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General Article

Rotifers and lower crustaceans from South-western Iceland

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Abstract

Background

Iceland has high availability of freshwater, and it is rich in brackish and coastal aquatic bodies. However, knowledge on rotifers and meiobenthic and planktonic crustaceans inhabiting these habitats is lacking, and the inland aquatic fauna in Iceland is relatively understudied in comparison with the fauna of adjacent marine ecosystems. The majority of past research focused on larger lakes with the exception of one study on rotifers from the 1950s (Bartoš 1951) and two more recent studies on crustacean fauna of shallow freshwater bodies (Novichkova et al. 2014, Scher et al. 2000). Data are particularly scarce for the south-western part of the country.

New information

We studied the composition of selected invertebrate taxa in various aquatic (marine, brackish and freshwater) habitats from South-western Iceland with a focus on Rotifera, Cladocera and Copepoda. Samples were collected from 12 localities, including marine interstitial, freshwater temporary shallow pools, swamps, wet mosses, springs, and lakes (both brackish and freshwater). We found 39 taxa in total. Rotifera dominated the sampled water bodies, followed by Copepoda and Cladocera. Three of the recorded taxa are new

for Iceland, of which two are rotifers [*Trichocerca* cf. *mucosa* (Stokes, 1896) and *T. vernalis* (Hauer, 1936)], and one is a marine copepod (*Cyclopina gracilis* Claus, 1862). For some of the sampled localities (Sikið and Leirvogsvatn Lakes, and some of the smaller habitats) we present the first data on their microinvertebrate fauna.

Keywords

Rotifera, Cladocera, Copepoda, Iceland, new records, marine, brackish, freshwater

Introduction

Iceland is one of the countries with the highest freshwater availability according to UNEP's Vital water graphics (http://www.eoearth.org/view/article/152861/). Additionally, being an island, it is rich in coastal brackish and saline aquatic habitats. However, little is known about the microcrustaceans and rotifers inhabiting these numerous habitats. The freshwater fauna of Iceland is relatively understudied compared to the fauna of adjacent marine ecosystems. Exhaustive sampling of deep-sea fauna was conducted within the inter-Nordic BIOICE project. As a result, Apostolov (2011) recorded 32 copepod harpacticoids of which 20 are new for the fauna of Iceland.

The first data on freshwater microinvertebrate fauna of Iceland date back to the 19th century (Guerne and Richard 1892a, Guerne and Richard 1892b). The first study on the rotifer fauna from the middle of the 20th century listed 59 species or subspecies (Bartoš 1951). The majority of the available studies on inland water bodies focused on large lakes: Mývatn in the north-east (Örnólfsd and Einarsson 2004, Adalsteinsson 1979, Jónasson 1979, Lindegaard 1979); and Thingvallavatn (Antonsson 1992) and Kerið Lakes (Evtimova et al. 2014) in the south-west of the country. Recently scientists have become increasingly interested in the inland freshwater copepods and cladocerans from small freshwater bodies (Novichkova et al. 2014, Scher et al. 2000). Data on observed morphological variability and teratology of lower crustacean in subpolar environments, including Iceland, were presented by Sinev et al. (2012), Pandourski and Evtimova (2009), Pandourski and Evtimova (2006), Pandourski and Evtimova (2005). These aberrations affected the fifth pair of legs in calanoids, the posterior part of the body in cyclopoids, or the head and antennule in cladocerans.

Our study presents data on taxa composition of Rotifera, Cladocera, and Copepoda in various aquatic habitats from South-western Iceland, including marine interstitial, wet bryophytes, springs, brackish and freshwater ponds and lakes.

Materials and Methods

Samples were collected from various aquatic habitats from South-western Iceland. The sampling sites included marine interstitial habitat, puddles, swamps, freshwater or brackish lakes (Table 1, Fig. 1). Rotifers and lower crustaceans were collected using a qualitative plankton net (type “Apstein”, mesh size 38 µm) and a hand-held plankton net (mesh size 40 µm). The hand-held plankton net was used for sieving the sand and rinsing the bryophytes in order to collect the invertebrates inhabiting these substrata. The material was fixed in 70% ethanol.

Table 1.

Locations and dates of sampling with coordinates and notes on water body type, habitat and substratum.

Site No.	Date	Collection method	Habitat/ substratum sampled	Notes	Coordinates
1	02.07.2004	Sieving	Marine interstitial, coarse sand	Garðskagaviti lighthouse; low tide	64°04'57.68"N, 22°41'36.08"W
2	08.07.2004	Hand-held net	Brackish lake, water column	Bessastaðatjörn Lake, coastal, shallow, coarse volcanic sand, macrophytes;	64°06'26.02"N, 21°59'43.79"W
3	29.06.2004	Hand-held net	Freshwater swamp, scraping overgrown stones	Small, c/a 200 m from Sandgerði Marine Centre	64°02'41.29"N, 22°42'45.64"W
4	29.06.2004	Hand-held net	Freshwater swamp, near the bottom	Small, beside Sandgerði Marine Centre, towards the sea; polluted	64°02'42.08"N, 22°42'45.14"W
5	30.06.2004	Hand-held net	Puddle overgrown by grass	Beside Sandvíkurtjörn Lake	63°51'14.90"N, 22°41'21.68"W
6	04.07.2004	Zooplankton net	Freshwater lake, water column	Sikið Lake; west of Garður Village	64°04'18.20"N, 22°38'45.38"W
7	05.07.2004	Zooplankton net	Freshwater lake, water column	Leirvogsvatn Lake, stoney bottom, high transperancy, oligotrophic, no macrophytes	64°12'07.42"N, 21°27'44.05"W
8	05.07.2004	Zooplankton net	Freshwater lake, water column	Small shallow, c/a 5-6 km eastwards from Stardalur and 35 km north-east of Reykjavik	64°12'37.89"N, 21°19'23.27"W

9	05.07.2004	Rinsing	Bryophytes	Wet mosses near Öxaráfoss waterfall, Þingvellir National Park	64°15'56.50"N, 21°07'02.94"W
10	05.07.2004	Hand-held net	Freshwater lake, water column	Laugarvatn Lake, shallow, hot springs on its shores; Arnes County, Laugardalur Valley	64°13'06.26"N, 20°43'40.61"W
11	05.07.2004	Rinsing	Spring, bryophytes	Small peat spring, low water temperature	64°18'24.79"N, 20°12'20.82"W
12	05.07.2004	Zooplankton net	Freshwater lake, water column	Kerið Lake, neovolcanic crater lake; Grimsnes area	64°02'26.36"N, 20°53'05.50"W

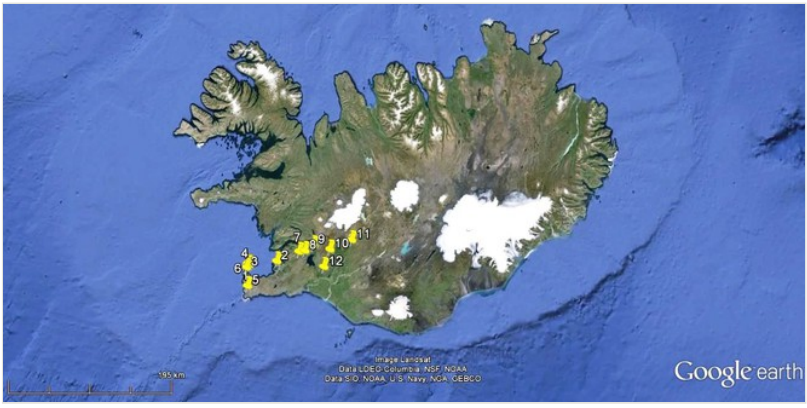

Figure 1.

Map of Iceland with sampling locations from 1 to 12. For site numbers please see Table 1.

The specimens were mounted temporarily in a mixture of glycerin and ethanol and were identified to the lowest practicable level following Wallace and Snell (2010), Sørensen (2009), Segers (1995), Einsle (1993), Monchenko (1974), Manuylova (1964). Harpacticoids were identified by Dr Apostolov and presented in earlier works (Apostolov 2014, Apostolov 2007).

Results

A total of 39 taxa from Rotifera, Cladocera, and Copepoda were recorded from South-western Iceland during our study. The most diverse were the rotifers with 21 taxa belonging to nine families and two orders. We found 11 taxa of copepods which belonged to five families from three orders, and seven taxa of cladocerans from three families. Twelve associated invertebrate taxa were also found in our samples Table 2.

Table 2.

List of taxa recorded from various habitats in South-western Iceland. For site numbers (No) please see Table 1.

Group	Taxon	Site No.
Rotifera		
Class Eurotatoria		
Order Ploima		
Family Brachionidae		
	Keratella americana Carlin, 1943	8; 12
	Keratella cochlearis (Gosse, 1851)	7
	Keratella quadrata (Müller, 1786)	3; 4; 5; 6; 7
	Keratella sp.	3
	Notholca acuminata Ehrenberg, 1832	2
Family Lecanidae		
	Lecane crenata (Harring, 1913)	10; 12
	Lecane sp.	10
	Lecane nana (Murray, 1913)	9
	Lecane sp.	9
Family Asplanchnidae		
	Asplanchna sp.	7
Family Lepadellidae		
	Colurella sulcata (Stenroos, 1898)	12
	Colurella sp.	12
	Lepadella (s. str) sp.	10
	Lepadella sp.	4
Family Nothommatidae		
	Cephalodella sp.	9; 12
Family Euchlanidae		
	Euchlanis dilatata Ehrenberg, 1832	10
Family Proalidae		
	Proales sp.	11

Family Trichocercidae		
	Trichocerca cf. *mucosa* (Stokes, 1896)	6
	Trichocerca vernalis (Hauer, 1936)	8
	Trichocerca sp.	9
Order Floscullariaceae		
Family Trochosphaeridae		
	Filinia terminalis (Plate, 1886)	3
Class Branchiopoda		
Order Anomopoda		
Family Daphnidae		
	Daphnia pulex Leydig, 1860	6
Family Chydoridae		
	Acroperus harpae (Baird, 1835)	8
	Alona affinis (Leydig, 1860)	8; 10; 12
	Alona quadrangularis (Müller, 1785)	8; 10
	Chydorus sphaericus (Müller 1776)	6
	Chydorus sp.	7
Family Macrothricidae		
	Macrothrix hirsuticornis Norman & Brady, 1867	6
Class Maxillopoda		
Order Calanoida		
Family Temoridae		
	Eurytemora velox (Lilljeborg, 1853)	2
Order Cyclopoida		
Family Cyclopidae		
	Acanthocyclops vernalis (s. lat. Fischer, 1853)	9; 12
	Cyclops abyssorum Sars, 1863	6
	Diacyclops bisetosus (Rehberg, 1880)	3; 9
	Eucyclops serrulatus (Fischer, 1851)	6; 8; 9; 10
	Megacyclops viridis (Jurine, 1820)	8
	Paracyclops fimbriatus fimbriatus (Fischer, 1853)	8

Family Cyclopinidae		
	Cyclopina gracilis Claus, 1862	1
	Copepodites	1; 2; 6; 8; 10; 12
	Nauplii	2; 6; 7; 10; 12
Order Harpacticoida		
Family Canthocamptidae		
	Bryocamptus (*Arcticocamptus*) *cuspidatus cuspidatus* (Schmeil, 1893)	9; 11
	Bryocamptus (*Bryocamptus*) *minutus* (Claus, 1863)	12
Family Ameiridae		
	Nitokra spinipes Boeck, 1865	2; 3
Class Ostracoda		
	Ostracoda indet.	1; 6; 9; 11
Associated fauna		
	Amphipoda	2
	Acari	5; 1; 9
	Acari (Halacaridae)	5
	Olygochaeta	10
	Polychaeta	1
	Colembolla	5; 9
	Tardigrada	1; 9
	Gastropoda	1; 9
	Diptera larvae	2; 9; 11
	Diptera (Chironomidae) larvae	10; 12
	Nematoda	9; 10; 12

Keratella quadrata (Müller, 1786) was recorded at five of the sampled localities, while the copepod *Eucyclops serrulatus* (Fischer, 1851) and the cladoceran *Alona affinis* (Leydig, 1860) were found at four and three of the sites, respectively. Twenty-eight taxa were recorded only at one of the 12 sampling locations. We recorded the highest diversity of rotifers and the lowest diversity of crustaceans from bryophytes near Öxaráfoss waterfall in Þingvellir National Park.

Discussion

We present data on rotifers and lower crustaceans from 12 aquatic habitats. For two of the stations (6 and 7), the lakes Sikið and Leirvogsvatn, we present the first data on zooplankton, and possibly also the first data for some of the smaller habitats (e.g. stations 3, 4, 5, 11). The majority of the recorded taxa either have a cosmopolitan distribution or are previously known from Iceland. For three of the recorded species we found no prevoius records in the available literature from Iceland: the rotifers *Trichocerca* cf. *mucosa* (Stokes, 1896) and *T. vernalis* (Hauer, 1936), and the copepod *Cyclopina gracilis* Claus, 1862. Rotifera dominated the sampled water bodies, followed by Copepoda and Cladocera. The most frequent taxon was the rotifer *Keratella quadrata*, previously recorded from Iceland by Bartoš (1951). All of the recorded rotifer species have a cosmopolitan distribution.

Many of the cladoceran taxa we recorded are frequently found in the arctic region. *Acroperus harpae* (Baird, 1835) is typical for the littoral fauna of freshwater lakes from the Holoarctic region (Novichkova et al. 2014, Sinev et al. 2012). Arctic populations of *Macrothrix hirsuticornis* Norman & Brady, 1867 are known to have high densities of specimens that are characterised with longer bodies and greater number of eggs per female (Meijering 2003, Margaritora and Usai 1983, Meijering 1979). *Macrothrix hirsuticornis* and *Alona quadrangularis* (Müller, 1785) are widely distributed and often are found in arctic regions and similar environments, likely owing to the resistance of their diapausing eggs to very low temperatures (Meijering 2003). We found these two species in permanent freshwater lakes (stations 6, 8, and 10).

All of the freshwater cyclopoid crustaceans recorded have cosmopolitan distribution and have been previously recorded from Iceland. We found only one marine copepod *Cyclopina gracilis* Claus, 1862. It is very common in the North Atlantic Ocean (Carey 1992, Grainger and Mohammed 1991, Mohammed and Neuhof 1985) but previously has not been reported from Iceland. The dominant cyclopoid in our samples was *Eucyclops serrulatus* (Fischer, 1851). *Cyclops abyssorum* Sars, 1863 is known to be among the dominant copepods in the large Icelandic lakes and is an important structural element for their zooplankton assemblages (Novichkova et al. 2014, Antonsson 1992). According to Larsen and Røen (1964) and Scher et al. (2000) another common cyclopoid for Iceland is *Megacyclops viridis* (Jurine, 1820). We found both *C. abyssorum* and *M. viridis* as well but only from shallow freshwater lakes (sites 6 and 8, correspondingly).

The two species of the harpactocoid genus *Bryocamptus* we recorded are associated with wet mosses (Evtimova et al. 2014, Apostolov 2007). *Nitokra spinipes* Boeck, 1865 can tolerate changes in salinity (Apostolov 2014) and was found from both brackish and freshwater habitats (sites 2 and 3).

Conclusions

This manuscript presents faunistic data on microinvertebrate aquatic fauna, including new species records, from an understudied region where detailed data are still scarce. We found 39 taxa from 12 sites, and three of the recorded taxa are new for Iceland. Moreover, here we present first data on the zooplankton of Sikið and Leirvogsvatn Lakes. Future studies in the region would likely further enrich our knowledge on the composition and origin of microinvertebrate aquatic fauna of the island.

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Hosting institution

Sanðgerdi Marine Centre and the Institute of Biology, University of Iceland.

Author contributions

Both authors contributed equally to samples collection and processing, and the writing of the manuscript.

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