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Macrophytobenthos of brackish lagoons and inlets in northeastern Iceland

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ABSTRACT: The benthic algal vegetation of lagoons and inlets around the peninsula of Melrakkaslétta in northeastern Iceland was studied regarding the species distribution, biomass, and main algal associations. In the lagoons there are sandy-muddy substrata, conditions of extreme shelter and salinity values which correspond to the oligo-, meso-and polyhalinikum. The temperatures are slightly elevated in relation to those found in the surrounding sea. The vegetation is dominated by filamentous algae, which exhibit locally high biomass values. Filamentous brown algae are dominant, being represented first of all by *Dictyosiphon foeniculaceus*, *D. chordaria*, *Ectocarpus siliculosus*, *Pylaiella littoralis*, *Stictyosiphon tortilis*, *Eudesme virescens* and locally also by *Chordaria flagelliformis*. Fucoids are subordinate in the vegetation. Sublittorally *Chorda filum* dominates and is in some sites accompanied by broad forms of *Laminaria saccharina* and *L. digitata*. Among the green algae component *Enteromorpha* species are outstanding and form locally entangled mats. Close to the connection with the sea red algae join the vegetation, such as *Ceramium* species, *Cystoclonium purpureum*, *Devaleraea ramentacea*, *Palmaria palmata*, *Polysiphonia stricta*. Close to freshwater lakes only green algae and *Vaucheria* species are left.

KEY WORDS: northeastern Iceland, brackish lagoons, land-locked inlets, filamentous algae, low-salinity conditions, vegetation gradients

INTRODUCTION

Melrakkaslétta is a lowland peninsula in the extreme Northeast of Iceland, situated between 66°16´ and 66°33´N; and 16°35´ and 15°40´W. It separates two wide, open fjords, Þistilfjörður in the east and Axarfjörður in the west (Figure 1). This peninsula is highly exposed to the full force of northerly and westerly winds and occasionally also to drift ice, as e. g. in the late sixties (MALMBERG 1984).

The mainland is prevailingly a marshy area, crossed by numerous rivers and spotted by lakes and ponds. There is a narrow strip of cultivated land near the coast in the eastern area. Landwards there are tidal saltmarsh environments and adjacent freshwater wetlands, which can be temporarily impacted by salt water intrusions. The coast is split into numerous open and land-locked bays, inlets and brackish lagoons, which communicate with freshwater lakes, and represent a particular environment for benthic algae.

FIGURE 1. Map og Melrakkaslétta.

The land vegetation of this peninsula was studied by STEINDÓRSSON (1936, 1941). It covers glacially sculptured lava bedrocks of dolerite and olivine, soil and peat deposits being rather thin. The author treated the vegetation units in accordance with the humidity of the ground and included also the submerse vegetation of lakes and ponds as well as of freshwater wetlands (»flói« in Icelandic). The marsh vegetation and that of the less humid grounds was treated separately. Some attention was paid also to the halophilic vegetation of sandy bays and inlets. There are, on the other hand, no data about the macrophytobenthos of the brackish lagoons and inlets, which are cut into the mainland and sheltered by narrow peninsulas and islets. These habitats, characteristic of Melrakkaslétta, will be described here. Some data on the vegetation of open bays and exposed coastal areas were given previously (e. g. MUNDA 1975, 1992).

Melrakkaslétta is, however, situated in a mixing area between different water masses and as such interesting in regard to hydrographically conditioned floristic and vegetational changes. The North Icelandic Irminger Current, which carries Atlantic water eastwards along the North Icelandic coast, meets the cold East Icelandic Current north of Melrakkaslétta (STEFÁNSSON 1962). Along the mixing area in the Northeast, between Melrakkaslétta, Langanes and Vopnafjörður, the North Icelandic vegetation gradually changes to the subarctic one, characteristic of eastern Iceland (MUNDA 1975, 1983, 1994). As far as open and exposed habitats are concerned North Icelandic and subarctic growth conditions grade into each other. Within the land - locked bays, inlets and lagoons the influence of oceanic waters is unconspicous and the vegetation is prevailingly influenced by reduced salinities, conditions of extreme shelter and soft substrata, and is thus untypical.

Melrakkaslétta is, however, interesting also from the geological point of view as a part of the northern volcanic zone of Iceland (THORODDSEN 1904-1905, SÆMUNDSSON 1977, PÉTURSSON 1979, 1991). The greater part of Melrakkaslétta is built of Pleistocene interglacial and supraglacial lavas.

There are sediments from different periods of glaciation and deglaciation. Changes in the regime of the ice sheet covering Melrakkaslétta were reflected in

sequences of the diverse sediments: fluvial, glaciofluvial and glaciomarine. The coastal cliffs are, however, built of sediments resting on a foundation of lava flow.

Glaciomarine sediments as well as pumice deposits in the bays and inlets are partly litiphied, while sorted sediments remained unlitified: sand, rounded and coarse gravel, and boulders. Beside, the land-locked inlets and lagoons are covered also by a layer of recent sediments of sand-mud.

HYDROGRAPHIC CONDITIONS AND STUDY AREA

Hydrographic data for the waters surrounding Melrakkaslétta were given by STEFÁNSSON (1962, 1969 a,b). Ten years monthly averages presented by STEFÁNSSON (1969 b) revealed temperature minima in March and April (1.6 °C) and maxima in July and August (8.2 °C), with a yearly temperature average of 4.4 °C. This was lower than around the neighbouring Tjörnes peninsula, and on the other hand, higher than at Langanes.

During the time of algal sampling around Melrakkaslétta (September and October of the subsequent years in the sixties and seventies) some temperature and salinity measurements were carried out. Average temperature values for a few exposed localities (September and October) are presented in Table I, while both, temperature and salinity values for some of the inlets and lagoons are given in Table II (September). The values are average of ten replicates.

The study area extends from the bay of Kollavík, facing Þistilfjörður, over Hraunhafnartangi and Rifstangi,which are Icelands nothernmost promontories, to Rauðinúpur and Grjótnes, facing Axarfjörður. Open bays and exposed rocky promontories were studied here, but in this contribution attention was focused to the land - locked brackish inlets and lagoons, which are characteristic of Melrakkaslétta.

Examples treated here represent a typical range of these aberant habitats, different from the fjords.

TABLE 1. Temperature conditions around Melrakkaslétta in September and October.

Localities	T(°C) Sept	Oct
Kollavík	6.9	5.5
Gegnisvík	6.3	5.9
Höskuldarnes	5.8	5.0
Neslón-outside	6.0	5.3
Ásmundarstaðir	6.7	5.0
Digranes	6.5	5.0
Harðbaksvík	5.9	4.8
Hestamöl	5.4	4.5
Skinnalón	6.0	4.8
Rifsvík	5.9	4.6
Rifstangi	5.5	4.5

TABLE 2. Temperature and salinity conditions within inlets and lagoons in Sept.

Localities	S(‰)	T(°C)
Neslón 1	33.2	5.7
Neslón 2	28.5	6.8
Neslón 3	15.7	7.0
Hringlón 1	19.5	6.8
Hringlón 2	15.3	8.5
Hringlón 3	7.3	12.5
Skinnalón-outer	34.1	6.0
Skinnalón-inner	27.5	8.0
Blikalón	18.0	11.2
Oddsstaðalón	32.4	7.3
Skeljalón	8.0	15.2

Neslón is an inlet north of the town of Raufarhöfn, close to the freshwater lakes Eggversvatn and Nesvatn. It is relatively open and fringed by a bar, formed of coarse sand and gravel. The substratum is prevailingly sandy – muddy and landwards there are bogs. Several localities were studied within this inlet in relation to the distance from the open sea.

Hringlón is cut deeply into the land and has only a narrow connection with the surrounding sea. It is situated between Digranes and Ásmundarstaðaeyri. Within this water body there are typical brackish habitats and the algal vegetation is locally mixed with the halophilic vegetation and mosses.

There are two lagoons, called **Skinnalón**. The first is relatively open and fringed by the sandy island Skinnalónsey, while the second is land – locked and fringed by the promontory Hestaröl and the islet Brúsi.

The lagoon **Blikalón** is a further example of an enclosed water body, fringed by a narrow bar.

As an example of a rather open inlet the Oddsstaðalón was studied. It is connected with the open sea and fringed by both sandy slopes and marshes. In this inlet there is a pronounced gradient from the marine to the brackish vegetation.

Skeljalón is, on the other hand, totally land-locked and salt water penetrates into this lagoon only at extreme high tides and at stormy weather. It is separated from the sea by a sandy bar and touches landwards a marshy ground.

The investigated sites treated here are indicated on the map (Figure 2).

METHODS

The benthic algal vegetation within the inlets and lagoons of Melrakkaslétta was studied along vertical transects from the level of the littoral fringe to the upper sublittoral. Characteristic spots, elucidating vegetation gradients were chosen. The species were roughly determined in the field and later thorougly examined in the laboratory, at the Biologische Anstalt Helgoland and the Biological Institute of the Centre for Scientific Research of the Slovene Academy of Science and Arts in Ljubljana. The material is preserved in 2.5 % formaldehyde-saline and kept also as herbarium.

The average fresh weight biomass of the populations was determined in the field by means of ¼ m^2 and ⅛ m^2 frames, within which the algal growth was harvested and weighted. Three replicates were carried out at each spot.

The temperature was measured simultaneously with algal sampling and salinity determined at the Marine Research Institute (Hafrannsóknastofnunin) in Reykjavík.

RESULTS OF FIELD OBSERVATIONS

Field observations had revealed that the benthic algal vegetation of the lagoons and inlets differs from that found in inner areas of open fjords. There the vegetation is influenced by river drain and fluctuating salinities, related to the amount of freshwater influx, and tidal exchanges of water masses. In the lagoons and inlets conditions are more stable, and the benthic algal vegetation locally overlaps with that of the marshes.

FIGURE 2. Map of the investigated localities on Melrakkaslétta

In **Neslón**, which is an example of a relatively open water body, a typically marine vegetation was observed in its outer area. Several red algae are represented there, such as *Palmaria palmata*, *Devaleraea ramentacea*, *Polysiphonia stricta*, *Ceramium* species and *Cystoclonium purpureum*. Fucoids are still prolific, forming belts (*Ascophyllum nodosum*, *Fucus vesiculosus*) but *Fucus distichus* L. emend. Powell and *F. spiralis* L. did not penetrate into the inlet. The eulittoral vegetation is dominated by filamentous brown algae, first of all *Dictyosiphon foeniculaceus*, appearing mainly as var. *flaccidus*. Close to the sea it is accompanied by *Chordaria flagelliformis*, *Punctaria planginea* and *Scytosiphon lomentaria*. With the increasing distance from the sea the two former species disappear, while *Scytosiphon lomentaria*, *Stictyosiphon tortilis*, *Eudesme virescens* and *Ectocarpus siliculousus* are still prolific. Longer inside the inlet also most of the red algae are absent and innermost, on soft substrata, only *Porphyra purpurea* is left. Among the brown algae, *Pylaiella littoralis* becomes dominant in the innermost regions of the inlet, together with *F. ceranoides*.

Sublittorally, *Chorda filum* dominates in most of the inlets and lagoons, being usually heavily epiphytized by *Ectocarpus* species and diverse microphytes. In Neslón it was accompanied by broad and wavy growth forms of *Laminaria digitata* and *L. saccharina*. They are, however, absent in the inner regions of the inlet. Green algae are outstanding in the vegetation of Neslón and extremely profilic in its innermost area. *Enteromorpha* and *Cladophora* species predominate, while *Ulva lactuca* was found in single, scattered specimens. At the level of the littoral fringe, *Blidingia minima*, *Prasiola stipitata* and *Rhizoclonium riparium* were found, interwoven into the marshy ground and mingling with the Phanerogams and mosses.

In the adjacent freshwater lakes *Myriophyllum alterniflorum* L. and *Potamogeton filiformis* Pers. were observed. At the edges of the lakes, on the freshwater wetland, further species were represented, such as *Equisetum palustre* L., *Hippuris vulgaris* L., *Potentilla palustris* (L.) Scop. *Cladophora albida* and *C. glomerata* penetrated into the vegetation of the »flói« and marshes.

The land-locked lagoon **Hringlón** is less influenced by oceanic waters than Neslón and its vegetation is impoverished. *Ascophyllum nodosum* was found only at the entrance to the lagoon together with *Chordaria flagelliformis*. Red algae were rare, but there was a profilic green algae vegetation of *Enteromorpha* species, forming entangled mats. Noteworthy are first of all *Enteromorpha ahlneriana*, *E. prolifera* and *E. intestinalis*, which exhibited high biomass values in the inner regions of Hringlón. The floristic composition and biomass in the middle area of this lagoon is dominated by filamentous brown algae *(Dictyosiphon foeniculaceus, Pylaiella littoralis, Stictyosiphon tortilis, Ectocarpus siliculosus, Eudesme virescens)*. The sublittoral is colonized by wide and dense mats of *Chorda filum*, while *Laminaria* species did not penetrate into the inner regions of this lagoon. Only at the entrance some *Laminaria saccharina* was found.

Foliose algae were well represented, such as *Porphyra purpurea* and *Ulva lactuca*, both occurring as giant specimens. In the innermost region of Hringlón loose *Cladophora albida* was found, along with *Vaucheria* species, interwoven into the muddy ground. There the algal vegetation migled with mosses, such as e. g. *Hygrohyphnum ochraceum* and *Fontinalis antipyretica*.

Skinnalón, situated farther to the north, is devided into two lagoons: a rather open upper one, and a lower lagoon, which is partly land-locked and more isolated. In the upper Skinnalón lagoon the vegetation bears still a typical marine character, which is less expressed in the lower one. *Devaleraea ramentacea, Palmaria palmata, Ceramium* species and *Rhodomela lycopodioides* are frequent in the upper Skinnalón lagoon, while into the lower one *Devaleraea ramentacea* and *Rhodomela lycopodioides* did not penetrate. Fucoids were well represented in both lagoons, with belts of both *Ascophyllum nodosum* and *Fucus vesiculosus*, while *Laminaria* species were only found in the upper one. Noteworthy is a rich undergrowth of crustose species on hard substrata, such as of *Ralfsia verrucosa*, *Phymatolithon lenormandii*, *Hildenbrandia rubra* and *Lithothamnion* spp. They are mainly absent in the lower lagoon, where soft substrata prevail.

Filamentous species were more frequent in the lower, enclosed lagoon, than in the upper one. Floristic elements, named already for Neslón, were dominant (representatives of the genera *Dictyosiphon, Ectocarpus, Pylaiella, Stictyosiphon*), along with *Enteromorpha* and *Cladophora* species. On the edges of the lagoon, touching the marsh or »flói« vegetation, *Rhizoclonium riparium, Blidingia minima* and *Cladophora glomerata* were found interwoven into the roots of the freshwater Phanerogams (e. g. *Juncus triglumis* L., *Triglochin palustris* L., *Carex* and *Scirpus* species).

There is, however a rather pronounced vegetational gradient throughout the Skinnalón lagoons, conditioned by the distance from the open sea, the isolation of the water bodies, and substrate configuration.

The next lagoon, **Blikalón**, is an enclosed water body with low salinity values and soft substrata. The vegetation is impoverished in terms of species diversity and biomass, and red algae are poorly represented. *Ascophyllum nodosum* and *Fucus vesiculosus* did not penetrate into this lagoon, neither did *Laminaria* species and crustose algae. The Blikalón vegetation is dominated by mats of green algae,

TABLE 3. Species distribution in lagoons and inlets around Melrakkaslétta

Localities	Neslón			Hringlón			Skinnalón 1			Skinnalón 2			Blikalón			Oddsstaðalón			Skeljalón		
	1	2	3	1	2	3	1	2		1	2		1			1	2		1	2	
RHODOPHYTA																					
Bangiophyceae																					
Porphyra purpurea (Roth.) C. Ag.	+	+	+	+	+			+		+	+						+				
P. umbilicalis (L) J. Ag.	+						+									+	+				
Florideophyceae																					
Ceramium areschougii Kylin.	+	+		+			+	+		+	+		+			+	+				
C. nodulosum (Lightf.) Ducluz.	+						+									+					
Cystoclonium purpureum (Huds.) Batters	+	+					+	+			+					+	+				
Devaleraea ramentacea (L.) Guiry	+						+	+								+					
Dumontia contorta (Gmel.) Rupr.		+	+	+			+						+			+	+				
Hildenbrandia rubra (Sommerf.) Menegh.	+	+	+	+	+		+	+		+	+		+			+	+				
Lithothamnion spp.	+						+	+		+						+	+				
Palmaria palmata (L.) Kuntze	+						+	+		+						+	+				
Phymatolithon lenormandii (Aresch.) Adey	+	+					+			+						+					
Polysiphonia stricta (Dillw.) Grev. (P. urceolata (Lightf.) Grev.)	+	+		+			+	+		+	+		+								
Rhodochorton purpureum (Lightf.) Rosenv.	+						+	+		+						+					
Rhodomella lycopodioides (L.) C. Ag.	+						+									+					
PHAEOPHYTA																					
Fucophyceae (Phaeophyceae)																					
Ascophyllum nodosum (L.) Le Jol.	+	+		+			+	+								+	+				
Chorda filum (L.) Stackh.	+	+	+	+	+	+		+		+	+		+			+	+				
Chordaria flagelliformis (O.F. Müll.) J. Ag.	+	+		+			+	+								+					
Dictyosiphon chordaria Aresch.			+			+					+		+						+		

TABLE 3, continued

Localities	Neslón			Hringlón			Skinnalón 1			Skinnalón 2			Blikalón			Oddsstaðalón			Skeljalón		
	1	2	3	1	2	3	1	2		1	2		1			1	2		1	2	
D. foeniculaceus (Huds.) Grev.	+	+	+	+	+	+	+	+		+	+		+	+		+			+	+	
Desmarestia viridis (O. F. Müll.) Lam.	+	+					+														
Ectocarpus fasciculatus Harv.		+	+		+	+		+		+	+					+	+				
E. siliculosus (Dillw.) Lyngb.	+	+	+	+	+	+		+		+	+		+			+	+		+		
Elachista fucicola (Vell.) Aresch.	+			+			+									+	+				
Eudesme virescens (Carm. ex Harv.) J. Ag.		+	+		+			+		+	+		+								
Fucus vesiculosus L.	+	+		+			+	+		+						+	+				
F. ceranoides L.			+			+					+		+								
Laminaria digitata (Huds.) Lam.	+	+					+									+					
L. saccharina (L.) Lam.	+	+		+			+									+					
Pylaiella littoralis (L.) Kjellm.	+	+	+	+	+			+			+		+				+		+	+	
P. varia Kjellm.						+							+							+	
Punctaria plantaginea (Roth) Grev.	+						+									+					
Ralfsia verrucosa (Aresch.) J. Ag.	+	+		+			+	+		+	+					+	+				
Scytosiphon lomentaria (Lyngb.) Link.	+	+	+				+			+						+	+				
Stictyosiphon tortilis (Rupr.) Reinke		+	+	+	+			+		+	+		+				+				
CHLOROPHYTA																					
Chlorophyceae																					
Acrosiphonia arcta (Dillw.) J. Ag.	+	+					+	+								+					
A. grandis Kjellm.		+	+	+				+		+	+					+	+				
A. sonderi (Kütz.) Komm.		+	+	+				+		+	+						+				
Blidingia minima (Näg. ex Kütz.) Kylin.		+	+	+	+	+		+		+	+		+			+	+		+	+	
Chaetomorpha capillaris (Kütz.) Börg.			+		+			+		+	+		+				+				

TABLE 3, continued

Localities	Neslón			Hringlón			Skinnalón 1			Skinnalón 2			Blikalón			Oddsstaðalón			Skeljalón		
	1	2	3	1	2	3	1	2		1	2		1			1	2		1	2	
Cladophora flexuosa (Müll.) Kütz.			+	+	+	+		+			+		+			+	+		+	+	
C. albida (Huds.) Kütz.					+	+					+		+						+	+	
C. glomerata (L.) Kütz.			+		+	+					+		+						+	+	
Enteromorpha ahlneriana Bliding			+	+	+	+				+	+		+				+		+		
E. clathrata (Roth.) Grev.		+	+	+	+	+		+		+	+		+			+	+				
E. compressa (L.) Grev.	+			+				+		+			+				+		+		
E. flexuosa (Wulf. ex Roth.) J. Ag.			+		+	+					+		+						+		
E. intestinalis (L.) Link	+	+	+	+	+	+	+	+		+	+		+			+	+		+		
E. linza (L.) J. Ag.		+	+				+									+					
E. prolifera (O. F. Müll.) J. Ag.		+	+	+	+	+		+		+	+		+				+				
Prasiola stipitata Suhr. in Jessen	+			+			+				+		+			+			+		
Rhizoclonium riparium (Roth.) Harv.	+	+		+		+		+			+		+			+			+		
Ulva lactuca L.	+	+		+	+		+	+		+	+		+			+	+				
Ulvaria fusca (Post. et Rupr.) Rupr.		+	+		+			+					+				+				
TRIBOPHYTA																					
Tribophyceae																					
Vaucheria spp.						+					+		+						+	+	
BRYOPHYTA																					
Hygrohyphnum ochraceum (Wils.) Loeske					+	+					+		+						+	+	
Fontinalis antipyretica Hedw.					+	+							+						+	+	

while brown filamentous algae are subordinate. The vegetation mingles with mosses and Phanerogams. STEINDÓRSSON (1936, 1941) mentioned, however, several *Scirpus* and *Carex* species for this lagoon.

Oddsstaðalón was observed as an example of a rather open inlet, with partly hard substrata. Although the typically marine vegetation found along the open coast, did not penetrate into this water body, the vegetation was still rich by red algae, and a narrow *Devaleraea ramentacea* belt was found in its outermost region. *Ascophyllum nodosum* and *Fucus vesiculosus* belts were dense and prolific, and *Laminaria* species were found sublittorally. Filamentous brown and green algae were less outstanding in Oddsstaðalón than in the rest of the lagoons. Scattered stands of *Acrosiphonia* species are noteworthy.

As a contrast to the open Oddsstaðalón the totally enclosed **Skeljalón** was studied. This lagoon is devoid of red algae and fucoids. The only brown algae detected were *Pylaiella littoralis, P. varia, Dictyosiphon chordaria* and *Ectocarpus siliculosus*, while green algae were represented by diverse *Cladophora* and *Enteromorpha* species, occurring in small amounts. *Vaucheria* mats cover the soft substrata in Skeljalón. At the edges of the lagoon the algal vegetation mingles with mosses and Phanerogams.

The species distribution in the inlets and lagoons is presented in Table III. It became obvious, that many red and brown algae, common in exposed rocky sites around Melrakkaslétta (cf. MUNDA 1975, 1992), were absent.

NUMBER OF SPECIES AND BIOMASS

The average fresh weight biomass of the eulittoral algal populations along with the number of recorded species is given in Figure 3. A decrease in both, biomass and species number from the outer towards the inner regions of the inlets and lagoons was obvious. In the outer regions, fucoids were dominant in the biomass, whereas farther inwards in the enclosed water bodies, filamentous brown and green algae dominated, in particular *Dictyosiphon foeniculaceus* and *Enteromorpha* species (*E. ahlneriana, E. intestinalis, E. prolifera*). The lowermost algal biomass was found in the land-locked lagoons of Blikalón and Skeljalón, the latter being devoid fucoids.

The total number of recorded species exhibited similar trends, viz. a decrease from the outer towards in inner regions of the lagoons and inlets e.g. in Neslón, Hringlón, Skeljalón. Looking on the main groups of algae separately, a decrease in number of the Rhodophytan species towards the inner regions of the lagoons was obvious. Red algae were rare in the enclosed Blikalón and absent in Skeljalón. Green algae showed the opposite trend viz. an increased floristic diversity from the outer towards the inner regions of the inlets and lagoons, with the exception of Skeljalón and Hringlón, where *Vaucheria* species dominated on muddy slopes. The brown algae exhibited less pronouced variations in species number. In both, Neslón and Hringlón, their number was slightly decreased in the inner regions, on account of the absence of fucoids (only *Fucus ceranoides* left)

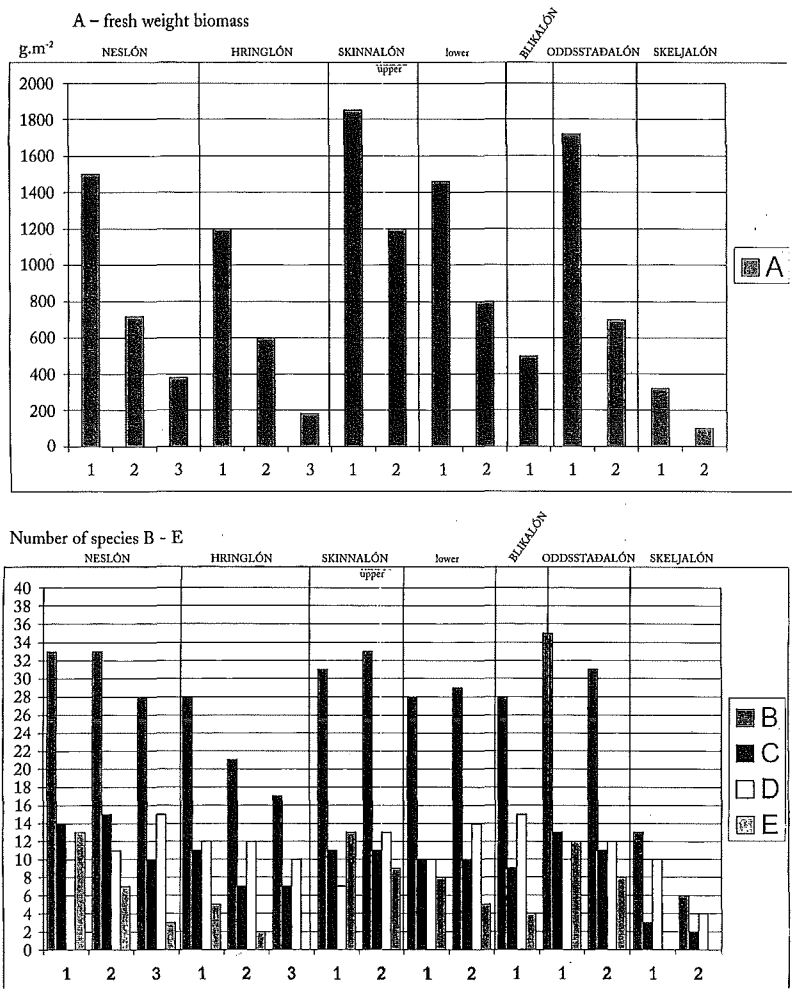

FIGURE 3 Average biomass and number of species in lagoons and inlets at Melrakkaslétta. A - fresh weight biomass (g m^{-2}), B – E number of species: B – total, C – Phaeophyta, D – Chlorophyta, E – Rhodophyta.

and Laminarians, whereas their number was approx. constant in the rest of the investigated sites.

DISCUSSION

The brackish inlets and lagoons, characteristic of Melrakkaslétta, are pristine environments, untouched by human interference.These enclosed and semi-enclosed water bodies are separated from the oceanic waters by islets and bars formed by sand and gravel, and touch marshy grounds. They represent particular habitats for benthic algae, different from those found in estuarine areas of open Icelandic fjords (MUNDA 1978, 1983, 1994, 1997).

In the fjords, there is a balanced inflow of fresh and salt water, whereas in the inlets and lagoons conditions are more stable. There is no river drain into these water bodies. They are, on the other hand, in an intimate connection with the adjacent freshwater wetlands, lakes and ponds. There is, however, an overlapping between the vegetation of the salt marshes, wetlands and lakes with the benthic algal vegetation of brackish lagoons and inlets. This is their main distinguishing character from the benthic algal vegetation of the estuarine areas of Icelandic fjords.

Salinity conditions, recorded during algal samplings, corresponded to the meso- and polyhalikum (cf. den HARTOG 1964, 1967), whereas on the edges of the marshes conditions were presumably oligohaline. Beside reduced salinities, the water temperatures were elevated during the time of our studies.

Vegetational features in the lagoons and inlets are thus determined by an interplay of several changed ecological factors, as compared to the surrounding sea. Due to the diminished exchange of water masses, the tidal movements are reduced. Soft substrata prevail, viz. recent sediments of sand-mud, mixed landwards with soil and peat. There are also pumice sediments in some of the inlets. The combined effects of these ecological factors create vegetation patterns, which are on the one hand different from those found in inner, estuarine areas of Icelandic fjords (MUNDA, 1978 1983, 1994, 1997) and from the vegetation of exposed, open rocky sites around Melrakkaslétta on the other (MUNDA 1992).

A - Comparison with fjords. In the fjords there is a gradual belt formation along the coast together with an increasing floristic diversity towards the outer regions. In the enclosed water bodies there are no distinct belts, and the zonation patterns in the eulittoral are obscured. The vegetation is, however, represented mainly by loose-lying mats of filamentous brown and green algae. Foliose algae (*Porphyra purpurea, Ulva lactuca, Ulvaria* species) appear in scattered stands and do not form a distinct association, like in the fjords. Innermost in the lagoons and inlets, *Vaucheria* mats cover muddy surfaces, while green algae mingle with Phanerogams and mosses of the salt marshes and freshwater wetlands. In fjords, on the other hand, the vegetation of the innermost regions is representd by dwarf *Pylaiella littoralis* and *Dictyosiphon chordaria* (MUNDA 1978).

Several species, especially Rhodophytan ones, are excluded from the vegetation of the brackish inlets and lagoons. Lowered salinities along with soft substrata, reduced tidal movements, and conditions of extreme shelter prevent the inward distribution of *Fucus spiralis, F. distichus* along with numerous brown and red algae in the eulittoral, and of *Alaria esculenta, Desmarestia aculeata,* and deep-water red algae sublittorally.

B - Comparison with open sites. The benthic algal flora and vegetation of exposed and open rocky sites around Melrakkaslétta differs essentially from the one described for the brackish inlets and lagoons. It belongs to the North Icelandic vegetation type, which was described by MUNDA (1975, 1977, 1992, 1997). It is characterised by several low-eulittoral associations, such as those of *Devaleraea ramentacea* (MUNDA, 1976), *Petalonia* species with *Scytosiphon lomentaria* and of *Chordaria flagelliformis* (MUNDA 1979). Extensive meadows of *Acrosiphonia* species are a further characteristic feature of the North Icelandic

vegetation pattern. In the upper sublittoral, *Alaria esculenta* is the main belt-former. Only in some bays *Laminaria saccharina* appears in its long and narrow growth form. In the tide pools, North Icelandic and Atlantic algal associations occur side by side (MUNDA 1981). The former are represented by associations of *Devaleraea ramentacea*, *Acrosiphonia* species and *Chordaria flagelliformis,* and the latter by *Corallina officinalis* L., *Ceramium* species and *Cystoclonium purpureum.* Tide-pool environments were, however, not found in the lagoons and inlets, where soft substrata prevail.

None of the associations, named above, penetrated into the enclosed water bodies. The low-level *Devaleraea ramentacea* association was only found in patches in the outermost regions of Neslón, upper Skinnalón and Oddsstaðalón, as did scattered settlements of *Chordaria flagelliformis. Petalonia* species, which form conspicuous belts in exposed rocky sites of northern Iceland, were absent as well as wide Acrosiphonia spp. mats, while *Scytosiphon lomentaria* was rare.

The low-eulittoral associations named above, were replaced in the enclosed water bodies by mats of filamentous brown and green algae. In their physiognomy they resemble to the »mixed association« described for inner and middle fjord areas in Iceland (MUNDA 1978, 1983, 1994, 1997), although the zonal position was less distinct and the floristic composition altered. A certain gradient was, however, found in the lagoons. *Dictyosiphon foeniculaceus* was dominant in their outer and middle regions. Innermost, the green algae component became outstanding within these mixed stands. Among the fucoids, *Fucus vesiculosus* and *F. ceranoides* penetrated into the lagoons and inlets, while *Ascophyllum nodosum* was limited to their outermost regions. Both, fucoids and red algae were absent in the totally enclosed Skeljalón.

It is noteworthy, however, that STEINDÓRSSON (1941) mentioned *Zostera marina* L. v. *stenophylla* as profilic and abundant in Skinnalón, on the basis of his studies in the area in 1934. During recent observation no *Zostera marina* was found around Melrakkaslétta. In the thirties a deterioration of *Zostera* beds occurred, however, in the entire North Atlantic.

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