

DET KGL. NORSKE VIDENSKABERS SELSKAB  
MUSEET

MISCELLANEA

23



Jon-Arne Snøli

THE DISTRIBUTION OF CAUDOFOVEATA, POLYPLACOPHORA, AND  
PROSOBRANCHIA IN BORGENTJORDEN, NORTH-TRØNDELAG, NORWAY

TRONDHEIM 1975

## EDITORIAL BOARD

Konservator Fredrik Gaustad  
Amanuensis Asbjørn Moen  
Førstebibliotekar Bo Harald Nissen  
Amanuensis Jon-Arne Sneli

## INFORMATION FOR CONTRIBUTORS

"Det Kgl. Norske Videnskabers Selskab, Muséet, Miscellanea," will mainly present original papers within the area of work and responsibility covered by The Royal Norwegian Society of Sciences and Letters, the Museum, — i.e. archaeology, cultural history, botany and zoology. The series is printed in offset.

## LANGUAGE

Contributions are accepted in English and Norwegian or exceptionally in other languages.

## MANUSCRIPTS

Authors should submit the original manuscripts to the editorial board and the authors are requested to retain one complete and corrected copy.

Manuscripts should be typed double-spaced on one side of the paper, with top and left-hand margins at least 3 cm wide.

Separate sheets should be used for the following:

- 1) title pages, with the authors name and institution,
- 2) an abstract in English not exceeding 200 words;
- 3) a summary not exceeding 3% of the original manuscript;
- 4) references;
- 5) Tables with their headings;
- 6) legends to Figures.

In case of papers submitted in a language other than English, the title page, summary, table headings and figure legends must also be translated into English.

## ILLUSTRATIONS

All illustrations and diagrams other than Plates are to be considered as Figures. Line drawings should be drawn with black Indian ink, in size allowing for reductions. Photographs should be unmounted glossy enlargements showing details. The authors name and number of the figure should be written on the back of each.

REFERENCES should be quoted in the text as Brown (1957), Brown & White (1961) or if more than two authors, Green et al. (1963). Multiple references should be given as "Several authors have reported (Brown 1957, Brown & White 1961, Green et al. 1963)," i.e. in chronological order, no comma between name and year.

Lists of references are to be unnumbered and in alphabetical order. The international alphabetical order of Scandinavian and German vowels is: Å = AA, Æ and Ä = AE, Ø and Ö = OE, Ü = UE. Indicate 1st, 2nd, 3rd, etc. works by the same author in the same year by a, b, c, etc. (White 1966a). Titles of journals should generally be abbreviated according to the last edition of World List of Scientific Periodicals.

Examples:

Brøgger, A. W. 1925. *Det norske folk i oldtiden*. Oslo.

Gjærevoll, O. 1963. Survival of plant on nunataks in Norway during the pleistocene glaciation. pp. 261–283 in A. & D. Löve (ed.), *North Atlantic Biota and Their History*. Oxford.

Sivertsen, E. 1935. Über die chemische Zusammensetzung von Robbenmilch. *Nytt Mag. Naturvid.* 75: 183–185.

## PROOFS

The author will receive one copy of the offset plates, which should be carefully corrected and returned within the specified time. Due to the printing method the author can be charged for alterations.

## OFFPRINTS

Authors will receive 100 offprints gratis. Additional copies can be ordered when the proofs are returned.

CORRESPONDENCE concerning manuscripts, offprints, subscription and other editorial matters should be adressed to: Universitetet i Trondheim, Det Kongelige Norske Videnskabers Selskab, Museet, Miscellanea, Erling Skakkes gt. 47 b, N-7000 Trondheim.

K. norske Vidensk. Selsk. Mus. Miscnea 23 - 1975

---

Contribution No. 187. Biological Station, Trondheim, Norway

THE DISTRIBUTION OF CAUDOFOVEATA, POLYPLACOPHORA, AND  
PROSOBRANCHIA IN BORGENTJORDEN, NORTH-TRØNDELAG, NORWAY

by

Jon-Arne Snøli

University of Trondheim  
The Royal Norwegian Society of Sciences and Letters, The Museum

ISBN 82-7126-063-4

ABSTRACT

Sneli, Jon-Arne. 1975. The distribution of Caudofoveata, Polyplacophora, and Prosobranchia in Borgenfjorden, North-Trøndelag, Norway. *K. norske Vidensk. Selsk. Mus. Miscnea* (23): 1-26.

The species distribution was investigated by grab sampling with a 0.1 m<sup>2</sup> Petersen grab (1,039 samples) during the years 1967-1971. A total of 1,195 specimens, belonging to 29 species, were obtained. The most abundant species on soft bottom substrates in Borgenfjorden were *Turritella communis* and *Aporrhais pespelecani*, comprising altogether 92.5% of all the specimens collected. About 40% of the species sampled are typical epifaunal organisms. In all three groups lusitanian-boreal species dominated within both fjord basins. Local distribution maps are presented.

*Jon-Arne Sneli, Biological Station, N-7001 Trondheim, Norway.*



CONTENTS

INTRODUCTION .....	7
AREA AND ENVIRONMENT .....	7
MATERIAL AND METHODS .....	10
RESULTS .....	11
Caudofoveata .....	12
Polyplacophora .....	12
Prosobranchia .....	14
DISCUSSION .....	21
ACKNOWLEDGEMENTS .....	24
REFERENCES .....	26
MAPS	





## INTRODUCTION

The first inventories of the algae, benthic invertebrates, fishes and mammals in Borgenfjorden were made about half a century ago (Nordgaard 1910, 1923). The fjord once harboured a large stock of plaice (*Pleuronectes platessa* L.), but the size of the stock decreased considerably after 1940-1945. An extensive biological survey, to study the ecological relationships in the fjord, and if possible, to find reasons for the decrease in the stock of plaice was therefore started in 1967 (see Borgenfjordundersökelsene 1969, 1970, 1971, 1973).

The Borgenfjord survey includes investigations of the bottom fauna (Gulliksen, 1971, 1972, 1974, Holthe 1973, E. Lande 1975, E. Lande & Gulliksen 1973, Skjæveland 1972, 1973), sediments (Strömngren 1974, Strömngren et al. 1971), hydrodynamics (McClimans 1973), food and feeding habits of cod (Denstadli 1972) and plaice (R. Lande 1972, 1973).

This paper deals with the Caudofoveata, Polyplacophora, and Prosobranchia sampled in Borgenfjorden during the period 1967-1971.

## AREA AND ENVIRONMENT

Borgenfjorden is located in the inner part of Trondheimsfjorden (Fig. 1). It is connected with Trondheimsfjorden proper by a narrow inlet, Strømmen, approximately 5-6 m deep and 150 m wide. The fjord itself is divided into two basins by a threshold, at a depth of 14 m. The maximum depth of the outer (southern) basin is nearly 40 m, of the inner (northern) about 30 m (cf. Fig. 3). The surface area of the fjord, at the high water mark, is estimated to be ca. 19.3 km<sup>2</sup>.

Based on SCUBA-diving forays and from the contents of dredges and grabs, Gulliksen (1971) has described the main types of bottom substrate; sediment analyses of subsamples from 85 grab samples have been published by Strömngren et al. (1971). The finest sediment types are found in the northern basin (Fig. 2). Coarser sediments occur where the tidal current has its greatest influence, i.e. near the entrance to the fjord, in areas situated on the west side

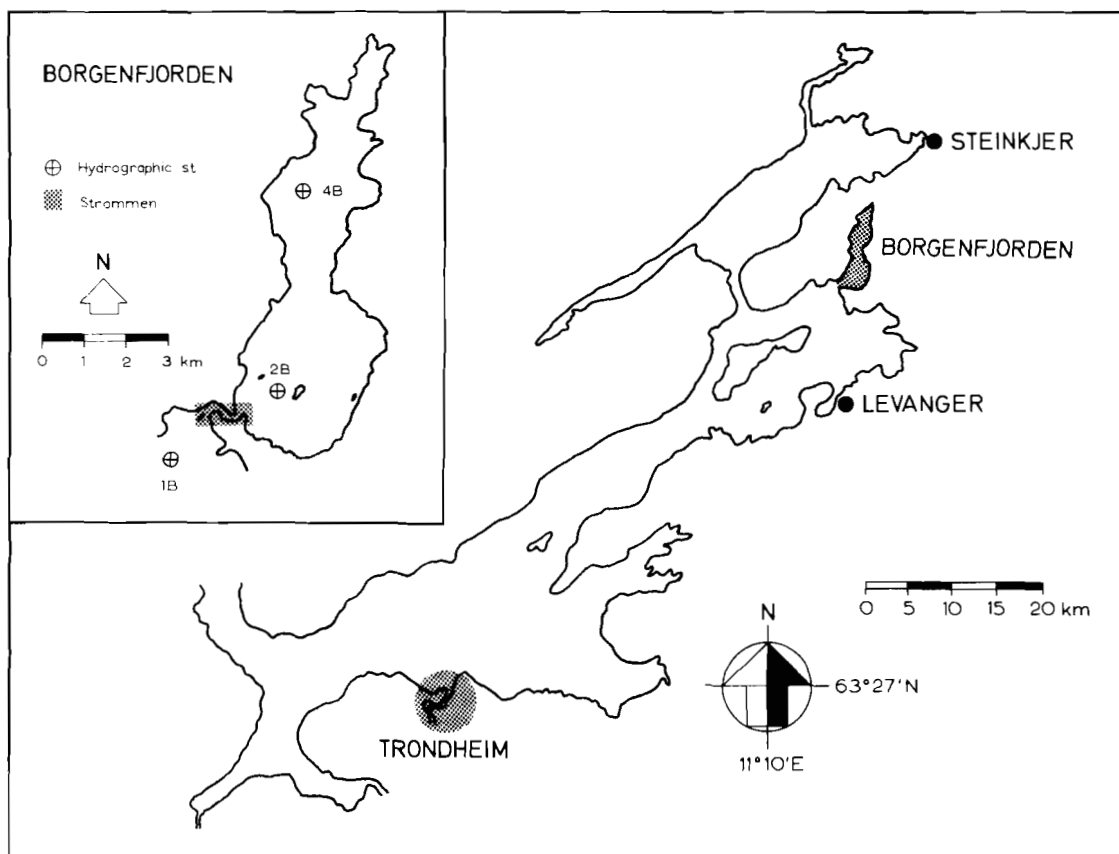


Fig. 1. Map of Trondheimsfjorden showing the location of the landlocked basin Borgenfjorden (after E. Lande & Gulliksen 1973).

of Rolsøy, and on the threshold between the two basins. Medium types of sediment are mainly found in the southern basin. The soft bottom material has a high content of organic matter (Strömngren et al. 1971).

The water masses of Borgenfjorden originate from the surface layers of Trondheimsfjorden proper, and 50% of the water masses are renewed over a period of 11-14 days (McClimans 1973). The tidal current through Strømmen, which may reach a speed of 5 m/sec near the surface (McClimans 1973), produces strong turbulence in the water masses of the southern basin, which are therefore practically homogeneous throughout the whole water column.

In the northern basin, however, a pycnocline is formed at about 15-20 m depth during the summer. Decomposition of trapped

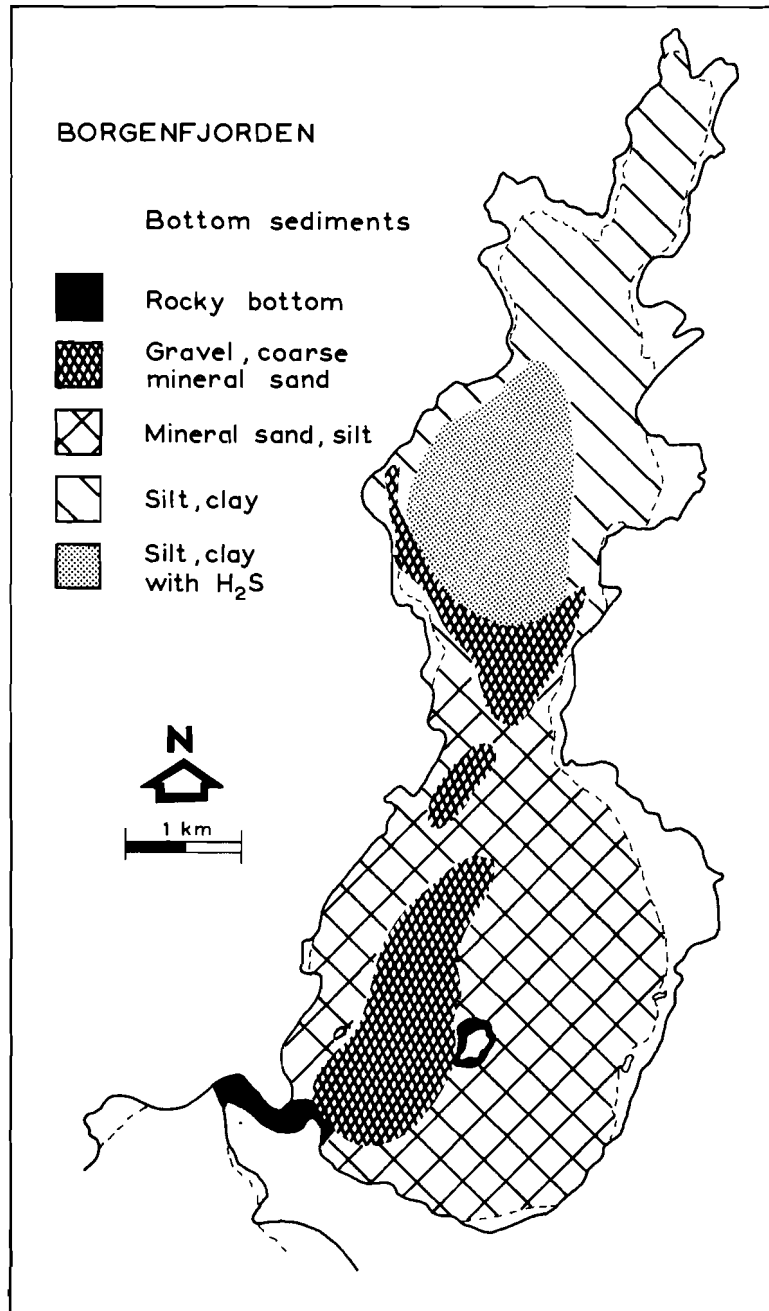


Fig. 2. Distribution of the main types of bottom sediments found in Borgenfjorden (after Gulliksen 1971).

organic matter below the pycnocline results in oxygen deficiency, and H<sub>2</sub>S is formed. An annual renewal of the stagnant bottom water starts in the autumn or early winter and continues throughout the winter.

The water temperature usually ranges annually from 1<sup>o</sup> to

20°C and the salinity from 20 to 30‰.

MATERIAL AND METHODS

Between September 1967 and October 1971 a total of 1.039 samples were obtained by means of a 0.1 m<sup>2</sup> Petersen grab. The most valuable, because consecutive, period of observations is from

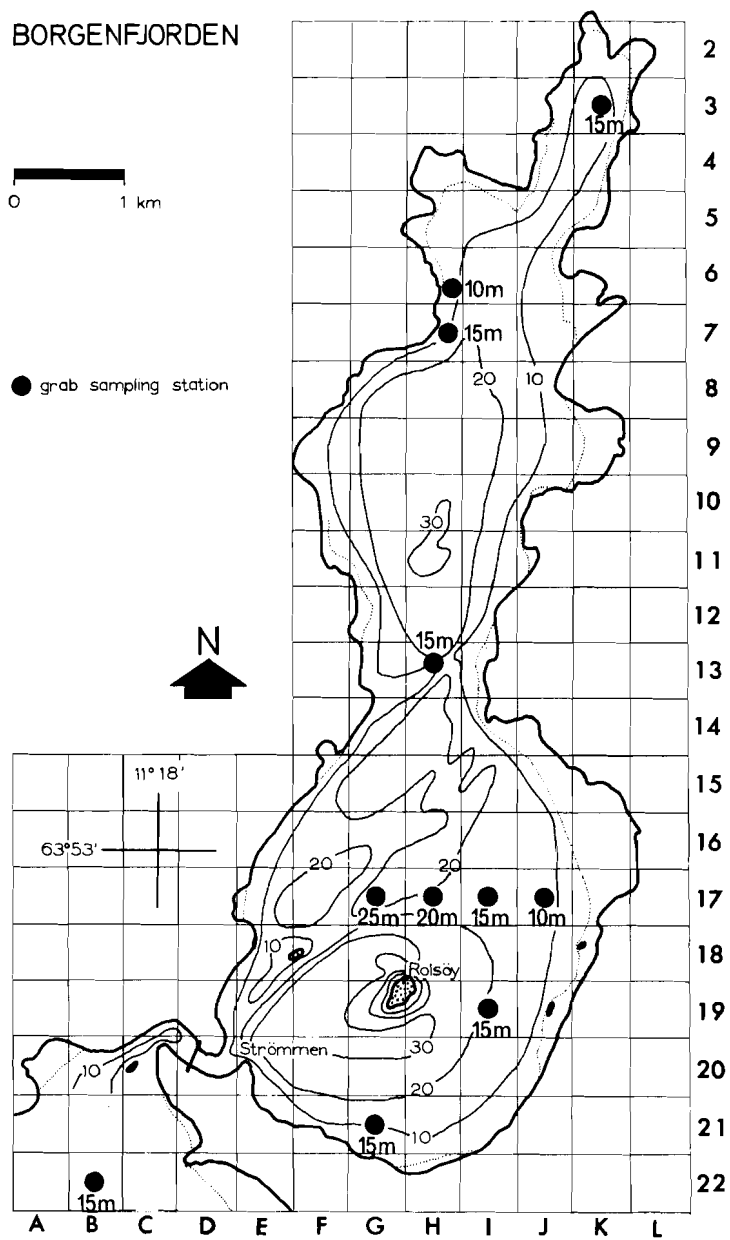


Fig. 3. Map of Borgenfjorden showing isobaths, coordinate grid, positions, and depths of all stations sampled between May 1970 and October 1971.

May 1970 to November 1971, comprising 12 cruises during which five replicate samples were obtained from each of the 11 stations (Fig. 3). Due to ice, three stations in the northern basin were omitted in February 1971. Thus, a total of 645 grab samples were collected during this period.

The contents of the grabs were sieved through a 1.0 mm mesh screen and the retained portion then sorted by hand. Holthe (1973) and E. Lande (1975) give an outline of the sampling programme, the methods used, and the stations worked.

Sampling errors due to half-filled grabs, incorrect positioning of the sampling stations, sorting by untrained personnel, etc., are of course present, but the size of the material sampled should provide valuable information about the distribution and frequency of occurrence of the molluscan species dealt with in this paper.

During the 1970-71 survey the station H 12 (Fig. 3) was located more or less on the threshold between the northern and southern basins. In the present paper it is considered as belonging to neither of the basins. E. Lande (1975) found that the species composition of the pelecypods found at H 12 more closely resembled the pelecypod fauna found at localities in the southern basin, than to that in the northern basin.

The material is deposited at the Zoological Department of the Museum of the Royal Norwegian Society of Sciences and Letters.

## RESULTS

All the caudofoveate, placophoran, and prosobranch species found during the Petersen-grab survey of Borgenfjorden made between May 1970 and November 1971 are listed below. Both the total numbers of specimens found and the months in which the species occurred in the material are given. The respective numbers of specimens found during the less efficient sampling period, from September 1967 to April 1970, are shown in brackets. "Outwith" refers to Stn B 22 and "Threshold" to Stn H 12 of the 1970-71 period (see map Fig. 3). Where frequency is reported the abbreviations O, S, T, N refer to Outwith, Southern basin, Threshold, and Northern basin.

Caudofoveata

*Chaetoderma nitidulum* (Lovén, 1846); (Map 1)

Northern basin: 0 (6 specimens: Desember 1967, July 1968)  
 Threshold : 3 specimens from June 1970  
 Southern basin: 5 specimens from April 1970, June 1971, October 1970, and November 1970 (2 specimens: July 1968)  
 Outwith : 10 specimens from March 1970, May 1970, July 1970, October 1970, and November 1970 (5 specimens: December 1967, July 1968)

	O	S	T	N
Frequency				
of total grabs sampled (T)	0.9	0.8	0.3	0
of grabs sampled within each basin (B)	10.0	1.4	3.3	0

A boreo-arctic species, abundant in Trondheimsfjorden. In Borgenfjorden the species was found with a maximum of four specimens per grab sample.

Polyplacophora

*Lepidopleurus asellus* (Gmelin, 1791); (Map 3)

Northern basin: 1 specimen from October 1970 (2 specimens: Desember 1967, July 1968)  
 Threshold : 3 specimens from July 1971 and August 1971  
 Southern basin: 0 (51 specimens: October 1967, January 1968, July 1968, September 1968)  
 Outwith : 264 specimens from February 1971, April 1970, May 1970,71, June 1971, July 1970, August 1970, October 1970, and November 1970 (31 specimens: December 1967, July 1968)

		O	S	T	N
Frequency	T	6.1	0	0.2	0.2
	B	65.0	0	1.7	0.6

A lusitanian-boreal species, abundant in Trondheimsfjorden. The species seems to be gregarious, since it occurred at times in rather large numbers, maximum 34 per grab.

*Tonicella marmorea* (Fabricius, 1780); (Map 2)

Northern basin: 0

Threshold : 0

Southern basin: 0

Outwith : 2 specimens from June 1971 (1 specimen: July 1968)

Underwater photography has shown that *T. marmorea* is commonly present on hard bottom substrates off Rolsøy in the southern basin. An arctic-boreal species, common in Trondheimsfjorden.

*Tonicella rubra* (Linnaeus, 1767); (Map 2)

Northern basin: 0

Threshold : 0

Southern basin: 0

Outwith : 3 specimens from February 1971, June 1971, and August 1970

An arctic-boreal species, occurring frequently in Trondheimsfjorden.

*Ischnochitona albula* (Linnaeus, 1767); (Map 3)

Northern basin: 0

Threshold : 0

Southern basin: 0

Outwith : 1 specimen from July 1970 (1 specimen: July 1968)

An arctic-boreal species, occurring occasionally in Trondheimsfjorden.

Prosobranchia

*Puncturella noachina* (Linnaeus, 1771); (Map 4)

Northern basin: 0  
Threshold : 0  
Southern basin: 0  
Outwith : 1 specimen from May 1970

An arctic species, abundant in Trondheimsfjorden.

*Acmaea testudinalis* (Müller, 1776); (Map 4)

Northern basin: 0  
Threshold : 0  
Southern basin: 0 (1 specimen: June 1968)  
Outwith : 1 specimen from July 1971

Underwater photography has shown that this species is frequently found on hard bottom substrates off Rolsøy. An arctic-boreal species, occurring frequently in Trondheimsfjorden.

*Acmaea virginea* (Müller, 1776); (Map 4)

Northern basin: 0  
Threshold : 0  
Southern basin: 0  
Outwith : 11 specimens from June 1971 and August 1970 (1 specimen: July 1968)

Underwater photography has shown that the species is common on hard bottom substrates off Rolsøy. A lusitanian-boreal species, abundant in Trondheimsfjorden.

*Lepeta caeca* (Müller, 1776); (Map 4)

Northern basin: 0  
Threshold : 0  
Southern basin: 0  
Outwith : 4 specimens from July 1970 and November 1970 (1 specimen: November 1969)



An arctic species, abundant in Trondheimsfjorden.

*Gibbula cineraria* (Linnaeus, 1758); (Map 5)

Northern basin: 4 specimens from October 1970

Threshold : 0

Southern basin: 2 specimens from October 1970 (8 specimens: July 1967, October 1967, July 1968)

Outwith : 60 specimens from February 1971, June 1971, July 1970, August 1970, October 1970, and November 1970 (7 specimens: July 1968)

		O	S	T	N
Frequency	T	3.6	0.2	0	0.3
	B	38.3	0.3	0	1.2

Outwith Strømmen an average of 2.6 specimens were found in each of the 23 grab samples in which it occurred, indicating an overall density of one specimen per 0.1 m<sup>2</sup>. A lusitanian-boreal species, occurring frequently in Trondheimsfjorden.

*Gibbula tumida* (Montagu, 1803); (Map 5)

Northern basin: 1 specimen from October 1970

Threshold : 0

Southern basin: 1 specimen from November 1970

Outwith : 10 specimens from May 1970, June 1971, July 1970, August 1970, and November 1970

		O	S	T	N
Frequency	T	1.4	0.2	0	0.2
	B	15.0	0.3	0	0.6

A lusitanian-boreal species, common in Trondheimsfjorden.

*Margarites groenlandicus* (Gmelin, 1791); (Map 6)

Northern basin: 0

Threshold : 0

Southern basin: 0 (8 specimens: October 1967, January 1968, July 1968)

Outwith : 6 specimens from May 1970 and August 1970 (2 specimens: July 1968)

An arctic species, common in Trondheimsfjorden.

*Margarites helicinus* (Phipps, 1774); (Map 6)

Northern basin: 0

Threshold : 0

Southern basin: 0

Outwith : 3 specimens from May 1970 and August 1970

An arctic-boreal species, occurring frequently in Trondheimsfjorden.

*Onoba striata* (Adams, 1803); (Map 7)

Northern basin: 1 specimen from June 1971

Threshold : 0

Southern basin: 0

Outwith : 0

A lusitanian-boreal species, occurring frequently in Trondheimsfjorden. It has also been found in Strømmen (E. Lande & Gulliksen 1973).

*Hydrobia ulvae* (Pennant, 1777); (Map 7)

Not recorded during the period 1970-71, but two specimens were found in the southern basin in July 1968. In the tidal zone of Borgefjorden, however, *H. ulvae* has been found at densities of up to 14,297 per m<sup>2</sup> (Strömngren et al. 1973). This lusitanian-boreal species is also common in Trondheimsfjorden.

*Turritella communis* Risso, 1826; (Map 8)

Northern basin: 4 specimens from July 1970, August 1970, and October 1970, 1971 (1 specimen: December 1967)

Threshold : 39 specimens from February 1971, May 1970, 71, June 1971, July 1971, August 1970, 71, October 1970, 71, and November 1970

Southern basin: 665 specimens from February 1971, May 1971, June 1970, 71, July 1970, 71, August 1970, 71, October

1970, 71, and November 1970 (123 specimens: October 1967, December 1967, February-March 1968, May-September 1968, August 1969, October 1969)  
 Outwith : 15 specimens from February 1971, May 1971, June 1970, August 1971, and November 1970 (10 specimens: December 1967, July 1968, November 1968, August 1969)

	O	S	T	N
Frequency T	1.7	25.3	3.0	0.6
B	18.3	45.3	31.7	2.4

*T. communis* is a sedentary filter feeder. It is gregarious and may therefore occur at high densities (Yonge 1946). In Borgenfjorden, the largest number of specimens found in a single grab sample was 25. A lusitanian-boreal species, abundant in Trondheimsfjorden.

*Bittium reticulatum* (da Costa, 1778); (Map 9)

Not recorded during the period 1970-71, one specimen found outwith Borgenfjorden in July 1968. The species is lusitanian-boreal, occurring frequently in Trondheimsfjorden. It is also common in Strømmen (E. Lande & Gulliksen 1973).

*Amauropsis islandicus* (Gmelin, 1791); (Map 9)

Northern basin: 0  
 Threshold : 0  
 Southern basin: 0  
 Outwith : 1 specimen from February 1971

An arctic-boreal species, occurring occasionally in Trondheimsfjorden.

*Lunatia intermedia* (Philippi, 1836); (Map 10)

Northern basin: 0  
 Threshold : 0  
 Southern basin: 0  
 Outwith : 1 specimen from October 1970

A lusitanian-boreal species, common in Trondheimsfjorden.

*Lunatia pallida* (Broderip & Sowerby, 1829); (Map 10)

Northern basin: 0  
 Threshold : 0  
 Southern basin: 1 specimen from November 1970  
 Outwith : 11 specimens from May 1971, June 1970, July 1971,  
 August 1971, November 1970 (5 specimens: July  
 1968, August 1969, October 1969)

An arctic species, common in Trondheimsfjorden.

*Trichotropis borealis* Broderip & Sowerby, 1829; (Map 12)

Not recorded during the investigation period 1970-71, 1 specimen  
 found outwith Borgenfjorden in July 1968. An arctic species,  
 occurring frequently in Trondheimsfjorden.

*Aporrhais pespelecani* (Linnaeus, 1758); (Map 11)

Northern basin: 45 specimens from May 1970,71, August 1970,71,  
 October 1970, and November 1970 (13 specimens:  
 December 1967, July 1968, August 1969, October  
 1969, December 1969)  
 Threshold : 9 specimens from February 1971, May 1971, July  
 1971, and October 1971  
 Southern basin: 100 specimens from February 1971, May 1970,71,  
 August 1970,71, October 1970,71, November 1970,  
 and December 1970 (33 specimens: October 1967,  
 January 1968, May-July 1968, October 1968, March  
 1969, August 1969, October 1969, December 1969)  
 Outwith : 3 specimens from May 1971

		O	S	T	N
Frequency	T	0.3	12.4	1.2	5.6
	B	3.3	22.2	13.3	21.8

The largest number of specimens found in a single grab sample was  
 four. A lusitanian-boreal species, common in Trondheimsfjorden.

*Velutina velutina* (Müller, 1776); (Map 12)

Northern basin: 0 (1 specimen: August 1968)  
Threshold : 1 specimen from July 1970  
Southern basin: 0 (6 specimens: January 1968, June-July 1968,  
August 1969)  
Outwith : 6 specimens from February 1971, April 1970, July  
1970, and October 1970

A lusitanian-boreal species, occurring frequently in Trondheimsfjorden.

*Thais lapillus* (Linnaeus, 1758); (Map 13)

Northern basin: 2 specimens from June 1970 and October 1970  
Threshold : 0  
Southern basin: 0 (2 specimens: October 1967)  
Outwith : 0

A boreal species, abundant in Trondheimsfjorden.

*Boreotrophon barvicensis* (Johnston, 1841); (Map 13)

Northern basin: 0  
Threshold : 0  
Southern basin: 0  
Outwith : 6 specimens from May 1970 and November 1970 (2  
specimens: July 1968, August 1969)

A boreal species, abundant in Trondheimsfjorden.

*Buccinum undatum* (Linnaeus, 1758); (Map 14)

Northern basin: 4 specimens from June 1971, July 1971, October  
1970, and November 1970 (7 specimens: December  
1967, July-August 1968, October 1969, December  
1969)  
Threshold : 2 specimens from March 1970 and November 1970  
Southern basin: 25 specimens from February 1971, May-August 1970,  
71, and October 1970 (23 specimens: October 1967,  
December 1967, January 1968, July 1968, August 1969)  
Outwith : 2 specimens from July 1970 and August 1970

		O	S	T	N
Frequency	T	0.3	3.3	0.3	0.6
	B	3.3	5.8	3.3	2.4

A boreo-arctic species, abundant in Trondheimsfjorden.

*Neptunea despecta* (Linnaeus, 1758); (Map 15)

Northern basin: 0 (2 specimens: July 1968, August 1969)

Threshold : 1 specimen from October 1971

Southern basin: 0 (but known from earlier dredge samples from 30 m depth off Rolsøy)

Outwith : 0

An arctic-boreal species, abundant in Trondheimsfjorden.

*Nassarius reticulatus* (Linnaeus, 1758); (Map 15)

Northern basin: 6 specimens from May 1971, June 1971, August 1970, and November 1970

Threshold : 0

Southern basin: 2 specimens from July 1971 and August 1971 (1 specimen: May 1968)

Outwith : 0

A lusitanian-boreal species, occurring frequently in Trondheimsfjorden.

*Oenopota harpularia* (Couthouy, 1838); (Map 16)

Northern basin: 4 specimens from May 1971, August 1971, October 1971, and November 1970 (1 specimen: December 1967)

Threshold : 0

Southern basin: 0

Outwith : 0

An arctic-boreal species, occurring occasionally in Trondheimsfjorden.

DISCUSSION

During the whole investigation period (1967-71), one species of Caudofoveata, four species of Polyplacophora, and 24 species of Prosobranchia have been found in the Petersen grab material. Three of the prosobranch species (viz. *Hydrobia ulvae*, *Bittium reticulatum*, and *Trichotropis borealis*) were not recorded during the more intensive sampling period 1970-71. However, *H. ulvae* is found abundantly on soft bottom substrates within the tidal zone in Borgenfjorden (Strömngren et al. 1973), and *B. reticulatum* is common in Strømmen (E. Lande & Gulliksen 1973).

Of the here treated 29 molluscan species recorded during 1967-1971, 24 were recorded at the stations lying outwith Strømmen, 15 in the southern basin, seven on the threshold between the southern and the northern basins, and 13 in the northern basin. The number of species common to more than one area are shown in a Venn-diagram (Fig. 4).

Probably the total number of polyplacophoran and prosobranch species in Borgenfjorden is higher than that reported in this paper. All grab samples were collected from 10 m depth, or deeper; i.e. species restricted to shallower areas, and the hard bottom substrates, are therefore likely to be under-represented in the present material.

It is interesting to note that of the 26 species recorded

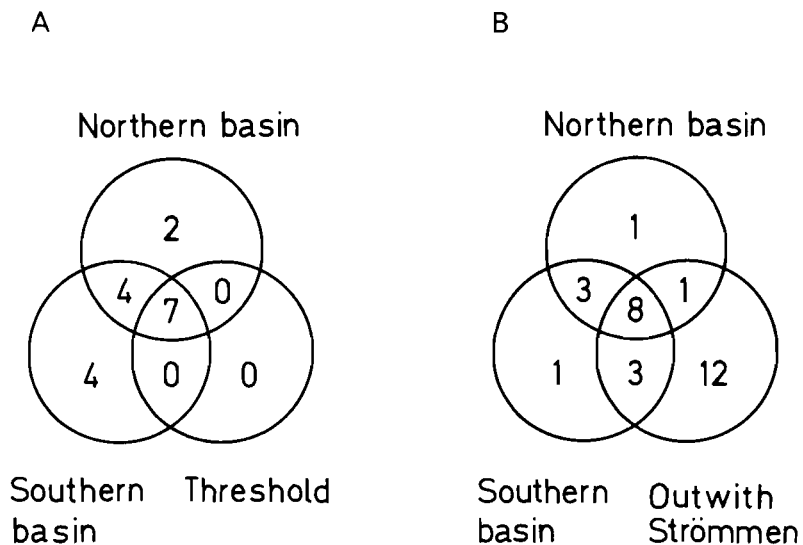


Fig. 4. Venn-diagrams showing the species distribution, a: in Borgenfjorden proper, b: in the three main distribution areas.

during 1970-71, 11 (42.3%) are more typically epifaunal organisms; most of them have probably been present on small stones or dead shells in the grab material.

During the 1970-71 sampling period a total av 585 grab samples, comprising 931 specimens, were obtained from Borgenfjorden proper. Six of the 14 species recorded during this period (*Chaetoderma nitidulum*, *Gibbula cineraria*, *Turritella communis*, *Apporhais pespelecani*, *Buccinum undatum*, *Nassarius reticulatus*) occurred with a total of more than five specimens each (Tabel I). *T. communis* and *A. pespelecani* seem to be abundant on soft bottom substrates in Borgenfjorden proper, constituting 76% and 16.5% respectively of the total number of individuals sampled. The less abundant *Ch. nitidulum*, *B. undatum*, and *N. reticulatus* are probably also relatively common soft bottom animals in the fjord. Four of the species, *Onoba striata*, *Lunatia pallida*, *Velutina velutina*, and *Neptunea despecta*, were only represented by a single specimen.

Outwith Strømmen, 62.7% of all specimens collected were *Lepidopleurus asellus*. *Gibbula cineraria* accounted for 14%, *Turritella communis* 3.6%, and *Chaetoderma nitidulum*, *Acmaea virginea*, *Gibbula tumida*, and *Lunatia pallida* 2.5% each.

Some information about the predators of gastropods is known from Borgenfjorden. *Apporhais pespelecani*, *Velutina velutina*, and *Buccinum undatum* have been found in the guts of plaice (R. Lande 1972, 1973), and *Turritella communis*, *V. velutina*, and *B. undatum* in the guts of cod (Denstadli 1972). *B. undatum* was common, the other species were more sparsely recorded. One specimen of *T. communis* has also been found in the stomach contents of *Ophiura albida* (Skjæveland 1973). In this respect it is interesting to note that *T. communis*, *A. pespelecani*, and *B. undatum* are the three most abundant benthic species. *V. velutina*, too, is probably more common than the results of the grab samples would indicate, since it is often found when dredging on hard bottom substrates.

From a zoogeographic viewpoint, 82.8% of the sampled are either arctic (41.4%) or lusitanian-boreal (41.4%) in their main distributions (Tabel II). The lusitanian-boreal element is predominant in Borgenfjorden proper, and the arctic element is less pronounced in the northern than in the southern basin (15.4% and 26.7% resp.). E. Lande (1975) found that within these two basins, 25-26%



Table I. Total number of specimens of the different species recorded at each of the sampling stations between May 1970 and October 1971. The main zoogeographical distribution of each species is also indicated (A = arctic, AB = arctic-boreal, B = boreal, LB = lusitanian-boreal)

Species	Zoo-geogr. distr.	B	22	G	21	I	19	G	17	H	17	I	17	J	17	H	12	H	7	H	6	K	3	Total: whole area	Total: Borgen-fjorden proper	Epi-faunal element (x)
<b>Caudofoveata</b>																										
<i>Chaetoderma nitidulum</i>	AB	10		2		1		2								3								18	8	
<b>Polyplacophora</b>																										
<i>Lepidopleurus asellus</i>	LB	264														3		1						268	4	x
<i>Tonicella marmorea</i>	AB	2																						2	-	x
<i>Tonicella rubra</i>	AB	3																						3	-	x
<i>Ichnochitona albula</i>	AB	1																						1	-	x
<b>Prosobranchia</b>																										
<i>Puncturella noachina</i>	A	1																						1	-	x
<i>Acmaea testudinalis</i>	AB	1																						1	-	x
<i>Acmaea virginea</i>	LB	11																						11	-	x
<i>Lepeta caeca</i>	A	4																						4	-	x
<i>Gibbula cineraria</i>	LB	60										2								4				66	6	
<i>Gibbula tumida</i>	LB	10											1							1				12	2	
<i>Margarites groenlandicus</i>	A	6																						6	-	
<i>Margarites helycinus</i>	AB	3																						3	-	x
<i>Onoba striata</i>	LB																		1					-	1	
<i>Turitella communis</i>	LB	15	16	200		22	216	167	44	39	1	2	1	723	708											
<i>Amauropsis islandicus</i>	AB	1																						1	-	
<i>Lunatia intermedia</i>	LB	1																						1	-	
<i>Lunatia pallida</i>	A	11						1																12	1	
<i>Aporrhais pespelecani</i>	LB	3	20	18		9	8	12	33	9	5	30	10	157	154											
<i>Velutina velutina</i>	LB	6														1								7	1	x
<i>Thais lapillus</i>	B																			1	1			-	2	x
<i>Boreotrophon barvicensis</i>	B	6																						6	-	
<i>Buccinum undatum</i>	AB	2	3	1	14	4	3			2	1	2	1	33	31											
<i>Neptunea despecta</i>	AB									1														-	1	
<i>Nassarius reticulatus</i>	LB					1	1											1	5					-	8	
<i>Oenopota harpularia</i>	AB																						4	-	4	

Table II. Zoogeographical distributions of the combined Caudofoveata, Polyplacophora, and Prosobranchia species sampled with the Petersen grab in various parts of Borgenfjorden during the period September 1967 - October 1971. The total numbers (N) and percentage representations (%) are given in each case

	Outwith Strømmen		Southern basin		Northern basin		Total for whole area	
	N	%	N	%	N	%	N	%
Arctic, arctic-boreal	10	43.5	4	26.7	2	15.4	12	41.4
Boreal, Boreo-arctic	4	17.4	3	20.0	3	23.1	5	17.2
Lusitanian-boreal	9	39.1	8	53.3	8	61.5	12	41.4
	23	100	15	100	13	100	29	100

of the pelecypod species have an arctic main distribution. For other benthic groups, i.e. Polychaeta (Holthe 1973), Echinodermata (Skjæveland 1972), and Ascidiacea (Gulliksen 1974), the arctic element dominates the species composition in both basins.

#### ACKNOWLEDGEMENTS

I am grateful to Mr. Björn Gulliksen, Mr. Torleif Holthe, and Mr. Eirik Lande for advice and criticism of the manuscript, and to Dr. Luitfried v. Salvini-Plawen for identifying the Caudofoveata. Miss Randi Sve and Mr. Harald Haakstad have assisted in sorting the molluscan material. Mr. P.A. Tallantire has kindly corrected the English text. Financial support was provided by the Norwegian Research Council for Science and the Humanities.

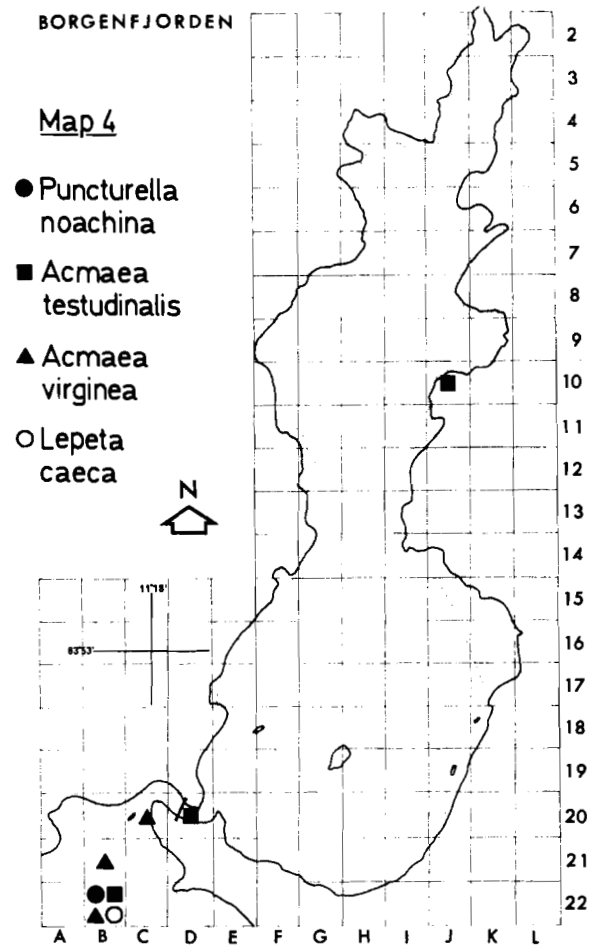
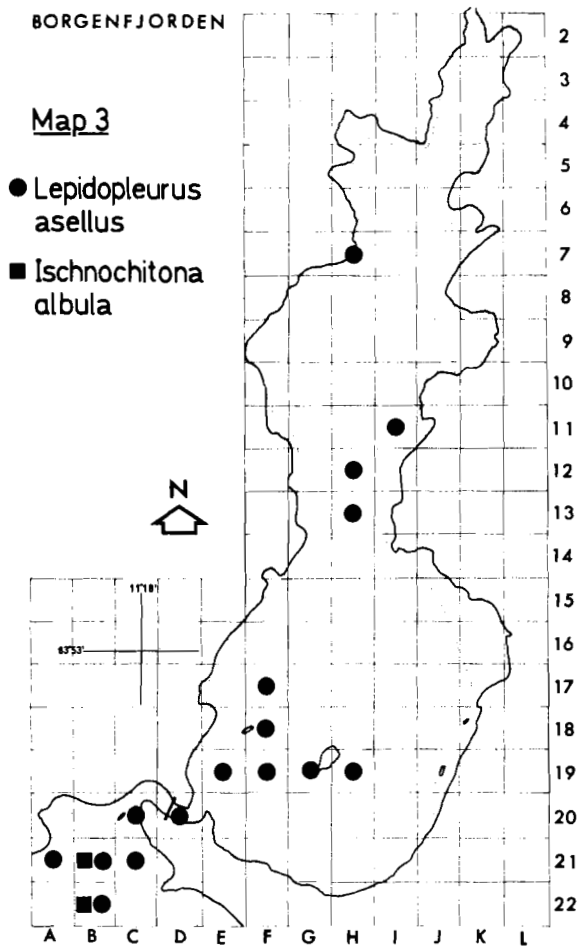
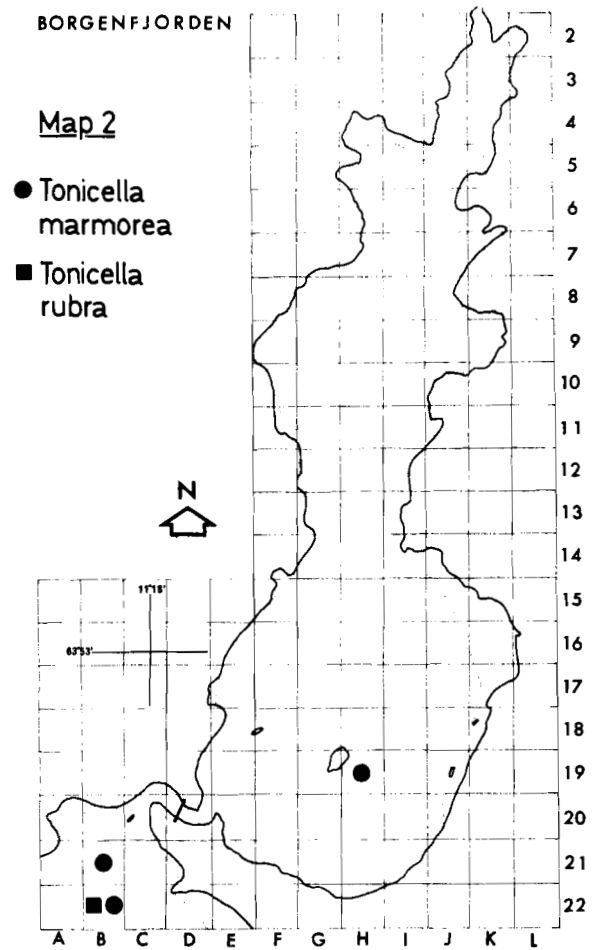
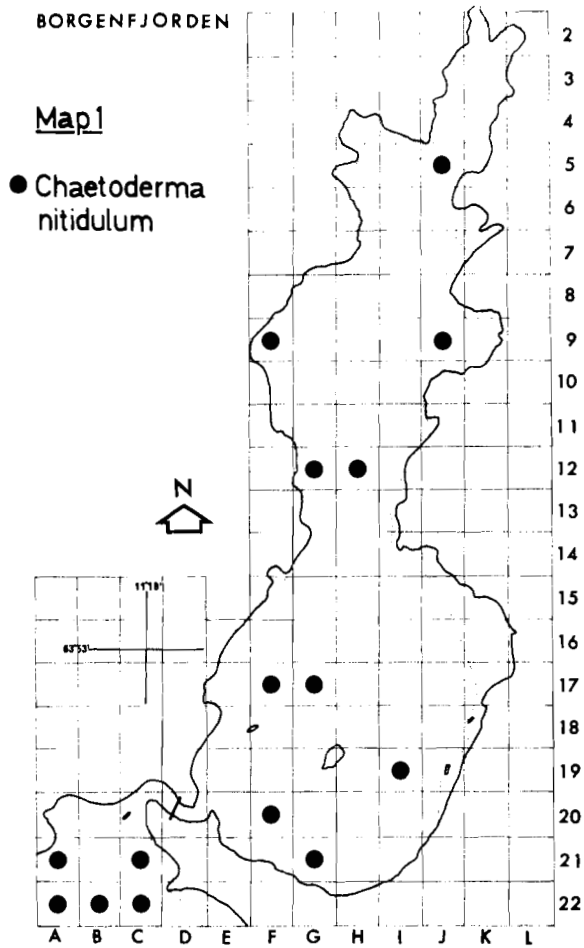
REFERENCES

- Borgenfjordundersökelsene 1969. *Borgenfjordundersökelsene. Preliminærrapport 1968*. Strömngren, T. (Ed.). The Royal Norwegian Society of Sciences and Letters, The Museum. Trondheim. 66 pp.
- 1970. *Borgenfjordundersökelsene. Preliminærrapport 1969*. Strömngren, T. (Ed.). The Royal Norwegian Society of Sciences and Letters, The Museum. Trondheim. 41 pp.
  - 1971. *Borgenfjordundersökelsene. Preliminærrapport 1970*. Strömngren, T. (Ed.). The Royal Norwegian Society of Sciences and Letters, The Museum. Trondheim. 40 pp.
  - 1973. *Borgenfjordundersökelsene. Preliminærrapport 1971-1972*. Strömngren, T. & B. Gulliksen (Eds.). The Royal Norwegian Society of Sciences and Letters, The Museum. Trondheim. 11 pp.
- Denstadli, S.O. 1972. Forplantning, vekst og ernæring hos torsk (*Gadus morhua* L.) i Borgenfjorden, Nord-Trøndelag. Unpublished thesis. University of Trondheim. 111 pp.
- Gulliksen, B. 1971. Ascidiene i Borgenfjorden. Biomassevariasjon og virkningen av bunnssubstrat, hydrografiske faktorer og predasjon på deres biologi og økologi. Unpublished thesis. University of Trondheim. 97 pp.
- 1972. Spawning, larval settlement, growth, biomass, and distribution of *Ciona intestinalis* L. (Tunicata) in Borgenfjorden, North-Trøndelag, Norway. *Sarsia* 51: 83-96.
  - 1974. The Ascidian fauna on level bottom areas in the Borgenfjord, 1967-1973. *K. norske Vidensk. Selsk. Mus. Miscnea* (21): 1-18.
- Holthe, T. 1973. Borgenfjordens Polychaeta, Echiurida, Sipunculida, Priapulida, Phoronida og Enteropneusta. Unpublished thesis. University of Trondheim. 190 pp.
- Lande, E. 1975. The distribution of pelecypods in Borgenfjorden, North-Trøndelag, Norway. *Norw. J. Zool.* 23: 55-66.
- Lande, E. & B. Gulliksen. 1973. The benthic fauna of the tidal rapids to Borgenfjorden, North-Trøndelag, Norway. *K. norske Vidensk. Selsk. Skr.* 1973 (1): 1-6.

- Lande, R. 1972. Aldersfordeling, vekst og næringsvaner hos rødspette (*Pleuronectes platessa* L.) fra ytre basseng i Borgenfjorden, North-Trøndelag. Unpublished thesis. University of Trondheim. 91 pp.
- 1973. Food and feeding habits of plaice (*Pleuronectes platessa* L.) in Borgenfjorden, North-Trøndelag, Norway. *Norw. J. Zool.* 21: 91-100.
- McClimans, T.A. 1973. Physical oceanography of Borgenfjorden. *K. norske Vidensk. Selsk. Skr.* 1973 (2): 1-43.
- Nordgaard, O. 1910. Beretning for forsök med utklækning av guld-flyndre (*Pleuronectes platessa*, Lin.) ved Trondhjems biologiske station i aarene 1908 og 1909. *K. norske Vidensk. Selsk. Skr.* 1909 (7): 1-46.
- 1923. Bemerkninger om dyrelivet i Borgenfjorden. *Ibid.* 1921 (5): 1-22.
- Skjæveland, S.H. 1972. Echinodermene i Borgenfjorden. Unpublished thesis. University of Trondheim. 140 pp.
- 1973. Ecology of echinoderms in Borgenfjorden, North-Trøndelag, Norway. *K. norske Vidensk. Selsk. Mus. Miscnea* (8): 1-51.
- Strömngren, T. 1974. The use of a weighted arithmetic mean for describing the sediments of a landlocked basin (Borgenfjorden, Western Norway). *Deep Sea Res.* 21: 155-160.
- Strömngren, T., Fagerjord, O. & E. Lande. 1971. Sedimentundersökelse i Borgenfjorden; pp. 37-40 in Strömngren, T. (Ed.). *Borgenfjordundersökelsene. Preliminærreport 1970.* Royal Norwegian Society of Sciences and Letters, The Museum. Trondheim. 40 pp.
- Strömngren, T., Lande, R. & S. Engen. 1973. Intertidal distribution of the fauna on muddy beaches in the Borgenfjord area. *Sarsia* 53: 49-70.
- Yonge, C.M. 1946. On the habits of *Turritella communis* Risso. *J. mar. biol. Ass. U.K.* 26: 377-380.

Received 8.04.1975

Printed 2.06.1975

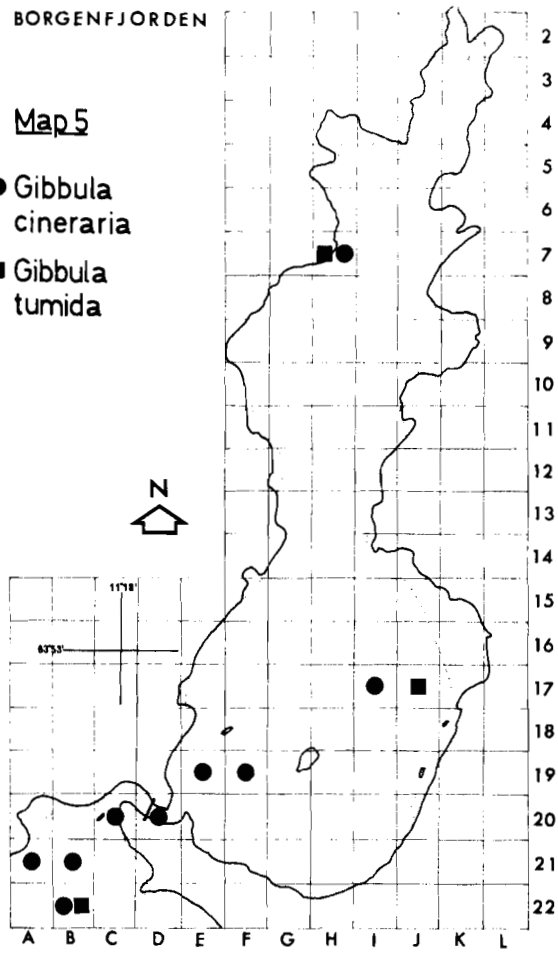




BORGENFJORDEN

Map 5

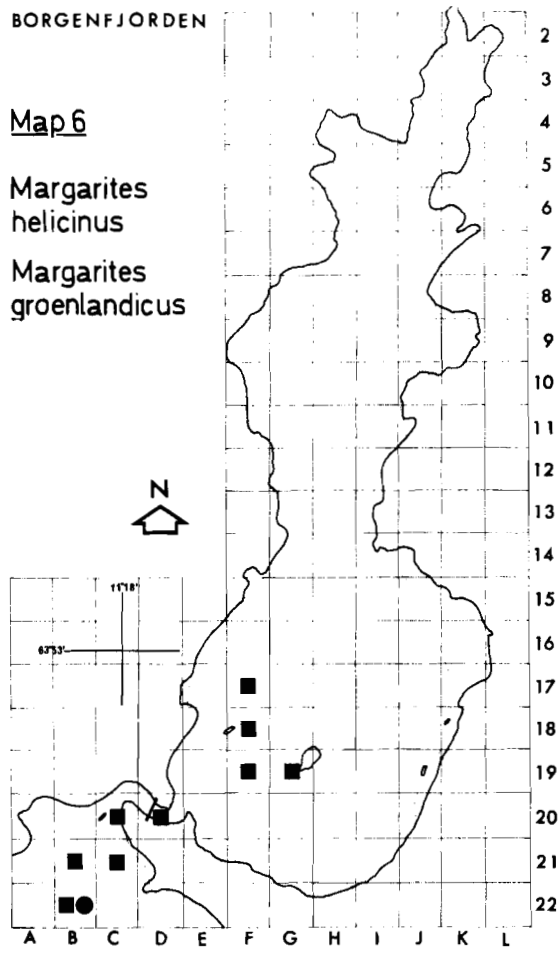
- *Gibbula cineraria*
- *Gibbula tumida*



BORGENFJORDEN

Map 6

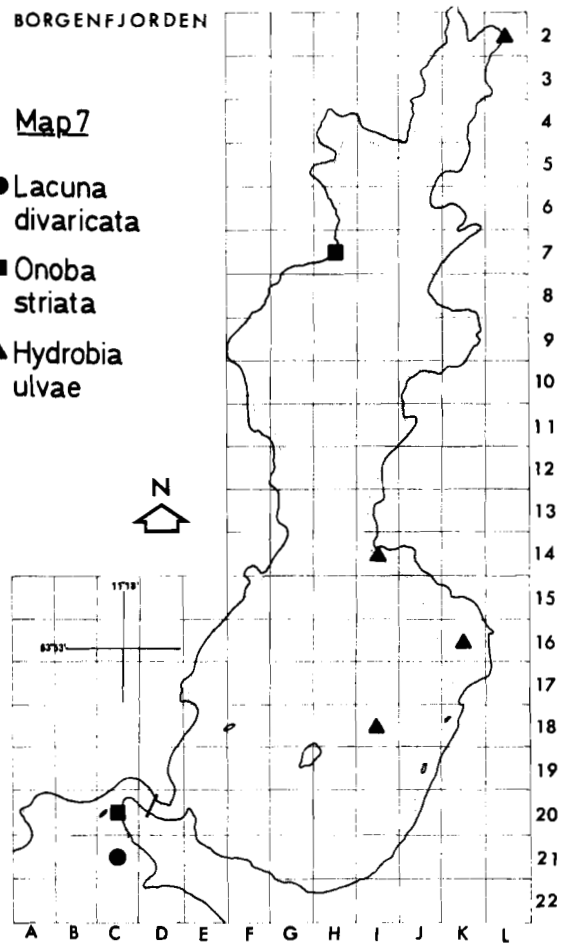
- *Margarites helicus*
- *Margarites groenlandicus*



BORGENFJORDEN

Map 7

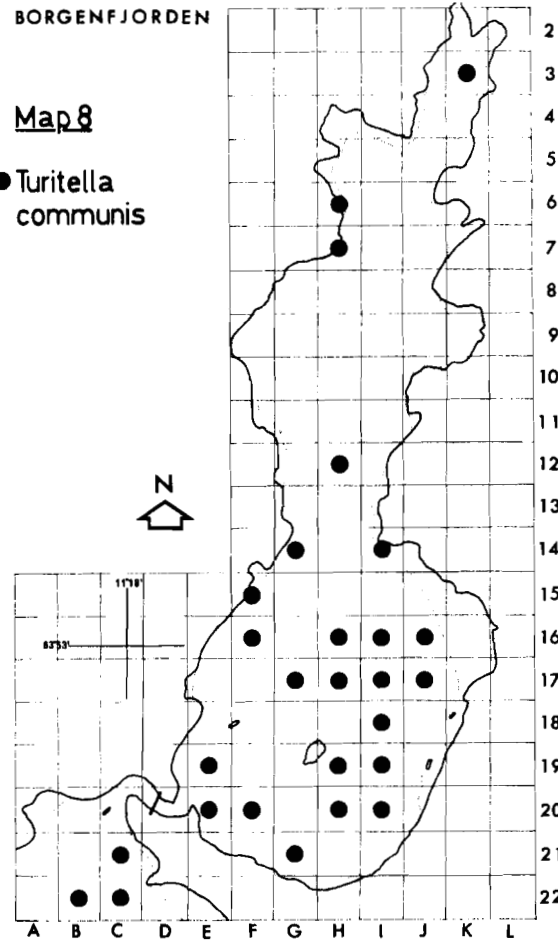
- *Lacuna divaricata*
- *Onoba striata*
- ▲ *Hydrobia ulvae*



BORGENFJORDEN

Map 8

- *Turritella communis*



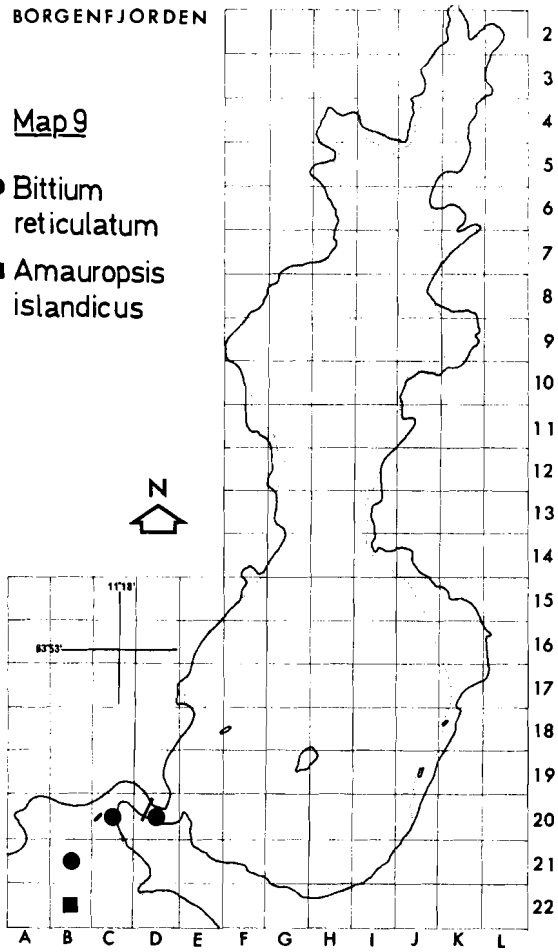




BORGENFJORDEN

Map9

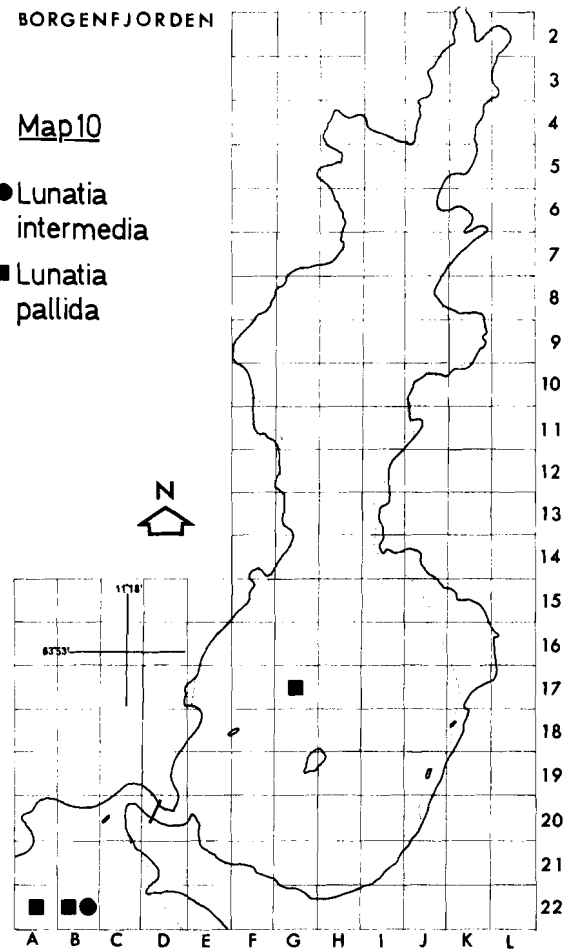
- *Bittium reticulatum*
- *Amauropsis islandicus*



BORGENFJORDEN

Map10

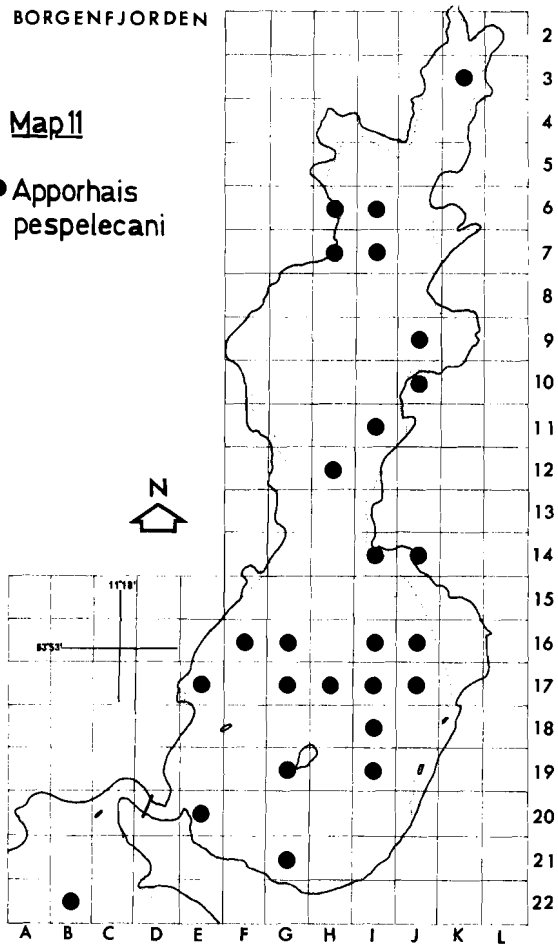
- *Lunatia intermedia*
- *Lunatia pallida*



BORGENFJORDEN

Map11

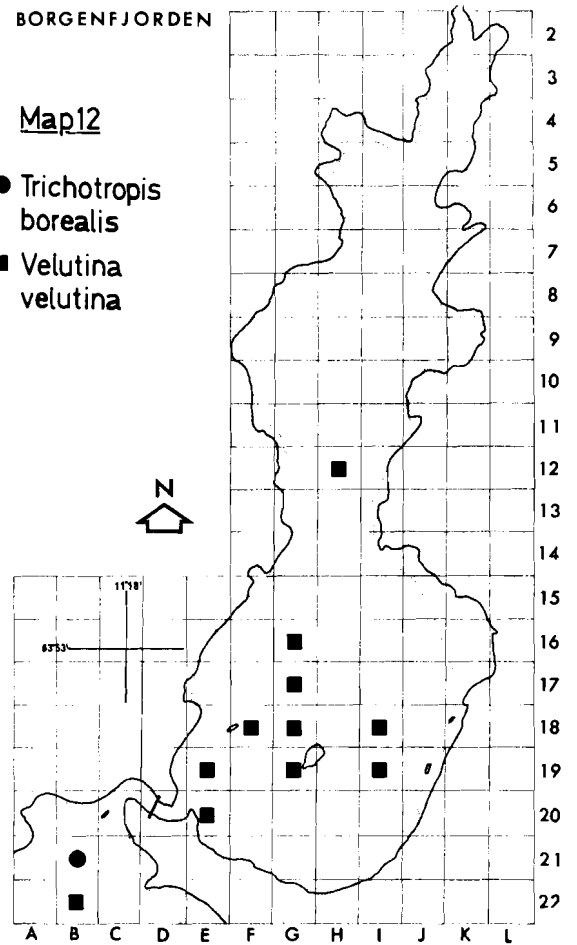
- *Apporhais pespelecani*



BORGENFJORDEN

Map12

- *Trichotropis borealis*
- *Velutina velutina*

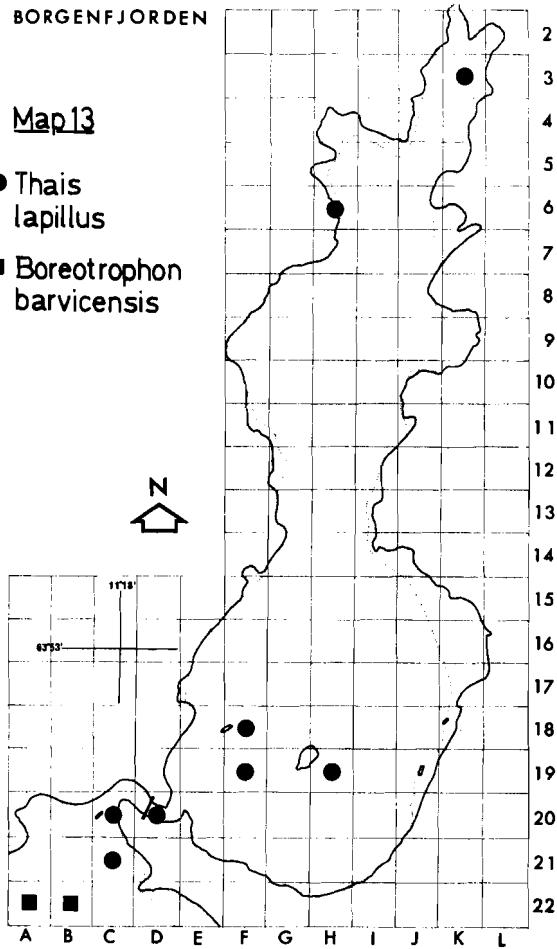




BORGENFJORDEN

Map13

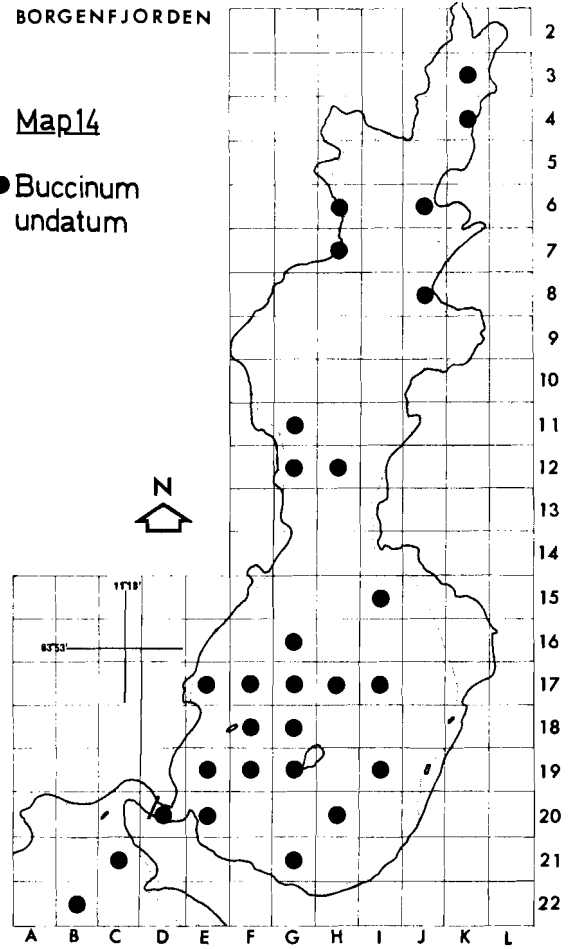
- *Thais lapillus*
- *Boreotrophon barvicensis*



BORGENFJORDEN

Map14

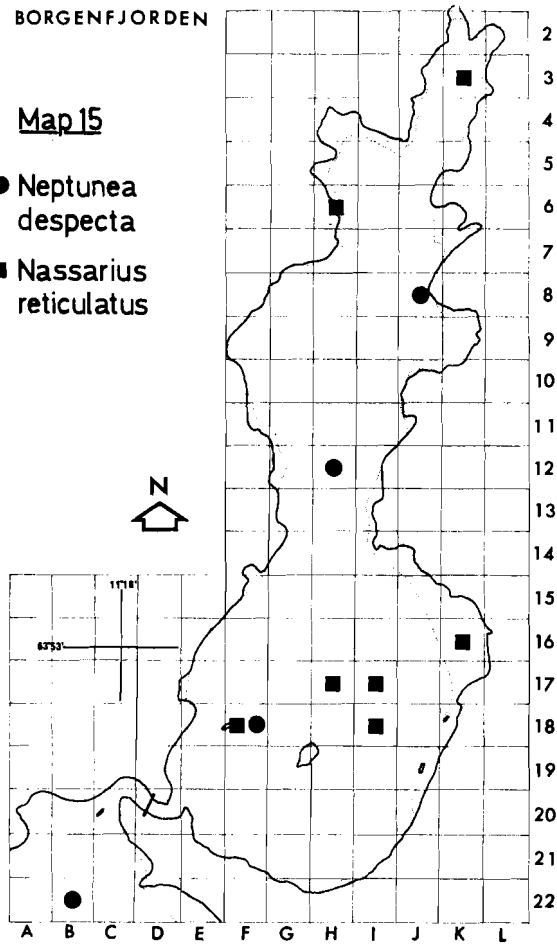
- *Buccinum undatum*



BORGENFJORDEN

Map15

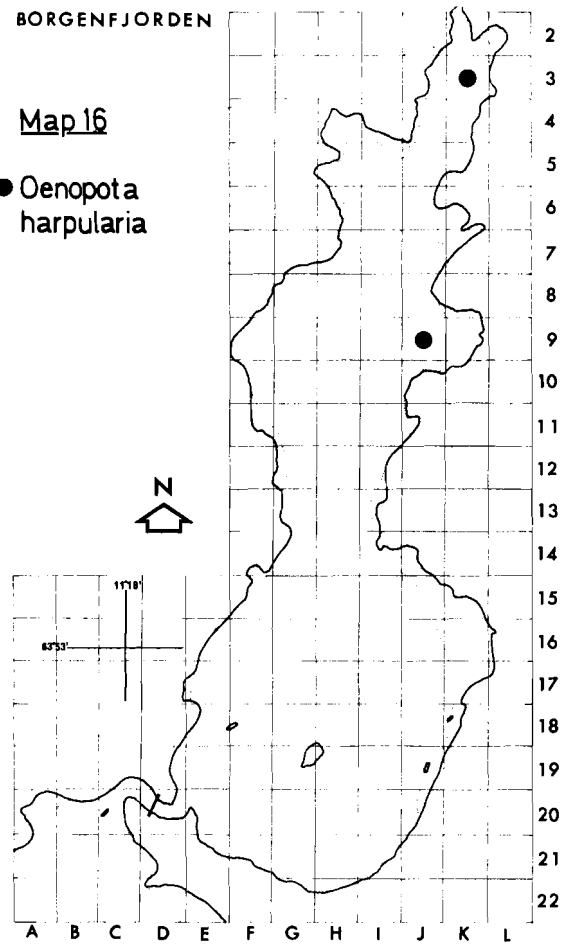
- *Neptunea despecta*
- *Nassarius reticulatus*



BORGENFJORDEN

Map16

- *Oenopota harpularia*





## TIDLIGERE UTKOMMET I SERIEN

1. Strømgren, T. 1971. Zooplankton investigations in Skjomen. Preliminary report, November 1969 – January 1971. 25 pp.
2. Malme, L. 1971. Oseaniske skog- og heiplante-samfunn på fjellet Talstadhesten i Fræna, nordvest-Norge, og deres forhold til om-givelsene. 39 pp. 12 Tab.
3. Baadsvik, K. 1971. Om klimaet ved jordover-flaten og de temperaturforhold fjellplantene lever under. 28 pp.
4. Mæhre Lauritzen, E. 1972. Mosefloraen på Bergsåsen i Snåsa, Nord-Trøndelag 1972 pp.
5. Farbregd, O. 1972. Pilefunn frå Oppdalsfjella. 138 pp. 17 pl.
10. Gulliksen, E. H. 1973. Jan Mayen – en bibliografi. 22 pp.
11. Lande E. 1973. Growth, spawning, and mortality of the mussel (*Mytilus edulis* L.) in Prestvaagen, Trondheimsfjorden. 26 pp.
12. Aune, E. I. 1973. Forest vegetation in Hemne, Sør-Trøndelag, Western Central Norway. 87 pp.
13. Strømgren, T. 1973. Zooplankton investigations in Trondheimsfjorden, 1963–66. 149 pp.
14. Strømgren, T. 1973. Vertical distribution and numerical variation of zooplankton in the upper to m at one station in Trondheimsfjorden. 54 pp.
15. Iversen, T.-H. 1974. The roles of statoliths, auxin transport, and auxin metabolism in root geotropism. 216 pp.
16. Evensen, D. 1974. The benthic algae of Borgenfjorden, North-Trøndelag, Norway. 18 pp.
17. Strømgren, T. 1974. Zooplankton and hydro-graphy in Trondheimsfjorden on the west coast of Norway. 35 pp.
18. Skogen, A. 1974. Karplantefloraen i Ørland herred, Sør-Trøndelag, nyfunn og forandringer etter 10 år. 49 pp.
19. Gulliksen, B. 1974. Marine Investigations at Jan Mayen in 1972. 46 pp.
20. Sneli, J.-A. 1974. A collection of marine mollusca from Møre and Romsdal, North-western Norway. 17 pp.
21. Gulliksen, B. 1974. The Ascidian fauna on level bottom areas in the Borgenfjord, 1967–1973. 18 pp.
22. Malme, L. 1975. Phytosociological studies of aquatic and marsh vegetation in Møre og Romsdal, Western Norway. 30 pp.

