19, Pl. XII a—j)

Length 150—440 μm. The body is brown-red or dark-brown. The pigment is arranged in transversal belts. Back of the body with two bright longitudinal strips connected in front of the body, almost at the height of the mouth opening. Cuticle is covered with regular granulation (diameter granules up to 2.0 μm). That granulation is the biggest at the body end, while on the legs granules distinctly smaller. On the dorsal side granules form "pseudoplates", variable in shape and indistinctly marked. Rear of the body without incisions (Kleeblattkerben). The eyes are lacking, the mouth opening is situated ventrally. Buccal apparatus of "*oberhaeuseri*-type" (Fig. 15). Buccal tube 34 μm in length, its outer diameter is 3 μm (dimension in specimen 290 μm long). Pharynx almost spherical (32×30 μm), with large apophyses and two macroplacoids. No microplacoid.

Claws very long, slender, "*oberhaeuseri*-type" (Figs. 16—18, Pl. XII c). The main branches of all claws without accessory spines. The main branches of outer claws very long, "poorly" connected with the remaining part of the claws (Fig. 18, Pl. XII c). The bases of all claws have developed lunules (?), very delicate and scarcely visible. The length of outer claws of IVth pair of

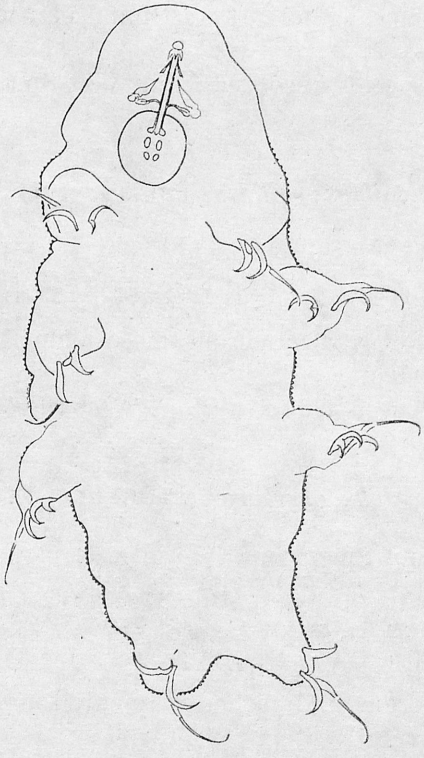


Fig. 18. *Hypsibius cataphractus* MAUCCI: habitus, ventral view

legs 43 μm; main branches 28 μm long, the height of the claw base is 15 μm. These claws are 30 μm long in specimen being 150 μm long; their main branches are 20 μm in length and height of the base is 10 μm.

The eggs are white. Chorion is covered with conical processes, rather unequally distributed and very variable in the number, size and shape (Fig. 19, Pl. XII d, f—j). Processes bases with irregular granulation (Fig. 19 b). Chorion surface between processes smooth, sometimes with granules rarely distributed and

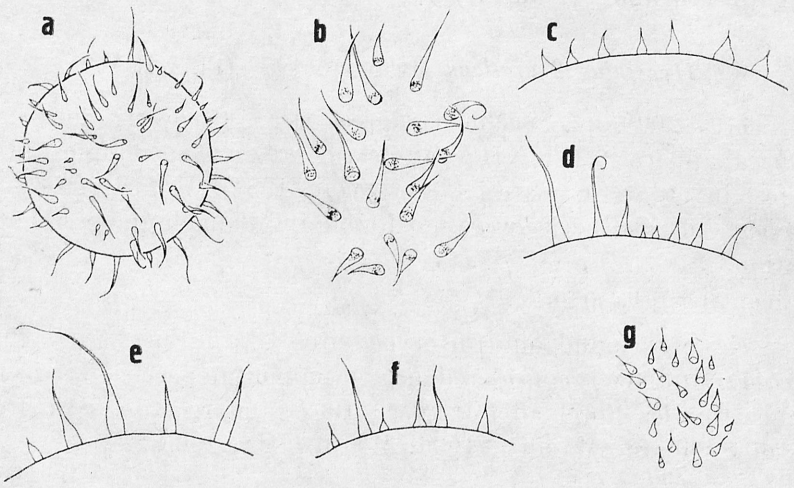



Fig. 19. *Hypsibius cataphractus* MAUCCI: a — egg; b—g — variability of egg processes

irregular in shape. Diameter of eggs without processes 70—82 μm. The height of processes 4—27 μm, the width of their bases 1.0—4.5 μm, usually 2—3 μm. On the circumference of eggs occur 30—82 processes. Two eggs with well developed embryos. The eggs of this species were not known up to date.

*H. cataphractus* MAUCCI belongs to the "*oberhaeuseri*-group" and is most similar to *H. anomalus* RAMAZZOTTI, 1962, especially in the formation of eggs. This species differs distinctly from *H. anomalus* RAMAZZOTTI by the lack of accessory spines on the main branches of the claws, cuticle granulation and dorsal pattern, by longer claws and the first macroplacoid. The eggs of both these species are extremely similar, however in *H. cataphractus* MAUCCI the shape and size of the chorion processes is more variable than at *H. anomalus* RAM.

Investigated specimens differ slightly from two compared paratypes of this species (ex coll. Prof. MAUCCI, CT. 2955, 2956) by underdeveloped "pseudoplates" on the dorsal side (comp. MAUCCI, 1974).

Locality: Bünsow Land **70** (176): in seven samples collected at the height of 2—3 m a.s.l.

*H. cataphractus* MAUCCI was known only from Austria (MAUCCI, 1974).

### *Hypsibius montivagus* DASTYCH, 1983

*Hypsibius* sp.: DASTYCH, 1980

Length up to 320 μm. This species was already recorded from Tatra Mts as *Hypsibius* sp. (l.c.., 1980).

Localities: Wedel Jarlsberg Land **15** (2); Atomfjella **63** (1).

This rare species was found in two samples from non-carbonate rocks, at the height of 700 and 970 m a.s.l.

### *Hypsibius* ? *arcticus* MURRAY, 1907 (Pl. XII k)

Length 110—200 μm. Specimens agree with the description of MARCUS (1936). Buccal apparatus (Pl. XII k) and claws are developed almost in the same way as these in antarctic material (DASTYCH, 1984). Unfortunately the characteristic eggs of this species were not found and it made impossible the exact identification.

Locality: Atomfjella **61** (6).

This species was found only in cryoconites, at the height of 400 m a.s.l.

*H. arcticus* MURRAY is considered as a cosmopolitan species. It was described from Prince Charles Foreland (MURRAY, 1907) and recorded also from other localities of Svalbard (MARCUS, 1936; WĘGLARSKA, 1965).

### **Diphascon conjungens* (THULIN, 1911)

Length up to 180 μm. Specimens agree with the description of THULIN (1911). The part of buccal tube with the striation.

Locality: Atomfjella **65** (2).

*R. conjungens* (THUL.) was found in one sample from non-calcareous rock, at the height of 1300—1400 m a.s.l. In Tatra Mts it belongs to the characteristic species for subnival zone (DASTYCH, 1980a).

This species is very widely distributed and besides Holarctics in known from Neotropical Region and New Zealand (comp. DASTYCH, 1980, HORNING et al., 1978). Lately has been found and described from Antarctic extremely similar species, which differs mainly from *R. conjungens* (THUL.) by different structure of egg chorion (DASTYCH, 1984). In the light of this fact, the known localities of *D. conjungens* (THUL.) in the Southern Hemisphere require a confirmation also by finding and investigating its eggs.

### **Diphascon oculatum* MURRAY, 1906

Length up to 230 μm. The rear of the body with regularly distributed granulation. Specimens typical (THULIN, 1911).

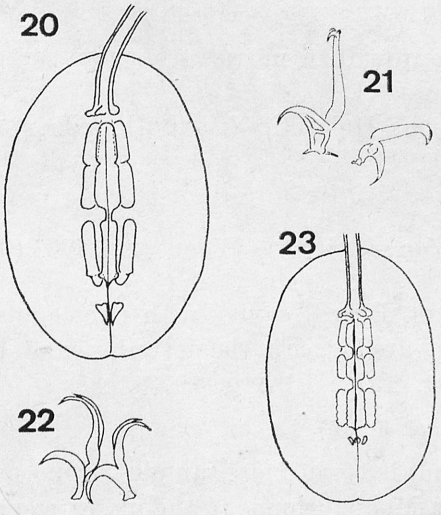
Locality: Atomfjella **66** (4).

It was found in one sample at the height of 1295 m a.s.l. In Tatra Mts *D. oculatum* MURR. belongs to the species characteristic for subnival zone (DASTYCH, 1980 a).

Holarctic species.

***Diphascon recamieri*** RICHTERS, **1911** (Figs. 20, 21; Pl. XIII a—f, i, j)

Length up to 350 μm. Specimens typically developed (MARCUS, 1936; WĘGLARSKA, 1959). The first macroplacoid is 1.2—1.4 times bigger than the second one. Most specimens with well visible tiny thickening in the rear part of the second macroplacoid (Fig. 20, Pl. XIII b, c). Outer claws with thin cuticular swellings at the bases, which are especially well formed on the IVth pair of legs (Fig. 21); main branches with well developed accessory spines. Two




Figs. 20—23. *Diphascon recamieri* RICHTERS: 20 — pharynx; 21 — claws of IVth pair of legs; *Diphascon* sp. nov. (?): 22 — claws of IInd pair of legs; 23 — pharynx

specimens without drop-like structure at the end of mouth tube. Species variable in shape and size of the pharynx and placoids.

Localities: Hornsund **3** (1), **5** (18), **7** (1), **13** (11), **14** (3); Albert I Land **20** (53); Ny Friesland **33** (1), **36** (1), **40** (29), **41** (540); Atomfjella **51** (7), **54** (13), **58** (35), **61** (47), **68** (1); Bünsow Land **73** (3), **75** (8), **79** (1).

Species numerous and rather frequent, strongly associated with non-carbonate bed-rocks (oligocalciphil) and was found at the heigth of 5—1000 m a.s.l. Dominant species in cryoconites.

Besides Holarctics, *D. recamieri* RICHT. is known from the mountains of Neotropical Region (IHAROS, 1963). It was recorded also from West Spitsbergen (MARCUS, 1936; WĘGLARSKA, 1965).

### *Diphascon angustatum* MURRAY, 1905

Length up to 670 μm. Typical specimens (ARGUE, 1971).

Localities: Hornsund **4** (1); Ny Friesland **40** (1); Atomfjella **58** (1); Bünsow Land **71** (1), **73** (1), **78** (1).

Mesocalciphil, not frequent. It was found mostly in the higher parts of the island, at the height up to 500 m a.s.l.

Holarctic species, recorded from West Spitsbergen by MURRAY (1907).

### *Diphascon belgicae* RICHTERS, 1911

Length 310 and 380 μm. Specimens conforming with the description of MARCUS (1936) and PILATO & BINDA (1977).

Localities: Albert I Land **20** (1); Atomfjella **55** (1).

Rare species: it was found in mosses from non-carbonate bed-rock, at the height of 10 and 600 m a.s.l.

*D. belgicae* RICHT. has Holarctic distribution; from West Spitsbergen was quoted by RICHTERS (1911 a).

### *Diphascon spitsbergense* RICHTERS, 1903 (Pl. XIII g, h)

Length 310—600 μm. Buccal cavity with two bands consisted of granules (Pl. XII g, h); these ones are bigger in the posterior band. Other features typically developed (RAMAZZOTTI, 1972; PILATO, 1973).

Locality: Ny Friesland **40** (15).

Rare species, found in two moss-samples from non-carbonate bed-rock (500 m a.s.l.). In Tatra Mts it belongs to the indicate species for acidic habitats (DASTYCH, 1980 a).

Holarctic species, several times mentioned from Svalbard (MARCUS, 1936; WĘGLARSKA, 1965).

### *Diphascon pingue* MARCUS, 1936 (Pl. XIV a)

Length up to 210 μm. Investigated specimens agree well with the description of *Diphascon alpinum* MURRAY, 1906 (sensu PETERSEN, 1951). Great systematic obscurities within the "*alpinum*-group" and suggestions of PILATO and BINDA (1977) are the reasons why mentioned specimens are determined as *D. pingue* (MARCUS) (comp. also DASTYCH, in print).

Localities: Hornsund **14** (3); Oscar II Land **18** (11); Albert I Land **22** (11); Atomfjella **46** (1), **65** (1), **66** (4).

Species not numerous and not frequent, collected exclusively in the mosses

from non-carbonate bed-rock (acalciphil). It occurred in a wide belt between 10 and 1400 m a.s.l., but was more frequent in the higher parts of the mountains.

*D. pingue* (MARCUS) is considered as a cosmopolitan species and several times was mentioned from Svalbard (MARCUS, 1936; WĘGLARSKA, 1965: as *D. alpinum* MURR.).

### *Diphascon scoticum* MURRAY, 1905

Length up to 420 μm. Typical specimens, conforming with redescription of PILATO (1974) a.

Localities: Hornsund **14** (1); Albert I Land **20** (7), **22** (1); Atomfjella **62** (2); Bünsow Land **76** (2).

Species not numerous and not frequent; mesocalciphil. It occurred at the height up to 600 m a.s.l.

Cosmopolitan species, known also from Svalbard (MARCUS, 1936; WĘGLARSKA, 1965).

### *Diphascon tenue* THULIN, 1928 (Pl. XIV e, f)

Length 140—200 μm (231 μm: in parentheses holotype dimensions are given, after THULIN, 1928). Mouth opening situated ventrally; small but distinct drop-shaped structure occurs between mouth tube and pharyngeal one. Apophyses very small, scarcely visible (Pl. XIV e, f). Pharynx is 18—24 μm long (21.6 μm) and 12—17 μm wide i.e. 66—77 *cph* (15.2 μm; 70 *cph*). Placoids row is shorter than a half of the pharynx length and amounts to 8.2—10.5 μm, i.e. 43.1—44.7 *cph* (9.7 μm; 45 *cph*). The first macroplacoid is 2 μm long = 9.1—11.1 *cph* (2.3 μm; 1.1 *cph*), the second one 2.2—2.5 μm=10.4—12.2 *cph* (2.7 μm; 12.5 *cph*); legth of the IIIrd macroplacoid is 3.2—4.0 μm i.e. 15.6—20.0 *cph* (3.6 μm; 16.8 *cph*). The mouth tube is 11.0—12.5 μm long, measured from mouth opening to stylet support, i.e. 55.0—61.5 *cph* (12.3 μm; 57 *cph*); the pharyngeal tube is 34—51 μm in length i.e. 175—231 *cph* (36.7 μm; 170 *cph*), measured from stylet support to apophyses. Outer diameter of the buccal tube is 1.0—1.2 μm = 4.5—5.5 *cph* (1.1 μm; 5.2 *cph*). Length of the leg claws of IVth pair 6—8 μm (6.7 μm). No cuticular bars near the bases of inner claws of I—III pair of legs and between the claws of the IVth ones.

Investigated specimens differ from original description (THULIN, 1928) by occurrence of the drop-shaped thickening, i.e. by the feature which has been recently accepted as the important one in the systematics of this genus (WĘGLARSKA, 1959; PILATO, 1975). This feature for *D. tenue* THUL. has been recorded lately by DURANTE PASA and MAUCCI (1979), though one cannot state at present hetter this structure really occurred in the type-material of THULIN (PILATO, in itt.). Specimens from West Spitsbergen completely agree with the description of mentioned authors (l.c., 1979).

Localities: Hornsund **2** (1), **10** (1), **14** (13); Ny Friesland **38** (1); Atomfjella **65** (2), **66** (26).

Species not numerous and not frequent, mesocalciphil. It occurred in the coastal tundra and in the highest part of the mountains (10—1400 m a.s.l.), but was more frequent in the highest parts of the island.

*D. tenue* THUL. is known from Faröer (THULIN, 1928), Carpathians (RUDESCU, 1964), Scandinavia (DURANTE PASA and MAUCCI, 1979) and West Spitsbergen (WĘGLARSKA, 1965).

### **Diphascon arduifrons* THULIN, 1928 (Pl. XIV b, c)

Length 118—170 μm (284 μm*). Mouth opening situated ventrally; no drop-shaped thickening between mouth- and pharyngeal tube. Placoid row is longer than a half of the pharynx length. Length of the pharynx 16—22 μm (39.9 μm), its width 10.5—14.0 μm, 63,1—65.0 *cph* (19.7 μm; 55 *cph*). Placoids row length 9—14 μm, 56.2—66.6 *cph* (19.7 μm; 55 *cph*). Apophyses very small, scarcely visible (Pl. XIV b, c). The first macroplacoid 2—3 μm, 10.—13.6 *cph* long (4.9 μm; 13.7 *cph*), the second one 2.2—3.0 μm, 11.5—18.7 *cph* (5.3 μm; 14.8 *cph*). The third macroplacoid is 4—6 μm, 25.0—27.5 *cph* in length (8.0 μm; 22.5 *cph*). The mouth tube length to the stylets support is 8—12 μm, 47.3—55.0 *cph* (16.1 μm; 45 *cph*); the pharyngeal tube length, measured to the apophyses, amounts to 28—36 μm, 147—175 *cph* (35,5 μm; 99 *cph*). Outer diameter of the buccal tube 1.0—1.2 μm, 5.4—6.3 *cph* (1.6 μm; 4.7 *cph*). Claws of the IVth pair of legs are 5.0—7.5 μm in length (12.8 μm). No cuticular bars near the bases of inner claws of the I—III pair of legs and between the claws of the IVth pair.

This species is very similar to *D. tenue* THUL., but differs by lack of drop-shaped structure, longer placoid row and by more elongated pharynx (comp. Pl. XIV b, c and e, f). On the other hand, from *D. prosirostre* THUL., 1928 it differs by distinctly narrower buccal tube, longer placoid row and claws and by shorter mouth tube.

Investigated individuals agree with description of *D. arduifrons* THUL. published by PILATO (1975), but they differ a little in comparison with the holotype (THULIN, 1928), having more rounded pharynx, longer placoid row, a little longer mouth tube and pharyngeal one and longer claws in regard to the pharynx length. All these differences maybe result from unlike body dimension of the holotype (284 μm — comp. THULIN, l.c.) and compared specimens. However, in the author's opinion these specimens one can determine as *D. arduifrons* THUL., what also was confirmed by PILATO (in litt.).

Localities: Hornsund **3** (1); Ny Friesland **31** (1); Atomfjella **56** (3); Bünsow Land **79** (3).

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* Holotype length. *Cph* in parentheses were calculated on the bases of holotype dimensions given by THULIN (1928).

Rare species, collected in the mosses from calcareous rock 5—300 m a.s.l. *Diphascon arduifrons* is known from Scandinavia, Siberia (THULIN, 1928), Middle Europe, Italy (BARTOŠ, 1967), Austria (MAUCCI, 1974) and Iceland (MORGAN, 1980).

### **Diphascon* spec. nov. (?) (Pl. XIV d, g)

Length 310 μm. The eyes are lacking. Dorsum covered with very tiny, densely and regularly distributed granulation. The granules irregular in shape, about 0.5 μm in size. Buccal tube without drop-shaped thickening and is 70 μm long; its outer diameter 2.0 μm. Pharynx oval (38×28 μm), with large apophyses, three macroplacoids and a small microplacoid (Fig. 23, Pl. XIV d). The first macroplacoid 4 μm, the second one 3 μm, the third macroplacoid is 6 μm in length. The last macroplacoid w th delicately curled outer edges. Microplacoid is 1.5 μm long. Macroplacoids w dth 2.0 μm. Claws slender, with narrow bases (Fig. 22, Pl. XIV g). Accessory spines on the main branches are poorly developed. No culticular bars at the inner claws of the I—III pair of legs. Outer claw length of IIIrd pair of legs 16 μm; inner ones are 12 μm long.

A combination of features shows that this specimen which was only found belong most probably to a new species. However, its very poorly visible (rolled up) claws of the IVth pair of legs do not permit any description.

Locality: Albert I Land **22** (1); in moss-sample from calcareous rock (10 m a.s.l.).

### *Milnesium tardigradum* DOYÈRE, 1840

Length up to 1030 μm. Typical specimens (RAMAZZOTTI, 1972).

Localities: Hornsund **8** (18), **12** (8), **14** (2); Wedel Jarlsberg Land **15** (1); Oscar II Land **17** (1); Haakon VII Land **28** (1), **29** (48); Ny Friesland **34** (1), **40** (1); Atomfjella **48** (3), **49** (1), **50** (34), **52** (1), **59** (153), **60** (62), **63** (30) **64** (7), **65** (6), **68** (15), **69** (2); Bünsow Land **70** [147], **78** (2).

Species rather numerous and frequent; mesocalciphil, but more frequent in mosses from calcareous bed-rock. Widely distributed, both in the coastal tundra and in the mountains (2—1600 m a.s.l.), however, the optimum of its occurrence lies in the higher or the highest parts of the island.

Cosmopolitan species, also recorded from West Spitsbergen (MARCUS, 1936; WĘGLARSKA, 1965).

## IV. ECOLOGICAL REMARKS

Our knowledge about the biology and ecology of water-bears is still very poor, therefore it seems advisable to exploit each material which can contribute to widening of the knowledge of these problems. In spite of the fact that the

material for this work was collected mainly for the purpose of faunistic elaboration, it permitted also to trace the influence exerted on Tardigrade fauna by the type of rocky substrate and the height above sea level.

## 1. Type of bed-rock

The geological structure of Svalbard is exceptionally complicated because of the rocks belonging to almost all geological formations. Over one half of the areas of this archipelago is covered by glaciers and perennial snows, the rest consists of rocky wilderness covered by tundra. Water-bears are a rather significant component of these ecosystems, occurring mainly in mosses and lichens. The composition of the tundra vegetation depends among other on the type of bed-rock, hence it can be supposed that it influences also the Tardigrade fauna.

Little is known so far about the relation between the kind of rocky substrate and the differentiation of Tardigrade fauna, except for the preliminary studies of this problem in Tatra Mts (DASTYCH, 1980 a). In Tatra I stated that there were distinct differences in the number and species composition depending on the fact whether the material originated from carbonate rocks (with alcaline reaction, i.e. from limestones, dolomites, marls), or from non-carbonate rocks (i.e. with acidic or neutral reaction: granites, quartzites, crystalline schists etc.).

The analysis of this problem in relation to water-bears of West Spitsbergen was carried out on the basis of 228 samples, 111 of them originated from non-carbonate bed-rock and 117 from carbonate one. These samples constituted in sum almost one half of the whole material collected. The indicated species and some coefficients characterizing them, i.e. their occurrence in samples, the number of specimens, the frequency (*C*) and individual dominance (*D*) on the two compared bed-rock types are shown in Tables II, IV and Fig. 25.

Depending on the degree of the attachment of the particular species to the investigated type of bed-rock in West Spitsbergen, 5 species groups were distinguished and they were divided into 6 classes (I—VI). This gathering was done on the base of *C* index value (Tables II, V; Fig. 24);

Table IV

The number of *Tardigrada* individuals per sample on carbonate and non-carbonate bed-rock (in %)

| The number of specimens per sample | 1 | 2—5 | 6—10 | 11—20 | 21—50 | 51—100 | 101—200 | 201—400 | 401—800 |
|---|---|---|---|---|---|---|---|---|---|
| Non-carbonate rocks | 4.0 | 15.0 | 3.0 | 3.0 | 3.0 | 1.0 | 2.0 | — | — |
| Carbonate rocks | 9.0 | 14.0 | 10.0 | 14.0 | 5.0 | 7.0 | 7.0 | 2.0 | 1.0 |

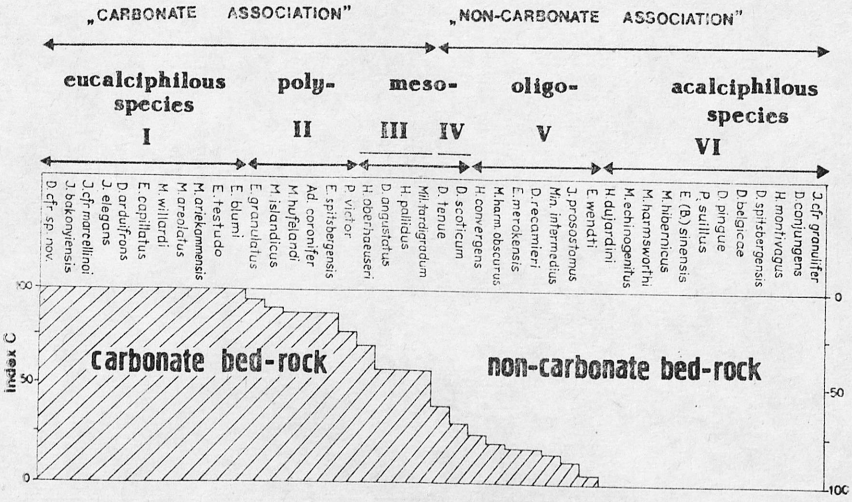


Fig. 24. The relation between *Tardigrada* species and the type of bed-rock

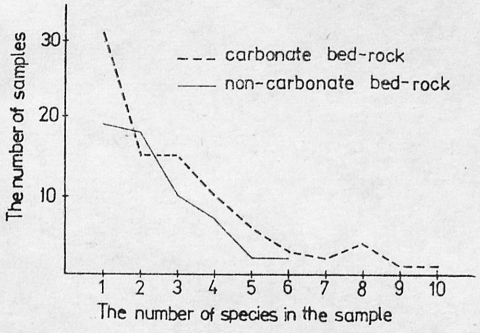


Fig. 25. The number of *Tardigrada* species in the samples on different type of bed-rock

1. Eucalciphilous species (class I; *C* index value for carbonate rocks =100%, for non-carbonate ones =0). The species of this group were found exclusively on calcareous (carbonate) rocks. They are: *Macrobiotus willardi* PILATO, *M. ariekammensis* WĘGLARSKA, *M. areolatus* MURRAY, *Echiniscus* (*E.*) *blumi* RICHTERS, *E.* (*E.*) *testudo* (DOYÈRE), *E.* (*E.*) *capillatus* RAMAZZOTTI, *Diphascon arduifrons* THULIN, *Isohypsibius elegans* BINDA and PILATO, *I. bakonyiensis* (IHAROS), *I. dastychi* PILATO, BERTOLANI & BINDA as well as *Diphascon* sp. nov. (?).
2. Polycalciphilous species (class II; *C* index value for carbonate rocks 75.1—99.9%, for non-carbonate 0.1—25.0%). This group shows a very great attachment to carbonate rocks and it comprises: *Echiniscus* (*E.*) *spitsbergensis* SCOURFIELD, *Macrobiotus islandicus* RICHTERS, *Echiniscus* (*E.*) *granulatus* (DOYÈRE), *Adorybiotus coronifer* (RICHTERS), *Pseudechiniscus victor* (EHRENBERG), *Macrobiotus hufelandi* SCHULTZE.
3. Mesocalciphilous species (classes III and IV). It comprises species

Table V.

The groups of *Tardigrada* species distinguished on the ground of their relation to the kind of bed-rock (indices *C*, *D* on the left side refers to carbonate bed-rock, on the right to non-carbonate one. The corresponding species group distinguished in Tatra Mts (DASTYCH, 1980a) is given in the brackets

| Eucalciphilous species | Polycalciphilous species | Mesocalciphilous species | | Oligocalciphilous species | Acalciphilous species |
|---|---|---|---|---|---|
| I | II | III | IV | V | VI |
| $C_4D_3$ *M. willardi*<br>$C_3D_3$ *M. ariekammensis*<br>$C_2D_5$ *M. areolatus* (III)<br>$C_2D_5$ *E. blumi* (VI)<br>$C_2D_3$ *E. testudo*<br>$C_2D_1$ *E. capillatus* (I)<br>$C_2D_1$ *D. arduifrons*<br>$C_1D_1$ *I. elegans*<br>$C_1D_1$ *I. bakonyiensis* (II)<br>$C_1D_1$ *I. dastychi*<br>$C_1D_1$ *D.* sp. nov. (?) | $C_5D_4$ *E. spitsbergensis* $C_2D_3$ (II)<br>$C_5D_4$ *M. islandicus* $C_2D_2$<br>$C_4D_5$ *E. granulatus* $C_1D_1$ (I)<br>$C_4D_5$ *Ad. coronifer* $C_2D_5$ (I)<br>$C_4D_4$ *Ps. victor* $C_2D_2$ (III)<br>$C_3D_5$ *M. hufelandi* $C_1D_1$ (IV) | $C_4D_4$ *Mil. tardigradum* $C_3D_1$ (III)<br>$C_3D_1$ *H. oberhaeuseri* $C_2D_3$ (II)<br>$C_1D_1$ *D. angustatus* $C_1D_1$ (VI)<br>$C_1D_1$ *H. pallidus* $C_1D_1$ (IV) | $C_1D_1$ *D. scoticum* $C_2D_2$ (V)<br>$C_1D_1$ *D. tenue* $C_1D_1$ | $C_1D_1$ *E. wendti* $C_4D_5$ (VI)<br>$C_1D_1$ *I. prosostomus* $C_4D_5$ (II)<br>$C_1D_1$ *D. recamieri* $C_4D_5$ (VI)<br>$C_1D_1$ *Min. intermedius* $C_3D_4$ (III)<br>$C_2D_1$ *M. h. obscurus* $C_4D_4$<br>$C_2D_1$ *H. convergens* $C_3D_3$ (II) | *H. dujardini* $C_4D_5$ (IV)<br>*M. h. harmsworthi* $C_4D_4$ (II)<br>*M. echinogenitus* $C_3D_3$ (V)<br>*D. spitsbergense* $C_2D_2$ (VI)<br>*D. pingue* $C_2D_1$ (IV)<br>*H. montivagus* $C_1D_1$ (VI)<br>*D. conjungens* $C_1D_1$ (VI)<br>*D. belgicae* $C_1D_1$ (VI)<br>*M. hibernicus* $C_1D_1$ (V)<br>*Ps. suillus* $C_1D_1$ (II)<br>*I.* ? *granulifer* $C_1D_1$ |
| ← "carbonate association" → | | | | ← "non-carbonate association" → | |

characterized by great flexibility regarding the investigated factor and they occur both on carbonate and non-carbonate rocks. However, they can be divided into two subgroups. The first subgroup (class III, *C* index for carbonate rocks amounts to 50.1—75.0%; for non-carbonate 25.1—50.0%) comprises species which are slightly more frequent on carbonate rocks and they are: *Milnesium tardigradum* DOYÈRE, *Hypsibius oberhaeuseri* (DOYÈRE), *Diphascon angustatum* MURRAY and *H. pallidus* THULIN. The second subgroup (class IV; *C* index value for carbonate rocks ranges from 25.1 to 50.0%; for non-carbonate: 50.1—75.0%) comprises species which are slightly more frequent on non-carbonate rocks, i.e. *Diphascon scoticum* MURRAY and *D. tenue* THULIN.

4. Oligocalciphilous species (class V; *C* index for carbonate rocks: 0.1—25.0%, for non-carbonate 75.1—99.9%). This species group comprises representatives with a very strong attachment to non-carbonate rocks, in comparison with carbonate ones. They are: *Echiniscus* (*E.*) *wendti Richters, Isohypsibius prosostomus* THULIN, *Diphascon recamieri* RICHTERS, *Minibiotus intermedius* (PLATE), *M. harmsworthi obscurus* ssp. anov. and *Hypsibius convergens* (URBANOWICZ).

5. Acalciphilous species (class VI; *C* index for carbonate rocks =0, for non-carbonate =100%). The species of this group, in contrast to eucalciphils occurred exclusively on non-carbonate (non-calcareous) rocks i.e. with acidic or neutral reaction. Here belong: *Hypsibius dujardini* (DOYÈRE), *Macrobiotus harmsworthi harmsworthi* MURRAY, *M. echinogenitus* RICHTERS, *Diphascon spitsbergense* RICHTERS, *D. belgicae* RICHTERS, *D. pingue* (MARCUS), *H. montivagus* DASTYCH, *D. conjungens* (THULIN), *M. hibernicus* MURRAY, *Pseudechiniscus suillus* (EHRENBERG) and *Isohypsibius ?granulifer* THULIN.

Thus on the basis of the above division, in West Spitsbergen two greater, distinctly different groups of water-bears can be distinguished which are attached to a definite type of rocky substrate. One of these groups can be called "carbonate association" which comprises species counted to classes I—III and occurring on rocks with alkaline reaction (limestones, dolomites etc.), the second group can be called "non-carbonate association" with classes IV—VI and its species were found on rocks with acidic or neutral reactions, e.g. on granites, quartzites, etc. (Table V, Fig. 24).

The above mentioned "associations" are similar to those described recently in Tatra Mts (DASTYCH, 1980 a), and *Tardigrada* species common for the two areas behave also very similarly in reaction to the discussed factor. This is proved by the comparison of the species composition and the distinguished groups and classes in West Spitsbergen and Tatra Mts (Table V). It is remarkable that *Echiniscus* (*E.*) *spitsbergensis* SCOURFIELD, *E.* (*E.*) *granulatus* (DOYÈRE), *Adorybiotus coronifer* (RICHTERS) and *E.* (*E.*) *capillatus* RAMAZZOTTI play an important role in both compared "carbonate associations" from Tatra Mts and West Spitsbergen, while *E.* (*E.*) *wendti* RICHTERS, *Diphascon recamieri* RICHTERS and *M. echinogenitus* RICHTERS are important in the "non-carbonate

associations". However, in Tatra Mts *E.* (*E.*) *blumi* RICHTERS was counted to a quite different group i.e. to calciphilous species (class VI), while in this arctic area, it was defined as eucalciphil (class I). Some differences occur also when we compare both "non-carbonate associations", since some acalciphilous species (class VI) in West Spitsbergen, e. g. *M. harmsworthi harmsworthi* MURRAY, *Pseudechiniscus suillus* (EHRENBERG) or oligocalciphilous ones (class V), e.g. *Hypsibius convergens* (URBANOWICZ) and *Isohypsibius prosostomus* THULIN are in Tatra Mts regarded as polycalciphilous species (class II). These differences, as some other less important ones, can follow from different conditions dominating in these distant areas. and in case of the most rare species they might be influenced also by a too small number of samples.

It is worthy noting that the "carbonate association" is richer in water-bears than the "non-carbonate" one. In spite of the fact that in both compared groups the same number of species was found (21), some distinct differences occur in higher percentage of positive samples of *Tardigrada* (TPS) on carbonate rocks (75.2%) than on the non-carbonate ones (52.2%), in greater number of species and specimens collected in the particular samples (Fig. 25, Table IV) and also in greater quantity. It amounts to 27982 specimens/m² on carbonate bed-rock, while on the non-carbonate one it is much lower (10477 per m²).

It is obvious that the "carbonate" or "non-carbonate" character of particular water-bears species is influenced by several presently unknown factors whose importance for these animals may only be guessed. The factor may be for example the usually different temperature of the two different rock groups, a different chemical composition and reaction (pH) of the constituing minerals, or a different composition of vegetation which supplies food for at least the majority of water-bears. Nevertheless, the above presented division shows distinctly the differentiation of the investigated fauna depending on the influence of that factor, and in many cases it can well explain the composition of *Tardigrada* species.

## 2. Altitude above sea level

The relative heights of the mountains of West Spitsbergen are most frequently comparatively high and this impression is additionally increased by the vicinity of the sea and the diversified coastal line. Numerous mountain groups of this island exceed the height of 1000 m above sea level, and two of the highest summits: Newtontoppen and Perriertoppen exceed even the height of 1700 m.

The altitude above sea level is a factor which plays a decisive role in the formation of flora and fauna. Its significance for *Tardigrada* is still poorly known, though, as it has been shown, it influences the species composition in the mountains lying below the Polar Circle (RODRIGUEZ-RODA, 1952; RAMAZZOTTI, 1956 b; BERTRAND, 1975; DASTYCH, 1980 a). So far, the influence of this factor on water-bears was completely unknown in the Arctic mountains which are characterized by a considerably more severe climate.

The investigated material (samples) was divided into 5 groups corresponding to the gradually higher and higher situated zones. They cover the following altitude belts which have been arbitrarily distinguished because of the different number of samples collected in these zones:
a) 0—100 m a.s.l.; b) 101—300 m; c) 301—700 m; d) 701—1100 m; e) 1101—1600 m a.s.l.

The characteristic of Tardigrade fauna of the particular zones is presented in Table I, III, VI, VII and Figs. 26, 27. It must be stressed that the obtained results are certainly influences by the different number of collected samples which is particularly small in the highest parts. Nevertheless the material permits to draw some conclusions:

Table VI

The number of *Tardigrada* specimens per sample in distinguished altitude zones (in %)

| Altitude zones | The number of specimens per sample | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2—5 | 6—10 | 11—20 | 21—50 | 51—100 | 101—200 | 201—400 | 401—800 |
| 0—100 m | 18.0 | 26.2 | 17.0 | 17.0 | 11.8 | 3.6 | 4.6 | 1.0 | 0.5 |
| 101—300 m | 12.5 | 14.7 | 11.3 | 20.4 | 25.0 | 4.5 | 6.8 | 2.3 | 2.3 |
| 301—700 m | 12.0 | 30.0 | 10.0 | 20.0 | 24.0 | — | 4.0 | — | — |
| 701—1100 m | — | 17.6 | 23.5 | 29.4 | 17.6 | 5.8 | 5.8 | — | — |
| 1101—1600 m | 18.9 | 37.8 | 13.5 | 16.2 | 10.8 | 2.7 | — | — | — |

Table VII

The number of *Tardigrada* species per sample in distinguished altitude zones (in %)

| Altitude zones in m a. s. l. | The number of species per sample | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 0—100 m | 39.1 | 26.8 | 17.0 | 8.2 | 3.6 | 3.1 | 2.1 | — | — | — |
| 101—300 m | 23.9 | 19.3 | 21.6 | 14.8 | 5.7 | 5.7 | 3.4 | 4.5 | — | 1.1 |
| 301—700 m | 40.0 | 22.0 | 22.0 | 8.0 | 4.0 | 2.0 | — | — | 2.0 | |
| 701—1100 m | 23.5 | 29.4 | 23.5 | 11.7 | — | 11.7 | — | — | — | — |
| 1101—1600 m | 43.1 | 35.1 | 13.5 | 8.1 | — | — | — | — | — | — |

The number of water-bears decreases distinctly with the increase of the height above sea level; from 40 species in the lowest parts of the island to 15 species in the upper parts of the highest summits. Over 700 m a.s.l. the number decreases by about one half (Table III; Fig. 26). For comparison, in Tatra Mts such significant drop of the species number takes place first at the height of 2200 to 2300 m a.s.l., i.e. at the border of the alpine and the subnival zone (DASTYCH, 1980 a). The height differences are understandable because of the different latitude of the two areas.

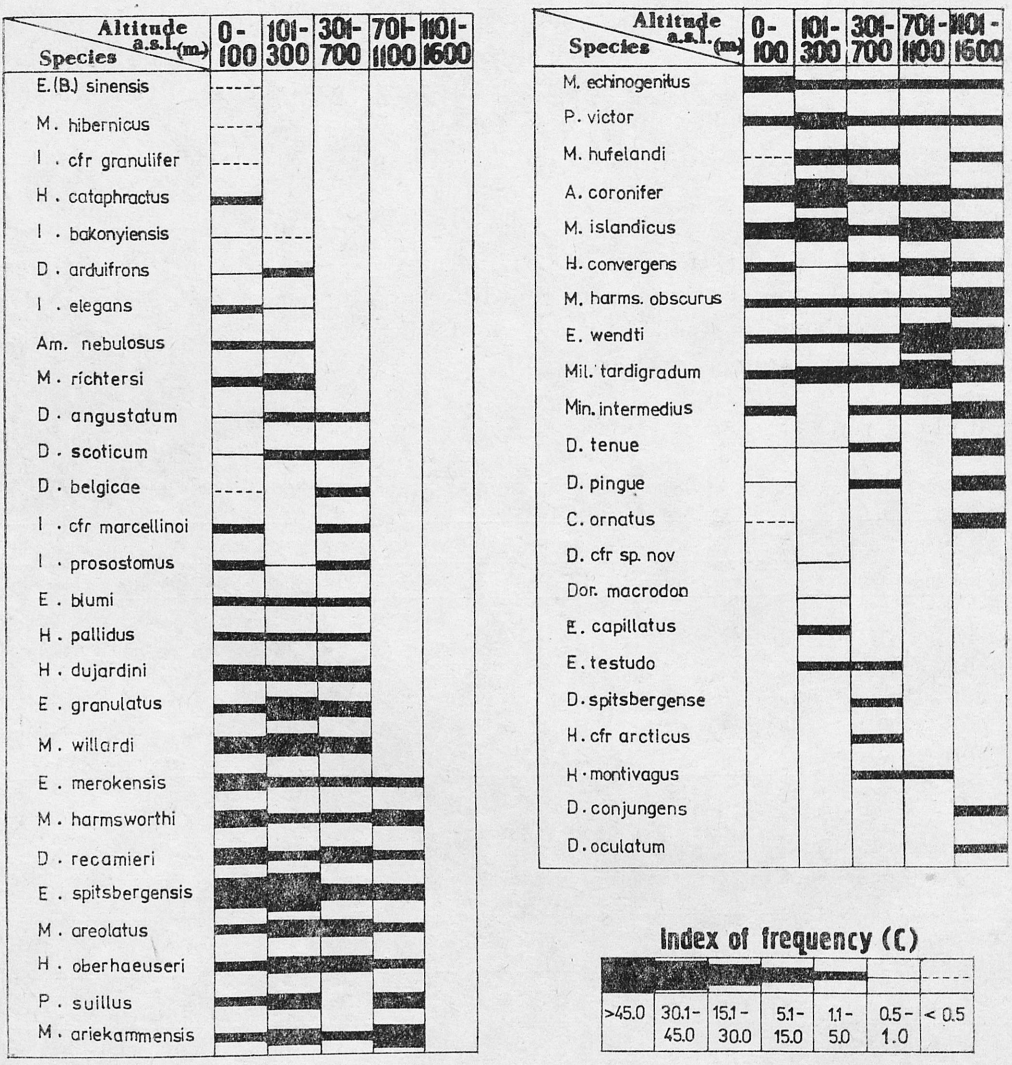


Fig. 26. Distribution of *Tardigrada* species in distinguished altitude zones of West Spitsbergen (*C*= frequency in samples)

The increase of the height influences negatively also the quantity of water-bears. It significantly decreases when 700 m a.s.l. are exceeded (Table III) and in the highest zone it amounts to 6606 specimens per m². In Tatra Mts such drop of *Tardigrada* quantity in the relation to the highest parts of the mountains was not found (l.c.). In West Spitsbergen these animals occur most numerously in the belt from 100 to 300 m a.s.l. (nearly 40000 specimens/m²), in contrast to the belts directly neighbouring with this zone where the number amounts to about 24000 specimens per m² (Table III). The distribution of the number of specimens and species in the investigated samples is shown in Tables VI, VII and Fig. 27.

Remarkable is the comparatively high percentage of positive *Tardigrada* samples (TPS) in all investigated zones and in the highest parts of mountains as well (about 75% — comp. Table III).

Among the five distinguished zones a great similarity of Tardigrade fauna* (Fig. 27) is shown by three zones situated at the lowest level, i.e. from 0 to 700 m a.s.l. On the other side, distinctly smaller is their similarity to the higher zones, particularly to the zone from 1100 to 1600 m a.s.l.

The found species of *Tardigrada* can be divided into three groups taking into account only their vertical reaches. The groups are the following (Fig. 26):

I. Species occurring in the range from sea level to the highest summits of West

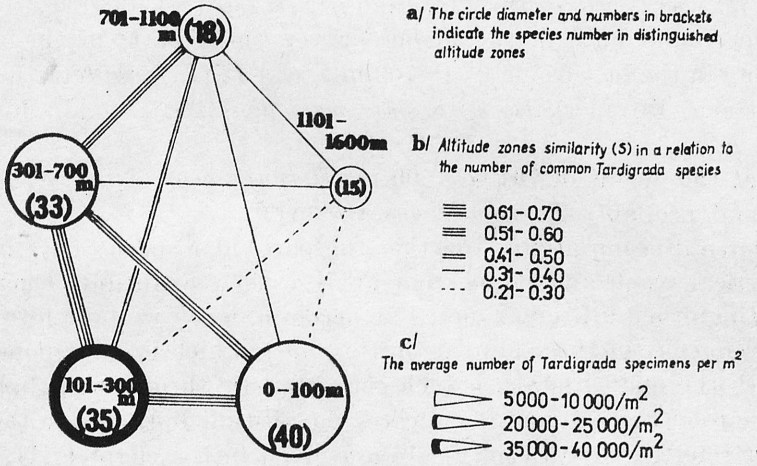


Fig. 27. The altitude zones distinguished in West Spitsbergen and some characteristics of their Tardigrade fauna

Spitsbergen. Here belong: *Macrobiotus hufelandi* SCHULTZE, *M. echinogenitus* RICHTERS, *M. islandicus* RICHTERS, *Minibiotus intermedius* (PLATE), *M. harmsworthi obscurus* ssp. nov., *Adorybiotus coronifer* (RICHTERS), *Hypsibius convergens* (URBANOWICZ), *Diphascon tenue* THULIN, *R. pingue* (MARCUS), *Milnesium tardigradum* DOYÈRE, *Echiniscus* (*E.*) *wendti* RICHTERS, *Pseudechiniscus victor* (EHRENBERG) and, as I believe, *Calohypsibius ornatus* (RICHTERS).

II. Species which are characteristic for smaller vertical reaches, whereas for some of them the altitude can be an essential factor limiting their distribution. Several smaller subgroups can be distinguished here according to their vertical distribution:

a) occurring from 0 to 100 m a.s.l. They are: *Echiniscus* (*B.*) *sinensis* PILATO, *M. hibernicus* MURRAY, *Isohypsibius* ? *granulifer* THULIN and *H. cataphractus* MAUCCI;

* This similarity refers to the number of species co-occurring in the particular zones and it was calculated according to the formula of MARCZEWSKI and STEINHAUS $S = \frac{w}{a+b-w}$ which is modification of JACCARD's one (ROMANISZYN, 1970).

b) found in the belt from 0 to 300 m. Here belong: *M. richtersi* MURRAY, I. *bakonyiensis* (IHAROS), *I. elegans* BINDA and PILATO, *Amphibolus nebulosus* (DASTYCH) and *D. arduifrons* THULIN;
c) found in the belt from 0 to 700 m: *E.* (*E.*) *granulatus* (DOYÈRE), *E.* (*E.*) *blumi* RICHTERS, *M. willardi* PILATO, *I. prosostomus* THULIN, *I. dastychi* PILATO et al., *H. dujardini* (DOYÈRE), *H. pallidus* THULIN, *D. angustatum* MURRAY, *D. scoticum* MURRAY and *D. belgicae* RICHTERS;
d) found in a wide zone from 0 to 1100 m a.s.l. They are: *E.* (*E.*) *spitsbergensis* SCOURFIELD, *E.* (*E.*) *merokensis* RICHTERS, *P. suillus* (EHRENBERG), *M. ariekammensis* WĘGLARSKA, *M. areolatus* MURRAY, *M. harmsworthi harmsworthi* MURRAY, *H. oberhaeuseri* (DOYÈRE) and *D. recamieri* RICHTERS.
III. Species found only in the higher or very high parts of the mountains:
a) occurring in the belt from 101 to 700 m a.s.l.: *E.* (*E.*) *capillatus* RAMAZZOTTI, *E.* (*E.*) *testudo* (DOYÈRE), *Doryphoribius macrodon* BINDA et al., *H.* ? *arcticus* MURRAY;
b) found at the height of 701 to 1600 m: *D. conjungens* (THULIN), *D. oculatum* MURRAY and probably *H. montivagus* DASTYCH.

The above division groups together the particular species only in reference to the vertical reach and it does not analyze their quantitative participation in the distinguished altitude zones. Furthermore, when we take into consideration the frequency of these animals in the zones which is correspondingly connected with the quantity*, then such characteristic throws some light on their biocoenotic role (Fig. 26) and it indicates the altitude optimum in their vertical reach. Not referring to all ecological data given in the chapter III, it is noteworthy that an absolutely dominating species, i.e. the most frequent and the most numerous in the lowest parts of West Spitsbergen was *Echiniscus* (*E.*) *spitsbergensis* SCOURFIELD. Its participation in the investigated fauna decreased distinctly together with the increase of the altitude, but it was not found in the highest parts of the mountains (Fig. 26). *Macrobiotus willardi* PILATO and *E.* (*E.*) *granulatus* (DOYÈRE) are a little similar species in this respect. On the other hand, to the species whose altitude optimum seems to lie in the slightly higher parts of the mountain belong *Ad. coronifer* (RICHTERS), *M. islandicus* RICHTERS, *M. areolatus* MURRAY, *M. ariekammensis* WĘGLARSKA and perhaps *Hypsibius montivagus* DASTYCH.

An interesting group are species which dominate in the highest parts of the mountains and which, as it may be believed, have found there the most favourable conditions. Among them *M. harmsworthi obscurus* ssp. nov. is notable as a taxon dominating in the highest parts, and *E.* (*E.*) *wendti* RICHTERS and *Mil. tardigradum* DOYÈRE are similar in this respect. This group comprises also *Calohypsibius ornatus* (RICHTERS), *Diphascon pingue* (MARCUS), *D. tenue* THULIN and *Min. intermedius* (PLATE). On the other hand, species which were

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* Species which occur more frequently were usually also more numerous (comp. Table VIII).

Table VIII

Frequency and dominance of particular *Tardigrada* species in the investigated material from West Spitsbergen (*C*, *D* — index of frequency and dominance)

| Species | very frequent $C>20.0$ | frequent $C=10.1—20.0$ | rather frequent $C=5.1—10.0$ | not frequent $C=1.1—5.0$ | rare $C<1.0$ |
|---|---|---|---|---|---|
| very numerous $D>10.0$ | *E. spitsbergensis* | | | | |
| numerous $D=5.1—10.0$ | | | *M. hufelandi*<br>*Ad. coronifer*<br>*D. recamieri* | *E. blumi* | |
| rather numerous $D=1.1—5.0$ | | *M. willardi*<br>*M. islandicus*<br>*Mil. tardigradum* | *E. wendti*<br>*E. granulatus*<br>*M. h. harmsworthi*<br>*M. h. obscurus*<br>*H. dujardini*<br>*H. convergens*<br>*H. oberhaeuseri* | *E. testudo*<br>*E. merokensis*<br>*Ps. victor*<br>*M. echinigenitus*<br>*M. ariekammensis*<br>*M. areolatus*<br>*I. prosostomus*<br>*H. cataphractus* | |
| not numerous $D=0.1—1.0$ | | | | *Ps. suillus*<br>*Min. intermedius*<br>*M. richtersi*<br>*Am. nebulosus*<br>*H. pallidus*<br>*D. pingue*<br>*D. scoticum*<br>*D. tenue* | *E. (B.) sinensis*<br>*E. capillatus*<br>*M. hibernicus*<br>*I. dastychi*<br>*D. spitsbergense* |
| singly $D<0.1$ | | | | *D. angustatum* | *D. macrodon*<br>*Cal. ornatus*<br>*I. ? granulifer*<br>*I. bakonyiensis*<br>*H. montivagus*<br>*H. ? arcticus*<br>*D. conjungens*<br>*D. oculatum*<br>*D. belgicae*<br>*D. arduifrons*<br>*D.* sp. nov. (?) |

found only in the summit parts of the highest mountains comprise: *Diphascon oculatum* MURRAY and *D. conjungens* (THULIN). It is worth noting that the two latter species and *E.* (*E.*) *wendti* RICHTERS and *Cal. ornatus* (RICHTERS) are four species which are characteristic and dominating for the subnival zone of the Polish part of Tatra Mts (DASTYCH, 1980 a).

The above data show that for many species of *Tardigrada* the increase of altitude may be a serious factor limiting their occurrence. These findings overlap to a great degree with the above mentioned investigations in Tatra Mts (l.c.), confirming distinctly the very great significance of the altitudinal zonality as the factor conditioning the distribution of water-bears.

## V. CONCLUDING REMARKS

The literature quoted at the beginning, as well as the monograph of MARCUS (1936) mention 52 species of *Tardigrada* from three islands of Svalbard archipelago (West Spitsbergen, Prince Charles Foreland and Bear Island), collected in the majority at the coasts of Hornsund, Isfjord, Kongsfjord and in the surrounding of Smeerenburg. This number is in reality smaller by several species when we take into account the synonyms and species with unclear systematic position.

In this paper 48 species and one subspecies of water-bears are recorded from West Spitsbergen, among them 5 taxa are new for science. Here belong: *Amphibolus nebulosus* (DASTYCH, 1983), *Hypsibius montivagus* DASTYCH, 1983, *Doryphoribius macrodon* BINDA, PILATO & DASTYCH, 1980, *Macrobiotus harmsworthi obscurus* ssp. nov. and *Isohypsibius dastychi* PILATO, BERTOLANI & BINDA, 1982. Besides them 12 species were not reported so far from Svalbard. They are: *Echiniscus* (*B.*) *sinensis* PILATO, *E.* (*E.*) *capillatus* RAMAZZOTTI, *E.* (*E.*) *granulatus* (DOYÈRE), *Macrobiotus willardi* PILATO, *M. hibernicus* MURRAY, *Isohypsibius bakonyiensis* (IHAROS), *I. elegans* BINDA & PILATO, *I.* ? *granulifer* THULIN, *Hypsibius cataphractus* MAUCCI, *Diphascon conjungens* (THULIN), *D. arduifrons* THULIN and *D.* sp. nov. (?). Taking into consideration the above data, we know presently 68 species and one subspecies from this archipelago; this number comprises also the unclear taxa. In the investigated material, definitely the most frequent and most numerous species proved to be *Echiniscus* (*E.*) *spitsbergensis* SCOURFIELD which can be in some way regarded as the leading species for the terrestrial habitats of this island, excluding its highest parts. Species which give a peculiar impress to the fauna of this area comprise also *Macrobiotus willardi* PILATO, *M. islandicus* RICHTERS, *M. hufelandi* SCHULTZE, *Adorybiotus coronifer* (RICHTERS), *Diphascon recamieri* RICHTERS, *Milnesium tardigradum* DOYÈRE (Table VIII) and also, though in a lesser degree, *Echiniscus* (*E.*) *wendti* RICHTERS, *E.* (*E.*) *granulatus* (DOYÈRE), *M. harmsworthi harmsworthi* MURRAY, *M. harmsworthi obscurus* ssp. nov., *Hypsibius dujardini*

(DOYÈRE), *H. convergens* (URBANOWICZ), and *H. oberhaeuseri* (DOYÈRE). The remaining majority of the found species was considerably less frequent and less numerous.

It is important to stress the great significance of the altitude above sea level and the type of bed-rock for water-bears. The influence of both these factors (as well as the factor of moisture not discussed here, but being not less important) decide about the species composition of *Tardigrada*.

Habitats which occur exclusively in polar regions and in glacial mountains are cryoconites. Most frequently they form numerous, rather small, water filled holes on the surface of glaciers occurring sometimes on a vast area of their ablation zone. Cryoconites are characterized by specific thermic and edaphic conditions. In West Spitsbergen 3 species of water-bears were found in this habitat, i.e. *Diphascon recamieri* RICHTERS, *Hypsibius dujardini* (DOYÈRE) and *H. ? arcticus* MURRAY. In the Arctic Region, the water-bears from this habitat were reported so far from Greenland (literature review: MILHELČIČ, 1963) and furthermore they were known from Alphine (l.c.) and Himalayan cryoconites (RAMAZZOTTI, 1968).

Noteworthy is the Tardigrade fauna of many localities with nonfavourable, as it might seem, thermic conditions, i.e. from mosses collected in the direct vicinity of glacier (e.g. locality No. 79, at Ebbabreen) or from places completely surrounded by glaciers (e.g. No. 64, Vestfjellet Mt). Usually these places did not belong to the poorest habitats in reference to fauna and in both quoted examples a rather great number of species was found there (11 and 10), showing also not the smallest quantity (10250 and 22100 specimens/m$^2$).

The presently known characteristic distribution of many *Tardigrada* species occurring in the Polar Circle and to the south of it in the mountains (boreal-mountain, in the wide sense of this word) proves distinctly that Pleistocen exerted a great influence on the present form of water-bears fauna in the Northern Hemisphere. Unfortunately, a complete lack of data from many areas of the Arctic Region (Northern Asia, partly America) and the poor state of investigation in many others regions are the reasons why at present even an attempt of approximate determination of the dispersal centers or consideration of the origin of Tardigrade fauna of any area, including Svalbard, is not possible.

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STRESZCZENIE

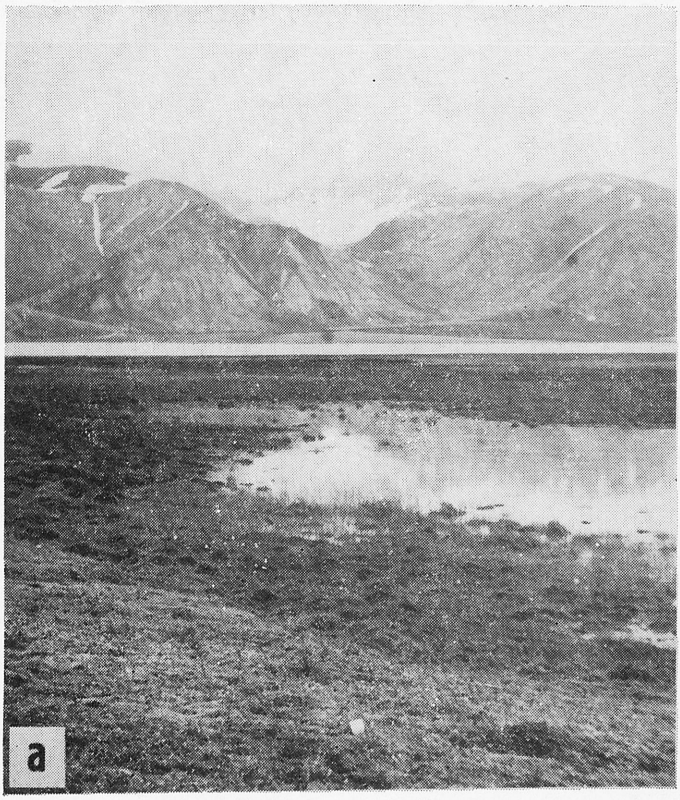
W latach 1973—1980 zebrano 544 próbki mchów i porostów na obszarze Zachodniego Spitsbergenu, w których stwierdzono 48 gatunków i jeden podgatunek *Tardigrada*. Spośród nich 12 gatunków nie było przedtem podawanych z tego terenu, 5 form okazało się nowymi dla wiedzy, z których 4 gatunki zostały opisane w innych pracach. Są to: *Amphibolus nebulosus* (Dastych, 1983), *Hypsibius montivagus* Dastych, 1983, *Doryphoribius macrodon* Binda, Pilato & Dastych, 1980, *Macrobiotus harmsworthi obscurus* ssp. nov. oraz *Isohypsibius dastychi* Pilato, Bertolani & Binda, 1982.

W pracy podano krótką charakterystykę morfologiczną rzadszych gatunków, rozmieszczenie poszczególnych gatunków oraz omówiono wpływ, jaki na faunę *Tardigrada* wywiera rodzaj podłoża skalnego i wysokość nad poziomem morza.

Redaktor pracy: prof. dr J. Pawłowski

Plate I (a, b)

a — small pool in Ebbadalen Valley, Bünsow Land (locality No. 73); b — stream in Ebbadalen Valley (locality No. 75)

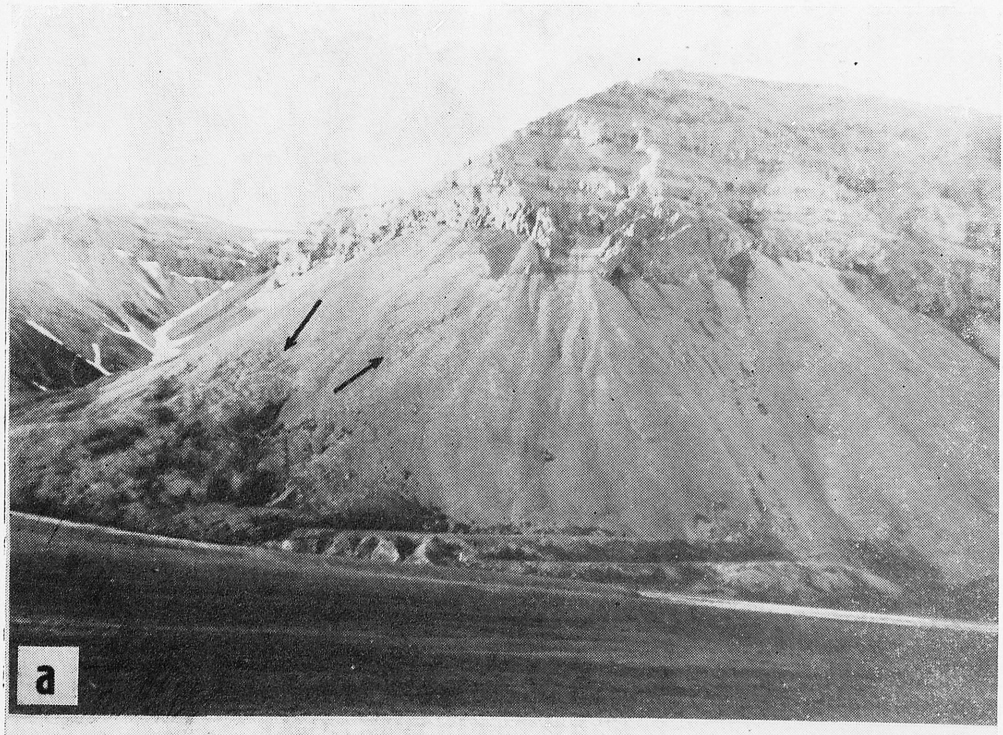




*H. Dastych*

Plate II (a, b)

a — Wordiekammen in Ebbadalen Valley (locality No. 78: arrows show the sampling area);
b — mouttons at the head moraine of Ebbabreen glacier (locality No. 80)





*H. Dastych*

## Plate III (a—d)

*Echiniscus (B.) sinensis* PILATO: a — front of the body, dorsal view; b — ventral plates; c — end of the body, dorsal view; d — *Echiniscus (E.) wendti* RICHTERS: claws of the IVth pair of legs (a—d: phase contrast)

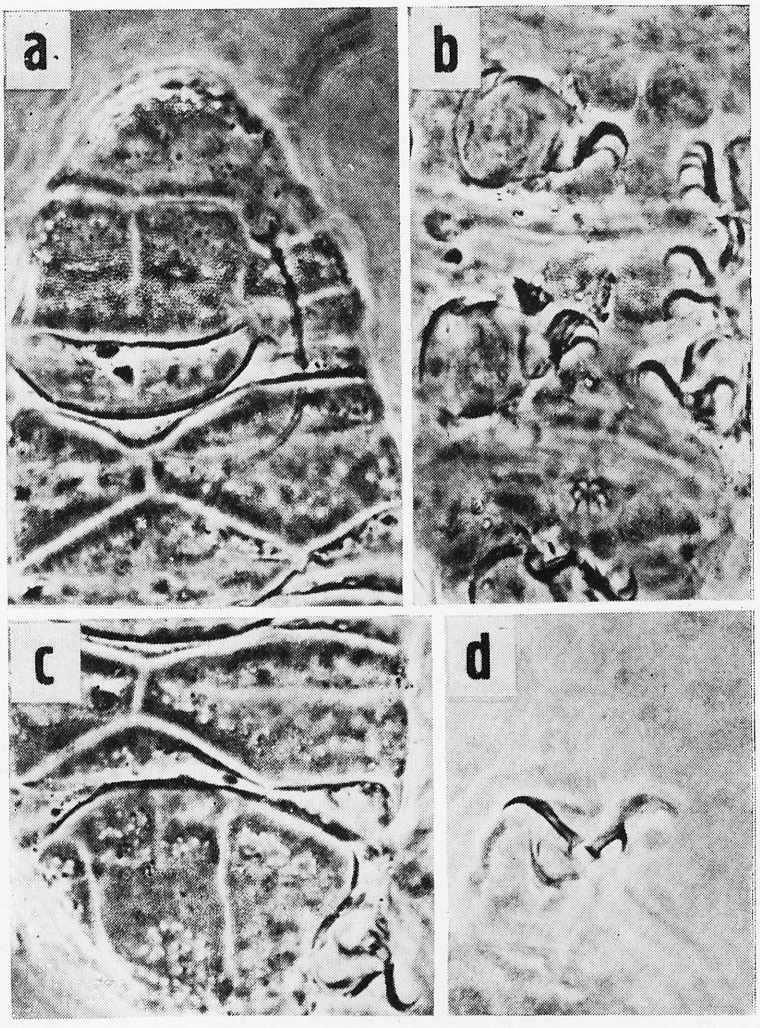
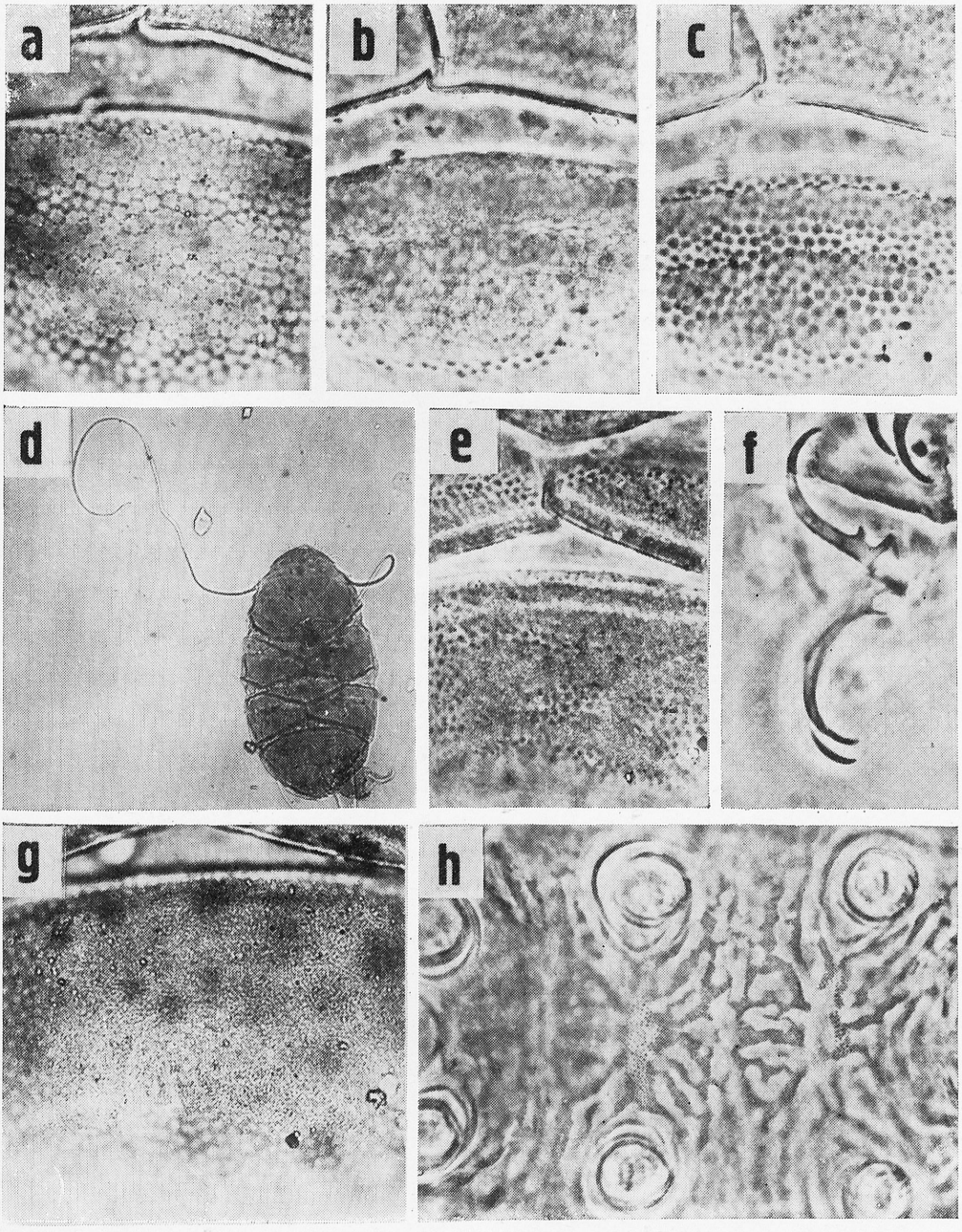

a
b
c
d

Plate IV (a—h)

*Echiniscus (E.) wendti* RICHTERS: a—c — end plate, dorsal view; d—*g* — *Echiniscus (E.) capillatus* RAMAZZOTTI: d — dorsal view; e, g — end plate; f — claws of the IVth pair of legs; h — *Pseudechiniscus suillus* (EHRENBERG): ventral side of the body (a, d, g — light microscope; others — phase contrast)


a
b
c
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e
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h

Plate V (a—f)

*Macrobiotus ariekammensis* Węglarska: a — front of the body; b — pharynx; c — claws of the IIIrd of legs; d — end of the body, laterial view; e — claws of the IVth pair of legs; f — processes of egg (e, f — phase contrast)

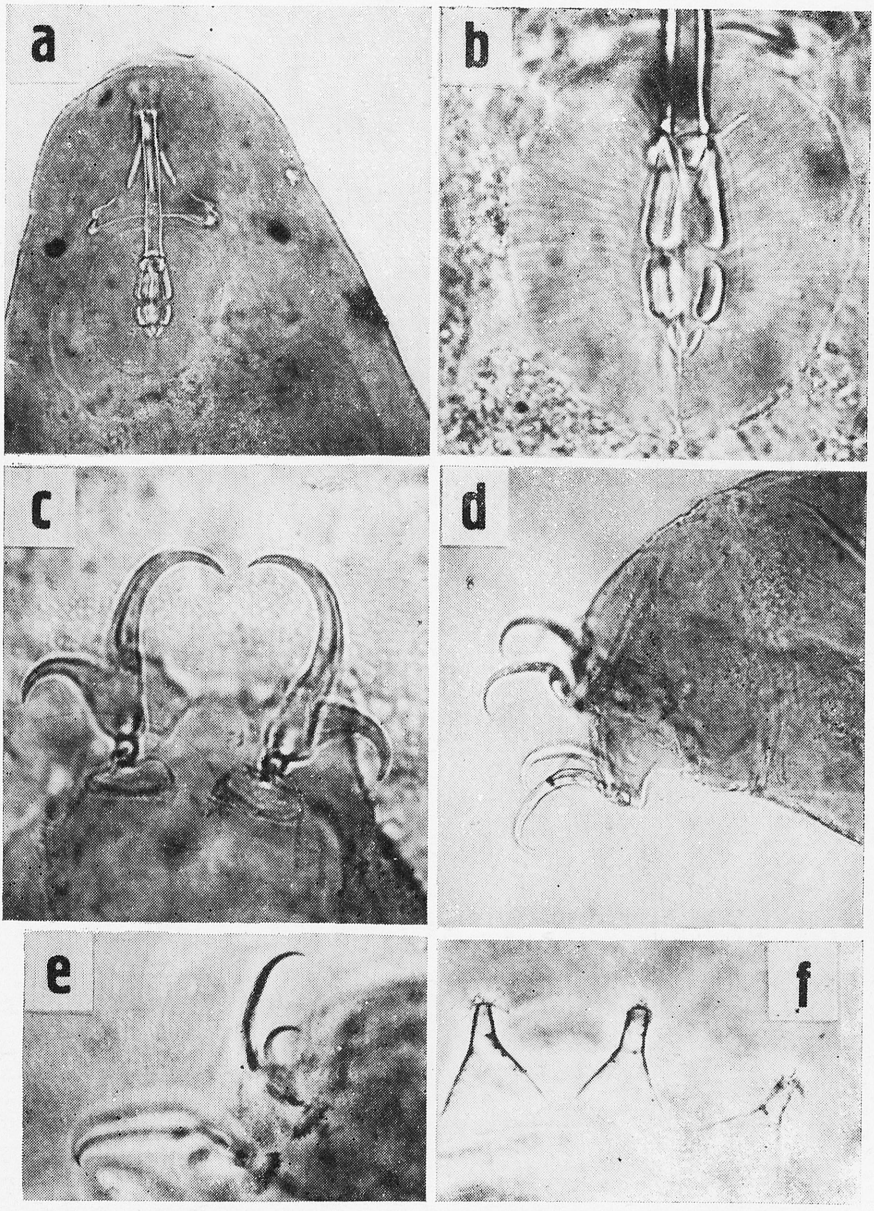
a
b
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Plate VI (a—g)

*Macrobiotus ariekammensis* WĘGLARSKA: a—g — processes of egg (g — phase contrast)

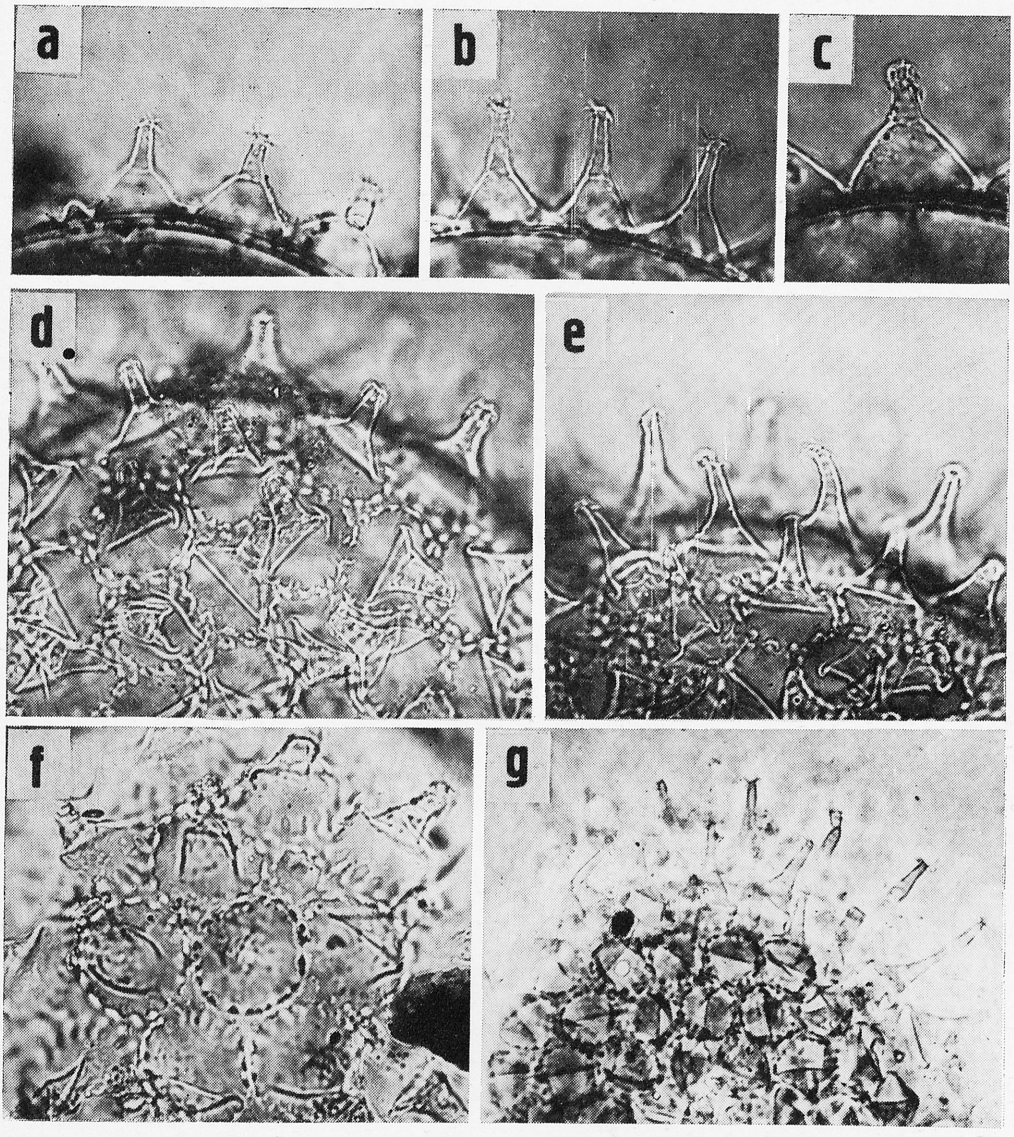
a
b
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Plate VII (a—d)

*Macrobiotus willardi* PILATO: a — buccal apparatus; b, c — pharynx; d — egg

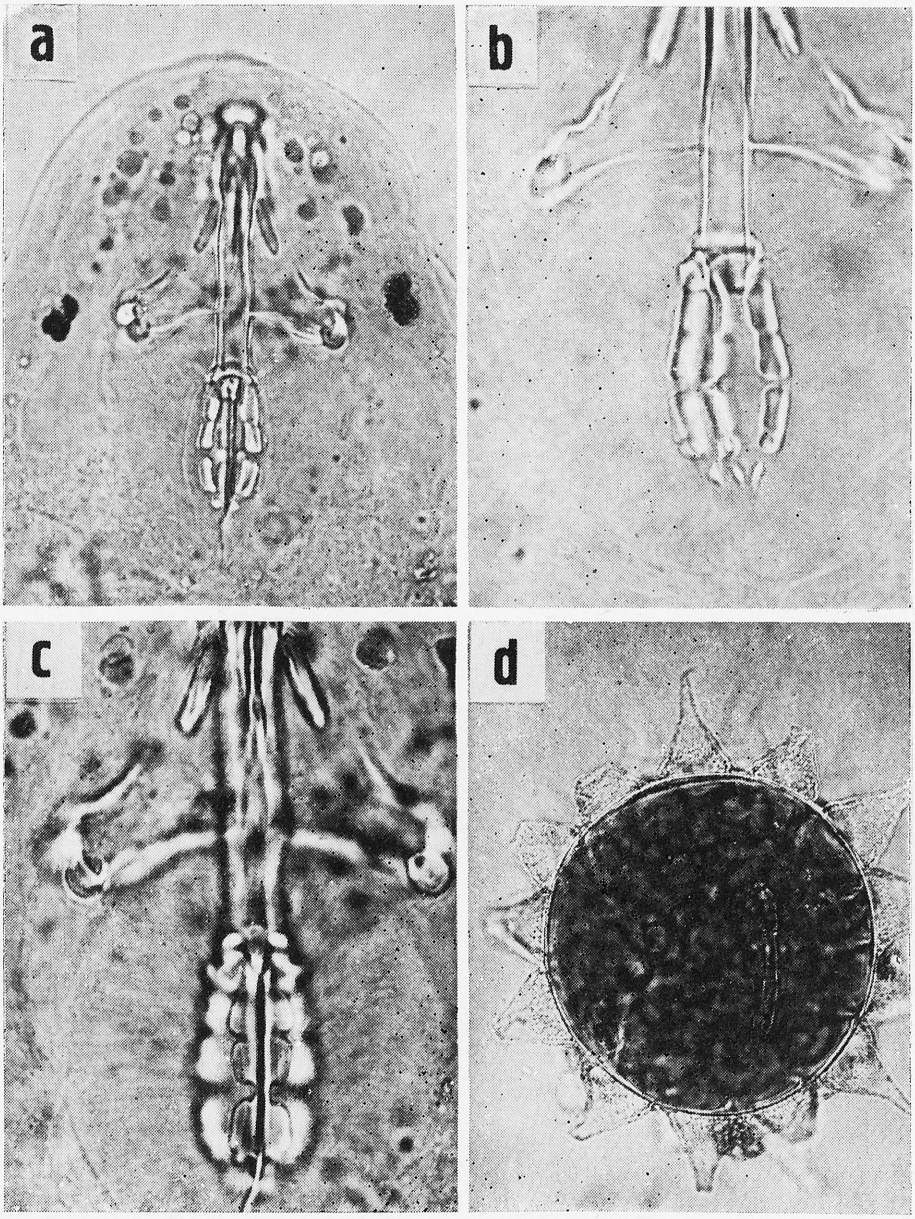
a
b
c
d

Plate VIII (a—h)

*Macrobiotus willardi* Pilato: a, b — claws of the IInd pair of legs (the same fragment: b — phase microscope); c — claws of the IIIrd pair of legs; d — claws of the IInd pair of legs; e, f — claws of the IVth pair of legs; g, — h — fragment of egg (b, h — phase contrast)

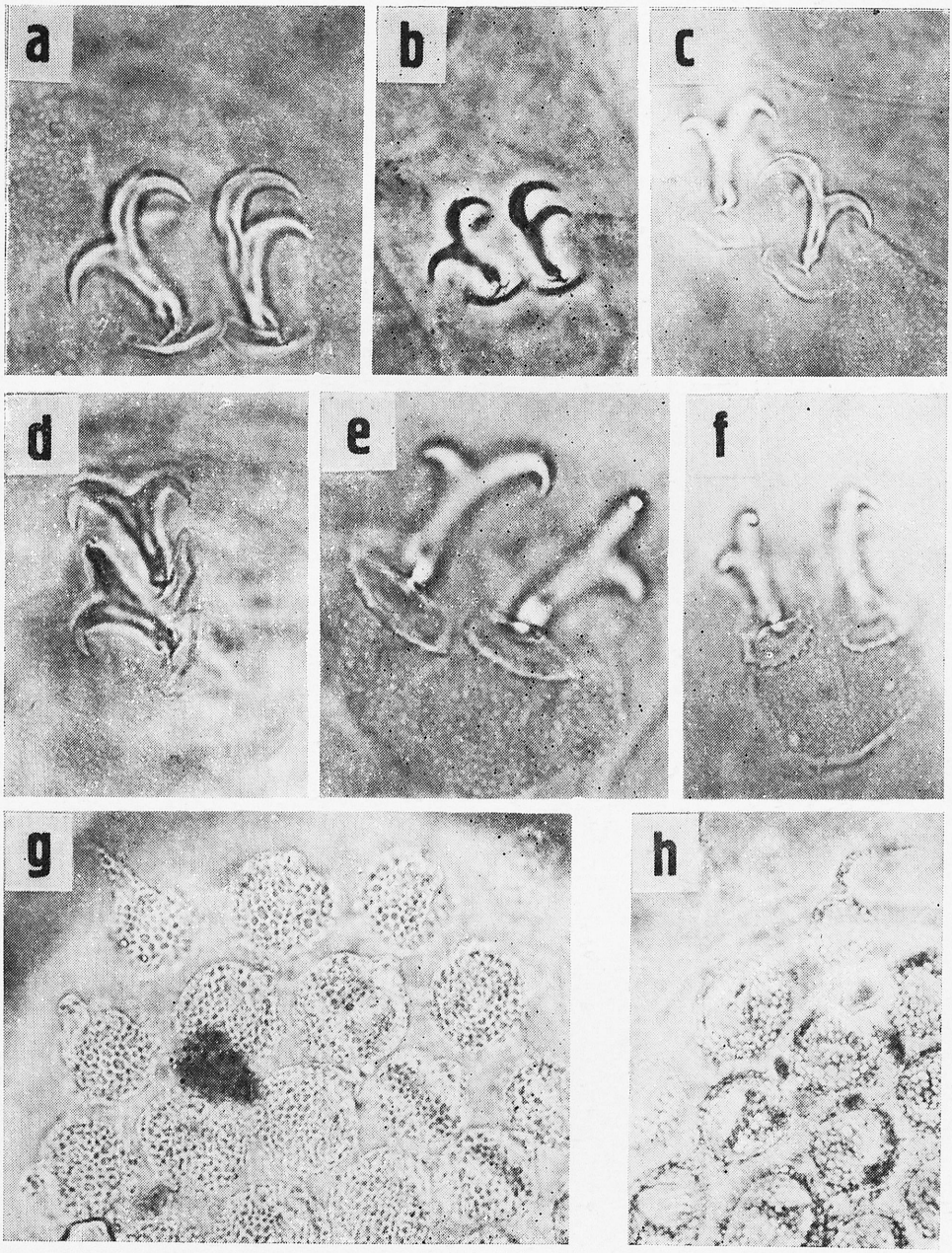
a
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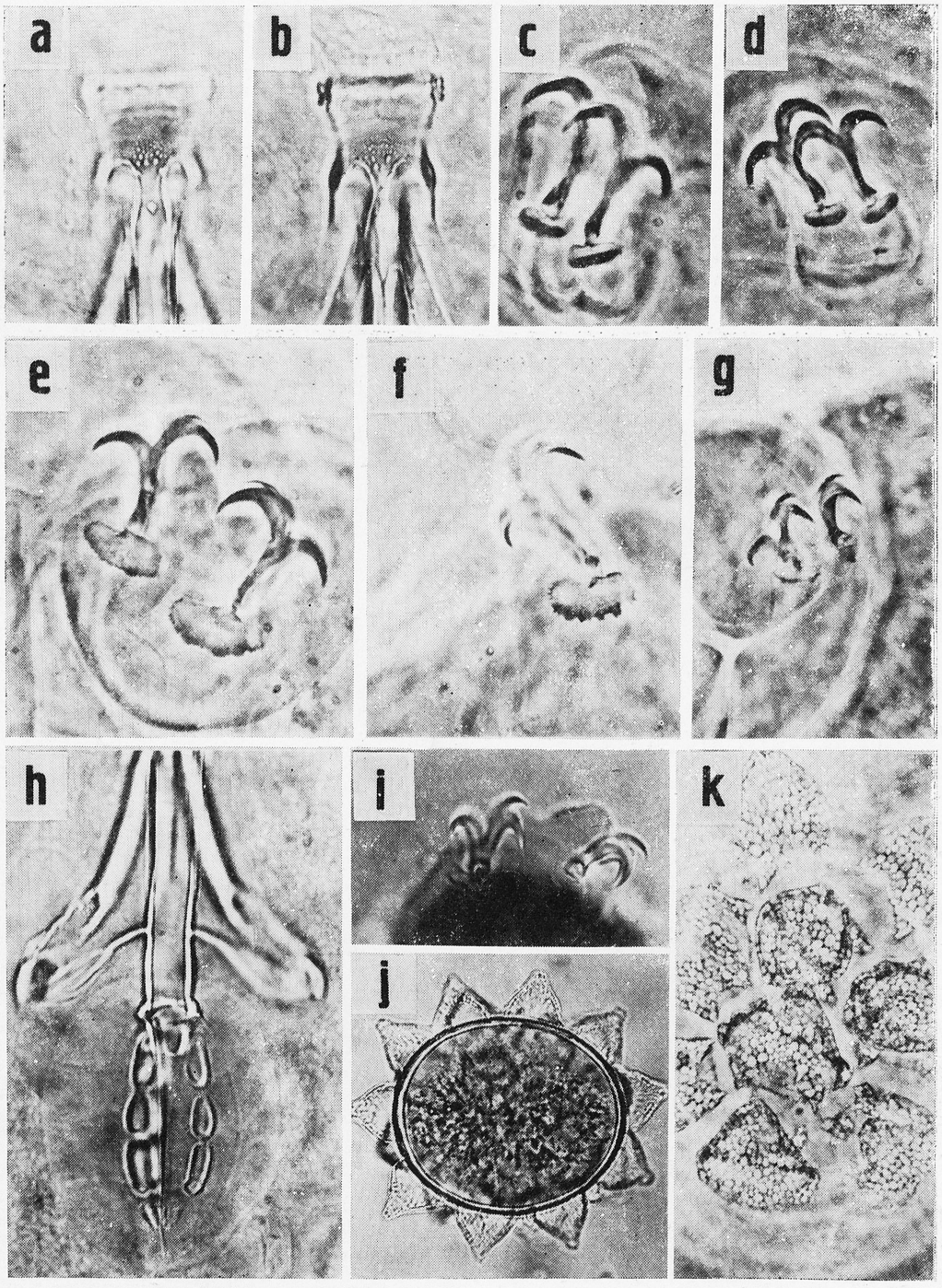
Plate IX (a—k)

*Macrobiotus islandicus* RICHTERS: a — buccal cavity, dorsal view; b — buccal cavity, ventral view; c, d — claws of the IInd pair of legs; e, f — claws of the IVth pair of legs; *Macrobiotus harmsworthi obscurus* ssp. nov.: g — and i — claws of the IVth pair of legs; h — buccal apparatus; j — egg; k — fragment of egg (a—d, k — phase contrast)


a
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g
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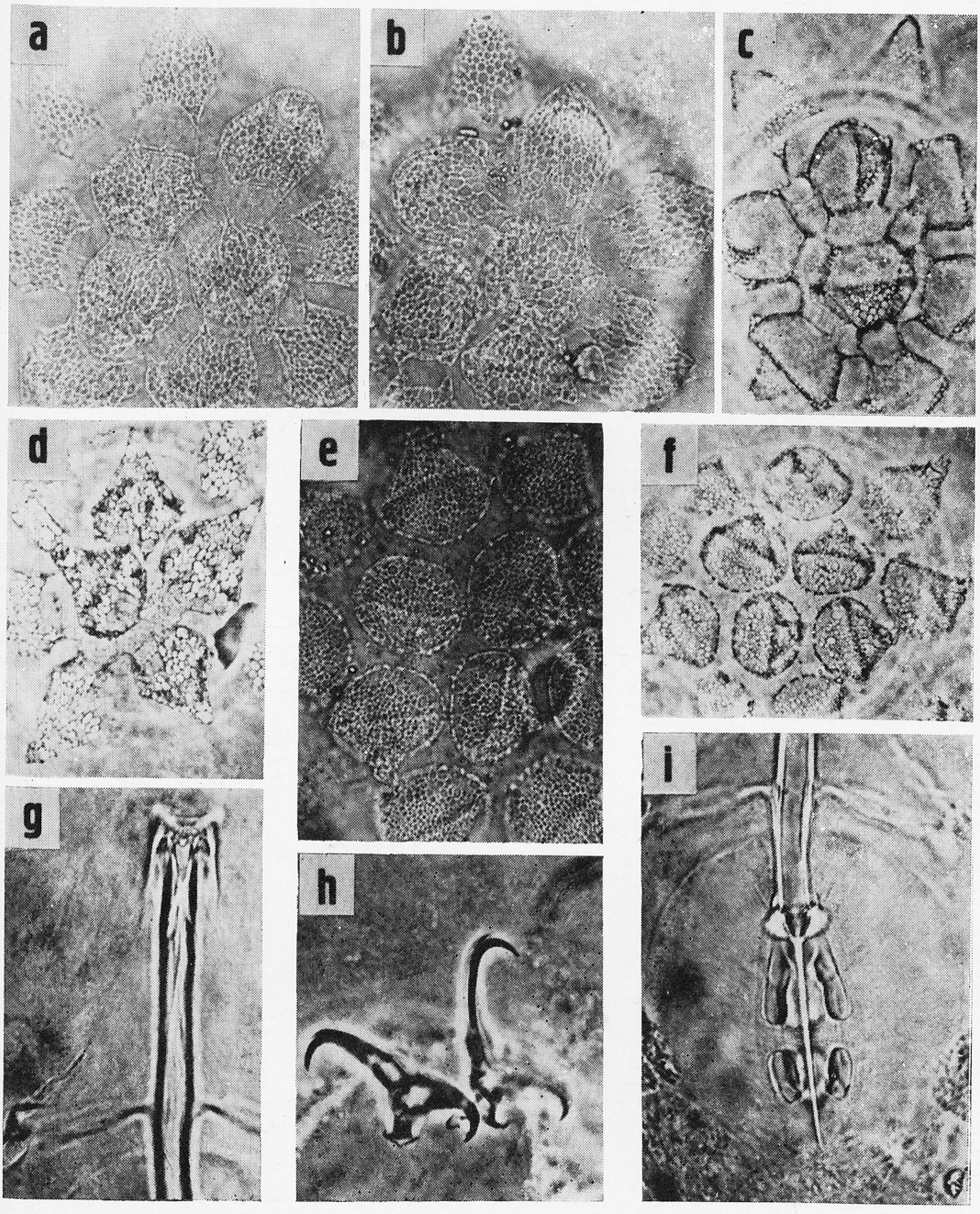
k

## Plate X (a—i)

*Macrobiotus harmsworthi obscurus* ssp. nov.: a—d — fragments of eggs; *Macrobiotus harmsworthi harmsworthi* MURRAY: e, f — fragments of eggs; *Doryphoribius macrodon* BINDA et al.: g — buccal tube; h — claws of the IVth pair of legs; i — pharynx (c, d, f, h — phase contrast)


a
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g
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i

## Plate XI (a—h)

*Isohypsibius* ? *granulifer* THULIN: a — buccal apparatus; b — claws of the IInd pair of legs
*Isohypsibius elegans* BINDA & PILATO: c — pharynx; e — buccal apparatus; f — claws of the second pair of legs; d — pharynx; g — claws of the IVth pair of legs; h — claws of the IInd pair of legs (a, b, g, h — phase contrast)

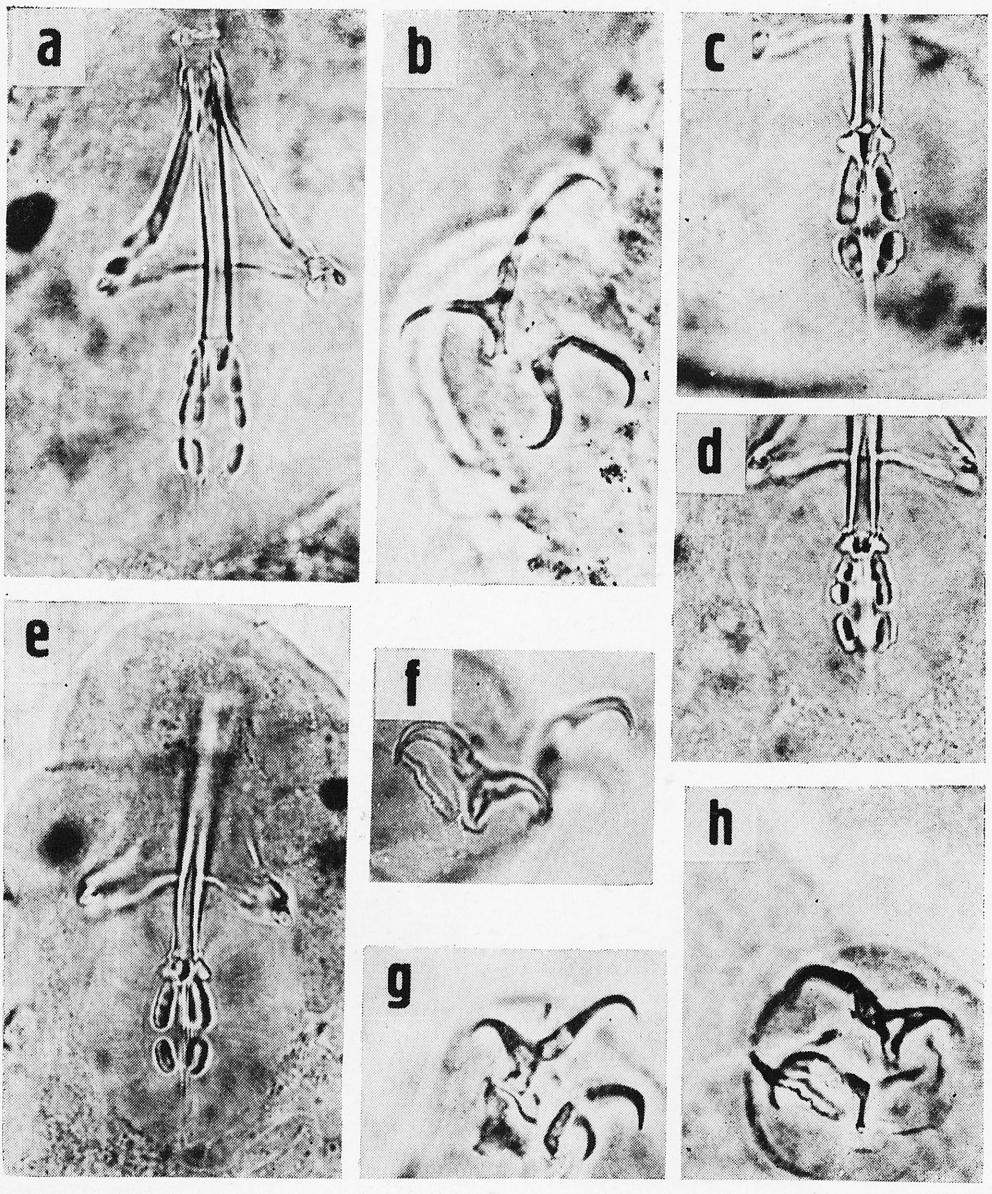
a
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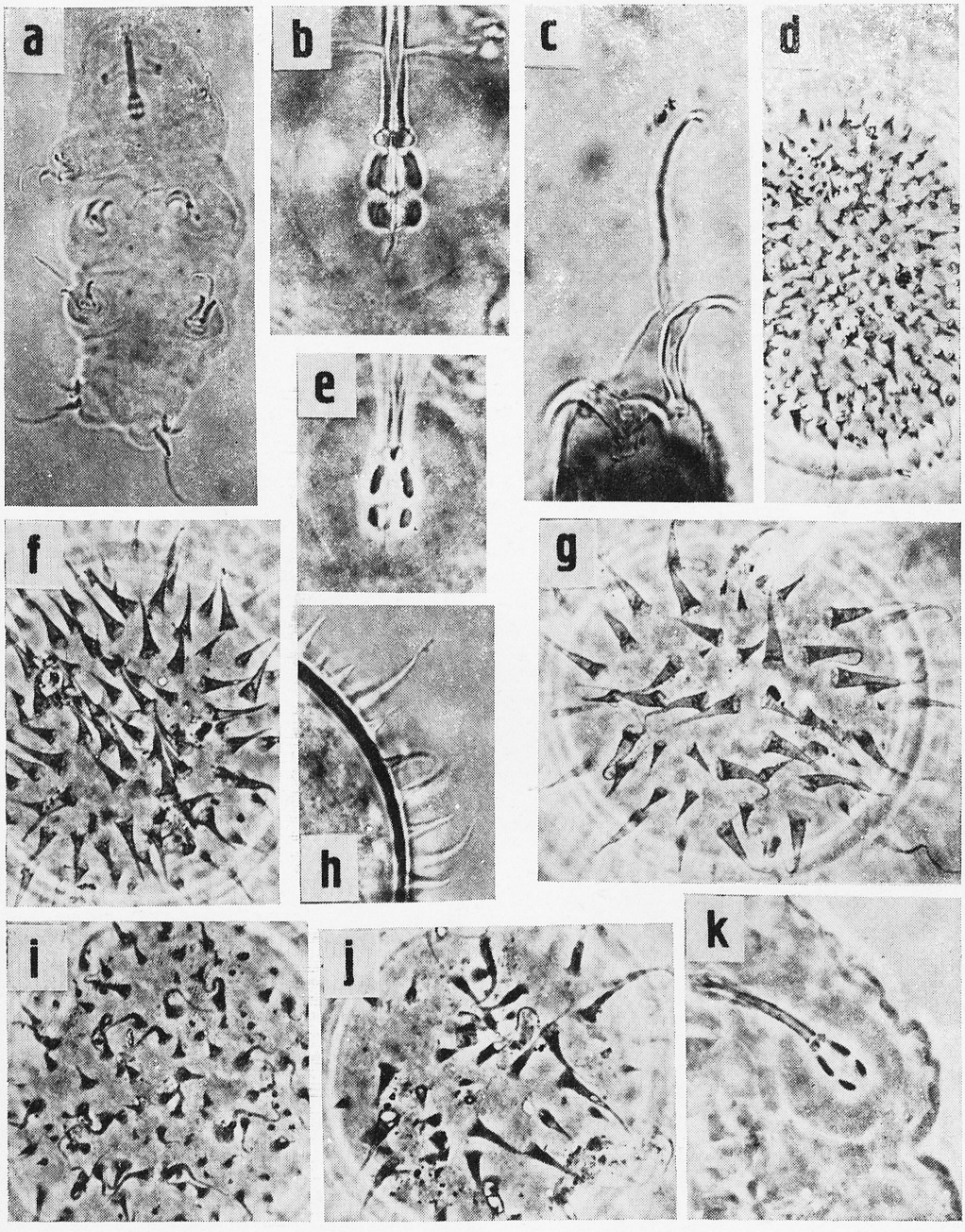
Plate XII (a—k)

*Hypsibius cataphractus* MAUCCI: a — habitus, ventral view; b, e — pharynx; c — claws of the IIIrd pair of legs; d, f—j: fragments of eggs; *Hypsibius ? arcticus* MURRAY: k — buccal apparatus (d—f, g, i—k: phase contrast)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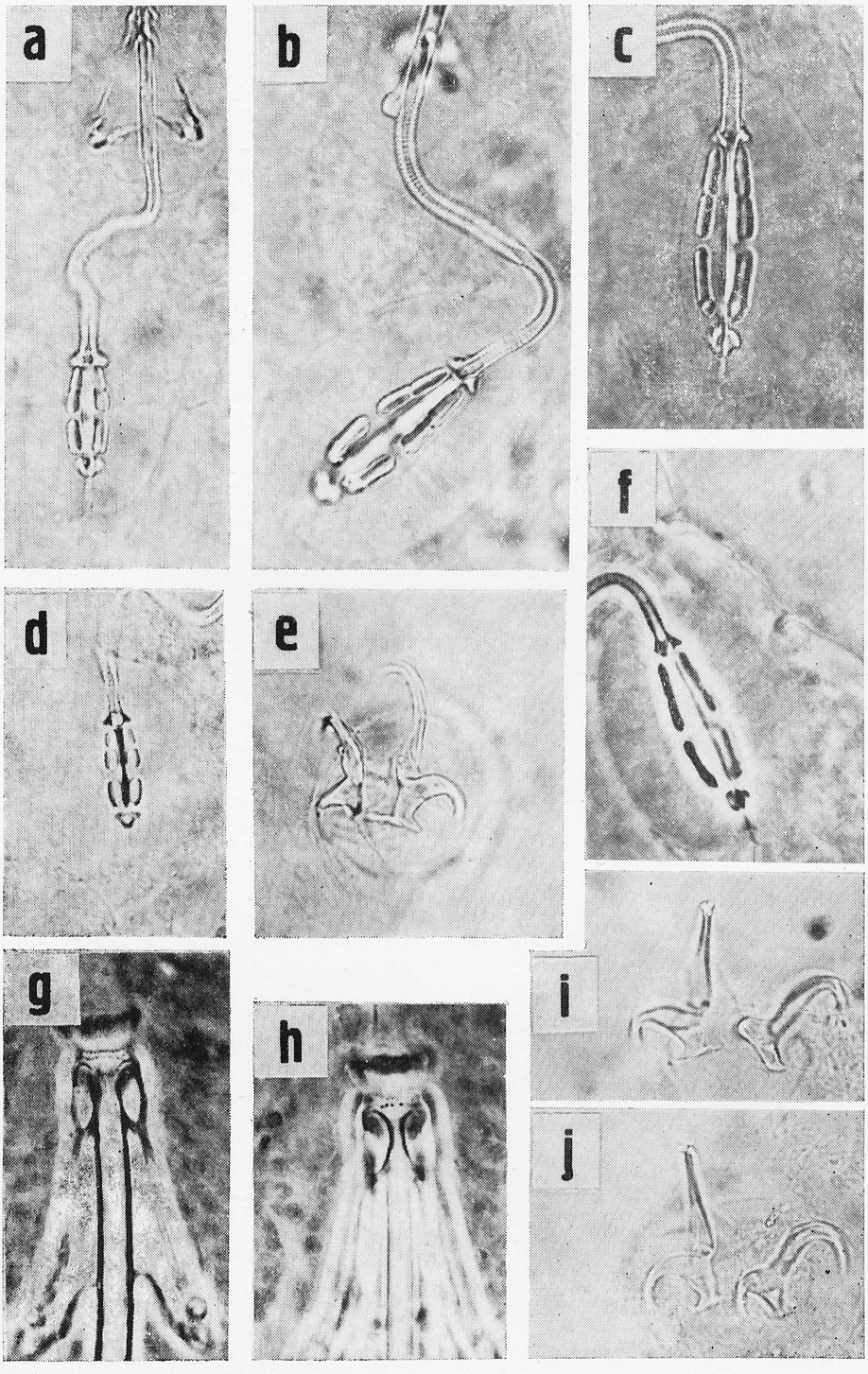
## Plate XIII (a—j)

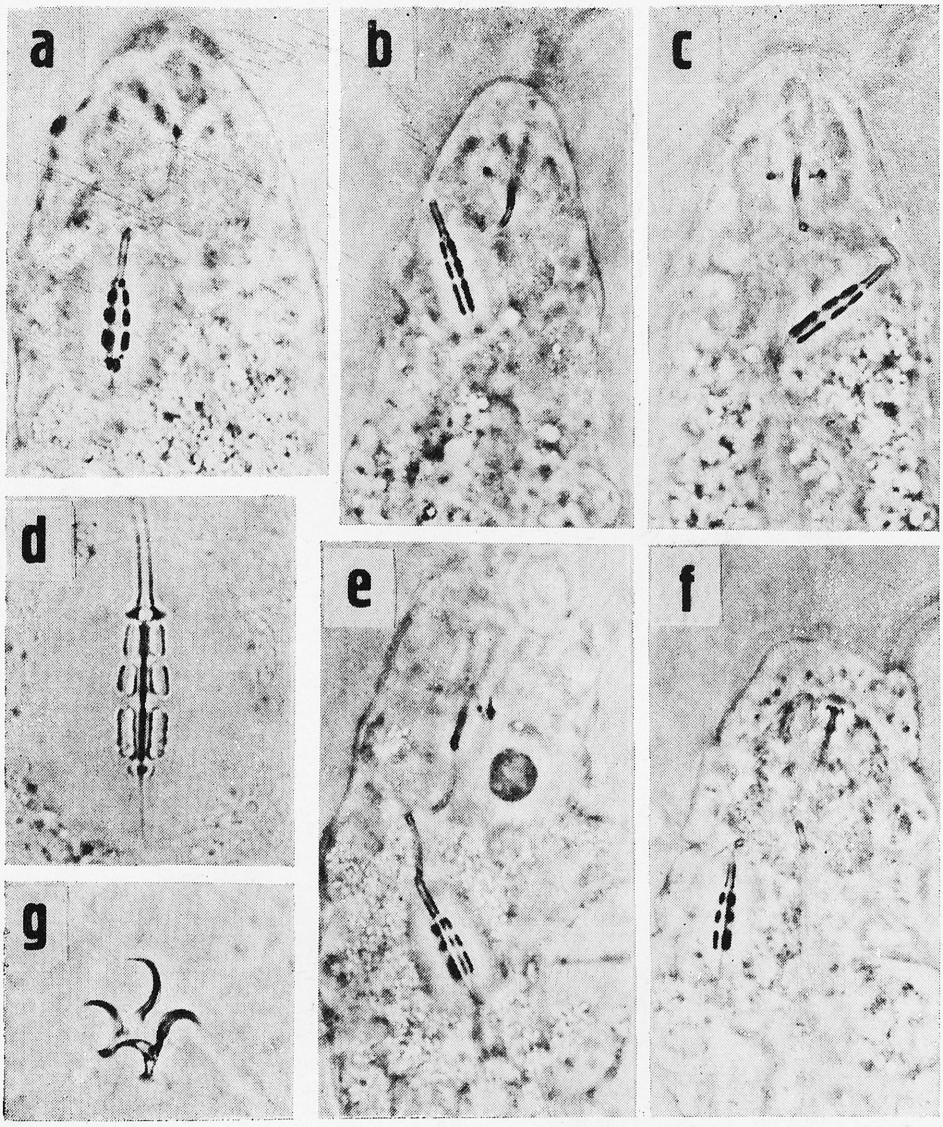
*Diphascon recamieri* RICHTERS: a — buccal apparatus specimen without drop-shaped thickening; b—d, f — pharynx; e — claws of the IInd pair of legs; i, j — claws of the IVth pair of legs; *Diphascon spitsbergense* RICHTERS: g, h — mouth tube with buccal cavity (f—h: phase contrast)




*H. Dastych*

Plate XIV (a—g)

*Diphascon pingue* (MARCUS): a — buccal apparatus; *Diphascon arduifrons* THULIN: b, c — buccal apparatus; *Diphascon* sp. nov. (?): d — pharynx; g — claws of the IInd pair of legs; *Diphascon tenue* THULIN: e, f — buccal apparatus (d — light microscope; others — phase contrast)


a
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