IMR/PINRO
JOINT REPORT SERIES
1
2010

Mapping and monitoring of benthos in the Barents Sea and Svalbard waters: Results from the joint Russian - Norwegian benthic programme 2006-2008

By
N.A. Anisimova, L.L. Jørgensen, P.A. Lyubin, and I.E. Manushin

Institute of Marine Research - IMR
Polar Research Institute of Marine Fisheries and Oceanography - PINRO

This report should be cited as:

Anisimova, N.A., Jørgensen, L.L., Lyubin, P.A. and Manushin, I.E. 2010. Mapping and monitoring of benthos in the Barents Sea and Svalbard waters: Results from the joint Russian - Norwegian benthic programme 2006-2008. IMR-PINRO Joint Report Series 1-2010. ISSN 1502-8828. 114 pp.

Mapping and monitoring of benthos in the Barents Sea and Svalbard waters: Results from the joint Russian-Norwegian benthic programme 2006-2008

N.A. Anisimova[1], L.L. Jørgensen[2], P.A. Lyubin[1] and I.E. Manushin[1]

[1]Polar Research Institute of Marine Fisheries and Oceanography (PINRO)
Murmansk, Russia
[2]Institute of Marine Research (IMR)
Tromsø, Norway

The detritus feeding sea cucumber *Molpodia borealis* taken as by-catch in bottom trawling and now ready to be weighed counted and measured. Photo: Lis Lindal Jørgensen

Contents

1 Introduction

By L.L. Jørgensen

This three-year project, supported by the Joint Norwegian-Russian Fishery Commission, is meant as a contribution to describe the status of the Barents Sea ecosystem with expected change under impact of the climate variability and human activities. As benthos is broadly accepted as environmental indicators, this report are also of interest for the the Joint Norwegian-Russian Commission for Environment. The report is designed as a contribution into the information basis for developing joint ecosystem-based management in the Barents Sea. Ecosystem-based management is a work in progress and should be considered as a process rather than an end state. Ecosystembased management plan for Norwegian waters in the area (*the Integrated Management of the Marine Environment of the Barents Sea and the Sea Areas off the Lofoten Islands: Rep No 8 to the Storting 2005-2006*) is now adopted but the analogous management plan for the Russian part is not yet developed.

Year 2007 marked the 50-year anniversary of a formal and active cooperation in marine research between the Institute of Marine Research (IMR) in Norway and the Polar Research Institute of Marine Fisheries and Oceanography (PINRO) in Russia. Whereas IMR has focused mainly on commercial species in the past, PINRO has also been working with benthic investigations for nearly a decade.

PINRO started the mapping of benthic fauna in the Southern and Eastern part of the Barents Sea in 1923. In 1968-1970, the entire Barents Sea was mapped with regard to the benthos, and this was done again in 2003-2008. PINRO holds therefore a long-term series of 85 years of monitoring the bottom fauna.

In 2005, the first joint benthic programme was established by IMR and PINRO at the "Ecosystem Survey" covering the entire Barents Sea. The main idea behind the joint benthic work was to establish a time and cost efficient "Long Term Monitoring Programme" for the benthic component of the Barents Sea ecosystem. The by-catch of the scientific demersal fish trawling (Campelen trawl) on all participating IMR and PINRO research vessels was analysed and recorded in a standardized way, and all data were made available for both IMR and PINRO benthic experts and evaluated in annual meetings.

In 2007, PINRO and IMR agreed upon a three-year joint programme. Here it was decided to describe the project, the progress, and the results of the study on benthic communities in the Barents Sea. The mail goals were: 1) map the benthic species and communities, 2) to initiate the long term monitoring of potential changes in the benthic composition resulting from bottom trawling, climate change, invasive species (primarily the king crab) and effects from gas and oil activities, and 3) to give recommendations on how the benthic component of the ecosystem can be used in the management of the environment and living recourses of the Barents Sea.

During 2007-2009 it was decided to 1) finalise the re-sampling of the historical station grid of PINRO, 2) to assess all the invertebrate species caught in bottom fishing-trawling, and 3) to study the foraging behaviour of the king crab and its impact on native fauna.

The benthic community is a three-dimensional habitat consisting of infaunal species (i.e. inside the sediment), epifaunal species (on the sediment surface), and species swimming above the sediment (mobile megafauna). In order to obtain a detailed picture of the in- and epifauna, a quantitative 0.1m^2 van-Veen grab is used. For the widely distributed, but often sparsely or aggregated large benthic species, a trawl has to be used. Combining both methods provides more information than using only one gear type. However, data of the two gear types can not be combined directly in order to obtain quantitative estimates, since trawl haul data are considered semi-quantitative (thus referred to as gross estimates), whereas vanVeen grab data are quantitative data.

Methods exist for the calculation of a catch-ability index for species occurring in both trawl and grab samples, but there are problems in using these indexes because of the different spatial scales addressed by the two sampling methods (sampling areas 0.1 m^2 for the grab versus up to 18.000 m^2 for the trawl). Since calculations can only be made for the large and sparsely distributed species sampled by both gear types, the accuracy of the calculations is somewhat uncertain. Nevertheless, despite such direct incompatibility of "trawl" and "grab" benthos data, it is important to use both gears in monitoring in order to sample the different components of the benthic communities. Using the trawl has, to a certain degree, the advantage of being more time- and cost-efficient than using the grab. Trawl samples produce a useful assessment of semi-quantitative estimates of the megafauna.

At present, the PINRO-IMR joint benthic research involves both types of sampling tools: 1) the classic benthic grab study (benthic surveys 2003-2008). which is the continuation of the long-term observations of major changes in the Barents Sea benthos, and 2) the trawl benthos study (by-catch in Campelen trawls). This opens up the prospect for operative monitoring in order to detect unpredicted changes in the benthic communities, and, as a second step, to initiate more detailed scientific research, which eventually should lead to management decisions.

The Barents Sea is strongly influenced by human activity; historically involving the fishing and hunting of marine mammals. More recently, human activities also involve transportation of goods, oil and gas, tourism, and aquaculture. Large-scale harvesting in the Barents Sea strongly impacts not only on the status of commercially important species, but also on the ecosystem as a whole. The impact of introduced and invasive species can be seen on a more localised scale.

The Barents Sea ecosystem is also strongly influenced by climatic conditions. Year-to-year variations in strength of Atlantic water inflow lead to adjustments in the ecosystem that affect production and the distribution of species. In the last years, there is an increasing interest in the evaluation of the most likely responses of the Barents Sea ecosystem to future climatic change. Anthropogenic warming is projected to lead to increased air and sea temperatures globally, with the highest increases in air temperature in the Arctic and Sub arctic regions. Climatic conditions effect primary production and feeding conditions for fish and invertebrates, as well as survival of their offspring. Inter-specific trophic relations are another key factor influencing the abundance and population dynamics of species.

2 Atlas of the macrobenthic species of the Barents Sea invertebrates

By P.A. Lyubin

For the use of the Russian-Norwegian ecosystem surveys, an electronic atlas, containing information about dominant invertebrate species in the Barents Sea, was created in order to standardize naming of species obtained from by-catches of macrobenthos. Images of bottom by-catch invertebrates taken during ichthyologic research were used in the atlas. The taxonomy of each species, their ecology and distribution are described in the atlas in accordance to original data and references. This background information was generated in the database using Microsoft Access 2002. To update the atlas automatically and create a web application, Macromedia Dreamweaver MX was used. This generates auxiliary programmes written in the Visual Basic programming language using the Active Server Pages (ASP) technology.

The structure of the electronic atlas represents six blocks which are linked to each other: "Main menu", "Express key", "Systematic key", "Catalogue of taxonomical groups", "Description of species", "Bibliographic Data" (Figure 2.1). Entrance to the electronic atlas is conducted via the "main menu" (Figure 2.2). Four options of the actions to be carried out are then suggested:

- search for information on a particular (discrete) species;
- go to the taxonomic group required;
- identify an organism using a picture;
- identify an organism using a systematic character.

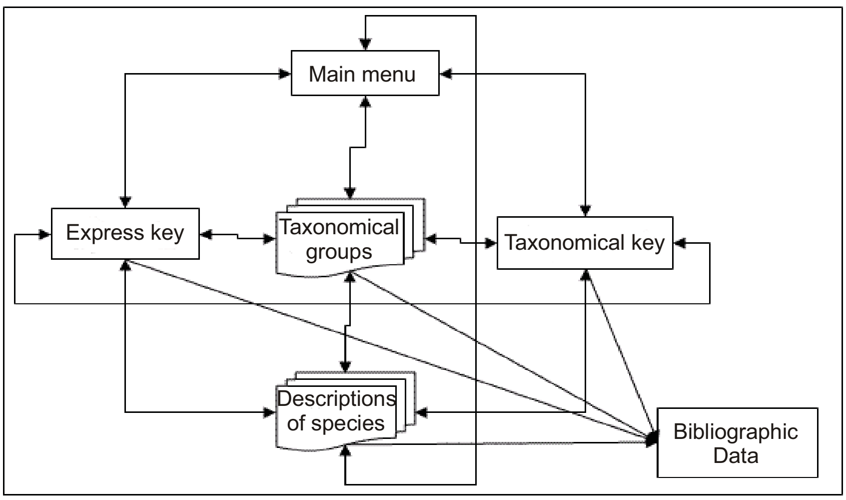


Figure 2.1. Structure of the electronic atlas.

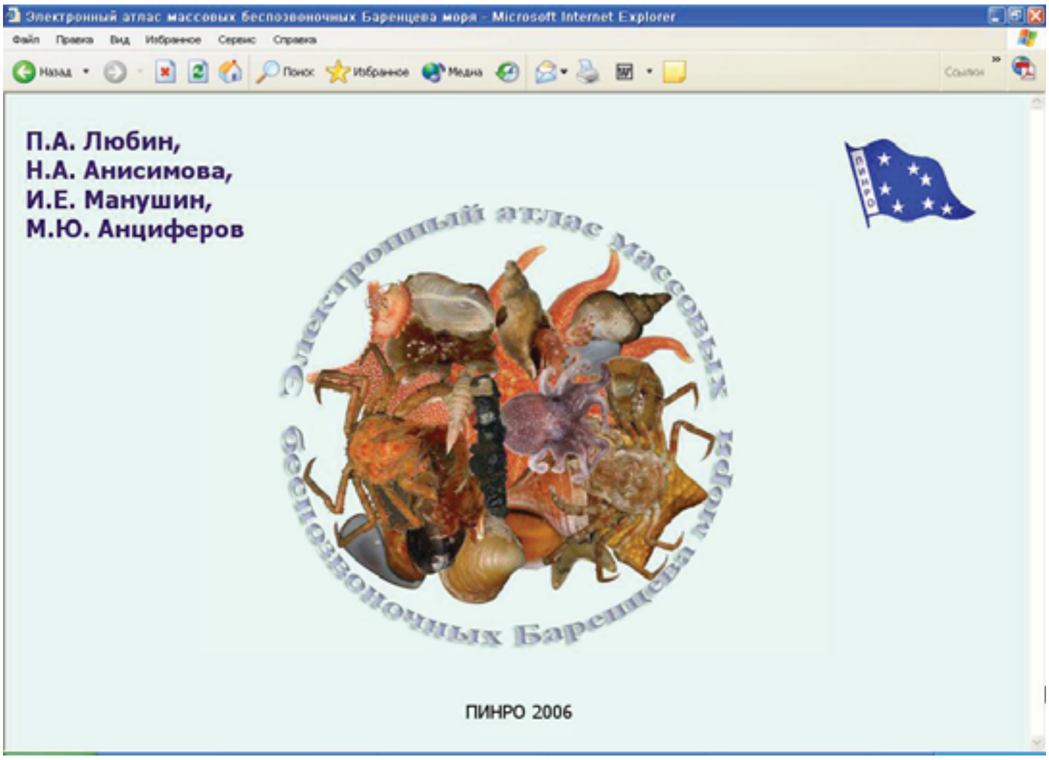


Figure 2.2. Example of the initial menu of the electronic atlas.

A user can go to the main menu or to the parallel menu from each menu item dependent on the search results (Figure 2.3). If there is no information available on a taxonomic group or species, the user is referred to a list of references on this issue (planned in the second version).

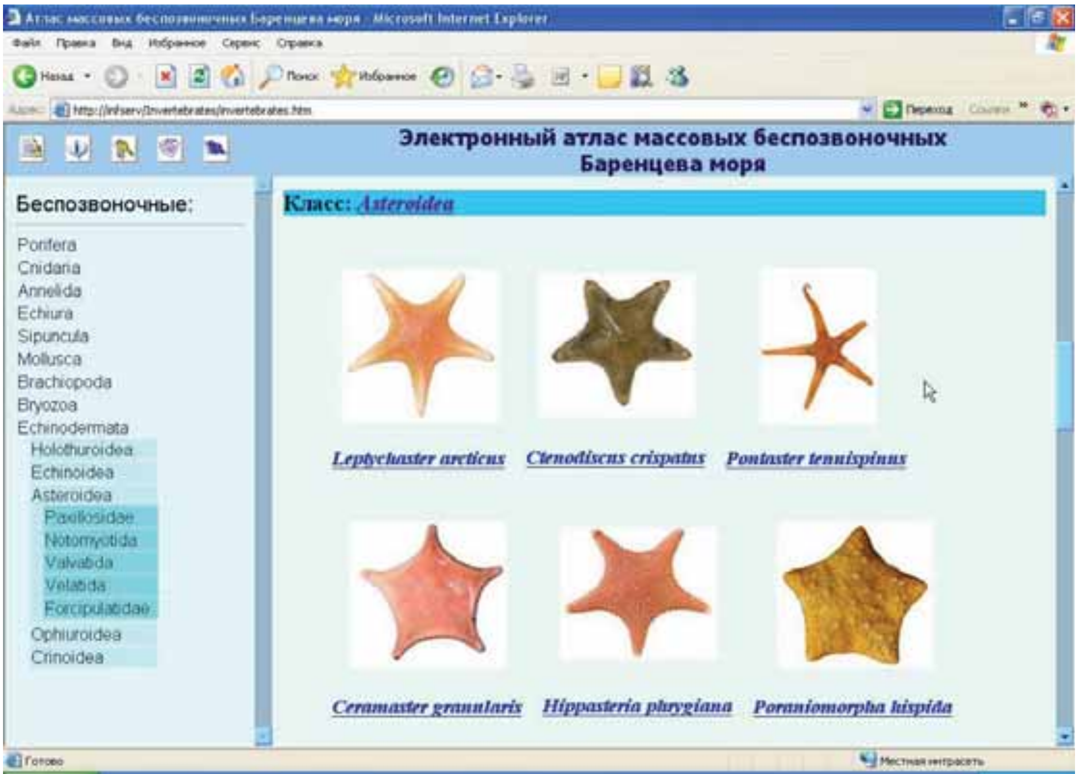


Figure 2.3. Example of a page for quick identification of sea-stars.

The result page gives information on each species containing an image of a typical individual, the taxonomical name, systematic position, morphological description using illustrative material, a map of distribution in the Northern hemisphere and a description of the ecological features (Figure 2.4).

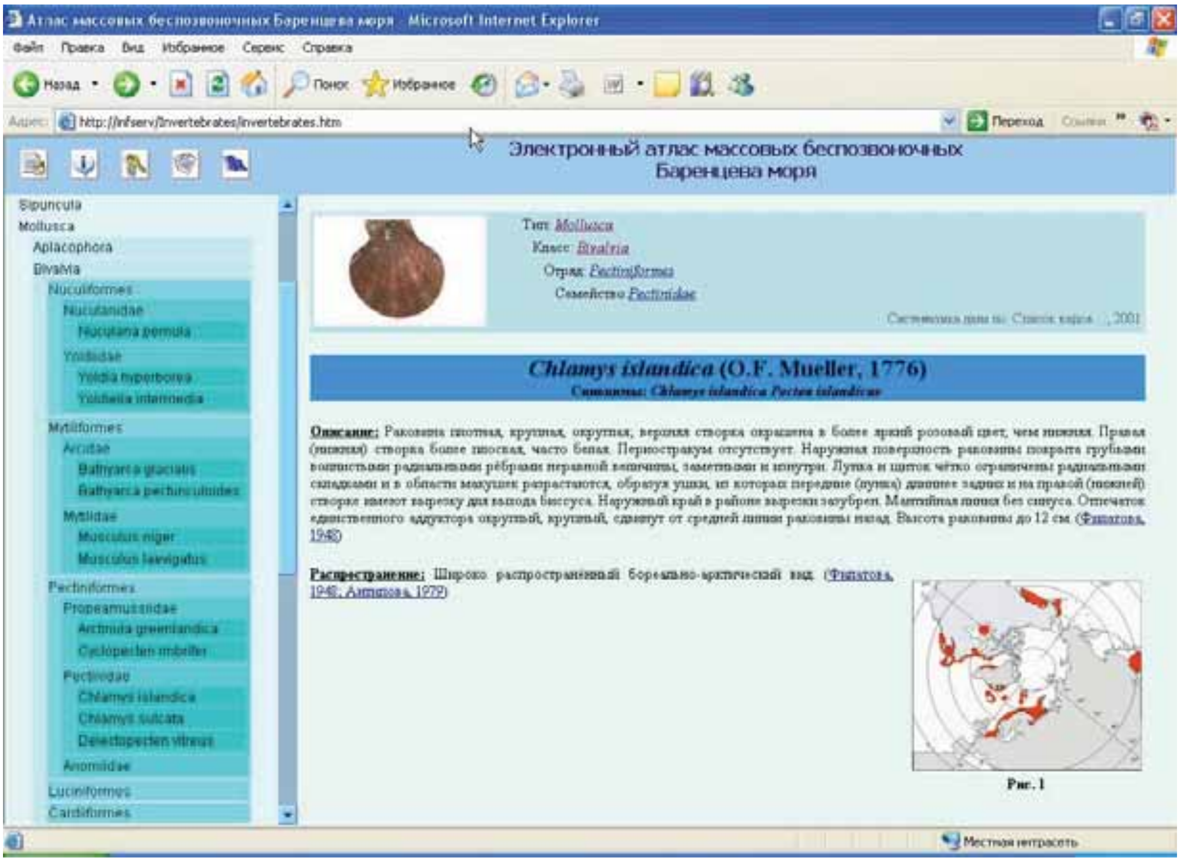
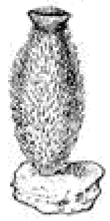
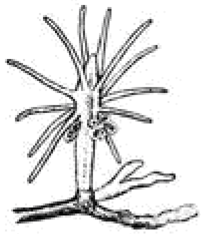
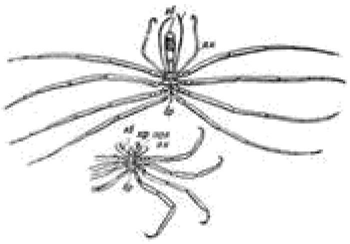
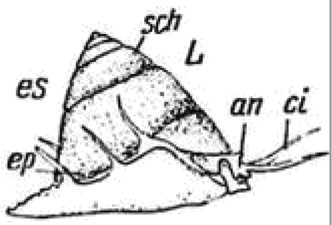
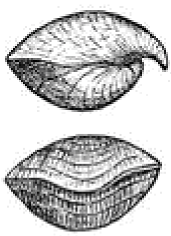
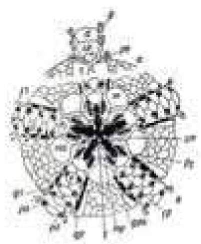


Figure 2.4. Example of result page for a particular species.

The "Picture-keys" are used to identify organisms following systematic characters. Such method has been applied traditionally in systematics and is the most accurate one to identify the systematic status of an organism. However, a method of dichotomous written keys (based on key couplets) is very inconvenient for algorithm elaboration if a number of taxonomic units to be used in the atlas (which is still in development) are unknown. The editing of such characters in the Atlas requires a software programme and is labour-intensive. For this reason a polytomous key was chosen. Despite the fact that this type of key is rarely used by taxonomists, the successful use of polytomous keys in the identification of living organisms has been described (Cannon 1986).

The advantage of using a polytomous key is that multiple choices are offered at each step as compared to two choices in the dichotomous key. This type of key couplets is convenient to organize keys into a hierarchical tree of taxa. At the same time, a number of identification steps in the key are equal to a number of taxonomic ranks. The first step identifies the general type an organism belongs to (Table 2.1, Figure 2.5), in the second stage – its class and so forth up to species level.

Table 2.1. Example of table for identification of a type of animal.

	Diagnosis	**Type**
	A colonial or non-colonial animal, a filter-feeder with internal body cavity but incapable of contractive activity because of absence of muscular tissue	Porifera
	A colonial or non-colonial animal, a filter-feeder with body cavity and capable of contractive activity as it has muscular tissue and thread-cells	Cnidaria
	An animal with segmented body and joint extremities	Arthropoda
	An animal with soft body consisting of a head, trunk and muscular foot which has or does not have an external or internal shell	Mollusca
	An animal with bivalve shell, abdominal valve forms a rostrum	Brachiopoda
	An animal with five-beam symmetry, its body is more or less covered with lime plates or spines	Echinodermata

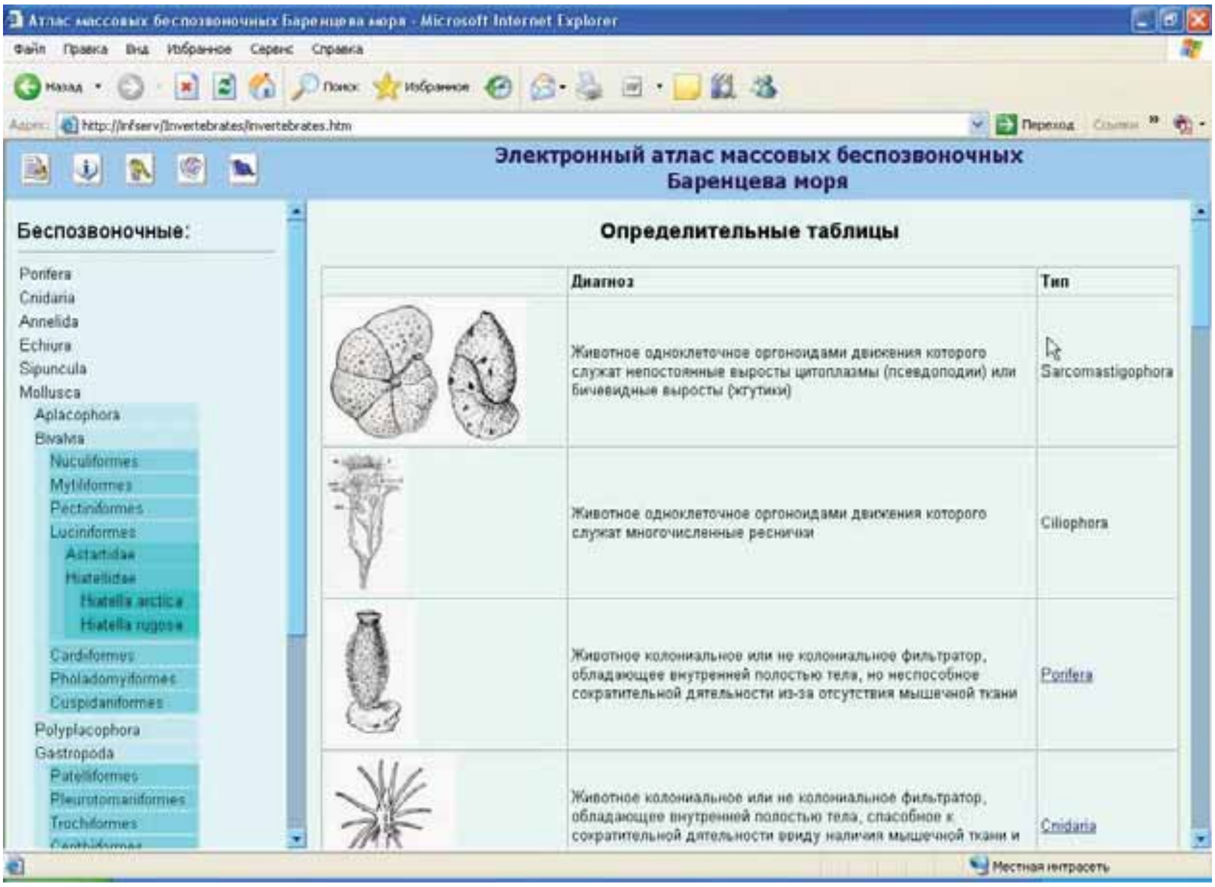


Figure 2.5. Example of key-table for identification of the type of animal.

At present there are 24 keys to identify faunal types, 10 keys to identify classes, 20 keys for orders, 29 keys for genera, 31 keys for families and 24 keys for species. At the beginning of 2009 information on 37 benthic invertebrate species occurring frequently in the Barents Sea is incorporated in the Electronic Atlas.

3 Benthic databases

By P.A. Lyubin

Modern and large-scale research cannot function without laborious mathematical and statistical methods of data processing. Thus, it is vital to implement databases and their management systems in such research projects. Extended databases are created during the joint PINRO and IMR benthic researches in the Barents Sea where we find up to 50 species (on average) of benthic invertebrates belonging to more than 10 animal types in each bottom sample (0.1 m^2). Since five replicate samples are taken per station the species inventory for each station can contain up to 150 species on average. For the assessing of bottom assemblages it is essential to not only take into account density and biomass of each sampled species but also the reliability of findings, biogeographically characteristics of each taxon, its life form and feeding behaviour. Thus the preparation of data for further use in, e.g., theoretical models, is labour-intensive. In this context, an information database, adapted for storag and processing of information on benthic invertebrates was created in 2004 in the Laboratory of Commercial Invertebrates (PINRO). By now this database works successfully and is continuously developed further. Microsoft Access 2002 was chosen as software environment for the database.

Currently, the benthic database used during joint investigation consists of three major blocks (Figure 3.1):

- cruise and station information storage;
- quantitative and biological information storage;
- storage of information on taxonomy, biology and ecology of species.

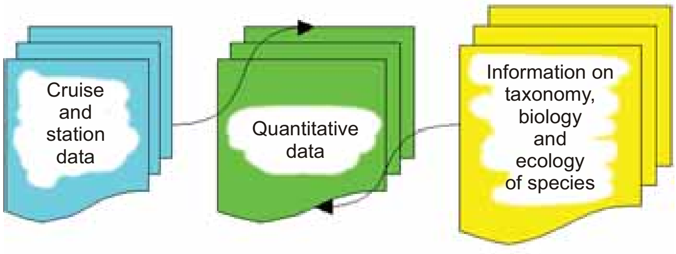


Figure 3.1. Circuit diagram of the PINRO benthic database structure.

The first block contains basic expedition information and consists of 7 tables (Figure 3.2). The main table in this block is the "Station Table" containing station data: date and time of station beginning and end, coordinates, area of samples collection, depth, bottom temperature and salinity, sediment description, gear used, catch description, method of sample processing and fixation, name of person(s) processing the sample and entering data. Each station has a unique identifier which consists of cruise code and station number. Thus, stations collected in one cruise are united under a cruise code. The "Table of cruises" contains cruise data: cruise dates, vessel characteristics, data on cruise managers, etc. Apart from the mentioned tables, this block contains additional tables with data on equipment used, description of sea bottom, research areas, data on vessels, and personnel processing the samples.

The block with systematic information contains data on invertebrates inhabiting the Barents, Kara and White Seas and other regions of the Arctic and the Atlantic. The "Table of species" is the main table of this block. Taxonomy, biogeographical, trophic and ecological characteristics are presented for each species along with their valid synonyms. Another important additional table is the "Table of synonyms" which is directly connected to the "Table of species". This table contains old and new names, invalid species synonyms used by experts to specify organisms and their connection to valid name of the species. Apart from this table there are some other additional tables that decipher code names used to describe biology of the species and its systematic location.

The last of the three blocks contains quantitative information and is linked to the other two blocks. This block consists of two tables. The first, "Table of quantitative data", contains quantitative data by species per station: abundance and biomass of species per sample. The second table contains the biological data (body length in mm; specimen's biomass in gram;

organism's sex; maturity stage, etc). Both tables are connected to the tables “Station Table” and “Table of synonyms”.

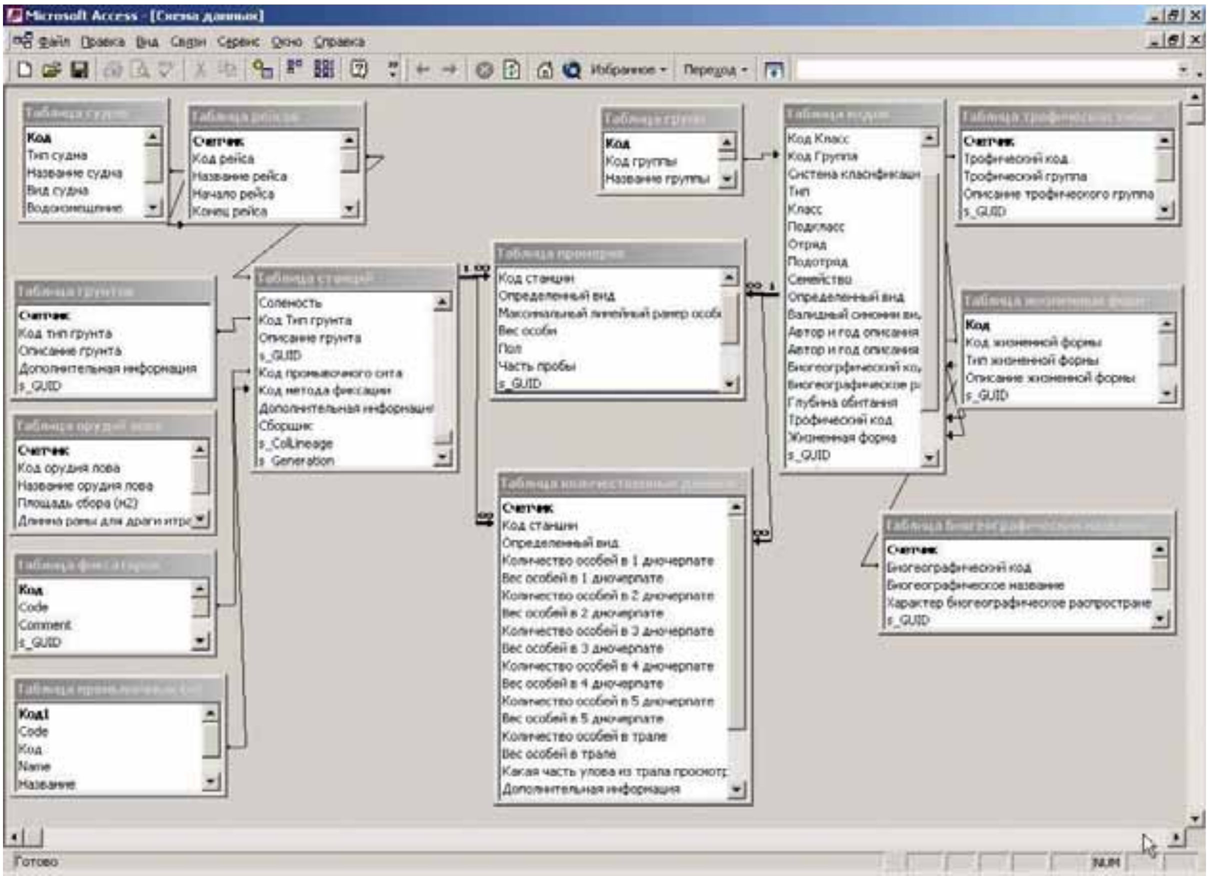


Figure 3.2. Chart of tables and links in the benthic database made in Microsoft Access 2002.

User surface, queries and macros in the database facilitate simple data entry and information retrieval (Figure 3.3).

Thus this database is one single (unified) complex of tables, user interfaces (forms), queries and macro instructions connected to each other that simplify the use of the base and allow rapid obtaining of information necessary for the analyses of benthic communities.

At the present, the database is transformed into a data storage system based on Visual FoxPro (V7.0). This will allow correlating benthic data to the ichthyologic database ‘BioFox’ and to the fisheries- biological database of cruise information on the PINRO server. Call cruises numbers are defined by vessels register, handbooks of biological and hydrological information of PINRO cruises. Tables of supplemental information are being created based on the block of systematic information and are entered into the linked software on benthic data base processing.

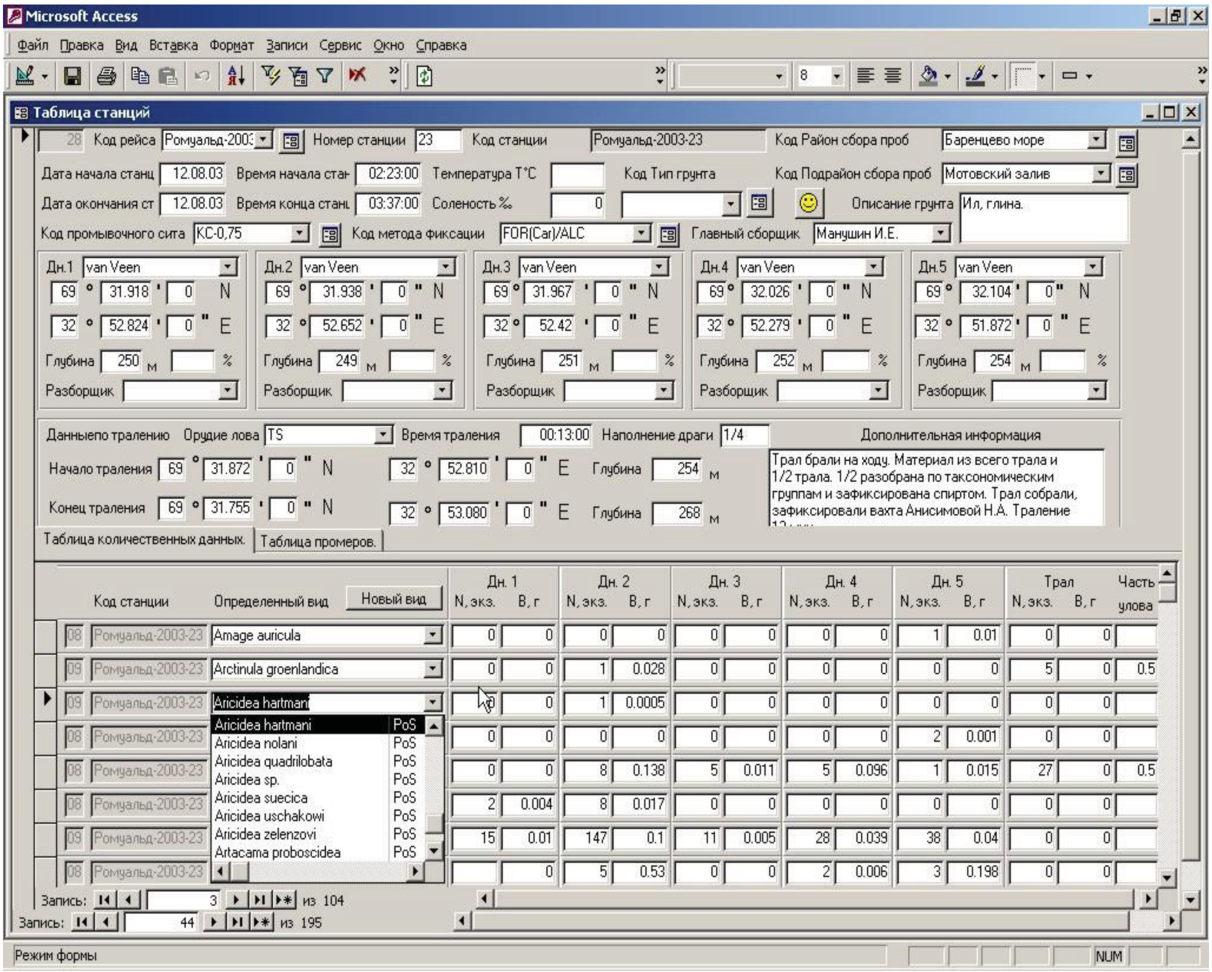


Figure 3.3. View of the “Station Table” in Microsoft Access 2002.

A user-friendly interface (Figure 3.4) was developed for easy use of the database.

The form “Table of species information” consists of three interdependent entry fields (Figure 3.5). A list of chosen cruise stations with brief information concerning the date of stations, coordinates and name of the responsible collector is situated at the top of the form. A station-specific species list and the quantitative information on trawl catches is located at the bottom left part of the form. The results of each grab are located at the right bottom part of the form.

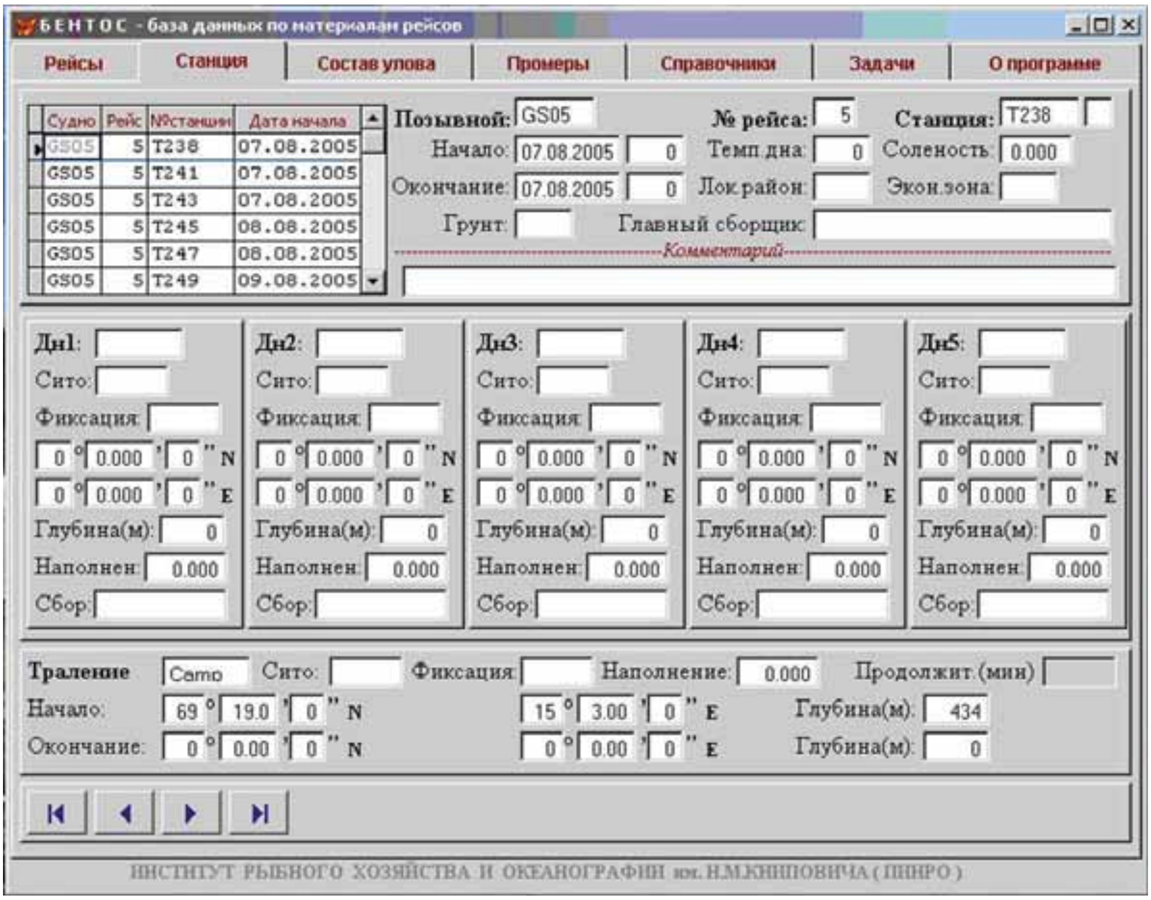


Figure 3.4. User-friendly interface for entering station information based on Visual FoxPro (V7.0).

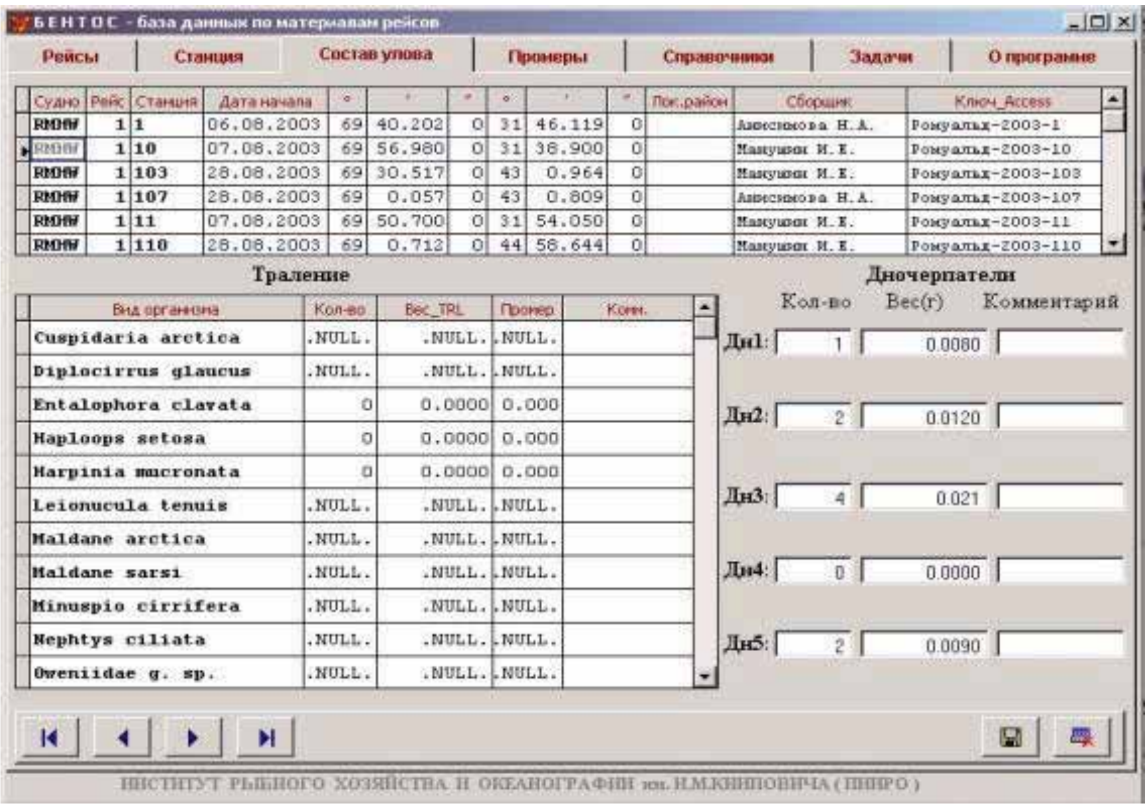
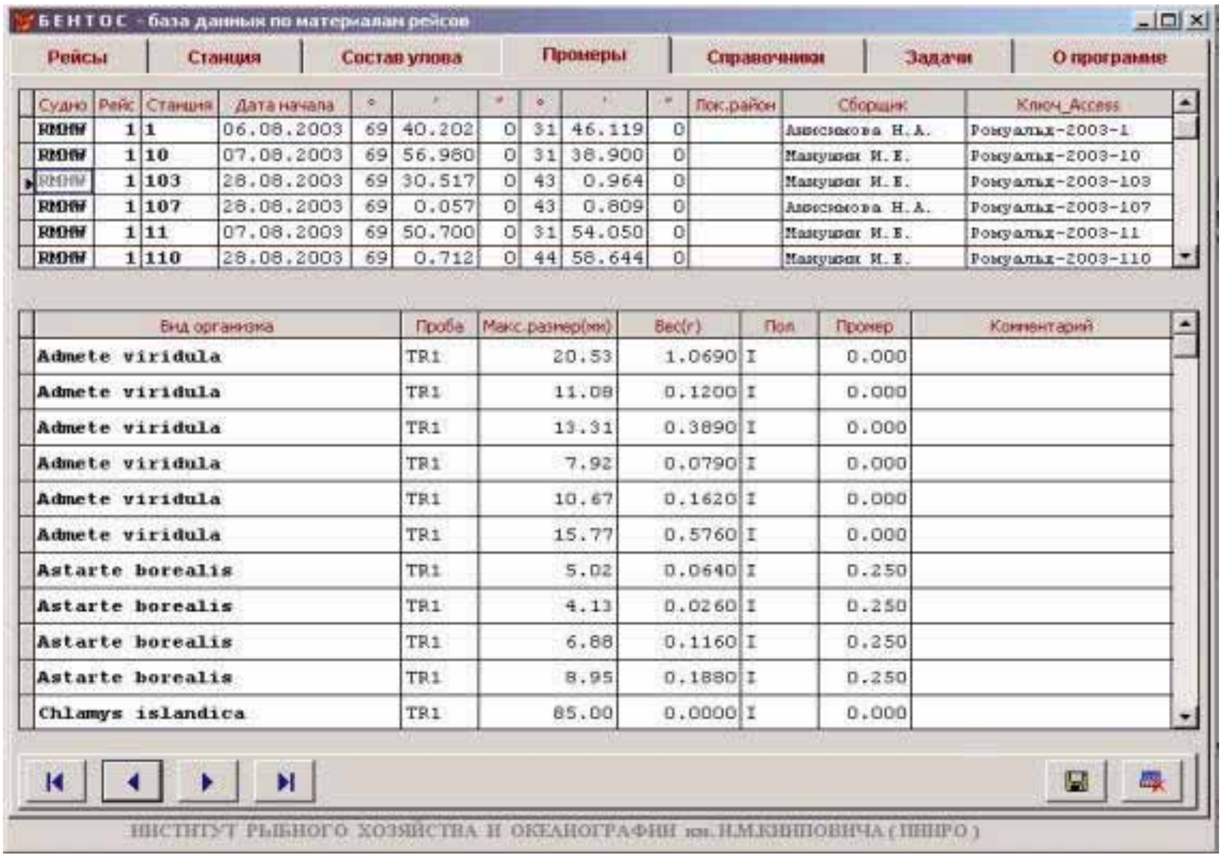


Figure 3.5. Interactive form for entering and editing quantitative information on species based on Visual FoxPro (V7.0).

The form for entering data of morphometric data as well as the form of information on species' biology consists of a top field with the list of chosen stations and a bottom field to enter survey data (Figure 3.6). The bottom field includes the species name, its maximum size and weight, and its proportion of the catch. There is a special column for comments.



БЕНТОС - база данных по материалам рейсов

Рейсы | Станция | Состав улова | Промеры | Справочники | Задачи | О программе

Судно	Рейс	Станция	Дата начала	°	'	"	°	'	"	Лок.район	Сборщик	Ключ_Access
RMHW	1	1	06.08.2003	69	40.202	0	31	46.119	0		Алексюкова Н.А.	Ромуальд-2003-1
RMHW	1	10	07.08.2003	69	56.980	0	31	38.900	0		Манушин И.Е.	Ромуальд-2003-10
RMHW	1	103	28.08.2003	69	30.517	0	43	0.964	0		Манушин И.Е.	Ромуальд-2003-103
RMHW	1	107	28.08.2003	69	0.057	0	43	0.809	0		Алексюкова Н.А.	Ромуальд-2003-107
RMHW	1	11	07.08.2003	69	50.700	0	31	54.050	0		Манушин И.Е.	Ромуальд-2003-11
RMHW	1	110	28.08.2003	69	0.712	0	44	58.644	0		Манушин И.Е.	Ромуальд-2003-110

Вид организма	Проба	Макс.размер(мм)	Вес(г)	Пол	Промер	Комментарий
Admete viridula	TR1	20.53	1.0690	I	0.000	
Admete viridula	TR1	11.08	0.1200	I	0.000	
Admete viridula	TR1	13.31	0.3890	I	0.000	
Admete viridula	TR1	7.92	0.0790	I	0.000	
Admete viridula	TR1	10.67	0.1620	I	0.000	
Admete viridula	TR1	15.77	0.5760	I	0.000	
Astarte borealis	TR1	5.02	0.0640	I	0.250	
Astarte borealis	TR1	4.13	0.0260	I	0.250	
Astarte borealis	TR1	6.88	0.1160	I	0.250	
Astarte borealis	TR1	8.95	0.1880	I	0.250	
Chlamys islandica	TR1	85.00	0.0000	I	0.000	

ИНСТИТУТ РЫБНОГО ХОЗЯЙСТВА И ОКЕАНОГРАФИИ им. Н.М.КНИПОВИЧА (ПИНРО)

Figure 3.6. Interactive form for entering and editing morphometry data based on Visual FoxPro (V7.0).

The information block contains description of the general chart and page frames of the programme. Descriptions are provided on how to enter data, use control keys functions and other supplemental information.

Currently the benthic database contains information on 38 cruises and 3825 stations, 173606 units of quantitative information, 7139 units of morphometric information, data on systematic location, ecology and biology of 2946 benthic invertebrate taxa, 2134 of which are on species level.

4 The by-catch survey

4.1 Collection and processing methods

By L.L. Jørgensen

Fieldwork was carried out from August to September 2006, 2007, and 2008 using the Russian research vessels *Fridtjof Nansen* (2006), *Smolensk* (2006 and 2007), *Vilnus* (2007 and 2008) and the Norwegian research vessels *G.O. Sars*, *Jan Mayen* and *Johan Hjort* (2006, 2007 and 2008).

Sampling on all vessels was carried out using a Campelen 1800 bottom trawl, which is constructed for catching benthic fish and the northern shrimp *Pandalus borealis* at and up to 3.5 - 4.2 m above the sea floor. However, a range of other benthic organisms are also collected, and this "by-catch" makes up the material for the benthic part of the Benthic Long Term Monitoring Programme described in this chapter. To achieve a constant "swept bottom area" during each haul, the trawl door-spread was recorded continuously and the full spread of the opening was maintained throughout each haul. The cross-section of the opening of the trawl bag, the Rockhopper bottom gear, which is in contact with the sea floor, is 13.5 m wide. The mesh size varies from the front part (60 mm) to the cod end (22 mm) of the bag. Therefore, for benthos larger than 40 mm, the effective catch width (cross-section) is calculated to be 11.7 m of the conical shaped trawl bag which is 44 m long (Figure 4.1).

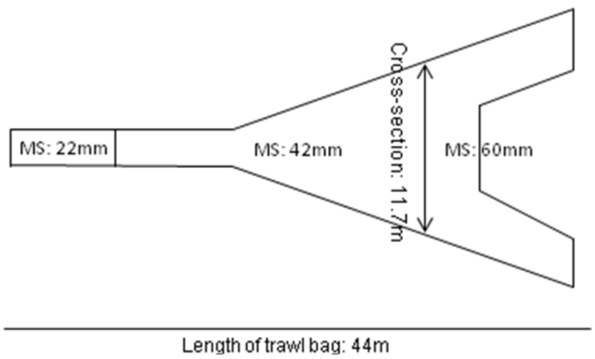


Figure 4.1.1. Schematic drawing of Campelen 1800 bottom trawl with mesh sizes (MS) given for each of the three sections (22, 42 and 60 mm) of the 44 m long trawl bag, with an effective catch cross-section of 11.7 m.

Trawling was carried out at 3 knots with a bottom time of 15 minutes, resulting in an average sampling area of 17900±1320 m^2, depending on wind and current conditions. There was no significant relationship between the amount of fish and shrimps collected in the trawl and the amount of benthos sampled (r^2 = 0.06). Therefore fish and shrimps were excluded from subsequent analyses of the benthic fauna. Whereas the grab and box core methods used in traditional benthic sampling give quantitative abundance and biomass data per unit area sampled, data from trawl samples are semi-quantitative and are to be considered as gross estimates. However, when carried out consistently over a large number of stations, relative spatial and temporal patterns can be identified also from trawl samples.

This study uses data from 1682 sampling stations (Figure 4.1.2), covering an area of approximately 30 km^2 (the total area of the Barents Sea is 1.4 mill km^2).

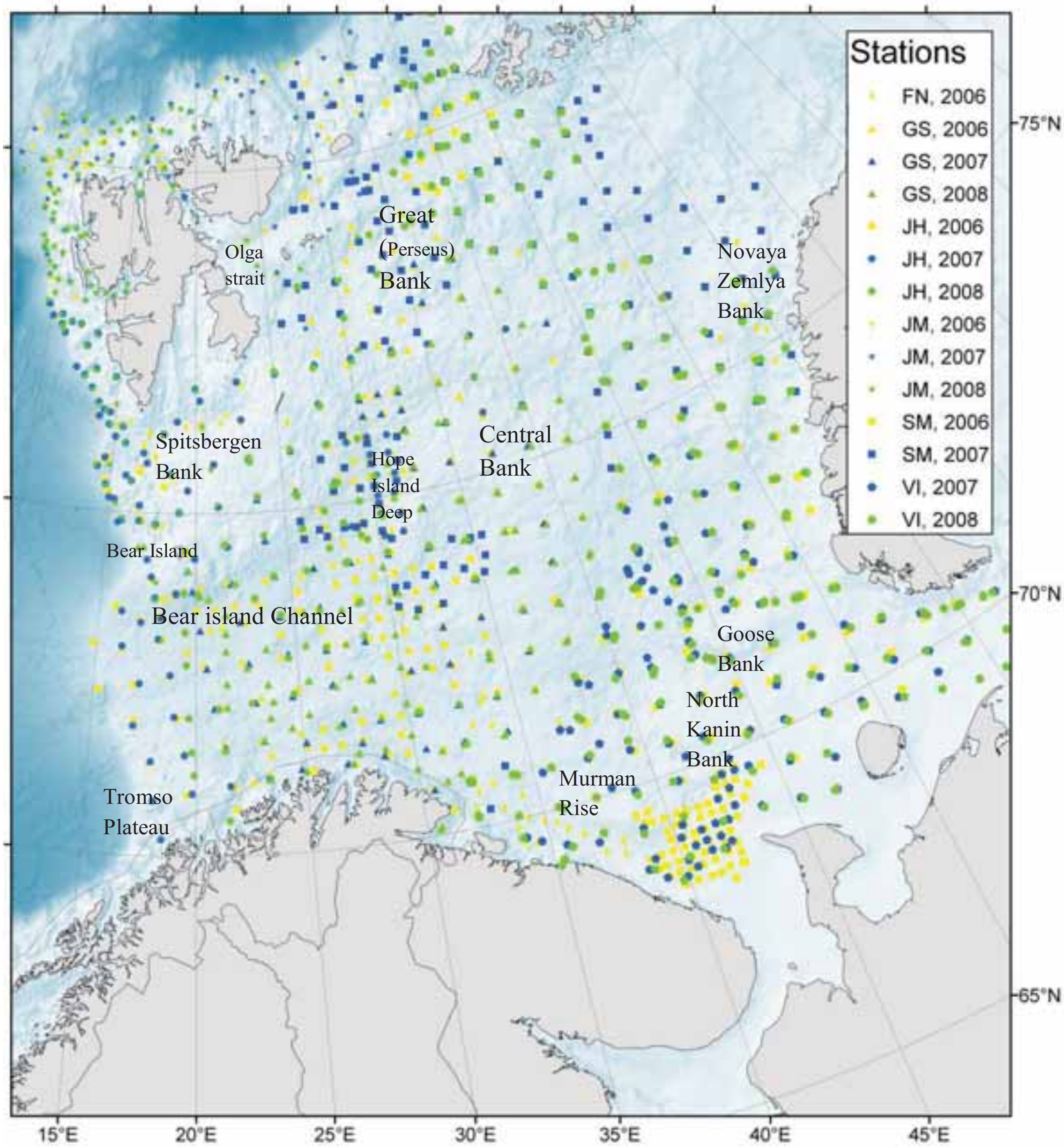


Figure 4.1.2. The Barents Sea with the positions of Campelen trawl deployments where benthos has been recorded annually from 2006-2008 by PINRO and IMR with the Norwegian R/V *Jan Mayen* (JM), *G.O. Sars* (GS), *Johan Hjort* (JH) and the Russian R/V *Vilnus* (VI), *Fridtjof Nansen* (FN) and *Smolensk* (SM).

The fauna was identified to the lowest possible taxonomic level, enumerated and the wet-weight biomass recorded on all Russian expeditions, but only on those Norwegian expeditions with benthic experts onboard (*G.O. Sars* 2006-2008). During the remaining Norwegian expeditions (onboard *Jan Mayen* and *Johan Hjort*) the invertebrate fauna was grouped into large animal groups (Table 4.1.1), enumerated and the wet-weight biomass recorded. The data were stored electronically as a taxon-by-station matrix. Identification was largely carried out on board, with quality control and standardisation of taxon names provided during subsequent join PINRO-IMR workshop and meetings.

Table 4.1.1. List of benthic faunal groups used for invertebrate component of Campelen trawl hauls onboard the Norwegian research vessel *Jan Mayen* and *Johan Hjort* annually from 2006-2008.

Porifera	Sipunculida	Mysida	Brachyura	Cephalopoda	Holothuroidea
Hydroider	Priapulida	Cumacea	Anomura	Brachiopoda	Ascidiacea
Alcyoniidae	Nemertini	Isopoda	Polyplacophora	Bryozoa	Echinoidea
Actiniaria	Echiura	Amphipoda	Bivalvia	Crinoidea	
Madreporia	Pycnogonida	Euphausiidae	Scaphopoda	Asteroidea	
Polychaeta	Cirripedia	Natantia	Gastropoda	Ophiuroidea	

4.2 Results

4.2.1 Total number of species

By I. E.Manushin

A total of 476 taxa of benthic invertebrates (337 of these at species level) related to 14 animal types, 28 classes, 79 orders and 190 families were recorded in by-catches of benthic trawls in the Barents Sea and the area round Svalbard from 2005 to 2008 (Appendix II Table 1). The largest number of taxa was found among molluscs, crustaceans (Arthropoda in Figure 4.2.1), coelenterates and echinoderms (Figure 4.2.1). It has to be noted that the number of identified taxa per group is not only dependent on the relative species richness of this particular group in the hauls, but also on the level of taxonomic expertise present on board during the surveys The total number of taxa registered per haul varied from 1 to 84 taxa with a mean of 16.0±0.3 taxa per a station.

According to the mean number of taxa identified per station all cruises can be divided into two groups: the number of taxa below the mean for all cruises and the number of taxa above the mean for all cruises (Figure 4.2.2). The first group includes cruises without participating benthic experts onboard, the other one, cruises with participating benthic experts. The total number of taxa identified per cruise is larger in the second group (Figure 4.2.3). Their mean number was 122±23 taxa. The only exception is the cruise of R/V *G.O. Sars* in 2008. According to the number of taxa per a station it can be included into the first group. But according to the total number of identified taxa it can be included into the second group. This can be explained by the fact that the experts only partly participated in this cruise.

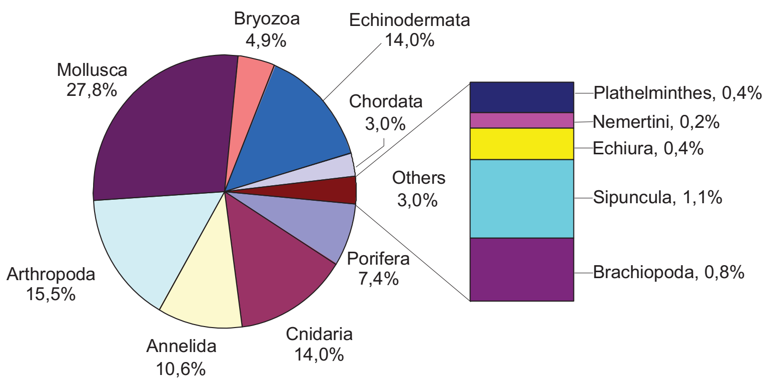


Figure 4.2.1. Ratio of the species number of the main taxonomic group of benthic invertebrate in by-catch of trawls.

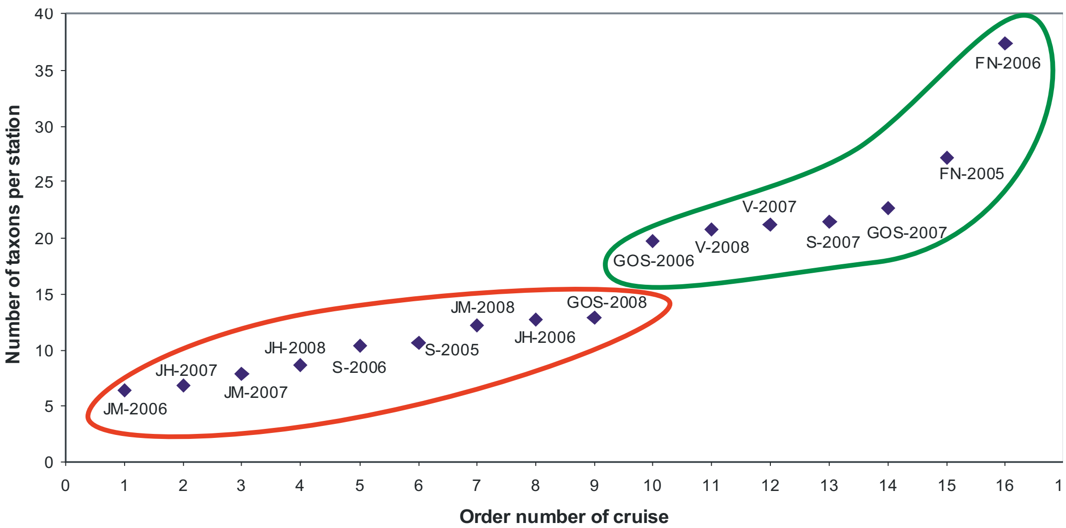


Figure 4.2.2. The mean number of benthic invertebrate taxa per station obtained during different ecosystem surveys in 2005, 2006, 2007 and 2008. Red line indicates the cruises with the number of taxa per station below the mean, green line indicate cruises with the number of taxa per station above the mean. JM – *Jan Mayen*, JH – *Johan Hjort*, S – *Smolensk*, GOS – *G.O. Sars*, V – *Vilnyus*, FN – *F. Nansen*. All cruises were arranged according to increasing number of identified taxa per a station.

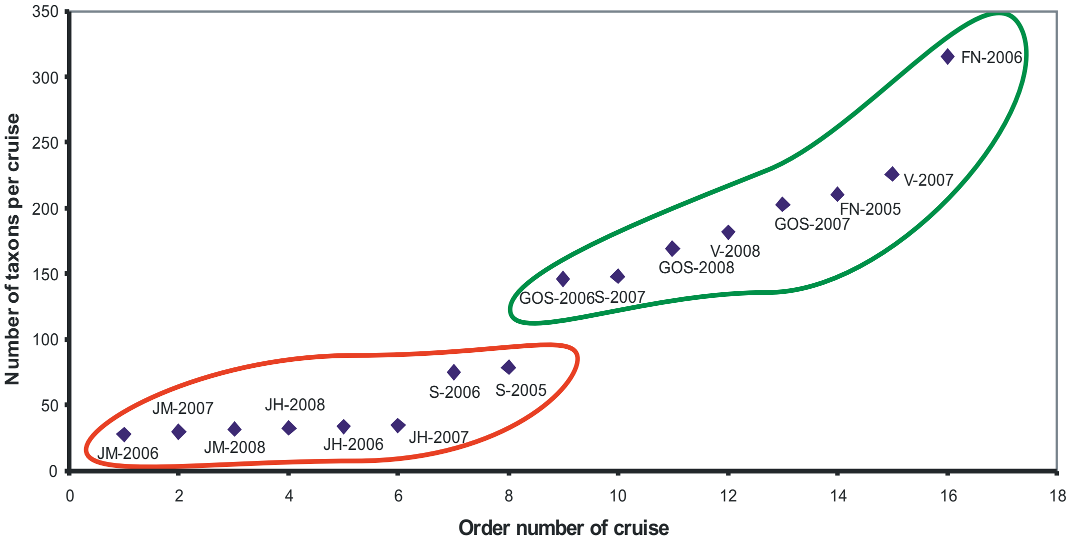


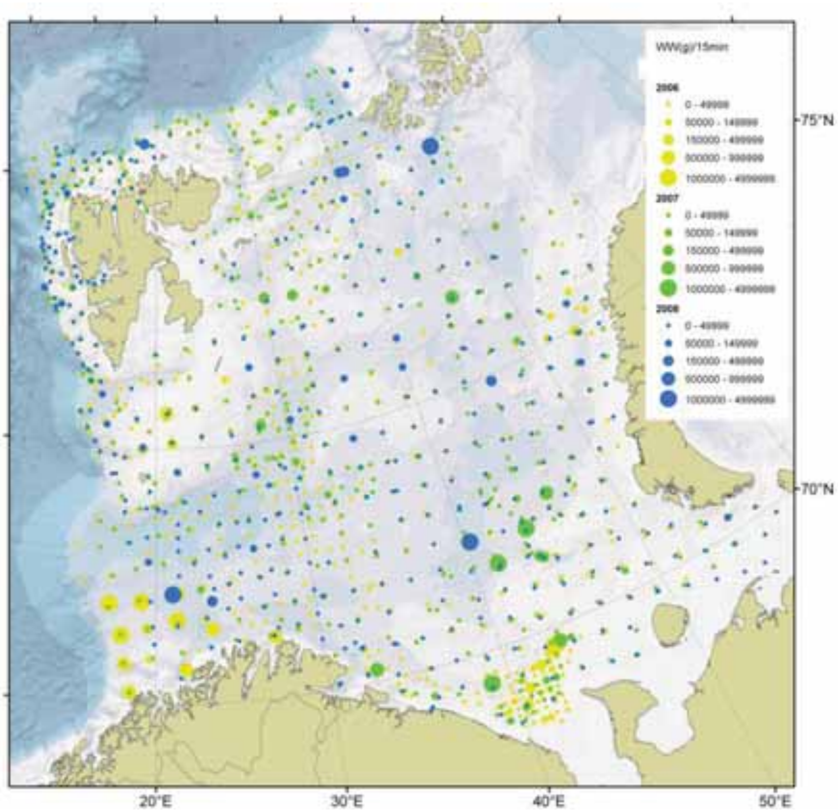
Figure 4.2.3. The mean number of taxa of benthic invertebrate taxa per station obtained during ecosystem surveys in 2005–2008. Conventions are the same as in Figure 4.2.2. All cruises were arranged according to increasing number of identified taxa per cruise.

4.2.2 Distribution of the total biomass and abundance

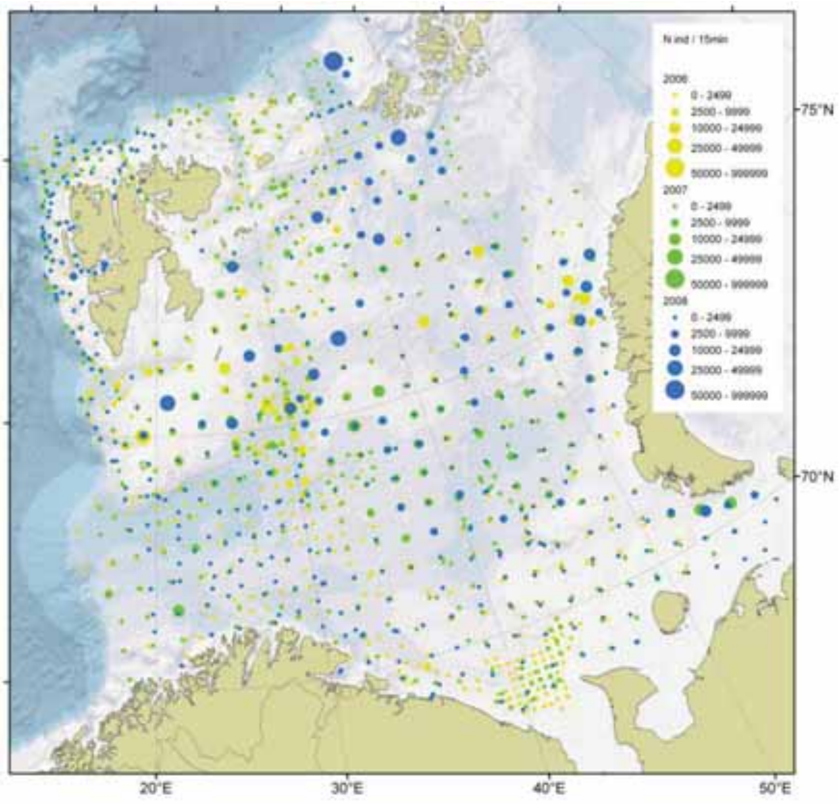
By L.L. Jørgensen and P.A. Lyubin

Benthos data derived from Campelen trawl hauls indicate that the biomass distribution of the benthos varies among areas (Figure 4.2.4). The biomass-“hotspots” are located in “shallow water areas” such as the Tromsø Plateau (decreasing from year to year), on the Spitsbergen Bank, Kanin Bank (increasing in 2006 and 2007, but then decreasing in 2008) south of Franz Joseph Land (increasing up to 2008) and east of Goose Bank (increasing from 2006 to 2007, and then decreasing on some of the stations in 2008).

Higher abundances were recorded at several stations north of 75°N. Most of such high abundances occurred in 2008. High abundance stations were also recorded east of 50°E and on the west coast of Svalbard. The abundance values are based on non-colonial taxa only since colonial taxa are usually not recorded.



A



B

Figur 4.2.4. Distribution of biomass (A) and abundance (B) of benthic invertebrates (excluding *Pandalus borealis* and pelagic invertebrates) taken annually from 2006 to 2008 (August-September) by campelen trawl from 1682 stations. Area covered per trawl haul estimated to be ~18.000 m^2/per station.

4.2.3 Distribution of main animal groups.

By L.L.Jørgensen and P.A. Lyubin

Different animal groups dominate the biomass in different parts of the Barents Sea for all the investigated years. Porifera (sponges) make up the largest part of the communities in weight along the continental slope from Tromso Plateau and north along the west coast of Svalbard, north of Svalbard and east to Franz Joseph Land (Figures 4.2.5, 4.2.6, and 4.2.7). Porifera also seems to dominate the communities with respect to biomass north of the Finnmark coast including the Bear Island Channel. Molluscs (mainly bivalves and gastropods) dominate off-shore parts of south-western Barents Sea and partly the west coast of Svalbard. Echinoderms make up the main communities in the main part of the Barents Sea though crustaceans (excluding *Pandalus borealis*) dominate the south-eastern part of the sea. The red king crab (*Paralithodes camtschaticus*) was found mainly on the Kanin Bank. The snow crab (*Chionoecetes opilio*) was recorded for the first time close to northern Goose Bank in 2007 but also north and south of the Central Bank.

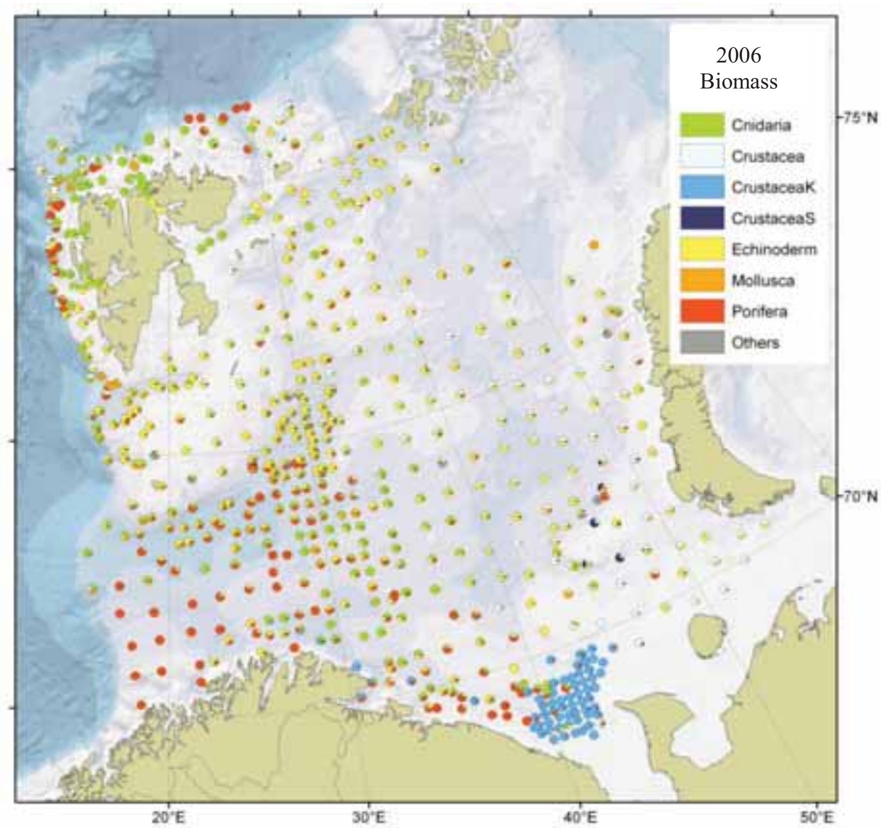


Figure 4.2.5. Distribution of main invertebrate groups in the Barents Sea in 2006 presented as % biomass per station. (*Pandalus borealis*, vertebrates and pelagic invertebrates excluded). The crustaceans are divided into snow crabs (*Chionoecetes opilio*) as "Crustacea S", red king crabs (*Paralithodes camtschaticus*) as "Crustacea K" while all other crustaceans are "Crustacea".

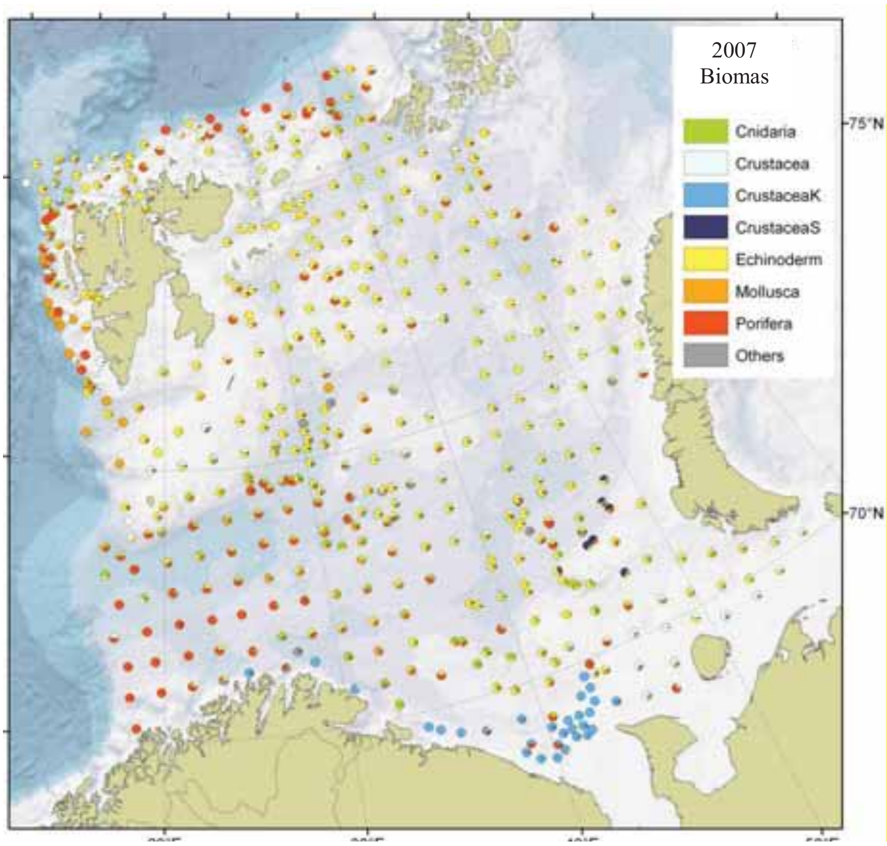


Figure 4.2.6. Distribution of main invertebrate groups in the Barents Sea in 2007 presented as % biomass per station. (*Pandalus borealis*, vertebrates and pelagic invertebrates excluded). The crustaceans are divided into snow crabs (*Chionoecetes opilio*) as “Crustacea S”, red king crabs (*Paralithodes camtschaticus*) as “Crustacea K” while all other crustaceans are “Crustacea”.

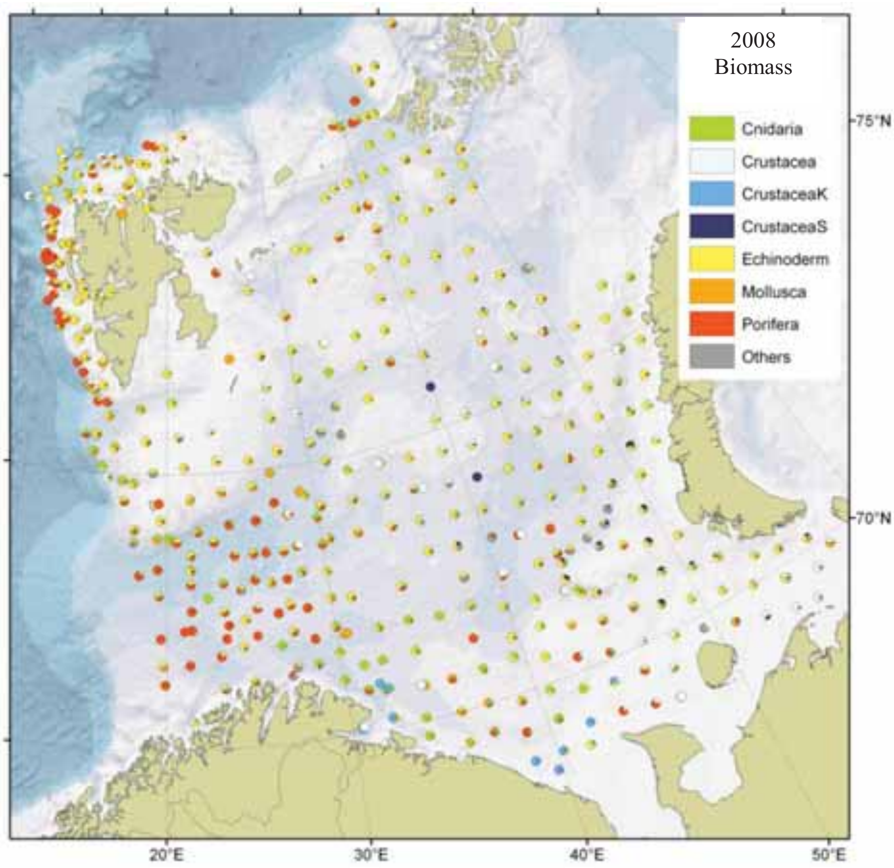


Figure 4.2.7. Distribution of main invertebrate groups in the Barents Sea in 2008 presented as % biomass per station. (*Pandalus borealis*, vertebrates and pelagic invertebrates excluded). The crustaceans are divided into snow crabs (*Chionecetes opilio*) as “Crustacea S”, red king crabs (*Paralithodes camtschaticus*) as “Crustacea K” while all other crustaceans are “Crustacea”.

Sponges not only dominate the same western areas with respect to biomass, but also in abundance, although the number of individuals seems to decline from 2006 to 2008 (Figures 4.2.8, 4.2.9 and 4.2.10). Many species of sponges are difficult to enumerate due to their tendency to fragmentation. The number of individuals presented here might therefore be overestimated. In 2006, cnidarians (mainly sea anemones and soft corals) made up large part of the communities around Svalbard, but also of the offshore areas of the Finnmark coast. Similar to the sponges, the number seemed to decline with very low abundances in 2007 and 2008. Instead molluscs (west of Svalbard in 2007), crustaceans (north of Svalbard) and echinoderms (all around Svalbard in 2008) start to dominate the communities. Echinoderms make up the larges part of the communities in the main part of the Barents Sea though crustaceans seem to dominate more in the south eastern parts with the king crab dominating strongly on the Kanin Bank. However, in 2008 the number of individuals caught by the trawl was low.

Comparing figures 4.2.5, 4.4.2.6, 4.2.7 (biomass,) and 4.2.8, 4.2.9, 4.2.10 (number of individuals) reveal that many mainly large sponges dominate the south eastern parts of the Barents Sea and the west coast of Svalbard, but as the colonial specimens was not counted, the distribution in numbers of individuals are incorrect. Many, but with a rather low biomass, cnidarians are recorded off-shore from the Finnmark coast. Many large echinoderms make up the main part of the communities in the central and eastern part of the Barents Sea, while many and large crustaceans (especially king crabs) dominate the south eastern part of the Barents Sea.

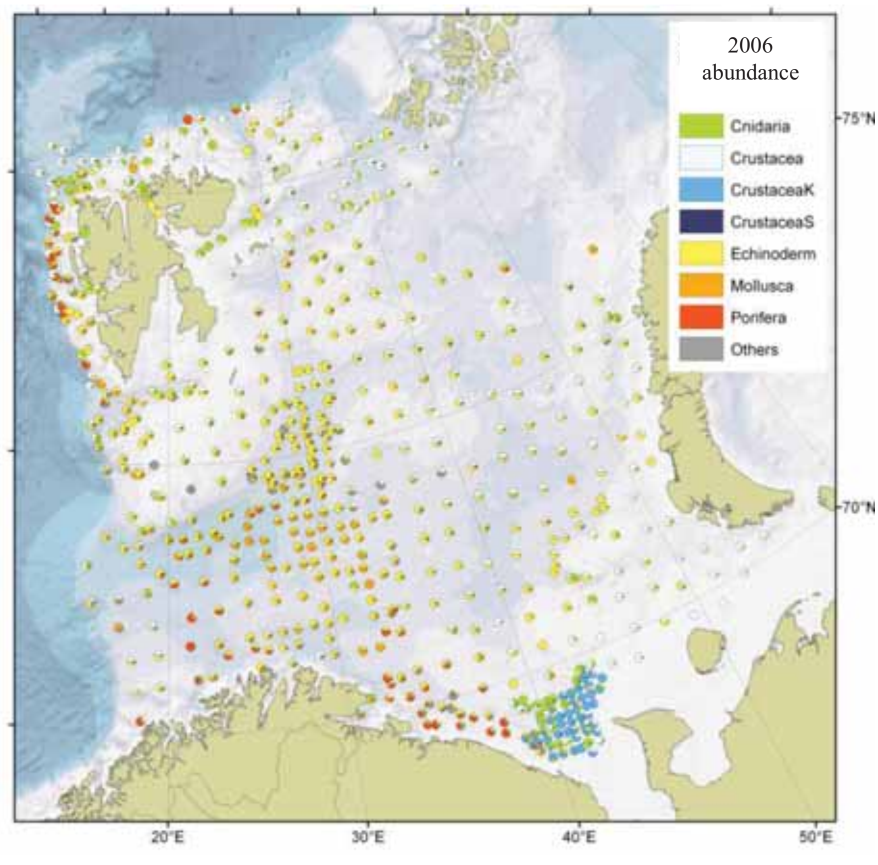


Figure 4.2.8.
Distribution in number of individuals of main invertebrate groups in the Barents Sea in 2006 given as % abundance per station. (*Pandalus borealis*, vertebrates and pelagic invertebrates excluded). The crustaceans are divided into snow crabs (*Chionoecetes opilio*) as "Crustacea S", red king crabs (*Paralithodes camtschaticus*) as "Crustacea K" while all other crustaceans are "Crustacea".

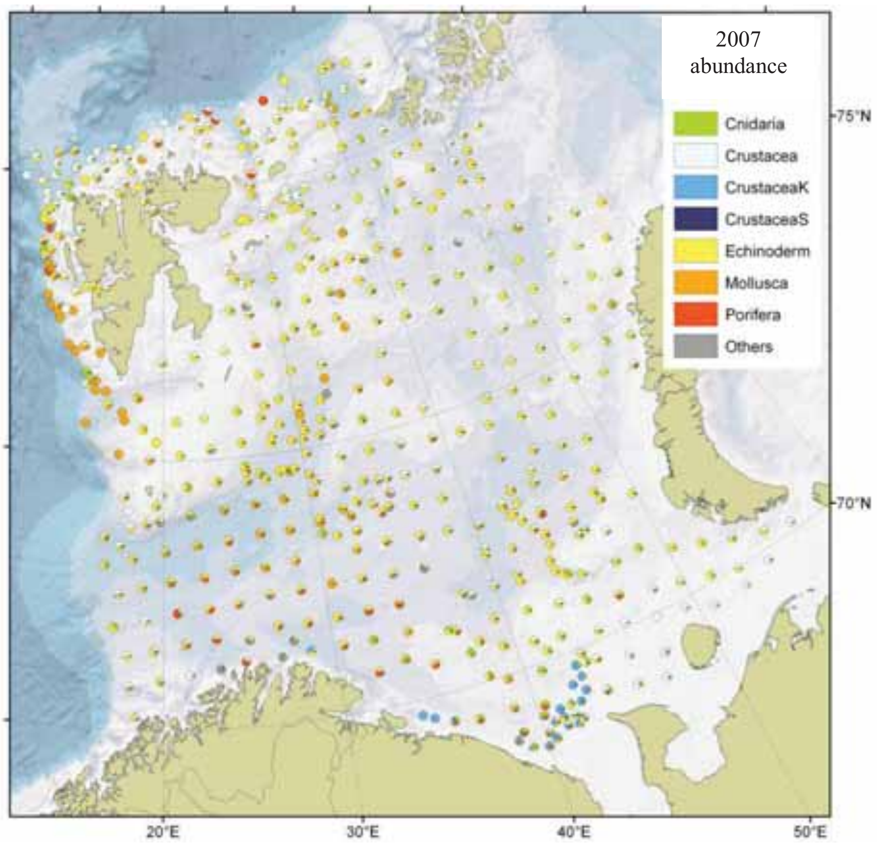


Figure 4.2.9. Distribution in number of individuals of main invertebrate groups in the Barents Sea in 2007 given as % abundance per station. (*Pandalus borealis*, vertebrates and pelagic invertebrates excluded). The crustaceans are divided into snow crabs (*Chionoecetes opilio*) as "Crustacea S", red king crabs (*Paralithodes camtschaticus*) as "Crustacea K" while all other crustaceans are "Crustacea".

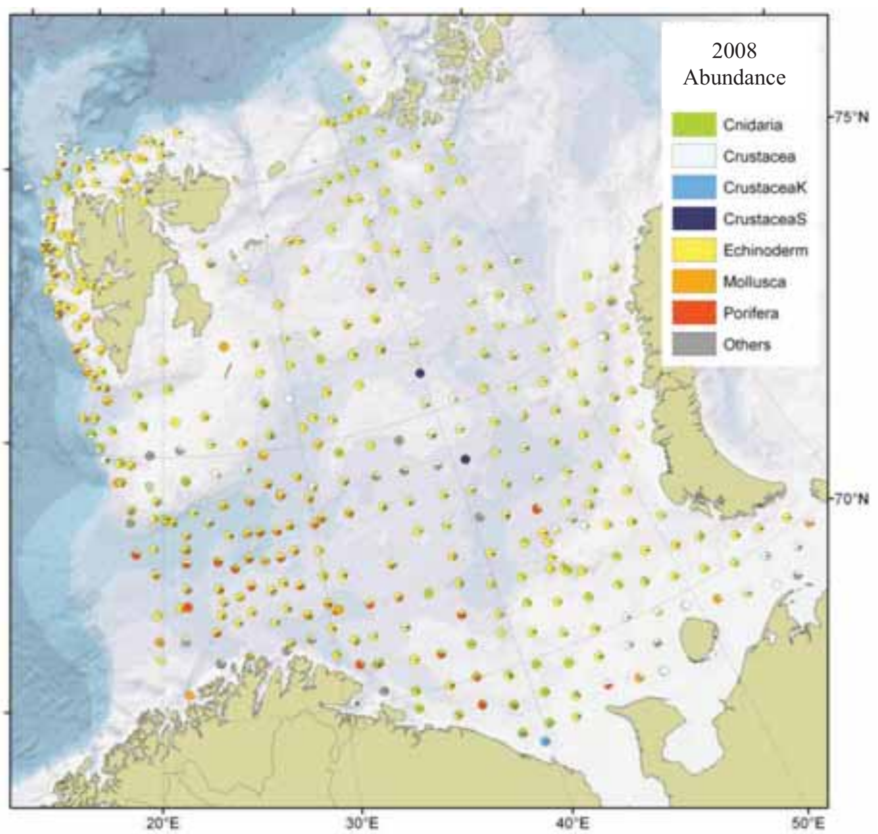


Figure 4.2.10. Distribution in number of individuals of main invertebrate groups in the Barents Sea in 2008 given as % abundance per station. (*Pandalus borealis*, vertebrates and pelagic invertebrates excluded). The crustaceans are divided into snow crabs (*Chionoecetes opilio*) as "Crustacea S", red king crabs (*Paralithodes camtschaticus*) as "Crustacea K" while all other crustaceans are "Crustacea".

4.2.4 Community description

Description of the community distribution was made separately for north-western and south-eastern part of the Barents Sea (based on the Russian data) and for south-western and central part of the sea (based on the Norwegian data). In spite of some differences in the procedures of excretion and description of communities, the obtained results are commensurable and substantially supplement each other.

4.2.4.1 Distribution of the benthic communities in the south-eastern and north-western part of the Barents Sea

By N.A. Anisimova

The by-catch of 255 trawl hauls were identified to the lowest possible taxon. Such resolution made it possible to identify faunistic assemblages (benthic communities). These 255 stations were sampled during the cruises carried out by R/V *Fridtjof Nansen* in 2005 and 2006 and R/V *Vilnus* in 2007.

Cluster analysis (using an average-weighted mean method) was employed in order to identify the faunistic assemblages. As a measure of similarity "quantitative Sorensen index" was used (Czeckanovski 1909, Andreev 1980) and the species/taxon biomass in the by-catches was used as the quantitative parameter.

Several indices have traditionally been used in Russia when describing bottom communities, analyzing community structure and assessing the importance of individual species. These indices link parameters such as the quantitative assessment of a species at a station (e.g., biomass) and frequency of occurrence within the area of community distribution (Anon 1939; Brotskaya & Zenkevich 1939, Zatsepin 1962).

In the present study "index of importance" of the species in the community, suggested by Zatsepin (1962), was used to describe the structure of singled-out assemblages. This index is calculated by the following formula:

$$I = F \cdot (\frac{\bar{b}}{\bar{B}} \cdot 100)$$

where: F – frequency of the species occurrence within the range of singled-out community, %; $\bar{b}$ – the average biomass of the taxa/species at the stations where it was occurred, g/trawling; $\bar{B}$ – the average biomass of benthos within the community distribution area, g/trawling.

The given index does not differ significantly from the same one used by Brotskaya and Zenkevich for describen the bottom communities of the Barents Sea (Anon 1939, Brotskaya & Zenkevich 1939). However, in contrast to Brotskaja and Zenkevich index, it is not dimensionless and varies from 0 to 10 000. This allows this index to be used for comparative porposes.

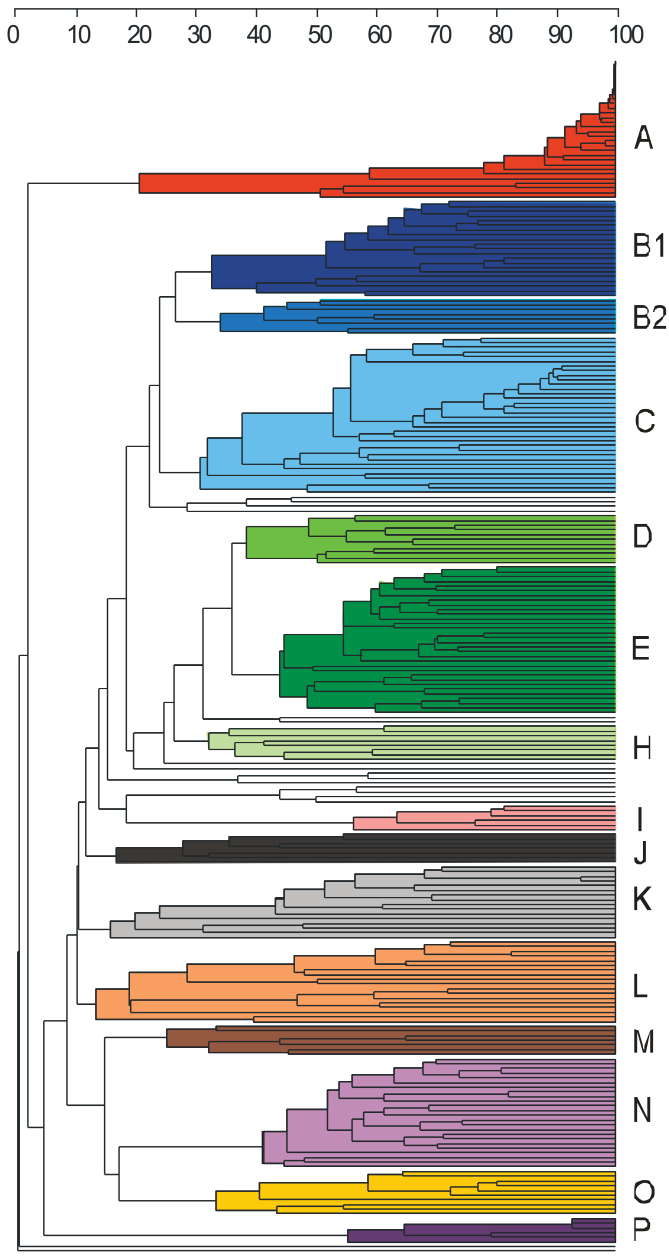
When describing the identified faunistical assemblages the species with the highest index of importance were regarded as **dominant**, the species with the highest frequency of occurrence, independent of biomass and index of importance, were regarded as **typical**. The species with frequency of occurrence within the range of singled-out community less than 50 % were assessed as unimportant (inessential) and are not taken into account in description of the communities structure.

The cluster analysis identified the stations into 15 groups (Figure 4.2.11). These groups differs in both species composition and the species biomass ratio. Bottom inhabitants of each group of stations is regarded as a "*faunistic assemblage*". As used here these "faunistic assemblages" are similar, in a general sense, to the conception of "*biocoenose*" or *"community"*. This is because stations are combined as groups, not only on the basis of the species composition similarity, but also on the structure of domination (the ratio of the taxa). The main features of the singled-out faunistic assemblages are given in Table 4.2.1.

The environmental conditions in any area influence strongly which feeding type(s) will be predominant in a faunal community. This allows the defined faunistic assemblages to be divided into three communities, each of which is characterized by a different feeding type:

- *Suspension feeders* which occur in areas with active hydrodynamics.
- *Detritus feeders* which occur in soft sediments rich in organic matter.
- *Carnivor*e**s**.

The distributional patterns of these communities reflect the various habitats which are characterized by parameters such as, e.g., bottom topography, type of sediment, depth, locality of the main food availability.



The taxa dominating into the singled-out groups of the stations:

A – Paralithodes camtschaticus

B1 – Molpadia borealis

B2 – Gorgonocephalus spp. et all.

C – Gorgonocephalus spp.

D – Ctenodiscus crispatus+Sabinea septemcarinata

E – Ctenodiscus crispatus

H – Ctenodiscus crispatus+Hormathia digitata

I – Chionoecetes opilio

J – Heliometra glacialis

K – Spongia g. spp.

Figure 4.2.11. Dendrogram of the station similarity by the invertebrates by-catches composition given as 15 (A-P) faunistic assemblages.

Table 4.2.1. The main features of the faunistical assemblages singled out according to the results of cluster analysis.

Group of stations	Area of distribution	Depth Average (min-max) m*	Predominant type of sediment	Biomass of by-catch Average (min-max) kg/trawling*	Dominant taxa	Typical taxa
A	Murman coast	112±9 (64-264)	Coarse and mixed sediment	133,0±70,3 (1,1-872,9)	*Paralithodes camtschaticus*	*Asterias rubens, Suberites ficus, Hormathia digitata, Hyas areneus*
B1	Eastern Basin, Hope Island Deep	305±12 (185-375)	Soft-bottom	15,7±3,3 (2,5-55,1)	*Molpadia borealis, Ctenodiscus crispatus*	*Sabinea septemcarinata, Strongylocentrotus pallidus, Ophiacantha bidentata, Pontaster tenuispinus,* Alcyonacea: Nephteidae g. spp.
B2	Storfiord Channel, northern slope of Eastern Basin slopes of West Novaya Zemlya trough	260±14 (196-304)	Silt and sandy silt	22,3±3,2 (11,2-35,2)	*Gorgonocephalus* spp., *Urasterias linckii, Strongylocentrotus pallidus, Ctenodiscus crispatus, Sabinea septemcarinata*	Alcyonacea: Nephteidae g. spp., *Ophiacantha bidentata, Hormathia digitata, Colus sabini, Molpadia borealis, Sclerocrangon ferax*
C	Kong Karls Basin, Olga Basin, inner part of Storfiord Channel	269±10 (165-354)	Silt and sandy silt	14,6±2,0 (1,8-57,8)	*Gorgonocephalus* spp.	*Ctenodiscus crispatus, Urasterias linckii, Pontaster tenuispinus*
D	South Novaya Zemlya trough, slopes of Goose Bank, North Kanin Bank, Murman Rise, inner slopes of Storfiord Channel and Hope Island Deep	197±15 (127-297)	Fine grained and mixed sediment	20,7±7,8 (0,3-82,3)	*Ctenodiscus crispatus, Sabinea septemcarinata*	*Urasterias linckii, Hormathia digitata, Ophiacantha bidentata,* Alcyonacea: Nephteidae g. spp.
E	Inner part of Bear Island Channel, northern part of the South Novaya Zemlya trough, Murman trough	293±13 (132-375)	Fine grained and mixed sediment	8,3±1,1 (0,3-23,5)	*Ctenodiscus crispatus*	*Sabinea septemcarinata, Hormathia digitata, Ophiura sarsi, Pontaster tenuispinus, Ophiacantha bidentata,* Alcyonacea: Nephteidae g. spp.
H	Outer part of Storfiord Channel and of the troughs in the south-eastern part of the sea	248±15 (183-317)	Silty and mixed sediment	5,6±2,7 (0,2-24,3)	*Ctenodiscus crispatus, Hormathia digitata* Subdominant taxa: *Henricia* sp., *Icasterias panopla*	*Ophiura sarsi*, *Henricia* sp., *Pontaster tenuispinus*, Alcyonacea: Nephteidae g. spp., *Astarte crenata*, *Brada* sp., *Epimeria loricata, Sabinea septemcarinata*.

Table 4.2.1. Cont.

Group of stations	Area of distribution	Depth Average (min-max) m*	Predominant type of sediment	Biomass of by-catch Average (min-max) kg/trawling*	Dominant taxa	Typical taxa
I	Area of Goose Bank and Moller Table	213±14 (166-250)	Silty sand mixed sediment	2,6±0,4 (1,6-4,7)	*Chionoecetes opilio*	*Ctenodiscus crispatus, Sabinea septemcarinata, Ophiura sarsi,* Alcyonacea: Nephteidae g. spp., *Hormathia digitata, Hyas araneus, Ophiacantha bidentata*
J	Slopes of Spitsbergen and Hopen Bank, Central Bank and Great (Perseus) Bank	178±24 (105-292)	Silty sand mixed sediment	15,3±2,1 (9,2-23,7)	*Heliometra glacialis, Strongylocentrotus pallidus*	*Lebbeus polaris, Ctenodiscus crispatus, Sabinea septemcarinata, Ophiacantha bidentata, Chlamys islandica, Ophiopholis aculeate, Brada sp.* Spongia g. spp., Alcyonacea: Nephteidae g. spp.
K	Slopes of the troughs in the southern part of the sea and western slope of the Spitsbergen Bank	191±19 (49-316)	Silty sand mixed sediment	5,2±1,7 (0,8-16,2)	Spongia g. spp.	*Strongylocentrotus pallidus, Sabinea septemcarinata, Ctenodiscus crispatus*
L	South-central part of the Barents Sea, West Novaya Zemlya trough	212±11 (159-282)	Silty and silty sand mixed sediment	22,0±14,8 (0,06-235,3)	*Hormathia digitata*	*Ctenodiscus crispatus,* Spongia g. spp.,
M	Area of North Kanin Bank	112±16 (69-198)	Sand and mixed sediment	2,0±11,2 (0,4-9,0)	*Hyas araneus* Subdominant taxa: *Hormathia digitata*	*Chlamys islandica, Myxilla incrustans, Urasterias linckii, Strongylocentrotus pallidus, Ophiura sarsi, Pagurus pubescens*
N	Northern part of the Pechora Sea, Novaya Zemlya Bank, shoal of Bear Island and Hope Island	134±14 (60-258)	Sand and mixed sediment	27,7±5,2 (0,2-103,8)	*Strongylocentrotus pallidus*	*Sabinea septemcarinata, Crossaster papposus, Gorgonocephalus spp., Balanus* spp., *Chlamys islandica, Ophiacantha bidentata*
O	Pechora Sea	80±7 (54-117)	Sand	2,9±0,8 (0,2-6,0)	*Sabinea septemcarinata*	*Sclerocrangon boreas, Hyas araneus, Boltenia echinata, Balanus* spp., Ascidiacea g. spp., *Pagurus pubescens*
P	Goose Bank, North Kanin Bank, shoal of Bear Island and Hope Island	63±10 (39-99)	Sand, coarse sediment	145,5±93,1 (1,8-564,6)	*Cucumaria frondosa*	*Balanus* spp., *Strongylocentrotus* spp., *Hyas araneus, Pagurus pubescens, Ophiura sarsi,* Spongia g. spp.

* – Depth and biomass are given with standard error.

Faunistical assemblages dominated by suspension feeders (B2, C, J, K, P)
The distribution of the faunistical assemblades dominated by suspension feeders (in biomass) is shown in Figure 4.2.12.

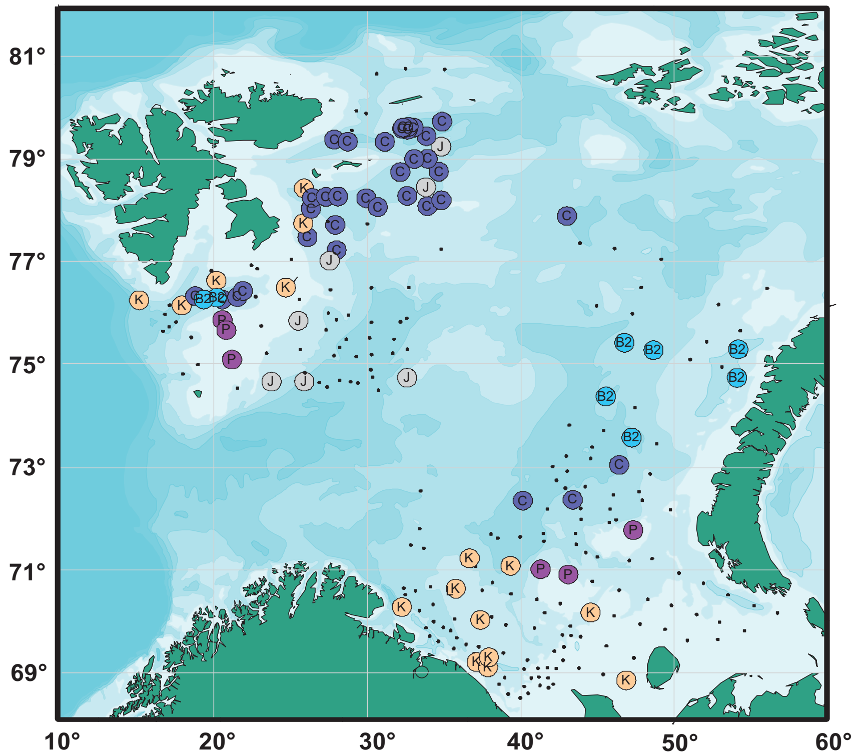


Figure 4.2.12. The distribution of faunistical assemblages dominated by suspension feeders. (The stations are labelled as in Figure 4.2.11).

B2 (*Gorgonocephalus sp. + Urasterias linckii + Strongylocentrotus pallidus + Ctenodiscus crispatus + Sabinea septemcarinata*)
On the northern slopes of the Eastern Basin, in the West Novaya Zemlya Trough area and the eastern part of the Storfjord Channel at depths between 200–300 m, a community with several species being predominant is distributed. These species have approximately similar importance in the community structure (Figure 4.2.12, 4.2.13).

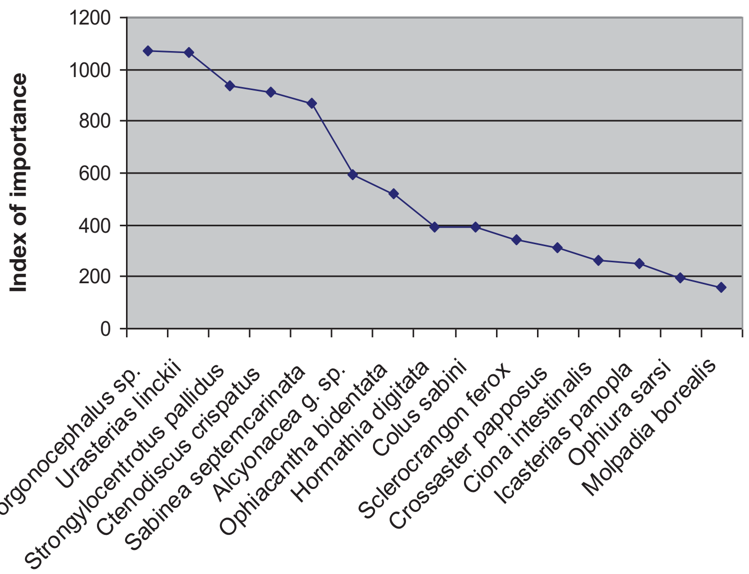


Figure 4.2.13. The structure of community Gorgonocephalus spp. + Urasterias linckii + + Strongylocentrotus pallidus + Ctenodiscus crispatus + Sabinea septemcarinata ("B2" group of stations). The fifteen most abundant taxa are presented.

The trophic conditions in the distribution area of this community are reflected by the composition of predominant species with the main types of feeding. Mean biomass in the community distribution area was 22,3±3,2 kg/trawling (Table 4.2.14). Soft corals of the family Nephtheidae, the brittle star *Ophiacantha bidentata*, the large sea anemone *Hormathia digitata* and the large crangonid shrimp *Sclerocrangon ferox* are characteristic (typical) species of this community. On the whole this community may be regarded as intermediate between deep-water communities, inhabiting soft bottom in trenches and troughs, and communities, typical of rough and mixed sediment of bottom rise with active hydrodynamics.

C (*Gorgonocephalus spp.)*

This community, occurred at the similar depth as community B2 on soft and mixed sediment west of the Franz-Victoria Trough (Olga Basin and Kong Karls Basin, deep-water areas south of Kvitøya and Victoria Island –see Figure 4.2.12). It has a similar species composition as B2, but a quite different structure (see Figure 4.2.13, Figure 4.2.14). High abundance of the large ophiuroids of the genus *Gorgonocephalus* (predominantly *G. arcticus*) is the typical feature of the bottom macrofauna in this area. Their biomass in by-catches in the area averaged 8,7±1,7 kg/trawling, and at some stations it reached 50 kg/trawling.

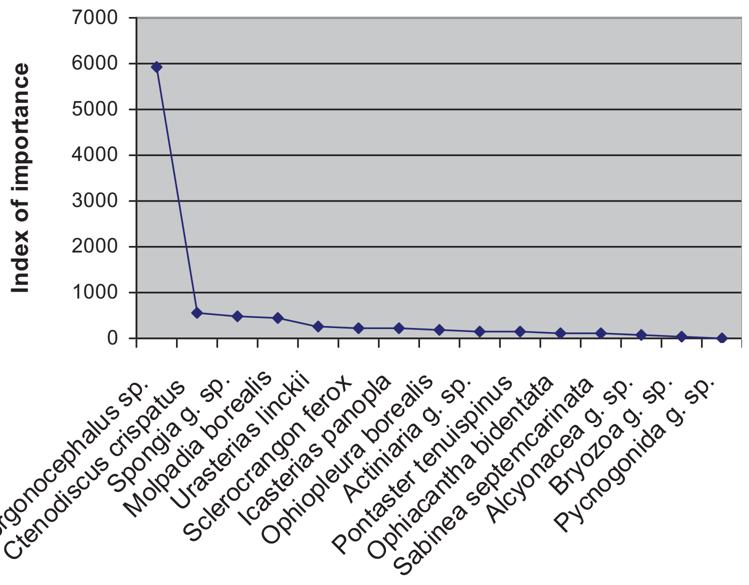


Figure 4.2.14. The structure of community *Gorgonocephalus* spp. ("C" group of stations). The fifteen most abundant taxa are given.

Ophiuroids of the genus *Gorgonocephalus* are typical plankton feeders and their high abundance indicates a special hydrological conditions within this area and a dense concentration of zooplankton in the near-bottom layer of water.

The species which are listed as typical for this community, are usually found on soft mud sediment in deep-water areas of the Barents Sea (see Figure 4.2.14 and Table 4.2. 1). The typical arctic species, such as *Ophiopleura borealis* and *Ophioscolex glacialis* in the by-catch community, is characteristic of the soft mud sediment in deep-water areas of the Barents Sea. Communities with similar species composition and structural characteristics were also recorded at some stations in the Storfjord Trough and the Eastern Basin (see Figure 4.2.12).

J *(Heliometra glacialis + Strongylocentrotus pallidus)*

This community is characterized by the predomination of the plankton-feeding sea-lily *Heliometra glacialis,* and the sea-urchin *Strongylocentrotus pallidus* and is recorded in the northern part of the Barents Sea between 105–292 m depth (on average 178±24 m), on the slopes of the Spitsbergen Bank, the Central Bank and the Great (Perseus) Bank (Figure 4.2.12, 4.2.15; Table 4.2.1). The trophic structure of this community taken as by-catch, and their high biomass, indicate that there are high concentrations of organic suspended material and plankton in these areas. Distribution of this community well proves the well-known thesis that suspension feeders are widely distributed near the slopes of the shelf and local rise of bottom (Sokolova 1956, Neyman 1963, Kuznetsov 1980 et al.). The community was recorded predominantly in the range of cold water masses of Arctic and local origin.

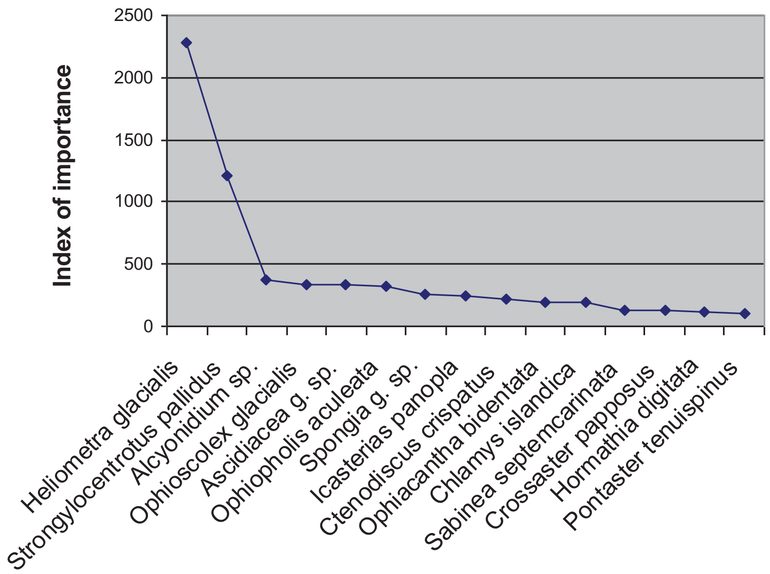


Figure 4.2.15. The structure of community *Heliometra glacialis+ Strongylocentrotus pallidus*. ("J" group of the stations). The fifteen most abundant taxa are given.

K (Spongia g. spp.)

This group of stations, with sponges as a predominant species, was recorded at a wide range of depths (49–316 m) in coastal waters of Spitsbergen and on the slopes of the many trenches and banks in the south-eastern Barents Sea (see Figure 4.2.12). These stations are also characterized by high abundance of bryozoans and sea anemones. This fauna complex is not a typical community as it combines stations with highly diverse species composition. The only similarity among this station group is the large taxonomic group of animals being predominant. It should be noted that if dense local populations of sea-lily *Heliometra glacialis* are distributed predominantly in Arctic waters then sponges communities are mainly occurring in waters of Atlantic origin.

P *(Cucumaria frondosa)*

The predominance in by-catches of the large commercial holothurian *Cucumaria frondosa* was recorded at several stations in the Goose Bank and the North Kanin Bank as well as in the central part of the Spitsbergen Bank at depth less than 100 m (see Figure 4.2.12). By-catches of invertebrates in these areas are characterized by significantly high biomass which averaged 145±93 kg/trawling. The highest by-catches (up to 500 kg per 15 minute trawling) were recorded in the Spitsbergen Bank. The main bulk (up to 330 kg) of these by-catches was made up by *Cucumaria frondosa*. The *Cucumaria frondosa* biomass, in by-catches at the stations in the south-eastern and north-western parts of the Barents Sea, differs significantly. On the eastern fishing banks it does not exceed tens kg per trawling, while on the Spitsbergen Bank it is estimated as hundreds kg per trawling. This fauna assemblage is characterized by the predominating suspension feeders and the wide distribution of epifauna organisms such as sponges, bryozoans, hydrozoans and ascidians (Figure 4.2.17, Table 4.2.1). Sea-urchins *Strongylocentrotus pallidus* and *S. droebachiensis* as well as barnacles *Balanus balanus* and *B. crenatus* also form dense, mixed, local populations in these particular areas.

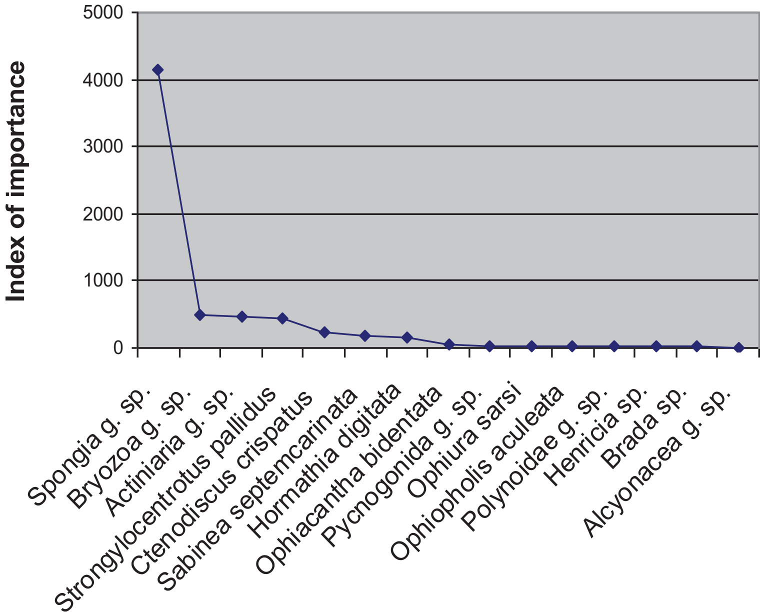


Figure 4.2.16. The structure of community Spongia g. spp. ("K" group of the stations). The fifteen most abundant taxa are given.

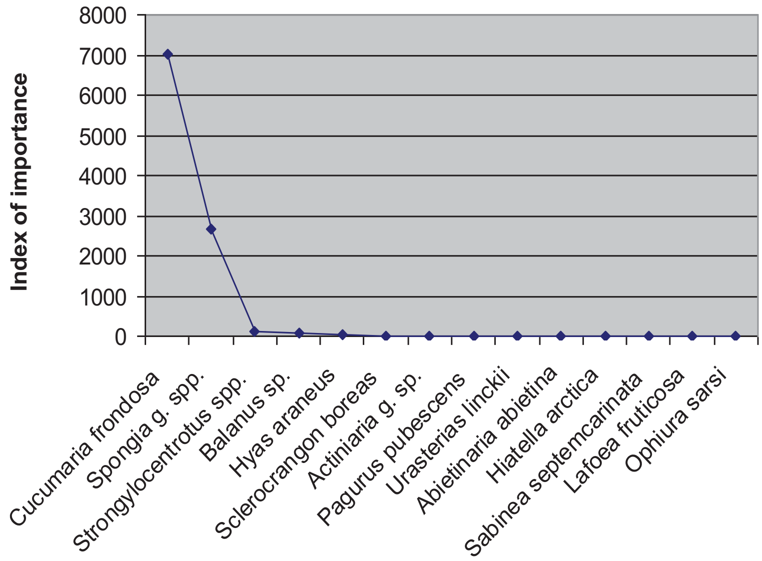


Figure 4.2.17. The structure of community *Cucumaria frondosa* ("P" group of the stations). The fifteen most abundant taxa are given.

Faunistical assemblages dominated by detritus feeders (B1, D, E, H, N)

The distribution of communities with detritus feeders predominant in biomass is shown in Figure 4.2.18.

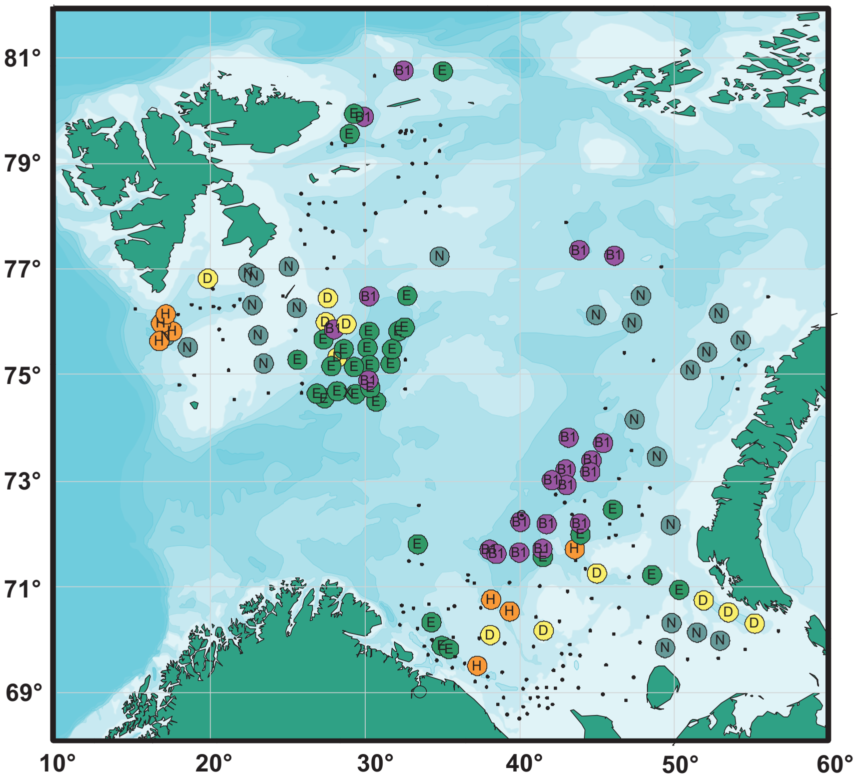


Figure 4.2.18. The distribution of faunistical assemblages dominated in biomass by detritus feeders. (The stations are marked as in Figure 4.2.11).

B1 (*Molpadia borealis)*

A community predominated with the large holothurian *Molpadia borealis* and the subdominant sea-star *Ctenodiscus crispatus* was found in the deep-water area of the Eastern Basin and at some stations in the eastern part of the Bear Island Trough, at depths more than 300m on muddy grounds (Figure 4.2.18, 4.2.19). Both the species are typical subsurface deposit feeders, and they form dense local populations in areas with soft muddy sediment, rich in organic fertilizer. The mean biomass of these species was 5,1±1,1 kg/trawling and 2,2±0,9 kg/trawling respectively. At some stations the biomass of these species in the by-catches reached 20 kg/trawl. The sea-star, subsurface deposit feeder *Pontaster tenuispinus*, the crangonid shrimp *Sabinea septemcarinata*, the brittle star *Ophiacantha bidentata* and the soft corals of the Nephteidae family are also characteristic taxa of this community. The described community is particular for the deep-water areas in the Eastern Basin (Figure 4.2.18).

E *(Ctenodiscus crispatus)*

The species composition of the community recorded in the eastern part of the Bear Island Trough (see Figure 4.2.18), is very similar to the described above community of *Molpadia borealis*, distributed in the deep-water area of the Eastern Basin. The only differences are the quantitative ration of dominant taxa. In the Eastern Basin *Molpadia borealis* had the highest biomass while *Ctenodiscus crispatus* was subdominant, but in the Bear Island Channel *Ctenodiscus crispatus* was dominant in biomass, frequency of occurrence, and index of importance (Figure 4.2.20). In this area about half of the biomass was *Ctenodiscus crispatus* which exceeded the mean biomass of *Molpadia borealis* several times.

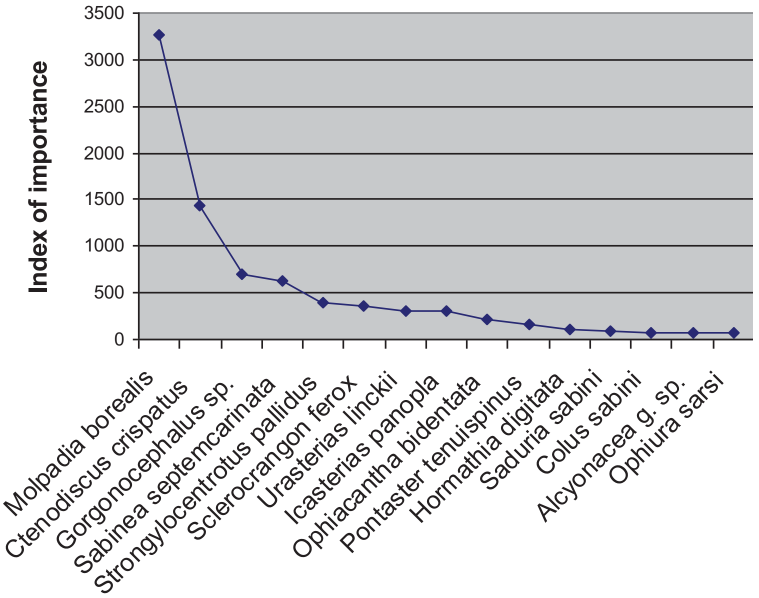


Figure 4.2.19.. The structure of the community dominated by *Molpadia borealis* ("B1" group of the stations). The fifteen most abundant taxa are given.

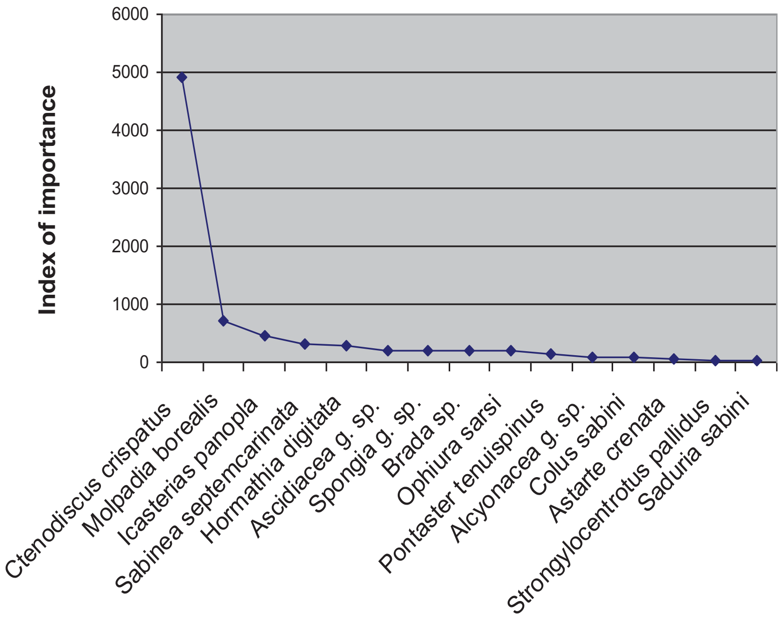


Figure 4.2.20. The structure of the community dominated by *Ctenodiscus crispatus* ("E" group of the stations). The fifteen most abundant taxa are given.

By-catches with similar species composition and ratio of species were also recorded at some stations in other deep-water areas of the Barents Sea. This was mainly on soft sediment in the deep-water troughs at the coasts of Murman, the southern island of Novaya Zemlya archipelago and north-east of Spitsbergen (see Figure 4.2.18).

D *(Ctenodiscus crispatus + Sabinea septemcarinata)*

The community, recorded in this group of stations, had a species composition which was very similar to the above mentioned community "E" *Ctenodiscus crispatus*, and may be regarded as its shallow-water variety (Table 4.2. 1). Specificity of this group of stations consists in the less pronounced dominance of *Ctenodiscus crispatus* and the high occurrence of crangonid shrimp *Sabinea septemcarinata* (Figure 4.2.21). The biomass (average 2,6±1,2 kg/trawling) of *Sabinea septemcarinata* was slightly lower than the biomass of *Ctenodiscus crispatus*. At some stations the biomass of *Sabinea septemcarinata* exceeded 10 kg/trawling.

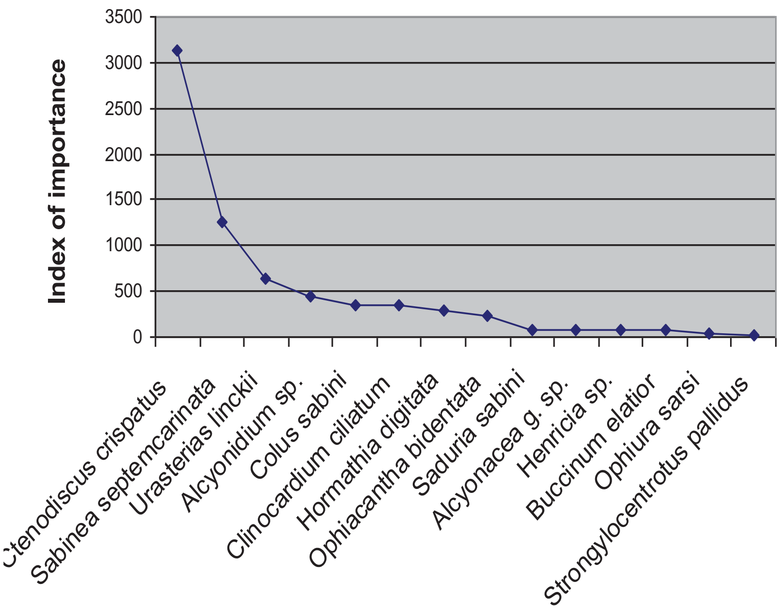


Figure 4.2.21. The structure of the community *Ctenodiscus crispatus+Sabinea septemcarinata* ("D" group of the stations). The fifteen most abundant taxa are given.

The by-catch stations with the above described correlation of species being predominant, were recorded both in the south-eastern Barents Sea (the South Novaya Zemlya Trough, the slopes of the Murman Rise, the North Kanin Bank and the Goose Bank) and in the north-western part of the Barents Sea and adjacent water, near the slopes of the Bear Island Channel and the Storfjord Channel (see Figure 4.2.18).

H *(Ctenodiscus crispatus + Hormathia digitata)*

The species community which was recorded at the stations in the mouth of the Storfjord Channel and deep-water troughs between the south-eastern banks (the Goose Trough, the Kanin Trough, Nord djupet) (see Figure 4.2.18), had a structure which was similar to the before described polydominant community (Figure 4.2.22). Dominant species of the community are *Ctenodiscus crispatus* and the sea anemone *Hormathia digitata*. Eventhough both species have a small size, their biomass reached several kg per 15 minute trawling. Sea-stars of the *Henricia* genera and *Icasterias panopla* are regarded as subdominants. The long list of typical species of this community includes brittle star *Ophiura sarsi*, sea-star *Pontaster tenuispinus*, Nephtheidae soft corals, bivalves *Astarte crenata*, polychaetes *Brada* sp., and the amphipoda *Epimeria loricata*.

A characteristic of this species assemblage is the occurrence of the large boreal sea-star *Hippasteria phrygiana* at some stations, both in the northern and southern areas of distribution. Occurrence of this species in by-catches is the clear indicator of the Atlantic boreal fauna distribution along deep-water troughs with waters of North Atlantic Current.

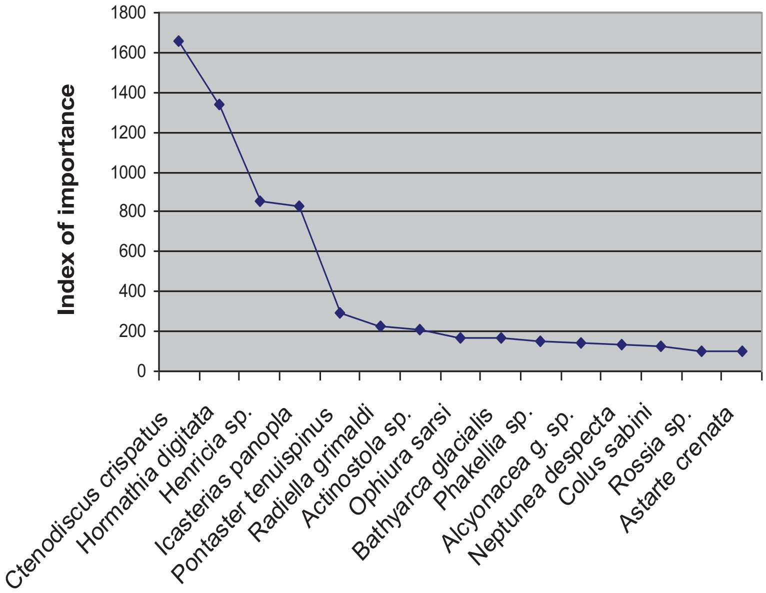


Figure 4.2.22. The structure of the community *Ctenodiscus crispatus+Hormathia digitata* ("H" group of the stations). The fifteen most abundant taxa are given.

N *(Strongylocentrotus pallidus)*

The dense local populations of the sea-urchin *Strongylocentrotus pallidus* form well-structured communities with a pronounced monodominant structure (Figure 4.2.23). This community occurs on coarse and mixed sediment of coastal shallows and local bottom rises in the open sea – north of Kolguev Island, on the Novaya Zemlya Bank, the Great (Perseus) Bank and the Spitsbergen Bank (see Figure 4.2.18).

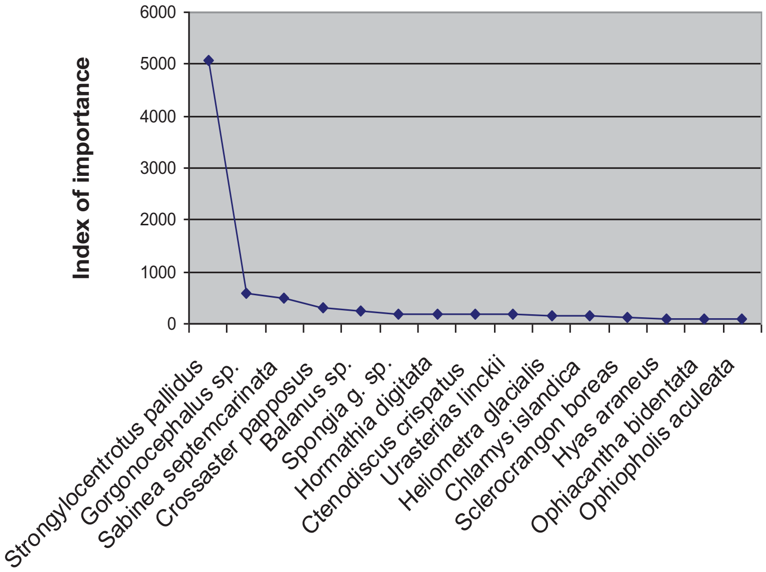


Figure 4.2.23. The structure of the community dominated by *Strongylocentrotus pallidus* ("N" group of the stations). The fifteen most abundant taxa are given.

The community was registered at depths of 60–258 m (in average 134±14 m). Sea-urchins biomass in by-catches reached up to 68 kg per 15 minute trawling and averages 14,1±3,1 kg/trawling in the area of the community distribution. The brittle stars *Ophiacantha bidentata* and *Gorgonocephalus* spp., the soft corals of the family Nephteidae, the crangonid shrimp *Sabinea septemcarinata* and the scallop *Chlamys islandica* are typical species of this community.

Faunistical assemblages predominated by carnivorous species (A, I, L, M, O)

The distribution of communities where carnivorous species are predominant in biomass is shown in Figure 4.2.24.

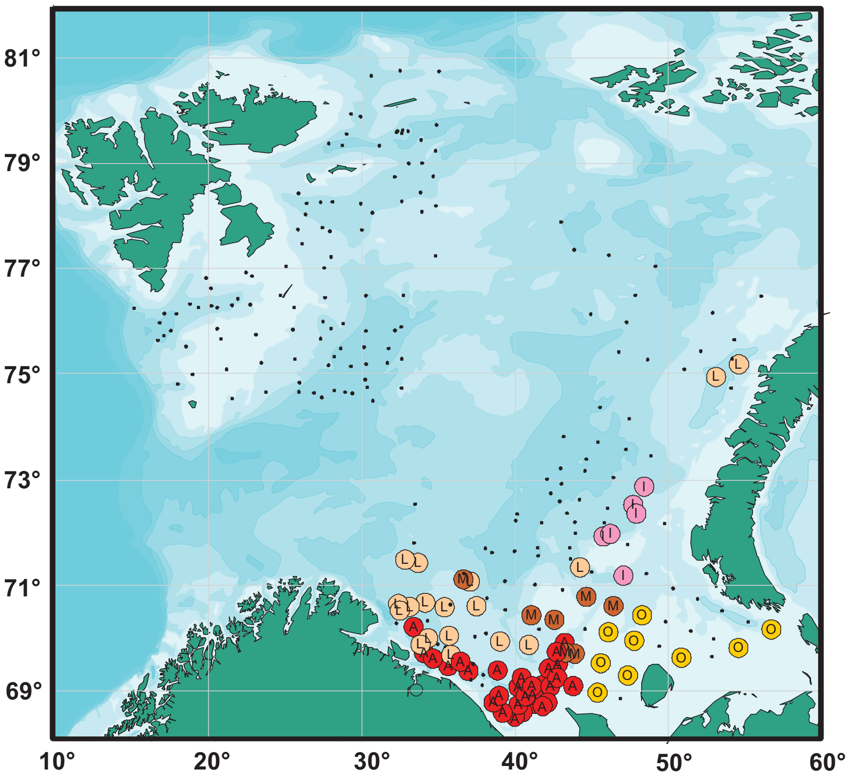


Figure 4.2.24. The distribution of faunistical assemblages dominated in biomass by carnivorous species. (The stations are marked as in Figure 4.2.11).

A *(Paralithodes camtschaticus)*

The stations, combined into the cluster "A", are compactly located in the coastal zone of the southern part of the Barents Sea and clearly mark the area of the red king crab distribution. This fauna assemblage is associated with coarse and mixed sediment of the coastal shoal (Table 4.2. 1, Figure 4.2.24). The main part of the by-catches biomass on these stations belongs to the red king crab (Figure 4.2.25). According to the data of the three years of observation, the biomass of king crab in by-catches average 71,5±33,0 kg/15 min of trawling. The contribution of the others species to the total biomass of by-catches is considerably less. Usually its biomass do not exceed 15 kg per 15 min of trawling and average about 1,5 kg/15 min of trawling. Besides the *Paralithodes camtschaticus* the others characteristic species of this assemblage are the sponge *Suberites ficus*, the sea star *Asterias rubens*, the sea anemone *Hormathia digitata*, and the crab *Hyas araneus*. At some stations the high biomass (up to 10 kg/15 min trawling) are made up by the large see cucumbers *Cucumaria frondosa* and the sponges *Myxilla incrustans*.

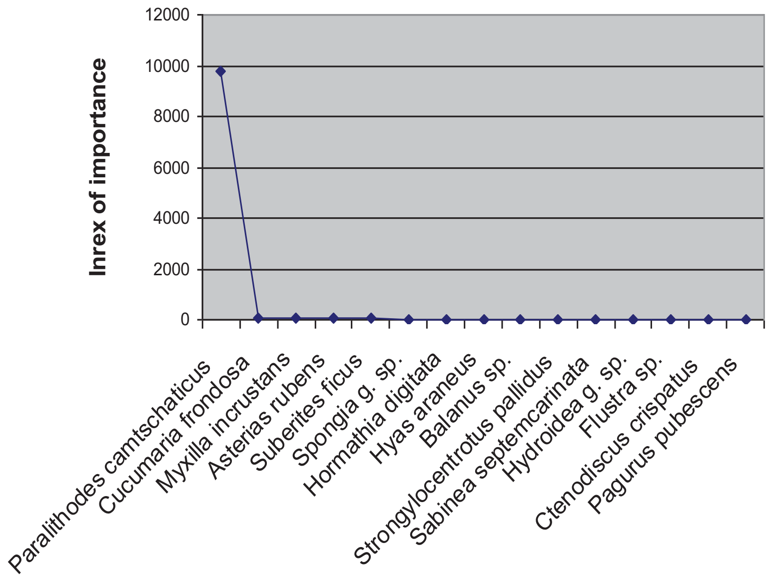


Figure 4.2.25. The structure of the faunistical assemblage dominated by *Paralithodes camtschaticus* ("A" group of the stations). The fifteen most important taxa are given.

I *(Chionoecetes opilio)*

Another large commercial crab species, *Chionoecetes opilio,* was predominant in the by-catches at a number of stations in the eastern Barents Sea near the Goose Bank at the depth 166-250 m (on average 213±13 m) (Figure 4.2.26). The distribution area of this fauna assemblage clearly indicates the area of the crabs densest concentrations (see Figure 4.2.24). Mean biomass of *Chionoecetes opilio* in the by-catches of this area was 1,4±0,2 kg per standard 15 minute trawling (up to 2,3 kg/trawling). The structure of the *Chionoecetes opilio* community is similar to the community structure of the red king crab distribution area. Mean biomass of the by-catches was 2,6±0,4 kg/trawling, and the characteristic species is typical of mixed muddy and sandy sediment of the eastern Barents Sea (Figure 4.2.26, Table 4.2.1).

O *(Sabinea septemcarinata)*

The crangonid shrimp *Sabinea septemcarinata* was predominant in by-catches from the northern Pechora Sea. These community was characterized by a specific species composition (Figures 4.2.24, 4.2.27, Table 4.2.1). The shrimp biomass here averages 1,4±0,5 kg/trawling and at some stations it reaches 4 kg/trawling. This assemblage is distributed on sandy grounds up to 100m. About 2/3 of the benthos biomass on these stations belong to the crustaceans. This includes species as the shrimp *Sclerocrangon boreas* and *Eualus gaimardi*, the crab *Hyas araneus* and the hermit crab *Pagurus pubescens*.

The community is characterized by a pronounced mono-dominant structure that is typical for the communities dominated by commercial species.

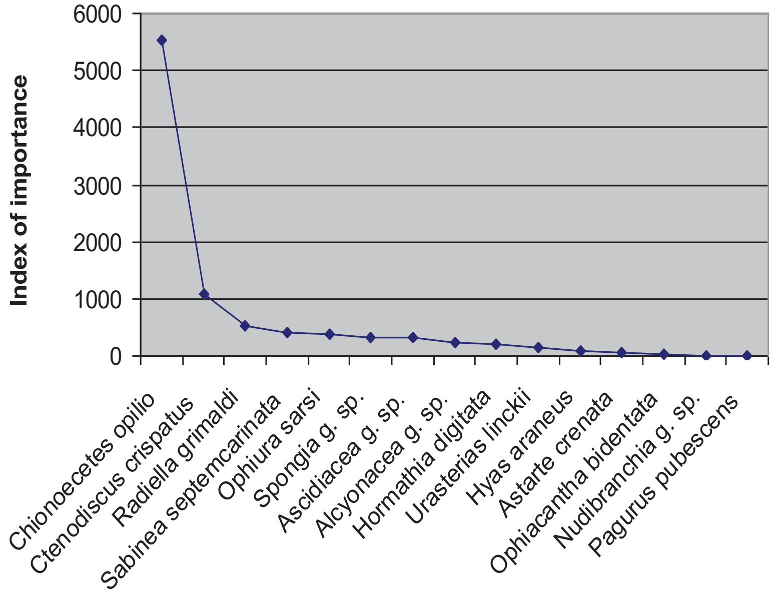


Figure 4.2.26. The structure of the faunistical assemblage dominated by *Chionoecetes opilio* ("I" group of the stations). The fifteen most important taxa are given.

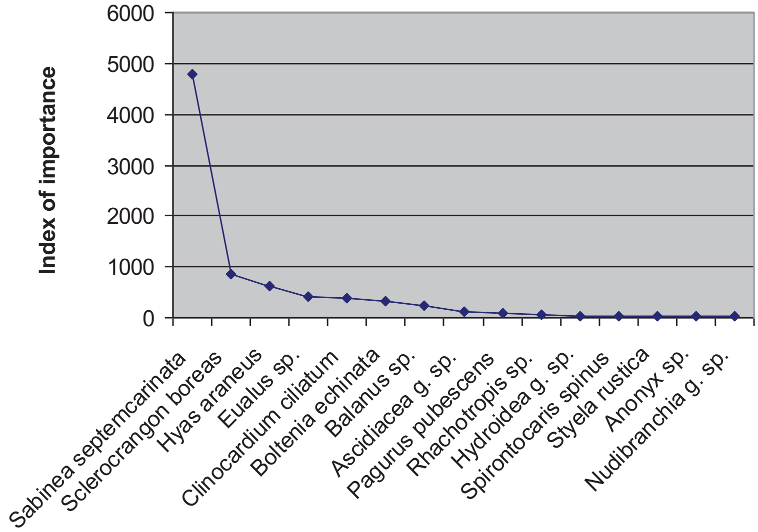


Figure 4.2.27. The structure of the faunistical assemblage dominated by *Sabinea septemcarinata* ("O" group of the stations). The fifteen most important taxa are given.

L *(Hormathia digitata)*
The sea anemone *Hormathia digitata* are widely distributed in the Barents Sea. But a number of stations in the deep-water areas of the Murman coastal zone and in the troughs between the eastern fishing banks are characterized by a predomination of *Hormathia digitata* (Figure 4.2.24**,** 4.2.28). Sea anemone biomass in this community averages 2,4±1,7 kg/trawling, at some stations it reach up to 30 kg/trawling. The subsurface deposit feeder *Ctenodiscus crispatus* is also a typical species in this group of stations. This community was recorded at muddy sediment at 159–278 m depth which also are the preferred depth of *Ctenodiscus crispatus*. Other species characterizing this community belongs to the sponges and includes, among other, *Phakellia* sp., *Radiella grimaldi, Polymastia mammillaris, Myxilla incrustans, Tetilla polyura,* and *Suberites ficus*.

Similar species composition in by-catches was also found in the deep-water area of the West Novaya Zemlya Trench. The community *Ctenodiscus crispatus* + *Hormathia digitata* with the similar dominant species composition (the group of stations H; see Figure 4.2.18, 4.2.22) was recorded in the northern Barents Sea in the mouth of the Storfjord Channel.

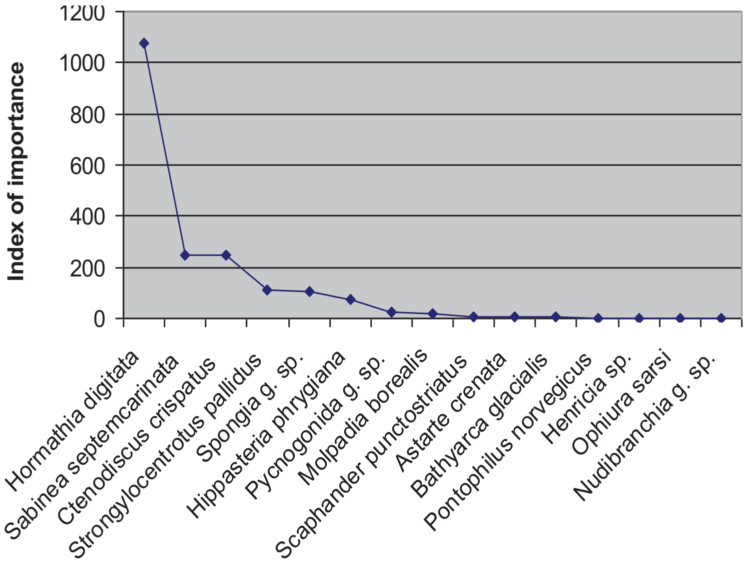


Figure 4.2.28. The structure of the community dominated by *Hormathia digitata* ("L" group of the stations). The fifteen most important taxa are given.

Sea anemones are passive predators. They are usually found in high abundances at localities with high availability of prey organisms such as small bentho-pelagic crustaceans and others invertebrates. The bentho-pelagic crustaceans and the other invertebrates themselves concentrate in areas with high availability of organic remains which acts as a source of food for them. Furthermore, *Hormathia digitata* prefer to settle on shells of large gastropods (predominantly on *Colus sabini*). *C.sabini* and other gastropods are typical scavengers and are likely to transport the sea anemones to areas with high concentration of organic material (remains) on which they feed. Dense concentrations of *Hormathia digitata* therefore indicate areas which might be rich in organic remains on the bottom.

M *(Hyas araneus)*
In the area of the North Kanin Bank a fauna assemblage dominated by the crab *Hyas araneus* (native for the Barents Sea and widely distributed) was recorded (Figure 4.2.24, 4.2.29). The sea anemone *Hormathia digitata* was a subdominant species in this assemblage. Stations belonging to the M group were located on sandy and mixed sediments at depths less than 200m (112±16 m). The species composition of this group is typical for this habitat (Table 4.2. 1).

It should be noted that, together with the communities dominated by the two introduced crab species – the red king crab *Paralithodes camtschaticus* and the snow crab *Chionoecetes opilio*, – this assemblage form a peculiar "crab belt" extending from the Murman coastal area through all eastern fishing banks up to the Moller Table near the south island of Novaya Zemlya archipelago. If also the area of the *Hormathia digitata* assemblages are taken into account (see L in the Figure 4.2.24 and partly H in Figure 4.2.18), it is possible to characterize a wide area in the south-eastern part of the Barents Sea to be dominated by carnivores. This area also overlaps spatially with the main fishing areas.

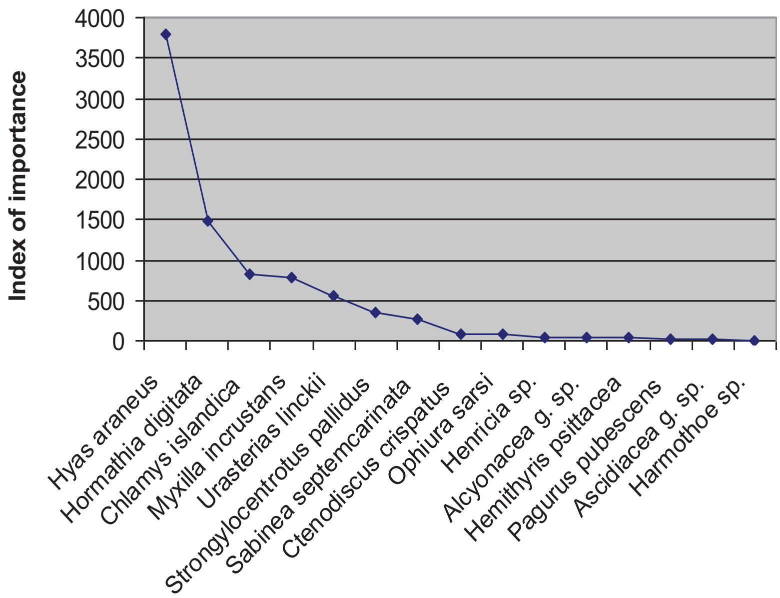


Figure 4.2.29. The structure of the community dominated by *Hyas araneus* ("M" group of the stations). The fifteen most important taxa are given.

4.2.4.2 Distribution of the benthic communities in the south-western and central parts of the Barents Sea

By L.L. Jørgensen

The trawl by-catches from 125 stations taken between 2006 and 2008 in the Norwegian area by RV *G.O. Sars* were identified to the lowest possible taxonomic level, counted and weighed per taxon.

In order to identify faunal communities cluster analysis was performed using biomass data (PRIMER version 6.1.9; Clarke & Gorley 2001). Between-sample similarity matrices data were computed using the Bray-Curtis coefficient (Bray, Curtis 1957) and hierarchical agglomerative clustering with group-average linking of the similarity values was performed.

The Bray-Curtis similarity coefficient (S_{jk}) (Bray and Curtis 1957) was used to describe the similarities between the analyzed stations with regard to their community composition in order to single out possible faunal communities. This coefficient is calculated using the following formula:

$$S_{jk} = \left[1 - \frac{\sum_{i=1}^{s} \left| Y_{ij} - Y_{ik} \right|}{\sum_{i=1}^{s} (Y_{ij} + Y_{ik})} \right]$$

where: S_{jk} – faunal similarity between sample *j* and *k* summarized for all the species; S – total number of species; Y_{ij} – weight of species *i* in the sample *j*; Y_{ik} – weight of species *i* in sample *k*.

Table 4.2.2. The main features of the bottomfauna communities as identified by cluster analysis.

Cluster	Area of distribution	Mean depth (min-max) (m)	Predominant type of sediment	Mean biomass of by-catch (min-max) kg/trawl	Dominant taxa	Typical taxa
A	North Cape Bank and surroundings	304 (243-422)	Coarse and mixed sediment	1.3 (0.23-5.5)	Porifera g. spp. (*Polymastia* spp., *Halichlona* sp., *Geodia* sp., *Thenea* sp.)	*Strongylocentrotus* spp., *Hippasterias phrygiana, Pontaster tenuispinus, Echinus* sp., *Stictopus tremulus*
B	Bear Island Channel	410 (281-497)	Soft-bottom	4.8 (15.5-0.7)	*Molpadia borealis*	*Polymastia* spp., *Bathyarca glacialis, Thenea muricata, Ctenodiscus crispatus*
C	Hopen Island deep	327 (182-386)	Soft-bottom	7.48 (1.60-18.7)	*Ctenodiscus crispatus*	*Molpadia borealis, Spiochaetopterus typicus, Urasterias linkii, Sabinea septemcarinata*
D	Tromso Plateau, North Cape Bank and areas between	317 (204-464)	Silt and sandy silt	540.9 (1.2-4349)	*Geodia sp*	*Astarte* sp., *Lithodes maja, Munnida sarsi, Stictopus tremulus, Hanleya nagelfar*
E	Slope of eastern Spitsbergen bank and westen Central Bank	205 (118-255)	Silt and sandy silt	11.07 (4.02-22.7)	*Heliometra glacialis*	*Strongylocentrotus* spp., *Solaster* sp., *Ophiopholis aculeata, Icasterias ponopla,* Porifera g. spp..

The cluster analysis allows singling out six megabenthic communities (Figure 4.2.30). The main features of the singled out communities are given in Table 4.2.2.

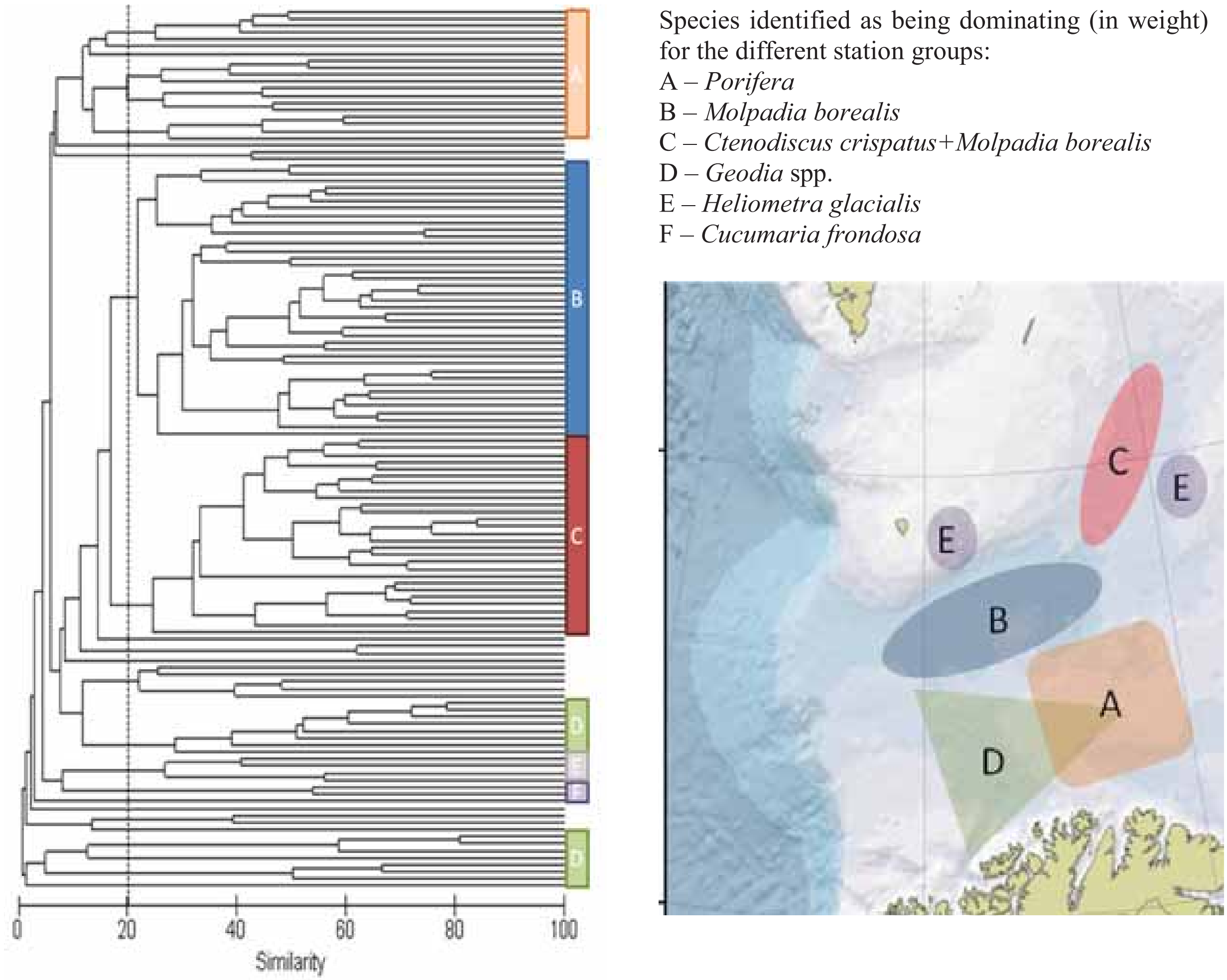


Figure 4.2.30. Dendrogramm of Barents Sea benthic communities (left) and the location of the communities (map on the right) together with the dominant (in weight) species for easch of the community (A-F).

A *(*Porifera*)*

This faunal community is distributed from the Finmark coast and north to Bear Island Channel at 300m depth (North Cape Bank and surroundings). It is dominated by several sponge species, and characterized by a variety of other species mainly belonging to the Echinodermata (Figure 4.2.31). This includes the sea urchins *Strongylocentrotus* sp. and *Echinus* sp. the sea stars *Hippasterias phrygiana, Ctenodiscus crispatus* and *Pontaster tenuispinus* and the holothurian *Stictopus tremulus*. The 15 dominant species with regard to biomass are responsible for up to 80% of the representative community (Figure 4.2.4.2-2). A sponge dominated community indicates an environment favouring suspension feeders while the presence of detritus feeders such as *C. crispatus* and *S. tremulus* indicates soft muddy sediment rich in organic material. Such a co-presence of filter- and detritus feeders suggest that a strong bentho-pelagic coupling might occur in this area.

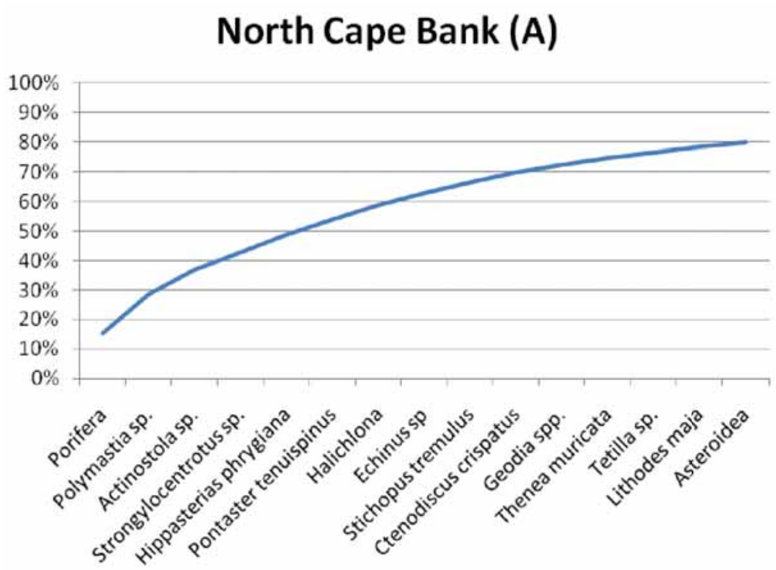


Figure 4.2.31. Cumulative biomass distribution of the 15 most important benthic species being identified as dominating/ characteristic in the North Cape Bank and surrounding areas.

B *(Molpadia borealis)*

This community, mainly found in the Bear Island Channel at 400 m depth, consisted of detritus feeders such as *Molpadia borealis* and *Ctenodiscus crispatus* (Figure 4.2.32). However, filtrating sponge species and the bivalve *Bathyarca glacialis* were also among the dominating species indicating the presence of strong currents and potentially bentho-pelagic coupling in this area.

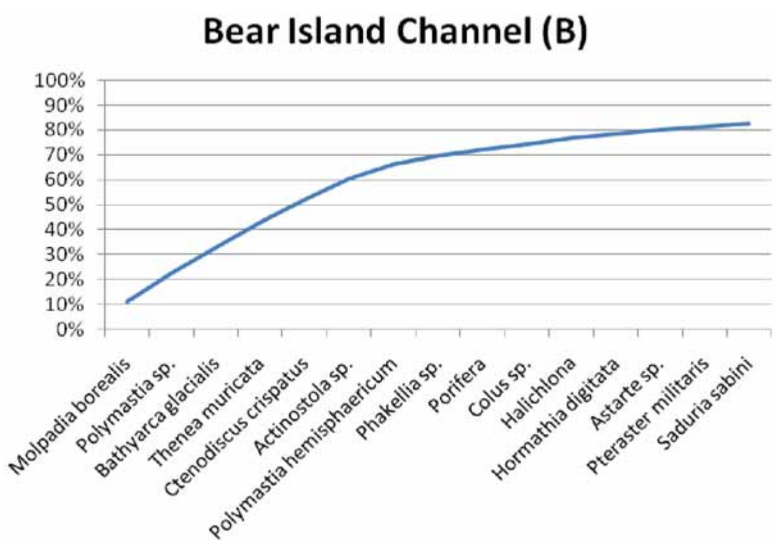


Figure 4.2.32. Cumulative bio-mass distribution of the 15 most important benthic species being identified as dominating/ characteristic in the Bear Island Channel.

C *(Ctenodiscus crispatus)*

The Hopen Island Deep was dominated by the same subsurface deposit feeders as those areas covered by PINRO in Figure 4.2.18 for Hopen Island Deep (B1), and in the Eastern Basin (E). *Ctenodiscus crispatus* and *Molpadia borealis* made up to 50% of the biomass of these stations (Figure 4.2.33). Other species important for this community was the polychaete *Spiochaetopterus typicus,* the sea stars *Urasterias linkii* and *Icasterias panopla* and the crangonidae *Sabinea septemcarinata*.

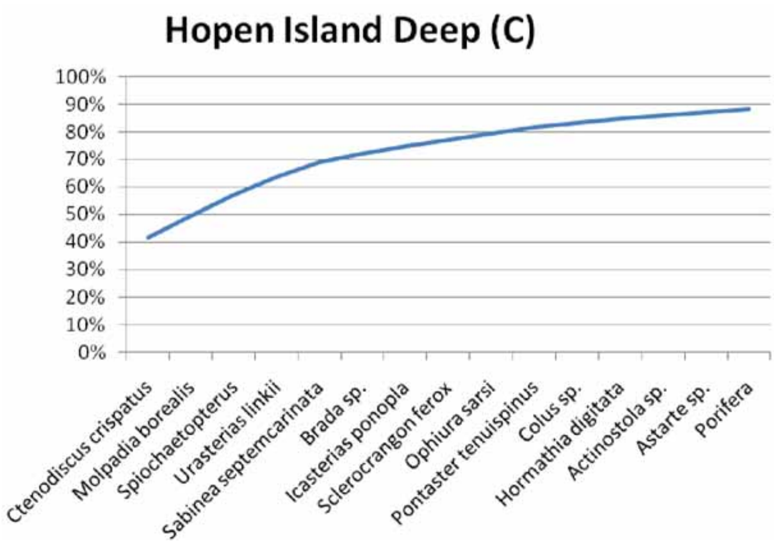


Figure 4.2.33. Cumulative biomass distribution of the 15 most important benthic species being identified as dominating/ characteristic in the Hopen Island Deep.

D *(Geodia* spp.*)*

On the sandy sediments of Tromso Plateau and further east in the open sea of the North Cape Bank, various large bodied sponges were recorded (Figure 4.2.34). More than 200 species of sponges are earlier recorded on the Tromso Plateau and sponge spicules belonging to the genera *Geodia* and *Thenea* have been reported to make up to 3.5 kg/m^2 of pure siliceous spicule material. *Geodia* spp. and other sponges made up nearly 100% of the community recorded by the by-catch investigation, and the boreal Atlantic sea cucumber *Stichopus tremulus*, ranking as the second most dominant species, indicates the Atlantic water affinity of this community.

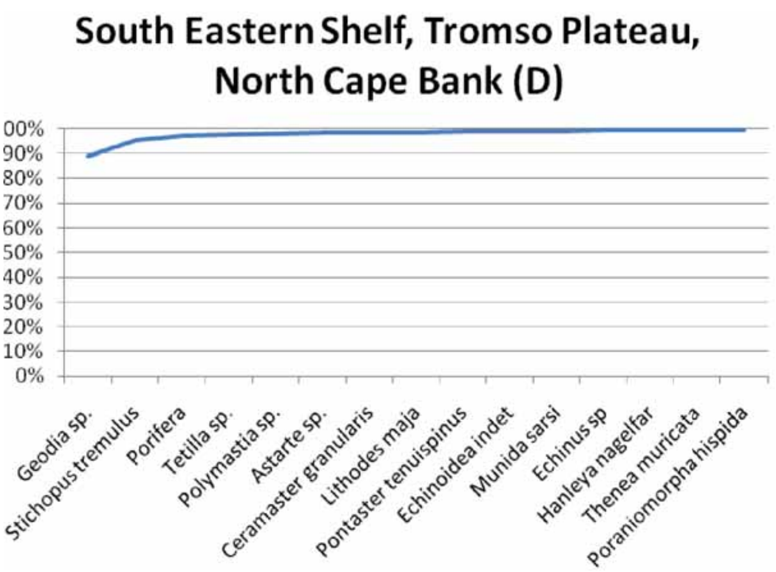


Figure 4.2.34. Cumulative biomass distribution of the 15 most important benthic species being identified as dominating/ characteristic on the continental slope of the southwestern Barents Sea, Tromso Plateau and the off-shore areas north of the Finnmark coast (North Cape Bank).

E (*Heliometra glacialis)*

This community is characterized by the plankton-feeding sea-lily *Heliometra glacialis* and the carnivorous crustacean *Sabinea septemcarrinata*. These two species made up 50% of the biomass of the community (Figure 4.2.35). The *Heliometra glacialis* community are also mention in figure 4.2.12, 4.2.15 and in table 4.2.1. This community is found on the eastern slopes of the Spitsbergen Bank and westen slope of the Central Bank. The plankton-feeding sea-lily indicate high concentrations of organic suspended material and plankton in these areas (see also chapter 4.2.4.1, community "J" for more information).

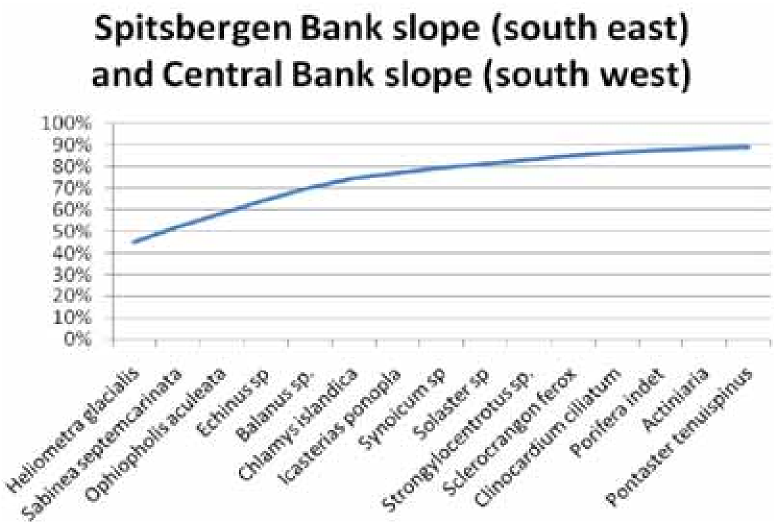


Figure 4.2.35. Cumulative biomass distribution of the 15 most important benthic species being identified as dominating/ characteristic at the slopes of Spitsbergen Bank (eastern slope) and Central Bank (western slope).

4.2.5 Monitoring areas and three years of recorded community dynamics of main groups and species

By L.L. Jørgensen, P.A. Lyubin and N.A. Anisimova

During this three year benthic programme, six long-term monitoring areas were evaluated in order to develop a method to detect fluctuations in benthic biomass in the Barents Sea (Figure 4.2.36, Table 4.2.3). Areas were chosen according to their perceived high level of susceptibility to climatic change and to human activities such as physical disturbance (effect from bottom trawling and petroleum activity) but also introduced species such as the red king crab *(Paralithodes camtschaticus)* and the snow crab (*Chionoecetes opilio*). For each area the mean biomass per station was calculated (Figure 4.2.37). The data for 2005 is to be viewed cautiously since the method used to obtain the by catches was still under development in Norway.

The results indicate (Figure 4.2.37) a drop in biomass between 2005 and 2007 at the Western Slope (Area 1, reduced catch of sponges) and in the Hope Island Deep (Area 6; reduced catch of several species of sea stars). Simultaneously there was an increase in benthic biomass on the North Cape Bank (Area 2) and along the Murman Rise (Area 3) which was related to an increased population of red king crab whereas at the Goose Bank (Area 4) an increasing population of snow crabs was responsible for the increase in mean biomass. In 2008, mean biomass decreased in areas 1, 2 and 3, while it remained relatively constant in areas 4, 5 and 6. Such decrease was partly due to a reduction in sponges in the catch, but also low coverage of sponge stations (area 2) and therefore an inappropriate way of data collection. The decreased biomass in area 3 could be attributed to low catches of the red king crab.

Table 4.2.3. Areas being monitored and the main human factors perceived as affecting benthic biomass. Numbering of the areas and the areas are the same as in Figure 4.2.36 and Figure 4.2.37.

Factor / Area	Fishery	Climate	Oil and gas exploitation	Introduced species
1 – Western Slope	+	+		
2 – North Cape Bank		+	+	
3 – Murman coast	+	+		+
4 – Goose Bank	+	+		+
5 – Shtokman field		+	+	
6 – Hope Island Deep	+	+		

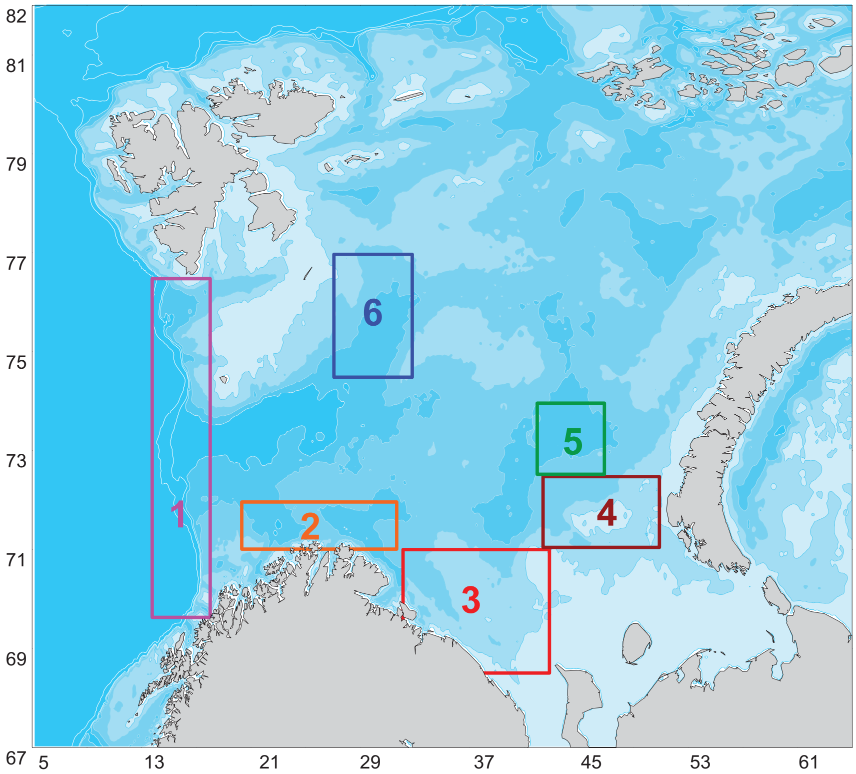


Figure 4.2.36. Long-term, monitoring areas.
Area 1 – Western Slope.
Area 2 – North Cape Bank.
Area 3 – Murman Rise.
Area 4 – Goose Bank.
Area 5 – Shtokman field.
Area 6 – Hope Island Deep.

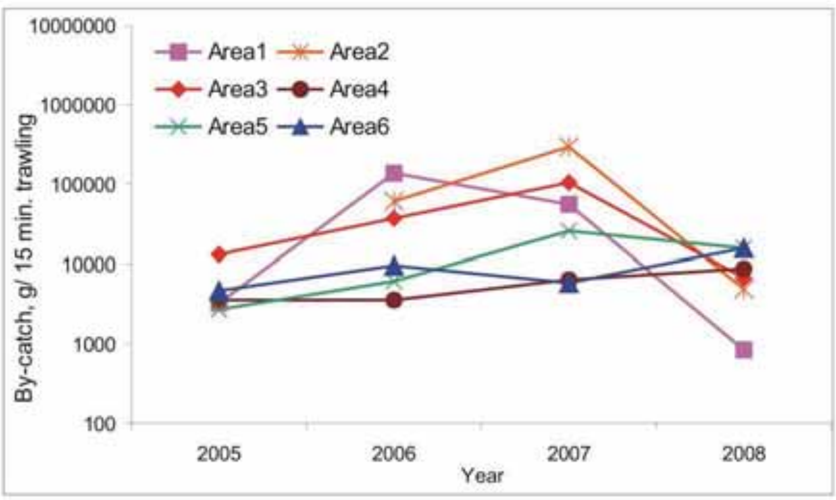


Figure 4.2.37 Mean biomass per station (g/15 minutes trawling) in defined monitoring areas 2005-2008. Area are the same as in Figure 4.2.37 and Table 4.2.3.

We recommend that for future long-term monitoring, the monitoring areas as they are presented here should be altered. Each monitoring area should be limited to as small an areas as possible and as precisely as possible on the target species distribution as possible without losing important information on the community and habitat supporting the target species. For instance, area 1 is presently spread over two different hydrodynamic regimes, i.e., the south-western Barents Sea is influenced by Atlantic water and the Storfjord Channel is influenced by cold Arctic waters. Area 6 in the Hope Island Deep should be limited to depths below 300 m with the Bear Island Channel being monitored separately and at depths of >300m. Area 4 should include the most south-reaching waterfront where Atlantic meets Arctic local seawater. Area 4 should be adjusted to the increasing population size and spreading population of the snow crab, as it is also the case for area 3 and the spreading distribution of the increasing population of the red king crab.

4.2.6. Advice on the monitoring areas with regard to the human impact

By L.L. Jørgensen

Disturbance from trawling and dredging has wide-ranging impacts on the diversity, and productivity of benthic communities (Jennnings & Kaiser 1998). In the Barents Sea, particular attention has been paid to biotic habitats generated by aggregations or colonial growth of single species and the vulnerability of such habitats. Habitat-generating species are represented by a wide range of taxonomic groups (e.g., Porifera, Polychaeta, Cnidaria, Mollusca and Bryozoa; see reviews in Jennings 1998, Auster & Langton 1999, Kaiser & de Groot 2000, Moore & Jennings 2000). The habitats house a high diversity of associated species, and are examples of whole communities that can be managed within restricted areas. For obvious reasons such habitats are seriously threatened by bottom trawling, and thus there is a strong need for their protection. Damage from bottom trawling is not limited to colonial species, but will impact all species with a life span that does not favor reproduction between disturbance events. This report states that the bycatch from bottom trawls includes a wide range of benthic animals and, as can be expected, in particular epifaunal, i.e., animals living freely or attached on the sediment surface. The areas of erect fragile suspension feeders (sponges, sea liljes, medusa heads, soft corals, sea cucumbers) are located in the Storfjord Channel, north and east of Svalbard, Spitsbergen Bank (see Figure 4.2.12) and Tromso Plateau (see Figure 4.2.30). One area of particular concern is the Tromso Plateau and the Bear Island southern slope due to the high level of fishing activity in this area (Figure 4.2.38).

Bottom trawling also occurs in the Hope Island Deep where we find large aggregations of detritus feeders, among others the holothurian *Molpadia borealis* (Figure 4.2.18). Holothurians are known to form dense assemblages to exploit fresh phytodetritus pulses on soft sediment (Wildish *et al.* 2008). Thus they might play a significant role in remineralization of newly deposited organic material and could characterize regions of tight benthic-pelagic coupling on the Arctic shelves. Piepenburg *et al.* (1995) noted that epifauna contributes significantly to the community carbon demand, a finding that has also been seen in other areas of the Arctic (Ambrose *et al.* 2001, Dunton *et al.* 2005, Renaud *et al.* 2007).

There are a variety of threats to the benthos that may alter ecosystem structure and value. Firstly, any factor affecting pelagic productivity and vertical flux will impact the benthos through tight pelagic-benthic coupling, Secondly, direct physical disturbance to the sea floor on small or larger scales can alter community structure. Thirdly, the introduction of species in the region may change food-web structure, and thus community functioning. It is therefore recommended to continue the monitoring of the detrivore communities in the Hopen Island deep and Eastern Basin which might be exposed to high trawling activity.

In August-September 2007 the water temperature in the bottom layer of the Barents Sea, on the whole, corresponded to that one in anomalously warm years (Ingvaldsen *et al*. 2007). The highest temperature anomalies in the bottom layer (>2 ºC) were observed in the North Cape and Murman Currents. Fluctuations within benthic biomass have been known for a long time (Antipova 1975b). The reasons for such biomass reduction are not clear but the boreal-arctic species which dominate the benthic biomass in the Barents Sea (as well as on the Arctic shelf) have an optimum temperature range within the long-term temperature mean of the region (Galkin 1987, Kiyko & Pogrebov 1997a, Kiyko & Pogrebov 1998). Any deviation from such mean might impact negatively on the reproduction, abundance, and biomass of boreal-arctic species. Since boreal-arctic species are rather susceptible to changes in temperature, changes in their distribution patterns indicate changes in climate. Therefore they are ideally suited for long-term monitoring studies.

Arctic species show low tolerance to increasing temperatures over time and thus their distribution might be indicative of long lasting temperature regimes. Areas populated by such Arctic species and therefore suitable as monitoring areas were identified in the eastern part of the Barents Sea and east of Svalbard (Figure 4.2.39). The two areas are distributed along the polar front and therefore are likely to show the effects of long lasting temperature increase in the bottom waters first.

Fluctuations in benthic communities might also be due to increasing populations of the opportunistic carnivorous king crab (Anisimova *et al.* 2005, Jørgensen & Primecerio 2007) and the snow crab both of which forage on a wide variety of benthic animals. For studying the effects of such invasions on the benthic fauna (Figure 4.2.24), the spreading area of the king crab along the Murman coast should be closely monitored in the future. For the snow crab, such areas lie along the Goose Bank, the Moller Table and the Central Bank. In order to detect such effects on the benthic community, both community composition and population structure (mean size of individuals) should be studied.

In summary, the results presented in this 3 year report suggest the monitoring areas as given in Figure 4.2.40 and Table 4.2.4.

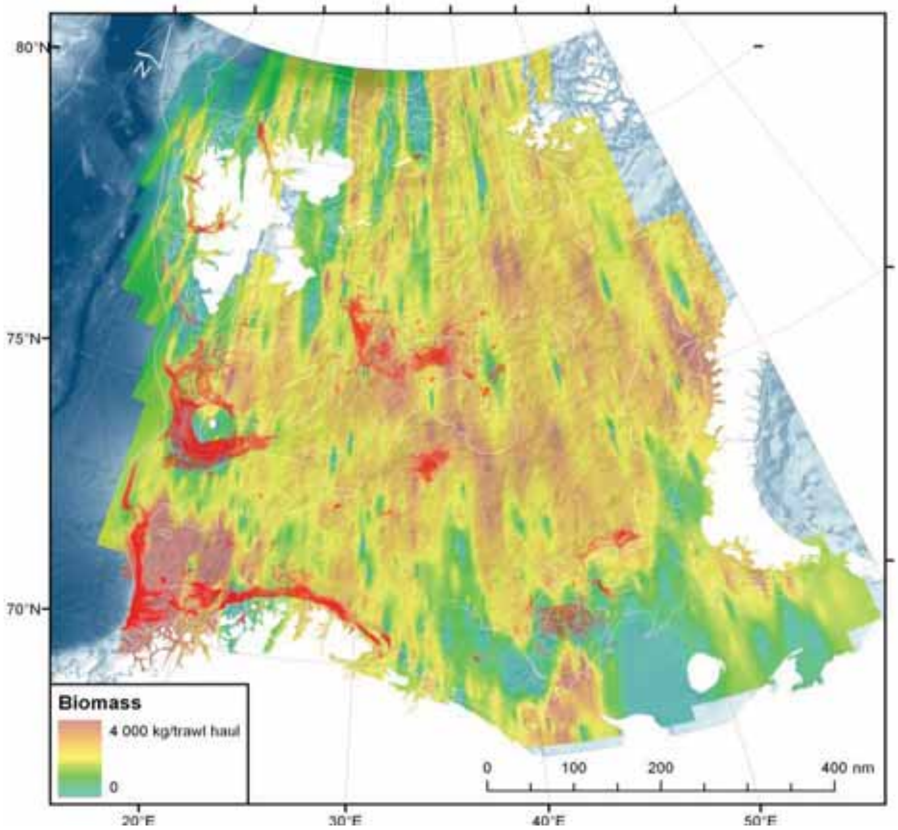


Figure 4.2.38. Impact of Fish trawling on the sea floor in 2007-2008 (red dots are modified VMS-data from the Norwegian fleet i.e. includes only trawling activity) overlaying the biomass distribution of epi- and megabenthos sampled by fish trawling in the same period.

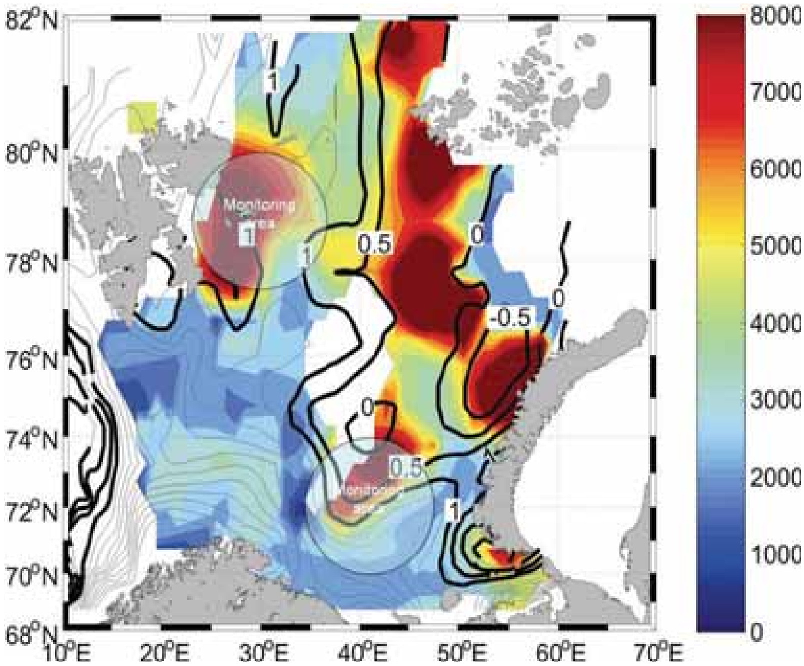


Figure 4.2.39. Distribution of arctic organisms (g/15 min. trawl) taken as by-catch and mean bottom temperature during the Joint Annual Ecosystem Survey 2005-2008. Suggested long term monitoring areas are included as circles.

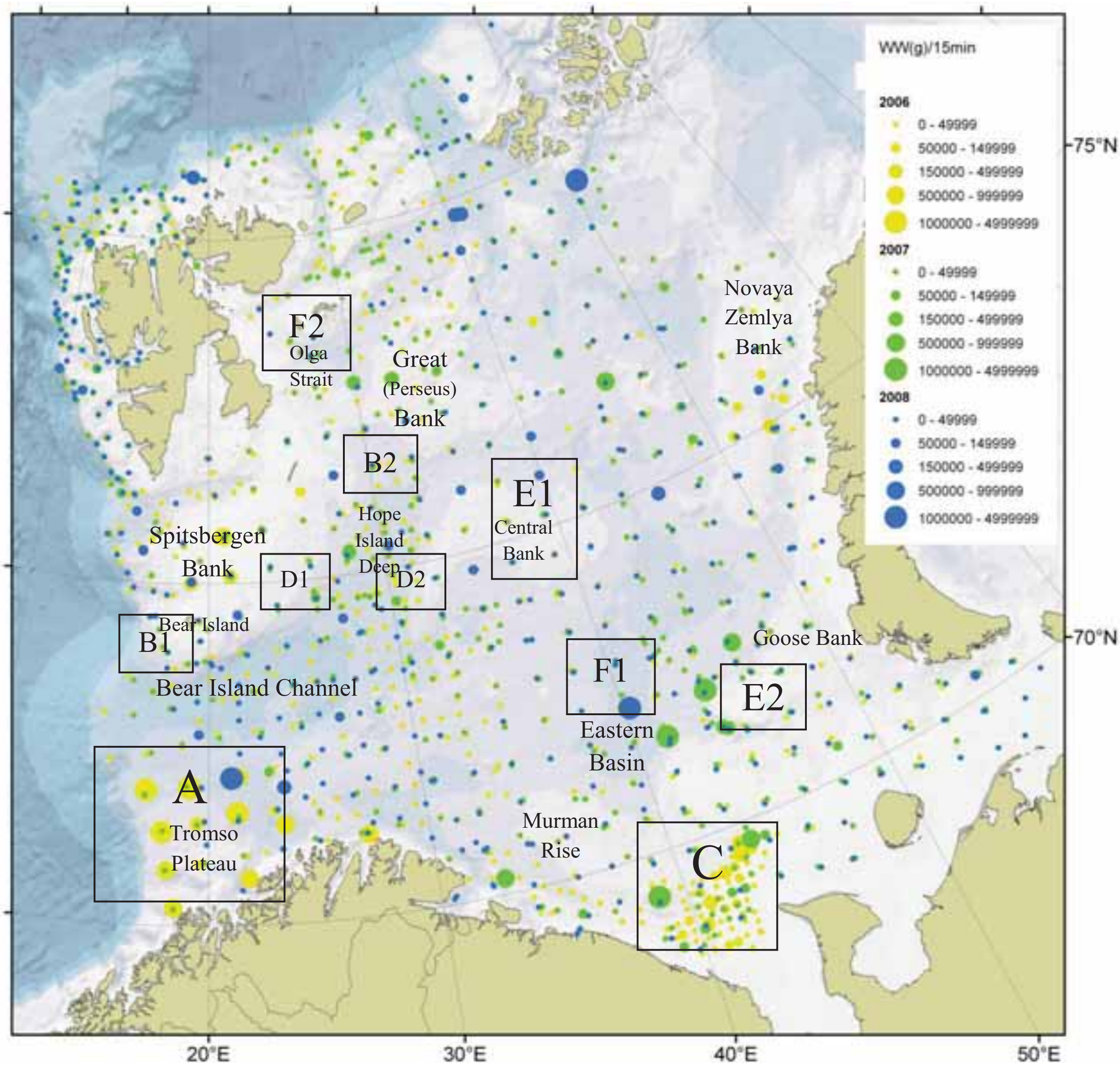


Figure 4.2.40. Suggested monitoring areas (in boxes, see also table 4.2.6-1) for future environmental management of the Barents Sea.

Table 4.2.4. Suggested monitoring areas (see also figure 4.2.6-3) with characteristic species, impact vector and group of organisms (target species or communities) exposed to the impact.

Area	Characteristic species	Impact	Target species
A: Tromso Plateau	*Geodia* sponge beds	High fishing intensity (see Figure 4.2.6-1)	Fragile sponge species removed or damaged by bottom trawling
B1: Bear Island southern slope	*Cucumaria frondosa* *Chlamys islandica*	High fishing intensity (see Figure 4.2.6-1)	Fragile species removed or damaged by bottom trawling
B2: Hope Island Deep – north	*Molpodia borealis* *Icasterias panopla* *Urasterias linkii*	High fishing intensity (see Figure 4.2.6-1)	Large-bodied species removed or damaged by bottom trawling
C: east of the Murman Rise and Kanin Bank	Red king crab *(Paralithodes camtschaticus)*	High abundance of red king crab.	King crab prey species (*Clinocardium ciliatum, Ctenodiscus crispatus* = lack of knowledge). But see also chapter 5.3 for infaunal studies.
D1: south eastern slope of Spitsbergen Bank D2: south westerm slope of Central Bank	*Heliometra glacialis*	Low fishing intensity (comparative to A and B= lack of knowledge).	Erect fragile species
E1: Central Bank east (new spreading area) E2: Goose Bank (high abundance area)	Snow crab (*Chionocetes opilio*)	Predation (knowledge gap= research on spatial and temporal effects urgently required	Abundance and distribution of snow crab prey species (lack of knowledge)
F1: Eastern Basin F2: Slopes of Kong Karl and Olga Basin	*Gorgonocephalus arcticus* *Ophiopleura borealis* *Ophioscolex glacialis*	Climate	Arctic species

5 Quantitative large-scale benthic survey of the Barents Sea 2003-2008

By N.A. Anisimova, P.A. Lyubin and I.E. Manushin

5.1 Background

During the extensive Russian research history of the bottom fauna in the Barents Sea, three quantitative benthos surveys have made it possible to evaluate the state of benthos in the Barents Sea in different climatic or specific historical periods. The first benthos survey was conducted by PLAVMORNIN (Seaborne Marine Research Institute) in the period 1924 to 1935 (Brotskaya & Zenkevich 1939). The next large benthos survey was done by PINRO in the period 1968-1970 (Antipova 1975). In 1991-1994 the third benthic investigation was conducted by VNIIOkeangeologia (Kiyko & Pogrebov 1997a, 1997b, 1998). A grab was the main quantitative sample equipment used during these three investigations.

In 2003 PINRO initiated a next full-scale benthic survey in the Barents Sea. The survey is the consecutive step among time-series of the large-scale observations of the state of the bottom communities in the Barents Sea. The survey was launched as an in-house PINRO scientific research programme but gradually went beyond the scope of PINRO's activities and gained international status. In 2006 it was decided at the 35th session of the Joint Fisheries Commission to include the programme as an individual item in a joint 3-year programme of IMR and PINRO in order to study the benthos of the Barents Sea.

Within the last few decades there has been an increase in human activies in the Bathents Sea such as commercial fishing, the exploitation of new target species such as scallop, northern shrimp and red king crab and the search for oil and gas on the Barents Sea shelf. Furthermore, invasive benthic species such as the red king crab (intended introduction) and the snow crab (unintended introduction) are spreading and changing the Barents Sea ecosystem. Because of these developments a new benthic survey was initiated to investigate possible changes in the benthic ecosystem.

The objectives of the benthic survey were to describe the current state of benthic communities in the Barents Sea and evaluate the changes caused by climatic and anthropogenic (mainly fishing) factors and by the intended introduction of red-king crab and the unintended introduction of snow crab, but also to obtain data for "ecological tracking" and "monitoring of oil and gas developments" and other economic activities on the Barents Sea shelf.

A network of stations of the benthic survey carried out previously by PINRO between 1968 and 1970 was used as the basis for a new survey design. Additional benthic sampling was carried out in Varangerfjord and the Motovsky Bay in order to study the impact of the red-king crab on the native benthic communities.

From 2003 to 2006, PINRO collected material throughout the Barents Sea area (including the western Svalbard waters up to 79°N), except from the Norwegian EEZ. Material was collected using the hydrographic vessel of the Northern Fleet *Romuald Muklevich* and PINRO's research vessels *Fridtjof Nansen* and *Smolensk* (Figure 5.1.1). In 2006, IMR joined the survey within the framework of the joint IMR-PINRO programme on benthic research in the Barents Sea. Samples were taken by IMR in the Norwegian EEZ in 2006, 2007 and 2008 using the R/V *G.O. Sars* (see Figure 5.1,1) during the joint Russian-Norwegian ecosystem surveys.

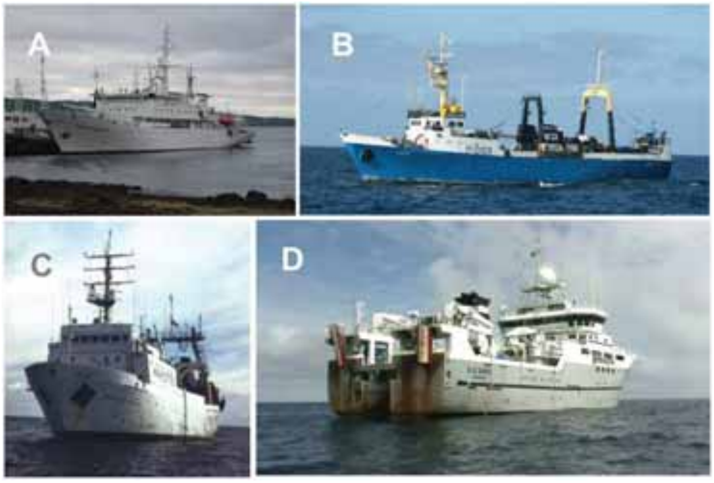


Figure 5.1.1. Research vessels participating in the 2003-2008 benthic survey:
A – hydrographic vessel of the Russian Northern Fleet *Romuald Muklevich*;
B – PINRO R/V *Smolensk*;
C – PINRO R/V *Fridtjof Nansen*;
D – IMR R/V *G.O. Sars*

By 2008 field sampling of the benthos as part of a regular full-scale benthic survey in the Barents Sea was completed. During the 6 years of works, 368 benthic stations were successfully sampled (Figure 5.1.2) resulting in 1798 grab samples and 325 hydrobiological trawl hauls.

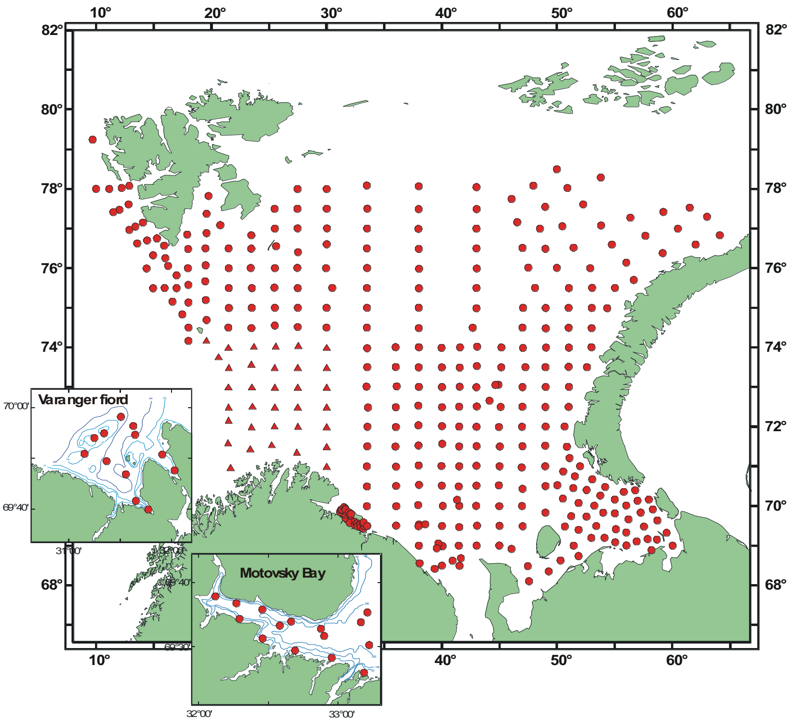


Figure 5.1.2. Stations sampled during the benthic survey 2003-2008. Stations sampled by PINRO (2003-2006) are shown as circles, stations sampled by IMR (2006-2008) are shown as triangles.

5.2 Material and methods

During the survey, the quantitative samples were taken by using an van Veen grab (0.1 m^2 surface area) (Figure 5.2.1). At each station, five replicate samples were taken and washed gently on a 0.5 mm mesh size.

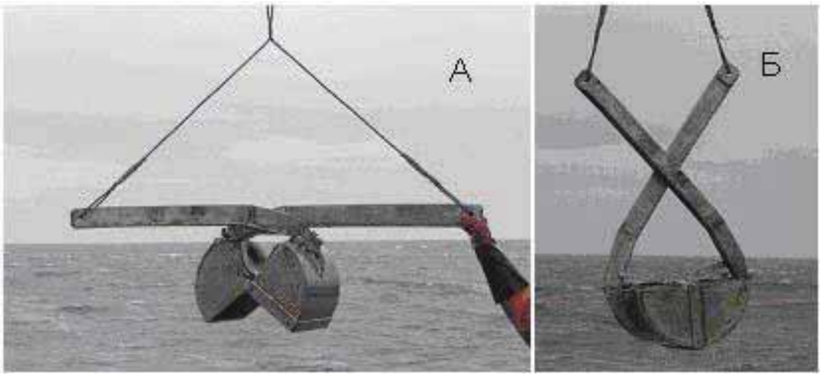


Figure 5.2.1. Van Veen grab (0.1 m^2 surface area) in open (A) and closed (B) position.

The retained material was fixed in buffered 4-5 % formaldehyde solution. Following sorting of the samples the animals were preserved in 70-75 % ethanol. Organisms were identified to the lowest possible taxonomic level with the help of taxonomists. Animals of each taxon were enumerated and weighed. When estimating biomass the effect of alcohol preservation was taken into account (biomass was recorded as alcohol-preserved wet weight). Tubes, enclosures or any protective outer layer were removed except molluscs shells and tubes of the polychaete *Spiochaetopterus typicus*. In contrast to other polychaets the tubes of *S. typicus* is the derivative of verms like the shells of molluscs.

On the Russian vessels Sigsby trawls with a frame size of 1 x 0.35 m were deployed (Figure 5.2.2, left) whereas beam-trawls with the frame length of 2.0 m were deployed on the Norwegian vessels (Figure 5.2.2, right). In any case, trawl samples were washed on a 5.0 mm mesh-size sieve. The retained material was then processed in the same way as the van Veen grab samples.

Figure 5.2.2. Sigsby trawl (left) and beam-trawl (right) used during the benthos survey 2003-2008.

5.3 First results

At present the collected samples is still under processing, and therefore not in a stage of analysis. The material collected in 2003 in the Varangerfjord, the Motovsky Bay and in central areas of the southern Barents Sea has been fully processed and partly analysed.

5.3.1 Varangerfiord

5.3.1.1 Biodiversity

383 taxa (318 of which have been identified to species level) of bottom invertebrates related to 143 families, 68 orders and 21 classes of 12 animals types (Appendix II Table 2) were identified in the samples collected in Varangerfjord.

Polychaetes, molluscs, bryozoans and crustaceans were the prevailing species in the benthic fauna of the Russian part of Varangerfjord. These groups comprised 80% of the species collected (Figure 5.3.1 A). Polychaetes and molluscs were the dominant groups in the inlets while bryozoans and polychaetes dominated in the shallows in the open fjord (Figure 5.3.1 B).

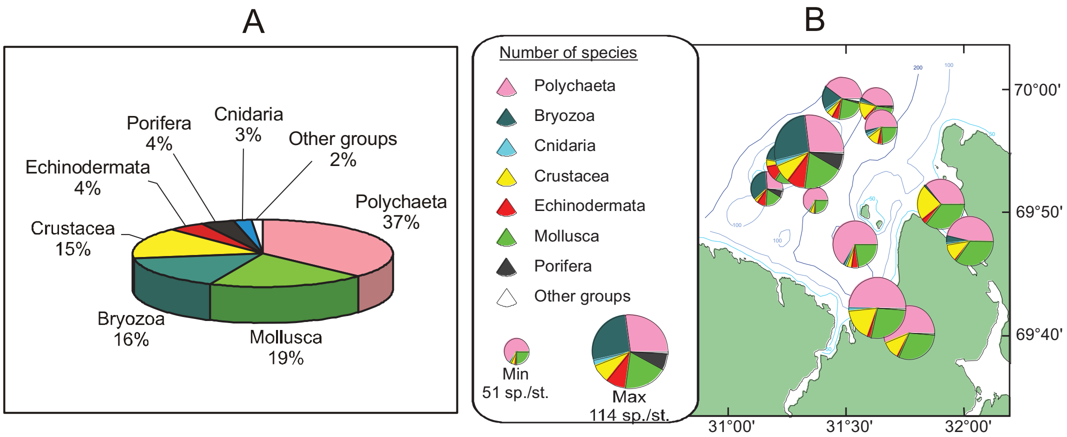


Figure 5.3.1. Percentage and number of species of main taxonomic groups in benthic macroinvertebrate samples from 12 stations sampled in the Varangerfjord. Overall composition of the fjord (A) and composition per station (B).

The results of grab sampling showed that the number of species/station varied from 51 to 114 and averaged 80.0±6.0 species/station in the investigated area of the Varangerfjord. Species density ranged from 22 to 46 species/0.1m^2 and averaged 38.2±3.1 species/0.1m^2.

The analysis of distributional pattern of different biodiversity indices (see list of used indices in the table 5.3.4) showed that the benthic population which occured on soft mud in the deep-water part of the fjord is characterized by lower species richness and species diversity compared to the inlets and shallow-water banks of the open fjord.

Biomass and abundance

Benthic biomass at the stations in Varangerfjord varied from 7 to 95 g/m^2 and averaged 36.7±7.6 g/m^2 in the entire area. Abundance ranged from 388 to 5940 ind./m² and was on average estimated calculated to be 2060±496 ind./m^2. Patterns of biomass and abundance distribution are diametrically opposite (Figure 5.3.2).

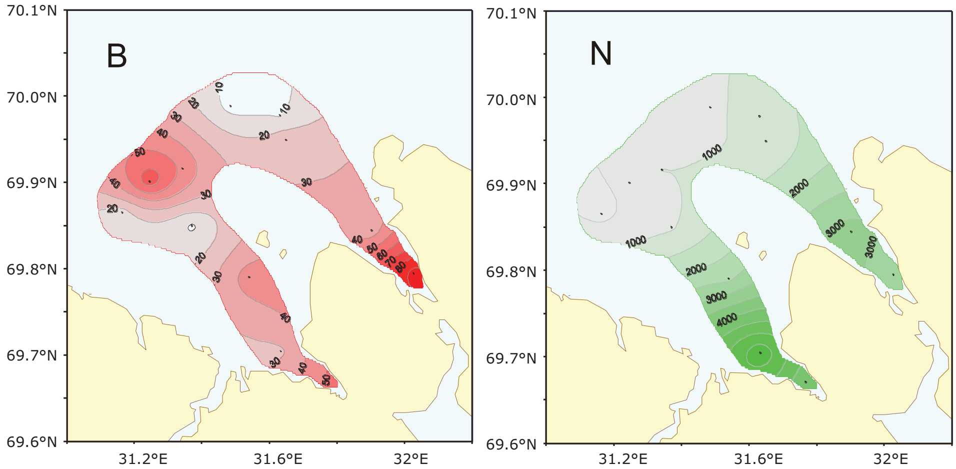


Figure 5.3.2. Distribution of biomass (B, g/m^2) and abundance (N, ind./m^2) of benthic macroinvertebrates in the Russian part of the Varangerfjord.

According to both biomass and abundance polychaetes and molluscs (predominantly bivalves) dominated the benthic communities in the Varangerfjord. In the investigated area polychaetes contributed with 47.0±6.3 % to the total biomass and 51.0±4.0 % to the total abundence, the molluscs contributed with 31.5±6.2% to the total biomass and 31.6±3.7 % to the total abundance.

5.3.1.2 Biogeographical structure of fauna[1]

Boreal-Arctic species are predominant in the Russian part of the Varangerfjord. They are responsible for more than half of the species composition (Figure 5.3-3) with an average of 68.3±6.8% of total biomass and 73.6±3.1% of mean abundance (Figure 5.3.4).

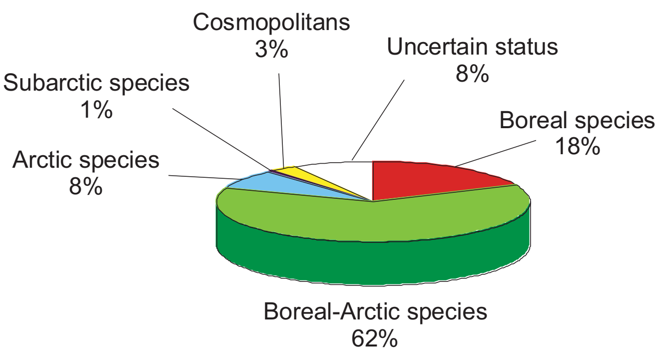


Figure 5.3.3. Percentage compositon of main biogeographical groups for the benthic macroinvertebrate communities in the Varangerfjord

[1] The species were divided into biogeographical groups based on the type of area classification developed and applied in the Institute of Zoology, the Russian Academy of Science (Sirenko *et al.* 2004).

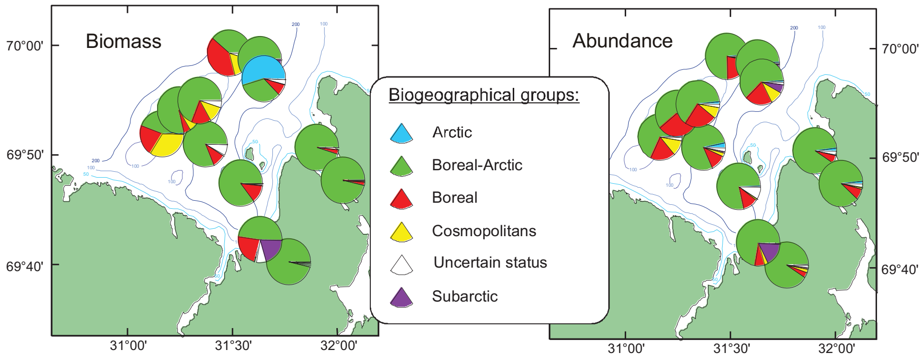


Figure 5.3.4. Percentage compositon of main biogeographical groups for biomass (left) and abundance (right) for macroinvertebrate communities sampled at 12 stations in Varangerfjord.

Boreal species are second in importance. Their comprised 18% of the total species composition, with a mean for stations biomass of 14.4±3.5 % and a mean abundance of 14.3±2.5 %. Arctic species were responsible for about 8% of the species composition, and their quantitative indexes (5.1±4.5 % of biomass and 1.5±0.2 % of abundance) was lower compared to cosmopolitan species.

5.3.1.3 Trophical structure of fauna[2]

The main trophic groups in the investigated area of the Varangerfjord are suspension feeders and surface deposit feeders. Each of the categories is responsible for approximately a third of both the species composition and total biomass (Figure 5.3.5). It should be noted that a great number of carnivores occurs as part of the macroinvertebrate fauna of the Varangerfjord. On average 19% of the species composition and 18% of total biomass of the benthic organisms are comprised of carnivorous species. These values are rather high since it has been estimated that the number of carnivores in the Barents Sea usually does not exceed 10-11 % of the total benthos biomass (Kuznetsov 1970). At some of the deeper stations in the fjord the biomass of carnivorous species reaches 43%. A high abundance of carnivores may indicate adverse environmental conditions caused by mass animal mortality or high concentrations of organic residues on the bottom.

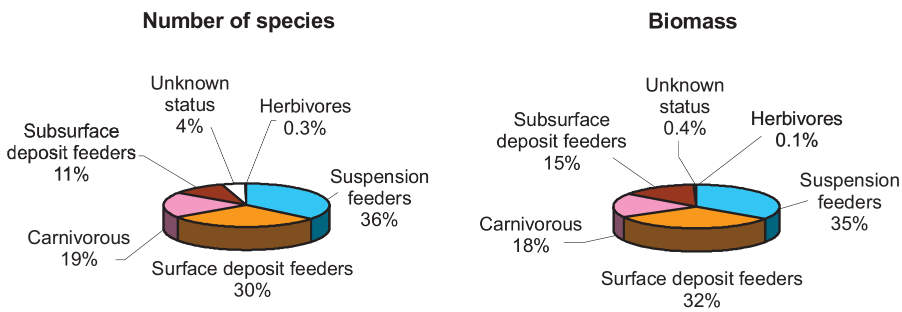


Figure 5.3.5. Percentage distribution of the main trophic groups for total number of species (left) and total biomass (right) in the investigated area of Varangerfjord.

[2] According to their feeding type species were divided into the following trophic groups: suspension feeders (filter feeders and planktivores), surface deposit feeders, subsurface deposit feeders, herbivores, carnivores (predator and scavenger).

Cluster analysis showed that the 12 stations are clearly separated into three clusters with regard to the dominating feeding type (Figure 5.3.6 left). When superimposing such clusters onto a map of the Varangerfjor three distinct zones appear: surface deposit feeders dominating the biomass, subsurface deposit feeders and suspension feeders (Figure 5.3.6 right).

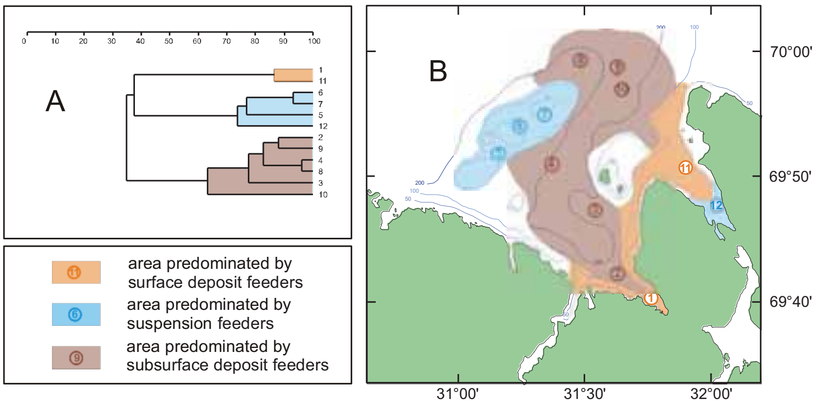


Figure 5.3.6. Results of hierarchical clustering (A) and trophic zones (B) in the Russian part of Varangerfjord according to the results of cluster analysis.

Two areas of with suspension feeders as predominant species were recorded. One is located at the head of the Bolshaya Volokovaya Bay at depths of 40–93 m with the second one being on a shallow-water bank in the fjord's centre. These zone overlap spatially with an area characterized by coarse sediment on coastal and offshore shallows (40-93 m), the presence of which is indicative of an active hydrodynamic regime. Highest values of mean biomass (57.3±15.9 g/m²) and mean size (mass) of individuals (approximately 50 mg) were recorded from this area.

The zone characterized by a surface deposit-feeding community occupies almost the entire Bolshaya Volokovaya Bay and the coastal zone of the deeper Malaya Volokovaya Bay. This zone extends to mean depths (59-81 m) with a silty sand sediment. The surface deposit-feeding community is characterized by a lower mean biomass (42.4±8.1 g/m²), a higher mean abundance (3687±421) and a smaller mean size of macrobenthic individuals (about 15 mg) than that of the suspension-feeding community.

The community being dominated by subsurface deposit feeders occupies the most expansive area in the deeper parts of the Varangerfjord (145–260 m), an area characterized by soft muddy sediment. Relatively low values of mean biomass (21.1±6.4 g/m²) and a much smaller mean size of individuals (10 mg) were recorded for this trophic area. This community differs also from the other two by a high percentage of carnivorous species, which on average contributed 23% of the biomass.

5.3.1.4 Predominant ecological groups (life forms) [3].

Another suitable integrating indicator of the main environmental conditions in the investigated area is the distribution of the main life forms (ecological groups). Comparing the

[3] Taxons are divided into three main life form (ecological groups): infauna –animals residing in sediment; onfauna – motile organisms on sediment surface and in the bottom-near water layer; epifauna –animals adherent to hard substrates and other organisms.

three main ecological groups being part of the benthos (in-, epi- and onfauna) for the western Varangerfjord shows that they are relatively equal with regards to number of species, but that the infauna predominates abundance and biomass (Figure 5.3.7).

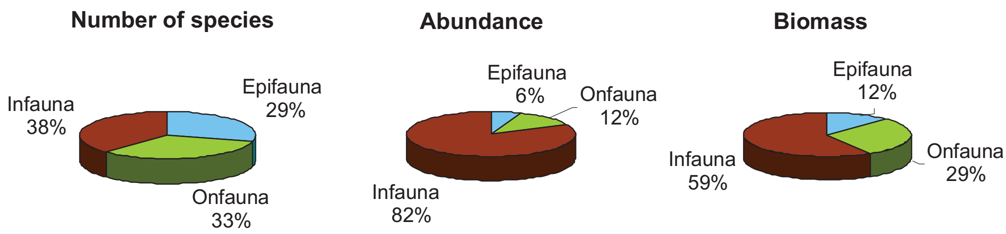


Figure 5.3.7. Percentage distribution of the three main ecological macrozoobenthic groups in the investigated area of Varangerfjord.

At the majority of stations in the Varangerfjord infaunal species contributed most to total biomass (Figure 5.3-8) followed by onfauna species being responsible for approximately a third of the total benthic biomass (Figure 5.3.7, 5.3.8). Epifaunal species dominated only on coarse sediments of the shallow-water bank in the open Varangerfjord. Here the biomass of this ecological group reached 20–21 g/m². At other stations, in general, it did not exceed 1 g/m² (Figure 5.3.8).

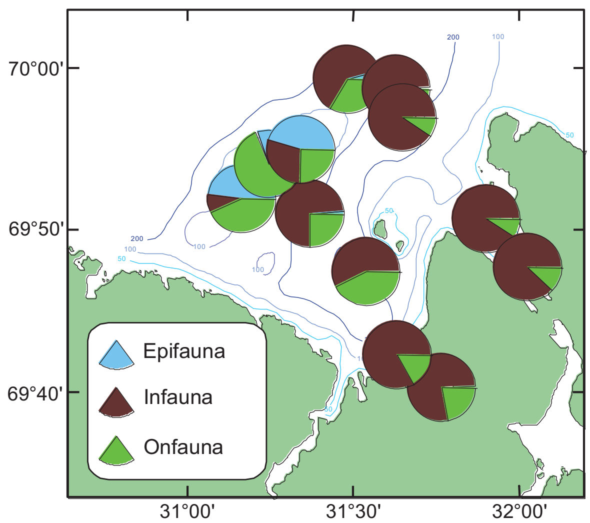


Figure 5.3.8. Percentage distribution of the biomass of three main ecological groups on 12 stations in Varangerfjord.

5.3.1.5 Distribution of benthic communities

Applying cluster analysis[4] three benthic communities were identified in the Russian part of Varangerfjord. Their distributional pattern and main characteristics are shown in Figure 5.3.9 and Table 5.3.1.

[4] For identification of the benthic communities the hierarchical agglomerative clustering (Clarke & Warwick 1994), using group–mid-weighted average lincking of Szekanowski similarity (Czeckanovski 1909) calculated on biomass and both biomas and abundance transformed data (Lyubin & Anisimova 2001) was used.

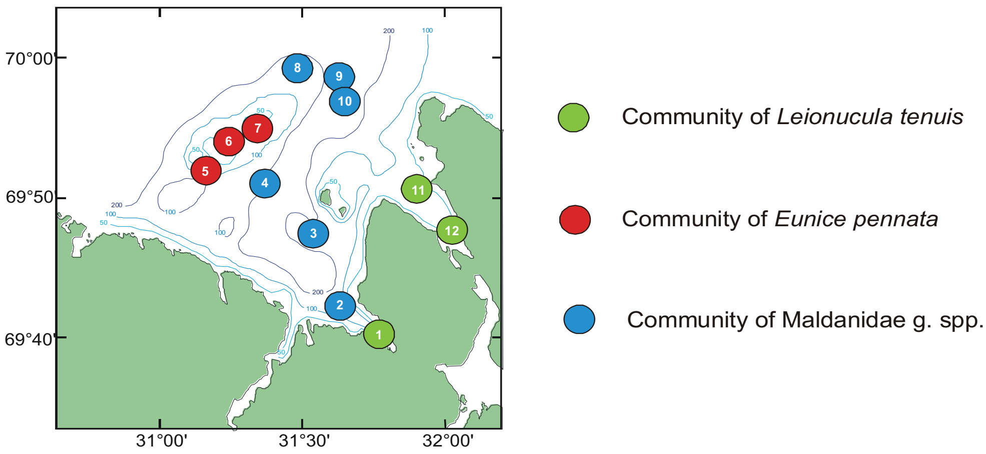


Figure 5.3.9. Distribution of benthic communities in the Russian part of Varangerfjord.

Table 5.3.1. Description of the benthic communities identified for Varangerfjord.

Descriptor	***Leionucula tenuis* community**	***Eunice pennata* community**	**Maldanidae g. spp. community**
Distribution	Inner parts of Bolshaya Volokovaya and Malaya Volokovaya Inlets	Shallow bank in open part	Deep area of open part
Stations	1, 11, 12	5, 6, 7	2, 3, 4, 8, 9, 10
Mean depth, m	62±10,2	71±15,8	213±16,1
Predominant type of sediment	Silty sand with shell fragments	Pebble, gravel, stones, coarse sand	Sandy silt, clay
Species dominating biomass	*Astarta crenata,* ***Leionucula tenuis*** *Astarta elliptica*	*Chlamys islandicus,* ***Eunice pennata*** *,*	*Molpadia borealis, Nephtis paradoxa, Ctenodiscus crispatus*
Species dominanting abundance	*Galathowenia aculata,* ***Leionucula tenuis***	*Verruca stroemia, Ophiura robusta,* ***Eunice pennata***	*Galathowenia aculata, Mendicula ferruginosa,* ***Maldane arctica***
Species dominating production	***Leionucula tenuis*** *Macoma calcarea*	*Chlamys islandicus,* ***Eunice pennata***	***Maldane, arctica*** *Asychis biceps* ***Maldane sarsi*** *Galathowenia aculata*
Mean biomass, g/m^2	59.79±18.01	44.89±14.15	21.02±6.39
Mean abundance, ind./m^2	3333±430	695±181	2106±804
Number of taxa/0,1 m^2	46.2±0.9	31.6±6.7	37.4±4.7
Number of taxa per station	86.3±2.0	85.3±16.0	74.2±7.11
Total number of taxa	150	175	210
Shannon-Wiener diversity index	3.50±0.28 (B)* 4.33±0.15 (N)**	3.59±0.37 (B) 5.52±0.13 (N)	3.08± 0.32 (B) 4.67±0.13 (N)

(B)* – index is calculated using biomass; (N)** – index is calculated using abundance.
Main qantitative parameters are given in the table ± standard error.

5.3.1.6 General estimation of the ecological state of the benthos [5]

When plotting the valus of the ecological Index of Well-being *(D_E)* it is apparent that species with a K-life strategy prevailed in the greater part of the open Varangerfjord. It indicates the ecological well-being of bottom communities (Figure 5.3.10).

Within the investigated part of Varangerfjord values of the index variy from –0,391 to +0,065 with a mean value for the whole area of –0,240±0,043. The maximum value, was recorded near the Malaya Volokovaya Bay, at the station located close to the mouth of the Pechenga Bay. The positive value at this station indicates the dominance of the r-strategists in the benthic community, in general a sign of areas exposed to high levels of disturbance (e.g., physical disturbance, pollution).

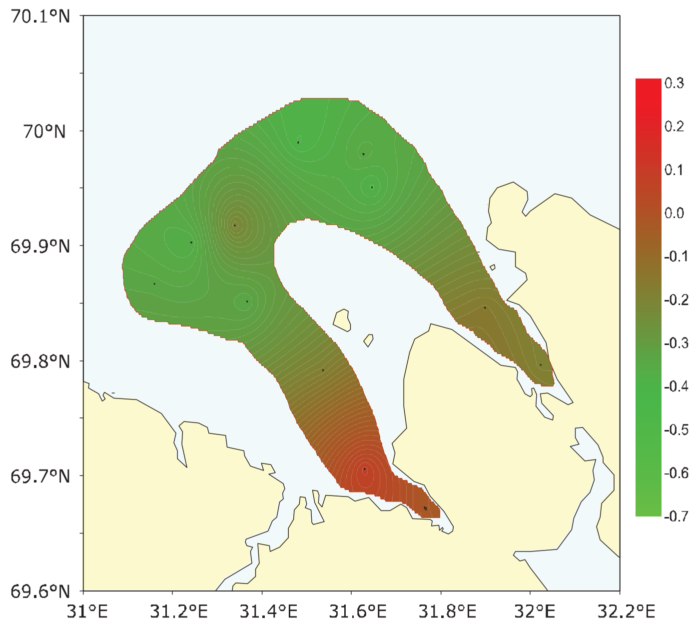


Figure 5.3.10. Distribution of the benthic index of ecological well-being (D_E) in the Russian part of the Varangerfjord.

The slight increasing of values of D_E was recorded in the shoal of the Bolshaya Volokovaya Bay and in the shallow-water bank in the open fjord. It may be coused by natural factors. It has to be noted that the index D_E does not differentiate between communities being exposed to natural (e.g., sediment relocation due to storms, constant or periodical decrease in salinity

---

[5] The index of dominant life strategy or Index of ecological well-being (D_E) was used for estimation of ecological state of benthos (Denisenko 2006):

$$D_E = (H'_B - H'_A)/\log_2 N$$

where H'_B – Shannon-Wiener diversity index calculated with biomass; H'_A – Shannon-Wiener diversity index calculated with abundence; N – number of the species/taxa.

This index is based on "Shannon information measuring" and reflects the ratio in the communities of species with K- and r-life strategy. The index ranges from -1 (hypothetical state of a community under no stress being totally dominated by organisms with K-life strategy) to +1 (a maximum possible level of stress resulting in total dominance of species with r-life strategy). The value of the index increases with increasing levels of stress and deterioration. An index value close to zero indicates an intermediate ecological state between a community under stress and an unstressed community.

due to fresh water run-off, predator-induced disturbance in the feeding ground in their steady places of fattening) or anthropogenic disturbances.

5.3.2 The Motovsky Bay

5.3.2.1 Biodiversity

There were identified 451 taxa (361 of which have been identified to species level) of benthic invertebrates beonging to 153 families, 74 orders and 25 classes of 14 types in the samples collected in the Motovsky Bay (Appendix II Table 2).

The majority of species (>80%) in the Motovsky Bay belonged to annelids (mainly polychaetes), crustaceans and molluscs (Figure 5.3.11).

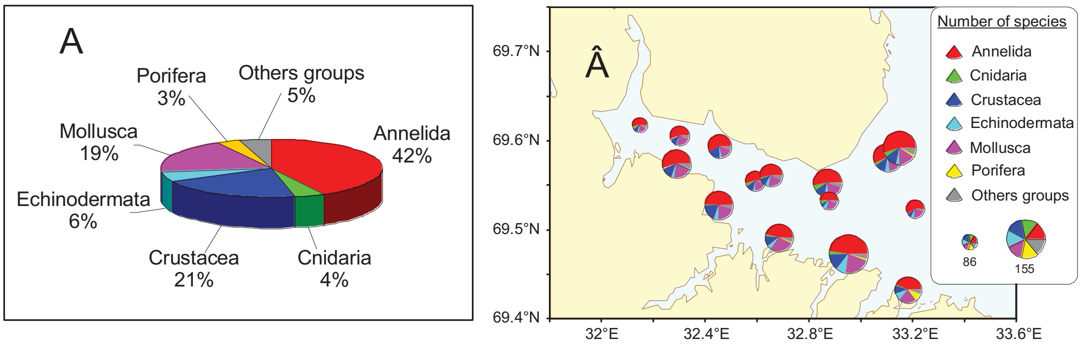


Figure 5.3.11. Percentage distribution of main taxonomical groups (based on number of species) in Motovsky Bay. Total (A) and for each of 15 stations (B).

Species density within the Motovsky Bay varied from 25 to 95 species per sample and averaged 55.4±1.8 species/0.1 m² in the investigated area.

Analysis of several biodiversity indices (see list of used indices in the table 5.3.4) showed that the benthos in the northern deep-water part of the Motovsky Bay is characterized by lower levels of species richness and diversity compared to the shallow-water part in the South of the bay.

5.3.2.2 Biomass and abundance

Benthos biomass in the Motovsky Bay varied from 24 to 207 g/m² with a mean value of 74.7±12.7 g/m². Abundance ranged from 1438 to 23609 ind./m² and averaged 6872±1355 ind./m². Abundance and biomass distribution is quite similar in the northern part of the Motovsky Bay but are pronouncedly differ in southern shallow-water part. In contrast to abundance, high biomass values were recorded in the mouth of the bay in its southern part (Figure 5.3.12).

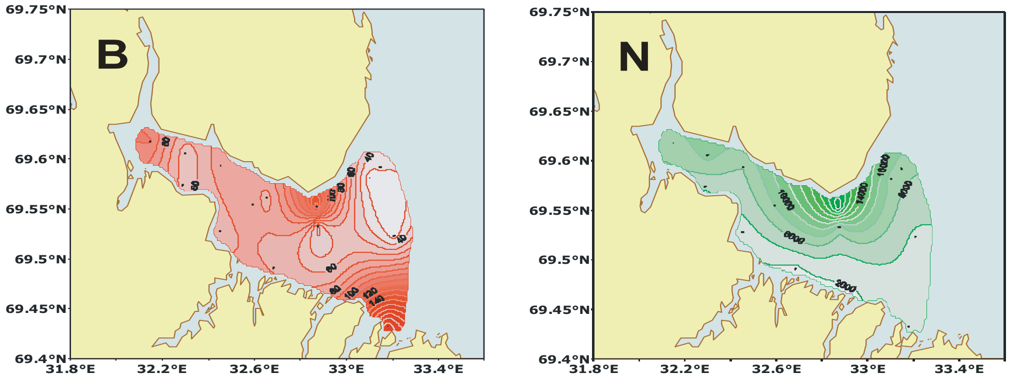


Figure 5.3.12. Distribution of benthic biomass (B, g/m²) and abundance (N, ind./m²) in Motovsky Bay.

The benthic fauna in the investigated area consisted mainly of polychaetes (56±8 % of total biomass), molluscs (19±5 % of total biomass) and crustaceans (12±5 % of total biomass).The biomass in the southern shallow-water part of the bay is dominated by crustaceans and molluscs, whereas polychaetes predominate in soft sediments in the the central and northern parts of the bay. Polychaetes and molluscs are the most abundant groups in most of the investigated area of the Motovsky Bay with on average 64±5 % and 26±3 %, respectively, of total macrozoobenthos abundance.

5.3.2.3 Biogeographical structure of fauna

Boreal-Arctic species are prevalent in the fauna of the Motovsky Bay. They make up more than half of the species composition (Figure5.3.13). With regard to biomass boreal-Arctic species contribute 75±2 % to the total macrozoobenthic biomass, with regard to abundance they contribute 65±2 % (Figure 5.3.14).

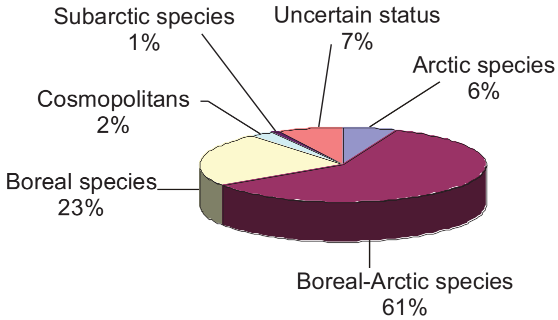


Figure 5.3.13. Percentage distribution of the number of species of the main biogeographical groups for macrozoobenthic fauna of Motovsky Bay.

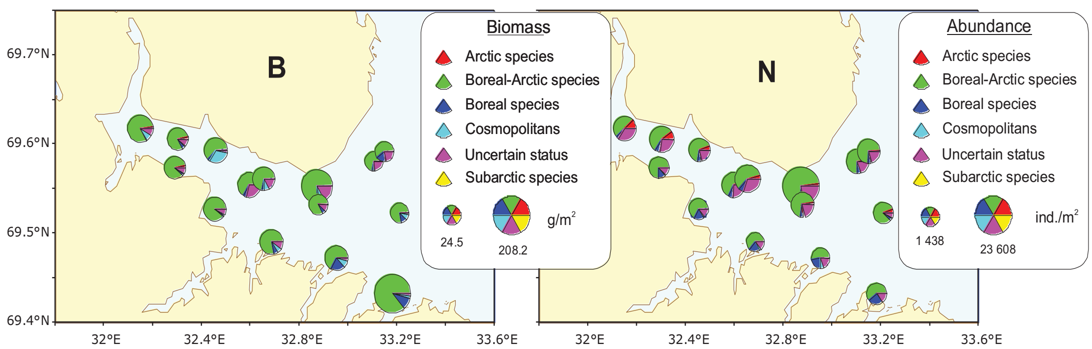


Figure 5.3.14. Biomass (B) and abundance (N) percentage distribution of main biogeographical groups at 15 stations in Motovsky Bay.

The second most import biogeographical group in Motosky Bay is the boral species both in terms of species richness and quantitative characteristics. Number of boreal species in the total species composition comprises 23 %. Their mean biomass averaged 6±1 % and mean abundance was 10±2 %. Arctic species comprised only 6% of species composition, 1.3±0.3 % of mean biomass and 4±1 % of mean abundance.

5.3.2.4 Trophic structure of fauna

In the entire Motovsky Bay suspension feeders, surface deposit feeders and subsurface deposit feeders were the main trophic groups as well with regard to species composition as total biomass (Figure5.3.15).

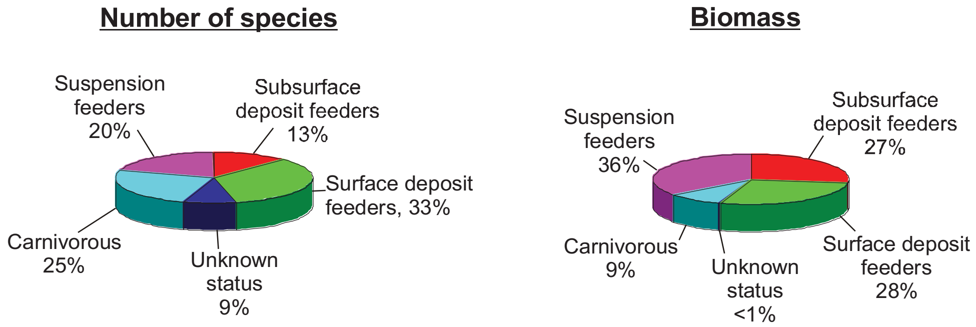


Figure 5.3.15. Percentage of the main trophic groups of macrozoobenthos in Motovsky Bay with regard to species richness (left) and biomass (right).

Suspension feeders dominated in the coastal zone of the southern shallow part of the bay. Detritus feeders (subsurface deposit feeders and surface deposit feeders) prevailed in the central and northern deeper parts (Figure 5.3.16).

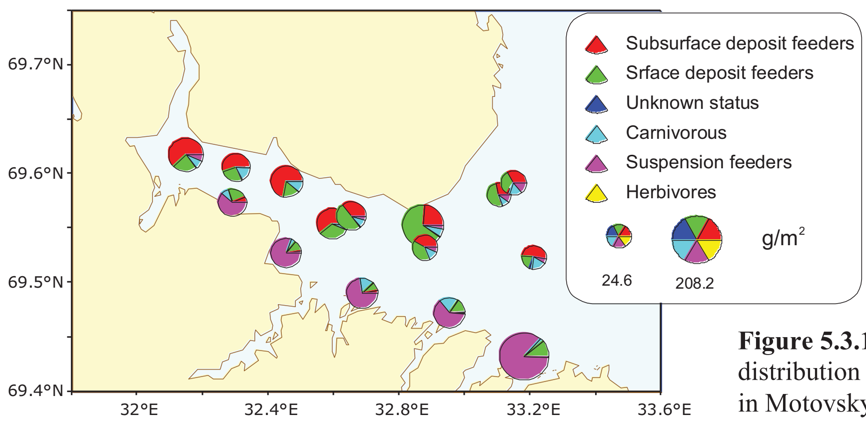


Figure 5.3.16. Biomass percentage distribution of trophic groups at 15 stations in Motovsky Bay.

5.3.2.5 Predominant ecological groups (life forms)

On the whole, infauna dominates the benthic biomass in the Motovsky Bay (Figure 5.3.17 A). Exceptions occur in the southern shallow part with hard substrates where fixed (epifauna) and free-living (onfauna) organisms prevailed (Figure 5.3.17 B).

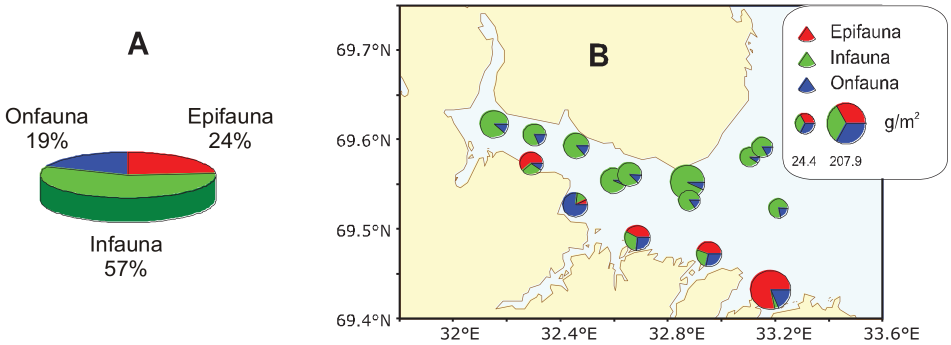


Figure 5.3.17. Percentage distribution of main ecological groups of invertebrates in Motovsky Bay (based on biomass) for total (A) and for each of 15 stations (B).

5.3.2.6 Distribution of benthic communities

Cluster analysis using biomass, abundance and production data identified two communities within the Motovsky Bay. The first one occurred on soft sediment in the deep-water part of the bay, wheras thesecond occurred on hard bottom and coarse sediment in the southern coastal shallow-water part of the bay (Figure 5.3.18). The main descriptos of the identified communities are given in Table 5.3.2.

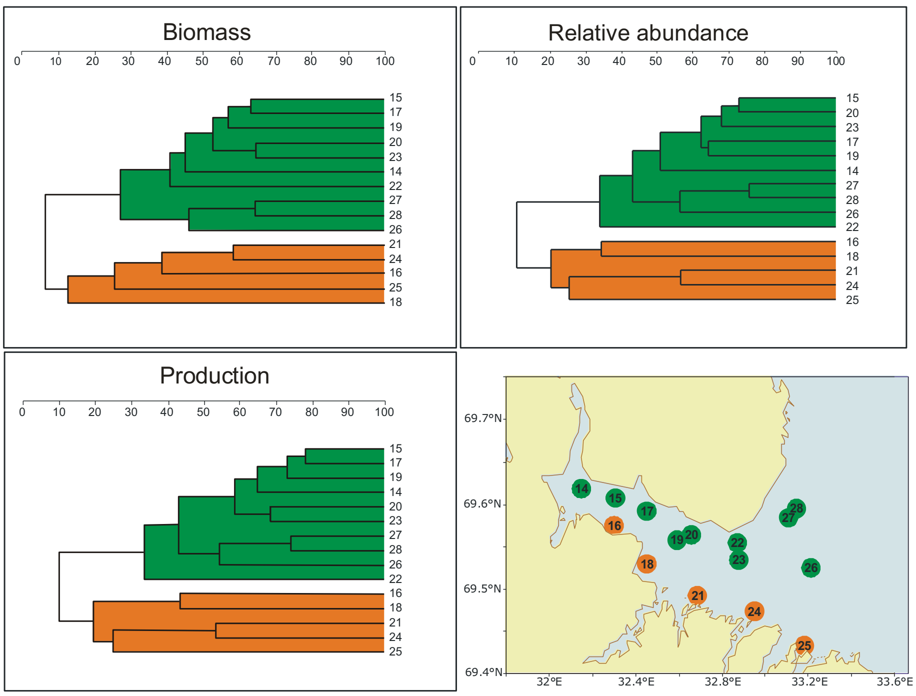


Figure 5.3.18. Distribution of macrozoobenthic communities identified in Motovsky Bay according to cluster analysis.

Table 5.3.2. Description of the benthic communities identified in Motovsky Bay.

Descriptor of communities	***Maldane sarsi*** **community**	***Balanus balanus*+ *Verruca stroemia*+ *Astarta crenata*** **community**
Area of distribution	Deep part of the bay	South shallow part of the bay
Stations	14, 15, 17, 19, 20, 22, 23, 26, 27, 28	16, 18, 21, 24, 25
Mean depth, m	222±8	58±5
Predominant type of sediment	Sandy silt, clay	Gravel, stones, sand, clay
Species predominant in biomass	***Maldane sarsi****, Galathowenia aculata, Golfingia margaritacea margaritacea*	***Balanus balanus****, Chlamys islandica,****Astarta crenata***
Species dominating abundance	***Maldane sarsi****, Galathowenia aculata, Myriochele heeri*	*Galathowenia culata,****Verruca stroemia****,Leionucula tenuis*
Species dominanting production	***Maldane sarsi****, Galathowenia aculata, Myriochele heeri*	***Balanus balanus, Verruca stroemia, Astarta crenata***
Mean biomass, g/m^2	65.1±12.9	97.8±27.7
Mean abundance, ind./m^2	9010±1720	3010±521
Total number of taxa	287	325
Number of taxa per station	109±5	130±6
Number of taxa/0,1 m^2	54±3	57±2
Shannon-Wiener diversity index	4.07±0.11 (N)* 2.93±0.07 (B)**	5.45±0.23 (N) 2.91±0.30 (B)

(N)* – index calculated using abundance. (B)** – index calculated using biomass; main qantitative parameters are given in the table with standard error

5.3.2.7 General estimation of ecological state of benthos

Unlike in Varangerfjord the index of ecological well-being (D_E) has a negative value in the entire investigated area of the Motovsky Bay indicating an absence of pronounced disturbance. The index varies in the bay from –0.058 to –0.473 with a mean value of –0.233±0.030.

At the head (innermost part) of the Motovsky Bay and its northern deep-water part near Gorodetsky and Monastyrsky Capes (Figure 5.3.19) D_E values were slightly higher, i.e., the community was exposed to some stress resulting in a change towards a predominance of r-strategists (small and abundant organisms with a short life cycle and high fecundity). The deteriorated ecological state in the innermost part of the bay may be a result of pollution by industrial and residential run-off in Titovka Inlet. Stations in the northern part of the bay with index values close to zero are within an area of enhanced fishing activity. So, negative changes of benthic communities in this area can be caused by this factor.

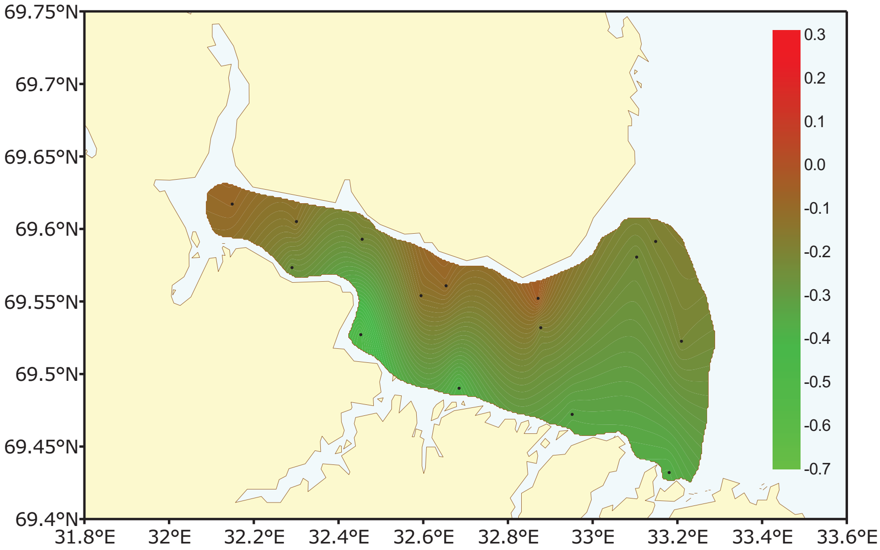


Figure 5.3.19. Distribution of the benthic index of ecological well-being (D_E) in Motovsky Bay.

5.3.3 Open waters of the southern Barents Sea

5.3.3.1 Biodiversity

There were identified 1084 taxa of benthic invertebrates (855 of which have been identified to species level) belonging to 247 families, 94 orders, 29 classes in 16 taxonomical groups from samples collected at 68 stations in the open waters of the central southern Barents Sea (Appendix II Table 2).

Polychaeta, crustaceans and molluscs represented the majority of taxa (Figure 5.3.20). This was the general pattern in the study area with some expections occurring at some coastal and shallow-water stations where bryozoans dominated species richness (Figure 5.3.21).

The number of species per station varied from 52 to 216 with a mean value of 132±4 species/station. Species density was estimated to be 26.5-114.3 species/0.1 m² with a mean value of 63.3±2.4 species/m². High numbers of species density is characteristic of shallow water sites on the Murman Shallow and the Murman Bank. The lowest number of species was recorded in the area of the Eastern Basin.

When analyzing various biodiversity indices it became apparent that species richness and diversity decreased pronouncedly with depth.

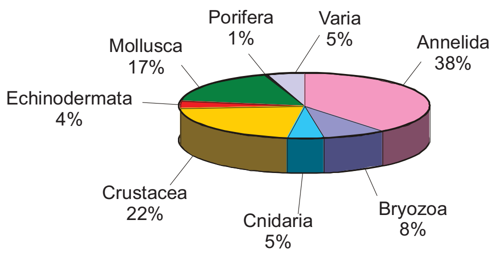


Figure 5.3.20. Distribution of species richness by the main taxonomic groups in the southern Barents Sea.

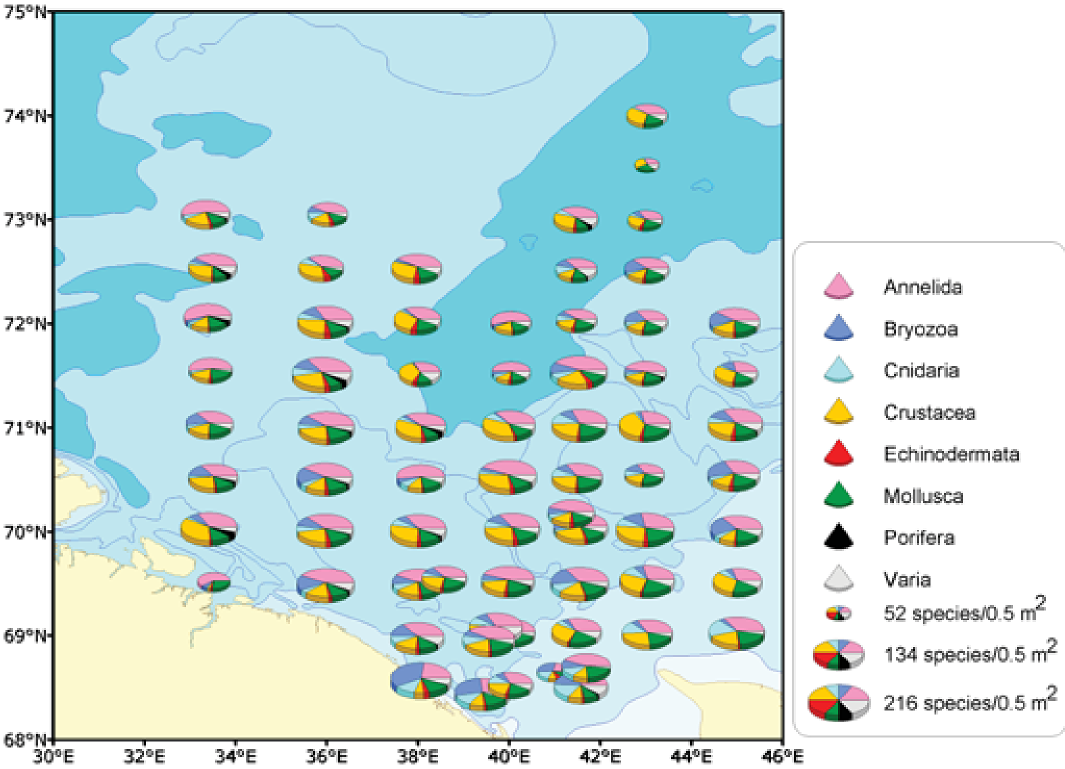


Figure 5.3.21. Percentage distribution of species richness for main taxonomic groups for 68 stations in the southern Barents Sea.

5.3.3.2 Biomass and abundance

Biomass of bottom invertebrates in the southern Barents Sea varied from 11.6 to 998.4 g/m² and averaged 95.2±15.5 g/m². Abundance varied from 922 to 10232 ind./m² and averaged 3940±228 ind./m². Both biomass and abundance have a general trend to decrease with increase in depth (Figure 5.3.22).

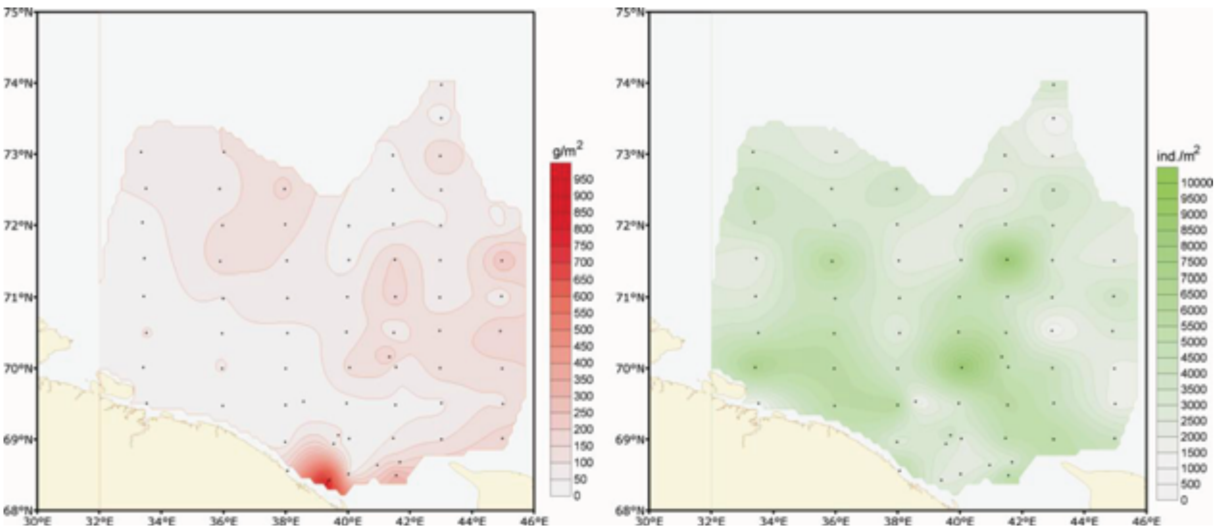


Figure 5.3.22. Distribution of biomass (left) and abundance (right) of macrozoobenthos in the central southern part of the Barents Sea.

The benthic biomass in the entire investigated area was dominated by molluscs, polychaetes and echinoderms with 39%, 26% and 16% of total biomass, respectively. Polychaetes were the most abundant group with 53% of total benthic abundance followed by molluscs (24%) and crustaceans (9%).

In the eastern part of the investigated area mollucks dominated total benthic biomass (90% and more at some stations) whereas echinoderms predominated in the northern area. Polychaetes were the most abundant group in total benthic abundance in almost the entire investigated area.

5.3.3.3 Biogeographical structure of fauna

An analysis of the biogeographical structure of the benthic fauna showed that Boreal-Arctic species almost completely dominate in the southern Barents Sea (Figure 5.3.23). They comprise 74% of species composition, 79% of biomass and 89% of the total number of benthic organisms. Boral species still contribute between 6 and 13% of number of species, biomass and abundance and Arctic species are represented even less. This ratio is observed in almost the entire investigated area, except at some northern and north-eastern stations where Arctic species predominate over Boreal species.

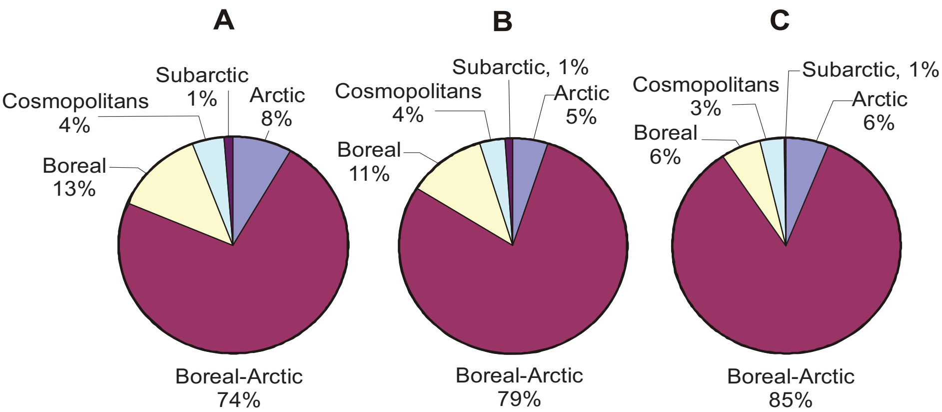


Figure 5.3.23. Percentage composition of the main biogeographical groups in the macrobenthic fauna of the southern Barents Sea: A –number of species, B –biomass, C –abundance.

5.3.3.4 Trophic structure of fauna

An analysis of the trophic structure of the fauna showed that most of the species occurring in the area were surface deposit feeders. This group also dominated in abundance in the investigated area (Figure 5.3.24 A, B). With regard to biomass suspension feeders were the dominating comprising almost half of the total benthos biomass in the area (Figure 5.3.24 C).

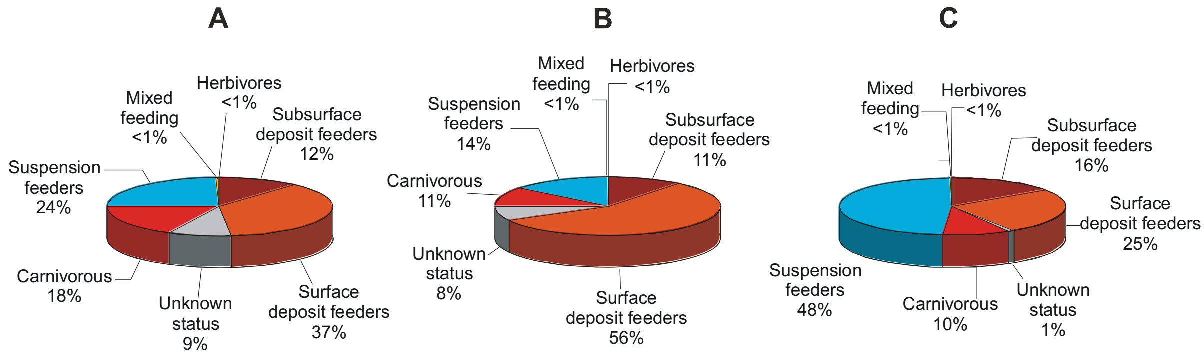


Figure 5.3.24. Percentage distribution of the main trophic groups in the southern Barents Sea in number of species (A), abundance (B) and biomass (C).

The benthos of the shallow water areas in the south-eastern part of the investigated area were dominated by suspension feeders. Surface deposit feeders were more prevalent at the stations in the central and north-western part of the area. Subsurface deposit feeders dominated in biomass at deep-water stations near the Eastern Basin and at some stations in the central part of the sea (Figure 5.3.25).

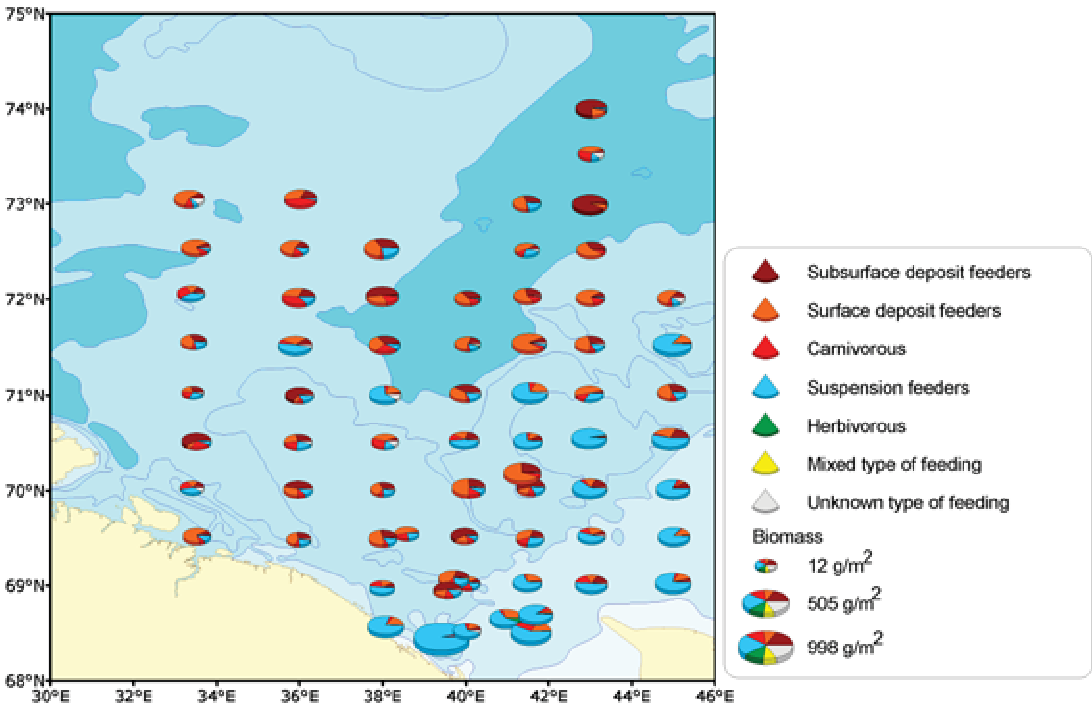


Figure 5.3.25. Biomass distribution of the main trophic groups at 68 stations in the southern Barents Sea.

The percentage of carnivorous species in the open sea does not exceed 10% of the total benthos biomass which corresponds in general to mean indices for stable non-disturbed marine communities (Kuznetsov, 1980).

5.3.3.5 Predominant ecological groups (life forms)

Overall, infaunal taxa dominated the benthic communities in the southern part of the Barents Sea with respect to species richness, biomass and abundance. Mobile free-living organisms (onfauna) ranked second. Epifauna did not exceed 17% of species composition and 10–15 % of biomass and abundance (Figure 5.3.26).

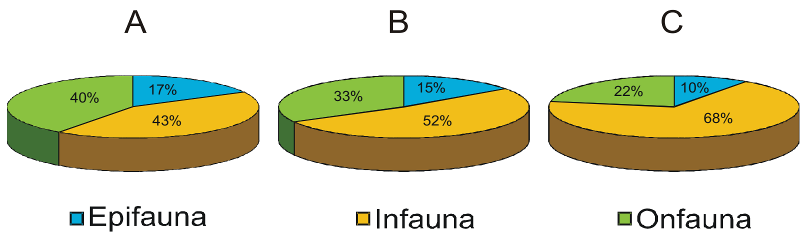


Figure 5.3.26. Distribution (%)of the main ecological groups in the southern part of the Barents Sea with regard to species richness (A), biomass (B), and abundance (C).

The distribution of the main ecological groups as described above is relatively uniform over almost the whole investigated area, except some stations in the south-eastern part of the area where epifaunal and mobile (onfaunal) organisms predominate in biomass (Figure 5.3.27).

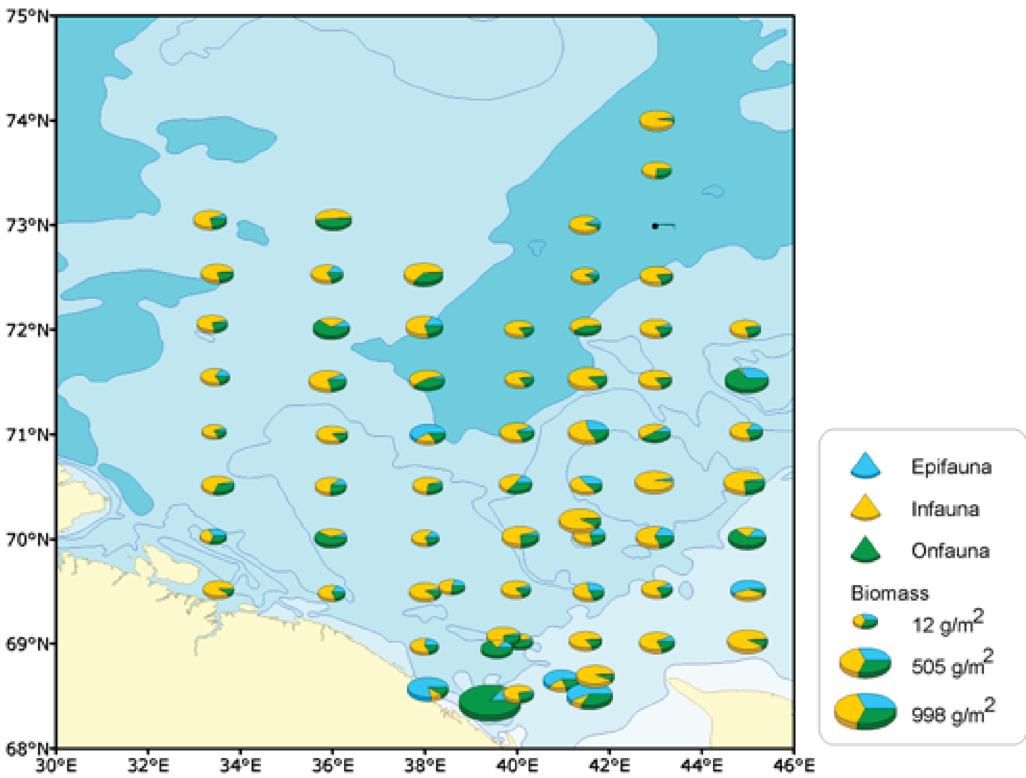


Figure 5.3.27. Biomass distribution (%) of 3 ecological groups of benthic invertebrates at 68 stations in the southern part of the Barents Sea.

5.3.3.6 Distribution of benthic communities

Analyses based on the material collected in 2003 identified eleven benthic communities (or groups of communities) in the central part of the southern Barents Sea. Such communities differed in species composition, dominant species, quantitative parameters and biotopes. The distribution of the identified communities is shown in Figure 5.3-28, and their characteristics are given in Table 5.3.3.

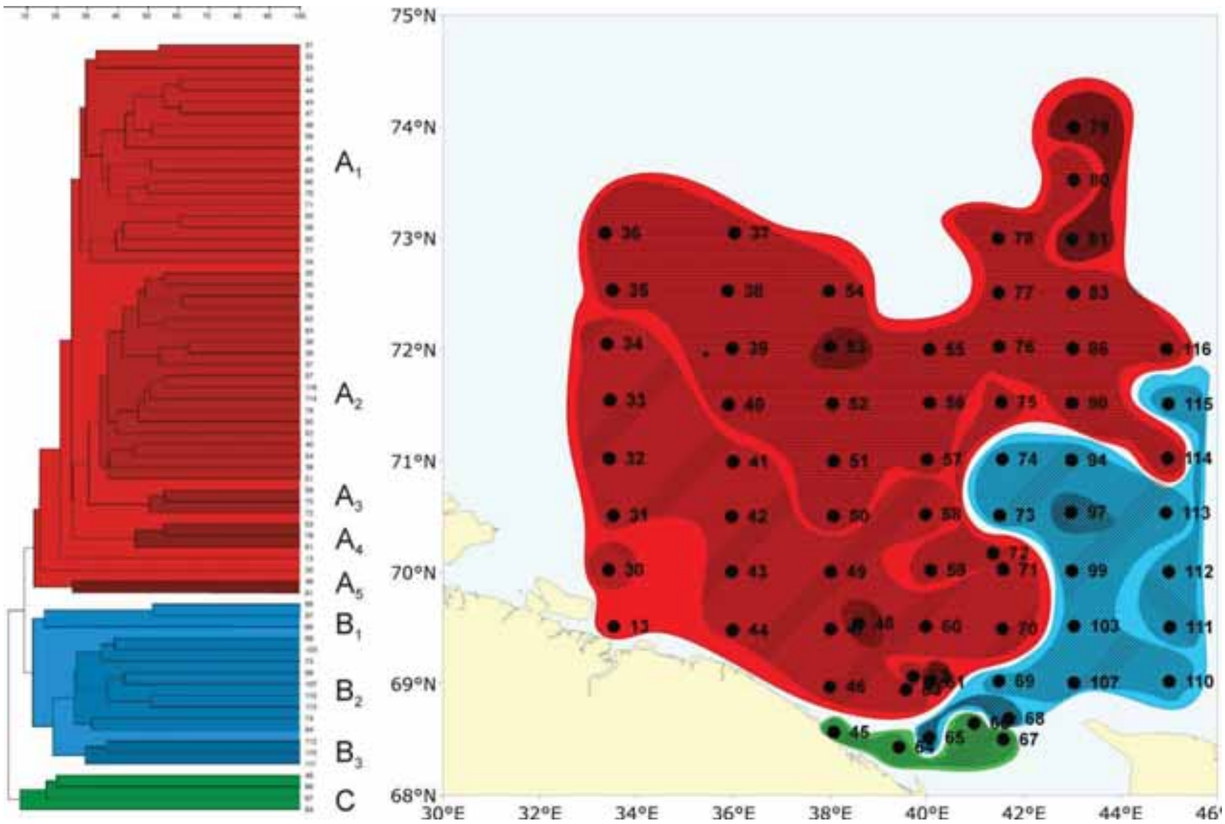


Figure 5.3.28. Cluster based on relative biomass and abundance data from the southern Barents Sea (left) and distribution of the main benthic communities as identified by cluster analysis (right). For a description of the communities see text.

Most of the investigated area – it's central, northern and western parts with the depths being closely to 200 m – is occupied by a complex of communities dominated by the polychaete *Spiochaetopterus typicus* (Figure 5.3.28 and Table 5.3.3 Part I). A community described in the station 13 in the western part of the investigated area was similar to this community complex with the dominant species, *S. typicus* being the same. However, differences in other community descriptors (low species richness, biomass, and abundance value) exclude this station from the A cluster.

At the deep-water stations of this area (>300 m), a deep-water variety of the *S. typicus* community is located. This deep-water community is characterized by abundance of the big subsurface detritus feeding holothurians *Molpadia borealis* (Table 5.3.3 Part I).

The sandy bottom of the Murman Rise harbors a special community dominated by the small bivalve *Dacridium vitreum*, the polychaete *Nothria hyperborean* and the gastropod *Scaphander punctostriatus* (Table 5.3.3 Part I).

In the eastern part of the investigated area communities can be found which are dominated by various species of bivalves such as *Serripes groenlandicus, Clinocardium ciliatum*, *Chlamys islandica*, *Astarte crenata* and *Crenella decussata* (see Figure 5.3.28 and Table 5.3.3 Part II). Such communities generally develop on sandy sediment with shell fragments and siltation in varying degree.

In the south-western part of the investigated area at station 30 a rather unusual community occurs. The sediment at this station contains high concentrations of sponge spicules, predominantly of the genus *Geodia*. Species of this genus form dense populations in the area. This peculiar community occurred nowhere else within the investigated area. The polychaetes *Chone murmanica* and *Abyssoninoe hibernica,* the sponge *Thenea muricata* and brittle star *Ophiocten sericeum* are dominant species of this community which shows high biodiversity.

5.3.3.7 General estimation of ecological state of benthos

Both the diapason and the mean of index of ecological well-being *(D_E)* are lower in the open waters of the southern part of the Barents Sea than in the closed areas of Varangerfjord and the Motovsky Bay. This indicates more low level of stress impacts on the benthic fauna of the southern Barents Sea and a higher level of its ecological well-being (mean D_E varies from –0.124 to –0.650 and averages –0.336±0.014).

Not much variation in D_E is apparent within the investigated area (Figure 5.3.29). Maximal values of index in the open southern Barents Sea are much low that in the Motovsky Bay and especially in Varangerfjord. On the whole, the index indicates a rather stable ecological state of benthos in this area of the Barents Sea.

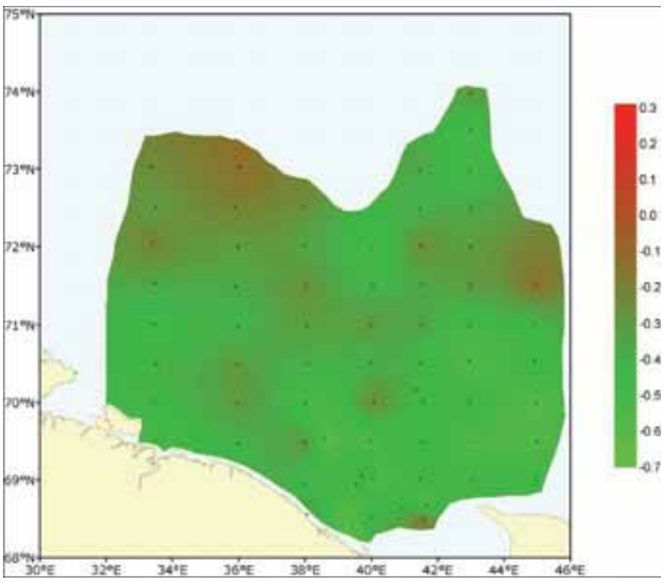


Figure 5.3.29. Distribution of the benthic index of ecological well-being (D_E) in the open waters of the southern part of the Barents Sea.

Table 5.3.3. Main descriptors for benthic communities identified in the southern Barents Sea.

Part I

Cluster	A1	A2	A3	A4	A5
Communities		***Spiochaetopterus typicus***		***Molpadia borealis***	***Dacrydium vitreum***
Area of distribution	Southern part of the study area	Nothern part of the study area	Central part of the study area	Deep waters of the Eastern Basin	Murman Rise
Stations	31, 32, 33, 34, 41, 42, 44, 43, 46, 47, 49, 55, 56, 58, 60, 63, 70, 71, 77, 80,	35, 36, 37, 38, 39, 40, 50, 51, 52, 54, 57, 62, 76, 78, 83, 86, 90, 116, 114	59, 72, 75	53, 79, 81	48, 61
Mean depth, m	217±18	251±10	208±48	321±21	121±19
Predominant type of sediment	Silty sand, clay	Silty sand, clay	Silty sand, clay	Sandy silt	Sand
Species dominating biomass	*Ctenodiscus crispatus* ***S. typicus*** *Brisaster fragilis*	***S. typicus***	***S. typicus***	***M. borealis***	*Scaphander punctostriatus*
Species dominating abundance	*Mendicula ferruginosa* *Galathowenia oculata* *Maldane sarsi* *Heteromastus filiformis*	***S. typicus*** *M. ferruginosa* *G.oculata*	*G. oculata* ***S. typicus*** *M. ferruginosa*	*G. oculata* *M. ferruginosa*	***D. vitreum*** *Ophiura robusta* *Philomedes globosus*
Species dominating production	***S. typicus****, G. oculata,* *Maldane sarsi,* *C. crispatus*	***S. typicus***	***S. typicus***	***M. borealis*** *S. typicus*	***D. vitreum*** *Nothria hyperborea*
Mean biomass, g/m^2	35.15±3.48	73.42±8.18	164.74±34.37	121.47±25.64	14.35±1.74
Mean abundance, ind./m^2	4030±378	3670±267	8638±1716	2796±629	1638±1012
Number of taxa/0.1 m^2	66.3±4.4	58.9±4.0	79.1±13.1	46.1±8.2	50.0±11.4
Number of taxa per station	139±9	124±8	155±25	89±17	109±9
Total number of taxa	602	564	291	162	169
Shannon-Wiener diversity index	4.19±0.17 (B) 5.09±0.14 (N)	3.44±0.13 (B) 4.48±0.17 (N)	2.72±0.66 (B) 4.68±0.02 (N)	2.15±0.80 (B) 4.37±0.58 (N)	4.18±0.24 (B) 5.47±0.42 (N)

Table 5.3.3. Cont.

Part II

Cluster	B1	B2	B3	C	St 30	St. 13
Communities	***Serripes groenlandicus*** + ***Astarte crenata***	***Clinocardium ciliatum***	***Balanus crenatus*** + ***Opiura robusta***	***Chlamys islandica***	***Chone murmanica***	
Area of distribution	South-eastern shoals	South-eastern shoals	South-eastern shoals	South part of the area		
Stations	65, 68, 97	69, 73, 74, 94, 99, 103, 107, 110, 113,	112, 115, 111	45, 64, 66, 67	30	13
Mean depth, m	83±18	87±16	80±11	63±6	143	265
Predominant type of sediment	Sand, shells	Sand, shells, stones	Silty sand, pebble, shells	Silty sand, stones, shells	Spiculite (spicules of sponges)	Sandy silt, clay
Species dominating biomass	***S. groenlandicus*** *C. ciliatum*	***C. ciliatum***	*C. islandica*	***C. islandica***	***Ch. murmanica*** *Thenea muricata* *Ophiocten sericeum* *Abyssoninoe hibernica*	*Spiochaetopterus typicus*
Species dominating abundance	***A. crenata*** *Crenella decussata*	*Galathowenia oculata*	***O. robusta***	*Securiflustra secu-rifrons, O. robusta*	***Ch. murmanica***	*Maldane sarsi*
Species dominating production	***S. groenlandicus*** ***A. crenata***	***C. ciliatum***	***B. crenatus*** ***O. robusta***	***C. islandica***	***Ch. murmanica***	*S. typicus*
Mean biomass, g/m^2	107.83±42.51	111.72±47.44	161.03±63.35	405.73±285.79	15.09	39.54
Mean abundance, ind./m^2	2227±775	4685±796	2095±111	4035±1266	7751	962
Number of tax /0.1 m^2	46.5±6.4	75.2±3.1	51.5±11.9	71.3±16.7	94.1	31.6
Number of taxa per station	102±16	155±7	123±19	150±38	180	60
Total number of taxa	209	489	258	388	180	962
Shannon-Wiener diversity index	1.94±0.81 (B)* 5.09±0.33 (N)**	3.66±0.15 (B) 5.55±0.09 (N)	2.41±0.19 (B) 4.94±1.26 (N)	2.84±0.79 (B) 5.24±0.51 (N)	5.41 (B) 5.34 (N)	1.89 (B) 4.92 (N)

(B)* – index calculated using biomass; (N)** – index calculated using abundance.

Main qantitative parameters are given in the table with standard error

5.3.4 Comparative characteristic of the investigated areas

A total of 1027 benthic macroinvertebrate species were identified from 471 grab samples collected in the Motovsky Bay, Varangerfjord and open waters of the southern Barents Sea in 2003 (Appendix II, Table 2). Most species were the polychaetes, crustaceans, molluscs and bryozoans with 27%, 26%, 16% and 13%, respectively, of total number of species.

Table 5.3.4. The main parameters (mean for all stations) of the benthos in Varangerfjord, Motovsky Bay and the open waters of the southern part of the Barents Sea.

Mean parameters	Equation	Varanger-fjord	Motovsky Bay	Open sea
Total number of species/taxa		383	451	855
Species richness SR_{St}	number of species per station	65-117	86-155	52-216
Species density SR_{Repl}	number of species per sample (0.1 m^2)	38.2±3.1	55.4±1.8	63.3±2.4
Margalef index	$D_{Mg} = (S\text{-l})/\ln N$	10.80.6	13.4±0.7	15.9±0.5
Simpson's domination	$D = \sum p_i^2$	0.09±0.01	0.13±0.02	0.22±0.02
Pielou evenness	$E = H/\log_2 S$	0.53±0.03	0.43±0.01	0.49±0.01
Shannon-Wiener diversity (B)	$H_B = -\sum b/B(\log_2 b/B)$	3.32±0.19	2.92±0.10	3.48±0.12
Shannon-Wiener diversity (N)	$H_N = -\sum n/N(\log_2 n/N)$	4.80±0.15	4.53±0.20	4.95±0.09
Simpson's diversity	$C = 1 - \sum (b/B)^2$	0.91±0.02	0.87±0.02	0.77±0.02
Mean biomass g/m^2		36.7±7.6	74.7±12.7	95.2±15.4
Mean abundance ind./m^2		2060±496	6875±1355	3940±228
Biomass of carnivorous, % of total biomass		18	9	11
Index of ecological stress (well-being)	$D_E = (H_B - H_N)/\log_2 S$	-0.24±0.04	-0.23±0.03	-0.34±0.01

Note: S – total number of species/taxa; N – total number of individuals (ind./ m^2); n – abundance of species/taxa within community (ind./ m^2); B – total biomass (g/m^2); b – average biomass of each species/taxa within community (g/m^2).

In accordance to quantitative characteristics as number of species, abundance and biomass the poorest benthic communities were recorded in the Varangerfjord. Mean biomass in this area was almost three times lower than in the open waters of the southern Barents Sea and twice as low as in the adjacent Motovsky Bay (Table 5.3.4). Abundance is a less reliable quantitative index (characteristic) of a community than biomass because abundance can be affected by the process of sampling and the quality of the preliminary sorting of material. But even the abundance values in Varangerfjord are low compared to other investigated areas. Bottom communities in the Varangerfjord differ from adjacent eastern areas also by their low values of species richness (D_{Mg}, SR_{Repl}, SR_{St}) (Table 5.3.4). Combination of all other indices of biodiversity given in Table 5.3.4 (D, E, H, C) indicates significantly higher level of evenness of communities in Varangerfjord than in other adjacent study areas. One explanation could be the high abundances of the red king crab in the fjord which as a non-selective benthic carnivore consumes first the most accessible abundant individuals of the dominant species.

With regard to quantitative parameters (species richness, total abundance and biomass) the Motovsky Bay is in a intermediate position between the Varangerfjord and the open water of the southern Barents Sea. The mean total biomasses in Motovsky Bay is twice as high as in Varangerfjord, but statistically lower than in the open waters of the southern part of the Barents Sea (see Table 5.3.4). The Motovsky Bay has the highest mean abundance compared to other areas (Varanger and open water). However, this exceeding is statistically unreliable as it is a result of extremely high abundance (23 000 ind./m²) recorded only at one station. With regard to biodiversity indices the Motovsky Bay samples show intermediate values between the Varangerfjord and the open waters of the adjacent sea (Table 5.3.4). The reasons for Motovsky Bay, which is as densely occupied by the red king crab as the Varangerfjord, to have higher abundances and a higher level of community structuring (more low level of Pielow eveness, more high Simpson domination index) remains open. One possible explanation could be the different topographies of the two bays. Compared to Motovsky Bay Varangerfjord is vaster and being more opened to the sea (and is more opened for the fishery and transport activity) bay, what can affect the structure of benthic communities and also the food conditions for the red king crab.

The highest values for mean total biomass and value of abundance close to Motovsky Bay were recorded in the open waters of the southern Barents Sea. The communities from the open sea can be characterized as richer and more structured compared to the communities inhabiting the Motovsky Bay and especially Varangerfjord. In addition, the highest values for biomass and Simpson's domination index *(D)* were observed in the shallow-water eastern part of the investigated area on sandy and mixed sediments and in the central and northern parts of the open sea on soft sediment (Table 5.3.3). These areas are either recently invaded by red king crab or situated outside of its area.

From the results presented here one can conclude that in areas with high and long-standing king crab populations a reduction in the structure of the communities is due to the feeding activity of the crab (grazing on the most abundant benthic organisms). An effect on total benthic biomass in the form of a decrease is less apparent because total benthic biomass is determined by the general food availability for benthic organisms and also dependent on topography and hydrology of a habitat. It should be noted that a pronounced correlation between locations with high indices of ecological well-being (indicating areas with changes in community structure due to disturbances) and the abundance of red king crabs could not be established..

Another important descriptor for benthic fauna well-being is the trophic structure of a community. Assuming that the ratio between suspension feeders and detritus feeders in general is determined by depth and type of sediment (which in turn reflects local current regime), then the relative abundance of carnivores reflects the ecological equilibrium of a community or how stable the community is. From this point of view mean values of relative abundance of carnivores in the open part of the sea and in the Motovsky Bay do not exceed mean values for the Barents Sea in total (Kuznetsov 1970, 1980). At the same time the number of carnivores in Varangerfjord evidently exceeds levels recorded elsewhere. Often the reason for increasing relative abundance of carnivores is enhanced fishing activity which means increased disturbance levels for benthic habitats and provides a source of additional nutrition for carnivores. The differences in trophic structure of benthic communities in the three areas investigated indicate that anthropogenic impact (fishery most likely) in the Varangerfjord is more pronounced than in the open water of the investigated area in the southern Barents Sea and the Motovsky Bay. The latter is used by the military and thus often closed for the public

Values of the index of ecological well-being *(D_E)* also indicate that environmental conditions in Varangerfjord are the most adverse compared to the other investigated areas (see Table 5.3.4). Besides generally higher levels of stress in the area, locally pronounced adverse environmental conditions were observed in immediate proximity to Pechenga Bay. As such the general ecological conditions of the benthos in the Motovsky Bay are similar to those in Varangerfjord. However, local increases in values of D_E, indicating changes in the communities caused by stress, are less pronounced than in Varangerfjord. The most favourable or least disturbed environmental conditions were observed in the open sea where the degree of disturbance is considerably lower than in the coastal zone of Western Murman.

6 Future research

By L.L. Jørgensen

This three years project for the Joint Norwegian-Russian Fishery Commission is meant as a contribution to describe the status of the Barents Sea benthic ecosystem with expected change under impact of the climate variability and human activities. As benthos is broadly accepted as an environmental indicator, this report is also of interest for the Joint Norwegian-Russian Commission for Environment. Therefore, this report contributes to the information basis for the developing joint ecosystem-based management in the Barents Sea. But though ecosystem-based management plan for Norwegian waters in the area is now adopted, the analogous management plan for the Russian part is not yet developed.

It is recommended to continue to process the **historical PINRO station** in order to get the full mapping of the Barents Sea benthic fauna finish. Then it would be possible to compared a new dataset with the historical dataset from 1960s (full coverage of the entire Barents Sea) and all the way back to 1930s (Southern Barents Sea). This will give detailed basis knowledge of long term changes in the benthic communities in the Barents Sea.

It is also recommended to continue to develop the Long Term Monitoring Project analysing the **by-catch** from the Campelen trawl on the Joint Ecosystem Surveys. The three-year programme has created a solid baseline study upon which it is now time to develop methods capable of detecting abnormal fluctuations in the species and biomass composition, and predict a forecasting model for future results.

In order to develop this detection and predictive tool, it is important to continue the annual coverage of the entire Barents Sea in the Joint Ecosystem Surveys, to develop the standardized sampling system, the standardized species identification control, and the standardized and quality controlled joint database.

It is recommended to continue to monitor the off-shore areas in the **snow crab spreading area** and the coastal areas in the **king crab spreading area**. The mapping and monitoring of changes in species composition, prey body size, and biomass fluctuations, are recommended to continue, not only in the Russian parts of the Sea, but also in the Norwegian part.

7 Acknowledgement

We will like to thank Kerstin Kröger for language improvement and helpful suggestions to this report.

8 Reference list

Ambrose WG, Clough LM, Tilney PR, Beer L (2001). Role of echinoderms in benthic remineralization in the Chukchi Sea. Marine Biology 139:937-949.

Andreev VL (1980). Classified analysis in ecology and taxonomy. Nauka Press, Moskow. 142 pp. (In Russian).

Anisimova N, Berenboim B, Gerasimova O, Manushin I and Pinchukov M (2005). On the effect of red king crab on some components of the Barents Sea ecosystem/Ecosystem dynamics and optimal long-term harvest in the Barents Sea Fisheries. Proceeding of the 11th Russian-Norwegian Symposium, Murmansk, 15-17 August 2005/ IMR/PINRO Joint Report Series 2:298-306.

Anon (1939). Instruction on the collection and preliminary processing of benthos. Pischepromisdat Moskow-Leningrad. 28 pp. (In Russian).

Antipova TV (1975). Distribution of the Barents Sea benthos biomass Trudy PINRO, 35:121-124 (In Russian).

Auster PJ and Langton RW (1999). The effects of fishing on fish habitat. Pp. 150–187, *In* L. Benaka (Ed.). Fish Habitat: Essential Fish Habitat and Rehabilitation. American Fisheries Society, Bethesda, MD

Bray JR and Curtis JT (1957) An ordination of the upland forest communities of southern Wisconsin. Ecol Monogr 27:325-349.

Brotskaja VA, Zenkevich LA (1939). Quantitative estimation of the bottom fauna of the Barents Sea. Trudy VNIRO 4: 5-126. (In Russian).

Cannon LRG (1986). Turbellaria of the World. A guide to families and genera. Brisbane, Poly-Graphics Pty Ltd. 240 pp.

Clarke KR and Warwick RM (1997). Change in marine communities: an approach to statistical analysis and interpretation. Plymouth Marine Laboratory, UK. 144 pp.

Czeckanovski J (1909). Zur differencial Diagnose der neandertalgruppe Korespbl. Dtch. Ges. Antropol. 40: 44-47.

Demel K and Rutkowicz S (1966). The Barents Sea. Warsaw, Poland. 301 pp.

Denisenko SG (2006). Shannon information measuring and its application to estimation of a biodiversity (on example of marine zoobenthos). – In: Marine invertebrates of Arctic, Antarctic and Subantarctic. Exploration of the fauna of the seas 56(64): 35-46. (In Russian).

Dunton KH, Goodall JL, Schonberg SV, Grebmeier JM and Maidment DR (2005). Multi-decadal synthesis of benthic-pelagic coupling in the western arctic: Role of cross-shelf advective processes. Deep Sea Research II 52(24-26):3462–3477.

Galkin YI (1987). Climatic fluctuations and long-term changes of benthic biomass in the Barents Sea (by the example of mollusc *Lepeta coeca* – Gastropoda: Lepetidae). Pp. 90-122 in: Skarlato, O.A., Alekseev, A.P. and T.G. Lyubimov (eds.). Biological resource of the Arctic and Antarctic. Nauka Press, Moscow (In Russian).

Ingvaldsen R, Budgell P, Karsakov AL, Ozhigin VK, Pedchenko AP, Titov O and Ådlandsvik B (2007). Climate. in: Stiansen, J.E. and A.A. Filin (eds) Joint PINRO/IMR report on the state of the Barents Sea ecosystem in 2006, with expected situation and considerations for management. IMR/PINRO Joint Report Series 2/2007:1-209.

Jennings S (1998). The effects of fishing on marine ecosystems. In: Blaxter JHS, Southward AJ and Tyler PA (eds.) Advances in Marine Biology. Academic Press, San Diego. Pp. 201-352.

Jennings S and Kaiser MJ (1998). The effects of fishing on marine ecosystems. Advances in Marine Biology 34:201-352.

Jørgensen LL and Primicerio R (2007). Impact scenario for the invasive red king crab Paralithodes camtschaticus (Tilesius, 1815) (Reptantia, Lithodidae) on Norwegian, native, epibenthic prey. Special Issue on Crustacean Invaders for the journal Hydrobiologia 590(1): 47-54.

Kaiser, M.J.; de Groot, S.J. (2000). The effects of fishing on non-target species and habitats: biological, conservation and socio-economic issues. *Fishing News Books*. Blackwell Science: Oxford, UK. ISBN 0-632-05355-0. XVI, 399 pp.

Kiyko OA and Pogrebov VB (1997a). Long-term benthic population changes (1920-1930s - present) in the Barents and Kara Seas. Marine Pollution Bulletin 35(7-12): 322-332.

Kiyko OA and Pogrebov VB (1997b). Mapping of bottom communities for ecological monitoring purposes: multivariate data classification. Proceeding of the 18th Internetional Cartography Conference, Stockholm, 1: 326-334.

Kiyko OA and Pogrebov VB (1998). Statistical analysis of spatio-temporal structure of the bottom population of the Barents Sea and adjacent waters. Biologiya Morya 24(1): 3-9 (In Russian).

Kuznetsov AP (1970). Features of the bottom invertebrate trophic group distribution in the Barents Sea. Trans Inst Oceanol 88: 5-80.

Kuznetsov AP (1980). Ecology of the bottom communities of the World Ocean (trophic structure of the marine bottom fauna). Nauka Press, Moscow. 244 pp. (In Russian).

Kuznetsov, A.P. 1970. The principles of feeding groups of bottom invertebrates distribution in the Barents Sea. Trudy Instituta Okeanologii USSR, 88: 5-80. (In Russian).

Lyubin P.A., Anisimova N.A. 2001. To the question on the methods of the benthic communities determination (abundance and biomass as equivalent quantitative indices). – Pp. 134-136 in: Biological grounding of the sustainable development of the coastal marine ecosystem (Matishov G.G. ed.). Abstracts of the presentations of the international Conference. – Apatity: Kola Science Centre RAS. (in Russian).

Moore PG and Jennings S (2000). Commercial Fishing: The Wider Ecological Impacts. Blackwell, Cambridge. 66 pp.

Neiman AA (1963). Quantitative distribution of benthos on the shelf and upper bathial slope of the eastern part of the Bering Sea. Trudy VNIRO 48: 145-205. (In Russian)

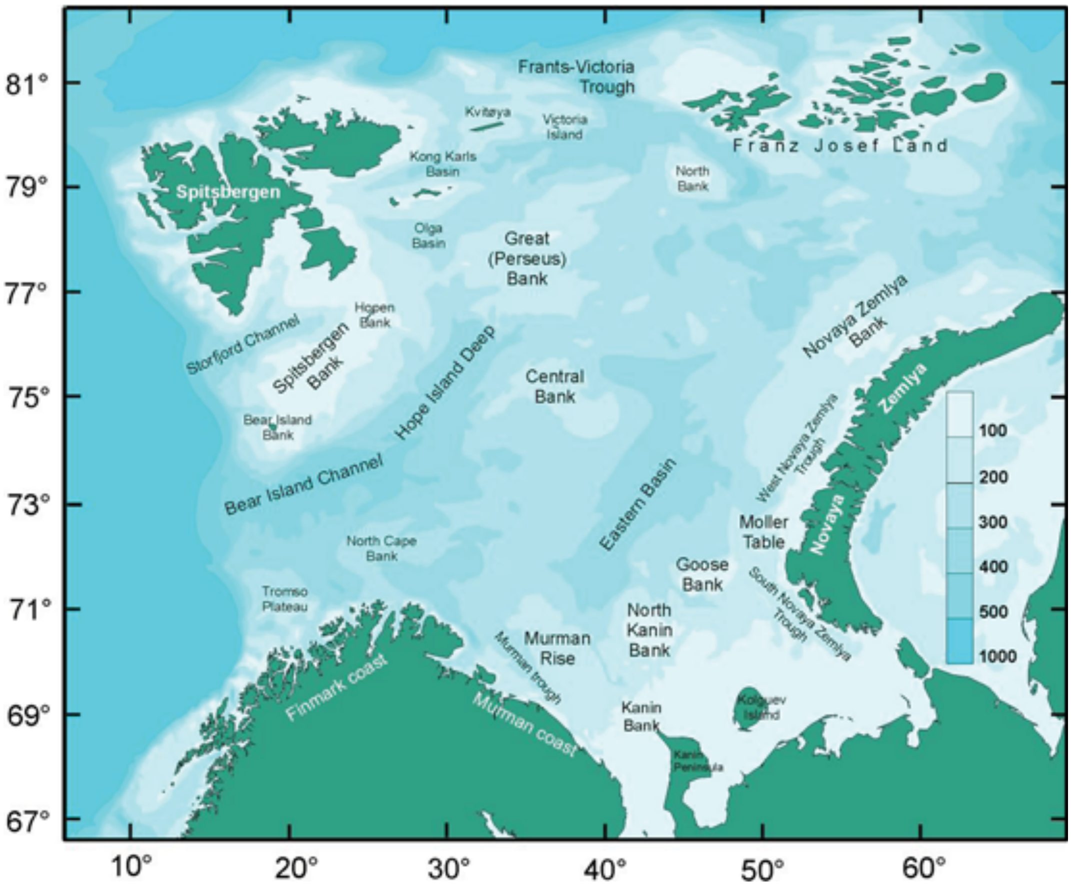
Piepenburg D, Blackburn TH, von Dorrien CF, Gutt J, Hall POJ, Hulth S, Kendall MA, Opalinski KW, Rachor E, Schmid MK (1995) Partitioning of the benthic community respiration in the Arctic (northwest Barents Sea). Mar Ecol Prog Ser 118:199-213.

Renaud PE, Morata N, Ambrose WG Jr, Bowie JJ, Chiuchiolo A (2007). Carbon cycling by seafloor communities on the eastern Beaufort Sea shelf. J. Exp. Mar. Biol. Ecol. 349, 248–260. doi:10.1016/j.jembe. 2007.05.021.

Sirenko BI, Vasilenko SV, Petryashev VV (2004). Abbreviations, accepted in zoogeogra-phical monenclature of the species, inhabiting Arctic Ocean. In: Fauna and ecosystems of the Laptev Sea and adjacent deep waters of the Arctic Basin. Part II. Explorations of the fauna of the Seas 54(62):105-107. (In Russian).

Sokolova MN (1956). On regularities of deep-water benthos distribution. Influence of the macrorelief and distribution of organic suspension matter on the trophic groups of bottom invertebrates. Doklady Akademii Nauk SSSR 110(4): 692-695. (In Russian).
Wildish DJ, Akagi HM, McKeown DL, Pohle GW (2008). Pockmarks influence benthic communities in Passamaquoddy Bay, Bay of Fundy, Canada. Mar Ecol Prog Ser 357:51-66.
Zatsepin VI (1962). Benthic invertebrate communities of the Murman Coast of the Barents Sea and their relationship to North Atlantic communities. Trudy Vsesoyuznogo Hidrobiologicheskogo Obschestva 12:245-344. (In Russian).

Appendix I. Topographic map of the Barents Sea



Topographic map of the Barents Sea with the main geographical names used in the text (according: Demel & Rutkowicz 1966 and others sources).

Appendix 2. Taxonomic composition of macrobenthos from trawl and grab surveys

Table 1. Taxonomical list of benthic fauna sampled by bottom fish trawls in the Barents Sea and adjacent water of Svalbard in 2005-2008.

TYPE	CLASS	ORDER	FAMILY	SPECIES
Porifera				Porifera g. sp.
	Demospongiae	Haplosclerida	Haliclonidae	*Haliclona cinerea* (Grant, 1827)
				Haliclona sp.
		Poecilosclerida	Cladorhizidae	*Asbestopluma pennatula* (Schmidt, 1875)
				Chondrocladia gigantea (Hansen, 1885)
			Hamacanthidae	*Hamacantha implicans* Lundbeck, 1902.
			Myxillidae	*Lissodendoryx indistincta* (Fristedt, 1887)
				Myxilla incrustans (Johnston, 1842)
		Astrophorida	Geodiidae	*Geodia barretti* Hentschel, 1929
				Geodia macandrewii Bowerbank, 1858
				Geodia sp.
			Pachastrellidae	*Thenea muricata* (Bowerbank, 1858)
			Tetillidae	*Tetilla cranium* (O.F. Müller, 1776)
				Tetilla polyura Schmidt, 1870
				Tetilla sp.
		Hadromerida	Polymastiidae	*Polymastia mammillaris* (Müller, 1806)
				Polymastia sp.
				Polymastia thielei Koltun, 1964
				Polymastia uberrima (Schmidt, 1870)
				Polymastiidae g. sp.
				Radiella grimaldi (Topsent, 1913)
				Radiella hemisphaericum (Sars, 1872)
				Sphaerotylus aff. *borealis* (Swarchevsky, 1906)
				Sphaerotylus sp.
				Tentorium semisuberites (Schmidt, 1870)
			Stylocordylidae	*Stylocordyla borealis* (Lovén, 1866)
			Suberitidae	*Pseudosuberites* sp.
				Suberites ficus (Johnston, 1842)
			Tethyidae	*Tethya norvegica* Bowerbank, 1872
		Halichondrida	Axinelliidae	*Phakellia bowerbanki* Vosmaer, 1885
				Phakellia sp.
			Halichondriidae	*Halichondria panicea* (Pallas, 1766)
				Halichondria sp.
	Calcarea	Calcarea	Amphoriscidae	*Amphoriscus glacialis* (Haeckel, 18??)
			Leucosoleniidae	*Leucosolenia* sp.
Cnidaria	Hydrozoa			Hydrozoa g. sp.
		Athecata	Bougainvilliidae	*Dicoryne conferta* (Alder, 1856)
			Eudendriidae	*Eudendrium capillare* Alder, 1856
				Eudendrium sp.
				Eudendrium vaginatum Norman, 1864
		Thecaphora	Aglaophenidae	*Cladocarpus integer* (G. O. Sars, 1874)
			Campanulariidae	*Campanularia volubilis* (L., 1758)

				Gonothyraea loveni (Allman, 1859)
				Laomedea flexuosa Hincks in Alder, 1856
				Obelia longissima (Pallas, 1766)
				Rhizocaulus verticillatus (L., 1758)
			Campanulinidae	*Calycella syringa* (L., 1767)
				Lafoeina maxima Levinsen, 1893
				Tetrapoma quadridentata (Hincks, 1874)
			Haleciidae	*Halecium beanii* (Johnston, 1838)
				Halecium marsupiale Bergh, 1887
				Halecium muricatum (Ellis & Solander, 1786)
				Halecium sp.
			Lafoeidae	*Grammaria immersa* Nutting, 1901
				Lafoea fruticosa (M. Sars, 1850)
				Lafoea sp.
			Laodiceidae	*Staurophora mertensii* Brandt, 1835
			Sertulariidae	*Abietinaria abietina* (L., 1758)
				Abietinaria filicula (Ellis & Solander, 1786)
				Abietinaria sp.
				Diphasia fallax (Johnston, 1847)
				Diphasia pulchra Nutting, 1904
				Hydrallmania falcata (L., 1758)
				Sertularella gigantea Mereschkowsky, 1878
				Sertularia albimaris Mereschkowsky, 1878
				Sertularia mirabilis (Verrill, 1873)
				Sertularia tenera G.O. Sars, 1874
				Symplectoscyphus tricuspidatus (Alder, 1856)
				Thuiaria breitfussi (Kudelin, 1914)
				Thuiaria carica Levinsen, 1893
				Thuiaria cupressoides (Lepechin, 1781)
				Thuiaria laxa Allman, 1874
				Thuiaria lonchitis Naumov, 1960
				Thuiaria sp.
				Thuiaria thuja (L., 1758)
			Tiarannidae	*Modeeria plicatile* (M. Sars, 1863)
			Zygophylaxidae	*Zygophylax pinnata* (G. O. Sars, 1874)
	Anthozoa			Anthozoa g. sp.
		Stolonifera	Clavulariidae?	*Clavularia arctica* (M. Sars, 1860)
		Alcyonacea	Nephteidae	*Drifa glomerata* (Verrill, 1869)
				Duva florida (Rathke, 1806)
				Gersemia fruticosa (M. Sars, 1860)
				Gersemia rubiformis (Ehrenberg, 1834)
				Gersemia sp.

		Pennatulacea	Umbellulidae	*Umbellula encrinus* (L., 1758)
		Ceriantihida	Cerianthidae	*Cerianthus lloydi* Gosse, 1839
		Scleractinida	Caryophyllidae	*Caryophyllia smithii* Stokes and Broderip, 1828
				Lophelia pertusa (Linnaeus, 1758)
		Actiniaria		Actiniaria g. sp.
			Actiniidae	*Bolocera tuediae* (Johnston, 1832)
				Urticina felina (L., 1767)
				Urticina felina lofotensis (Danielssen, 1890)
			Actinostolidae	*Actinostola* sp.
				Glandulactis spetsbergensis (Carlgren, 1913)
			Hormathiidae	*Hormathia digitata* (O.F. Müller, 1776)
				Hormathia sp.
			Liponematidae	*Liponema multicornis* (Verrill, 1879)
			Metridiidae	**?** *Metridium senile* (L., 1767)
		Zoanthacea	Epizoanthidae	Epizoanthidae g. sp.
				Epizoanthus sp.
			Zoanthidae	*Palythoa mammillosa* (Ellis & Solander, 1786)
Plathelminthes	Turbellaria			Turbellaria g. spp.
Nemertini	Nemertini			Nemertini g. spp.
Cephaloryncha	Priapulida	Priapulomorpha	Priapulidae	*Priapulopsis bicaudatus* (Danielssen, 1868) van der Land, 1970
				Priapulus caudatus Lamarck, 1816
Annelida	Polychaeta			Polychaeta g. sp.
		Phyllodocida	Aphroditidae	Aphroditidae g. sp.
				Laetmonice filicornis Kinberg, 1855
			Glyceridae	*Glycera capitata* Örsted, 1843
			Nephtyidae	Nephtyidae g. sp.
				Nephtys paradoxa Malm, 1874
				Nephtys sp.
			Nereididae	*Nereis pelagica* L., 1761
			Phyllodocidae	Phyllodocidae g. sp.
			Polynoidae	*Harmothoe imbricata* (L., 1767)
				Harmothoe sp.
				Polynoidae g. sp.
		Spinterida	Spintheridae	Spintheridae g. sp.
		Amphinomida	Euphrosinidae	*Euphrosine* sp.
		Eunicida	Eunicidae	*Eunice dubitata* Fauchald, 1974
				Eunice norvegica (L., 1767)
				Eunice pennata (O.F. Müller, 1776)
			Lumbrineridae	Lumbrineridae g. sp.
				Lumbrineris sp.
				Scoletoma fragilis (Müller, 1776)

			Onuphidae	*Nothria hyperborea* (Hansen, 1878)
		Chaetopterida	Chaetopteridae	*Spiochaetopterus typicus* M. Sars, 1856
		Flabelligerida	Flabelligeridae	*Brada* af. *nuda* Annenkova, 1922
				Brada granulata Malmgren, 1867
				Brada granulosa Hansen, 1880
				Brada inhabilis (Rathke, 1843)
				Brada villosa (Rathke, 1843)
				Pherusa plumosa (O.F. Müller, 1776)
				Pherusa sp.
		Opheliida	Opheliidae	*Travisia forbesii* Johnston, 1840
			Scalibregmidae	*Scalibregma inflatum* Rathke, 1843
				Scalibregma sp.
		Capitellida	Maldanidae	*Nicomache lumbricalis* (Fabricius, 1780)
		Terebellida		Terebellida g. sp.
			Ampharetidae	*Ampharete* sp.
			Pectinariidae	*Pectinaria hyperborea* (Malmgren, 1865)
				Pectinaria sp.
			Terebellidae	*Pista maculata* (Dalyell, 1853)
				Terebellidae g. sp.
				Thelepus cincinnatus (Fabricius, 1780)
		Sabellida	Sabellidae	*Branchiomma arcticum* (Ditlevsen, 1937)
				Chone infundibuliformis Krøyer, 1856
				Potamilla neglecta (M. Sars, 1851)
				Sabellidae g. sp.
			Serpulidae	*Filograna implexa* Berkeley, 1827
				Hydroides norvegicus Gunnerus, 1768
				Protula globifera (Théel, 1879)
				Serpulidae g. sp.
			Spirorbidae	Spirorbidae g. sp.
	Hirudinea			Hirudinea g. sp.
Echiura	Echiurida	Echiuroinea	Bonelliidae	*Hamingia arctica* Danielssen & Koren, 1881
			Echiuridae	*Echiurus echiurus echiurus* (Pallas, 1767)
Sipuncula	Sipunculidea	Golfingiiformes	Golfingiidae	*Golfingia margaritacea margaritacea* (M. Sars, 1851)
				Golfingia vulgaris vulgaris (de Blainville,1827)
				Nephasoma abyssorum abyssorum (Koren & Danielssen, 1875)
				Nephasoma diaphanes diaphanes (Gerould, 1913)
			Phascolionidae	*Phascolion strombus strombus* (Montagu, 1804)
Arthropoda	Pycnogonida	Pantopoda		Pycnogonida g. sp.
			Colossendeidae	*Colossendeis angusta* G.O. Sars, 1877
				Colossendeis sp.
			Nymphonidae	*Nymphon* sp.

	Cirripedia	Thoracica	Balanomorpha	*Balanus balanus* (L., 1758)
				Balanus crenatus Bruguière, 1789
				? *Semibalanus balanoides* (L., 1766)
			Scalpellidae	*Ornatoscalpellum stroemii* (M. Sars, 1859)
				Scalpellum sp.
	Malacostraca	Leptostraca	Nebaliidae	*Nebalia bipes* (Fabricius, 1780)
		Decapoda	Crangonidae	*Crangon allmanni* Kinahan, 1864
				Pontophilus norvegicus M. Sars, 1861
				Sabinea sarsi Smith, 1879
				Sabinea septemcarinata (Sabine, 1821)
				Sclerocrangon boreas (Phipps, 1774)
				Sclerocrangon ferox (G.O. Sars, 1821)
			Galatheidae	*Munida bamffica* (Pennant, 1777)
			Geryonidae	*Geryon trispinosus* (Herbst, 1803)
			Hippolitydae	*Bythocaris payeri* (Heller, 1875)
				Bythocaris sp.
				Eualus gaimardi (Milne-Edwards, 1837)
				Eualus gaimardi gibba (Krøyer, 1841)
				Eualus sp.
				Lebbeus polaris (Sabine, 1821)
				Spirontocaris lilljeborgii (Danielssen, 1859)
				Spirontocaris phippsii (Krøyer, 1841)
				Spirontocaris spinus (Sowerby, 1802)
			Lithodidae	*Lithodes maja* (L., 1758)
				Paralithodes camtschaticus (Tilesius, 1815)
			Majidae	*Chionoecetes opilio* (Fabricius, 1788)
				Hyas araneus (L., 1758)
				Hyas coarctatus Leash, 1815
			Paguridae	*Pagurus bernhardus* (L., 1758)
				Pagurus pubescens (Krøyer, 1838)
			Pandalidae	*Pandalus borealis* Krøyer, 1837
				Pandalus montagui Leach, 1814
			Pasiphaeidae	*Pasiphaea multidentata* Esmark, 1886
				Pasiphaea sivado (Risso, 1816)
		Amphipoda		Amphipoda g. sp.
			Acanthonotozomatidae	*Acanthostepheia behringiensis* (Lockington, 1877)
				Acanthostepheia malmgreni (Goës, 1866)
			Amathillopsidae	*Amathillopsis spinigera* Heller, 1875
			Ampeliscidae	*Ampelisca eschrichti* Krøyer, 1842
				Ampelisca macrocephala Lillijeborg, 1852
				Ampelisca sp.
				Haploops sp.
			Calliopiidae	*Cleippides quadricuspis* Heller, 1875

			Caprellidae	Caprellidae g.sp.
			Epimeriidae	*Epimeria loricata* G.O. Sars, 1879
				Paramphithoe hystrix (Ross, 1835)
			Eusiridae	*Rhachotropis aculeata* (Lepechin, 1780)
				Rhachotropis inflata (G.O. Sars, 1882)
				Rhachotropis sp.
			Gammaridae	Gammaridae g. sp.
				Gammarus sp.
				Gammarus wilkitzkii Birula, 1897
			Lysianassidae	*Anonyx nugax* (Phipps, 1774)
				Anonyx sp.
				Lysianassidae g. sp.
				Onisimus sp.
				Tmetonyx similis (G.O. Sars, 1891)
			Stegocephalidae	Stegocephalidae g. sp.
				Stegocephalus inflatus Krøyer, 1842
				Stegocephalus sp.
		Cumacea		Cumacea g. sp.
			Diastylidae	*Diastylis goodsiri* (Bell, 1855)
		Isopoda		Isopoda g. sp.
			Aegidae	*Aega* sp.
			Idotheidae	*Saduria sabini* (Krøyer, 1849)
				Saduria sp.
			Paranthuridae	*Calathura brachiata* (Stimpson, 1854)
Mollusca	Poly placophora			Polyplacophora g. sp.
		Lepidopleurida	Hanleyidae	*Hanleya nagelfar* (Bean, 1844)
		Chitonida	Ischnochitonidae	*Stenosemus albus* (L., 1767)
	Aplacophora			Aplacophora g. sp.
			Neomeniidae	Neomeniidae g. sp.
			Simrothiellidae	Simrothiella sp.
		Solenogastres	Neomeniidae	*Proneomenia sluiteri* Hübrecht, 1880
	Gastropoda	Patelliformes	Lepetidae	*Lepeta coeca* (O.F. Müller, 1776)
			Tecturidae	*Capulacmaea radiata* (M. Sars, 1851)
				Tectura virginea (Müller, 1776)
		Pleuro-tomariiformes	Fissurellidae	*Puncturella noachina* (L., 1771)
		Trochiformes	Trochidae	*Margarites costalis* (Gould, 1841)
				Margarites groenlandicus groenlandicus (Gmelin, 1790)
				Margarites helicinus (Phipps, 1774)
				Margarites sp.
		Cerithiiformes	Cerithiellidae	*Laiocochlis granosa* (Wood, 1848)
			Naticidae	*Bulbus smithi* Brown, 1839
				Cryptonatica affinis (Gmelin, 1791)
				Lunatia pallida (Broderip & Sowerby, 1829)

				Polynices sp.
			Trichotropidae	*Ariadnaria borealis* (Broderip & Sowerby, 1829)
				Iphinoe kroyery (Phillippi, 1849)
			Turritellidae	*Tachyrhynchus reticulatus* (Mighels & Adams, 1842)
			Velutinidae	*Limneria undata* (Brown, 1838)
				Marsenina glabra (Couthouy, 1838)
				Onchidiopsis glacialis (M. Sars, 1851)
				Onchidiopsis sp.
				Velutina sp.
				Velutina velutina (Müller, 1776)
				Velutinidae g. sp.
		Bucciniformes	Beringiidae	*Beringius ossiani* (Friele, 1879)
				Beringius sp.
				Beringius turtoni (Bean, 1834)
			Buccinidae	Buccinidae g. sp.
				Buccinum angulosum Gray, 1839
				Buccinum belcheri Reeve, 1855
				Buccinum ciliatum ciliatum (Fabricius, 1780)
				Buccinum ciliatum sericatum Hancock, 1846
				Buccinum cyaneum Bruguière, 1789-1792
				Buccinum elatior (Middendorff, 1849)
				Buccinum finmarchianum Verkrüzen, 1875
				Buccinum fragile Verkrüzen in G.O. Sars, 1878
				Buccinum glaciale L., 1761
				Buccinum hydrophanum Hancock, 1846
				Buccinum polare Gray, 1839
				Buccinum sp.
				Buccinum undatum L., 1758
				Colus altus (S. Wood, 1848)
				Colus holboelli (Møller,1842)
				Colus islandicus (Mohr, 1786)
				Colus kroyeri (Møller,1842)
				Colus pubescens (Verrill, 1882)
				Colus sabini (Gray, 1824)
				Colus sp.
				Colus turgidulus (Jeffreys, 1877)
				Neptunea communis (Middendorff, 1901)
				Neptunea denselirata Brogger, 1901
				Neptunea despecta (L., 1758)
				Neptunea sp.
				Neptunea ventricosa (Gmelin, 1789)

				Pyrulofusus deformis (Reeve, 1847)
				Turrisipho fenestratus (Turton, 1834)
				Turrisipho lachesis (Mörch, 1869)
				Turrisipho moebii (Dunker & Matzger, 1874)
				Volutopsis norvegicus (Gmelin, 1790)
			Muricidae	*Boreotrophon truncatus* (Strøm, 1767)
		Coniformes	Admetidae	*Admete viridula* (Fabricius, 1780)
			Turridae	*Oenopota* sp.
				Propebela exarata (Møller, 1842)
		Cephalaspidea		Opistobranchia g. sp.
			Philinidae	*Ossiania quadrata* (S. Wood, 1839)
				Philine finmarchica G.O. Sars, 1878
				Philinidae g. sp.
			Scaphandridae	*Scaphander lignarius* (L., 1758)
				Scaphander punctostriatus (Mighels & Adams, 1842)
				Scaphander sp.
		Nudibranchia		Nudibranchia g. sp.
			Aeolidiidae	*Aeolidia papillosa* (L., 1762)
			Aldisidae	*Aldisia zetlandica* (Alder et Hancock, 1854)
			Dendronotidae	*Dendronotus robustus* Verrill, 1870
				Dendronotus sp.
			Onchidoridiae	Onchidoridae g. sp.
	Bivalvia			Bivalvia g. sp.
		Nuculiformes	Nuculanidae	*Nuculana pernula* (Müller, 1779)
			Nuculidae	*Leionucula tenuis* (Montagu, 1808)
			Yoldiidae	*Yoldia hyperborea* (Torell, 1859)
				Yoldiella intermedia (M. Sars, 1865)
		Mytiliformes	Arcidae	*Bathyarca glacialis* (Gray, 1842)
				Bathyarca pectunculoides (Scacchi, 1834)
			Mytilidae	*Modiolus modiolus* (L., 1758)
				Musculus discors (L., 1767)
				Musculus laevigatus (Gray, 1824)
				Musculus niger (Gray, 1824)
				Mytilus edulis L., 1758
		Pectiniformes	Anomiidae	*Anomia squamula* (L., 1767)
			Pectinidae	*Chlamys islandica* (O.F. Müller, 1776)
				Chlamys sulcata (O.F. Müller, 1776)
				Delectopecten vitreus (Gmelin, 1791)
				Pectinidae g. sp.
				Pseudamussium septemradiatum (Müller, 1776)
			Propeamussiidae	*Arctinula greenlandica* (Sowerby, 1842)
				Cyclopecten imbrifer (Lovén, 1846)

		Luciniformes	Astartidae	*Astarte arctica* (Gray, 1824)
				Astarte borealis Schumacher, 1817
				Astarte crenata (Gray, 1842)
				Astarte elliptica (Brown, 1827)
				Astarte sp.
			Hiatellidae	*Hiatella arctica* (L., 1767)
				Hiatella rugosa (L., 1758)
				Panomya arctica (Lamarck, 1818)
		Cardiiformes	Cardiidae	Cardiidae g. sp.
				Clinocardium ciliatum (Fabricius, 1780)
				Serripes groenlandicus (Bruguière, 1789)
			Mactridae	*Spisula elliptica* Gray, 1837
			Myidae	*Mya truncata* L., 1767
			Tellinidae	*Macoma calcarea* (Gmelin, 1791)
		Pholadomyiformes	Lyonsiidae	*Lyonsia arenosa* (Møller, 1842)
			Thraciidae	*Thracia myopsis* (Møller, 1842)
		Cuspidariiformes	Cuspidariidae	*Cuspidaria arctica* (M. Sars, 1859)
				Cuspidaria sp.
	Scaphopoda			Scaphopoda g. sp.
	Cephalopoda			Cephalopoda g. sp.
		Sepiida	Sepiolidae	*Rossia moelleri* Steenstrup, 1856
				Rossia palpebrosa Owen, 1834
				Rossia sp.
		Teuthida		Teuthida g. sp.
			Gonatidae	*Gonatus fabricii* (Lichtenstein, 1818)
		Octopoda		Octopoda g. sp.
			Bathypolypodinae	Bathypolypodinae g. sp.
				Bathypolypus arcticus (Prosch, 1849)
				Benthoctopus sp.
Brachiopoda				Brachiopoda g. sp.
	Rhynchonellata	Rhynchonellida	Hemithyrididae	*Hemithyris psittacea* (Gmelin, 1790)
		Terebratulida	Cancellothyrididae	*Terebratulina retusa* (L., 1758)
			Macandreviidae	*Macandrevia cranium* (Müller, 1776)
Bryozoa	Gymnolaemata			Bryozoa g. sp.
		Cheilostomida	Bicellariidae	*Bugula* sp.
				Dendrobeania sp.
			Celleporidae	*Cellepora* sp.
			Flustridae	*Flustra foliacea* (L., 1758)
				Flustra sp.
			Myriaporidae	*Myriapora* sp.
			Reteporidae	*Retepora beaniana* King, 1846
				Retepora sp.
				Sertella septentrionalis Jullen, 1933
			Schizoporellidae	*Myriozoella crustacea* Smitt, 1868
				Myriozoella sp.
			Scrupariidae	*Eucratea loricata* (L., 1758)

			Scrupocellariidae	*Scrupocellaria* sp.
			Smittinidae	*Porella* sp.
				Smittina sp.
		Cyclostomata	Crisiidae	Crisiidae g. sp.
			Diastoporidae	*Diplosolen intricarius* (Smitt, 1872)
			Horneridae	*Hornera* sp.
				Stegohornera lichenoides (L., 1758)
		Ctenostomata	Alcyonidiidae	*Alcyonidium disciforme* (Smitt, 1878)
				Alcyonidium gelatinosum (L., 1767)
				Alcyonidium sp.
Echinodermata	Holothuroidea	Dendrochirotida	Cucumariidae	*Cucumaria frondosa* (Gunnerus, 1867)
				Pentamera calcigera (Stimpson, 1851)
			Phyllophoridae	*Ekmania barthi* (Troschel, 1846)
				Thyonidium drummondi (Thompson, 1840)
			Psolidae	*Psolus phantapus* Strussenfelt, 1765
				Psolus sp.
		Aspidochirotida	Stichopodidae	*Stichopus tremulus* (Gunnerus, 1767)
		Molpadiida	Caudinidae	*Eupyrgus scaber* Lütken, 1857
			Molpadiidae	*Ankyroderma jeffreysii* Danielssen & Koren, 1879
				Molpadia arctica von Marenzeller, 1878
				Molpadia borealis (M. Sars, 1859)
		Apodida	Chiridotidae	*Chiridota laevis* (Fabricius, 1780)
			Myriotrochidae	*Myriotrochus rinkii* Steenstrup, 1851
				Myriotrochus sp.
	Echinoidea	Echinoida	Echinidae	*Echinus acutus* Lamarck, 1816
				Echinus sp.
			Strongylocentrotidae	*Strongylocentrotus droebachiensis* O.F. Müller, 1776
				Strongylocentrotus pallidus (G.O. Sars, 1871)
		Spatangoida	Spatangidae	*Brisaster fragilis* (Düben & Koren, 1846)
	Asteroidea		Pterasteridae	*Diplopteraster multipes* (M. Sars, 1877)
		Paxillosida	Astropectinidae	*Leptychaster arcticus* (M. Sars, 1851)
				Psilaster andromeda (Müller & Troschel, 1842)
			Ctenodiscidae	*Ctenodiscus crispatus* (Retzius, 1805)
		Notomyotida	Benthopectinidae	*Pontaster tenuispinus* (Düben & Koren, 1846)
		Valvatida	Goniasteridae	*Ceramaster granularis granularis* (Retzius, 1783)
				Hippasteria phrygiana phrygiana (Parelius, 1768)
				Pseudarchaster parelii (Düben & Koren, 1846)
			Poraniidae	*Poraniomorpha hispida* (Sars, 1872)
				Poraniomorpha tumida (Stuxberg, 1878)

		Spinulosida	Echinasteridae	*Henricia* spp.
		Velatida	Korethrasteridae	*Korethraster hispidus* W. Thomson, 1873
			Pterasteridae	*Hymenaster pellucidus* W. Thomson, 1873
				Pteraster militaris (O.F. Müller, 1776)
				Pteraster obscurus (Perrier, 1891)
				Pteraster pulvillus M. Sars, 1861
			Solasteridae	*Crossaster papposus* (L., 1768)
				Crossaster sp.
				Lophaster furcifer (Düben & Koren, 1846)
				Solaster endeca (L., 1771)
				Solaster sp.
				Solaster syrtensis Verrill, 1894
		Forcipulatidae	Asteriidae	*Asterias rubens* L., 1758
				Icasterias panopla (Stuxberg, 1879)
				Leptasterias groenlandica (Steenstrup, 1857)
				Leptasterias hyperborea (Danielssen & Koren, 1883)
				Leptasterias mulleri (M. Sars, 1846)
				Leptasterias sp.
				? *Marthasterias glacialis* (Linnaeus, 1765)
				Stephanasterias albula (Stimpson, 1853)
				Urasterias linckii (Müller & Troschel, 1842)
	Ophiuroidea	Euryalida	Gorgonocephalidae	*Gorgonocephalus arcticus* (Leach, 1819)
				Gorgonocephalus eucnemis (Müller & Troschel, 1842)
				Gorgonocephalus lamarcki (Müller & Troschel, 1842)
		Ophiurida	Ophiacanthidae	*Ophiacantha bidentata* (Retzius, 1805)
				Ophiacantha sp.
			Ophiactidae	*Ophiopholis aculeata* (L., 1767)
			Ophiomyxidae	*Ophioscolex glacialis* Müller & Troschel, 1842
			Ophiuridae	*Ophiocten sericeum* (Forbes, 1852)
				Ophiopleura borealis Danielssen & Koren, 1877
				Ophiura robusta (Ayers, 1851)
				Ophiura sarsi Lütken, 1855
				Stegophiura nodosa (Lütken, 1854)
	Crinoidea	Comatulida	Antedonidae	*Heliometra glacialis* (Owen, 1833)
				Poliometra prolixa (Sladen, 1881)
Chordata	Ascidiacea			Ascidiacea g. sp.
		Aplousobranchia	Didemnidae	Didemnidae g. sp.
				Didemnum sp.
			Polyclinidae	*Synoicum tirgens* Phipps, 1774
		Phlebobranchia	Ascidiidae	*Ascidia prunum* (Müller, 1776)

				Ascidia sp.
			Cionidae	*Ciona intestinalis* (L., 1767)
		Stolidobranchia	Molgulidae	*Molgula* sp.
			Pyuridae	*Boltenia echinata* (L., 1767)
				Halocynthia pyriformis (Rathke, 1806)
			Styelidae	*Botryllus schlosseri* (Pallas, 1776)
				Pelonaia corrugata (Forbes & Good, 1841)
				Styela rustica (L., 1767)
				Styela sp.

"?" – question mark before species name is marked doubtful (questionable) identification.

The pelagic taxa like Ctenophora, medusa, euphasiid crustaceans and others (fallen into a net from the water column during lifting of trawl) are not included to the taxonomical list.

Table 2. Species list of macrobentic fauna, sampled by grabs, during cruise of RV *Romuald Muklevish*, in Varangerfiord, Motovsky Bay and open waters of the southern Barents Sea in 2003.

Taxa	Varangerfiord	Motovsky Bay	Open sea
Porifera			
Axinella rugosa (Bowerbank, 1866)	+		
Clathrina coriacea (Montagu, 1812)	+		
Gellius primitivus Lundbeck, 1902		+	
Grantia arctica (Haeckel, 1872)		+	
Grantia mirabilis (Fristedt,1887)			+
Guancha sagittaria (Haeckel, 1872)		+	
Hymedesmia dermata Lundbeck, 1910		+	
Hymeniacidon assimilis (Levinsen, 1886)	+		+
Leucandra egedii (Schmidt, 1869)	+		
Leucandra polejaevi (Breitfuss, 1896)		+	+
Leucosolenia complicata (Montagu, 1818)		+	
Lissodendoryx indistincta (Fristedt, 1887)	+		+
Mycale lobata (Bowerbank, 1866)		+	
Polymastia euplectella Rezvoj, 1927			+
Protosuberites epiphytum (Lamarck, 1814)			+
Pseudosuberites hyalinus (Ridley & Dendy, 1887)	+		
Quasillina brevis (Bowerbank, 1861)	+		+
Radiella grimaldi (Topsent, 1913)			+
Radiella hemisphaericum (Sars, 1872)	+		
Radiella sarsi (Ridley & Dendy, 1886)			+
Rhizaxinella schaudinni Hentschel, 1929			+
Spongionella carteri (Burton, 1930)	+	+	+
Suberites carnosus (Johnston, 1842)	+		
Suberites domuncula spermatozoon (Schmidt, 1872)	+	+	+
Sycandra utriculus (Schmidt, 1869)		+	+
Sycetussa glacialis (Haeckel, 1872)		+	+
Sycon ciliatum (Fabricius, 1780)		+	
Sycon sp.	+		
Tedania suctoria Schmidt, 1870	+	+	+
*Tentorium semisuberite*s (Schmidt, 1870)	+		+
Tethya norvegica Bowerbank, 1872	+		
Tetilla polyura Schmidt, 1870			+
Thenea muricata (Bowerbank, 1858)			+
Vosmaeria crustacea Fristedt, 1885	+	+	+
Cnidaria			
Hydrozoa			
Abietinaria abietina (L., 1758)			+
Abietinaria thujarioides (Clark, 1876)			+
Calycella syringa (L., 1767)			+
Campanularia groenlandica Levinsen, 1893			+
Clytia gracilis (M. Sars, 1850)		+	+
Dicoryne conferta (Alder, 1856)			+
Diphasia pulchra Nutting, 1904			+
Diphasia rosacea (L., 1758)			+
Eudendrium capillare Alder, 1856			+
Eudendrium rameum (Pallas, 1766)			+
Eudendrium ramosum (L., 1758)			+
Eudendrium vaginatum Norman, 1864			+
Filellum serpens (Hassal, 1848)			+
Gonothyraea loveni (Allman, 1859)			+
Grammaria abietina (M. Sars, 1850)			+
Grammaria immersa Nutting, 1901			+
Gymnogonos crassicornis Bonnevie, 1898			+
Halecium corrugatum Nutting, 1899			+
Halecium curvicaule Lorenz, 1886			+
Halecium groenlandicum Kramp, 1911			+
Halecium labrosum Alder, 1859			+
Halecium marsupiale Bergh, 1887			+
Halecium muricatum (Ellis & Solander, 1786)			+
Halitholus yoldia-arcticae (Birula, 1897)		+	
Hydrallmania falcata (L., 1758)			+
Lafoea dumosa (Fleming, 1820)			+
Lafoea fruticosa (M. Sars, 1850)			+
Lafoea grandis Hincks, 1874			+
Lafoeina maxima Levinsen, 1893			+
Modeeria plicatile (M. Sars, 1863)			+
Obelia geniculata (L., 1758)			+
Obelia longissima (Pallas, 1766)	+	+	+
Orthopyxis integra (McGillivray, 1842)			+
Rhizocaulus verticillatus (L., 1758)	+		+
Sertularella gigantea Mereschkowsky, 1878			+
Sertularia albimaris Mereschkowsky, 1878			+
Sertularia brashnikowi Kudelin, 1914			+
Sertularia cupressina L., 1758			+
Sertularia mirabilis (Verrill, 1873)			+
Sertularia plumosa (Clark, 1876)			+
Symplectoscyphus tricuspidatus (Alder, 1856)			+
Tamarisca tamarisca (L., 1758)			+
Tetrapoma quadridentata (Hincks, 1874)			+
Thuiaria arctica (Bonnevie, 1899)			+
Thuiaria articulata (Pallas, 1766)			+
Thuiaria carica Levinsen, 1893			+
Thuiaria cupressoides (Lepechin, 1781)			+
Thuiaria laxa Allman, 1874			+
Thuiaria obsoleta (Lepechin, 1781)			+
Thuiaria thuja (L., 1758)			+
Anthozoa			
Actinia equina (L., 1758)		+	+
Actiniaria g. sp.	+	+	+
Cerianthus sp. (? *lloydi* Gosse, 1939)			+
Clavularia arctica (M. Sars, 1860)			+
Drifa glomerata (Verrill, 1869)			+
Duva florida (Rathke, 1806)			+
Edwardsia andresi Danielssen, 1890		+	+
Edwardsia arctica Carlgren, 1921	+	+	+
Edwardsia finmarchica Carlgren, 1921	+	+	+
Edwardsia fusca Danielssen, 1890	+	+	+
Edwardsia vitrea	+	+	+
Edwardsiella cornea (Gosse, 1856)		+	+
Edwardsiella loveni (Carlgren, 1892)		+	+
Edwardsiella sp.		+	+
Epizoanthus lindahlii Carlgren, 1913			+
Epizoanthus sp.		+	
Gersemia fruticosa (M. Sars, 1860)	+	+	+
Gersemia rubiformis (Ehrenberg, 1834)			+
? *Haliactis arctica* Carlgren, 1921 ?			+
Hormathia digitata (O.F. Muller, 1776)		+	+
Limnactinia laevis Carlgren, 1921		+	
Pennatulacea g. sp.		+	+
Zoanthacea g. sp.			
Platelmintes			
Turbellaria g. sp.			+
Nemertini			
Nemertini g. sp.	+	+	+

Nematoda

Nematoda g. sp.		+	+

Entoprocta = Kamptozoa

Ascopodaria sp.			+

Priapulida

Halicriptus spinulosus Siebold, 1849			+
Priapulopsis bicaudatus (Danielssen, 1868)		+	+
Priapulus caudatus Lamarck, 1816		+	+

Annelida

Polychaeta

Abyssoninoe hibernica (M'Intosh,1903)	+		+
Abyssoninoe sp.		+	
Aglaophamus malmgreni (Theel, 1879)	+	+	+
Amage auricula (Malmgren, 1865)	+	+	+
Ammotrypane sp.			+
Ampharete borealis			+
Ampharete finmarchica (M. Sars, 1866)		+	+
*Ampharete goes*i (Malmgren, 1865)			+
Ampharete gr. *lindstroemi* Malmgren, 1867 in Hessle 1917	+	+	+
Amphicteis gunneri (M. Sars, 1835)	+	+	+
Amphicteis ninonae Jirkov, 1985	+	+	
Amphitrite cirrata (O.F. Muller, 1771)		+	+
Amphitrite groenlandica Malmgren, 1865		+	+
Anobothrus gracilis (Malmgren, 1866)	+	+	+
Anobothrus laubieri Desbruyeres, 1978	+	+	+
Aphelochaeta marioni (de Saint-Joseph, 1894)	+		+
Aphelochaeta sp.	+	+	+
Apistobranchus tullbergi (Theel, 1879)			+
Aricidea catharinae Laubier, 1967	+	+	+
Aricidea hartmani (Strelzov, 1968)		+	+
Aricidea nolani Webster & Benedict, 1887	+	+	+
Aricidea quadrilobata (Webster & Benedict, 1887)	+	+	+
Artacama proboscidea Malmgren, 1865			+
Asychis biceps (M. Sars, 1861)	+	+	+
Augeneria algida (Wiren, 1901)			+
Autolytus sp.			+
Axiothella catenata (Malmgren, 1865)		+	+
Bispira crassicornis (Sars, 1851) Knight-Jones, 1990			+
Brada granulosa Hansen, 1880			+
Brada inhabilis (Rathke, 1843)		+	+
Brada villosa (Rathke, 1843)	+	+	+
Branchiomma arcticum (Ditlevsen, 1937)		+	+
Brania sp.		+	
Bushiella quadrangularis (Stimpson, 1854)			+
Bushiella sp.	+	+	
Bylgides annenkovae Pettibone, 1993			+
Bylgides elegans (Theel, 1879)		+	+
Bylgides groenlandicus (Malmgren, 1867)		+	+
Bylgides sp.	+	+	+
Capitella capitata (Fabricius, 1780)	+	+	+
Ceratocephale loveni Malmgren, 1867		+	
Chaetozone setosa Malmgren, 1867	+		+
Chaetozone sp.	+	+	+
Chitinopoma serrula (Stimpson, 1854)	+	+	
Chone duneri Malmgren, 1867	+	+	+
Chone infundibuliformis Kroyer, 1856	+	+	+
Chone longocirrata ?		+	
Chone murmanica Lucash, 1910	+		+
Chone perseyi Zenkewitsch, 1925			+
Circeis armoricana Saint- Joseph, 1894			+
Circeis spirillum (L., 1758)		+	
Cirratulus cirratus (O.F. Muller, 1776)		+	+
Cirratulus sp.	+		+
Cirrophorus branchiatus Ehlers, 1908	+		+
Cirrophorus furcatus (Hartman, 1957)		+	
Cirrophorus lyra (Southern, 1914)			+
Clymenura polaris (Theel, 1879)		+	+
Cossura longocirrata Webster & Benedict, 1887		+	+
Diplocirrus glaucus (Malmgren, 1867)	+		+
Diplocirrus hirsutus (Hansen, 1879)	+	+	+
Diplocirrus longisetosus (Marenzeller, 1890)	+		+
Dodecaceria concharum Oersted, 1843	+	+	
Dorvilleidae g. sp.			+
Dysponetus pygmaeus Levinsen, 1879		+	+
Eclysippe vanelli Fauvel, 1936			+
Ehlersia oerstedi (Malmgren, 1867)	+		
Enipo torelli (Malmgren, 1865)		+	+
Eteone flava (Fabricius, 1780)	+	+	+
Eteone foliosa Qautrefages, 1866		+	
Eteone longa (Fabricius, 1780)	+	+	+
Eteone spetsbergensis Malmgren, 1865		+	+
Eteone s. spetsbergensis Malmgren, 1865	+		+
Euchone analis (Kroyer, 1856)	+	+	+
Euchone papillosa (M. Sars, 1851)	+	+	+
Euclymeninae g. sp.	+	+	+
Eulalia bilineata (Johnston, 1840)			+
Eulalia sp.		+	
Eulalia tjalfiensis Ditlevsen, 1917		+	
Eulalia viridis (L., 1767)		+	+
Eumida arctica (Annenkova, 1946)			+
Eumida bahusiensis Bergstrom, 1914		+	+
Eumida sanguinea (Orsted, 1843)			+
Eunice dubitata Fauchald, 1974		+	
Eunice pennata (O.F. Muller, 1776)	+	+	
Eunoe nodosa (M. Sars, 1861)			+
Eunoe oerstedi Malmgren, 1865			+
Euphrosine borealis Orsted, 1843			+
Eurysyllis sp.		+	
*Eusyllis blomstrand*i Malmgren, 1867	+		+
Euzonus flabelligerus (Ziegelmeier, 1955)			+
Exogone gemmifera Pagenstecher, 1862			+
Exogone hebes (Webster & Benedict, 1884)			+
Exogone naidina Orsted, 1845	+		+
Exogone verugera (Claparede, 1868)	+	+	+
Flabelligera affinis M. Sars, 1829			+
Flabelligera assimilis ?		+	
Galathowenia fragilis Nilsen & Holthe, 1985	+	+	+
Galathowenia oculata Zachs, 1923	+	+	+
Gattyana amondseni (Malmgren, 1867)		+	+
Gattyana cirrhosa (Pallas, 1766)		+	+
Gattyana cirrosa (Pallas, 1766)			+
Gattyana nutti Pettibone, 1955			+
Glycera capitata Orsted, 1843	+	+	+
Glycera lapidum Quatrephages, 1865			+
Glyphanostomum pallescens (Theel, 1873)	+	+	+
Goniada maculata Orsted, 1843	+	+	+
Goniada norvegica Orsted, 1845			+
Harmothoe aspera (Hansen, 1878)		+	+
Harmothoe fragilis Moore, 1910		+	
Harmothoe imbricata (L., 1767)		+	+
Harmothoe impar impar (Johnston, 1839)			+
Harmothoe macintoshi Tebble & Chambers, 1982		+	
Harmothoe propinqua (Malmgren, 1867)			+
Harmothoe villosa ?	+		+
Heteromastus filiformis (Claparede, 1864)	+	+	+
Hydroides norvegicus Gunnerus, 1768	+	+	

Lacydonia sp.		+	
Lanassa nordenskjoldi Malmgren, 1865	+	+	+
Lanassa venusta venusta (Malm, 1874)	+	+	+
Laonice cirrata (M. Sars, 1851)	+	+	+
Laonome kroeyri Malmgren, 1865		+	+
Laphania boecki Malmgren, 1865	+	+	+
Leaena abranchiata Malmgren, 1865	+	+	+
Lepidonotus squamatus (L., 1767)		+	+
Levinsenia gracilis (Tauber, 1879)	+		+
Lumbriclymene cylindricaudata M. Sars, 1871	+		+
Lumbriclymene minor Arwidsson, 1906	+	+	+
Lumbrineris gracilis		+	
Lumbrineris latreilli Audouin & Milne-Edwards, 1834			+
Lumbrineris mixochaeta Oug, 1998		+	+
Lumbrineris sp.	+		+
Lumbrineris tetraura (Schmarda, 1861)			+
Lysilla loveni Malmgren, 1866		+	+
Lysippe labiata Malmgren, 1865	+	+	+
Macellicephalinae g. sp.			+
Macrochaeta polyonyx Eliason,1962		+	
Macrochaeta sp.		+	+
Maldane arctica Detinova, 1985	+	+	+
Maldane sarsi Malmgren, 1867	+	+	+
Marenzelleria wireni Augener, 1913			+
Mediomastus fragilis Rasmussen, 1973		+	
Melinna cristata (M. Sars, 1851)	+	+	+
Melinna elisabethae McIntosh, 1922	+	+	+
Microclymene acirrata Arwidsson, 1906		+	
Micronephthys minuta (Theel, 1879)		+	+
Micronephthys neotena Noyes, 1980		+	+
Minuspio cirrifera (Wiren, 1883)	+	+	+
Myriochele danielsseni Hansen, 1878			+
Myriochele heeri Malmgren, 1867	+	+	+
Mystides borealis Theel, 1879			+
Mystides caeca Langerhans, 1880	+		+
Mystides sp.		+	+
Myxicola infundibulum (Reinier, 1804)			+
Neopolynoe paradoxa (Storm, 1888)	+		+
Nephtys caeca (Fabricius, 1780)			+
Nephtys ciliata (Muller, 1779)	+	+	+
Nephtys longosetosa Orsted, 1843			+
Nephtys paradoxa Malm, 1874	+	+	+
Nephtys pente Rainer, 1984	+	+	+
Nereifilla lutea (Malmgren, 1865)		+	+
Nereimyra aphroditoides (Fabricius, 1780)			+
Nereimyra punctata (O.F. Muller, 1788)	+	+	
Nereis pelagica L., 1761			+
Nereis zonata Malmgren, 1867			+
Nicolea zostericola Orsted, 1844		+	+
Nicomache lumbricalis (Fabricius, 1780)	+	+	+
Nicomache minor Arwidsson, 1906			+
Nicomache personata Johnson, 1901		+	+
Nicomache quadrispinata Arwidsson, 1906	+	+	+
Nothria hyperborea (Hansen, 1878)	+	+	+
Notomastus latericeus M. Sars, 1851	+	+	+
Notoproctus oculatus Arwidsson, 1906	+	+	+
Ophelia limacina (Rathke, 1843)	+	+	+
Ophelina abranchiata Stop-Bowitz, 1948			+
Ophelina acuminata Orsted, 1843	+	+	+
Ophelina cylindricaudata (Hansen, 1878)	+	+	+
Ophryotrocha sp.			+
Owenia assimilis (Malmgren, 1867)	+		+
Owenia borealis ?	+	+	+
Owenia fusiformis Delle Chiaje, 1841	+		+
Owenia gr. *fusiformis* Delle Chiaje, 1841			+
Owenia polaris ?	+	+	+
Paradexiospira vitrea (Fabricius, 1780)		+	+
Paradoneis eliasoni Mackie, 1991	+	+	+
Paramphinome jeffreisii (McIntosh, 1868)	+	+	+
Paramphitrite birulai (Ssolowiew, 1899)		+	+
Paranaitis wahlbergi (Malmgren, 1985)			+
Paraninoe minuta (Theel, 1879)	+		+
Paraonella nordica (Strelzov, 1968)		+	+
Paraonidae g. sp.	+		+
Pectinaria granulata (L., 1767)			+
Pectinaria hyperborea (Malmgren, 1865)	+	+	+
Pectinaria koreni Malmgren, 1865		+	
Petaloproctus tenuis (Theel, 1879)	+	+	+
Pherusa arctica Stop-Bowitz, 1948			+
Pherusa falcata Stop-Bowitz, 1948	+	+	+
Pherusa plumosa (O.F. Muller, 1776)		+	+
Pholoe assimilis Orsted, 1845		+	+
Pholoe baltica Orsted, 1843	+	+	
Pholoe inornata Johnston, 1839	+		+
Pholoe longa (Muller, 1776)			+
Phyllodoce groenlandica Oersted, 1842	+	+	+
Phyllodoce maculata (L., 1767)			+
Pionosyllis sp.		+	+
Pista bansei Safronova, 1988			+
Pista maculata (Dalyell, 1853)	+	+	+
Placostegus tridentatus (Fabricius, 1779)	+	+	
Polycirrus arcticus M. Sars, 1865	+	+	+
Polycirrus fedorovi Jirkov & Leontovich, 2001			+
Polycirrus medusa Grube, 1850	+	+	+
Polycirrus norvegicus Wollebek, 1912			+
Polydora caeca (Orsted, 1843)		+	+
Polydora caulleryi Mesnil, 1897			+
Polydora quadrilobata Jakobi, 1883	+		
Polydora socialis (Schmarda, 1861)		+	+
Polyphysia crassa (Orsted, 1843)		+	+
Pomatoceros triqueter (Linnaeus, 1767)	+	+	
Potamilla neglecta (M. Sars, 1851)			+
Praxillella affinis (M. Sars, 1872)		+	+
Praxillella gracilis (M. Sars, 1861)	+	+	+
Praxillella praetermissa (Malmgren, 1865)	+	+	+
Praxillura longissima Arwidsson, 1906		+	+
Proclea graffi (Langerhans, 1880)	+	+	+
Protula globifera (Theel, 1879)	+		
Pseudopotamilla reniformis (O.F. Muller, 1771)			+
Pseudoscalibregma parvum (Hansen, 1878)	+	+	+
Pygospio elegans Claparede, 1869		+	+
Rhodine gracilior Tauber, 1879	+	+	+
Rhodine loveni Malmgren, 1867	+	+	+
Sabellidae g. sp.	+		+
Sabellides borealis (M. Sars, 1856)			+
Sabellides octocirrata (M. Sars, 1835)		+	
Samythella elongata Verrill, 1873			+
Scalibregma inflatum Rathke, 1843	+	+	+
Schistomeringos sp.		+	+
Scolelepis korsuni Sikorski, 1994	+	+	+
Scolelepis matsugae Sikorski, 1994			+
Scoletoma fragilis (Muller, 1776)	+	+	+
Scoletoma magnidentata (Winsnes, 1981)		+	
Scoloplos acutus Verrill, 1873	+	+	+
Scoloplos armiger (O.F. Muller, 1776)		+	+
Sosanopsis wireni Hessle, 1917	+	+	+
Sphaerodoridae g. sp.	+	+	+
Sphaerodoridium fauchaldi Hartmann-Schroder, 1993			+
Sphaerodoropsis minuta (Webster & Benedict, 1887)			+
Sphaerodoropsis philippi (Fauvel, 1911)	+		+
Sphaerodoropsis sp.		+	
Sphaerodorum gracilis (Rathke, 1843)		+	+
Spio armata (Thulin, 1957)	+	+	+

Spio goniocepala Thulin, 1957			+
Spio martinensis Mesnil, 1896	+	+	+
Spio theeli (Soderstrom, 1920)			+
Spiochaetopterus typicus M. Sars, 1856	+	+	+
Spiophanes kroeyeri Grube, 1860	+	+	+
Streblosoma intestinale M. Sars, 1872			+
Syllidae g. sp.	+	+	+
Syllides longocirrata Orsted, 1845			+
Tauberia gracilis (Tauber, 1879)	+	+	+
Terebellides stroemi Sars, 1835	+	+	+
Terebellides williamsae Jirkov, 1989	+		+
Terebellinae g. sp.		+	+
Tharyx killariensis (Southern, 1914)		+	+
Tharyx sp.		+	+
Thelepus cincinnatus (Fabricius, 1780)	+	+	+
Travisia forbesii Johnston, 1840			+
Typosyllis armillaris (O.F. Muller, 1776)	+	+	+
Typosyllis cornuta (Rathke, 1843)		+	
Typosyllis fasciata (Malmgren, 1867)			+
Typosyllis hyalina (Grube, 1863)	+		+
Typosyllis sp.	+	+	
Typosyllis variegata (Grube, 1860)			+

Hirudinea

Hirudinea g. sp.			+

Oligochaeta

Oligochaeta g. sp.		+	

Sipuncula

Golfingia elongata (Keferstein, 1863)			+
Golfingia m. margaritacea (M. Sars, 1851)		+	+
Golfingia v. vulgaris (de Blainville,1827)		+	+
Golfingia sp.	+	+	+
Nephasoma a. abyssorum (Koren & Danielssen, 1875)			+
Nephasoma d. diaphanes (Gerould, 1913)			+
Nephasoma eremita (M. Sars, 1851)	+	+	+
Nephasoma improvisa (Théel, 1905)			+
Nephasoma minutum (Keferstein, 1863)		+	
Nephasoma sp.	+	+	+
Phascolion s. strombus (Montagu, 1804)	+	+	+

Pantopoda

Eurycyde hispida (Kroyer, 1844-45)		+	+
Nymphon sp.			+
Nymphon spinosum (Goodsir, 1842)			+
Pseudopallene circularis (Goodsir, 1842)		+	+

Crustacea

Cirripedia

Balanus balanus (L., 1758)	+	+	+
Balanus crenatus Bruguiere, 1789		+	+
Verruca stroemia (O.F. Muller, 1776)	+	+	+

Leptostraca

Nebalia bipes (Fabricius, 1780)			+

Euphasiacea

Meganyctiphanes norvegica (M. Sars, 1857)	+	+	+
Thysanoessa inermis (Kroyer, 1846)		+	+
Thysanoessa longicaudata (Kroyer, 1846)	+	+	+
Thysanoessa raschii (M. Sars, 1864)		+	+

Decapoda

Crangonidae g. sp.			+
Eualus gaimardi gaimardi (Milne-Edwards, 1837)			+
Hyas araneus (L., 1758)		+	+
Hyas coarctatus Leash, 1815			+
Lithodidae g. sp. zoea	+		
Pagurus bernhardus (L., 1758)			+
Pagurus pubescens (Kroyer, 1838)	+		+
Pandalus borealis Kroyer, 1837			+
Paralithodes camtschatica (Tilesius, 1815)		+	
Pontophilus norvegicus M. Sars, 1861			+
Sabinea septemcarinata (Sabine, 1821)			+
Spirontocaris liljeborgy (Danielssen, 1859)			+

Mysidae

Erytrops erythophthalma (Goës, 1864)	+		+
Mysidae g. sp.	+	+	
Pseudomma roseum G.O. Sars, 1870			+
Pseudomma truncatum Smith, 1879			+

Amphipoda - Gammaridea

Acanthonotozoma rusanovae Bryazgin, 1974		+	+
Acanthostepheia behringiensis (Lockington, 1877)			+
Aceroides latipes (G.O. Sars, 1882)		+	+
Acidostoma obesum (Bate, 1862)			+
Ampelisca eschrichti Kroyer, 1842	+	+	+
Priscillina armata (Boeck, 1861)			+
Ampelisca macrocephala Lillijeborg, 1852		+	+
Amphilochus manudens Bate, 1862		+	+
Amphilochus tenuimanus (Boeck, 1870)			+
Andaniella pectinata (G.O. Sars, 1882)			+
Andaniexis abyssi Boeck, 1871		+	
Anonyx debruynii Hoek, 1882			+
Anonyx lilljeborgii Boeck, 1870			+
Anonyx nugax (Phipps, 1774)			+
Anonyx sarsi Steele, Brunel, 1986			+
Apherusa megalops (Buchholz, 1874)			+
Apherusa sarsi Schoemaker, 1930			+
Argissa hamatipes (Norman, 1869)			+
Arrhinopsis longicornis Stappers, 1911	+	+	+
Arrhis phyllonyx (M. Sars, 1858)	+	+	+
Atylus nordlandicus (Boeck, 1871)			+
Atylus smitti (Goës, 1866)			+
Autonoe borealis (Myers, 1976)			+
Autonoe megacheir G.O. Sars, 1879			+
Bathymedon obtusifrons (Hansen, 1883)			+
Byblis crassicornis Metzger, 1875			+
Byblis erythrops G.O. Sars, 1882		+	+
Byblis gaimardi (Kroyer, 1846)	+	+	+
Byblis longicornis (G.O. Sars, 1891)		+	
Centromedon productus (Goës, 1866)		+	+
Centromedon pumilus (Liljeborg, 1865)	+		+
Crassicorophium bonelli (Milne-Edwards, 1830)	+		
Crassicorophium crassicorne (Bruzelius, 1859)			+
Cressa dubia (Bate, 1856)			+
Deflexilodes norvegicus (Boeck, 1860)			+
Deflexilodes tesselatus (Schneider, 1883)			+
Deflexilodes tuberculatus (Boeck, 1870)		+	+
Dulichia falcata (Bate, 1857)			+
Dulichia tuberculata Boeck, 1870		+	
Dyopedos bispinis (Gurjanova, 1930)			+
Dyopedos monocanthus (Metzger, 1875)			+
Dyopedos porrectus Bate, 1857			+
Ericthonius megalops (G.O. Sars, 1879)			+
Ericthonius rubricornis (Stimpson, 1853)			+
Ericthonius stephenseni Myers & McGrath, 1984			+
Gammaropsis melanops G.O. Sars, 1882			+
Gitanopsis arctica G.O. Sars, 1892			+
Goesia depressa (Goës, 1866)		+	+
Guernea nordenskioldi (Hansen, 1888)			+
Haliragoides inermis (G.O. Sars, 1882)		+	

Haploops laevis Hoek, 1882			+
Haploops setosa Boeck, 1871	+		+
Haploops similis Stephensen, 1925			+
Haploops tenuis Kanneworff, 1966			+
Haploops tubicola Liljeborg, 1855	+	+	+
Harpinia crenulata Boeck, 1871			+
Harpinia laevis G.O. Sars, 1981		+	+
Harpinia mucronata G.O. Sars, 1879	+		+
Harpinia plumosa Kroyer, 1842		+	+
Harpinia propinqua G.O. Sars, 1891	+	+	+
Harpinia serrata G.O. Sars, 1879			+
Hippomedon gorbunovi Gurjanova, 1930			+
Hippomedon holbolli (Kroyer, 1846)	+		
Hippomedon propinquus G.O. Sars, 1890	+	+	+
Idunella aequicornis (G.O. Sars, 1876)	+	+	+
Ischyrocerus anguipes Kroyer, 1838			+
*Ischyrocerus megachei*r (Boesk, 1871)			+
Ischyrocerus megalops G.O. Sars, 1894			+
Ischyrocerus nanoides (Hansen, 1887)	+		+
Lepechinella arctica Schelenberg, 1926			+
Lepidepecreum umbo (Goës,1866)		+	+
Leptophoxus falcatus G.O. Sars, 1882			+
Lilljeborgia brevicornis (Bruzelius, 1859)		+	
Lilljeborgia fissicornis (M. Sars, 1858)		+	+
Maera loveni (Bruzelius, 1859)		+	
Medicorophium affine (Bruzelius, 1859)		+	+
Megamoera dentata (Kroyer, 1842)		+	+
Melphidippa goesi Stebbing, 1899			+
Menigrates obtusifrons (Boeck, 1861)			+
Metopa alderi (Bate, 1857)			+
Metopa borealis G.O. Sars, 1882			+
Metopa norvegica (Liljeborg,1851)			+
Metopa propinqua G.O. Sars, 1892			+
Metopa robusta G.O. Sars, 1892			+
Metopa uschakovi Gurjanova, 1948			+
Monoculodes coecus Gurjanova, 1946		+	+
Monoculodes latimanus (Goës, 1866)			+
Monoculodes packardi Boeck, 1871			+
Monoculopsis longicornis (Boeck, 1871)		+	+
Neochela monstrosa (Boesk, 1861)		+	+
Neopleustes assimilis (G.O. Sars, 1882)			+
Nicippe tumida Bruzelius, 1859			+
Odius carinatus (Bate, 1862)		+	+
Oediceros borealis Boeck, 1871			+
Oediceros saginatus Kroyer, 1842			+
Onisimus brevicaudatus Hansen, 1886			+
Onisimus normani (G.O. Sars, 1895)			+
Onisimus simus Gurjanova, 1962			+
Opisa eschrichti (Kroyer, 1842)			+
Orchomene pectinata G.O. Sars, 1882			+
Orchomene serrata (Boeck, 1861)	+		+
Orchomenella glabra (Lagardere, 1968)	+		
Orchomenella minuta (Kroyer, 1846)	+		+
Orchomenella pinquis Boeck, 1861		+	+
Pacifoculodes pallidus (G.O. Sars, 1892)			+
Paradulichia typica Boeck, 1870			+
Paraphoxus oculatus (G.O. Sars, 1879)			+
Parapleustes gracilis (Buchholz, 1874)			+
Pardalisca cuspidata Kroyer, 1842			+
Paroediceros lynceus (M. Sars, 1858)	+	+	+
Photis reinhardi Kroyer, 1842			+
Photis tenuicornis G.O. Sars, 1882			+
Phoxocephalus holbolli (Kroyer, 1842)		+	+
Pleustes panoplus (Kroyer, 1838)			+
Pleustomesus medius (Goës, 1866)			+
Pleusymtes pulchellus (G.O. Sars, 1876)			+
Pontocrates arcticus G.O. Sars, 1895		+	+
Priscillina armata (Boeck, 1861)			+

Protomedeia fasciata Kroyer, 1842	+	+	+
Protomedeia grandimana Bruggen, 1905			+
Rhachotropis inflata (G.O. Sars, 1882)			+
Rosinante fragilis (Goës, 1886)			+
Rostroculodes borealis Boeck, 1871	+		+
Rostroculodes longirostris (Goës, 1866)		+	+
Rostroculodes schneideri G.O. Sars, 1895		+	+
Socarnes bidenticulatus (Bate, 1858)			+
Socarnes vahli (Kroyer, 1838)			+
Stegocephalus inflatus Kroyer, 1842			+
Stenopleustes malmgreni (Boeck, 1871)			+
Syrrhoe crenulata Goës,1866	+	+	+
Tiron spiniferus (Stimpson. 1853)		+	+
Tmetonyx similis (G.O. Sars, 1891)			+
Tryphosella nanoides (Liljeborg, 1865)	+	+	+
Tryphosella sarsi (Bonnier, 1893)			+
Tryphosella schneideri Stephensen, 1925	+		+
Tryphosella tryangula (Stephensen, 1925)		+	+
Unciola leucopis (Kroyer, 1845)	+	+	+
Unciola planipes Norman, 1867	+	+	+
Urothoe elegans Bate, 1857	+		+
Westwodilla coecula (Bate, 1856)			+
Westwoodilla brevicalcar (Goës, 1866)	+		+

Amphipoda – Caprellidea

Caprella linearis (L., 1767)			+
Caprella microtuberculata G.O. Sars, 1880			+
Caprella septentrionalis Kroyer, 1838			+

Cumacea

Brachydiastylis nimia Hansen, 1920			+
Brachydiastylis resima (Kroyer, 1896)	+	+	+
Campylaspis costata (Lilljeborg, 1855)	+		+
Campylaspis costata typica G.O. Sars, 1864		+	
Campylaspis horrida G.O. Sars, 1870			+
Campylaspis rubicunda (Lilljeborg, 1855)		+	+
Campylaspis sulcata G.O. Sars, 1870			+
Campylaspis umbensis Gurwitch, 1939			+
Diastylis cornuta (Boeck, 1864)			+
Diastylis edwardsi (Kroyer, 1841)	+	+	+
Diastylis glabra Zimmer, 1926			+
Diastylis goodsiri (Bell, 1855)			+
Diastylis lepechini Zimmer, 1926	+	+	+
Diastylis oxyrhyncha Zimmer, 1926			+
Diastylis rathkei (Kroyer, 1841)			+
Diastylis rathkei sarsi Norman, 1902	+		+
Diastylis rathkei typica (Kroyer, 1841)		+	
Diastylis scorpioides (Lepechin, 1780)		+	+
Diastylis spinulosa Heller, 1875			+
Diastylis sulcata Calman, 1912			+
Eudorella arctica Hansen, 1920			+
Eudorella emarginata (Kroyer, 1846)	+	+	+
Eudorella groenlandica Zimmer, 1926			+
Eudorella hispida G.O. Sars, 1871			+
Eudorella spitzbergensis Zimmer, 1926		+	+
Hemilamprops cristata (G.O. Sars, 1870)			+
Hemilamprops rosea (Norman, 1863)			+
Hemilamprops uniplicata (G.O. Sars, 1871)			+
Lamprops fasciata G.O. Sars, 1863			+
Lamprops fuscata G.O. Sars, 1864			+
Leptostylis ampullacea (Lilljeborg, 1855)		+	+
Leptostylis longimana (G.O. Sars, 1864)			+
Leptostylis macrura G.O. Sars, 1869			+
Leptostylis villosa G.O. Sars, 1869	+	+	+
Leucon acutirostris G.O. Sars, 1864	+	+	+
Leucon fulvus G.O. Sars, 1864	+		+
Leucon minor Lomakina, 1955		+	
Leucon nasica typicus (Kroyer, 1841)		+	+
Leucon nasicoides typicus Lilljeborg, 1855	+		+

Leucon nathorsti Ohlin, 1901			+
Leucon pallidus G.O. Sars, 1864	+	+	+
Petalosarsia declivis (G.O. Sars, 1864)		+	+
Platysympus tricarinatus Hansen, 1920			+

Tanaidacea

Apseudes spinosus (M. Sars, 1858)	+		
Cryptocopoides arcticus (Hansen, 1886)			+
Leptognathia af. *subaequalis* Hansen, 1913			+
Leptognathia brevimana (Lilljeborg, 1865)			+
Leptognathia gracilis (Kroyer, 1847)		+	+
Leptognathia polita Hansen, 1913			+
Leptognathia sarsi Hansen, 1909			+
Leptognathia vicina Hansen, 1913			+
Pseudotanais affinis Hansen, 1886			+
Pseudotanais forcipatus (Lilljeborg, 1864)			+
Pseudotanais lilljeborgi G.O. Sars, 1882			+
Pseudotanais macrocheles G.O. Sars, 1882			+
Sphyrapus anomalus (G.O. Sars, 1899)			+
Thyphlotanais cornutus (G.O. Sars, 1879)			+
Thyphlotanais finmarchicus G.O. Sars, 1882		+	+
Thyphlotanais irregularis Hansen, 1886			+
Thyphlotanais sp.			+
Typhlotanais finmarchicus G.O. Sars, 1881		+	+

Isopoda

Calathura brachiata (Stimpson, 1854)			+
Desmosoma af. *strombergi* Svavarsson, 1988			+
Desmosoma globiceps (Meiner, 1890)			+
Desmosoma sp.		+	+
Echinozone arctica Hansen, 1916			+
Baeonectes muticus (G.O. Sars, 1864)			+
Eurycope producta G.O. Sars, 1868			+
Eurycope sp.		+	+
Gnathia elongata (Kroyer, 1846)	+	+	+
Gnathia sp.	+	+	+
Ilyarachna bergendali Ohlin, 1905			+
Ilyarachna bicornis Hansen, 1916			+
Ilyarachna hirticeps G.O. Sars, 1870	+		+
Ilyarachna longicornis (G.O. Sars, 1871)			+
Ischnomesus sp.			+
Jaera albifrons Leach, 1814			+
Janira maculosa Leach, 1814			+
Katianira cornigera Gurjanova, 1930			+
Macrostylis sp.			+
Macrostylis spinifera G.O. Sars, 1864			+
Munna acanthifera Hansen, 1916			+
Munna fabricii Kroyer, 1846			+
Munna hanseni Stappers, 1911			+
Munna kroeyeri Goodsir, 1842			+
Munna roemeri Gurjanova, 1930			+
Munnopsis typica M. Sars, 1861			+
Nannoniscus oblongus G.O. Sars, 1870			+
Pleurogonium inerme G.O. Sars, 1886			+
Pleurogonium rubicundum (G.O. Sars, 1864)		+	+
Pleurogonium spinosissimum (G.O. Sars, 1866)		+	+
*Saduria sabin*i (Kroyer, 1849)			+
Synidothea af. *marmorata* (Packard, 1867)			+
Synidothea nodulosa (Kroyer, 1846)			+

Ostracoda

Ostracoda g. sp.	+	+	+
? *Philomedes globosus* (Lilljeborg, 1853)	+	+	+

Mollusca

Polyplacophora

Boreochiton ruber (L., 1767)		+	
Stenosemus albus (L., 1767)	+	+	+
Tonicella marmorea (Fabricius, 1780)	+	+	

Aplacophora

Caudofoveata g. sp.	+	+	+
Chaetoderma sp.	+	+	+

Gastropoda

Adalaria loveni Alder & Hancock, 1862	+		
Admete viridula (Fabricius, 1780)	+	+	+
Adostomia sp.		+	
Alvania mighelsi			+
Amaura candida Moller, 1842			+
Anatoma crispata (Fleming, 1828)			+
Ariadnaria borealis (Broderip & Sowerby, 1829)		+	+
Astyris rosacea (Gould, 1840)	+		+
Boreotrophon clathratus (L., 1767)		+	+
Boreotrophon truncatus (Strom, 1767)		+	+
Buccinum ciliatum ciliatum (Fabricius, 1780)			+
Buccinum finmarchianum Verkruzen, 1875			+
Buccinum undatum L., 1758			+
Cerithiella whiteavesii (Verrill, 1880)			+
Cima cuticulata Waren, 1993			+
Colus sp.			+
Cryptonatica clausa (Broderip & Sowerby, 1828)	+	+	+
Curtitoma sp.			+
Curtitoma trevelliana (Turton, 1834)	+	+	+
Curtitoma violacea (Mighels & Adams, 1842)			+
Cylichna alba (Brown, 1827)	+	+	+
Cylichna densistriata (Leche, 1878)			+
Cylichna scalpta (Reeve, 1855)		+	+
Dendronotus sp.			+
Diaphana hiemalis (Couthouy, 1939)	+		+
Diaphana minuta (Brown in Smith, 1839)	+		+
Erginus rubella (Fabricius, 1780)		+	
Frigidoalvania cruenta (Odhner, 1915)			+
Frigidoalvania janmayeni (Friele, 1978)		+	+
Frigidoalvania scrobiculata (Moller, 1842)			+
Gibbula tumida (Montagu,1803)		+	
Hemiaclis glabra			+
Lepeta coeca (O.F. Muller, 1776)	+	+	+
Limneria undata (Brown, 1838)			+
Liostomia sp.		+	
Lunatia pallida (Broderip & Sowerby, 1829)	+	+	+
Margarites costalis (Gould, 1841)	+	+	+
Margarites gigantea (Leche, 1878)		+	+
Margarites groenlandicus (Gmelin, 1790)	+	+	+
Margarites olivacea (Brown, 1827)	+		+
Margarites olivacea marginata			+
Margarites olivacea olivacea			+
Menestho albula			+
Menestho truncatula Odhner, 1915			+
Moelleria costulata (Moller, 1842)		+	+
Neptunea sp.			+
Nudibranchia g. sp.			+
Obesotoma woodiana (Moller, 1842)			+
Obtusella tumidula			+
Oenopota elegans (Moller, 1842)			+
Oenopota harpa (Dall, 1884)			+
Oenopota impressa (Morch, 1869)			+
Oenopota pyramidalis (Strom, 1788)		+	+
Oenopotinae g. sp.		+	+
Ondina sp.		+	
Onoba aculeus (Gould, 1841)		+	
Philine finmarchica G.O. Sars, 1878			+
Philine lima (Brown, 1827)			+
Philine quadrata (S. Wood, 1839)		+	+
Propebela assimilis (G.O. Sars, 1878)			+
Propebela bergensis			+
Propebela exarata (Moller, 1842)			+
Propebela harpularia (Couthouy, 1838)		+	+

Propebela nobilis (Moller, 1842)			+
Propebela rugulata (Moller in Troschel, 1866)	+	+	+
Propebela scalaris (Moller, 1842)			+
Propebela turricula	+		+
Propebela viridula (Moller, 1842)			+
Punctulum wyvillethomsoni (Jeffreys in Friele, 1877)			+
Puncturella noachina (L., 1771)	+	+	+
Retusa pertenuis (Mighels, 1843)			+
Scaphander punctostriatus (Mighels & Adams, 1842)	+		+
Setia latior (Mighels & Adams, 1842)			+
Skenea granesa			+
Solariella obscura (Couthouy, 1838)			+
Solariella varicosa (Mighels & Adams, 1842)	+		+
Taranis amoena		+	+
Taranis moerchi		+	
Tectura virginea (Muller, 1776)	+	+	+
Turritellopsis acicula (Stimpson, 1851)			+
Velutina sp.			+
Velutina velutina (Muller, 1776)		+	

Bivalvia

Acanthocardia echinata (L. 1758)			+
Anomia aculeata (Muller, 1776)	+	+	+
Anomia squamula (L., 1767)	+	+	+
Arctica islandica (L., 1767)			+
Arctinula greenlandica (Sowerby, 1842)	+	+	+
Astarte arctica (Gray, 1824)	+	+	
Astarte borealis Schumacher, 1817			+
Astarte crebricostata (McAndrews & Forbes, 1847)		+	
Astarte crenata (Gray, 1842)	+	+	+
Astarte elliptica (Brown, 1827)	+	+	+
Astarte montagui (Dillwyn, 1817)		+	
Axinopsida orbiculata (G.O. Sars, 1878)	+		+
Bathyarca glacialis (Gray, 1842)	+	+	+
Bathyarca pectunculoides (Scacchi, 1834)	+	+	+
Cardiidae g. sp.			+
Chlamys islandica (O.F. Muller, 1776)	+	+	+
Clinocardium ciliatum (Fabricius, 1780)	+		+
Crenella decussata (Montagu, 1808)	+	+	+
Cuspidaria arctica (M. Sars, 1859)	+	+	+
Cuspidaria sp.			+
Cyclopecten imbrifer (Loven, 1846)	+		+
Dacrydium vitreum (Holboll in Moller, 1842)	+	+	+
Hiatella arctica (L., 1767)	+	+	+
Hiatella rugosa (L., 1758)	+		+
Kelliella millaris (Philippi, 1844)			+
Leionucula corticata (Moller, 1842)		+	+
Leionucula tenuis (Montagu, 1808)	+	+	+
Liocyma fluctuosa (Gould, 1841)			+
Lyonsia arenosa (Moller, 1842)			+
Lyonsiella abyssicola M. Sars, 1868	+		+
Macoma calcarea (Gmelin, 1791)	+	+	+
Macoma crassula (Stenstrup, 1882)			+
Macoma moesta (Dashayes, 1855)		+	
Mendicula croulinensis Jeffreys, 1847		+	+
Mendicula ferruginosa (Forbes, 1844)	+	+	+
Modiolus modiolus (L., 1758)	+	+	+
Montacuta spitzbergensis Knipowitsch, 1901			+
Musculus corrugatus (Stimpson, 1851)			+
Musculus discors (L., 1767)			+
Musculus laevigatus (Gray, 1824)			+
Musculus niger (Gray, 1824)		+	+
Mya pseudoarenaria L., 1758	+		+
Mya truncata L., 1767		+	+
Nuculana minuta (Muller, 1776)	+		+
Nuculana pernula (Muller, 1779)	+	+	+
Palliolum tigerinum (Muller, 1776)	+	+	
Pandora glacialis (Leach, 1819)			+
Panomya arctica (Lamarck, 1818)	+		+
Parvicardium elegantulum (Moller, 1842)	+	+	+
Parvicardium ovale (Sowerby, 1840)	+	+	+
Pododesmus patelliformis (Linnaeus, 1761)		+	
Poromya granulata (Nyst & Westendorp, 1839)		+	
Serripes groenlandicus (Bruguiere, 1789)			+
Spisula elliptica Gray, 1837			+
Thracia myopsis (Moller, 1842)	+		+
Thracia septentrionalis Jeffreys, 1872	+	+	+
Thyasira equalis (Verrill & Bush, 1898)	+	+	+
Thyasira gouldi (Philippi, 1845)	+	+	+
Thyasira sarsii (Philippi, 1845)	+	+	+
Yoldia amygdalea (Valenciennes, 1846)	+		
Yoldia hyperborea (Torell, 1859)	+	+	+
Yoldiella frigida (Torell, 1859)			+
Yoldiella intermedia (M. Sars, 1865)	+	+	+
Yoldiella lenticula (Moller, 1842)	+	+	+
Yoldiella lucida (Loven, 1846)	+	+	+
Yoldiella nana (M. Sars, 1865)	+	+	+
Yoldiella propinqua (Leche, 1878)	+		
Yoldiella solidula (Waren, 1989)	+	+	+

Scaphopoda

Antalis entalis L., 1758	+	+	+
Siphonodehtalium lobatum (Sowerby, 1860)	+	+	+

Brachiopoda

Hemithyris psittacea (Gmelin, 1790)	+		+
Macandrevia cranium (Muller, 1776)			+
Terebratulina retusa (L., 1758)	+		

Bryozoa

Alcyonidium disciforme (Smitt, 1878)	+		+
Alcyonidium gelatinosum (L., 1767)			+
Alcyonidium gelatinosum anderssoni Abrikossov, 1932			+
Alcyonidium gelatinosum pachydermatum (Kluge, 1962)			+
Alcyonidium mamillatum (Alder, 1857)			+
Alcyonidium mytili (Dalyell, 1847)			+
Alcyonidium radicellatum Kluge, 1946			+
Amphiblestrum solidum quadrata (Hincks, 1880)	+		+
Amphiblestrum trifolium typica (S. Wood, 1844)	+		
Arctonula arctica (M. Sars, 1871)			+
Bowerbankia imbricata (Adams, 1800)			+
Buffonelaria biaperta Michelin, 1841-1842	+		+
Bugula elongata Nordgaard, 1906	+		+
Bugula fastigiata Dalyell, 1817			+
Bugula harmsworthi Waters, 1900			+
Caberea ellisi (Fleming, 1816)			+
Callopora craticula (Alder, 1857)	+		+
Callopora derjugini (Kluge, 1915)	+		
Callopora smitti (Kluge, 1946)			+
Callopora whiteavesi Norman, 1903	+		+
Cauloramphus cymbaeformis (Hincks, 1877)			+
Cauloramphus intermedius Kluge, 1962			+
Cellepora sp. (c. f. nodulosa Lorenz, 1886)			+
Cellepora sp. (c. f. ventricosa Lorenz, 1886)	+		+
Celleporella hyalina (L., 1767)	+		+
Celleporina incrassata (Lamarck, 1886)			+
Celleporina ventricosa Lorenz, 1886			+
Cheilopora inermis (Busk, 1880)			+
Cheiloporina sincera (Smitt, 1868)			+
Cheiloporina sincera praelucida (Hincks, 1888)			+
Cribrilina punctata (Hassal, 1841)			+

Cribrilina watersi Andersson, 1902	+		+
Crisia denticulata (Lamarck, 1816)			+
*Crisia denticulata borg*i Kluge, 1962			+
Crisia eburneo-denticulata (Smitt, 1865)			+
*Crisia klug*ei (Ryland, 1967)			+
Cystisella saccata Busk, 1856	+		+
Dendrobeania fruticosa frigida (Waters, 1900)			+
Dendrobeania fruticosa Packard, 1863			+
Dendrobeania fruticosa quadridentata (Waters, 1900)	+		+
Dendrobeania murmanica (Kluge, 1915)	+		
Dendrobeania murrayana (Johnston, 1847)	+		+
Dendrobeania pseudomurrayana fessa Kluge, 1955			+
Dendrobeania pseudomurrayana Kluge, 1955	+		+
Dendrobeania pseudomurrayana tenuis Kluge, 1955	+		
Diplosolen obelia (Johnston, 1838)			+
Disporella hispida (Fleming, 1828)			+
Doryporella spathulifera Smitt, 1868	+		+
Electra arctica (Borg, 1931)			+
Entalophora clavata (Busk, 1859)	+		+
Escharella dijmphnae Kluge, 1929			+
Escharella immersa Fleming, 1828			+
Escharella indivisa (Levinsen, 1916)			+
Escharella latodonta (Kluge, 1962)			+
Escharella ventricosa Hassall, 1848	+		+
Escharelloides spinulifera (Hincks, 1889)			+
Escharoides bidenkapi (Kluge, 1946)	+		
Escharopsis lobata (Smitt, 1868)	+		+
Eucratea loricata (L., 1758)	+		+
Flustra sp.			+
Haplopoma impressum (Audouin, 1826)			+
Hippoponella hippopus (Smitt, 1868)	+		+
Hippoporina harmsworthi (Waters, 1900)			+
Hippoporina propinqua Smitt, 1868			+
Hippoporina reticulatopunctata (Hincks, 1877)	+		+
Hippoporina ussovi (Kluge, 1908)			+
Hippothoa divaricata arctica Kluge, 1906			+
Hippothoa expansa Dowson, 1859			+
Idmonea atlantica (Forbes, 1847)	+		+
Kinetoskias smitti Danielssen, 1868			+
Lepraliella contiqua (Smitt, 1868)	+		+
Lichenopora verrucaria (Fabricius, 1780)	+		+
Microporella ciliata (Pallas, 1766)	+		+
Myriapora coarctata (M. Sars, 1863)	+		+
Myriozoella costata Kluge, 1962			+
Myriozoella crustacea Smitt, 1868			+
Oncousoecia diastoporoides (Norman, 1869)	+		+
Oncousoecia poligonalis (Kluge, 1915)			+
Pachyegis groenlandica Norman, 1894			+
Palmicellaria skenei bikornis (Busk, 1856)			+
Palmicellaria skenei Ellis & Solander, 1786			+
Palmicellaria skenei tridens (Busk, 1856)	+		
Parasmittina jeffreysii (Norman, 1903)			+
Phylactella labiata (Boeck in Smitt, 1868)			+
Porella acutirostris Smitt, 1868			+
Porella aperta Boeck, 1862	+		+
Porella concinna belli Douson, 1859			+
Porella fragilis Levinsen, 1914			+
Porella minuta Norman, 1869			+
Porella plana Hincks, 1888	+		+
Porella princeps Norman, 1903			+
Porella proboscidea Hincks, 1888	+		+
Porella smitti Kluge, 1962			+
Porelloides laevis Fleming, 1828			+
Proboscina major (Johnston, 1847)	+		+
Proboscina sp.	+		+
Pseudoflustra solida (Stimpson, 1854)	+		+
Ragionula rosacea (Busk, 1856)			+
Retepora sp. (c.f. *cellulosa* (L., 1758))	+		+
Rhamphostomella bilaminata (Hincks, 1877)			+
Rhamphostomella bilaminata sibirica Kluge, 1929			+
Rhamphostomella costata Lorenz, 1886			+
Rhamphostomella ovata (Smitt, 1868)			+
Rhamphostomella plicata (Smitt, 1868)			+
Rhamphostomella radiatula (Hincks, 1877)			+
Rhamphostomella scarba (Fabricius, 1780)			+
Rhamphostomella spinigera Lorenz, 1886			+
Sarsiflustra abyssicola (G.O. Sars, 1872)	+		+
Schizomavella auriculata lineata (Nordgaard, 1896)			+
Schizomavella porifera (Smitt, 1868)			+
Schizoporella sp.			+
Scrupocellaria arctica (Smitt, 1868)			+
Scrupocellaria minor Kluge, 1915			+
Scrupocellaria scabra (Van Beneden, 1848)			+
Securiflustra securifrons (Pallas, 1766)			+
Sertella septentrionalis Jullen, 1933	+		+
Smittina majuscula (Smitt, 1868)			+
Smittina minuscula Smitt, 1868	+		+
Smittina mucronata Smitt, 1868			+
Smittina rigida Lorenz, 1886	+		+
Smittina smitti (Kirchenpauer, 1874)			+
Stegohornera lichenoides (L., 1758)	+		+
Stomachetosella cruenta (Busk, 1854)	+		+
Stomachetosella magniporata Nordgaard, 1906	+		+
Stomachetosella producta (Packard, 1863)	+		+
Stomachetosella sinuosa (Busk, 1860)	+		+
Tegella arctica (D'Orbigny, 1850)			+
Tegella armifera Hincks, 1880			+
Terminoflustra membranaceo-truncata (Smitt, 1868)			+
Tricellaria gracilis Van Beneden, 1848			+
Tricellaria peachi Busk, 1851			+
Tricellaria ternata (Ellis & Solander, 1786)	+		+
Tubulipora flabellaris (Fabricius, 1780)	+		+
Tubulipora sp.	+		+

Chaetognata

Eukrohnia sp.			+
Parasagitta elegans (Verrill, 1873)		+	
Sagitta sp.			+

Pogonophora

Pogonophora g. sp.	+	+	

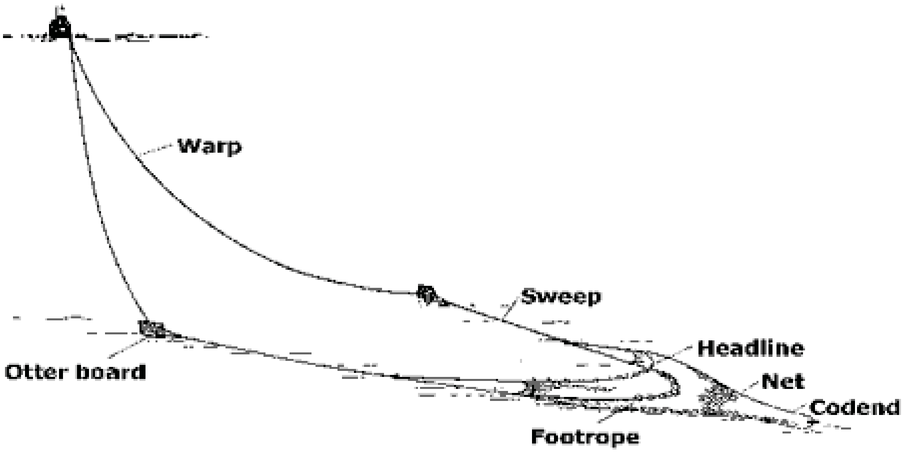
Echinodermata

Holothurioidea

Ankyroderma affine Danielssen & Koren, 1879			+
Ankyroderma jeffreysii Danielssen & Koren, 1879	+		+
Chiridota laevis (Fabricius, 1780)			+
Cucumaria frondosa (Gunnerus, 1867)			+
Ekmania barthi (Troschel, 1846)		+	+
Eupyrgus scaber Lutken, 1857	+	+	+
*Labidoplax busk*i (McIntosh, 1866)	+	+	+
Molpadia borealis (M. Sars, 1859)			+
Myriotrochus rinkii Steenstrup, 1851		+	+
Ocnus glacialis (Ljungman, 1880)			+
Pentamera calcigera (Stimpson, 1851)			+
Psolus phantapus Strussenfelt, 1765	+	+	+

Psolus squamatus (O.F. Muller, 1776)	+	+	
Thyonidium drummondi (Thompson, 1840)		+	+
Trochoderma elegans Theel, 1877			+
Echinoidea			
Brisaster fragilis (Duben & Koren, 1846)			+
Strongylocentrotus droebachiensis O.F. Muller, 1776	+	+	+
Strongylocentrotus pallidus (G.O. Sars, 1871)	+	+	+
Asteroidea			
Asterias rubens L., 1758		+	+
Asteriidae g. sp. juv.		+	
Crossaster papposus (L., 1768)		+	+
Ctenodiscus crispatus (Retzius, 1805)	+	+	+
Henricia sp. juv.	+		
Leptasterias sp. juv.			+
Lophaster furcifer (Duben & Koren, 1846)			+
Pontaster tenuispinus (Duben & Koren, 1846)			+
Pteraster pulvillus M. Sars, 1861	+		
Stephanasterias albula (Stimpson, 1853)			+
Ophiuroidea			
Amphipholis squamata (Delle Chiaje, 1828)	+	+	+
Amphipholis torelli Ljungman, 1871			+
Amphiura sundevalli (Muller & Troschel, 1842)			+
Ophiacantha bidentata (Retzius, 1805)	+	+	+
Ophiocten sericeum (Forbes, 1852)	+	+	+
Ophiopholis aculeata (L., 1767)	+	+	+
Ophioscolex glacialis Muller & Troschel, 1842			+
Ophiura albida Forbes, 1841		+	
Ophiura robusta (Ayers, 1851)	+	+	+
Ophiura sarsi Lutken, 1855	+	+	+
Stegophiura nodosa (Lutken, 1854)			+
Crinoidea			
Heliometra glacialis (Owen, 1833)			+
Chordata			
Ascidiacea	**+**	**+**	**+**
Boltenia echinata (L., 1767)			+
Chelyosoma macleayanum Broderip & Sowerby, 1830		+	
Cnemidocarpa rhizopus (Redikorzev, 1907)			+
Dendrodoa grossilaria (Van Baneden, 1846)			+
Didemnum albidum (Verrill, 1871)	+		
Didemnum sp.		+	
Pelonaia corrugata (Forbes & Good, 1841)			+
Styela sp.			+

Appendix 3. Joint three-year programme (2006-2008) of IMR-PINRO for the research on benthos in the Barents Sea.



The main aims of this 3 year programme is to study the benthic communities in the Barents Sea as one of the components of the ecosystem approach of the management of living resources in the Barents Sea

Main goals

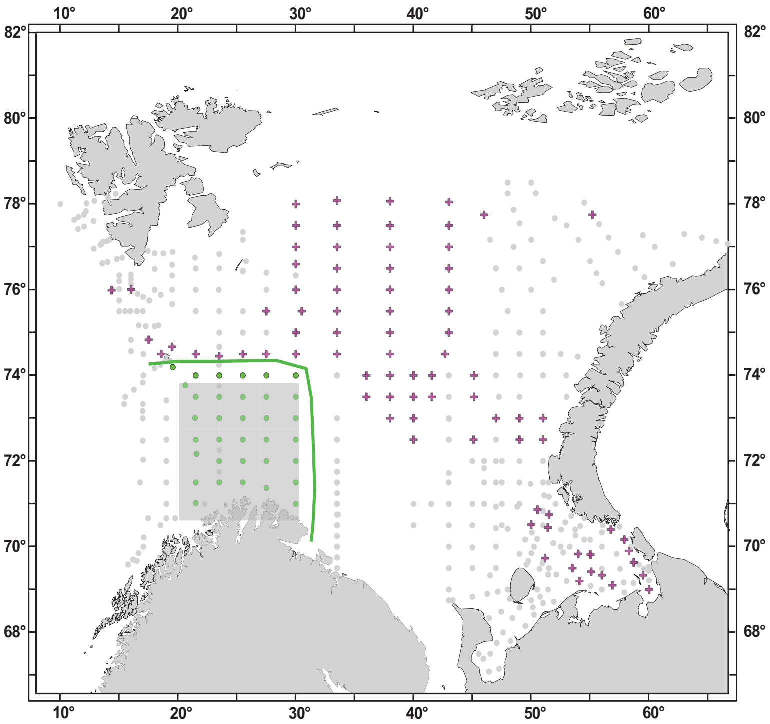
- Mapping of benthic species and communities.
- Initiate long term monitoring for the study of possible changes in the benthic composition connected with:
    - effects of bottom trawling
    - climate
    - invasion species
    - effect from gas and oil activities

Activity

- Sampling of historical station grid of PINRO within the 3 year programme
- Assessment of all the invertebrate species caught in bottom fishing-trawling.
- Video-monitoring of the distribution of benthic species.
- Improve benthic species identification in stomach content of cod and haddock.
- Experimental studies of king crab foraging and its impact on native fauna

Methods

Soft-bottom sampling will be carried out during the joint ecosystem survey in 2006-08.
The selection of station will be in accordance with the historical station grid made by PINRO in 1968-70ties. During the 3-year programme PINRO will continue sample in the Russian part of the Barents Sea, while IMR will sample in the south-western part of the Barents Sea (Figure).



Map of PINRO historical station grid established in 1960ties. the stations south-west of the line (shaded area) should be sampled by IMR, and cross pointed stations by PINRO, in the presented 3-year programme.

PINRO and IMR should use the same methods in collecting and processing data to obtain a comparable datasets. All stations will be covered by 5 x 0.1m^2 Van Veen grab and 10 minutes trawling by Sigbytrawl (PINRO) or Beamtrawl (IMR).

The processing of the IMR samples will be in a joint corporation between PINRO and IMR. IMR has to sort the animals from the sediment. In order to develop a high quality standard of species identification, some taxonomic group will be identified by IMR (Polychaetes etc), while other groups in PINRO (Echinoderms, Molluscs, etc).

Identification and measures (biomass, abundance) of benthic invertebrates caught as by catch in standard Campelen trawling, will be carried out on board of PINRO and IMR vessels during joint ecosystem surveys.

Video-monitoring of the distribution of benthic animals (IMR):
Video-transects (20 min) with Campod will be done at defined stations along a line from coastal areas (Norwegian coastal current), through Atlantic waters and into the Polar front in order to identify any changes in benthic communities.

Experiments with king crab will include cage studies with diving investigation in situ (PINRO) and in laboratory (IMR).

Impact of the king crab will be monitored on hard- (IMR) and soft-bottom (PINRO and IMR) communities in selected areas along the coast of the Russian and Norwegian part of the distribution area of the crab

Expected results of the 3-year program

- Analyses of the correlation of fish stomachs content with the distribution of main prey-taxa in the Barents Sea.
- Analyses of the distribution of selected vulnerable indicator species for bottom trawling in some areas of the Barents Sea.
- Establish areas for monitoring effects of bottom trawling.
- Initiation of a long term monitoring programme of king crab impact on the native fauna in some areas of Norwegian and Russian waters. This includes a list of possible indicator species and knowledge of their population dynamics.
- Results which includes comparable data from laboratory and shallow waters cage studies (in situ) on the consumption of benthic animals by king crab
- Translation of the following PINRO reports with the intension of future publications:
  - Bottom community of the southern part of the Barents Sea as an environment and a foraging reserve of the king crab.
  - Observations of king crab feeding and its impact on the benthic community and population of commercial species.

Exchange of data

Data collected during joint three-year programme (2006-2008) will be exchanged on a mutual and appropriate way.

Appendix 4. List of publications and presentations made during the three year program

Reports

Anisimova N.A., Lyubin P.A., Manushin I.E. 2006. Characteristic of the bottom communities state in the south part of the Barents Sea according results of the benthic survey 2003. Scientific report. PINRO. Murmansk. P. 42-107. (In Russian)

Anisimova N.A., Lyubin P.A., Manushin I.E. 2006. Electronic atlas of the mass species of the Barents Sea macrozoobenthos. Scientific report. PINRO. Murmansk. P. 108-111. (In Russian)

Anisimova N.A., Lyubin P.A., Manushin I.E. 2007. Estimation of macrozoobenthos in by-catches on materials of ecosystem surveies. Scientific report. PINRO. Murmansk. 58 pp. (In Russian)

Anisimova N.A., Lyubin P.A. 2008. Distribution of the red king crab compared to benthic communities. pp. 28-32 in: Sundet J., Berenboim B. (eds.) Research on the red king crab (*Paralithodes camtschaticus*) from the Barents Sea in 2005-2007. IMR/PINRO Joint Report Searies 3/2008. (In Russian)

Anisimova N.A., Manushin I.E. 2008. Benthos as prey for the red king crab. pp. 32-36 in: Sundet J., Berenboim B. (eds.) Research on the red king crab (*Paralithodes camtschaticus*) from the Barents Sea in 2005-2007. IMR/PINRO Joint Report Series 3/2008. (In Russian)

Anisimova NA, Jørgensen LL, Lyubin PA, ManushinIE (In Press). Benthos. In: Ozigin and Jakobsen (eds.). The Barents Sea ecosystem: Russian-Norvegian cooperation in research and management.

Anon 2006. Benthos. Pp.12-14, 28-29, 88-92 in: Survey report from the joint Norwegian/Russian ecosystem survey in the Barents Sea August-Seprember 2006. Vol. 1. IMR/PINRO Joint Report Series 2/2006. 97 pp.

Anon 2007. Benthos. Pp. 10-12, 28-29, 87-89 in: Survey report from the joint Norwegian/Russian ecosystem survey in the Barents Sea August-September 2007. Vol.1. IMR/PINRO Joint Report Series 4/2007. Murmansk: PINRO-Press 2008. 97 pp.

Anon 2007. Benthos. Pp. 39-53 in: Survey report from the joint Norwegian/Russian ecosystem survey in the Barents Sea August-Oktober 2007. Vol. 2. IMR/PINRO Joint Report Series 1/2007. 56 pp.

Anon 2009. Benthos. Pp. 15, 38 In: Survey report from the joint Norwegian/Russian ecosystem survey in the Barents Sea August-October 2008. IMR/PINRO Joint Report Series 1/2009.

Jørgensen L.L. 2008) Artssammensetning og mangde av bunndyr og fisk i forskningstrål in: Knut Sunnanå og Maria Fossheim. Forvaltningsplan Barentshavet -rapport fra overvåkingsgruppen 2008 Fisken og havet, særnummer 1b-2008

Jørgensen LL. Hassel A, og Anisimova, N. 2006. Bunndyr. Pp 67-70 i: Iversen, S. Fossum, P. Gjøsæter, H. Skogen, M og Toreson, R. Havets ressurser og miljø 2006. Fisken og Havet, særnr. 1-2006.08.26

Jørgensen L.L, Anisimova N.A., Liubin P.A., Manushin I.E., Sundet J. 2007. Benthos. Pp.105-109 in: Stiansen, J.E. and A.A. Filin (editors) Joint PINRO/IMR report on the state of the Barents Sea ecosystem in 2006, with expected situation and considerations for management. Issue № 2. IMR/PINRO Joint Report Series 2/2007. ISSN 1502-8828. 209 pp.

Jørgensen, L. L., Primicerio, R., Olsen, E., Anismova, N., Manushyn, I. 2007. 1.5.7 Bunndyr - Bottom fauna. Pp. 58-61, I Skogen, M., Gjøsæter, H., Toresen, R., Robberstad, Y. (Eds.) Havets ressurser og miljø 2007, Fisken og havet, særnummer 1-2007. Havforskningsinstituttet, Bergen

Jørgensen L.L., Anisimova N.A., Lyubin P.A., Manushin I.E. 2008. Benthos. Pp. 101-104 in: Stiansen, J.E. and A.A. Filin (editors). Joint PINRO/IMR report on the state of the Barents sea ecosystem in 2007 with expected situation and considerations for management. IMR/PINRO Joint Report Series 1/2008. ISSN 1502-8828. 185 pp.

Lubin PA, Sabirov RM 2007. To the fauna cephalopods molluscs (Mollusca, Cephalopoda) archipelago Spitsbergen \\ Complex investigations of Spitsbergen nature. Issue. 7. Apatity. 2007 P. 300-306. (In Russian).

Lubin P.A., Jørgensen L.L., Anisimova N.A. (in press) Benthos. In Arneberg and Stiansen (editors). Joint Norwegian-Russian environmental status 2008, Report on the Barents Sea Ecosystem.

Oral presentations

Cochrane SJ, Denisenko SG, Anisimova N, Jørgensen. 2007. How does ice cover affect the benthic fauna in the Barents Sea. In: Haug T, Misund OA, Gjøsæter H, Røttingen I (edt) Long term bilateral Russian-Norwegian scientific co-operation as a basis for sustainable management of living marine reources in the Barents Sea. 12-th Norwegian-Russian Symposius. Tromso, 21-22 August 2007. IMR/PINRO Joint Report Series 5/2007. IMR. Bergen. 2008. P.199-200.

Jørgensen LL 2008. Promoting Norwegian-Russian collaboration in benthos of the Barents Sea, solving previous obstacles to cooperation. Russian-Norwegian Network Meeting “Taxonomic research and biodiversity assessment of zoobenthos in the seas of European sector of the Arctic (the Barents and the White Seas): results and perspectives of Russian-Norwegian collaboration” 24-28 November 2008 St-Petersburg, Russia.

Lyubin P.A, Novikov M.A., Anisimova N.A., Zolotarev P.N., Pinchukov M.A., Manushin I.E. .2006. Capitalized stock assessment of commercial invertebrates and foraging benthos in the Barents sea. IIV All-Russian conference on commercial invertebrates. Murmansk, October 9-13, 2006. Thesis of reports. VNIRO-Press. Moscow. 2006. P. 30-32. (In Russian).

Lubin P.A., Anisimova N.A., Manushin I.E., Antsiferov M.Yu. 2006. Electronic atlas of numeral bottom-dwelling invertebrates of the Barents sea // Information Systems and WEB-Portals on Diversity of Species and ecosystems. Proceedings & Abstracts of the International Symposium. KMK Scientific Press LTD. Moskow. 2006 P. 56-57 (In Russian).

Lubin P.A. 2006. Electronic base of benthic data of Arctic Seas // Information Systems and WEB-Portals on Diversity of Species and ecosystems. Proceedings & Abstracts of the International Symposium. KMK Scientific Press LTD. Moskow. 2006 P. 33-34. (In Russian).

Manushin I.E., Anisimova N.A. 2006. Adaptation of the red king crab introduced in the Barents Sea to the trophic capacity of the new habitat. IIV All-Russian conference on commercial invertebrates. Murmansk, October 9-13, 2006. Thesis of reports. VNIRO-Press. Moscow. 2006. P. 91-94. (In Russian).

Manushin I.E., Anisimova N.A., Lyubin P.A. 2008) Benthos of the southern part of the Barents Sea as the king crab forage reserve \\Materials of the X scientific seminar «Readings in memory of K.M. Derjugin», 7 December 2007. - St-Petersburg: Ichthyology and Hydrobiology department St-Petersburg State University, 2008. P 67-88.

Posters

Anisimova N. Lubin P. Manushin I., Berenboim B. 2007. Barents Sea benthos survey, 2003-2006. Abstracts for the 2007 ICES Annual Science Conference 17-21 Sept., Helsinki, Finland, 2007. P. 94.

Golikov A.V., Sabirov R.M., Lubin P.A. 2008. Distribution and ecology of cephalopods in the Barents Sea. Biodiversity and Functioning of Aquatic Ecosystems in the Baltic Sea Region. Abst. Intern. Conf. – Klaipeda (Lithuania), 2008. -P. 36-37.

Jørgensen, L.L., Primicerio, R., Olsen, E., Gjøsæter, H., Knutsen, T., Lønne, O.J., Loeng, H. 2007. Ecosystem approach to Barents Sea Ecology: spatial and trophic relationship. Arctic Fronties. Tromsø, Januar 2007. Poster.

Jørgensen L.L., Primicerio R., Anisimova N., Lubin P., Manuchin I. Barents Sea bottom animals: large scale distribution // Arctic frontier. Balancing human use and ecosystem protection. 21-26 January 2007. Abstract. Tromsø, 2007. P. 70.

Jørgensen, L.L.,Ingvaldsen R, Ljubin P, Anisimova N. 2008. The joint Barents Sea Ecosystem Survey: Benthic animals used as indicators of climatic change. Arctic Science Summit Week-konferanse. Bergen March 2008.

JOINT REPORT

Institute of Marine Research
Nordnesgaten 50,
5817 Bergen
Norway

Polar Research Institute of Marine Fisheries and Oceanography (PINRO)
6 Knipovich Street,
183763 Murmansk
Russia