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The comparison of freshwater invertebrates of Spitsbergen (Arctic) and King George Island (Antarctic)

ABSTRACT: Nematoda, Tardigrada, Rotifera and Crustacea composition in different freshwater habitats on Spitsbergen (Arctic) and King George Island (Antarctic) was presented. In all surveyed groups more genera and species were recorded from Spitsbergen than from King George Island. Habitats richest in taxa were moss banks and thaw ponds, whereas streams were poorest in species. In all groups in both regions cosmopolitan species dominated, but higher number of endemic species was recorded on King George Island. Regarding species composition in surveyed groups it can be suggested that freshwater habitats on Spitsbergen are more similar to each other than those on King George Island.

Key words: Arctic, Antarctic, freshwater invertebrates, species composition, Nematoda, Tardigrada, Rotifera, Crustacea.

Introduction

Investigation of freshwater invertebrates (Nematoda, Tardigrada, Rotifera and Crustacea) of polar regions have already had almost one-hundred-year history. First description of Arctic Nematoda come from Novaya Zemlya (Steiner 1916). Manual of freeliving and plant parasitic nematodes species from Spitsbergen was prepared by Loof (1971). It contains a list of 73 species, collected from the soil, moss and freshwater habitats. In Antarctica first nematode surveys were done by De Man (1904) and Steiner (1916). More contemporary review papers concerning nematode distribution in the Antarctic were presented by Spaull (1973a, b) and Maslen (1979), who reported 22 species of Nematoda from sub-Antarctic, 40 species from maritime Antarctic and 10 species from the continental Antarctic.

Arctic Tardigrada were at first investigated by Scourfield (1897), Murray (1907, 1910 a) and Richters (1904, 1911a, b). From Spitsbergen Island Węglarska (1965) reported 30 tardigrade species, from mosses mainly, while Dastych (1985) 49 species from the same area. Antarctic Tardigrada were at the beginning described by Murray (1906) and Richters (1908). More recently species lists of Antarctic Tardigrada were prepared by Japanese (Morikawa 1962, Sudzuki 1964, Utsugi and Ohyama 1989, 1993) and British (Jennings 1976, 1979) investigators. Information on 25 Tardigrada species together with description of new taxa, mainly from mosses, was presented by Dastych (1984).

First Arctic Rotifera from Svalbard archipelago were reported by Bryce (1897). Since that time Svalbard rotifers were subject of huge faunistic research (Thomasson 1958, 1961, Amrén 1964a, b, Pejler 1974, De Smet, Van Rompu and Beyens 1987, 1988, De Smet 1990, De Smet 1993). From Spitsbergen Island and from Shetlands De Smet, Van Rompu and Beyens (1987) reported 34 species of Rotifera, mainly new for that region. Faunistic research of Antarctic rotifers started from papers published by Murray (1910 b). Later on, systematic research on the continent was conducted by Kutikova (1958 a, b), Sudzuki (1964, 1979) Sudzuki and Shimoizumi (1967). More recently a huge body of literature concerning Antarctic Rotifera was given from Signy Island by Dartnall (1977, 1980, 1983, 1992), and Everitt (1981). Dartnall and Hollowday (1985) prepared a guide and description of 42 Antarctic rotifer species, including 9 species of Bdelloidea.

Freshwater Crustacea from Canadian Arctic were first described by Juday (1920) and Johansen (1922). Svalbard Crustacea were reported by Oloffson (1918), and Summerhayes and Elton (1923) at first, and investigated later by many researchers (Thomasson 1958, 1961, Amrén 1964 a, b, 1976, Husmann *et al.* 1978, Meijering 1979). Halvorson and Gullestad (1976) reported from Svalbard one Notostraca, three Cladocera, and three Copepoda species. From the Antarctic full list of crustaceans from Signy Island was given by Heywood (1967). It contains 8 species, including one anostracan, three cladocerans, two copepods and two ostracods. But from South Shetlands Islands only *Branchinecta gaini* (Anostraca) and *Pseudoboeckella poppei* (Copepoda) were observed (Campos, Arenas and Steffen 1978, Jurasz, Kittel and Presler 1983, Paggi 1987, Janiec 1991). The aim of this work was to compare species composition of Rotifera, Nematoda, Tardigrada and Crustacea occurring in different habitats in two polar regions: in the Arctic and Antarctic.

Study area

Freshwater invertebrates were surveyed in two polar regions. In the summer season of 1989 research was conducted in Svalbard Archipelago, on Spitsbergen Island, in the vicinity of Polish Polar Station in Hornsund (φ = 77°00′ N, λ =

15°33′ E)), and in summer season of 1990/91 in the South Shetlands Archipelago, on King George Island, in the vicinity of Polish Antarctic *H. Arctowski* Station (φ = 62°09′ S, λ = 58°29′ W) in Admiralty Bay region.

Spitsbergen

Polish Polar Station on Spitsbergen is situated on the shore of Hornsund fjord on west Spitsbergen. In the vicinity of the Station (Fig. 1) following freshwater habitats were surveyed:

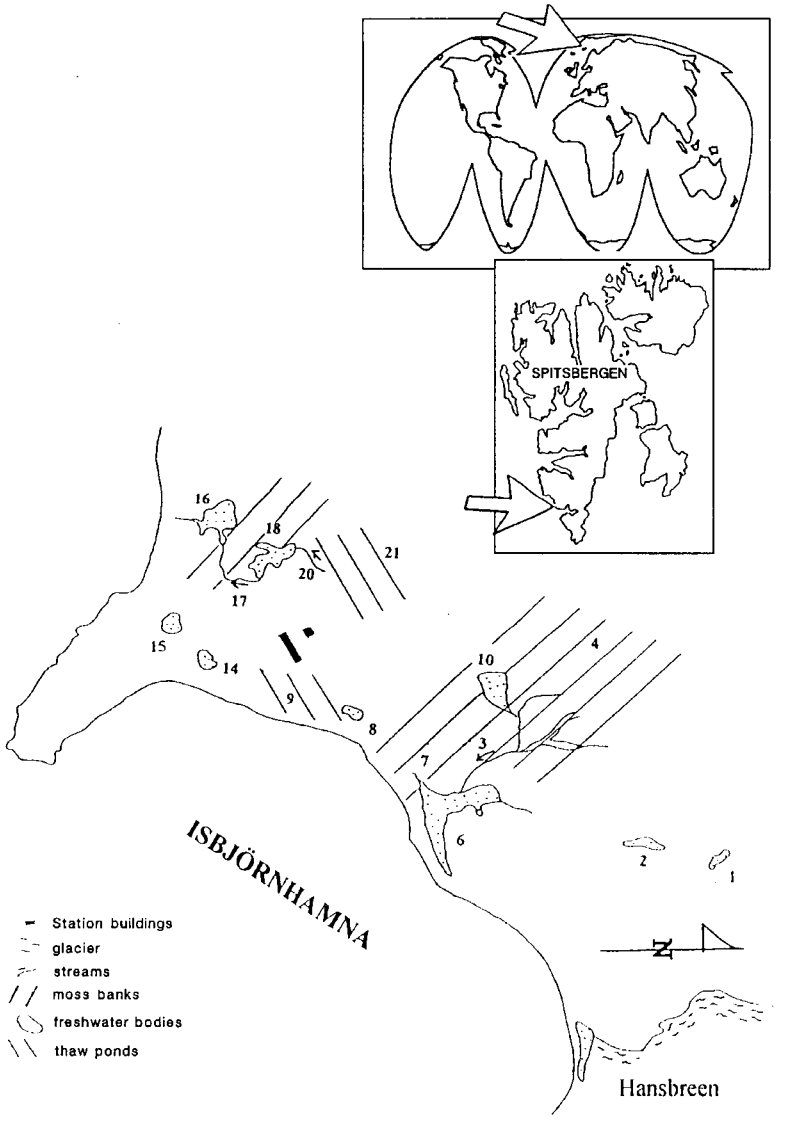

Fig. 1. Study area — Hornsund region. Numbers indicate sampling sites.

— streams supplied with precipitation water and water from melting snow and glacier, up to few kilometres long, running through glacial lateral moraines in their upper course, and through the moss banks in their lower course (sampling stations no. 3, 17 and 20). Streams shores were inhabited by mosses *Cirryphyllum cirrosum* and *Bryum weigelii*;
— moraine ponds (sampling sites no. 1, 2, 8, 14 and 15) situated on lateral moraines or marine terraces covering up to 100 m^2, attaining depths of some 15 to 40 cm, which exist for 1–2 months and then dry up. Their mainly stony bottom was scarcely covered by filamentous chlorophytes;
— nearshore ponds (sampling sites no. 6, 10, 16, 18), situated on beaches close to the seashore, behind the storm ridge, covering between 3000 and 20000 m^2, and attaining depths of 1.5 m. Their bottom was covered with sediments up to 50 cm thick and filamentous chlorophytes;
— thaw ponds (sampling sites no. 5, 9, 21), temporary (1–2 months) and shallow (10–15 cm) basins filled with water from melting snow, covering up to 5000 m^2. Mosses *Sanonia uncinata* and *Calliergonella* sp. covered only a small part of the bottom;
— moss banks (sampling sites no. 4, 7, 19) consisting of *Calliergon sarmentosum*, *Calliergon stramineum*, *Drepanocladus revoliens*, *Scorpidium turgescens*, *Sanonia uncinata*, *Cirryphyllum cirrosum* (sites 4, 7, 19).

Lowest water temperatures were observed in streams while highest in thaw ponds. Water was well saturated with oxygen (97 to 130%, oxygen content 10.8 to 16.7 ppm). All habitats, except moss banks (pH from 5.2 to 6), were alcalic (pH between 7.7 and 9.5).

King George Island

Polish Antarctic Station *H. Arctowski* is situated on King George Island in Admiralty Bay region. Surveyed freshwater habitats were in the direct neighbourhood of the station (Fig. 2):

— streams (sampling sites no. 3, 15, 21) are short and run through glacial moraines in their upper course, and later through moss banks, mainly *Brachytecium austrosalebrosum*;
— moraine ponds (sampling sites no. 5, 6, 8, 9, 13, DL, PAP) situated on glacial moraines, at different altitude over sea level. They last for about 6–8 weeks, attain depth between 15 and 60 cm and cover area from about 15 to 150 m^2. With stony bottom, their shores are inhabited mainly by *Sanonia uncinata*, but also *Calliergon sarmentosum* and *Bryum pseudotriquetrum*;
— moss banks (sampling sites no. 4 and 7) are mainly composed of *Calliergon sarmentosum* and *Calliergidium austro-stramineum*;
— thaw pond (sampling site no. 2) filled with water from melting snow on marine terrace, is a temporary (1–2 months) and shallow (10–15 cm) area,

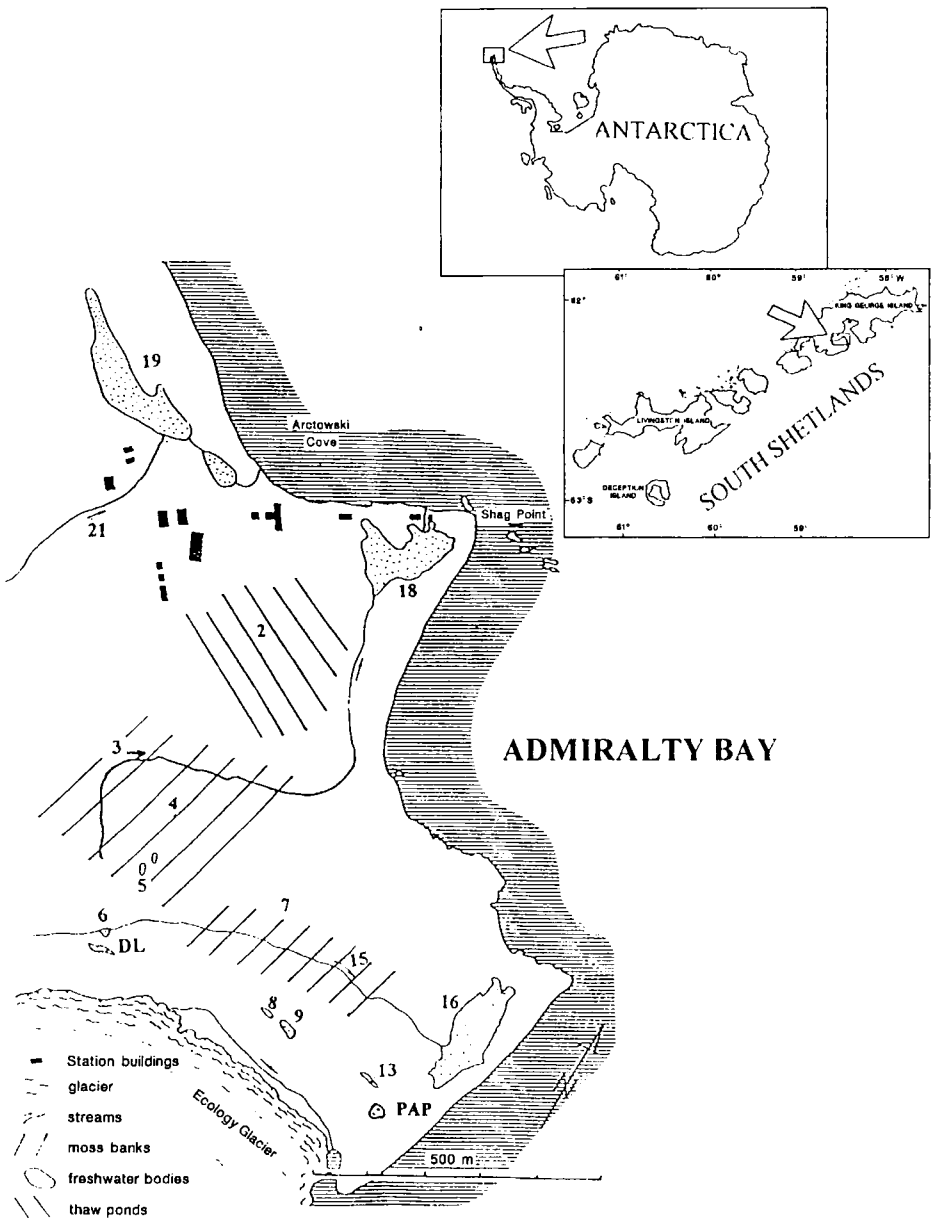

Fig. 2. Study area — Admiralty Bay region. Numbers indicate sampling sites.

covering up to 5000 m^2 and with the bottom inhabited by *Calliergon sarmentosum*;

— nearshore ponds (sampling sites no. 16, 18 and 19) covering between 3000 and 20000 m^2, and attaining depths of 1.5 m. They are situated on marine

beaches behind the storm ridge, free from ice for 5 months, but frozen to the bottom in winter. They might be brackish due to sea breeze. Shores are colonised by *Calliergidium austro-stramineum* and *Calliergon sarmentosum.*

Lowest water temperatures were observed in streams, while highest in moraine ponds. Water saturation was high (92 to 133%), oxygen content varied between 10.5 to 14.8 ppm except for habitats enriched with penguin guano. pH fluctuated between 6.5 and 9.9 in all habitats except for moss banks, where pH was from 5.6 to 6.1.

Materials and methods

In the Arctic material was collected from 9th June to 1st September 1989. In the Antarctic samples were taken from 12th November 1990 to 21st January 1991. All the samples from selected habitats were taken once a week.

Microfauna

In surveyed freshwater habitats microfauna was most numerous in sediment-water interface. Samples were taken from up to 10 cm above the sediment, with a modified Patalas sampler of dimensions 7×7×7 cm and volume of about 0.35 dm^3 in each pond type. Sampling procedure included 2 repetitions, containing 3 Patalas samplers each. Water was then filtered through a 30 μm mesh plankton net and the material in the net was collected in a small volume of water in a sample jar. Two 5 ml subsamples were taken of each sample and observed in vivo under the light microscope. After this initial examination all samples were fixed with formalin to a final concentration of 4%, and 1 subsample examined further at a later date. Samples from the moss banks were taken by squeezing the water from a ca. 25 cm^2 area directly into a sample jar.

After returning to Poland samples were examined once again. From every sample two 5 ml subsamples were checked. Rotifera, Tardigrada and Nematoda were counted and identified possibly to the species level. Permanent slides of Nematoda and Tardigrada were prepared. In case of low numbers of individuals (n) all the animals were removed to the slides. In case of higher numbers first 30 individuals were transferred. Permanent slides of Tardigrada were done in Faure's liquid (Ramazotti and Maucci 1983) and Nematoda slides according to Seinhorst procedure (Seinhorst 1959, 1962). Within Rotifera, Monogononta only were determined to the species or genus level and these slides were prepared in glycerine jelly, while Bdelloidea remained undetermined. Densities for species and groups were calculated per 1 ml.

Nematoda were identified according to Loof (1971), Maslen (1979), and Andrassy (1981, 1985), Tardigrada according to Ramazotti and Maucci (1983)

and Dastych (1984, 1985), while Rotifera according to Kutikova (1970), Dartnall and Hollowday (1985) and Dartnall (1993).

Crustacea

Samples of Cladocera and Copepoda were taken in two repetitions, using 3-litre Patalas sampler. For every repetition 3 samplers were taken (totally 9 litres), then the water was filtered through a 50 μm mesh plankton net and the material in the net collected in a small volume of water in a sample jar. Samples were taken in permanent sampling sites in those ponds, where the depth was bigger than 50 cm, and fixed with 4% formalin. Notostraca and Anostraca samples were taken using bottom trawl with semicircle entry surface of 157 cm^2. Trawl was pulled for 2, 3 or 5 m, in two repetitions. Samples were fixed in 4% formalin. Cladocera and Copepoda were examined in two 10 ml subsamples each. Species, number, sex and stage of development were determined. Notostraca and Anostraca samples were examined in toto and number, sex, number of eggs and stage of development were determined. The results were recalculated per 1 litre. Crustacea were identified according to Flössner (1972).

Ostracoda remained undetermined for further examination.

Calculations

Data was gathered and drawings were prepared using Quattro Pro, version 1.0 and Harvard Graphics version 2.0. Densities for every habitat were calculated as mean (x) and standard deviation (SD) for all samples collected from sampling sites of every habitat. Sörensen similarity index ($S_{ö}$) was calculated according to the formula:

$$S_{ö} = \frac{2W}{A+B} \times 100$$

where: W — number of species present in both habitats, A — number of species in first habitat, B — number of species in second habitat.

Results

Species composition of invertebrate fauna inhabiting freshwater habitats of both polar regions (Table 1) was determined.

Spitsbergen

Nematoda (Fig. 3). — In collected material 16 species from 12 genera were determined. Nematode composition was different in surveyed habitats, but in all freshwater habitats Monhysteridae and Plectidae families dominated, constitut-

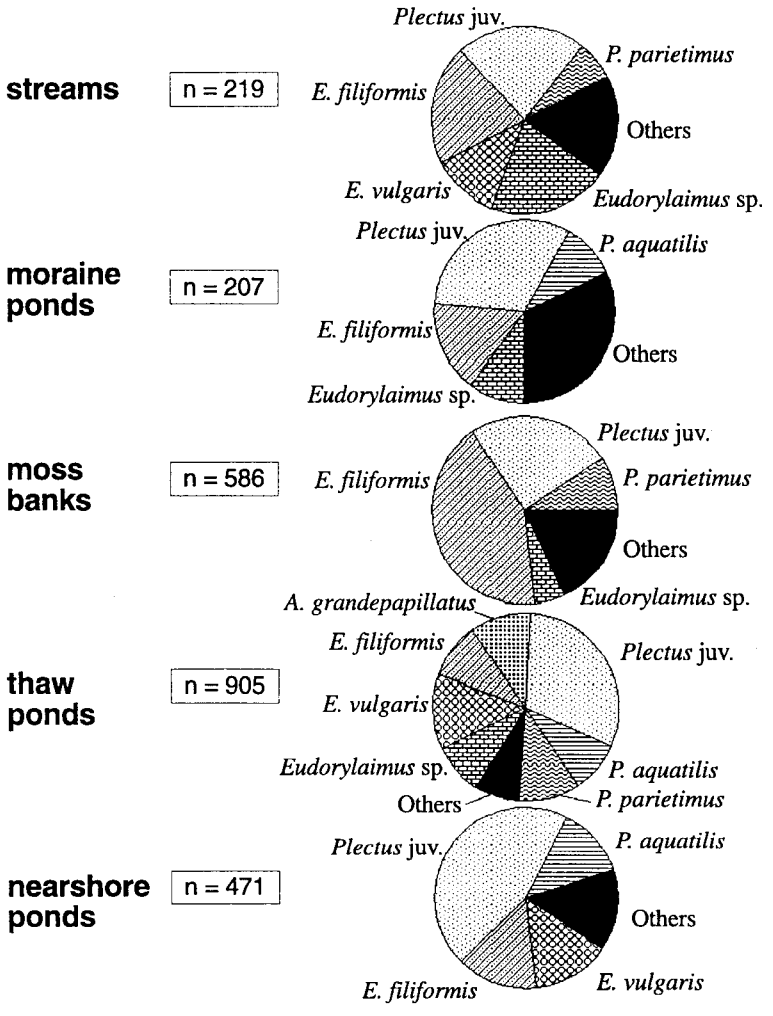

Fig. 3. Nematode composition in freshwater habitats in Hornsund area in summer season; n — total number of observed individuals.

ing 68 to 80% of total number of individuals. Juvenile stage of genus *Plectus* was most numerous in almost all habitats.

In streams, except juvenile *Plectus*, adult *Plectus aquatilis* and *Plectus parietinus*, most abundant were *Eumonhystera filiformis* and *Eudorylaimus* sp. In this habitat Plectidae were less numerous than elsewhere.

In moraine ponds species composition was similar: most numerous were juvenile *Plectus*, *Eumonhystera filiformis*, *Plectus aquatilis*, and more numerous than elsewhere *Eudorylaimus* sp. (9.9%) and *Tobrilus* sp. (9.2%).

Nematode fauna in moss banks was the most diverse: all 16 species occurred. Dominant species was *Eumonhystera filiformis*, numerous were also juvenile

Plectus and *Plectus parietinus*. Less frequent than elsewhere was *Eumonhystera vulgaris*.

In thaw ponds except numerous juvenile *Plectus* (30.7%) *Plectus parietinus* and *Anaplectus grandepapillatus* were more abundant than in other habitats. Representatives of family Eumonhysteridae were similarly numerous as elsewhere.

In nearshore ponds juvenile *Plectus*, probably *Plectus aquatilis*, and *Eumonhystera filiformis* and *Eumonhystera vulgaris* were most numerous nematodes found. Same as in thaw ponds *Tripyla infia* constituted more than 2% of nematodes.

Plectus aquatilis, Tobrilus sp. and *Tripyla infia* were typical species of all freshwater ponds, *Eudorylaimus* sp. of streams., and *Eumonhystera filiformis* of moss banks.

Sörensen similarity index for Nematoda was very high and reached 94.4 for moss banks and thaw ponds. Lowest value (69.0) was calculated for moss banks and moraine ponds. Moss banks and thaw ponds have similar physical conditions because thaw ponds are very shallow and their shores and sometimes the bottom were covered by mosses. Moraine ponds surveyed in Hornsund region had very little vegetation, so their small similarity to moss banks is well understandable.

Tardigrada (Fig. 4). — 13 species, belonging to 4 genera were determined (Table 1). In all habitats, except streams, *Hypsibius (Hypsibius) dujardini, Hypsibius (Isohypsibius) granulifer* and *Hypsibius (Hypsibius) pallidus* dominated. Frequent species was *Amphibolus smreczynskii*. Most numerous in streams was *Hypsibius (Hypsibius) convergens*, but tardigrade numbers in streams were very low.

In moraine ponds, 3 species typical of freshwater habitats dominated. More numerous than elsewhere was *Amphibolus smreczynskii*, but typical freshwater species *Dactylobiotus ambiguus* was not observed.

In moss banks tardigrade species diversity was the highest: 12 species, with three typical species dominating. More numerous than in other habitats was the genus *Diphascon*, mainly *Diphascon recamierii*.

In thaw ponds most abundant was *Hypsibius (Hypsibius) pallidus*. Scarce were *Hypsibius (Hypsibius) dujardini* and *Dactylobiotus ambiguus*.

In nearshore ponds *Hypsibius (Hypsibius) dujardini* dominated. *Hypsibius (Hypsibius) pallidus* was more abundant than *Hypsibius (Isohypsibius) granulifer*.

Diphascon recamierii was the characteristic species of moss banks and streams, *H. (H) pallidus* of thaw ponds and nearshore ponds, while *H. (H.) dujardini* of moraine ponds.

Sörensen index showed 100% similarity between moss banks and thaw ponds, and its minimum value (80%) was calculated for moss banks and streams.

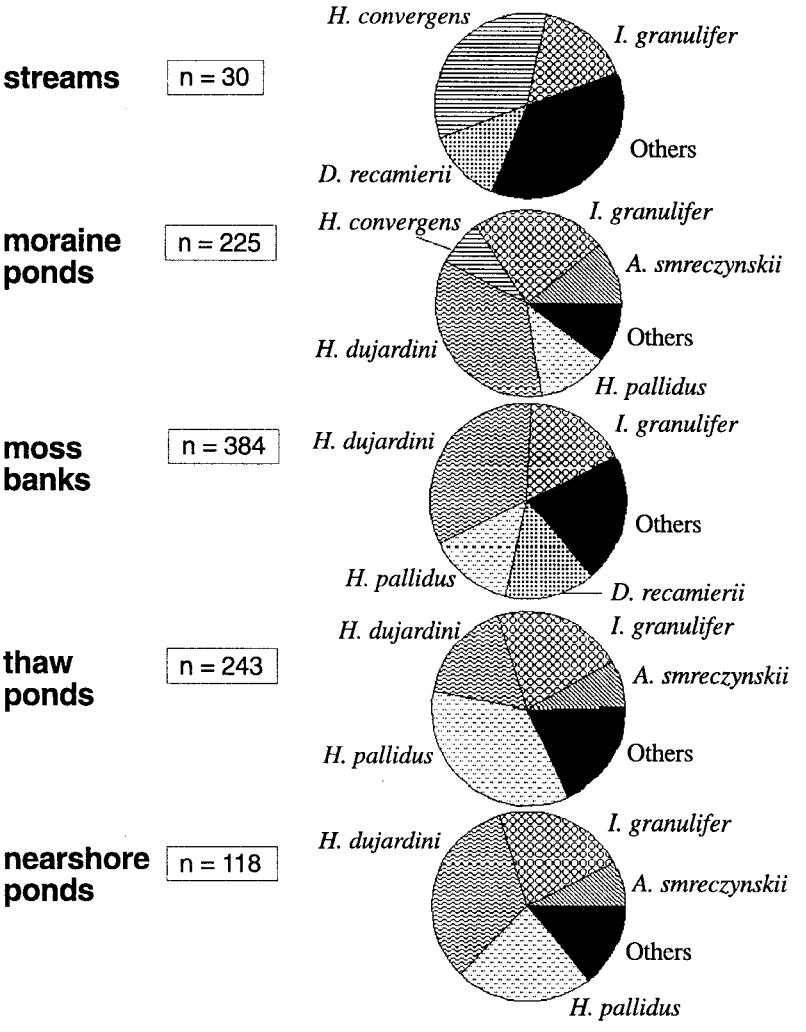

Fig. 4. Tardigrade composition in freshwater habitats in Hornsund area in summer season; n — total number of observed individuals.

This result shows biggest similarity between moss banks and thaw ponds in both Nematoda and Tardigrada composition.

Rotifera (Fig. 5.). — Class Bdelloidea constituted from 70.1 to 96.1% of all Rotifera, depending on habitat; their percent contribution was the highest in streams and the lowest in thaw ponds. Species composition was determined only for class Monogononta: 20 species from 11 genera were found (Table 1).

In streams *Colurella colurus* and *Euchlanis dilatata* were the most numerous, but Monogononta were scarce in this habitat. More abundant than elsewhere was *Dicranophorus uncinatus*.

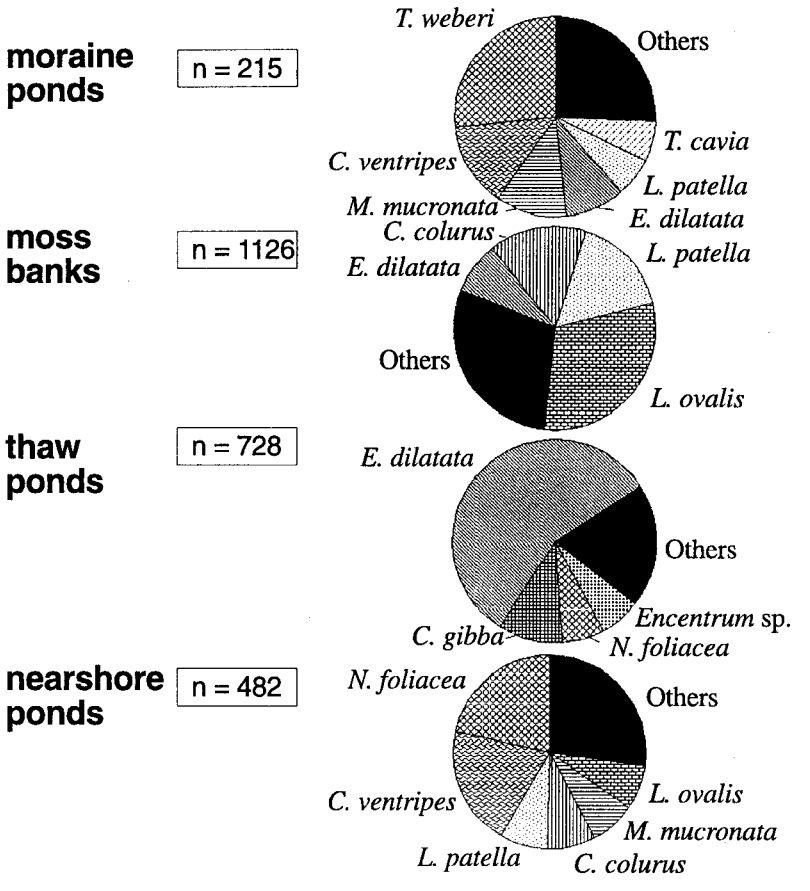

Fig. 5. Monogonont composition in freshwater habitats in Hornsund area in summer season; n — total number of observed individuals.

Moraine ponds were dominated by *Trichocerca weberi,* being present so frequently only there. Typical of this habitat were also *Mytilina mucronata* and *Cephalodella ventripes.*

In moss banks species typical for mosses occurred: *Lepadella ovalis, Lepadella patella* and *Colurella colurus,* but monogononts were only 11% of all rotifers. *Cephalodella gibba* and *Cephalodella catellina* were more common there than elsewhere.

Thaw ponds were dominated by *Euchlanis dilatata.* Similarly as in nearshore ponds *Notholca foliacea* was common, together with *Cephalodella gibba.*

In nearshore ponds typical species was *Notholca foliacea*, but *Cephalodella ventripes* was also abundant. Common were three Colurellidae species.

All habitats had typical rotifer species; there were *Dicranophorus uncinatus* in streams, *Trichocerca weberi* in moraine ponds, Colurellidae (*Lepadella pa-*

tella, Lepadella ovalis, Colurella colurus) in moss banks, *Euchlanis dilatata* in thaw ponds and *Notholca foliacea* in nearshore ponds.

Sörensen index was the highest for moss banks and nearshore ponds (100.0), and the lowest for nearshore ponds and streams (69.0).

Comparing Sörensen index values for all groups and habitats we can say, that in species composition most similar were moss banks, thaw ponds and nearshore ponds. The reason for this similarity might be that the shores and, to some extent, the bottom of thaw ponds and nearshore ponds, were covered with mosses.

Rotifera showed the highest species differentiation in particular habitats ($S_{ö}$ between 69.0 and 100.0, while Tardigrada the lowest (S between 80.0 and 100.0). Tardigrada are the most tolerant for different conditions in specific habitats.

Crustacea composition (Fig. 6). — Crustacea were present in two types of biotopes only: in some moraine and in all nearshore ponds. Nauplii of Copepoda were found in moss banks too, but no copepodits or adults occurred in this habitat.

In moraine ponds, which dried up by the end of August, two cladocerans *Daphnia middendorffiana* and *Chydorus sphaericus*, as well as *Diacyclops crassicaudis* (Copepoda, Cyclopoida) were identified. *Chydorus sphaericus* dominated till the end of June, while maximum number of *Daphnia middendorffiana* was reached in the end of July, together with the peak of much less numerous *D. crassicaudis.*

In nearshore ponds three cladocerans (*D. middendorffiana, Ch. sphaericus* and *Macrothrix hirsuticornis*) and a calanoid species, *Eurytemora raboti*, were identified. At the end of July most numerous was *E. raboti*, while *D. middendorffiana* maximum number was below 2 ind. per litre. Abundance of *Ch. sphaericus* and *M. hirsuticornis* was low throughout whole season. Except of Cladocera and Copepoda, *Lepidurus arcticus* (Phyllopoda, Notostraca) was present in nearshore ponds. Individuals caught occurred in dense populations and their distribution had a mosaic character, connected with the presence of vegetation.

King George Island

Nematoda (Fig. 7). — 13 species out of 8 genera were determined (Table 1). In all habitats two families dominated: Plectidae and Monhysteridae, in their juvenile forms. In all habitats most frequent were species of *Eumonhystera* and *Plectus antarcticus.*

Streams were very poor in nematode fauna; only 4 species occurred, between them most numerous were juvenile *Plectus* and *Amphidelus* sp.

In moraine ponds most numerous were juvenile Monhysteridae and *Plectus*, and adult *Eumonhystera vulgaris* and *P. antarcticus. Coomanchus gerlachei* had a higher percent contribution than in other habitats.

In moss banks 13 species were identified, with juvenile *Plectus* being most numerous (40% of all nematodes). More abundant than elsewhere were *P. ant-*

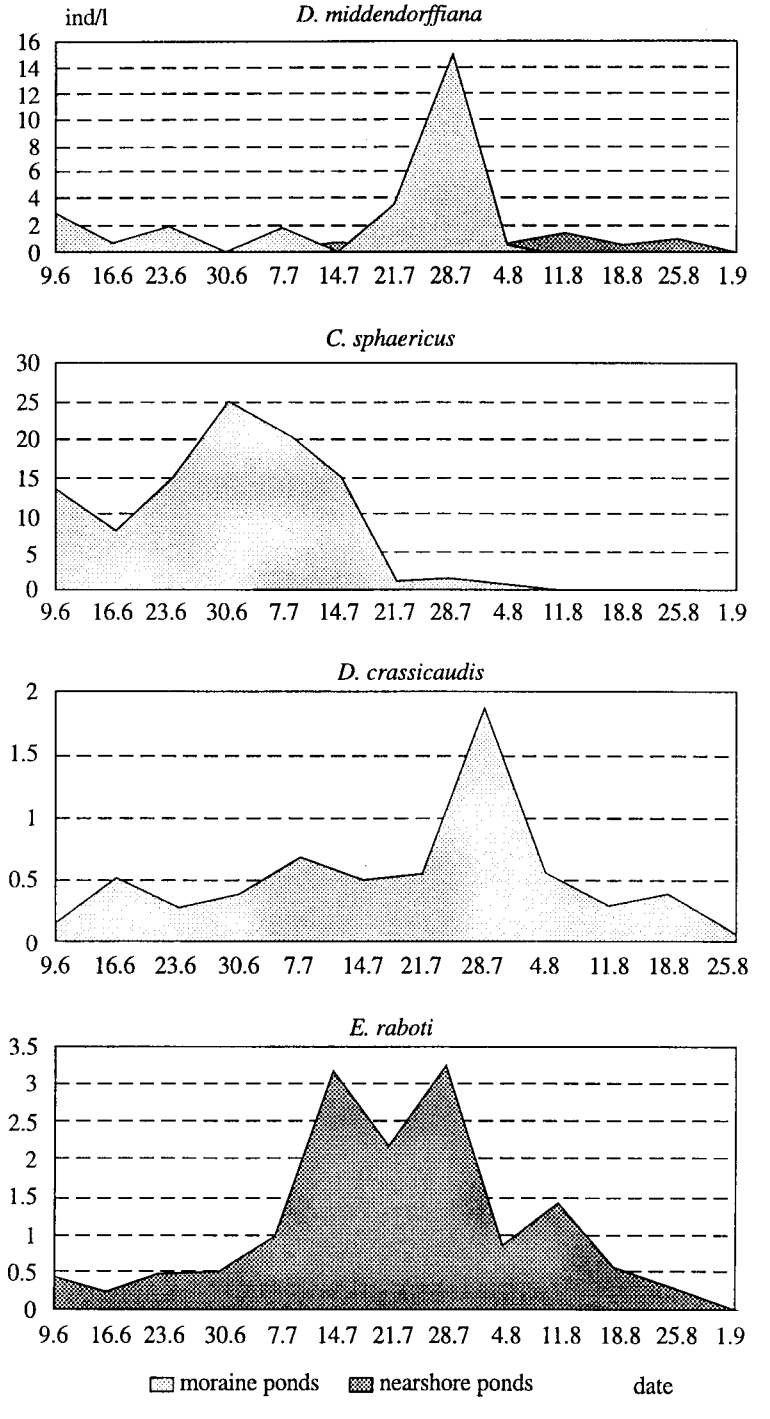

Fig. 6. Seasonal changes of Crustacea number in moraine and nearshore ponds of Hornsund area in summer.

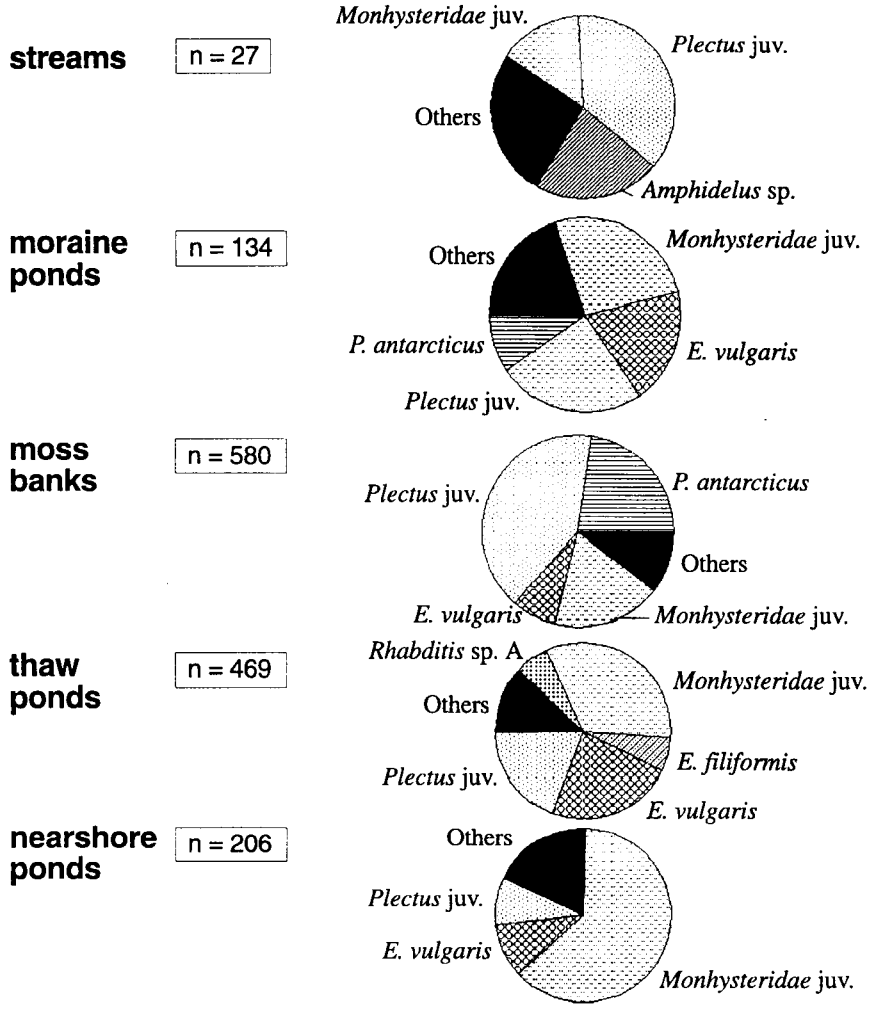

Fig. 7. Nematode composition in freshwater habitats in Admiralty Bay area in summer season; n — total number of observed individuals.

arcticus and *Eudorylaimus* sp. Only in this habitat *Geomonhystera villosa* was observed.

In thaw ponds 10 species were determined, with juvenile Monhysteridae being most abundant. Adult Monhysteridae constituted about 30% of all nematodes. More numerous than in other habitats were Rhabditidae and *Plectus parietinus*.

Juvenile Monhysteridae dominated also in nearshore ponds. More common than elsewhere was *Geomonhystera* sp.

Species typical of streams was *Amphidelus* sp., of moraine ponds *C. gerlachei*, of moss banks *G. villosa* and of thaw ponds *Rhabditis* (subgenus A) sp. In

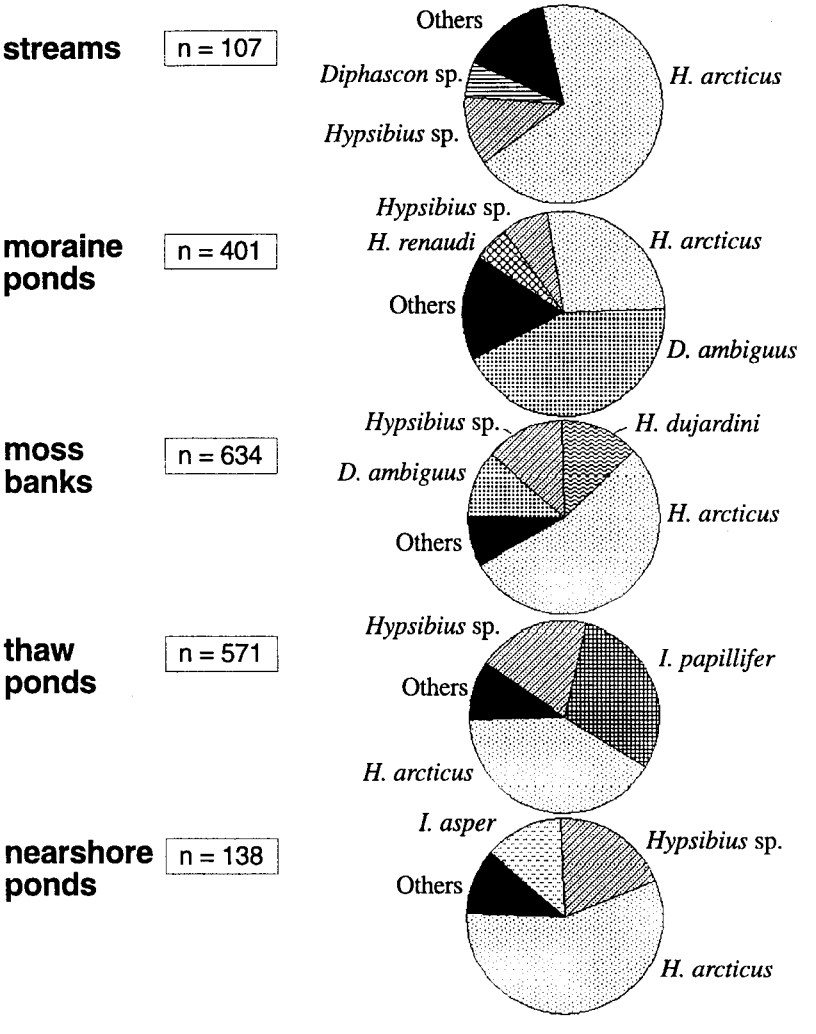

Fig. 8. Tardigrade composition in freshwater habitats in Admiralty Bay area in summer season; n — total number of observed individuals.

moss banks the percent contribution of Monhysteridae was low, while in nearshore ponds *P. antarcticus* and *E. vulgaris* were lacking.

Sörensen similarity index varied between 52.6 and 90.3, depending on habitats compared. Highest value was obtained for moss banks and nearshore ponds, and the lowest for thaw ponds and streams.

Tardigrada (Fig. 8). — 11 species out of 4 genera were identified (Table 1). Except of moraine ponds dominant species in other habitats was *Hypsibius (Hypsibius) arcticus.*

In streams *H. (H.) arcticus* composed 70% of all Tardigrada; almost 4% was *Dactylobiotus ambiguus.*

Only in moraine ponds *D. ambiguus* was more numerous than *H. (H.) arcticus.* Relatively abundant was genus *Diphascon* with dominating *Diphascon cf. greveni.*

In moss banks, except of dominating *H. (H.) arcticus,* two species rare in other habitats occurred: *Hypsibius (Hypsibius) dujardini* and *Macrobiotus furciger.* More abundant than in other habitats, except moraine ponds, was *Dactylobiotus ambiguus.*

In thaw ponds, where Tardigrada were numerous, except of *H.arcticus*, abundant were *Hypsibius (Isohypsibius) papillifer* and *Hypsibius (Isohypsibius) renaudi. Dactylobiotus ambiguus* and *Diphascon* were very rare; single individuals occurred only.

In nearshore ponds *D. ambiguus*, which is considered to be a typical freshwater species, did not occur. *H. (H.) arcticus* constituted more than 50% of tardigrades, and numerous were also *Hypsibius (Isohypsibius) asper* and *H. (I.) papillifer.*

D. ambiguus was characteristic of moraine ponds, *H. (H.) dujardini* and *M. furciger* of moss banks, *H. (I.) papillifer* of thaw ponds and *H. (I.) asper* of nearshore ponds.

Sörensen index was the highest (90.9) for nearshore ponds and streams, and the lowest (53.3) for moraine ponds and streams.

Rotifera (Fig. 9). — Bdelloidea constituted more than 50% of Rotifera in most habitats: from 98.5% in moss banks to 58.8% in nearshore ponds. Only in thaw ponds Monogononta were more abundant (51.3%) than Bdelloidea. Same as for Hornsund region, species composition of Monogononta was determined only. Out of that class 11 species from 7 genera were identified (Table 1).

There were only few individuals of Monogononta caught in streams, therefore the species composition in this habitat was not presented.

In moraine ponds *Resticula gelida* dominated. Other monogononts constituted only 21% of all rotifers. Comparing to other habitats *Notholca squamula salina* was not abundant, but *Notholca walterkostei* was observed; this species was absent elsewhere.

In moss banks the number of Monogononta was very low and they were represented almost exclusively by the family Notommatidae. The most abundant was *Encentrum* sp.; *Encentrum mustela, R. gelida* and *Resticula nyssa* were also present. In comparison to the moss banks of Hornsund region, number of Colurellidae was very low.

In thaw ponds number of Monogononta in a whole season was 10 times higher than elsewhere. Species diversity was also the highest: 9 species occurred. The most numerous was *N. squamula salina*, (more than 50% of all individuals).

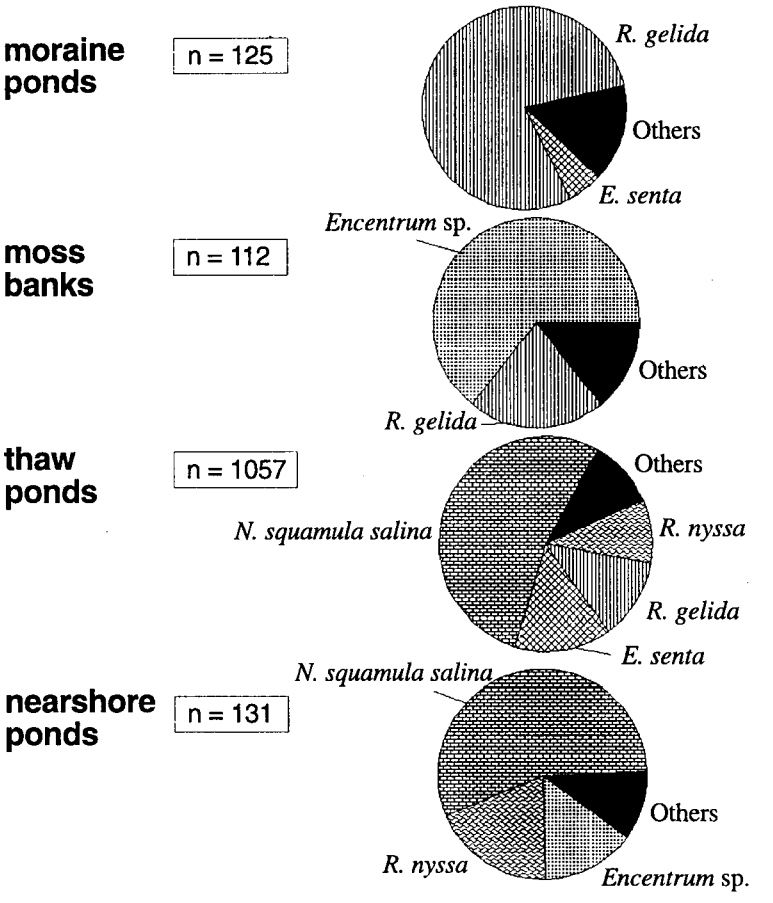

Fig. 9. Monogonont composition in freshwater habitats in Admiralty Bay area in summer season; n — total number of observed individuals.

The highest numbers of *Epiphanes senta* and *Lepadella patella* were observed there.

In nearshore ponds, as in thaw ponds, *N. squamula salina* dominated. *R. nyssa* constituted almost 20% of abundance, while *Cephalodella catellina* was more abundant in this habitat than in others.

R. gelida was a typical species of moraine ponds, *Encentrum* sp. of moss banks, and *N. squamula salina* of nearshore and thaw ponds.

Sörensen index ($S_ö$) values were lower for Rotifera than for the other groups: it reached 82.4 for moraine ponds and thaw ponds, and was only 36.4 for moss banks and nearshore ponds.

In freshwater habitats on King George Island $S_ö$ was most diversified for Monogononta (between 36.4 and 82.4), and for Nematoda and Tardigrada $S_ö$ ranged from 53 to 90.

Table 1

List of freshwater invertebrates of Hornsund and Admiralty Bay region.

Spitsbergen	King George Island
NEMATODA	
Family: Plectidae	
Plectus parietinus Bastian, 1865	*Plectus parietinus* Bastian, 1865
Plectus aquatilis Andrassy, 1984	*Plectus antarcticus* de Man, 1904
Plectus cf. opisthocirculus Andrassy, 1952	*Plectus cf. parvus* Bastian, 1865
Anaplectus cf. grandepapillatus (Ditlevsen, 1928)	
Family: Monhysteridae	
Eumonhystera vulgaris (de Man, 1880)	*Eumonhystera vulgaris* (de Man, 1880)
Eumonhystera filiformis (Bastian, 1865)	*Eumonhystera filiformis* (Bastian, 1865)
Monhystera stagnalis Bastian, 1865	*Geomonhystera villosa* (Bütschli, 1873)
	Geomonhystera sp.
Family: Dorylaimidae	
Eudorylaimus sp.	*Eudorylaimus* 2spp.
Mesodorylaimus sp.	
Family: Mononchidae	
	mononchid sp.1
	Coomanchus gerlachei (de Man, 1904)
Family: Alaimoidae	
	Amphidelus sp.
Family: Cyatholaimidae	
Achromadora tenax (de Man, 1876)	
Achromadora sp.	
Family: Microlaimidae	
Ethmolaimus sp.	
Family: Tripylidae	
Tripyla cf. infia Brzeski *et* Winiszewska-Ślipińska, 1903	
Tobrilus sp.	
Family: Teratocephalidae	
Teratocephalus sp.	
Family: Rhabditidae	
Rhabditis sp.	*Rhabditis* (subgenus A) sp.

Table 1 (*cont.*)

TARDIGRADA

Spitsbergen	King George Island
Family: Echiniscidae	
Echiniscus wendti Richters, 1903	*Echiniscus* sp.
Echiniscus sp.	
Family: Macrobiotidae	
Dactylobiotus ambiguus (Murray, 1907)	*Dactylobiotus ambiguus* (Murray, 1907)
Amphibolus smreczynskii (Węglarska, 1970)	*Macrobiotus furciger* Murray, 1907
Hypsibius (H.) convergens Urbanowicz, 1925	*Hypsibius (H.) arcticus* (Murray, 1907)
Hypsibius (H.) dujardini (Doyere, 1840)	*Hypsibius (H.) dujardini* (Doyere, 1840)
Hypsibius (H.) pallidus Thulin, 1911	*Hypsibius (H.) renaudi* Ramazotti, 1972
Hypsibius (I.) granulifer Thulin, 1928	*Hypsibius (I.) papillifer* (Murray, 1905)
Hypsibius (I.) cf. prosostomus (Thulin, 1928)	*Hypsibius (I.) asper* (Murray, 1906)
Diphascon recamierii Richters, 1911	*Diphascon cf. greveni* Dastych, 1984
Diphascon scoticum Murray, 1905	*Diphascon cf. mirabilis* Dastych, 1984
Diphascon alpinus (Murray, 1906)	*Diphascon pinguis* (Marcus, 1936)
Diphascon spitsbergense Richters, 1903	

ROTIFERA

Class: Bdelloidea

Class: Monogononta

Spitsbergen	King George Island
Family: Notommatidae	
Cephalodella gibba (Ehrenberg, 1832)	*Cephalodella fortificata* (Ehrenberg, 1832)
Cephalodella ventripes (Dixon-Nuttall, 1901)	*Cephalodella catellina* (O.F. Müller, 1786)
Cephalodella catellina (O.F. Müller, 1786)	*Resticula gelida* (Harring *et* Myers, 1922)
	Resticula nyssa Harring *et* Myers, 1924
Family: Colurellidae	
Lepadella patella (O.F. Müller, 1786)	*Lepadella patella* (O.F. Müller, 1786)
Lepadella ovalis (O.F. Müller, 1786)	*Colurella colurus* (Ehrenberg, 1830)
Colurella colurus (Ehrenberg, 1830)	
Family: Brachionidae	
Notholca foliacea (Ehrenberg, 1838)	*Notholca squamula salina* Focke, 1961
Notholca squamula (O.F. Müller, 1786)	*Notholca walterkostei* De Paggi, 1982
Family: Dicranophoridae	
Encentrum 2 spp.	*Encentrum* sp.
Dicranophorus uncinatus (Milne, 1886)	*Encentrum mustela* (Milne, 1885)
Family: Trichocercidae	
Trichocerca weberi (Jennings, 1903)	
Trichocerca cf. cavia (Gosse, 1886)	
Family: Epiphanidae	
	Epiphanes senta (O.F. Müller, 1773)

Table 1 (*cont.*)

Family: Lecanidae	
Lecane rotundata (Oloffson, 1918)	
Lecane (Monostyla) lunaris (Ehrenberg, 1832)	
Lecane (Monostyla) piepelsi De Smet, 1993	
Family: Mytylinidae	
Mytilina mucronata (O.F. Müller, 1773)	
Mytilina ventralis brevispina (Ehrenberg, 1832)	
Family: Euchlanidae	
Euchlanis dilatata Ehrenberg, 1832	
Family: Collothecidae	
Collotheca ornata cornuta (Dobie, 1842)	
CRUSTACEA	
Spitsbergen	**King George Island**
Order: Phyllopoda **Suborder: Notostraca**	
Lepidurus arcticus (Pallas, 1793)	
Suborder: Anostraca	
	Branchinecta gaini Daday, 1910
Suborder: Cladocera	
Chydorus sphaericus (O.F. Müller, 1785)	
Daphnia middendorffiana Fischer, 1851	
Macrothrix hirsuticornis Norman *et* Brady, 1867	
Order: Copepoda **Suborder: Calanoida**	
Eurytemora raboti Richard, 1897	*Pseudoboeckella poppei* Mrazek, 1901
Suborder: Cyclopoida	
Diacyclops crassicaudis (Sars, 1863)	

Comparing Sörensen index values for freshwater habitats of King George Island we could not find habitats similar in terms of species composition for all surveyed groups. $S_{ö}$ was the highest for Nematoda in comparison of moss banks and nearshore ponds, within Tardigrada for nearshore and thaw ponds and within Rotifera for moraine and thaw ponds.

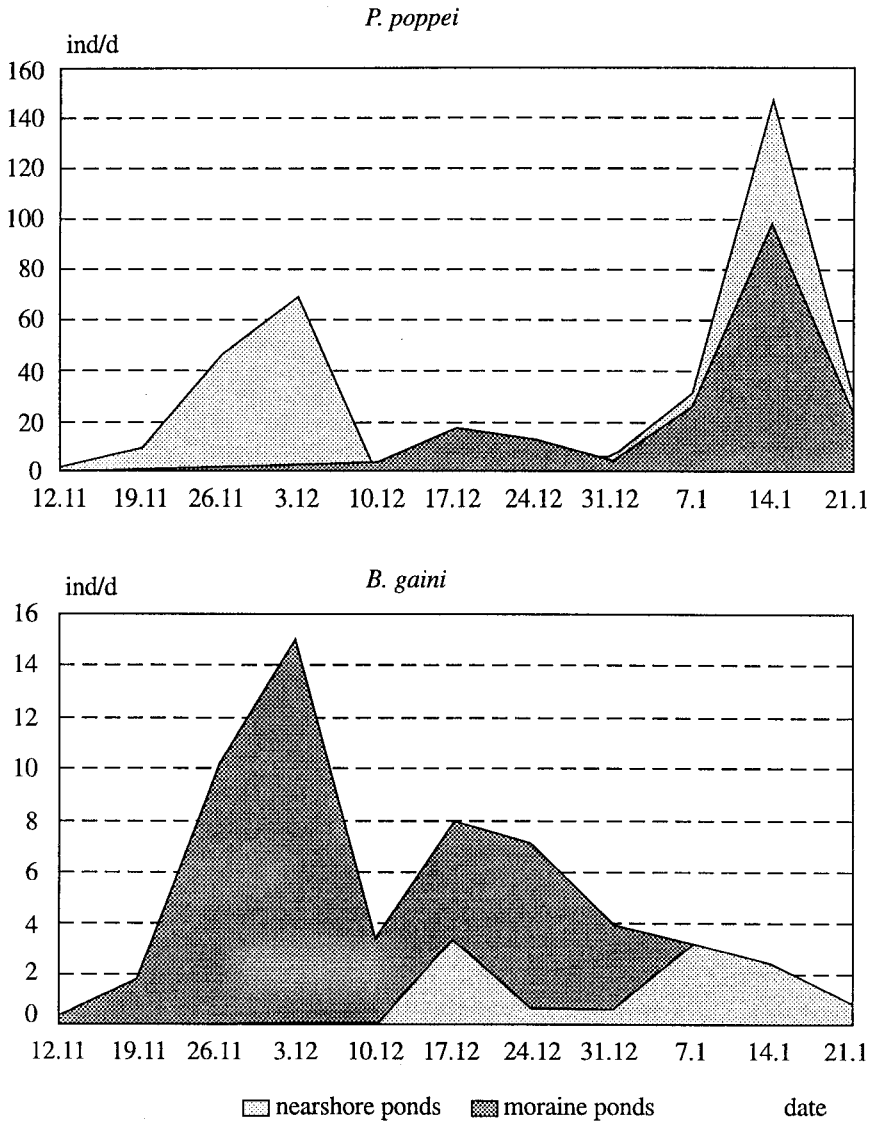

Fig. 10. Seasonal changes of Crustacea number in moraine and nearshore ponds of Admiralty Bay area in summer.

Crustacea composition (Fig. 10). — Crustacea were represented by two species: *Pseudoboeckella poppei* (Copepoda, Calanoida) and *Branchinecta gaini* (Phyllopoda, Anostraca). Both species were found only in moraine and nearshore ponds, although juvenile *P. poppei* occurred in moss banks and thaw ponds too. Both species occurred in high densities up to 150 ind/l of *P. poppei* and up to 15 ind/l of *B. gaini*.

Discussion

The comparison of species common in both regions (Table 2) with total number of species identified in these areas showed that similarity on the species level on Spitsbergen and on King George Island is low or none in surveyed groups. Full similarity in both regions is achieved on family level only by Tardigrada.

The fact, that number of species decreases together with growing latitude (Remmert 1980) has been confirmed. Both on Spitsbergen and on King George Island freshwater fauna was poorer than in Subarctic (Remmert 1980) and Subantarctic (Maslen 1979, Dartnall and Hollowday 1985, Dartnall 1993) respectively.

The comparison between species and genus composition in both regions showed many interesting results.

Table 2

Similarity of surveyed taxa on Spitsbergen and King George Island.

	Number of taxa common in both regions / number of taxa present in both regions (% of common taxa)			
Taxa	**Nematoda**	**Tardigrada**	**Rotifera**	**Crustacea**
Species	3/29 (10%)	2/24 (8%)	3/31 (10%)	0/8 (0%)
Genera	4/20 (20%)	3/8 (38%)	5/18 (28%)	0/8 (0%)
Families	5/10 (50%)	2/2 (100%)	4/10 (40%)	0/8 (0%)

Nematoda

From Spitsbergen (mainly Isfjorden) Loof (1971) reported 72 species, from mosses, soil and water. As typically freshwater species he reported *Monhystera stagnalis* (species present in our research too) and *Tripyla papillata.* Only 7 species were the same as in our research. Genera *Plectus* and *Monhystera* were typical of freshwater habitats both in our and Loof (ibid.) research. Loof recorded numerous nematodes from family Tylenchidae and genus *Cervidellus*, which were absent in our investigation. Comparing to temperate regions Loof (ibid.) emphasized domination of few genera on Spitsbergen *i.e.* of the genus *Plectus*. Species dominating in our research (both *Eumonhystera* and most *Plectus* species) are common in Europe, but *Plectus opisthocirculus, Anaplectus grandepapillatus* and *Tripyla infia* are new records for Spitsbergen. In our research in Hornsund region endemic nematodes were not recorded.

In maritime Antarctic 40 nematode species from 19 genera were recorded by Maslen (1979), but they were mainly soil nematodes. Most frequent were *Plectus*

antarcticus, Plectus parietinus, Aphelenchoides sp. and *Coomanchus gerlachei* First two species were also dominant in our research, and *Coomanchus gerlachei* was not numerous, but present in all habitats. From the Maslen's list (ibid.) of nematodes in maritime Antarctic, at least 6 were also present in Admiralty Bay region of King George Island; next 5 species in our investigation was identified only to the generic level, and 2 species (*Eumonhystera vulgaris* and *Eumonhystera filiformis*) were recorded from Subantarctic, not in maritime Antarctic (Spaull 1973b, Maslen 1979). Species diversity of Nematoda decreased with growing latitude: in continental Antarctic only 10 species from 6 genera were recorded (Timm 1971, Maslen 1979, Yeates 1979). Maslen (ibid.) estimates, that about 85% of species and 16% of genera in maritime Antarctic, is endemic. On King George Island 4 endemic Antarctic species were identified (comparing to the total number of 13 species recorded), and 2 other *Eudorylaimus* species are probably endemic too.

Three species of Nematoda *(Plectus parietinus, Eumonhystera vulgaris* and *Eumonhystera filiformis*) present in our research have a bipolar distribution. In Arctic and Antarctic *Plectus parvus* is considered as a bipolar species, but it was absent in our investigation in Hornsund region.

Tardigrada

Węglarska (1965) from Spitsbergen reported 30 Tardigrada species from mosses and terrestrial habitats of Hornsund region, of which 7 species (out of 13) were also observed in our research. Other 5 species were mainly freshwater species, of which 2 were reported by De Smet, Van Rompu and Beyens (1988) from freshwater habitats of Edgeoya (Svalbard archipelago). The above authors identified there 9 species, including 7 the same as in Hornsund region. Dastych (1985), describing moss Tardigrada in Hornsund region, found 21 species and 10 same species as in our research. Out of tardigrades identified in the present work only 1 species (*Amphibolus smreczynskii*) has a northern range of occurrence, others are cosmopolitan.

From maritime Antarctic and the continent Dastych (1984) reported 25 Tardigrada species from mosses and lichens. From the eastern part of the continent Utsugi and Ohyama (1989) recorded 5 tardigrade species. On Signy Island 16 species were identified (Jennings 1979, McInnes and Ellis-Evans 1987), including 9 same as in our research. From King George Island Utsugi and Ohyama (1993) reported 11 species; of which 4 were also present in this research. *Hypsibius (H.) arcticus, Dactylobiotus ambiguus* and *Hypsibius (I.) papillifer*, which are most frequent in Admiralty Bay region of King George Island, are cosmopolitan species. In the paper by Dastych (1984), out of 25 reported species, 8 were new for science. It seems however, that in the Antarctic the endemism of Tardigrada is lower than that of Nematoda. In present research, common

species for both Spitsbergen and King George Island were only 2 tardigrades: *Hypsibius* (*H.*) *dujardini* and *Dactylobiotus ambiguus*.

Rotifera

All Monogononta found in our research (20 species) were reported earlier from the Arctic, but *Lecane rotundata* only from the Canadian Arctic (De Smet and Bafort 1990), and *Lecane* (*M.*) *lunaris* and *Mytilina mucronata* from the Canadian Arctic and Greenland (De Smet and Bafort 1990, De Smet, Van Rompu and Beyens 1993). Other species were already observed in Svalbard archipelago (De Smet, Van Rompu and Beyens 1988, De Smet 1990, 1993). In our research in Hornsund region we did not find cold stenothermic species *Notholca latistyla*, present in other areas of Spitsbergen (Olofsson 1918, Amrén 1964 a, b).

Out of species identified in Hornsund region *Lecane rotundata* only has a northern range of occurrence and is considered to be an Arctic species, while *Lecane piepelsi* is a new species described from Spitsbergen by De Smet (1993). Other Rotifera species are cosmopolitan.

From Antarctica (south of 60°) 49 monogonont and 27 bdelloid species have already been reported (Dartnall and Hollowday 1985). On Signy Island 38 Rotifera species were found (ibid.), while on Macquarie Island 28 Monogononta and 8 Bdelloidea species (Dartnall 1993). From King George Island De Paggi (1982) reported 10 Monogononta, out of which only four (*Lepadella patella, Notholca walterkostei, Notholca squamula salina* and *Epiphanes senta*) were the same as in our research. All our Monogononta, except *Resticula nyssa*, were formerly reported from the Antarctic (Dartnall and Hollowday 1985). *Cephalodella catellina* and *Epiphanes senta* were observed in McMurdo Sound region (Murray 1910b). *Resticula nyssa* has up to now been reported from subantarctic Macquarie Island (Dartnall 1993). In our research *Lepadella patella* was present in 1987/1988 only (Janiec 1993), while it was absent in 1991/1992 season. Thaw ponds, where these species occurred during the first season, in 1991/1992 season existed for a short time only and then dried up. Out of our species list, only *Notholca walterkostei* can be considered as an endemic species for Antarctica.

In both surveyed polar areas cosmopolitan species *Lepadella patella, Colurella colurus* and *Cephalodella catellina* were found. Few other bipolar monogononts (*Dicranophorus uncinatus, Encentrum mustela, Lecane lunaris*, and *Collotheca ornata cornuta*) were present only in one region.

Out of the surveyed microfaunal groups lower number of species were recorded comparing to other papers dealing with Arctic and Antarctic invertebrates. One of the reasons could be that in the present research freshwater habitats and mosses were surveyed only, while Nematoda occur abundantly in soil and Rotifera and Tardigrada in mosses not necessarily connected with water basins.

Crustacea

In both polar regions studied, different Crustacea species occurred.

In Hornsund region of Spitsbergen 3 Cladocera species were found, while cladocerans in Admiralty Bay region of King George Island were not found at all. Husmann *et al.* (1978) from Svalbard archipelago reported 6 Cladocera species; 3 of them were recorded in the present research. Two copepod species (*Eurytemora raboti* and *Diacyclops crassicaudis*) on Spitsbergen and one (*Pseudoboeckella poppei*) on King George Island were observed by the present author, but maximum density of *E.raboti* (3.3 ind/l) and *D.crassicaudis* (1.9 ind/l) never reached the one of *P. poppei* (150.9 ind/l), which did not have any competitive cladocerans in the ponds inhabited. *Eurytemora raboti* (Copepoda, Calanoida), is considered as a species of marine origin and present in shallow ponds (Olofsson 1918, Halvorson and Gullestad 1976). Halvorson and Gullestad (ibid.) reported from Spitsbergen the same Crustacea species as they were found in the present research, except of *Cyclops abyssorum*, found by these authors in large and deep water bodies.

Lepidurus arcticus from Hornsund region and Branchinecta gaini from Admiralty Bay region seem to occupy the same ecological niche in freshwater ecosystem of shallow, nearshore pond. In Hornsund region only *Lepidurus arcticus* is a cold stenothermic species restricted to Arctic; other Hornsund crustaceans have a wide distribution in the Holarctic. *Branchinecta paludosa*, present in whole Arctic (Daborn 1978), seems to be absent on Spitsbergen.

In the Antarctic, Crustacea were recorded from Signy Island, South Georgia, Alexander Island, South Shetlands and Antarctic Peninsula. In eastern Antarctic in a saline lake marine new species of *Gladioferens* Henry (Copepoda, Calanoida) (Bayly 1994) was identified. *Pseudoboeckella poppei* and *Branchinecta gaini* common in our research were recorded earlier from King George Island (Campos, Arenas and Steffen 1978, Jurasz, Kittel and Presler 1983, Paggi 1987, Janiec 1993), and common in whole western Antarctic. Neither *Parabroteas sarsi* (Copepoda, Cyclopoida), identified from Signy Island (Heywood 1967), nor Cladocera present there (Heywood 1967, 1977), were not recorded. *Pseudoboeckella poppei* (Calanoida, Centropagidae), present on King George Island is common not only in western Antarctica, but also in all southern hemisphere, and Branchinecta gaini is a cold stenothermic species present in western Antarctica and in South America. In Subantarctic crustaceans are considered as a dominant component of ponds fauna (Paggi 1987); on King George Island, even though there are only two species present, they play an important role taking into account their density (up to 150 ind/l of *P. poppei* and up to 15 ind/l of *B. gaini*), biomass and the fact that they are detritivorous.

In all surveyed groups more genera and species were recorded from Spitsbergen than from King George Island. On King George Island more Antarctic

endemic species were present, than Arctic endemic species on Spitsbergen, where most of the species are common on northern hemisphere.

Despite similar climatic conditions and similar freshwater habitats, composition of invertebrate freshwater fauna in Hornsund and Admiralty Bay regions were very different probably because of many reasons:

— different duration of colonisation. The age of marine terraces in Hornsund region is estimated for about 10 000 years and more (Karczewski, Kostrzewski and Marks 1981), whereas freshwater habitats from Admiralty Bay region are 100 to 500 years old (Birkenmajer 1981 a, b);

— different sources of colonisation. Except cosmopolitan species, many Spitsbergen species come from northern Europe, and many King George species derive probably from South America;

— different stage of tundra development. In Hornsund region typical tundra, with rich moss and vascular flora occurs, which increases freshwater habitats trophy. In Admiralty Bay region we do not encounter typical tundra habitat;

— different avifauna: on Spitsbergen more bird species, including migrating species, than on King George Island occur, which can transfer propagules of microfauna;

— different anthropogenic impact in both regions: Svalbard had been the area of whaling for 700 years, while South Shetlands have been explored for only about 100 years.

It seems, that the consequence of all mentioned above factors is a richer composition of freshwater invertebrate fauna on Spitsbergen than on King George Island.

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Streszczenie

Porównano skład gatunkowy Nematoda, Tardigrada, Rotifera i Crustacea w różnych środowiskach słodkowodnych rejonu Hornsundu (fig. 1, Spitsbergen, Arktyka) i rejonu Zatoki Admiralicji (fig. 2, King George Island, Antarktyka). We wszystkich badanych grupach więcej gatunków i rodzajów stwierdzono na Spitsbergenie niż na King George Island (tab. 1–2). Środowiskiem najbogatszym w gatunki w obu rejonach były mszarniki i rozlewiska, najuboższym strumienie (fig. 3–5, 7–9). W obu rejonach dominowały gatunki kosmopolityczne, ale więcej endemidów stwierdzono na King George Island. Pod względem składu gatunkowego w badanych grupach środowiska słodkowodne rejonu Hornsundu są do siebie bardziej podobne niż te z rejonu Zatoki Admiralicji. Średnia liczebność mejofauny, reprezentowanej przez Crustacea, była kilkakrotnie niższa w zbiornikach słodkowodnych Hornsundu niż w rejonie Zatoki Admiralicji (fig. 6, 10). Pomimo podobnych warunków klimatycznych środowiska słodkowodne rejonu Hornsusndu są bogatsze niż odpowiadające im środowiska rejonu Zatoki Admiralicji. Przyczyną tego stanu może być m.in. dłużej trwające zasiedlenie rejonu Hornsusndu (około 10 000 lat) niż rejonu Zatoki Admiralicji (do 500 lat), bogatsza i większa powierzchniowo tundra, co zwiększa trofię zbiorników, oraz bogatsza awifauna migrująca Spitsbergenu, ułatwiająca przenoszenie mikrofauny.