

The Svalbard Archipelago investigations are still one of the priority directions of many scientific disciplines involved in the Arctic region problems. Its unique geographical location, rich history, and intensive economic usage attract attention not only of the natural sciences specialists such as glaciologists, geologists, biologists, ecologists, seismologists etc., but also historians, archaeologists, and economists.

International Conference «Complex investigations of the Spitsbergen nature» held in February 2002 under the aegis of MMBI with more than 70 participants from various spheres of science proved the constant and unremitting interest in this high-latitude Arctic Archipelago.

Complex investigations in the area of West Svalbard started in 2001 by the specialist of Murmansk Marine Biological Institute were continued this year. As well as the previous year the works included both the inner island areas studying and coastal zone investigations using small size vessels; marine expedition aimed at West Svalbard coastal waters studying was carried out as well (Figure 1).

Aims and tasks of investigations

- Investigations of water masses hydrological and hydrochemical characteristics;
- Investigation of biodiversity, and structure and dynamics of plankton, benthos, and fishes communities;
- Investigation of biology, fauna, and the conduct of sea birds (first of all colonial) and marine mammals abundance;
- Determination of morpho-functional state of algae in different parts of the coast, as well as algae sampling for heavy metals contents;
- Assessment of current periglacial processes and their impact on geological, geomorphological, and sedimentological peculiarities of the Archipelago.

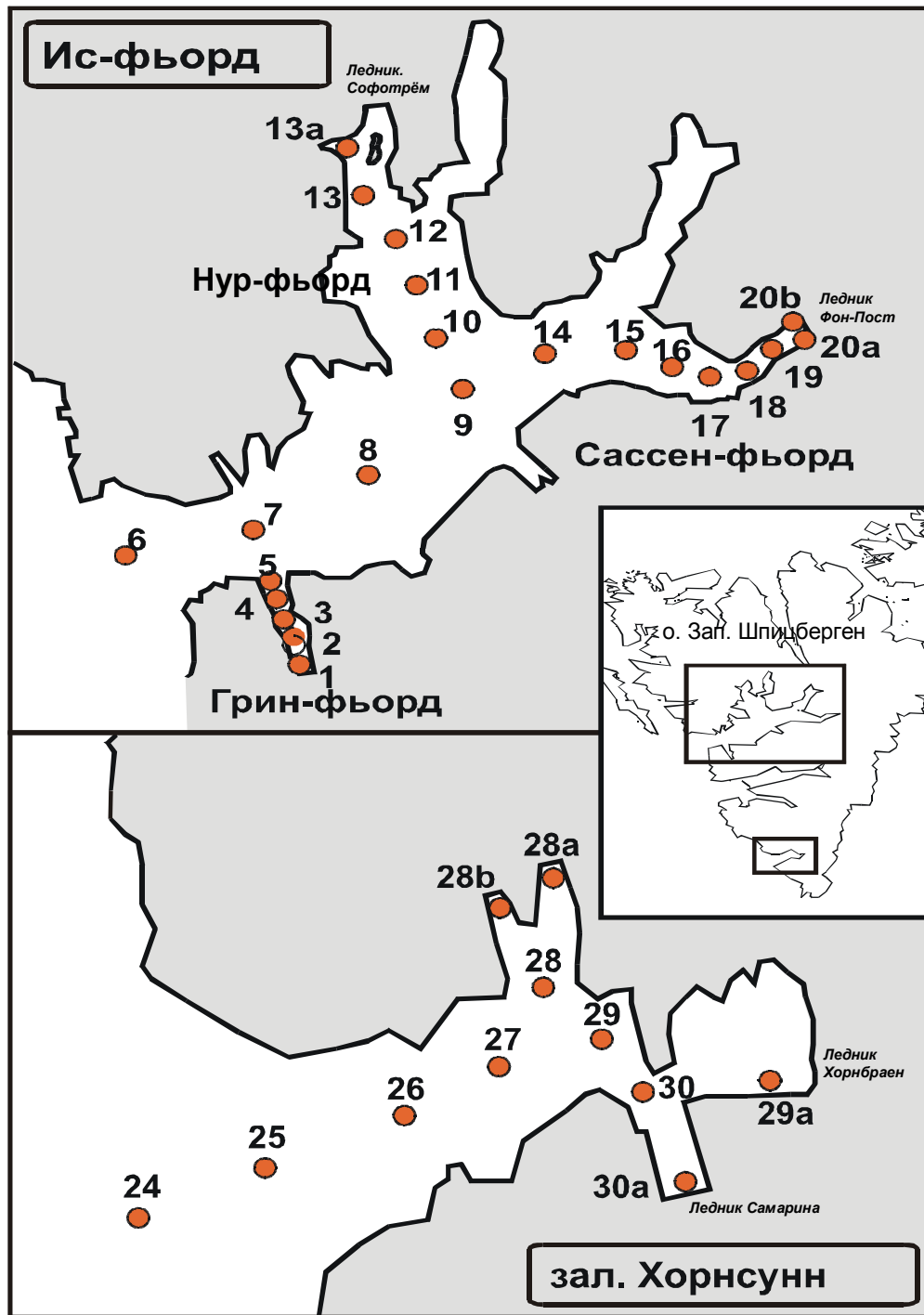
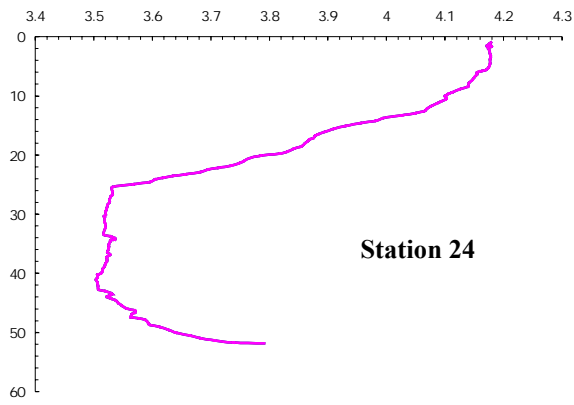


Figure 1. The scheme of RV Dalnie Zelentsy expedition stations location (28 June – 29 July 2002) in the coastal waters of the Island of West Svalbard.

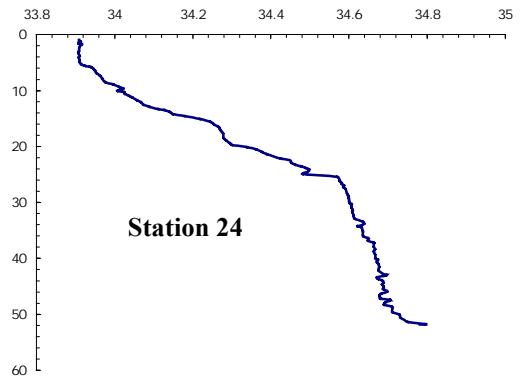
HYDROLOGICAL INVESTIGATIONS

During RV Dalnie Zelentsy cruise STD-profiling was carried out.

Temperature profiles

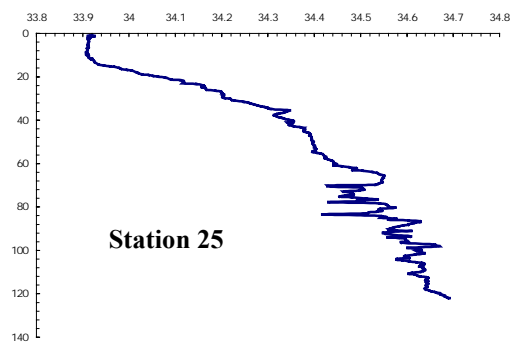
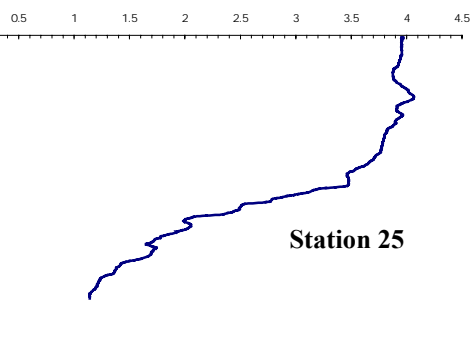


Salinity profiles



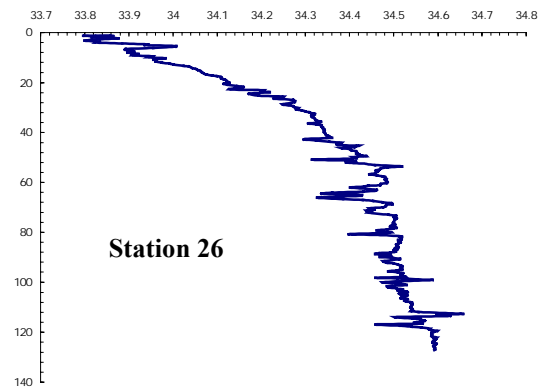
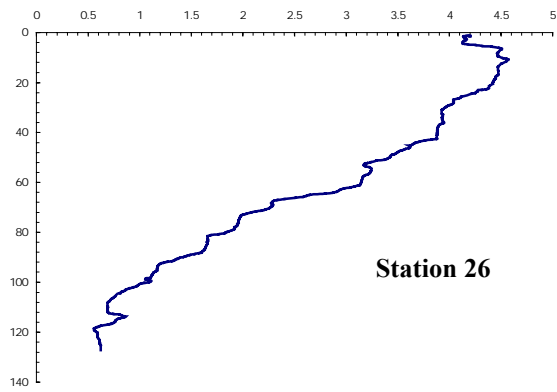
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Station 24



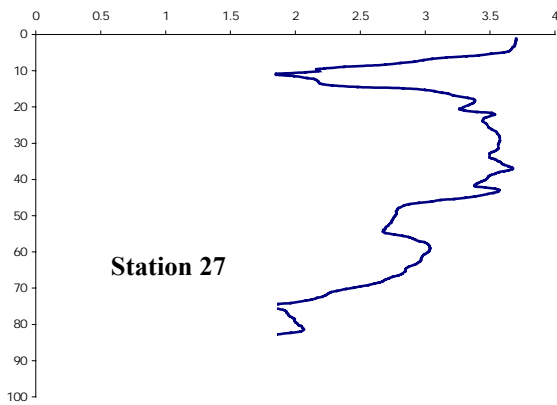
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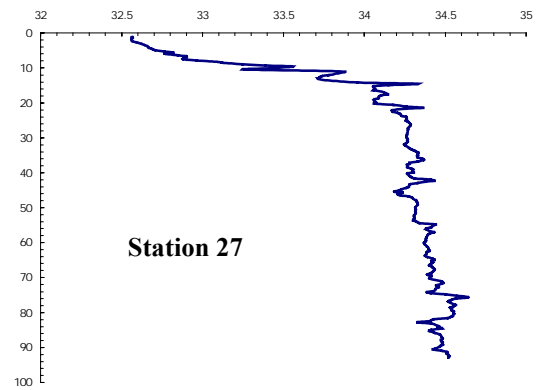


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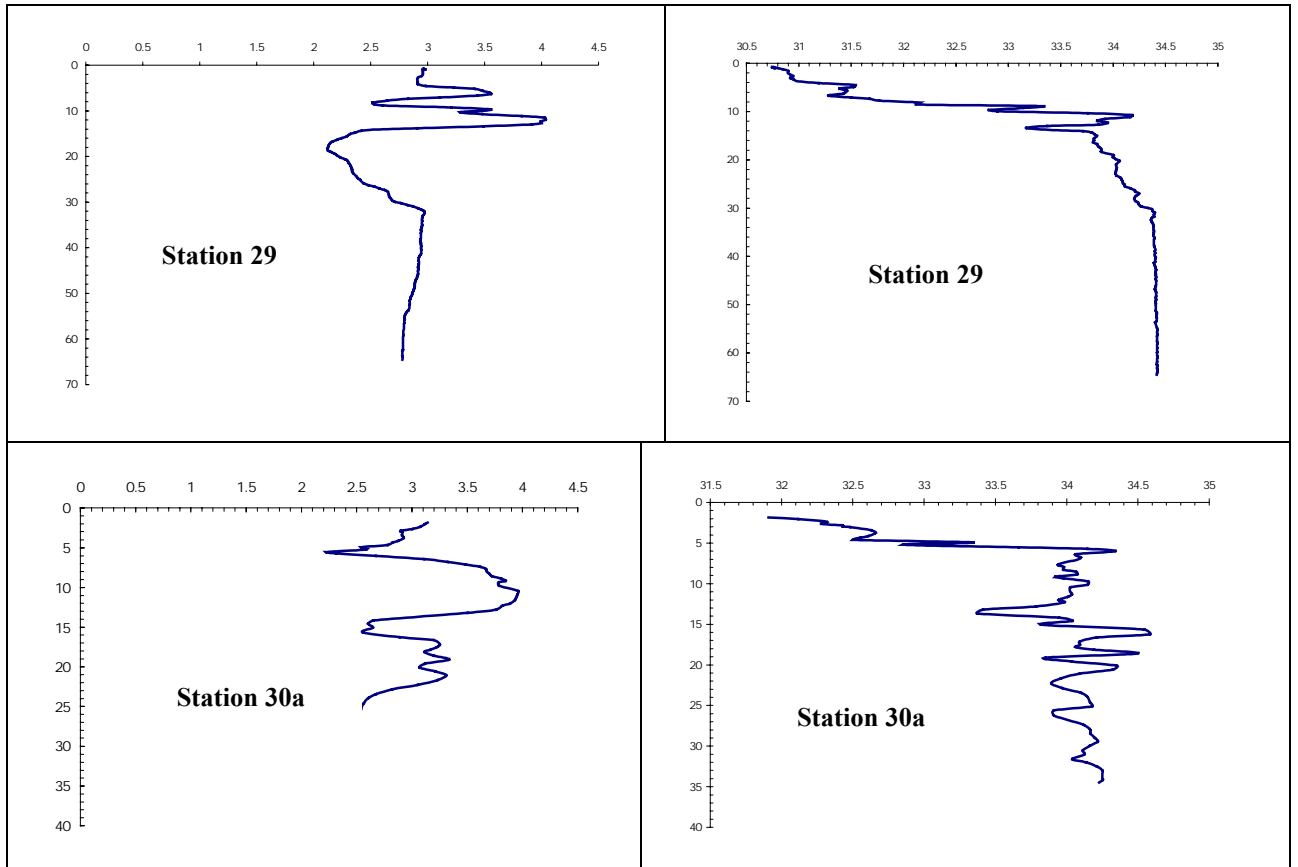


Figure 2. Profiles of vertical distribution of temperature and salinity in Hornsund Bay at the stations, located transect from the bay mouth to Samarin glacial (the Island of west Svalbard).

On Figure 2 the profiles of vertical distribution of temperature and salinity got in Hornsund Fjord (the Island of west Svalbard) at the stations, located transect from the fjord mouth to Samarin glacial in its upper part are shown (stations location can be seen on Figure 1).

HYDROCHEMICAL INVESTIGATIONS

The fjords of West Svalbard differ considerably in the biogenic elements content distribution. The reason for that is that of every fjord its own character of water layers stratification is typical. The common for all the investigated fjords tendency is registered. Its essence is in the biogenic elements' concentration increase from the surface to the bottom, as well as in the decrease

of their content from the upper part of the fjords in the direction of the open sea. The average content of oxygen in the production layer in all the investigated fjords is about 105%. The most aerated fjord is Hornsund. Nord-fjord differs from all the rest by the absence of nitrites. In the upper part of Is-fjord and in its spurs the content of nitrites is the highest and reaches 2 mkg/l in the near bottom layers (in Sassen-fjord). By the amount of nitrates concentration in the production layer the upper parts stations of Grøn-fjord and Hornsund fjord can be noted, as well as the near bottom layers of Sassen-fjord (126 mkg/l N-N₀₃). The amount of mineral phosphorus in the water column on average is about 25 mkg/l. The content of silicates to a considerable degree depends on the freshwater runoff, that is why the lowest concentrations of Si were registered in the central part of Is-fjord. The hydrogen indices in all the fjords decrease from the surface to the bottom. Hornsund fjord differs from Is-fjord by a lower pH.

PLANKTON INVESTIGATIONS

Vertical distribution of pelagic micro-algae in general reflected the distribution of water column density characteristics. The dominating position in the content of plankton community of Grøn-fjord was taken by micro-plankton fraction, represented exceptionally by small size cell colonial diatoms of *Chaetoceros*. The quantity of micro-algae increased in the direction of the upper part of the fjord, where it reached 5 mln. cells/l, of the fjord exit. The whole abundance of micro-phytoplankton was timed to layer 0 m. Below the layer of temperature rise the quantity of micro-phytoplankton decreased quickly and was 0.5 mln. cells/l at 10 meters depth and totally disappeared from pelagic zone at the depth of 20 meters. In the community of nanophytoplankton in the surface layers the largest in number dimension fraction prevailed > 10 mkm (0.5 mnl cells/l), in the composition of which Cryptophytes (genera *Plagioselmis* and *Cryptomonas*) and gymnodino (*Katodinium rotundatum*) algae dominated.

Below the layer of temperature rise in the nanoplankton community the dominance changes: against sharp elder dimension fraction abundance decrease background the quantity of smaller than 10 mkm dimension fraction nano-algae reaches 0.4 mln cells/l.

The role of micro-phytoplankton in pelagic algae formation in Is-fjord and Nord-fjord was inconsiderable. Regularities in the nanoplankton structure mainly were the same as those revealed for Grøn-fjord: transition of dominance from elder to younger dimension fraction with the depth (with the maximum of quantity under the layer of temperature rise). Nano-algae of elder dimension fraction were mainly represented by cryptophytes, in the younger dimension fraction Flagellata class with a diameter of 3 mkm comprised up to 90% of quantity. Total disappearance of micro-phytoplankton from pelagic zone was typical of Sassen-fjord (in comparison to the described above).

In off-sea part of Hornsund micro-phytoplankton fraction, represented unlike Grøn-fjord, by large colonial centric diatom genera *Chaetoceros* and *Thalassiosira* (the quantity is up to 200 thousand cells/l) starts playing a considerable role in phytoplankton community composition. At the same time the abundance of nano-phytoplankton reaches considerable values (up to 6 mln cells/l) with the absolute dominance of nano-algae with a diameter of 4 mkm (70% of the total nanoplankton abundance). In the fjord upper part the described structure of the community is preserved at the depths from 20 meters to the bottom (below the temperature rise zone). In the surface layers of stations of the fjord upper part (the depth of 0-10 meters) phytoplankton is mainly represented by autotrophic Flagellata class with the cell's diameter of 10 mkm. The quantity of these micro-algae reaches 2-3 mln cells/l, what is 80-90% of the total phytoplankton quantity.

BENTHOS INVESTIGATIONS

Benthos investigations, conducted during this expedition in the coastal waters of the Island of West Svalbard, cover both the areas investigated during the previous MMBI expeditions of 1995 and 2001 (Grøn-fjord, Hornsund) and new for investigations water areas (Nord-fjord and Sassen-fjord in Is-fjord). So, benthos materials, obtained in this expedition, will let broaden the picture of spatial distribution of bottom communities, as well as assess more precisely species diversity and quantitative abundance of bottom fauna of specific biotopes of this arctic region. Preliminary visual assessment of the obtained in the expedition material confirm the made before conclusion that of the fauna of fjords of West Svalbard, which possess a rather poor species diversity, considerable quantitative abundance is typical. At the same time the main part of biomass is made up of several commonplace for the Barents Sea fauna boreal-arctic species, such as *Ciliatocardium ciliatum*, *Maldane sarsi*, *Macoma calcarea* and several other. A more precise characteristic of the benthos communities will be given after complete laboratory processing of the gained material.

ICHTHYOLOGICAL INVESTIGATIONS

The processing of the material was conducted according to standard ichthyological methods. The total catch was sorted out into species and counted. The size composition of fishes was studied with the help of mass measurements of length method. A part of the fishes was вскрывалась для анализа питания и биологического состояния. Объем исследованного материала и видовой состав ихтиофауны представлены в таблицах 1 и 2

Table 1.

The volume of ichthyological material (specimens), studied in RV «Dalnie Zelentsy» cruise.

Species	Number of specimens
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Cod	251
Haddock	15
Arctic cod	59
Canadian plaice	166
Catfish	40
Others	55
Cod	117
Haddock	15
Catfish	40
Others	5

On the studied stations the representatives of 11 families, 20 species were registered (see table 2). Cottidae family was represented by the largest amount of species – 5.

Considerable remunerative concentrations of fishes were not registered in the majority of investigated areas, the catches often were composed of several dozens specimens of fishes of different species. In the area of the Island of West Svalbard a cod concentration (about 97% in the catch with productivity of about 0,2 tons per hour of trawling) was registered.

Table 2.

Species composition of RV «Dalnie Zelentsy» expedition ichthyological samplings.

Class, family	Species
Class ELASMOBRANCHII Family RAJIDAE	Raja radiata
Class TELEOSTOMI Family OSMERIDAE	Mallotus villosus villosus,
Family GADIDAE	Gadus morhua morhua, Melanogrammus aeglefinus, Boreogadus saida, Eleginus navaga
Family COTTIDAE	Arctiellus europeus, Triglops murrayi, Icelus bicornis, Myoxocephalus scorpius, Gymnacanthus tricuspis

Family AGONIDAE	Leptagonus decagonus
Family CYCLOPTERIDAE	Eumicrotremus spinosus, Eumicrotremus sp.
Family LIPARIDAE	Careproctus sp
Family ZOARCIDAE	Lycodes polaris
Family ANARHIHADIDAE	Anarhihas minor, Anarhihas lupus
Family LUMPENIDAE	Leptoclinus maculatus maculatus
Family PLEURONECTIDAE	Hipoglossoides platessoides limandoides

Some biology features of some species

Cod (*Gadus morhua morhua*)

This species was represented mainly by fry (the specimens length being from 21 cm to 70 cm with the average length – 48,3 cm), but at the depths of more than 200 m large post-spawning specimens were present in small amounts.

Crustacean prevailed in cod food composition in the Greenland Sea (table 3).

Table 3.

The frequency of occurrence of different food objects (%) and the degree of stomachs' filling (DSF in points) of cod in some areas investigated during RV «Dalnie Zelentsy» cruise.

Food objects	DSF
Capelin	12.1
Cod	5.6
Arctic cod	25.7
Catfish	0.9
Triglops	3.7
Arteidiellichthys <i>Taranetz</i>	0.9
Lumpenidae family	20.6
Canadian plaice	0.9
Fish indefinite	2.8
Themisto	64.5
Euphausiidae	35.5
Shrimps	40.2

Amphipods (Gammaridea)	7.5
Sipunculidae	0.9
Comb-bearers	1.9
Polychaeta	2.8
Sea cucumbers	0.9
Bivalves	1.9
N, specimens	116
DSF, point	1.98
Fed, %	92.2

Some biological characteristics of the other fish species are represented in table 4.

Table 4.

Size composition and main food objects of the mass fish species in the ichthyological samples of the RV «Dalnie Zelentsy» expedition.

Species		Biological characteristics
Haddock	<i>lim, cm</i>	19.0-49.0
	<i>M, cm</i>	31.3
	food	Brittle stars, polychaete
Catfish	<i>lim, cm</i>	15.0-68.0
	<i>M, cm</i>	31.7
	food	Brittle stars, crabs
Spotted catfish	<i>lim, cm</i>	33.0-101.0
	<i>M, cm</i>	66.6
	food	Brittle stars
Canadian plaice	<i>lim, cm</i>	11.0-42.0
	<i>M, cm</i>	27.9
	food	Brittle stars
Arctic cod	<i>lim, cm</i>	8.0-20.0
	<i>M, cm</i>	14.6
	food	
Capelin	<i>lim, cm</i>	13.0-17.0
	<i>M, cm</i>	15.7
	food	

ORNITHOLOGICAL INVESTIGATIONS

The routes of the year 2001, the time, places and methods of observations were

mainly repeated during the expedition, that gives an opportunity to compare the results of works for two-year period.

30 minutes accounts of flying in the coastal zone (the width of 150 m) birds were carried out (table 5) in different time of the day in calm and wind and in different tidal phases. Birds accounts on board the ship were carried out along the southern coast of Is-fjord (from the entrance to Grøn-fjord to the zone of Longyearbyen airport and over Bille-fjord water area).

Species composition of birds registered in the area of Is-fjord in summer 2001-2002 (19 species in total) was as follows:

1. Fulmar (*Fulmarus glacialis*);
2. Black-throated diver (*Gavia arctica*);
3. Bean goose (*Anser fabalis brachyrynchus*);
4. Barnacle goose (*Branta leucopsis*);
5. Eider (*Somateria mollissima*);
6. Kittiwake (*Rissa tridactyla*);
7. Glaucous gull (*Larus argentatus*);
8. Arctic tern (*Sterna paradisaea*);
9. Great skua (*Stercorarius skua*);
10. Arctic skua (*Stercorarius parasiticus*);
11. Ringed plover (*Charadrius hiaticula*);
12. Sand purple (*Calidris maritima*);
13. Brunnich's (thick-billed) guillemot (*Uria lomvia*);
14. Black guillemot (*Cephus grylle*);
15. Puffin (*Fratercula arctica*);
16. Little auk (*Alle alle*);
17. Alpine ptarmigan (*Lagopus mutus heperboreus*);
18. Snow bunting (*Plectrophenax nivalis*);
19. Long-tailed duck (*Clangula hyemalis*).

In the year 2002 we registered 17 bird species in Is-fjord water area. *Stercorarius skua* and *Gavia arctica* were not registered, while one specimen of *Clangula hyemalis* was registered for the first time.

Data obtained in the ornithological observations indicate that the quantitative values of sea birds number in Is-fjord in the year of 2001 and the year of 2002 are very close to each other.

Table 5. The results of the sea birds coastal account from the stationary observation point Storheya (number of specimens per 30 minutes of account).

Species	20 July 14.00-14.30 high water	22 July 12.35-13.35 half water	24 July 22.30-23.00 low water	Average index per hour, specimen
Fulmar	521	711	54	852
Murre	193	186	213	361
Kittiwake	234	219	67	173
Black guillemot	6	2	3	7
Glaucous gull	3	10	2	10
Eider	8	35	93	91
Puffin	1			
Little auk	4			

On the whole the species composition of ornithofauna and birds number in the coastal area of Is-fjord did not undergo considerable changes. Of 18 species we registered in the year 2001 only 16 were registered in the year 2002. With the registered for the first time in Grøn-fjord Long-tailed duck the total number of species inhabiting this part of Is-fjord amounts to 19 species. The fact that in the year 2002 some species were not registered, this refers first of all to tundra birds, is determined by their rarity (Black-throated diver and Great skua). As to the sea birds within Is-fjord and one of its bays – Grøn-fjord – the observations results of the year 2002 in many ways repeat the data of the year 2001.

There are some differences, for example concerning the nestling hatching out time, but they can be explained by the difference in mean month temperatures (according to the data of ZGMO) during this period. But the difference in the number of birds in the year 2001 when compared to the year 2002 in the synanthropic colonies of Kittiwakes and Glaucous gulls cannot be explained by the temperature differences. During the summer period the cases of birds deaths, mainly of Great skua, were registered within the settlement's boundaries and in its close vicinity. According to our observations these birds, which nest and live within the settlement's boundaries, consume mostly food leftovers found on the neighbouring dump ground.

The number of Kittiwakes decreased as well, though these birds get food only in the sea. We registered not a single case of this species feeding on the dump ground. At the same time, the colony of Kittiwakes on the buildings of the settlement of Pyramid has not changed its number.

At the same time, the colony of terns, located in Barentsburg airport, has even slightly increased in quantity. This probably is determined by a low intensity of the helicopters' flights in the year 2001, and in spring-summer of the year 2002 they practically were stopped.

Marine mammals

During the expedition period the presence of seals was not noted in Grøn-fjord area. Single specimens of Harp seals and one sea hare were registered in June and early July in Is-fjord water area from the board of tugboat when conducting sea routes. At the end of July (the 26th) in the area of Kols-bukhta 12 harp seals were noted, and this is probably connected with cod presence.

ALGOLOGY INVESTIGATIONS

The investigations were carried out in the coastal zone of Is-fjord of the Island of West Svalbard with the help of light diving equipment (table 6).

Table 6.

The algology investigations programme volume of works.

Sampling place	Date	Coordinates	Note
The settlement of Grumant	30.07.02	N 78° 10, 670' E 15° 06, 665'	2 frames (0,5 x 0,5), depth 5,5 m; 9 m
Port area of the settlement of Barentsburg	31.07.02	N 78° 03, 800' E 14° 12, 286'	1 frame (0,5 x 0,5), depth 5 m
Grøn-fjord exit	02.08.02	N 78° 06, 081' E 14° 11, 267'	2 frames (0,5 x 0,5), depth 2,6 m; 3,5 m

With the help of this method were estimated: algae distribution depth, projecting covering, bottom relief and ground description. Samples were taken at three points – directly in the coal port of the settlement of Barentsburg, Grøn-fjord exit, and in the area where the economic activity has been put an end – near the settlement of Grumant. Five frames were collected and described in details.

During frames processing the following measurements were taken: thallus length (the length of stipes, plate), the width of plate, plant mass, age, general state was estimated.

For heavy metals 4 algae kinds, belonging to *Phaeophyta* (*Fucus distichus*, *Laminaria saccharina*, *L. digitata*, *Desmarestia*) and *Rhodophyta* (*Palmaria sp.*), were sampled.

Additionally from storm casts quality algae samples were taken.

Further processing is planned to be carried out in the MMBI KSC RAS laboratories.

GEOLOGICAL INVESTIGATIONS

Sea investigations

During RV «Dalnie Zelentsy» expedition the lithological description of surface bottom sediments was carried out, at some stations the description was accompanied by sampling for foraminiferal and lithological analysis.

Among the preliminary results the following can be noted:

Modern surface sediments of the central part of Is-fjord can be considered as marine and glacio-marine ones with a slight influence of the glacial material. In three self-dependent fjords (Grøn-fjord, Sassen-fjord, and Nord-fjord) the glaciers influence considerably the modern processes of sedimentation. All these fjords are the systems of depressions separated from the central part of Is-fjord by a sill.

If consider bottom sediments in the direction from the glaciers to the fjord exit then, most likely, all facial transitions from glacial to glacio-marine ones will be singled out. Qualitative assessment of suspended matters shows that from none of the fjords the suspension is carried out to the central part of Is-fjord, where, apparently, its content is minimal and compared to the content of suspension in the open sea areas. Analogous situation is observed in Hornsund, but on a smaller scale. The main difference between Hornsund and Is-fjord and its offspurs is in the absence of the upper oxidized horizon in the modern surface sediments. Modern surface sediments of the studied fjords belong to fine muddy-clay sediments with a slight admixture of aleurite – coarse fragmentary material. At some stations in surface sediments a considerable presence of stone material (pebbles, break-stones, boulders) was observed,

which indicates the places of modern relief of coarse fragmentary material caught by icebergs and fast ice.

Thus, the following can be considered to be the main preliminary results of geologic-geomorphologic study of the fjords of the Island of West Svalbard and of their surface bottom sediments:

- every fjord-bay is a self-dependent sedimentation basin
- in every fjord-bay two zones can be distinguished: inner – glacial and external – glacio-marine, expressed in relief by closed depressions
- suspended matter is not carried out from the inner zone of the fjords-bays beyond their boundaries
- sedimentation speed decreases from inner to external parts of the fjords-bays
- in Hornsund the sedimentation speed is higher than in Is-fjord and its offspurs

Coastal works

As the result of coastal expedition works, aimed at scientific material and information gathering and gaining, required for loose sediments studying, composing the forms of land relief, several routes with coastal zone and morainic sediments samples taking were carried out, as well as in the areas of original rocks outcrops.

Conclusion

In the year 2002 in the area of the Island of West Svalbard 15 MMBI specialists carried out their scientific activities. The investigations covered a large number of scientific problems. New data have been obtained practically covering all the groups of sea organisms from micro-algae to marine mammals. Geological and sedimentological investigations have been carried out. Material for coastal ecosystems' pollution assessment (first of all heavy metals concentration in the living organisms) has been collected. The net of

ornithological observations account routes has been extended (in comparison to the year 2001) and two years avifauna observations comparative analysis has been carried out.

As planned in the year 2001, the programme was extended owing to the works carrying out aimed at coastal algocenoses investigations, when the structure and species composition of algae-macrophytes littoral communities were studied. Besides, the coastal geologic investigations programme has begun.

Next year continuation of works is planned in all the directions established in the years 2001 and 2002.