

Intergovernmental Oceanographic Commission

Russian State Hydrometeorological University

Baltic Floating University Facility

Contract SC/RP-207.590.9

REPORT

International Training through Research Cruise

(July 26 - August 20, 1999)



St.-Petersburg

1999

International Training through Research cruise aboard Russian hydrographical research vessel "Sibiryakov" was held on July-August, 1999. It is considered as a contribution to continuation of the 1998 International Year of the Ocean (IYO'98). This Cruise was held within the framework of UNESCO/IOC Programme TEMA (Training, Education and Mutual Assistance), UNESCO-IOC-HELCOM Project "Baltic Floating University", as well as research programmes of the Ministry of Science and Technologies of the Russian Federation, Ministry of Common and Professional Education of the Russian Federation.

The basic scientific direction of the expedition works was the research of influence of hydrophysical, hydrochemical and hydrobiological processes on a condition of the Baltic Sea ecosystem and Baltic coastal areas, including:

- Data collection and analysis of the hydrophysical, hydrochemical and hydrobiological characteristics in research areas;
- Study of spatial-time variability of the hydrophysical characteristics including microstructure analysis of their fields on oceanographic surveys and in points of the Baltic monitoring system (HELCOM-stations);
- Study of conditions of water masses distribution, formation of vertical stratification as a result of thermodynamic processes and interaction with an atmosphere;
- Study of spatial-time variability of the basic hydrochemical parameters, such as contents of dissolved oxygen, hydrogen parameter, alkalinity, biogenic elements and dissolved organic substance;
- Realization of monitoring of the water environment pollution and ground adjournment, in particular, pollution estimation of the surface and near-bottom layers of various areas of the Baltic sea and definition of the contents of polluting substances in ground adjournment;
- Study of species structure and spatial distribution of phyto- and zooplankton biomass, zoobenthos, chlorophyll "a" definition, estimation of primary production;
- Study of spatial variability of hydrophysical (temperature and salinity), hydrochemical (concentration of dissolved oxygen and pH) and hydrobiological (chlorophyll "a" concentration) parameters and the petroleum quality in the

surface layer of the whole research area in the Baltic sea with the help of automatic system of continuous registration of the specified characteristics.

Educational tasks of the Cruise included:

- Practical realization of a principle "training through practice and scientific researches" by attraction of Russian and foreign students to performance of field researches, realization of thematic lectures, seminars and discussions of observed results;
- Realization of educational and practical employment with the senior class schoolchildren from the Baltic countries who participated in the Cruise.

To number of organisational tasks of the Cruise it is necessary to relate:

- Organisation and realization of meetings with the persons of the international educational projects on the environmental protection of the Baltic countries;
- Organisation and realization of the seminar devoted to the discussion of research results onboard the vessel.

The Cruise was held on RV "Sibiryakov" in two parts: from July 26 till July 29, 1999 and from July 30 till August 20, 1999. The common duration of the Cruise makes 26 days. The arrangement of stations at the first and second parts is shown in Fig. 1-2. During the Cruise RV "Sibiryakov" called to Stockholm (August 16-18). Planned call to Klaipeda (August 6-9) was not held owing to failure of giving the permission for the call of RV "Sibiryakov" by the authorities of the Lithuanian Republic. As a result, planned change of students and schoolchildren was not carried out and schoolchildren (Latvian, Lithuanian and German) and students (Lithuanian), who arrived to participate in the Cruise, were compelled to leave Klaipeda. The Lithuanian and Estonian participants, being onboard, could not leave "Sibiryakov", as it was planned, and had to stay onboard until arrival to Stockholm.

Scheme of oceanological station during the first part of Cruise 1999

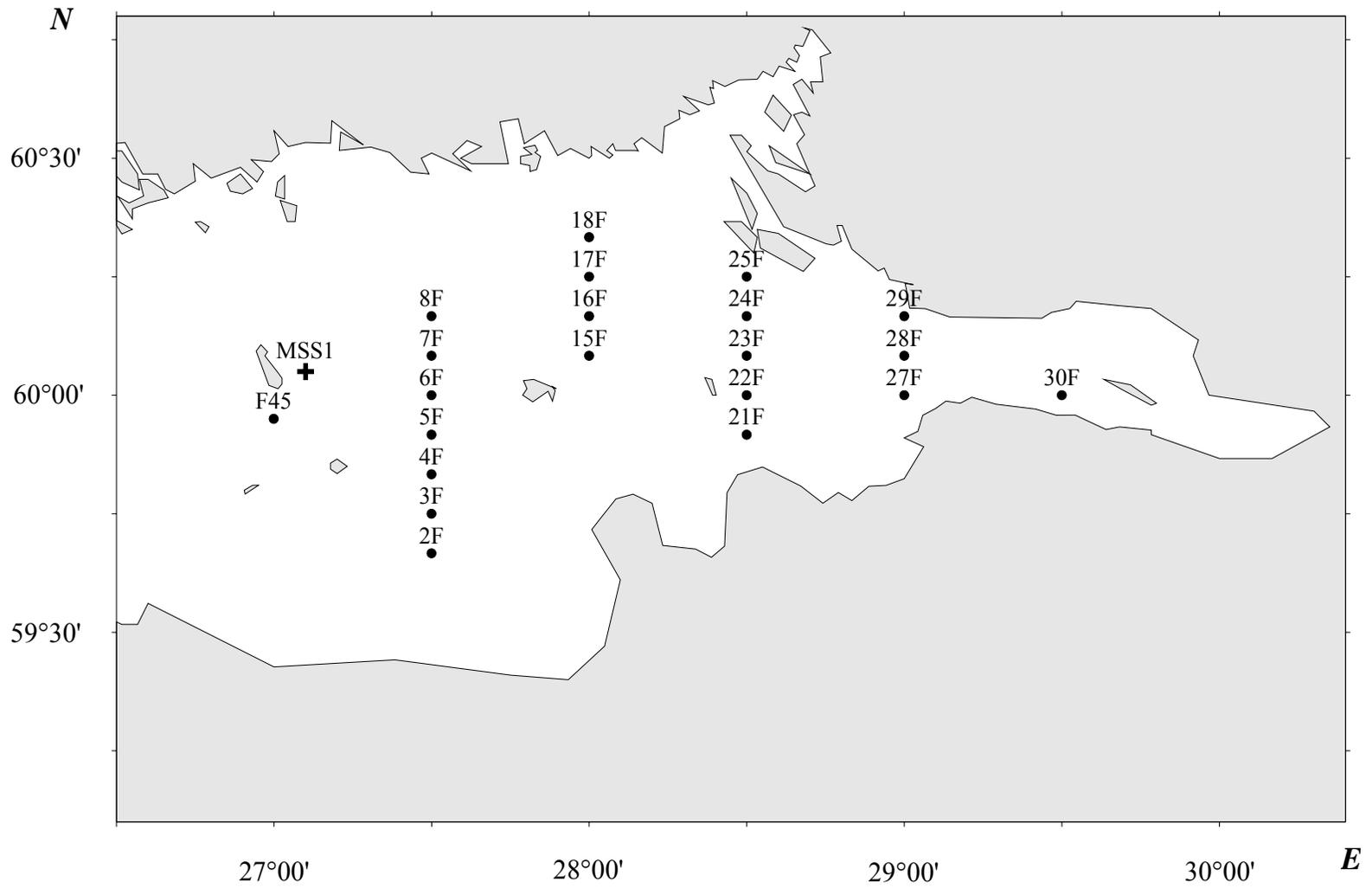


Fig. 1

Scheme of oceanological station during the second part of Cruise 1999

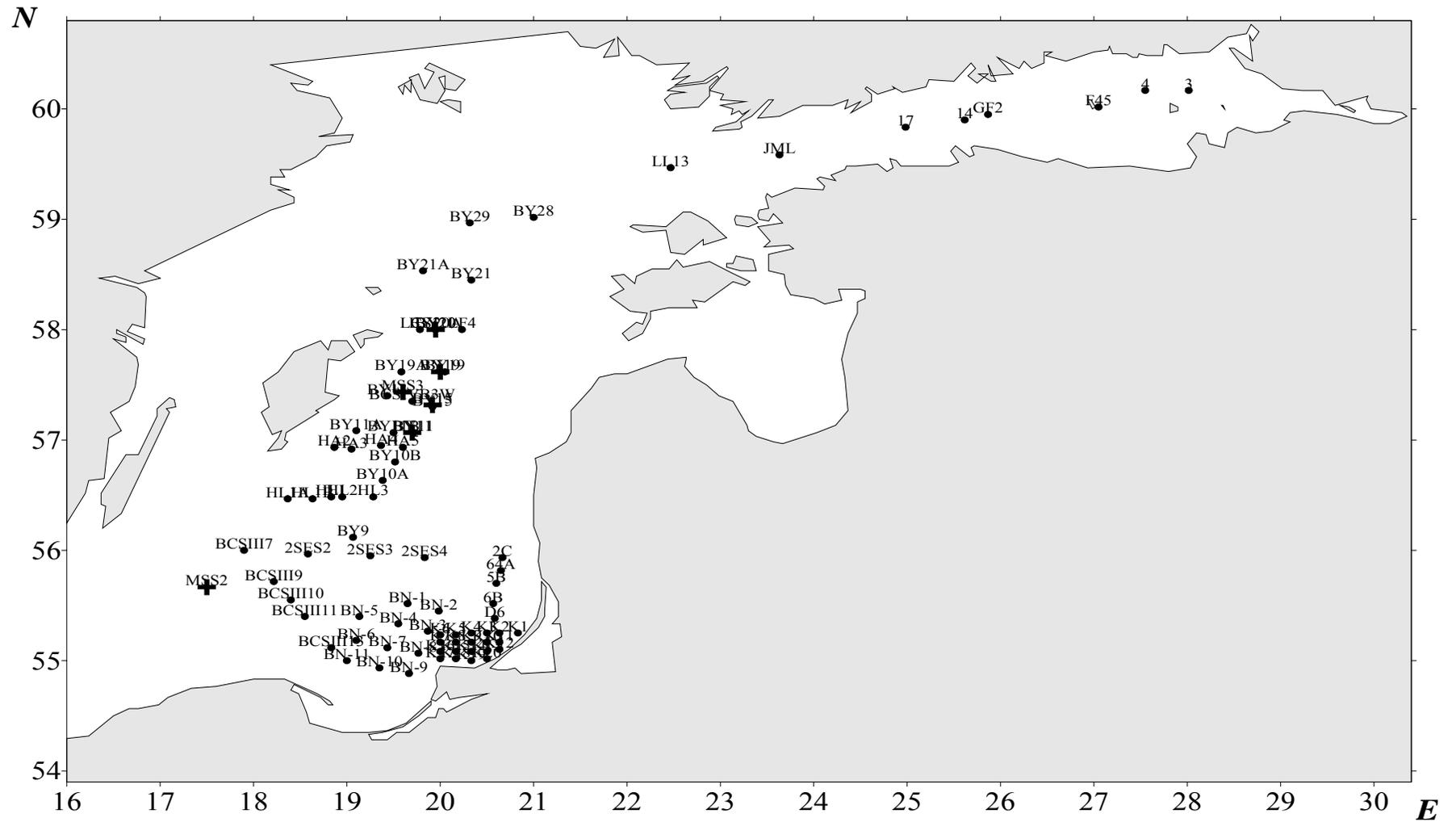


Fig. 2

38 persons, including 17 teachers and scientific employees from RSHU, Scientific Centre "Monitoring of Arctic Region", State Hydrological University, Volny University (Pskov) and Television Science University, students of the Oceanography Department of RSHU (9 persons), students of St.-Petersburg State University by The Baltic University Programme support (2 persons), students of Klaipeda University (Lithuania) and Cadiz University (Spain) (3 and 4 persons, accordingly), and 3 schoolchildren from Estonia have been engaged in realization of the Cruise tasks. List of the Cruise participants is shown in Appendix 1.

July 26 the vessel started the Cruise for performance of hydrological works in the Gulf of Finland (Fig. 1). During the first part of the Cruise 20 oceanographical stations on sections and one long-term station near Gogland Island were executed. Hydrochemical observations included taking samples for determination of dissolved oxygen contents, pH, alkalinity and nutrients. Besides, samples from the surface and near-bottom layer have been taken at 10 stations for definition of the contents of polluting substances. Taking samples for hydrobiological purposes also was carried out. In particular, at 9 stations samples for definition of phyto- and zooplankton concentrations have been taken, as well as the samples of the bottom for definition of species structure and macrobenthos biomass at 8 stations.

Having accepted aboard foreign participants from Lithuania, Estonia and Spain on July 30 RV "Sibiryakov" left St.-Petersburg and began working on an axial section the Gulf of Finland – the Baltic Sea (Fig. 2). In respect of absence of sanction on performance of works in the Estonian and Latvian economic zones, one station in the Gulf of Finland was missed, and the co-ordinates of stations which are situated in these areas were displaced westward from the economic zones of the specified states. On August 2 the works on the axial section have been completed, and the vessel began oceanographical works on the Kaliningrad survey and on the Kurshskaya tongue survey.

In connection with failure of call to Klaipeda by August 6-7 oceanographical works on a longitudinal section of the Kurshskaya tongue and cross section in

direction from the coastal area to the central part of the Baltic Sea were continued. The scheme of stations, executed at this part, is shown on Fig. 3.

From August 10 till August 15 works were carried out on cross sections near the Gotland Island. Whenever possible the stations located in Latvian and Estonian economic zones have been displaced westward. The station scheme of this area is submitted in Fig. 4. During the whole specified period 109 oceanographical stations with hydrochemical measurements, including 3 long-term stations, have been executed.

Hydrobiological researches were carried out at 42 stations. They included taking samples of water for definition of chlorophyll "a" concentration, as well as taking samples of phytoplankton, zooplankton and macrobenthos. Experiments for definition of primary production and destruction process of organic substances by the plankton community also were held.

During the whole period of realization of researches onboard the vessel the flowing automatic system for measurement of water parameters (named "System") developed by the employees of Krylov Scientific Institute was working. The system is designed for measurement, registration and archiving of temperature, salinity, pH, dissolved oxygen, chlorophyll and dissolved petroleum data.

Before the call to Stockholm students and schoolchildren, leaving the vessel, were given the Certificate of the Cruise Participant and memorable gifts.

August 16 the vessel arrived to Stockholm. The representatives of the Sweden and International educational programs of environment protection of the Baltic region were invited onboard the "Sibiryakov". In particular, they were Prof. Lars Ryden, Director of The Baltic University Programme, Uppsala University, and Dr. Kristina Dahlberg, "Baltic 21" Secretariat for Agenda 21 for the Baltic Sea Region, Ministry of the Environment of Sweden. They have held a meeting with the Cruise participants.

Scheme of oceanological station during the second part of Cruise 1999
in South Baltic

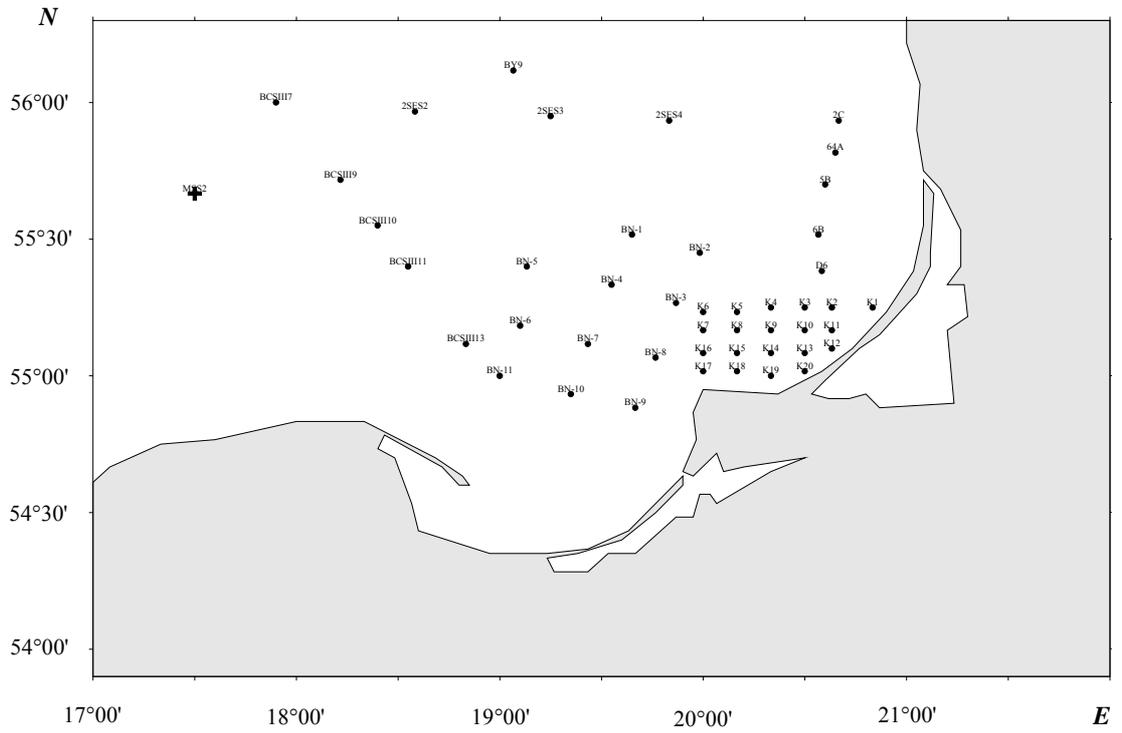


Fig. 3

Scheme of oceanological station during the second part of Cruise 1999
in Central Baltic

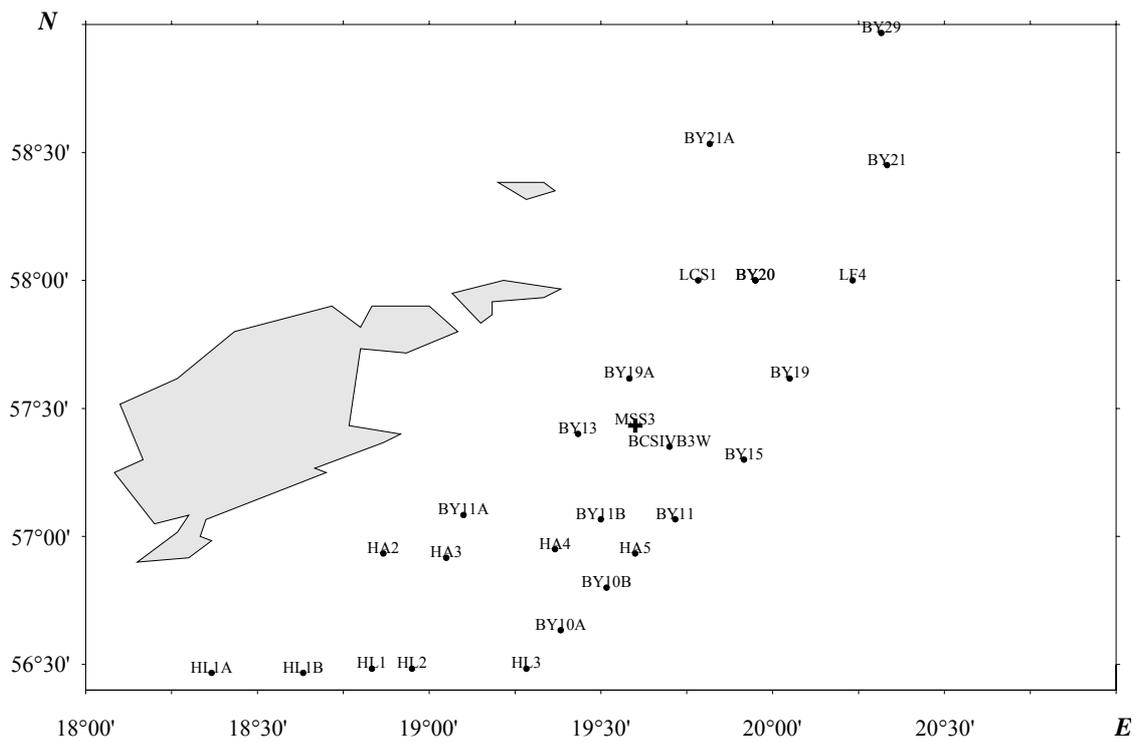


Fig. 4

During discussions about opportunities of co-operation extension of the "Baltic Floating University" Facility with the various international projects and programs, the contract about intentions on interaction of the Baltic Floating University and The Baltic University Programme was signed, concerning BFU realization in summer 2000 (Appendix 3). The materials and offers on interaction of BFU with the "Baltic 21" Programme are given for consideration to the program staff.

August 18 the representative of the UNESCO Office in Sweden (Ministry of Culture of Sweden) Mrs. Eva Hermansson visited the vessel by the invitation of the Cruise staff. She has got acquainted with the Baltic Floating University and Children Cruise Programme, visited laboratories and during conversation with the chiefs of Cruise has stated an approval and support to the BFU Programme address.

On behalf of the Baltic Floating University the circulars to Prof. Lars Kristoferson, the General Secretary of the World Fund of Nature in Sweden, to Mrs. Birt Zimmermann, General Co-ordinator of the Baltic Sea Project and to Mrs. Nine Munthe, Project Manager Central and Eastern Europe Co-operation Programme, Swedish Environmental Protection Agency (EPA of Sweden) with the request about support of realization of the BFU Cruise in 2000 were distributed.

On arrival to Stockholm the Cruise participants from Estonia and Lithuania left a vessel to Tallinn and Klaipeda, accordingly.

August 18 the vessel left Stockholm. August 19 a scientific international seminar, where the Cruise participants presented the scientific results of their work, was held. The evening of the same day they were given the BFU Cruise Certificates and memorable gifts. August 20 RV "Sibiryakov" arrived to St.-Petersburg.

Basic scientific results and conclusions:

The Gulf of Finland

The surface temperature decreases in the western direction from 19.6 °C to 17.0 °C. In connection with storm conditions the upper mixed layer depth was 20-30 m. In distribution of the near-bottom temperature the connection with a relief is precisely traced and the temperature values change from 18.0 °C in the east to 3.0 °C in the west. In the southern part of the Gulf of Finland the warm fresh waters due to the drain of the rivers were observed. The surface salinity changes from 2.0 ‰ to 4.0 ‰ in the western direction. In near-bottom layer due to the features of the bottom relief and mixing processes the salinity variability was within the limits of 3.5-6.5 ‰.

Owing to storm conditions in the Gulf of Finland the high oxygen saturation is marked in the upper layers. In Luga-Koporye area water mass rich with oxygen is observed (up to 7.2 ml/l, in other areas - about 6.5-6.7 ml/l). Westward there is an increase of concentration of the dissolved oxygen to 7.0 ml/l. The near-surface maximum of the oxygen concentration is well expressed in the western areas (about 8.0 ml/l). In the near-bottom layer the oxygen concentration decreases to 6.0 ml/l, and in deeper western part - to 5.2 ml/l. Oxygen saturation in percent is 100-110 % on the surface (in Luga-Koporye area - 120 %) and about 100 % on the 20-m depth. In the near-bottom layer saturation is 60-80 %.

The pH values on the surface are increased from 8.25 to 8.36 in the southern direction. With increase of depth this tendency changes the direction to east - west one and near the bottom pH values vary from 8.10 to 7.50.

The alkalinity decreases on the whole water area in the western direction. On the surface alkalinity values vary within the limits of 0.95-1.45, in near-bottom layer - 1.10-1.60.

Practically within the whole water area of the Gulf of Finland the absence of biogenic elements is fixed. Only in the near-surface layer the phosphate

concentration from 3-6 mkg/l in the eastern part of the area and to 40 mkg/l in the western part is marked.

The Baltic Sea

By the oceanographic data obtained on the stations of the axial section of the Gulf of Finland and the Baltic Sea the following features of the thermohaline structure are allocated:

1. By the strong radiating heat and weak wind-wave mixing the depth of the upper mixing layer did not exceed 15 meters with the temperature near 18-20 °C and salinity 5-6 ‰. Upper mixed layer is spread by the sharply expressed thermocline with gradients about 2.5 °C/m and temperature 3-4 °C on the lower thermocline border.
2. At all deep-water (more than 60 m) stations a cold intermediate layer (CIL) with thickness of 10-20 m is allocated. It was generated during winter convection and is exposed to erosion as a result of interaction with above- and low-laying waters.
3. Deep-water mass (80-225 m in Gotland Deep) is a transformed northern-sea water with temperature about 7 °C and salinity 12.5 ‰. On T,S-curve three water masses are distinguished – surface fresh warm water, intermediate cold water and near-bottom water with higher salinity.
4. The prevailing stratification types are complete stability in the upper layers (above the CIL nucleus) and level-by-level convection in the lower layers. Hence, in deep waters the mechanism of difference-diffusion convection (DDC) and formation of thin structure are possible. In the case of weak advection stream processes the DDC is one of few mechanisms of mixing in deep stagnant waters.
5. Quite often large smoothing of the salinity structure in the upper layer in comparison with temperature is marked. Obviously, it is caused by the small fresh budget (river drainage + precipitation) and convection, caused by the salinity increase in the surface layer due to intensive evaporation.

The investigations carried out on the axial section in the Baltic Sea in August 1999 allowed to receive a picture of spatial variability of the basic hydrochemical parameters.

The surface layer of the open sea, despite of not typical heating of the Baltic Sea, is characterised by the high level of oxygen saturation. Almost in all parts of the researched water area oxygen concentration in the surface layer changes within 100-120 %. Such high content of the dissolved oxygen appears to be caused by intensive photosynthesis, which was observed in the second half of the summer. The spatial variability of the absolute meanings of dissolved oxygen concentration characterises by uniformity, almost everywhere changes are insignificant - from 6.80 ml/l to 7.4 ml/l in the south region. The spatial variability of pH and alkalinity is expressed poorly, that testifies to decreased influence of the fresh water drainage. In spatial distribution of biogenic elements in the surface layer on the axial section the low phosphate, silicate and nitrate contents is marked, nitrites in 0-30 m layer at many stations are absent. It testifies to utilisation of nutrients during the period of extensive phytoplankton flowering.

The vertical structure of waters on the axis section in the central part of the Baltic Sea was typical. Using dissolved oxygen contents variability data it is possible to allocate three layers - upper mixed layer, intermediate layer and deep layer. The upper layer of water (0-15 meters) is rich with oxygen - 100-120 %. In intermediate layer (20-50 meters) in the central part of the Baltic the oxygen maximum is observed, which is characterised by 80 % saturation. Deeper than 50 meters a sharp reduction of oxygen concentration occurs and starting from 70 meters the oxygen is practically absent, and there are signs of hydrogen sulphide presence. It is necessary to note, that on the axis of the Gulf of Finland very weak variability was marked in vertical distribution of the dissolved oxygen, which is not typical for the summer period, when in near-bottom layers an intensive oxidation of organic substance takes place. It is possible to make an assumption, that such vertical distribution of dissolved oxygen in the Gulf of Finland is explained by presence of winter water with temperature 2 °C in near-bottom layers, that caused a delay of destruction processes. The general traits in

pH distribution are conditioned by the same factors (photosynthesis and organic substance destruction) on which the content of dissolved oxygen depends. On vertical pH decrease is marked from 8.4 on the surface to 7.2 near bottom with the well-expressed minimum near halocline.

The vertical distribution of biogenic elements is characterised by the minimum of their contents in the surface layer, increase of concentration in halocline and accumulation in near-bottom layers.

In 1999 within the framework of the Baltic Floating University Cruise the survey located in Russian waters of the Kurshskaya tongue coastal zone was executed for the first time.

Summarising the obtained results, it is possible to note the following features:

1. The significant role in spatial distribution of hydrological and hydrochemical parameters in the given area is played by a configuration of a coastal line and bottom relief.
2. The cold intermediate water stream from the west is marked and 30-meter isobath serves as a border of distribution for these waters.
3. As the salinity is smoothly increased deepward and the salinity vertical gradient does not exceed 1 ‰, it is possible to consider the halocline to be dim.
4. In the surface layer strong oversaturation by dissolved oxygen (more than 118 %) is marked. In deeper layers the minimum of saturation is marked close to the 30-meters isobath, that is caused by distribution of temperature and salinity in the given layer.
5. The phosphate concentration in the most parts of researched water area is close to analytical zero.

During the long-term station MSS-3 the experiment on influence of internal waves on the results of STD-systems measurements was carried out. As a result of experiment the significant changes of temperature were registered on separate layers, the periodicity of these changes is determined. The amplitude of the observed fluctuations varied from 0.1-0.2 °C to 7-8 °C, periods of fluctuations - from 3.5 seconds about 5 minutes. The spectral analysis was carried out using

the experiment data. It revealed the quasi-harmonical fluctuations in above-stated ranges.

The basic results of hydrobiological researches will be received after processing. At the same time, the visual observations, and also the analysis of preliminary results testifies to strong flowering of water in the western part of the Gulf of Finland and in the Central Baltic, that is connected to massive development of blue-green algae in the specified areas. In deep-water areas of the Baltic Sea (deeper 90 - 100M) the absence of the ground macrofauna due to an adverse gas mode of the near-bottom waters is marked.

The educational work with students and schoolchildren (see Appendix 2) included the lecture cycle connected with researches of the hydrological and hydrochemical regimes of the Baltic Sea (given by Dr. T. Eremina, Dr. P. Provotorov), with natural and cultural heritage of the Baltic region and ecological problems of the Baltic (given by lecturer V. Grigorieva). Participation in the BFU 1999 of the winners of the international competition "World of Water by Eyes of Children" has allowed to assist in preparation of the photo-newspapers onboard RV "Sibiryakov" and regularly to cover the Cruise cultural-educational program. Linguistic lessons (Russian, Spanish, Lithuanian, Estonian, Swedish, and Arabian) were carried out by the representatives of the different countries for the Cruise participants. In the field of modern information technologies the CD-media "Ocean", presentation of RSHU and BFU Web page in Internet were submitted. The Cruise participants took part in seminars and discussions of results of the previous hydrographical Cruises, discussions on video-materials seen, participated in preparation of the video-film about work of the Baltic Floating University. For the participants of Cruise various cultural activities (Sea-question Game for 4 teams, concerts etc.) were prepared.



Students and schoolchildren - participants of the Baltic Floating University & Children's Cruise aboard the research vessel "SIBIRYAKOV" with memorable photo-newspaper about Cruise.



The computer time.

The CD-media presentation "Baltic Floating University" Facility.



Discussion on the lecture "The Baltic Sea - our common heritage".
Lecturer - V. Grigorieva.



The laboratory science lesson
in the meteorological laboratory.



Lecture by Kristina Dahlberg,
Baltic 21 Secretariat for Agenda 21 for the Baltic Sea Region.
Stockholm, 17 August 1999



Lecture by Prof. Lars Ryden,
Director Programme The Baltic University Programme.
Stockholm, 17 August 1999