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Björn Gulliksen

THE ASCIDIAN FAUNA ON LEVEL BOTTOM AREAS IN THE BORGENFJORD, 1967-1973

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THE ASCIDIAN FAUNA ON LEVEL BOTTOM AREAS IN THE BORGENFJORD, 1967-1973

by

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ABSTRACT

Gulliksen, Björn. 1974. The Ascidian fauna on level bottom areas in the Borgenfjord, 1967-1973. *K. norske Vidensk. Selsk. Mus. Miscnea* (21): 1-18.

Hitherto, 15 species of ascidians have been recorded from the Borgenfjord area. This is 39% of the total ascidian species recorded from the Trondheimsfjord. 8 of the species from the Borgenfjord are primarily found in arctic regions.

During the investigations in 1967-1971 using a Petersen grab, six species were recorded in the inner basin of the Borgenfjord, eight species on the threshold between the two basins, and nine species in the outer basin. The "arctic" tendency is more pronounced in the Borgenfjord proper than in the areas just outside.

No relationship was found between substrate particle size and ascidian distribution, but subsequent investigations using diving equipment have revealed that coarse and shell-rich substrates contain higher numbers of ascidians than soft substrates with less shell.

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CONTENTS

INTRODUCTION

Investigations of different aspects of the ecosystem, including phytoplankton, zooplankton, benthos, and the feeding habits of the common teleosts of the Borgenfjord, have taken place since 1967 (Borgenfjordundersökelsene 1969, 1970, 1971, 1973).

The benthic fauna on level bottom areas in the Borgenfjord was initially sampled by means of the 0.1 m^2 Petersen grab. It was soon realized that parts of the fauna, especially the epifauna, was not being sampled efficiently with this equipment. Being very common in the fjord, the ascidians were therefore primarily collected using SCUBA-equipment (Gulliksen 1972, 1973). A comparison of the qualitative and quantitative composition of the samples obtained with the Petersen grab and with a diver-operated bottom corer also indicated that for ascidians living on soft bottom areas the corer on average sampled 30 times more efficient than the Petersen grab (Gulliksen, unpubl.).

However, the material collected with the Petersen grab did contain many ascidians, but an exhaustive treatment of the quantitative aspects seemed to be unjustified, due to the low sampling efficiency of the Petersen grab.

MATERIAL AND METHODS

The 0.1 m^2 Petersen grab was used between September 1967 - November 1971 in the Borgenfjord and a total of 1039 grab samples were obtained. Holthe (1973) gives an outline of the sampling programme, methods used and stations worked.

Due to several factors, the grab sampling programme has been somewhat discontinuous, both with regard to time and sampling stations. The most valuable consecutive period of observations is the 12 cruises from May 1970 to October 1971 when five replicate samples were obtained at each of the 11 stations (Fig. 1). (Three stations were omitted in February 1971 due to ice.)

Less extensive studies have also been carried out using a diver-operated bottom corer and occasional dredgings made with a triangular dredge. The results from these investigations are included

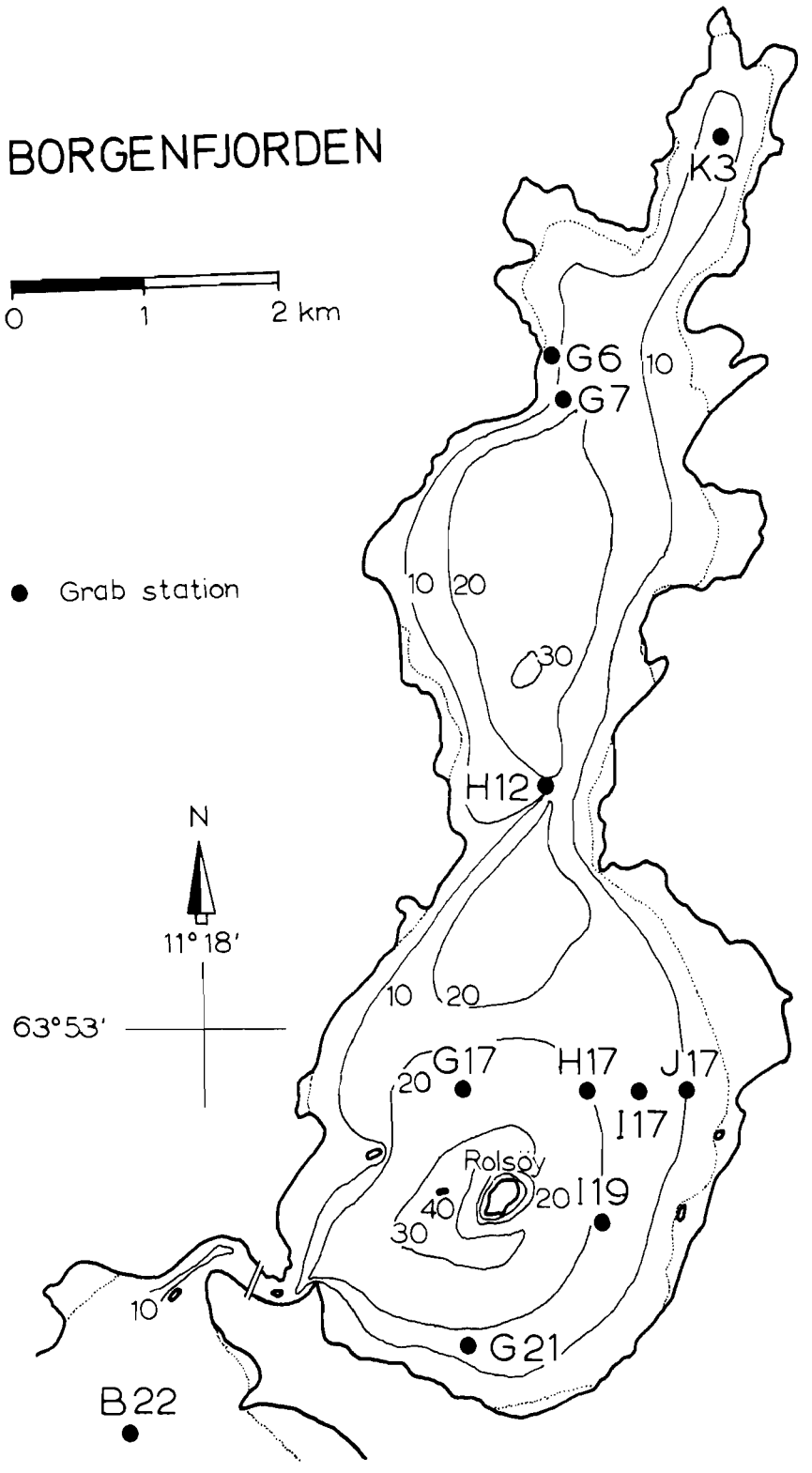

Fig. 1. Map of the Borgenfjord with the 11 stations at which sampling with the Petersen grab took place from May 1970 - October 1971.

in the section on species and distributions in this paper.

AREA AND ENVIRONMENT

Up to the high water mark, the surface area of the Borgenfjord is 19.3 km^2 (Fig. 1). It is separated from the Trondheimsfjord proper by a shallow threshold, about 5-6 m deep and 150 m wide. This landlocked fjord is itself divided into two basins by a secondary threshold at a depth of 14 m. The maximum depth of the outer basin (southern) is nearly 40 m, of the inner (northern) basin about 30 m.

Information concerning temperature, salinity, and oxygen for the period September 1967 - November 1971 have been included in other publications (Gulliksen 1972, McClimans 1973); the hydrography is treated thoroughly by McClimans (1973). Accordingly, only the main principles will be mentioned here.

The water masses of the Borgenfjord originate from the surface layers of the Trondheimsfjord proper. At the entrance to the Borgenfjord, the tidal current may attain a speed of 5 m/sec. In the outer basin the tidal current produces strong turbulence in the water masses, which are therefore practically homogeneous throughout the whole water column.

During the spring and autumn a pycnocline is formed in the northern basin, at about 15-20 m below the surface. Exchange through the pycnocline is weak. Decomposition of organic matter results in oxygen deficiency below the pycnocline and H_2S is formed. An annual renewal of the water in the northern basin starts in the autumn and continues throughout the winter.

Water temperature usually ranges from 1° to $20^{\circ}C$ during the year and salinity from 20 to $33^{\circ}/oo$. Temperatures above $20^{\circ}C$ and salinities below $20^{\circ}/oo$ are rare in the Borgenfjord.

The main types of substrates observed while diving and from the contents of dredges and grabs are reported in Skjæveland (1973). Additional information was gained during a cruise in July 1968, during which subsamples for sediment analysis were collected from 85 grab samples. The results of these investigations are given in Holthe (1972) and Strömgren (1974).

The finest sediment types (clay, silt) are found in the northern basin, especially where the water is stagnant. Coarser sediments (stone, gravel, coarse mineral sand) are found where the tidal current has most influence, i.e. near the entrance to the fjord, in areas situated on the west side of Rolsöy and on the threshold between the two basins. Medium types of sediment (mineral sand, silt) are found east of Rolsöy.

SPECIES LIST AND DISTRIBUTIONS

Hartmeyer (1922) reported four species of ascidians (*C. intestinalis, S. rustica, M. oculata, E. arenosa*) from the Borgenfjord. Eleven more species were recorded during the investigations made between 1967 and 1973, bringing the total number of ascidian species up to 15.

Notes concerning specific general distributions and the numbers found in the grab samples are presented here; specimens obtained with the diver-operated corer are mentioned separately. For synonyms, see: Hartmeyer (1923, 1924), Van Name (1945), Berrill (1950), Millar (1966).

Ciona intestinalis (Linnaeus, 1767)

Almost cosmopolitan. Very common in the Trondheimsfjord. 142 specimens from the Borgenfjord.

Corella parallelogramma (Müller, 1776)

Boreal-lusitanian. Common in the Trondheimsfjord. Four specimens from the Borgenfjord.

Ascidia obliqua Alder, 1863

Arctic-boreal. North Atlantic Sea. Common in the Trondheimsfjord. One specimen from the Borgenfjord.

Dendrodoa grossularia (van Beneden, 1846)

Arctic-boreal. Common in the Trondheimsfjord. 93 specimens from the Borgenfjord. The solitary form only has been found in the Borgenfjord.

Styela coriacea (Alder & Hancock, 1848)

Mainly arctic, but also occurring in boreal regions. Common in the Trondheimsfjord. 208 specimens from the Borgenfjord.

Styela rustica (Linnaeus, 1767)

Arctic. Circumpolar. Common in shallow water areas of the Trondheimsfjord. 25 specimens from the Borgenfjord.

Polycarpa pomaria (Savigny, 1816)

Boreal-lusitanian, but also occurring in arctic regions. One of the most common ascidians of the Trondheimsfjord, but recorded only once in the Borgenfjord - one specimen was found.

Cnemidocarpa rhizopus (Redikorzev, 1907)

Arctic, but has been recorded a few times in the boreal region (Millar 1966, Lützen 1967). 76 specimens from the Borgenfjord.

Pelonaia corrugata Forbes & Goodsir, 1841

Arctic. Circumpolar. Not common in the Trondheimsfjord. Three specimens from the Borgenfjord.

Molgula manhattensis (De Kay, 1843)

Boreal. Very common on the American Atlantic coast, but has also been recorded frequently on the European side. Four

specimens were found in the Borgenfjord, forming the northernmost records so far.

Molgula occulta Kuppfer, 1875

Boreal. Not recorded in the grab samples. The records from the Borgenfjord are derived from the faunal investigations made in the inlet of the fjord (Lande & Gulliksen 1973) and from other investigations carried out with the diver-operated bottom corer in the southern basin of the Borgenfjord.

Molgula oculata Forbes, 1848

Boreal. Recorded only once in the Borgenfjord, by Hartmeyer (1922). Hartmeyer, however, did not distinguish between *M. oculata* and *M. occulta* (Berrill 1950), and this record accordingly, is somewhat uncertain. Hartmeyer's original specimens from the Borgenfjord has not been located.

Molgula siphonalis M. Sars, 1859

Primarily arctic. Not common in the Trondheimsfjord. 101 specimens from the Borgenfjord.

Eugyra glutinans (Möller, 1842)

Primarily arctic. Not common in the Trondheimsfjord. Only recorded in the Borgenfjord in the samples taken with the bottom corer.

Eugyra arenosa Alder & Hancock, 1870

Boreal. Not common in the Trondheimsfjord. Three specimens were found in the Borgenfjord.

Of all the ascidian species found in the Trondheimsfjord proper, 39% have been found in the Borgenfjord. The corresponding value for polychaetes is 41% (Holthe 1973).

The wide amplitude of the water temperature in the southern basin throughout the year and the lack of a variety of hard substrates for settlement are probably the two main reasons for the lower percentage of ascidians found in the Borgenfjord compared to the Trondheimsfjord proper. The annual temperature range of the whole water column in the southern basin is usually 15-20^{o}C. The only regions in which the temperature range throughout during the year is low are the water masses lying below the threshold depth (ca. 14 m) in the northern basin, but here the formation of H_2S in the summer excludes nearly all kinds of life. All animals found in the Borgenfjord which live for more than one year are therefore probably all eurythermal.

Holthe (1973) divided the Borgenfjord polychaete fauna into two groups, "arctic" and "non-arctic" species, and he found that the "non-arctic" species were underrepresented. This tendency is also found among the ascidians, quantitatively more than qualitatively. Nine of the 15 species recorded in the Borgenfjord are common in arctic regions. The ascidians most frequently recorded (Table 1), with one axception, the cosmopolitan *C. intestinalis*, have their main distribution in arctic seas. The low numbers of ascidians found do not allow an extensive distribution analysis to be made, but this arctic tendency seemed to be more pronounced in the Borgenfjord proper than in areas situated just outside the fjord, e.g. at Stn B 22 (Fig. 1).

Dybern (1969) has investigated the ascidian fauna in two small fjords or "polls", Kviturdvikpollen and Vågsböpollen, near Bergen (about 300 statute miles SW of the Borgenfjord). However, only five of the 16 species recorded in these polls near Bergen (*C. intestinalis*, *C. parallelogramma*, *D. grossularia*, *S. rustica*, *M. manhattensis*) were found during the Borgenfjord investigations. *C. intestinalis* was also the dominant ascidian in Kviturdvikpollen and Vågsböpollen.

A separation of the ascidians recorded in Kviturdvikpollen and Vågsböpollen into "arctic" and "non-arctic" species, provided a total of six species common in arctic regions, and thus the

Table 1. Occurrence of ascidians (ind. per sq. m) on grab stations in Borgenfjorden, May 1970 - November 1971

Station	No. of samples	Ciona int.	Corella par.	Ascidia obl.	Dendro. gross.	Styela cor.	Styela rust.	Polyc. pom.	Cnem. rhiz.	Molg. man.	Molg. sip.	Eugyra aren.
K 3	55	0	0	0	0	0	0	0	0	0	0	0
H 6	55	5.09	0	0.18	0.55	1.82	0.36	0	0	0	0	0
H 7	55	0	0	0	0	0.18	0	0	0	0	0	0
H 12	60	2.66	0.16	0	9.00	0.45	0.67	0.16	2.83	0	2.83	0
G 17	60	0.66	0	0	4.16	0.25	1.50	0	0.33	0	1.16	0
H 17	60	2.66	0	0	0.33	0.25	0.50	0	0.16	0	0.50	0
I 17	60	1.83	0.16	0	0	0.35	0.66	0	0	0	0.16	0.16
J 17	60	1.16	0	0	0.16	0.83	0	0	0	0.66	0	0
I 19	60	0.50	0	0	0	3.50	0.33	0	0	0	0	0
G 21	60	8.16	0.16	0	0	3.16	0	0	0.16	0	6.66	0.16
B 22	20	0.16	0.16	0	0	1.50	0.50	0	7.50	0	1.00	0.50

"arctic" features are more pronounced in the Borgenfjord than in the polls near Bergen.

FAUNAL COMPOSITION IN RELATION TO SUBSTRATE

The highest number of ascidian species was recorded at Stn H 12 (Table 1). The H 12 of the period May 1970 - November 1971 is located farther south (on the threshold between inner and outer basin) than the initial H 12 reported by Holthe (1973) and Strömgren (1974). *In situ* observations have shown that the bottom at the May 1970 - November 1971 station consists of gravel and coarse mineral sand while the initial H 12 is quite soft.

The highest numbers of specimens were recorded at stations H 12, G 17, and G 21. The substrate of H 12 has been discussed above. At G 17, substrate is quite coarse, while at G 21, the nature of the bottom is somewhat uncertain. G 21 is almost identical to a station at a depth of 16 m on transect 1 in the investigations made with SCUBA-equipment (Gulliksen 1972). On this transect, pebbles and molluscan shells were common from 8 to 16 m depth, although both Holthe (1972) and Strömgren (1974) reported the bottom to be soft.

Our diving programme in the Borgenfjord has shown that ascidians are to be found more frequently in coarse substrate areas than in soft substrate areas, and that there probably is a relationship between ascidian density and the distribution of dead shells, pebbles, and other coarse substrates. The lack of clear relationship between substrate and faunal composition in these investigations may therefore be due to the sampling efficiency of the Petersen grab: the coarser the substrate, the less efficient the grab.

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