BFU RESEARCH BULLETIN

№ 7, 2004

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Foreword

In 2003 a regular stage of the IOC/UNESCO 'Baltic Floating University' project was implemented. The present Bulletin, already the seventh, contains the description of work that has been done in 2003, of obtained scientific results and of the project's educational activities. During the year under review, as well as before, the project work has been carried out on two vessels: RV 'Sibiriakov' and sailing catamaran 'Centaurus-II'. In both cases research was combined with educational tasks.

Researchers from Russian State Hydrometeorological University, 'Sevmorgeo' Geological Company (Russia), Centre for Ecological Safety (Russia), Zoological Institute (Russia), Cádiz University (Spain) and students from RSHU, St. Petersburg State University (Russia), Cádiz University (Spain), Aveiro University (Portugal), Plymouth University (Great Britain), Stockholm and Uppsala Universities (Sweden), Hamburg Technical University (Germany), Gdansk Technical University, Szczecin, Lodz, Lublin Universities (Poland) took part in the BFU 2003 expeditions.

The research has been carried out within the framework of the project 'Interdisciplinary research of the Northwest Russia seas', subprogram 'Research of the World ocean nature' of the Federal Program 'World Ocean', and also within the Ministry of Industry and Science of the Russian Federation project 'Developing the method of assessment of the changes of the Baltic and Caspian ecosystem under influence of the nature and antropogenic factors', IOC/UNESCO 'Baltic Floating University' project, BOOS project, projects of the Ministry of Education of the Russian Federation and state company 'Sevmorgeo'.

The project works were financed by the Ministry of Industry and Science of Russian Federation, Ministry of Education of the Russian Federation, Russian State Hydrometeorological University and by state company "Sevmorgeo".

The research has been carried out jointly with Head Department for Navigation and Oceanography of the Ministry of Defense of the Russian Federation and with sailing catamaran 'Centaurus-II'.

Scientific results obtained within the BFU 2003 were reported on authoritative international and domestic scientific forums: Baltic Sea Congress in Helsinki (August, 2003), Finland-Estonian-Russian Trilateral meeting in Helsinki (November, 2003), International Baltic Sea Day in St.-Petersburg (March, 2004), Annual BOOS workshop in Sweden (May, 2004).

Data of the observations during expedition have transmitted in the Near Real Time Regime to the BOOS web site and were available for the members of BOOS.

Rector RSHU
Prof.

Lev Karlin

BFU 2003. XI International Training Through Research Cruise on the RV 'Sibiriakov'

Tatyana Eremina, Svyatoslav Tyuryakov

Annual survey in the Proper part of the Baltic Sea and its coastal areas was held in July - August 2003. Research was done according to subprogram 'Research of the World ocean nature' of the Federal Program 'World Ocean', international IOC-UNESCO program 'Floating University', contract with 'Sevmorgeo' geological company and some other programs.

TASKS FOR THE CRUISE

To estimate the current state of the Baltic Sea, to describe the bottom sediments and evaluate their pollution, to research the changes of waters structure in the central and southern basins of the Baltic Sea due to the north-sea waters inflow in January 2003, to carry out geomonitoring in the Gulf of Finland and on the Kaliningrad shelf, to research the influence of chemical munitions dumped in the Bornholm Deep on state of marine environment, to give training and education for students from the Universities of Great Britain, Poland, Portugal, Russia, Spain and Sweden implementing the 'training-through-research' principle, to organise the mid-cruise seminar in Stockholm, to develop international collaboration in the sphere of environmental and marine investigations on different levels became the tasks for the expedition onboard the RV "Sibiriakov" in summer 2003.

THE CRUISE

Activities in general. All the students being supervised by experienced teachers worked in laboratories (geology, chemistry, hydrology, biology, meteorology and data processing). They attended lectures and seminars, made presentations of their own scientific projects, contributed significantly to the discussion of preliminary results of the expedition during the seminar in Stockholm. Additionally foreign students attended Russian language classes.

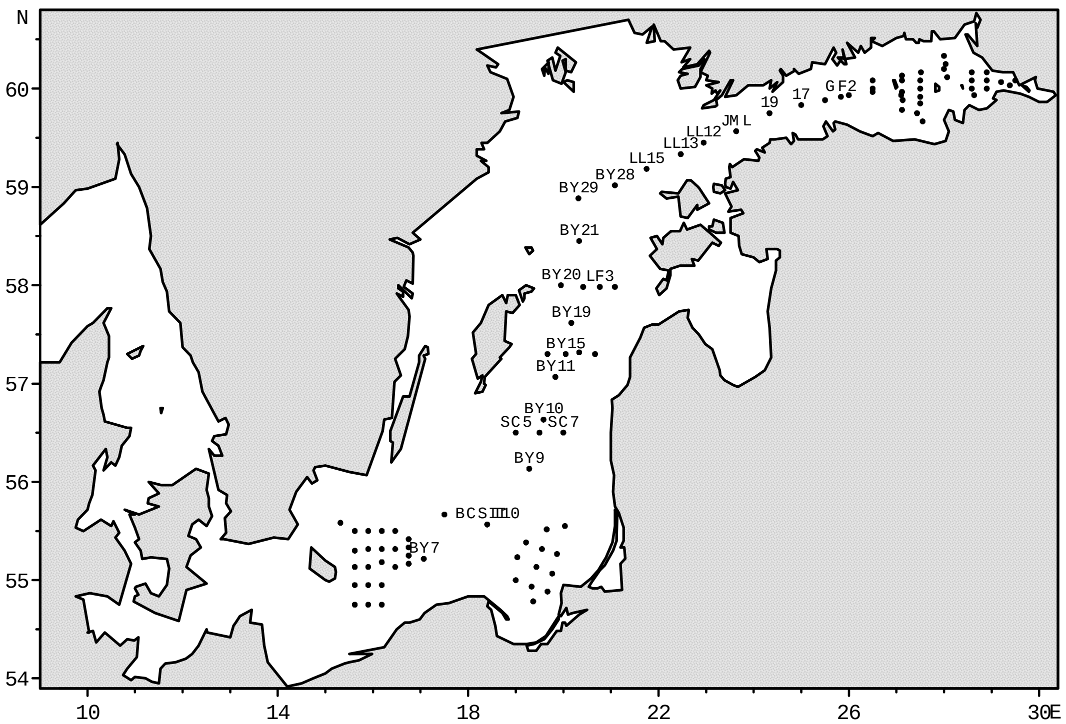


Figure1. Scheme of stations in the Baltic Sea and in the Gulf of Finland. RV "Sibiriakov".

Lectures. The lectures and presentations given by both professors and students onboard the vessel covered the significant variety of topics.

Prof. G. Frumin (RSHU, Russia)	1. Global ecological problems 2. Main ecological problems of the Baltic Sea 3. Ecological and health risks
Prof. A. Rybalko ('Sevmorgeo', Russia)	Sedimentation processes in the Baltic Sea
Prof. G. Frumin, prof. A. Rybalko	Chemical munitions dumped into theBaltic Sea
Dr. M. Shilin (RSHU, Russia)	1. Physical geography of the Baltic 2. Life in the Baltic Sea 3. Eutrophication in the Baltic Sea
Dr.P. Provotorov (RSHU, Russia)	1. Some peculiarities of thermohaline structure of the Baltic Sea waters 2. Main features of hydrological regime of the Baltic Sea
Dr.R. Vankevich (Centre for Ecological Safety, Russia)	1. Organisation of observations data set 2. Filed data processing in GIS 3. Visualisation of data sets
Dr. M. Sáez Ribas (Cádiz University, Spain)	Bioconcentration and toxicity effects of surfactants
M. Ruiz Núñez (Cádiz University, Spain)	Microsensors in marinescience
C. Gonzalez Mejias (Cádiz University, Spain)	Mimicry of marineinvertebrates
F.Arjona Madueño (Cádiz University, Spain)	Osmoregulation in teleostfishes
I. Serra Martins (Aveiro University, Portugal)	Tidal wave propagationin a channel
L. Blom (Uppsala University, Sweden)	CIRCUM alternative sewage treatment of black water – preliminary life cycle assessment and comparison to conventional treatment

Seminar in Stockholm. This activity became traditional onboard the RV 'Sibiriakov'. The seminar worked during August 12 and was dedicated mainly to various issues related to the Baltic Sea environment. Invited guests attended the seminar. Among them Lars Ryden, professor at Uppsala University and director of the Baltic University Program, Leif Litsgård, Chairman of EUrora, which is the environmentally orientated secondary school in Sweden, Oleg Savchuk, assistant professor, visiting scientist at Stockholm University. They contributed with speeches and with interest listened to students, who presented the results of the

WORDS OF WELCOME	
Dr.Tatyana Eremina RSHU, Head of the Expedition	OPENING THE SEMINAR
Captain Vadim Sharomov Head of Navy Hydrometeorological Service of Russian Federation	CONTRIBUTION OF NAVY HYDROGRAPHICAL SERVICE OF RUSSIAN FEDERATION TO THE BALTIC FLOATING UNIVERSITY PROJECT
GUESTS SPEECHES	
Prof. Lars Ryden Uppsala University, Director of the Baltic University Program	INTERNATIONALISATION OF EDUCATION IN THE BALTIC SEA REGION, AND THE BALTIC UNIVERSITY PROGRAM
Leif Litsgård Chairman of EUrora	EURORA – EDUCATION FOR A LIVING BALTIC SEA

research done during the expedition, and participated in discussion. It is also a tradition that students prepare the reports together with their supervisors and become the main speakers of the seminar. Program was very tight as many interesting facts were found which had to be discussed.

Also Dr. Oleg Savchuk read the lecture entitled "Eutrophication of the Baltic Sea: recent developments and simulation".

SCIENTIFIC RESULTS

Hydrological conditions. Due to fair with some cloud weather and intensive absorption of solar radiation strong heating of the surface layer was observed over the whole basin and especially in the eastern Gulf of Finland (up to 24.5°C). Vertical T,S-profiles and sections demonstrate significant stratification: thin (not more than 10m) upper mixed layer, sharpened (with gradients up to 2-3°C/m) summer thermocline, often with underlying cold intermediate layer, and near-bottom inversion. Such a sharp stratification was not observed during none of the preceding cruises of the RV "Sibiriakov". Calculation of some stratification parameters for separate stations of the axial section confirmed the layers stability, dominating influence of temperature variations on density gradient (except for the very near-bottom layers where the role of salinity is increasing).

Thermohaline structure of the southern Baltic (Kaliningrad and Bornholm polygons) was formed and is influenced by the incoming north-sea waters. This can be seen on indented T,S-profiles, alternating sublayers with different T,S-indexes. Variability in distribution of salinity is less than of temperature, and at stations on the Bornholm polygon homogeneous distribution of salinity was marked up to depths of 50-60m.

Combined diagnostics of hydrological and hydrochemical conditions lets speak about their certain abnormality (in comparison with data of preceding expeditions) caused mainly by the recent (January 2003) strong inflow of the north-sea waters. Indirect indications of this event are: sharp stratification in fields of almost all the elements; lockup of relatively warm and salty deep waters and consequent wedging of the thermocline

PRESENTATIONS BYTHE BFU STUDENTS	
Alexander Smirnov Denis Gladikov	PECULIARITIES OF THERMOHALINE STRUCTURE OF WATERS ON HELCOM SECTION IN THE BALTIC SEA IN AUGUST 2003
Inés Serra Martins Carlos Gonzalez	THERMOHALINE STRUCTURE OF WATERS ON MERIDIONAL SECTIONS IN THE GULF OF FINLAND
Lidia Alexandrova Yevgeny Morozov Paulina Pawlak Lubomira Blom	INFLUENCE OF THE NORTH SEAWATER INFLOW ON OXYGEN REGIME OF DEEP LAYERS OF THE BALTIC NITRATES AND SILICON DISTRIBUTION IN THE BALTIC PROPER
Natalia Guslina Alexander Storonkin	INFLUENCE OF THE NORTH SEAWATER INFLOW ON THE NUTRIENTS DISTRIBUTION IN DEEP LAYERS OF THE BALTIC
María del Mar Ruiz Núñez Francisco Arjona	SPATIAL DISTRIBUTION OF TROPHIC CONDITIONS IN THE BALTIC SEA
Holly Coombes	RELATIONSHIPS BETWEEN CHLOROPHYLL-A CONCENTRATIONS AND CHEMICALVARIABLES IN THE BALTIC SEA
Ewelina Ferchow	ESTIMATION OF BOTTOM SEDIMENTS AND NEAR-BOTTOM WATERS POLLUTION IN THE MAIN SEDIMENTATION BASINS OF THE GULF OF FINLAND
Alexandra Ershova	GEOECOLOGICAL RESEARCH IN THE AREA OF BORNHOLM POLYGON
Lubomira Blom	DRINKING WATER IN SWEDEN

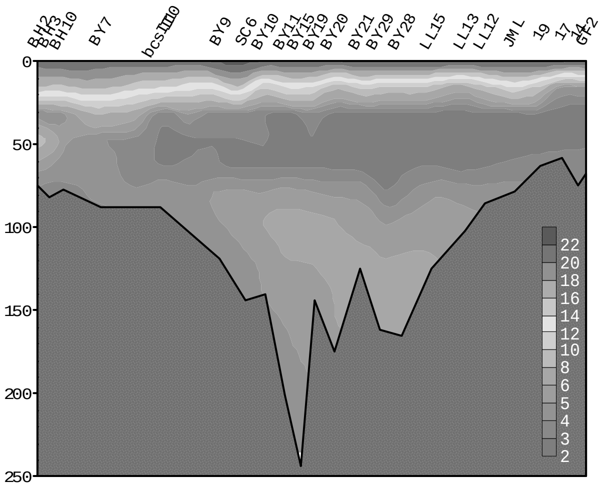


Figure 2. Distribution of temperature (°C) along the axis of the Baltic Sea.

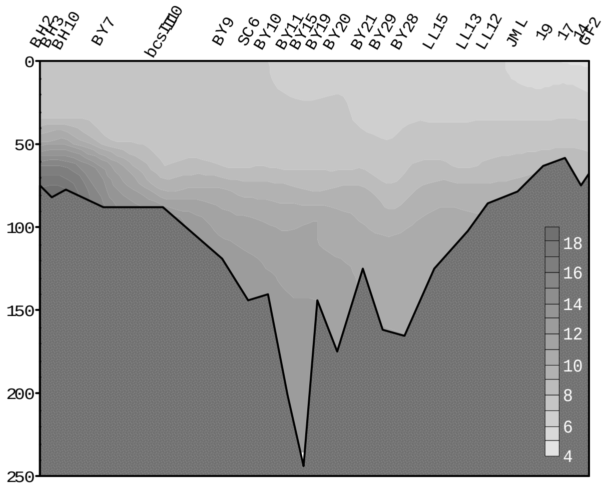


Figure 3. Distribution of salinity (PSU) along the axis of the Baltic Sea.

to the surface; increased salinity in the near-bottom and intermediate layers, and also high content of oxygen, silicon and other characteristics typical for transformed north-sea waters slowly spreading in the deep water parts of the Baltic Sea.

Inflow event. The main factor, that influenced the formation of hydrochemical structure in deep-water parts of the Baltic Sea in August 2003, is the strong inflow of the north-sea waters, which occurred in January 2003. Intensity of the inflow is estimated within the range from 130 to 180km^3. Analysis of the collected data showed, that at the moment of observations under the influence of the inflow transformed waters with increased salinity and decreased temperature filled the Gotland Deep, pushing "old" Baltic water northward (Fig.2, 3). Concentration of dissolved oxygen in the Deep was between 2.4 and 3.7ml/l (Fig.4). Content of phosphates (Fig.5) and silicates decreased, concentration of nitrates increased. The border of displaced "old" Baltic waters with deficit and complete absence of oxygen and corresponding content of nutrients was clearly observed on the northern slope of the Deep. Measurements in the end of June 2003 done by the joint Shirshov Institute of Oceanology (Kaliningrad) and RSHU (Saint-Petersburg) expedition onboard the sailing catamaran "Centaurus-II" showed that in the indicated period the water in the Gotland Deep was not renewed still. Thus we can conclude that observations in August coincided in time with the moment of filling and renewal of deep waters in the Gotland Deep.

Bornholm polygon. Here geoecological research was done at 10 stations, two of which were located in the place of chemical munitions dumping after the World War II. In 2002 on the Bornholm polygon anaerobic conditions were prevailing. Oxidation zone was found at none of the stations. In 2003 the situation sharply changed. At 5 stations oxidation zone appeared, which indicated on changes in ecological situation. Amount of dissolved oxygen in the near-bottom layers is linked with changes of redox-potential (Fig.6).

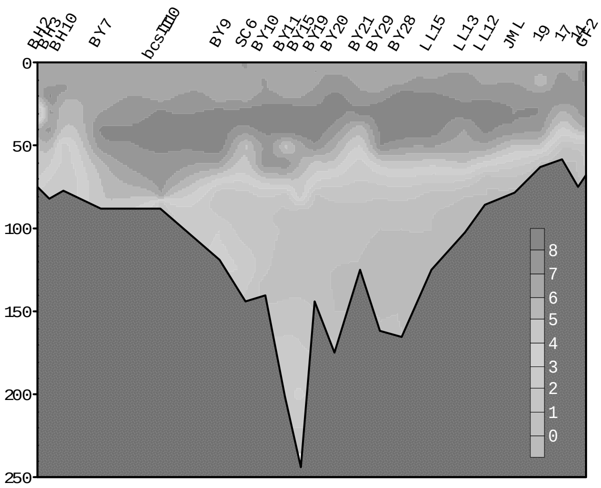


Figure 4. Distribution of oxygen (ml/l) along the axis of the Baltic Sea.

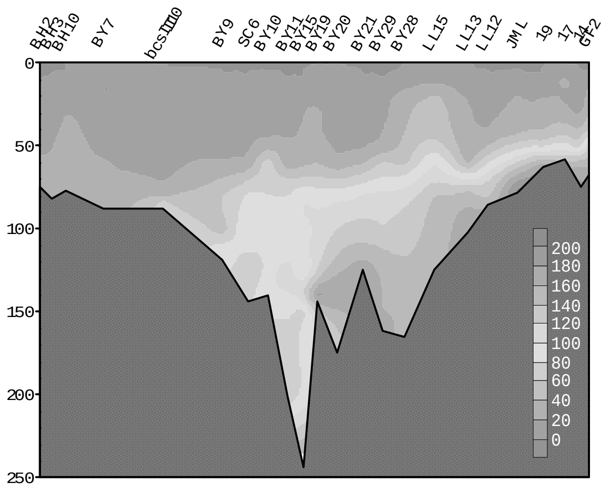


Figure 5. Distribution of phosphates (μg/l) along the axis of the Baltic Sea

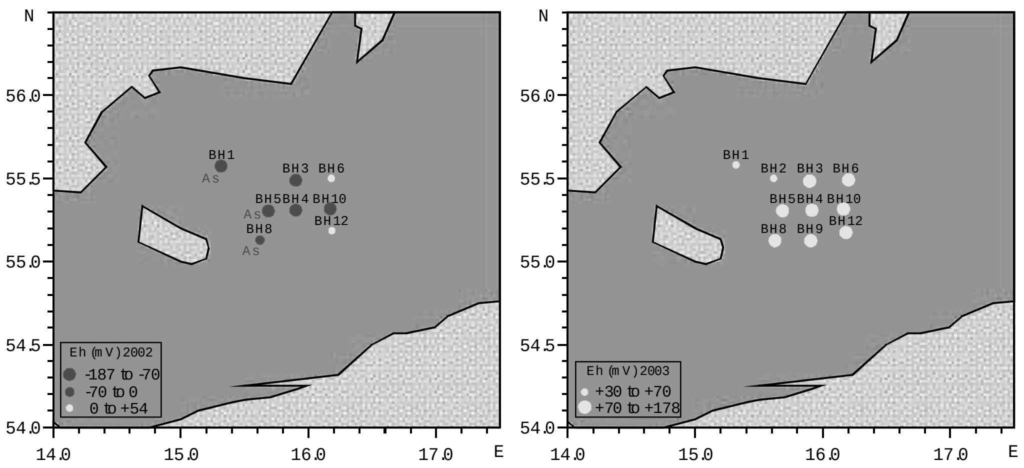


Figure 6. Change of redox-potential in the near-bottom waters on the Bornholm polygon in 2002 and 2003.

Oxygen concentration changes from 2.3 to 6.5ml/l. In the very Bornholm Deep minimum values of dissolved oxygen concentration are kept (stations BH4, BH5). Apparently its large amounts are used for oxidation of the upper layer of sediments.

Geoecological situation sharply changed during only one year, which is most likely related with the inflow event from the North Sea resulted in ventilation of the near-bottom layers of water. Oxidation zone appeared and Eh values in the near-bottom waters and bottom sediments became positive. Thus we can speak about improvement of ecological situation. This is also reflected in decreased concentrations of toxicants in the near-bottom waters, which we can see on the example of arsenic. In this sense we can consider that influence of the dumping site on the environment will be also decreased. However accumulation of destruction products will take place in the very sediments and when anaerobic conditions will be established again this can lead to more intensive pollution of the near-bottom waters.

WHO DID THE CRUISE

1	Name	Country	Institution	Position
1	Tatyana Eremina	Russia	RSHU	Dr., chief of the expedition
2	Alexander Averkiev	Russia	RSHU	Dr., vice-chief of the expedition
3	Jury Scherbakov	Russia	RSHU	Hydrologist
4	Sergey Vilenkin	Russia	RSHU	Data manager
5	Alexey Isaev	Russia	RSHU	Ph.D., hydrologist
6	Larisa Rusina	Russia	RSHU	Chemist
7	Mikhail Shilin	Russia	RSHU	Dr., biologist
8	Grigory Frumin	Russia	RSHU	Prof., chemist
9	Piotr Provotorov	Russia	RSHU	Dr., hydrologist
10	Tagir Lakhov	Russia	RSHU	Hydrologist
11	Svyatoslav Tyuryakov	Russia	RSHU	Ph.D. student
12	Alexander Tenilov	Russia	RSHU	Dr., hydrologist
13	Sergey Vinogradov	Russia	RSHU	Data manager
14	Alexey Nikiforov	Russia	RSHU	Ph.D., hydrologist
15	Alexander Rybalko	Russia	Sevmorgeo, Russia	Prof., geologist
16	Natalia Fedorova	Russia	Sevmorgeo, Russia	Dr., geologist

17	Roman Vankevich	Ukraine	Centre for Ecological Safety, Russia	Dr., data manager
18	Monica Saez Ribas	Spain	University of Cádiz, Spain	Dr., chemist
19	María del Mar Ruiz	Spain	University of Cádiz, Spain	Student
20	Carlos Gonzalez	Spain	University of Cádiz, Spain	Student
21	Francisco Arjona	Spain	University of Cádiz, Spain	Student
22	Inés Serra Martins	Portugal	University of Aveiro, Portugal	Student
23	Ewelina Ferchow	Poland	Technical University of Hamburg, Germany	Student
24	Paulina Pawlak	Poland	Technical University of Gdansk, Poland	Student
25	Holly Coombes	Great Britain	University of Plymouth, GB	Student
26	Lubomira Blom	Sweden	University of Uppsala, Sweden	Ph.D. student
27	Olga Pasyukova	Russia	RSHU	Student
28	Lidia Alexandrova	Russia	RSHU	Student
29	Alexander Smirnov	Russia	RSHU	Student
30	Natalia Guslina	Russia	RSHU	Student
31	Yevgeny Morozov	Russia	RSHU	Student
32	Alexander Storonkin	Russia	RSHU	Student
33	Alexandra Ershova	Russia	RSHU	Student
34	Denis Gladikov	Russia	Saint-Petersburg State University, Russia	Student

*Tatyana Eremina is associate professor doing environmental research in the Department of Fisheries at RSHU. Since 1999 she is the Head of the BFU expeditions onboard the RV 'Sibiriakov'. E-mail: tanya@rshu.ru

*Svyatoslav Tyuryakov is a Ph.D. student in the ICZM Department at RSHU. Involved in the BFU since 1998 with the main focus on international cooperation. E-mail: slavik@rshu.ru

Marine research and education onboard the sailing catamaran "Centaurus-II" in 2003

Alexey Nekrasov, Galina Bashkina, Svyatoslav Tyuryakov

XI CRUISE. RESEARCH IN THE BALTIC PROPER

This expedition was undertaken by joint efforts of Russian State Hydrometeorological University and Shirshov Institute of Oceanology (Atlantic Branch, Kaliningrad). Research was done according to section "The Baltic Sea" of the subprogram 'Research of the World ocean nature', which is the part of the Federal Program 'World Ocean'. International cooperation was developed during the visit to Germany and participation in Kiel Week on invitation from Christian-Albrechts Kiel University.

TASKS FOR THE CRUISE

The main task for this cruise of the catamaran was to study the effects produced by an intensive inflow of saline water from the Kattegat into the Baltic Sea, which occurred between January 16-26, 2003. Also the "Centaurus-II" for the second time was invited to visit Germany and participate in environmental educational project within the framework of the Kiel Week.

THE CRUISE

Thermohaline structure, dissolved oxygen regime and pH structure were studied with IDRONAUT 316 multi-parameter probe. At the first stage (June 12-19) the measurements were done in the Fårö Deep, the Gotland Basin, the Stolpe Channel, the Stolpe Sill, the Bornholm Basin and the Hamrarne Strait. At the second stage (July 1-5) the area under investigation covered the Arkona Basin, the Hamrarne Strait, the Bornholm Basin, the Stolpe Sill, the Stolpe Channel and the Gdansk Basin (Fig.1).

Figure 1. Scheme of stations in the Baltic Sea. The sailing catamaran "Centaurus-II"

SCIENTIFIC RESULTS

The data obtained in the cruise evidence of continuing and extending impact of the inflow upon the conditions in the bottom layers of the Baltic Sea. These data give a June-July specification to the process of saline water penetration along the main axis of the Baltic generally described by the results of successive cruises of German research vessels (RV "Professor Albrecht Penk" (January), RV "Gauss" (February and March), RV "A.v.Humboldt" (May and July)). In Figures 2 and 3 the vertical distribution of temperature and salinity along the main Baltic axis is given. Figure 4 (based on the results by mentioned German vessels and those of "Centaurus-II") demonstrates variation of the near-bottom salinity at several representative stations in Arkona (A), Bornholm (B), Stolpe Channel (SC), SE Gotland (SEG), Gotland (G) and Fårö (F) regions (basins). Two peaks are present on most of the variation curves suggesting that two impulses of inflow apparently took place. Coarse estimate of times of the curve peaks gives some rough idea about the speed of propagation of the maximum inflow effect from one basin to another.

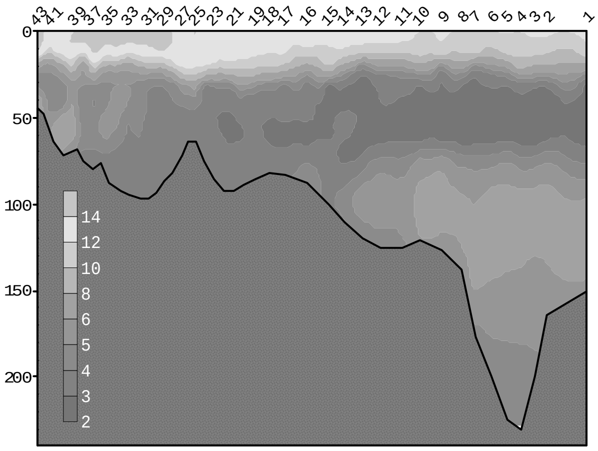


Figure 2. Distribution of temperature (°C) along the axis of the Baltic Sea. June 12-19

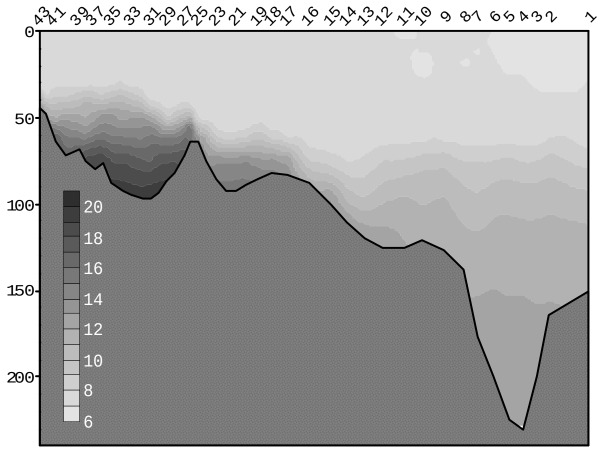


Figure 3. Distribution of salinity (PSU) along the axis of the Baltic Sea. June 12-19

The following estimations were obtained for the speed of this process, which may characterise the 'transmission capacity' of sills separating the basins:

Boundary	A-B	B-SC	SC-SEG	SEG-G	G-F
Transmission speed, miles/day	Very high	0,4	0,9	Very high	0,5

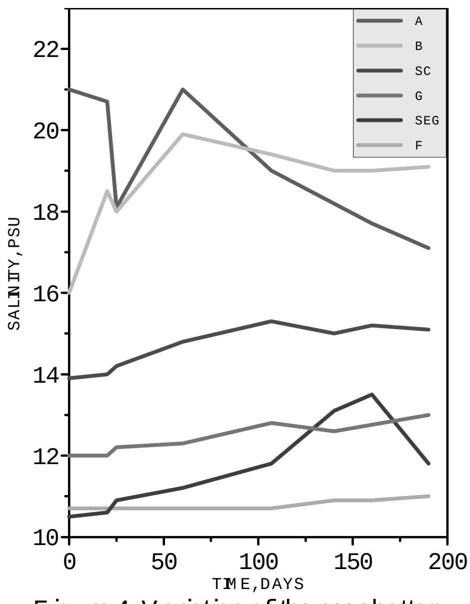


Figure 4. Variation of the near-bottom salinity in 6 basins of the Baltic.

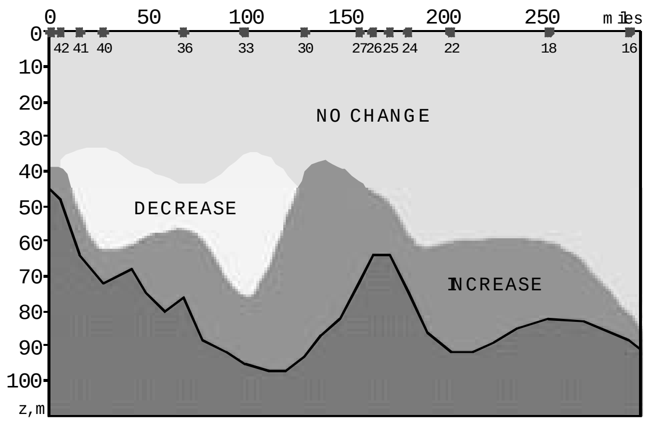


Figure 5. Development of the inflow process in the last two weeks of June.

Some stations during the cruise of the catamaran "Centaurus-II" were done twice with shift in time. This permits to compare the hydrographic conditions separated in time by about two weeks (from June 18 to July 2-3). In Figure 5 the result of this comparison is shown demonstrating the areas where the salinity increased/decreased and illustrating development of the inflow process during the mentioned time interval. We see that the increase of salinity predominated practically everywhere in the near-bottom layers from the Hamrame Strait to the SEG region.

At the same time, in the most part of the Bornholm region, decrease of salinity was observed above the increase area. This possibly can be assigned to oscillations of the halocline due to internal waves and also one-time observed thickness of the near-bottom saline layer not always can be regarded as a comprehensive characteristic of an inflow influence.

KIEL WEEK

In 2003 the sailing catamaran "Centaurus-II" for the second time participated in Kiel Week (June 23-30), which is one of the largest events in the northern Europe. The invitation was received from Academic Service of International Relations at Christian-Albrechts Kiel University. The initiative to invite the catamaran came from Hohe Tied - non-govequmental organisation for environmental protection of the North and the Baltic Seas.

Environmental education. During the Kiel Week the catamaran and all the members of the BFU expedition were involved into activities within the framework of the project named "Kiel-sailing city". The project is aimed at dissemination of environmental knowledge and involvement of local population (first of all students) in activities on studying and protection of the environment. The program of participation of the BFU expedition in the project was developed together with Hohe Tied, representatives of Centre for Applied Ecology (Sillamäe, Estonia) and of Cádiz University (Spain).

During the Kiel Week members of the BFU expedition worked together with scientists-ecologists from the Institute of Marine Research (IfM, Kiel) and Hohe Tied society. Two classes about ecological state of the Baltic Sea were held every day with different groups of visitors (mostly students from Kiel and towns around). The classes included lectures and demonstration experiments on the model of the Baltic Sea, and also practical part, when the catamaran went to the sea to take samples and measure hydrophysical, hydrochemical and hydrobiological parameters at two points of the Kiel bight. In the end of each class the samples were analysed and results demonstrated on a computer. Active participation of guests in all the kinds of practical environmental work is worth to be marked.

Who attended the classes. 8th year students from real school in Raisdorf; 5th year students from Freiherr von Stein-Schule in Kiel; 4th year students from Friedrich-Junge-Schule in Kiel; students of biological course from gymnasium in Ekkernferde; representatives of Academic Service of International Relations at Kiel University, of the IfM Assistance Society, of energetics company Camp24sieben, of HeiTel Digital Video company, of Bingo-Lotto lottery, of Kiel Environment Department, who co-sponsored the "Kiel-sailing city" project; members of coordination group of the scientific and technical program "Marine Research", which is jointly fulfilled by the IfM, GEOMAR scientific-research centre, Pedagogic Institute and Hohe Tied; representatives of mass-media (newspapers "Kieler Nachricnten" and "Kieler Woche online", radio station "Norddeutscher Rundfunk – Welle Nord", television channels SAT1 and RT1, international magazine "Multihulls").

Exhibition. The RSHU group was invited to take part in exhibition dedicated to oceanographic research onboard the RV "Alkor". Three posters contained the materials about activities of the Baltic Floating University, its history and structure, types of field research by the vessels "Sibiriakov" and "Centaurus-II", the main results, broad international relations.

Lectures. On agreement with Institute of Marine Research during the Kiel Week the chiefs of the expedition gave lectures within the framework of lectures cycle "Planet Earth", held in the IfM Aquarium. Professor A.V. Nekrasov has read a lecture "Energy of ocean tides and its application". Doctor V.T. Paka spoke about "Large inflow events of the north-sea waters into the Baltic and their consequences". During all the indicated activities RSHU students were in permanent contact with students from Kiel University and scientists from Institute of Marine Research.

WHO DID THE CRUISE

№	Name	Institution	Position
1	Vadim Paka	Shirshov Institute of Oceanology	Dr., chief of the expedition
2	Alexey Nekrasov	RSHU	Prof., chief of RSHU group
3	Galina Bashkina	RSHU	Chief of the field practice
4	Sergey Vilenkin	RSHU	Data manager
5	Nikolay Golenko	Shirshov Institute of Oceanology	Ph.D., hydrologist
6	Alexander Podufalov	Shirshov Institute of Oceanology	Hydrologist
7	Svyatoslav Tyuryakov	RSHU	Ph.D. student, hydrologist
8	Alexey Skomorokh	RSHU	Hydrologist
9	Yevgeny Morozov	RSHU	Student
10	Natalia Ivanova	RSHU	Student
11	Alexander Kurilo	RSHU	Student
12	Filipp Bashkin	RSHU/ Centaurus-II	Student/sailor
13	Sergey Kharkov	Centaurus-II	Captain
14	Anatoly Korovin	Centaurus-II	Vice-captain
15	Oleg Dzhoubaba	Centaurus-II	Sailor

XII CRUISE. EDUCATION AND RESEARCH IN THE GULF OF FINLAND

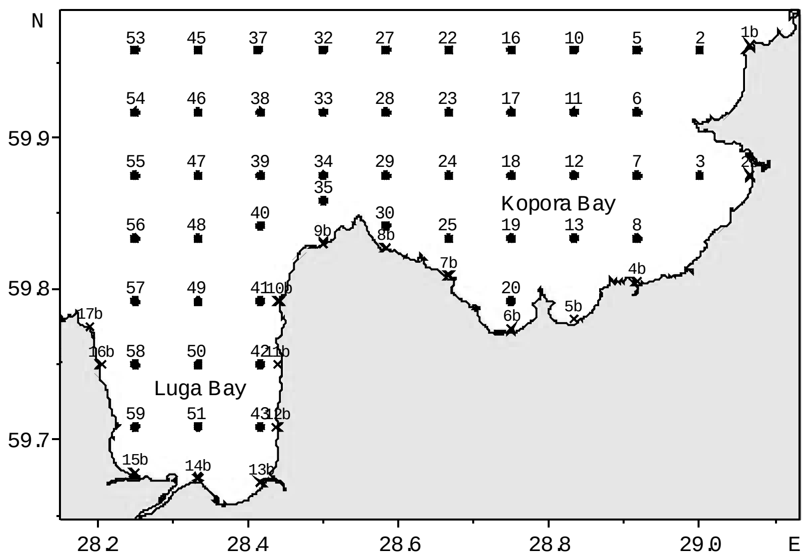
The cruise was organised by Russian State Hydrometeorological University and mainly dedicated to field practice for students studying marine sciences at RSHU and universities of Europe. Activities during the cruise followed the program of field practice developed and accepted at RSHU, general BFU program, agreement with BOOS project "Harmful Algal Blooms" and agreement with Zoological Institute.

TASKS FOR THE CRUISE

To carry out annual standard oceanographic research in the Luga-Kopora basin, to take plankton samples at points determined by the agreement with BOOS project "Harmful Algal Blooms", to take plankton samples within the framework of agreement with Zoological Institute (Saint-Petersburg), to provide field practice for students, including diving practice, were the tasks for this cruise.

THE CRUISE

The cruise was held between July 19 and August 05. See the research polygon on Figure 6. During the cruise the students performed all the kinds of field work onboard the catamaran, including measurements of oceanological and meteorological characteristics, sampling, processing materials of observations. The guiding principle of all the expeditions onboard the catamaran "Centaurus-II" is "training-through-research", which lets students and young scientists be involved in all the research activities.



The catamaran is a comfortable vessel for diving. That is why every summer students who have diving licenses get the opportunity to dive. It is a good practice and also they help with sam-

pling from the bottom. Special attention is paid at foreign students-divers to exclude the slightest difference in understanding the rules of underwater signals.

10 students from Russian State Hydrometeorological University and 8 students from European Universities (Cadiz (Spain), Plymouth (Great Britain), Stockholm and Uppsala (Sweden), Szczecin, Lublin and Lodz (Poland)) took part in the cruise.

SCIENTIFIC RESULTS

General hydrological conditions in the Luga-Kopora region were determined by relatively stable weather conditions. Heating of the surface waters was intensive, but not deep due to weak wind mixing. The upper mixed layer was almost not developed at the moment of observations (average vertical gradients of temperature in the upper 5m layer frequently exceeded 3^{0}C/m). Average vertical gradients of salinity in the same layer reach up to 0.3‰/m. Further up to the depth of 10m the vertical gradients are weaker, and deeper distribution of the characteristics becomes quasi homogeneous.

At the surface two temperature minimums are observed (Figure 7). One located in the northeast of Kopora Bay, and the other in the southern Luga Bay. In both cases temperature is about 7-8^{0}C, which is the sharp anomaly as surrounding waters were warmed up to 17-21^{0}C, corresponding to typical summer heating in this region in the end of July.

Distribution of salinity at the surface is characterised by slightly increased background values exceeding 3.0-3.5‰ (Figure 8). On the most part of the research area the surface salinity is decreasing coastward, which is natural due to rivers discharge. But there are some exceptions. The most evident is in the north - eastern part of the Kopora Bay, where salinity is increasing coastward and reaches the absolute maximum (4.99‰) on the coastline. In combination with the surface temperature minimum (7.00^{0}C, see above) this indicates on intensive upwelling event near this part of the coast. At the same time in the area of the second temperature minimum (the southern Luga Bay) no increased values of salinity are observed. Probably this can be due to strong freshening effect of the Luga River. Also in relation with intensive construction in the area of future port complex, observed in the southern Luga Bay environmental conditions can be determined by not standard reasons.

Figure 7. Surface temperature (^{0}C) in the Luga and Kopora Bays

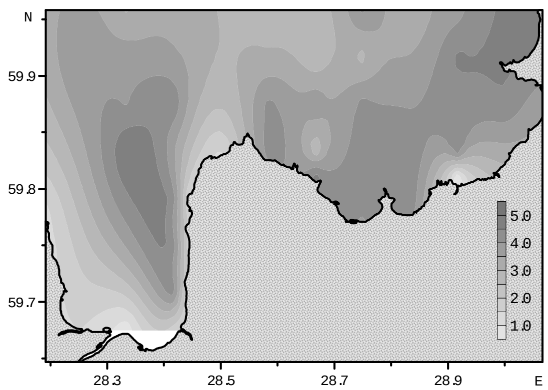


Figure 8. Surface salinity (PSU) in the Luga and Kopora Bays

Near-bottom distribution of temperature and salinity demonstrates spreading of the near-bottom waters from the deep-water part of the Gulf of Finland coastward along the relatively deep canal in the eastern part of the Luga Bay. This process was observed in previous years also. Almost everywhere in the region the near-bottom salinity is higher than 5‰, which exceeds the average climatic value.

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1	Alexey Nekrasov	Russia	RSHU	Prof., chief of the expedition
2	Galina Bashkina	Russia	RSHU	Vice-chief of the expedition
3	Veniamin Merlin	Russia	RSHU	Chief of the diving team
4	Anatoly Korovin	Russia	RSHU/ Centaurus-II	Diving supervisor/ Vice-captain
5	Sergey Golubkov	Russia	Zoological Institute, Russia	Dr., biologist
6	M. Golubkov	Russia	Zoological Institute, Russia	Biologist
7	Irina Vilenkina	Russia	RSHU	Hydrologist
8	Natalia Fedorenko	Russia	RSHU	Student, diver
9	Maria Sharatunova	Russia	RSHU	Student
10	Mikhail Kazakov	Russia	RSHU	Student
11	Olga Prakina	Russia	RSHU	Student
12	Vladislav Ivanov	Russia	RSHU	Student
13	L. Petrova	Russia	RSHU	Student
14	Konstantin Vasilyev	Russia	RSHU	Student, diver
15	K. Bobrov	Russia	RSHU	Student, diver
16	D. Dergach	Russia	RSHU	Student, diver
17	Filipp Bashkin	Russia	RSHU/ Centaurus-II	Student/ Sailor
18	David Roque Atienza	Spain	University of Cádiz, Spain	Student, diver
19	Natasha Croker	Great Britain	University of Plymouth, GB	Student
20	Joseph Butler	Great Britain	University of Plymouth, GB	Student
21	Jurgita Kornijenko	Lithuania	University of Uppsala, Sweden	Student
22	Thomas Hansmann	Germany	University of Stockholm, Sweden	Student
23	Anna Szyperska	Poland	University of Szczecin, Poland	Student
24	Ksawery Kuligowsky	Poland	University of Lodz, Poland	Student
25	Dominika Boguszewska	Poland	University of Lublin, Poland	Student
26	Sergey Kharkov	Russia	Centaurus-II	Captain
27	Oleg Dzhoubaba	Russia	Centaurus-II	Sailor

WHO DID THE CRUISE

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Some peculiarities of thermohaline structure of waters on the HELCOM section in the Baltic Sea in August 2003

Piotr Provotorov, Denis Gladikov, Alexander Smirnov

General information

Thermohaline structure of the Baltic Sea waters is analysed using data obtained on trans-Baltic axial section. It consists of 23 stations: starting from station GF2 in the Gulf of Finland up to station BH2 on the Bornholm polygon. According to CTD-sounding data vertical profiles of temperature and salinity have been obtained, as well as parameters of a cold intermediate layer (depth of a nucleus, T and S), and also energy necessary for overcoming stratification in the upper 10m-layer was calculated. For typical stations in various climatic zones (JML, BY29, BY20, BY15, BCSIII10) a number of characteristics of stratification has been obtained and calculated: temperature, salinity, general stability, Brunt-Väisälä frequencies and corresponding periods of free oscillations, density ratio and Rossby deformation radii.

The analysis of vertical structure of temperature (T) and salinity (S)

Water surface temperature at the majority of stations changes from 21,2°C to 22,3°C. It is possible to distinguish upper quasi-homogeneous layer (0-5m), jump layer (5-20m) with the strongest gradients at stations in the eastern part of the Baltic Sea, cold intermediate layer (CIL) with minimum temperatures of 2°C and the maximum thickness in the Gotland Deep area, and near-bottom layer with maximum temperature 6°C at stations from LL15 to BY20, and on the rest if the section - 4°C. Surface salinity distribution considerably varies along the section: from 4,8‰ in the western part of the Gulf of Finland up to 7,2‰ at last stations of the section (Southern Baltic). Salinity monotonously grows with depth forming a halocline in the layer 50-75m with gradients 0,5-1,0‰/m. Vertical distribution of water density has the same features as the distribution of salinity (Figure1).

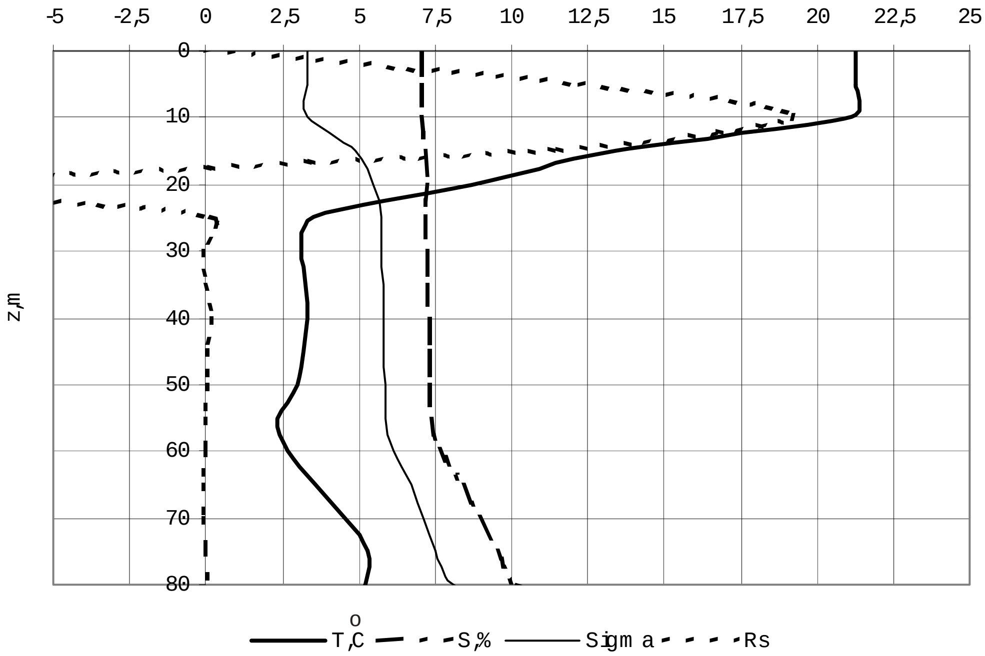

Figure 1. Vertical profiles of temperatures, salinity, conditional density and density ratio at station BCSIII10 in the Baltic Sea (August, 2003).

Cold intermediate layer (CIL)

It is well known that the important feature of thermal structure in the Baltic Sea is cold intermediate layer (CIL), which appears as a consequence of autumn-winter convection. According to obtained data nucleus of this layer is located at the depth of 30-40m in the Gulf of Finland and 50-60m at stations of the western part of the section. The CIL temperature along the section varies from 1,9°C up to 3,4°C (Tab.1). Nevertheless this layer does not sink, as its salinity (7,0-7,5 ‰) is lower than near-bottom salinity.

Table 1. Characteristics of CIL, energy necessary for mixing (A) and Rossby radii on the HELCOM section in the Baltic Sea (August, 2003).

Stations	ρ_1, kg/m^3	ρ_2, kg/m^3	A, J/m^3	$H_{nucleus}$, m	$T_{nucleus}$, °C	$S_{nucleus}$, ‰	T_b, °C	Rossby radius, m
GF2	1002,5	1004,1	39,24	30,7	1,92	6,75	4	
14	1001,15	1002,25	26,97	39	2,35	7,22	4,13	
17	1002,65	1004,3	40,46	39	2,07	7,11	3,2	
19	1001,75	1002,8	25,75	43	2	7,3	3,64	
JML	1002	1002,8	19,62	45	1,98	7,38	4,4	16632,6
LL15	1002,5	1003,45	23,29	47	2,04	7,22	6,09	
BY28	1002,65	1003,35	17,16	53,5	2,01	7,25	6,29	
BY29	1002,65	1003,4	18,39	46	2,04	7,07	6,37	24691,5
BY21	1002,7	1003,35	15,94	57,8	2,15	7,4	6,42	
BY20	1003,05	1003,9	20,84	55,5	2,22	7,33	6,04	24260,4
BY19	1003	1003,25	6,13	57	2,36	7,51	5,53	
BY15	1005,85	1006	3,67	51	2,42	7,31	4,66	35479,3
BY11	1005,75	1005,95	4,90	55	2,23	7,36	4,68	
BY10	1003,1	1003,8	17,16	52,5	2,24	7,36	5,3	
BY9	1003	1003,55	13,48	57,5	2,17	7,45	4,35	
BCSIII10	1003,3	1003,35	1,22	55	2,35	7,38	4,42	19793,1
BY7	1003,45	1003,5	1,22	45	3,39	7,33	4,13	

Energy necessary for mixing

An important feature of vertical structure of waters in the beginning of August 2003 is presence of sharply expressed stratification in the field of temperature reaching 2-3°C/m in the layer 5-20m. One of the possible reasons for this is strong radiation heating. Significant amount energy is required for overcoming stratification even in top 10m-layer. For its estimation the following relationship has been used [2]:

$A = g/2[z_1(\rho_1+\rho_2)-z\rho_1]$. Here $z_1=z_2=5$m, $z=10$m, ρ_1, ρ_2 – mean water density in layers 0-5m and 5-10m respectively. The calculated values of energy for separate stations (Tab.1) are in the interval of 25-40J/m^3 for stations in the Gulf of Finland and decrease for less stratified waters of the Baltic Proper. We shall note, that mechanical wind power $[A= C_d * \rho_a * (W^3/z)]$ at wind speed W of 10m/s for the same thickness of a layer makes only 0,26J/m^3 that is obviously not enough for overcoming density stratification even in the upper 10m-layer.

Parameters of stratification

The main parameter here is vertical hydrostatic stability E (Hesselberg-Sverdrup criterion) [1]:

$E = \alpha*(\Delta T/\Delta z)+\beta*(\Delta S/\Delta z)=E_t + E_s$, where Et, Es are temperature and salinity components of stability. Additional parameters of stratification are Brunt-Vaisala frequency $N=(g/\rho)*E$, period of thermohaline oscillations $t=2\pi/N$, density ratio $R_\rho=\alpha*\Delta T/\beta*\Delta S$. The physical meaning of these parameters is well known. The obtained estimations show that the strongest stability is observed in thermocline and the main contribution to it is made by temperature component. Lower to the bottom the main role belongs to salinity component with the maximum values in halocline (Fig.2).

Density ratio values vary in the range from 50 in thermocline up to 0 in the CIL. Vertical distribution of Brunt-Väisälä frequency values have two maximums, in thermocline and halocline, with values up to 0,055 sec^{-1} and corresponding periods from 2 to 15 minutes (Tab.2). In assumption of continuous stratification at the same stations estimations of Rossby deformation radius have been obtained $L_R=N*H/f$. Maximum L_R value is 35 kilometres for station BY15, that is in the vicinity of Gotland Deep.

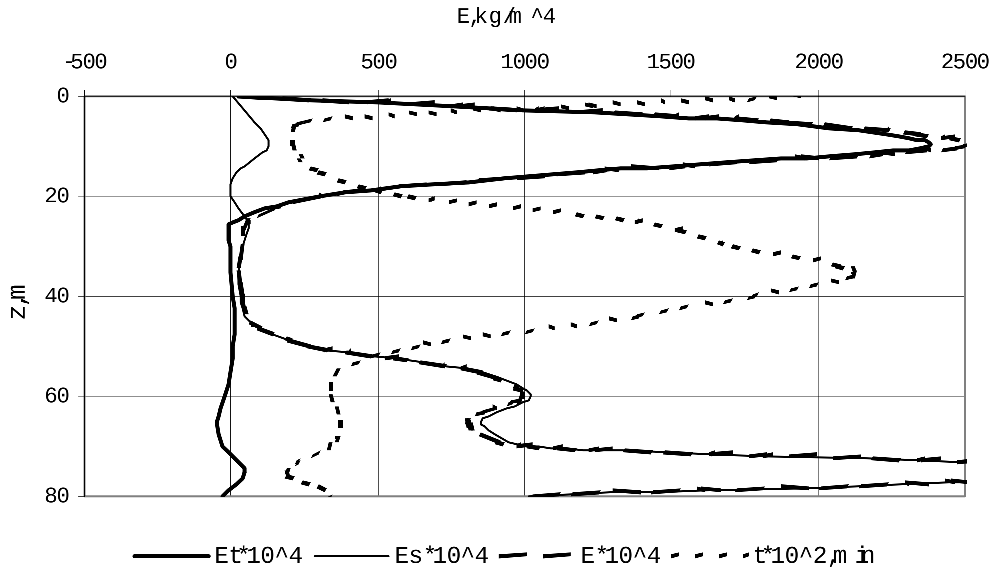

Figure 2. Total stability, its temperature and salinity components and periods of free oscillations at BCSIII10.

Conclusion

Comparison of thermohaline structure of waters based on this year expedition data with data of similar surveys during the last years has shown that the peculiar features of 2003 are:

- more expressed stratification, especially in the field of temperature: very thin upper quasi-homogeneous layer and sharp thermocline;
- more intensive heating of the surface layer (22-24°C against 18-20°C in two last years);
- presence of warm and saline near-bottom waters, especially in the southern part of the section. It testifies, together with distribution of hydrochemical parameters (O_2, Si, etc.), about recent inflow event from the North Sea.

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Thermohaline structure of waters on meridional sections in the Gulf of Finland

Inés Martins, Carlos Gonzalez

Abstract

The present study is built upon the data received in August 2003 during the fieldwork onboard the hydrographic research vessel 'Sibiriakov'. Spatial variability in hydrophysical characteristics was studied. After a convenient treatment of data collected, it was obtained like a result that different water layer influences the structure of the Gulf of Finland sections.

Introduction

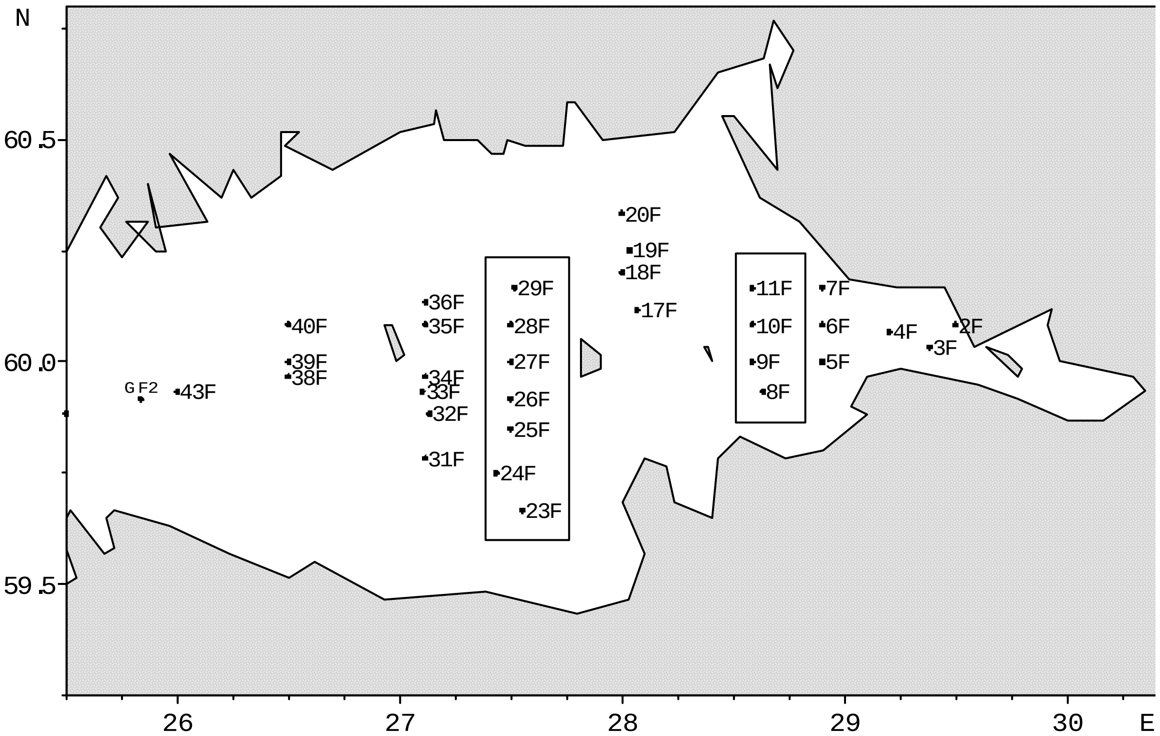

Figure 1. Stations in the Gulf of Finland.

The main goal of this study is to characterize the thermohaline structure of meridional sections in the Gulf of Finland, study of water masses distribution, condition of vertical stratification formation and compute the oscillation period of stratification.

The Gulf of Finland is located in the Baltic Sea, which is the largest brackish water area in the world. In order to get a good characterization, some parameters were computed through the following mathematical relations:

Stratification Parameter (Hesselberg-Sverdrup) $E = \frac{\partial \rho}{\partial T}\frac{\partial T}{\partial z} + \frac{\partial \rho}{\partial S}\frac{\partial S}{\partial z}$, where Δz=5m.

Density Relationship $R_\rho = \frac{\alpha \Delta T}{\beta \Delta S}$. Shows the input of temperature and salinity into stratification and is used in the analysis of fine structure.

Stratification Oscillation Period $\tau = \frac{2\pi}{\sqrt{N^2}}$, where $N^2 = \frac{g}{\rho}E$. If E<0, a particle in the layer won't return up which would be possible in a convection process.

Methods and Materials

During the cruise, temperature and salinity were measured using a CTD-sounder (Multi Water Sampler MWS 12/S, HydroBios) (Fig. 2).

CTD is the instrument that measures the Conductivity, Temperature, and Depth (or more accurately pressure) of the seawater that we are studying. The CTD sensor is mounted to the rosette water sampler and lowered through the water while continuously measuring various properties of the water. This information is instantly transmitted through an electronic cable to the surface, which gives a read-out of the water's characteristics. This allows distinguish various boundaries within the water column.

Figure 2. CTD-sounder.

Results and Discussion

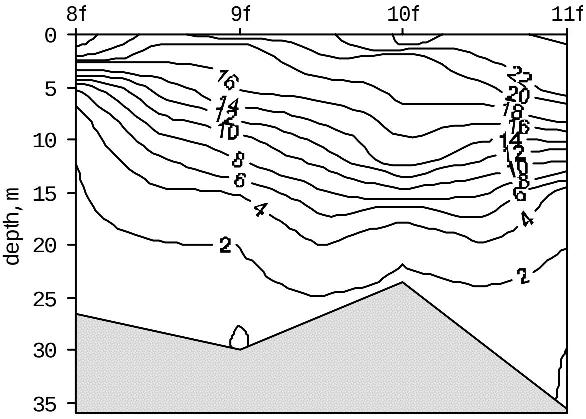

Figure 3. Cross section of temperature (λ=28°30′)

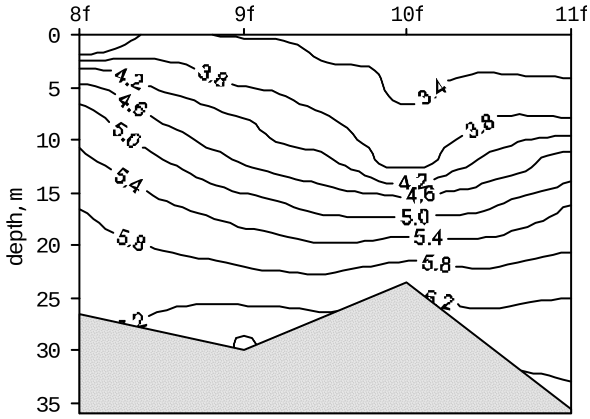

Figure 4. Cross section of salinity (λ=28°30′)

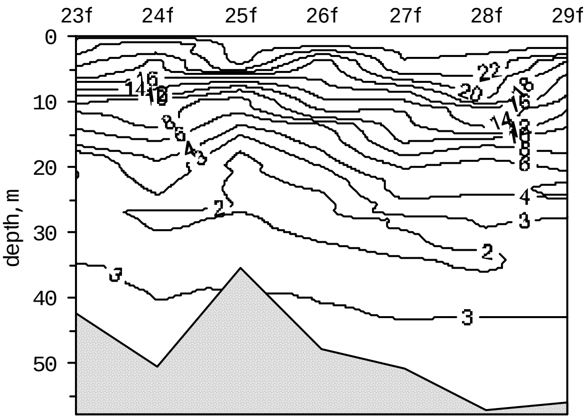

Figure 5. Cross section of temperature (λ=27°30′)

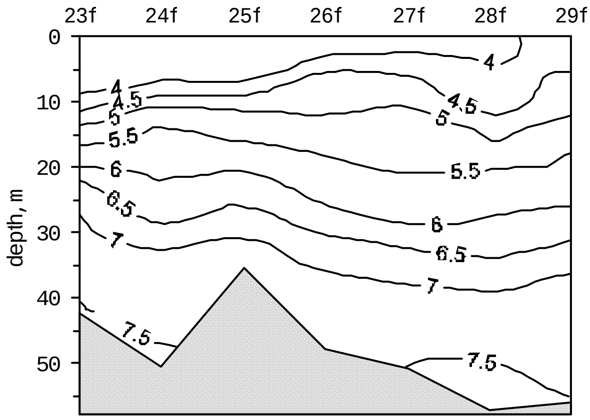

Figure 6. Cross section of salinity (λ=27°30′)

Conclusions

Different water layer influences the structure of the Gulf of Finland sections. The surface layer is influenced by solar radiation and it can be seen abnormal high values of salinity because of the unusual increasing of temperature this summer. The mixed layer is very thin or almost negligible due to the higher temperature (more than 7°C) than the previous year.

So, the thermocline can be found near the surface and has a high stratification. It exist a thin layer of cold water under the last one, remaining from the primitive Baltic Lake convection.

Finally we have the bottom layer, warmer and more saline than the previous, influenced by the Proper Baltic.

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Influence of the North Sea water inflow on the ecosystem of the Gulf of Finland

Alexander Averkiev, Tatyana Eremina, Alexey Isaev

January - February 2003 quite intensive inflows of the North Sea waters were observed in Baltic Sea. Previous intensive inflows were observed in 1993-1994 and the long absence of waters renewal has resulted in development of stagnation events not only in deep parts of the Baltic Sea, but also on vast water areas, including the Gulf of Finland. The present work is purposed to demonstrate how the North Sea water inflow has affected the ecosystem of the Gulf of Finland. It is revealed, that the transformed North Sea waters have not reached directly the eastern Gulf of Finland by August 2003, nevertheless, their influence has affected the state of the Gulf's ecosystem. Since 1993 Russian State Hydrometeorological University carries out annual oceanographic research in the Baltic Sea and in the Gulf of Finland. Surveys are carried out within the framework of the federal target program "World Ocean" (subprogram "Research of the nature of the World Ocean") and the international program "Baltic Floating University". The basic scientific purpose of regular field research is studying influence of hydrophysical, hydrochemical and hydrobiological processes on the state of the sea's and the gulf's ecosystem. Interdisciplinary oceanographic observations are carried out on several polygons and at stations of the Baltic monitoring system (HELCOM-stations). The research was carried out in July - August on vessels of the Russian Navy Hydrographic Service (last 5 years on the RV "Sibiriakov"), and also from the board of the sailing catamaran "Centaurus-II". The program of research includes a polygon of stations in the eastern Gulf of Finland, axial section in the Gulf of Finland, axial HELCOM-section and polygons on the Kaliningrad shelf and above the Bornholm Deep. Last years the basic sections and polygons were done similarly, providing an opportunity to compare distribution of the main hydrophysical and hydrochemical characteristics within stagnation periods and during the years of inflows and aeration.

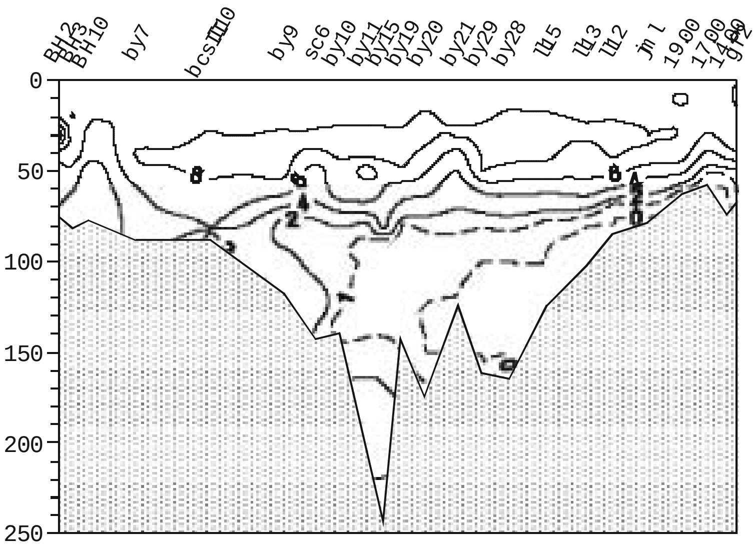
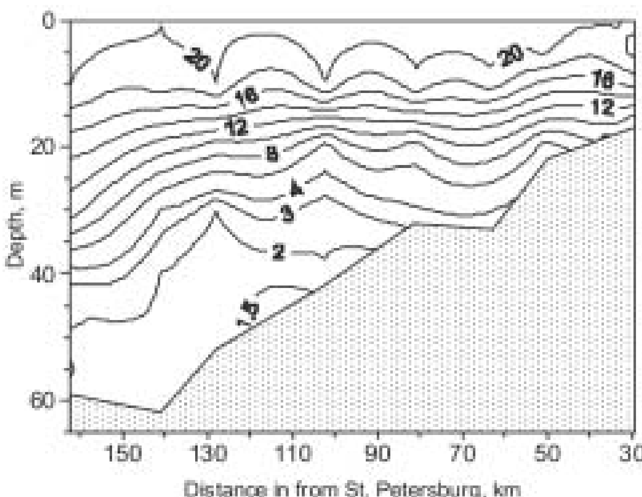


Figure 1. Distribution of dissolved oxygen (ml/l) on axial section in the Baltic Sea. August 2003.

Thermohaline structure, aeration and saturation with nutrients of deep-water areas depend on time and intensity of the North Sea water inflows through the Danish Straits. Before 2003 the last significant inflow was observed in 1993. According to some sources minor inflows were observed in 1997, but their intensity and volume were rather insignificant, and waters renewal was not marked even in the Bornholm Deep, which is close to the Straits. As a result of the long period of stagnation from 1998 till 2002 zones with deficiency or full absence of oxygen extended, the horizon of distribution of hydrogen sulphide raised, salinity in the near-bottom layers appeared decreased.

Figure 2. Distribution of phosphates (mg/l) on axial section in the Baltic Sea. August 2003.

Observations of some Baltic oceanologists in January - April 2003 showed that quite intensive inflows of the North Sea waters have taken place, which, apparently, continued in summer period. Observations done by the RSHU expedition in August of the same year have confirmed the facts of inflows and have fixed penetration of the transformed (mixed) waters consistently in the Arkona and Bornholm Deeps, Stolpe Channel and Gotland Deep. Penetration of the transformed waters has led to decrease of temperature, increase of salinity on 1-2‰ and dissolved oxygen content on 1-1.5ml/l, to changes of nutrients concentration, i.e. to renewal of structure in these deep-water areas. Comparative estimations of intensity and volume of the inflow made by the Kaliningrad Shirshov Institute of Oceanology, Polish and German researchers, have shown that volume of the inflow was enough to fill the Bornholm Deep with consequent "overflow" of transformed waters over the Stolpe Sill into the Gotland Deep. Intensity and volume of the inflow according to different estimations is classified as "above the average". Distribution of salinity on the HELCOM-section in August 2003 differs from the previous years, but most clearly distribution of the transformed mixed waters in deep-water areas is seen on distribution of dissolved oxygen (Fig.1), phosphates (Fig.2) and other nutrients. We see that consecutive filling by the renewed water of the Bornholm Deep, Stolpe Channel and part of the Gotland Deep has already been finished by August 2003. According to foreign researchers intensity of the inflow and speed of propagation of the transformed waters allowed the mixed waters penetrate into the Gotland Deep in April and supersede stagnant waters from its southern slope. Then the process has stopped, so on the northern slope of the Gotland Deep presence of old water is distinctly visible.
Such distribution of hydrological and hydrochemical characteristics obviously testifies that the renewed waters directly have not reached the Gulf of Finland. However distribution of key parameters in the Gulf of Finland in August 2003 shows that the inflow has affected the regime of the Gulf up to its eastern part.
Vertical structure of waters of the eastern Gulf of Finland is well illustrated by distribution of temperature on axial (close to latitudinal) section (Fig.3 and 4).



section along
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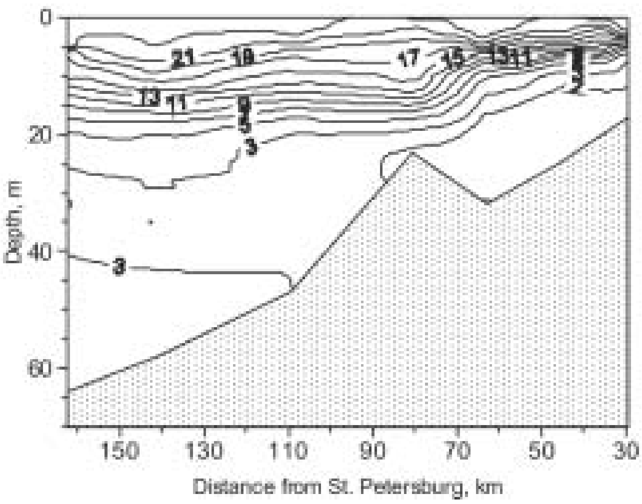

Figure 4. Distribution of temperature on a section along the parallel 60°N in the eastern Gulf of Finland. August 2003.

Figure 3 demonstrates the results of observations in the year of 2002, with conditions close to average. The upper mixed layer on the section has temperature of 20-23°C and goes down up to depth of 10-12m, and this depth increases in westward direction. The jump layer (thermocline) with temperature drop from 20 up to 7-8°C is well defined and is located on depths from 12 up to 18m in the east up to 20-32m in the west. Cold water - a result of autumn - winter convection - with temperature below 5°C allocates below.
Figure 4 demonstrates the results for 2003 in the Gulf of Finland when the phenomenon of well-defined "lockup" of deep waters was typical and which in this sense can be considered abnormal. In our opinion the specified anomaly to some extent is a consequence of the North Sea water inflow (Fig.4). The near-bottom layer of cold (with temperature below 5°C) waters has the increased thickness and its upper boundary has risen on 15-20m. Due to "lockup" this layer was spread far to the east and has penetrated into a coastal shallow zone with depths less than 5m. As a result upper warm layer appeared compressed, and thermocline-sharpened in comparison with average conditions. Depth of the latter is 3-7 m in the vicinity of the Neva Bay and 8-18m - in the western part of the aquatory.

We shall note a peculiarity in vertical distribution of temperature, consisting in observed lowest temperatures not at the bottom, but on some distance from the bottom in the western part of the studied area. Therefore vertical distribution of temperature is characterised by presence of a cold intermediate layer with temperature below 3°C, which occupies a range of depths between 25 and 40m, while the near-bottom horizons (in particular, near the Island of Gogland) are filled with slightly warmer water entering from the western part of the Gulf of Finland.

Spatial distribution of salinity in the eastern part of the Gulf of Finland varies year by year to much less extent, than temperature. We can say, that the "lockup" effect influences the general background of salinity in the most part of the studied aquatory of the Gulf of Finland, resulting in its increase with depth, and also at the surface in areas influenced by upwelling.

Vertical distribution of absolute (Fig.5) and relative content of oxygen for the second half of summer 2003 corresponds to summer type: thermal stratification prevents the transport of oxygen from the top layers, under the halocline concentration of oxygen decreases up to complete disappearance at the bottom. The main reason for spreading of a zone of oxygen deficiency from the west to the east, as well as in a case with temperature, is a spatially significant intrusion of near-bottom waters from the open western part of the Gulf, caused by intensive inflow of the North Sea waters to the Baltic and by filling of the Gotland Deep with the transformed water at the moment of measurements. A consequence of these processes was filling of the near-bottom layers of the Neva's internal estuary with water of increased salinity, low - less than 2ml/l oxygen concentration and saturation - less than 20% and increased phosphates concentrations (Fig.6), that is observed for the first time during the period of research.

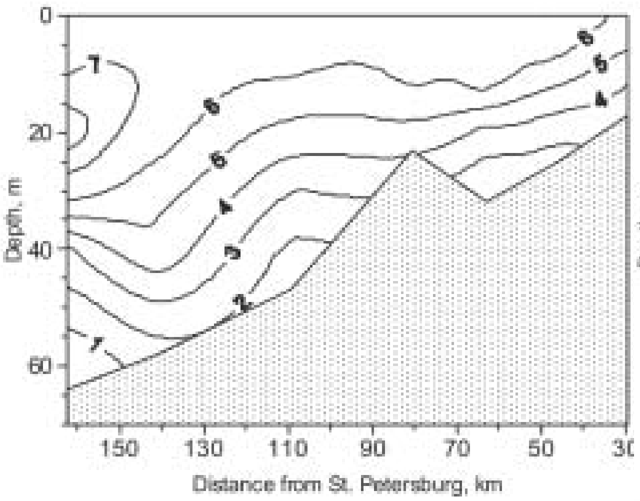

Figure 5. Distribution of dissolved oxygen (ml/l) on a section along the parallel 60°N in the eastern Gulf of Finland. August 2003.

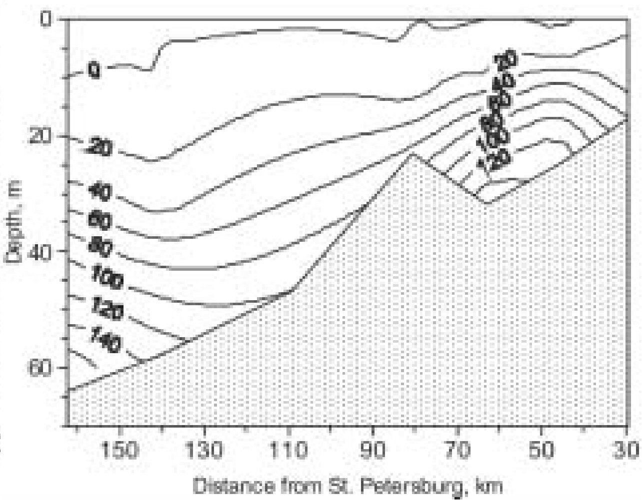

Figure 6. Distribution of phosphates (mg/l) on a section along the parallel 60°N in the eastern Gulf of Finland. August 2003.

Thus, obviously, the inflow of the North Sea waters to the Baltic and filling by the transformed waters of the Bornholm and Gotland Deeps has resulted in renewal, aeration and enrichment with nutrients of deep waters of the Baltic Sea. Influence of the inflow has affected the ecosystem of the Gulf of Finland. However this influence was expressed in penetration into the eastern part of near-bottom waters with increased salinity and decreased oxygen content, i.e. stagnant waters from the Northern Baltic are superseded to the Gulf of Finland (not only to its rather deep-water areas, but also to shallow parts) that as a whole is unfavourable for the ecosystem of the Gulf.

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Influence of the North Sea water inflow on oxygen regime of deep layers of the Baltic

Lidia Alexandrova

It is well known that the surface waters of the Baltic Sea are generally well oxygenized with O_2 concentrations about 7ml/l. Starting form depth of about 60-70m we can observe sharp gradient of oxygen concentration and at the depth of about 140m usually no oxygen is present. So in bottom layers of all the Baltic deeps stagnation processes develop. This situation could be changed only when the North Sea water inflows occur.

On the basis of the results of the RV "Sibiriakov" cruises we compared oxygen concentration in deep layers of the Gulf of Finland and of the Baltic Proper in August 2002 and August 2003.

August 2002 minimal oxygen concentration in the Gulf of Finland is about 3ml/l, which is higher than the critical limit (2ml/l). August 2003 we can observe lack of oxygen (concentration below 2ml/l) in the deep layers at some stations in the Gulf of Finland.

At stations BY11 and BY15 located in the Gotland Deep on August 2002 we could observe the lack of oxygen from approximately 100m down to the bottom (Fig.1). Deeper than 150m the oxygen was absent and anaerobic conditions observed. So in 2002 almost all the Gotland Deep was a zone of stagnation.

August 2003 we observe H_2S in the near-bottom layers only at boundary stations in the Gotland Deep (Fig.2).

The near-bottom water with no oxygen in the Gotland Deep was replaced by oxygenized North Sea water and was pushed to the north. August 2003 average oxygen concentration increased on more than 1ml/l. Oxygen concentration near the bottom at deepest stations of the Gotland Deep BY15 (235m) and BY11 (199m) is 1.16 and 2.74ml/l respectively.Therefore, oxygen content in deep layers increased.

Also oxygen concentration increased in deep layers of the Bornholm polygon in comparison with 2002, when the whole Bornholm deep was in stagnation.

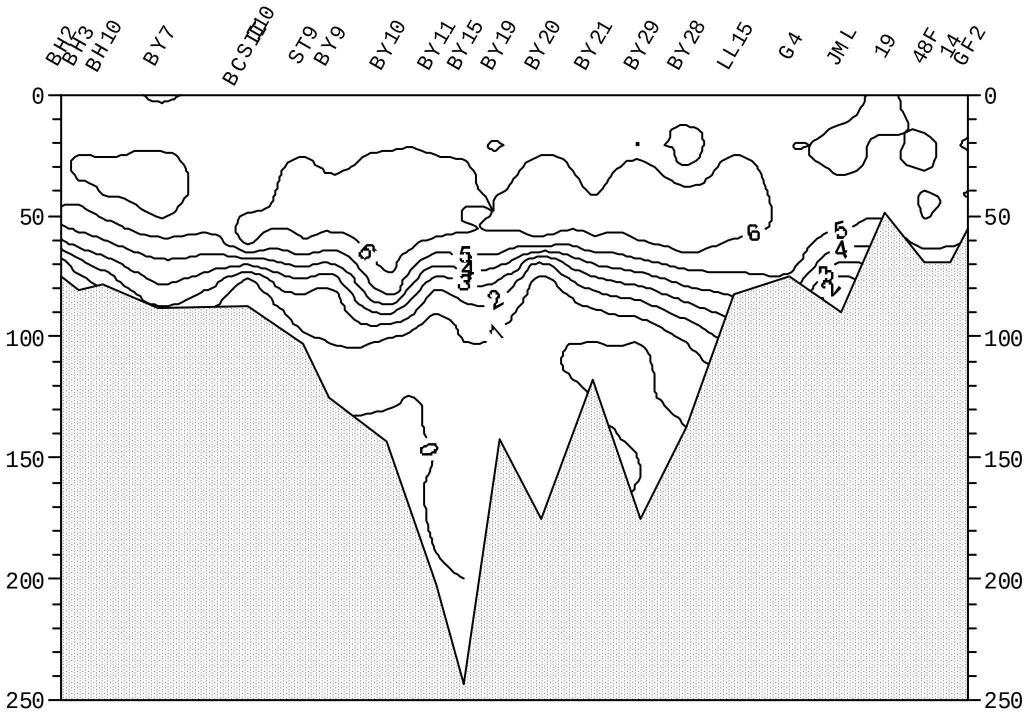

Figure 1. Distribution of oxygen concentration (ml/l) along the HELCOM-section in 2002.

As a conclusion we can say that in 2003 we observe significant inflow of rich with oxygen North Sea water into the Baltic Sea. Due to this inflow processes of stagnation in the Bornholm Deep were stopped and the Gotland Deep waters were completely renewed.

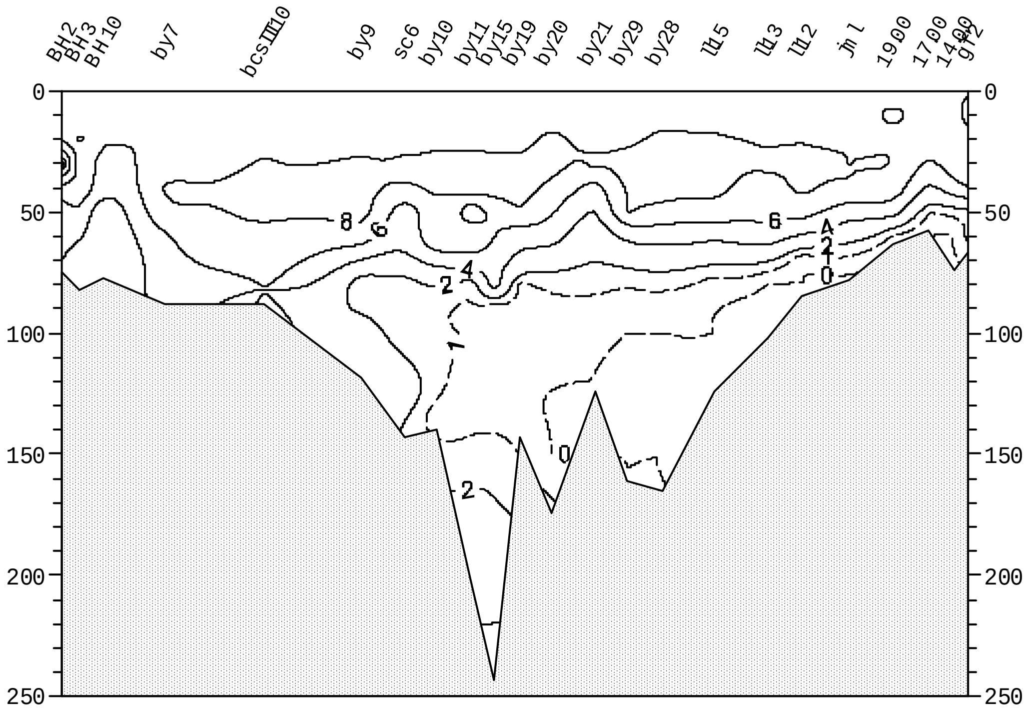

Figure 2. Distribution of oxygen concentration (ml/l) along the HELCOM-section in 2003.

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Nitrates and silicon distribution in the Baltic Proper, 2003

Lubomira Blom, Paulina Pawlak

Introduction

The Baltic Sea basin covers approximately 1.7 million km^2, 14 nations and some 80 million inhabitants. The Sea has a semi-enclosed character; witch makes it vulnerable to pollution. Contributions from freshwater and nutrients from rivers, pollution from industries, municipalities and shipping is also affecting the sea. The inflow of water with high salinity and oxygen concentration is a critical factor for the ecosystem of the Baltic Sea [1].

In January 2003, a deep-water renewal process in the Baltic Sea commenced by an inflow of about 200 km^3 of cold and well oxygenated water from the Kattegat. This phenomenon is considered the most important since 1993. Already in May, the central Gotland Basin was reached by water with near bottom oxygen c force substantial amounts of seawater, enriched with salt and oxygen, from the Kattegat through the Danish Straits into the W estern Baltic. From there, it slowly moves as a thin bottom layer into the central Baltic basins, replacing aged water masses there. To make this happen, easterly winds have to blow continuously for about 10 days to lower the Baltic fill factor, followed by a sudden turn to westerly gale winds, which again need to last for about 10 days or longer in order to cause the fill factor rising to its maximum. [3]

The effect of the January inflow was enhanced by preceding smaller inflows in autumn 2002 and an exceptional water movement in late summer 2002. Unusual weather conditions in late summer 2002 caused the transport of extremely warm waters into layers at and below the permanent pycnocline. The warm waters, though carrying small amounts of oxygen, were capable to remove completely hydrogen sulphide from the Gdansk Basin by November 2002 and considerably reduced its concentrations even up to the Gotland Basin. [3]

Baltic Floating University Survey

During the summer of 2003, data were collected aboard HRV Sibiriakov as part of the Baltic Floating University survey to determine the nutrient status of the Baltic. A range of chemical data was collected including salinity, temperature, dissolved oxygen and nutrients. This paper presents the oxygen concentrations along with nitrogen and silicon data. The data presented reflects data collected in previous years and published in previous BFU Research Bulletins.

Method

The photometrical method applied for determining the nutrients (phosphates, nitrates, nitrites, silicon). The analysis was conducted on photoelectrocolorimeter KFK-2. [4]

Silicon, dissolved in water, was determined by method, devised in VNIRO, providing the use of ascorbic acid for reduction the siliciomolibdenum complex, which allow determining the silicon content in wide range of concentrations – from 10 to 2000 µg/l and more. For taking samples were used plastic bottles; the analysis was held after temperature equalizing. [4]

For determination of nitrates the method used was on capability of these conjunctions to oxidize some organic matters with forming colored products and on reduction nitrates to nitrites. Finished by Cu small-grained Cd was used as a reductioner.The sum of nitrites and nitrates was determined in the sample after passing seawater through cadmium reduction gear with Griss-Ilosvai reactive. After determination the concentration of nitrites in the sample, the concentration of nitrates in this sample was determined by difference between the sum of nitrites and nitrates and concentration of nitrites. [4]

Results and discussion

When nutrients end up in the Baltic proper they are generally consumed by the living organisms. The general tendency is for nutrients' concentration to be at a minimum at the surface where depletion by organisms like diatoms occurs with the maximum at the sea bottom. The eventual excess of nutrients falls to the bottom where they accumulate. In order for the nutrients to degrade there has to be a presence of oxygen in the deep waters. Where there is a lack of oxygen the consuming process is slower.The mineralization of dead organisms normally also accounts for maximal concentrations at the bottom, where the nutrients are released.

Oxygen

Figure 1 shows the vertical distribution of oxygen. The oxygen decreases down the profile from 8 to 1 ml/l to the depth of approximately 180 meters where the Gotland Deep is situated, being designated by stations BY10, 11 and 15. Underneath 180 meters the amount is 2 ml/l. This is the proof of fresh oxygenated water coming in from the straits and pushing the less-oxygenated, old masses of water further north-east in the proper. Compared with the situation two years ago the amount of oxygen in the deep-waters was 1 ml/l from 100 meters and down [5]. The amount of oxygen has thus been doubled since 2001 in the deep layers.

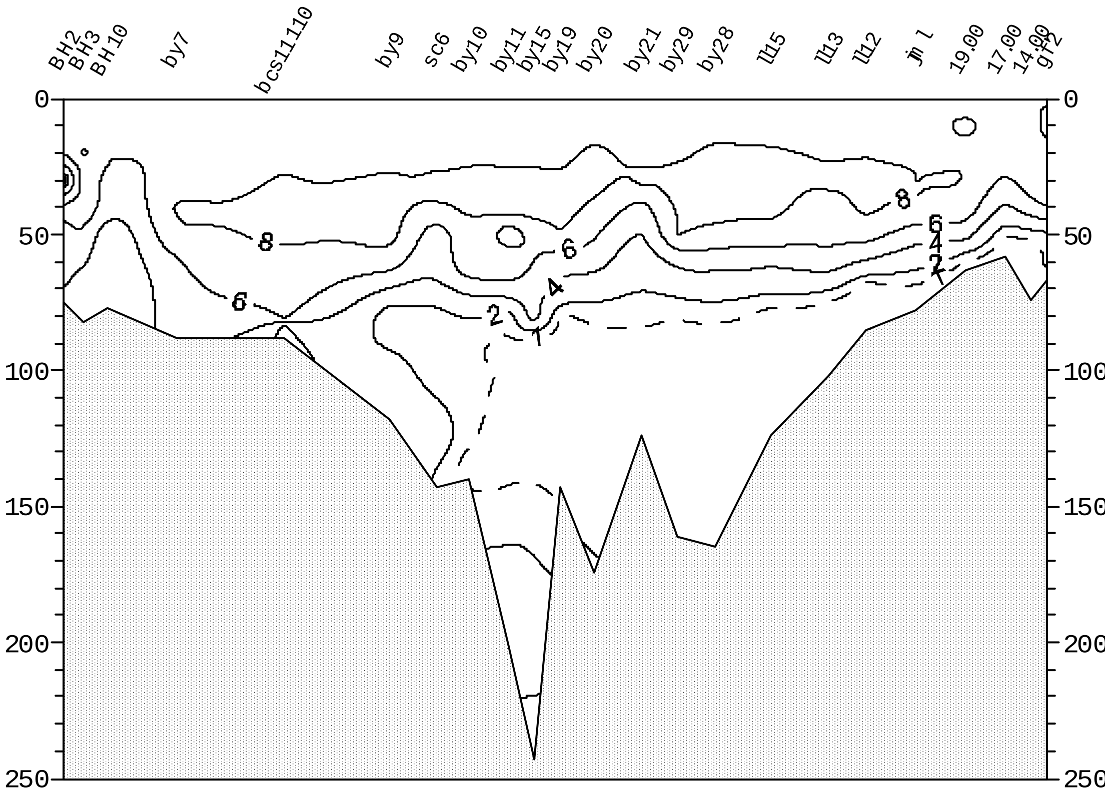

Figure1. Vertical distribution of oxygen (ml/l), 2003.

Nitrate distribution

Figure 2, shows the vertical distribution of nitrate concentrations. The concentrations range from 5-105µg/l. Generally the trend for 2003 is a mixed distribution of nitrates throughout the profile. The amounts in the surface are however continuously low as normally expected. The biggest difference from previous years (2001, 2002) is the relatively high concentrations of nitrates in the deeper waters, which correlates with high oxygen levels. Former research results have shown a decreasing tendency in nitrate concentration with the depth.

The circumstance during 2001 and 2002 is denitrifying stages in the deep waters, due to low oxygen concentrations, which led to nitrogen release [5, 6]. In 2003 on the other hand, it is interesting to observe that Gotland Deep is characterised by relatively high nitrates concentration being an effect of mineralization processes occurring at aerobic conditions. It is plain to see that the new, oxygen-rich masses of water from the Northern Sea haven't managed to move further towards the north-east at the time of the expedition. If one consider the fact that new water has entered the Baltic it is not impossible to draw the conclusion that mixing has occurred.

2003 the nitrate concentration in the deep waters is as high as 65µg/l; this is in clear contrast to 2001, when the concentrations were 5µg/l in the deepest parts of the Baltic proper. The maximum in both 2001 and 2002 is situated at 100 m depth [5, 6]. The maximum concentrations of nitrates in 2003 were at a depth of 50 m (stations BH10 and by7).

Another important observation is that the maximum concentration of nitrates is more than four times higher in 2003 than in 2001. In 2002 the amount of nitrates had a maximum of 28 µg/l, less than half of the concentration on the same depth during 2003 (at station by 15).

The figure also shows that there has been a vertical uplift of the "old water" with a lower nitrate concentration towards the eastern parts of the Baltic proper. It is also likely that a bigger part of the total nitrogen in the Sea consists in this chemical state (nitrates) than in 2001.

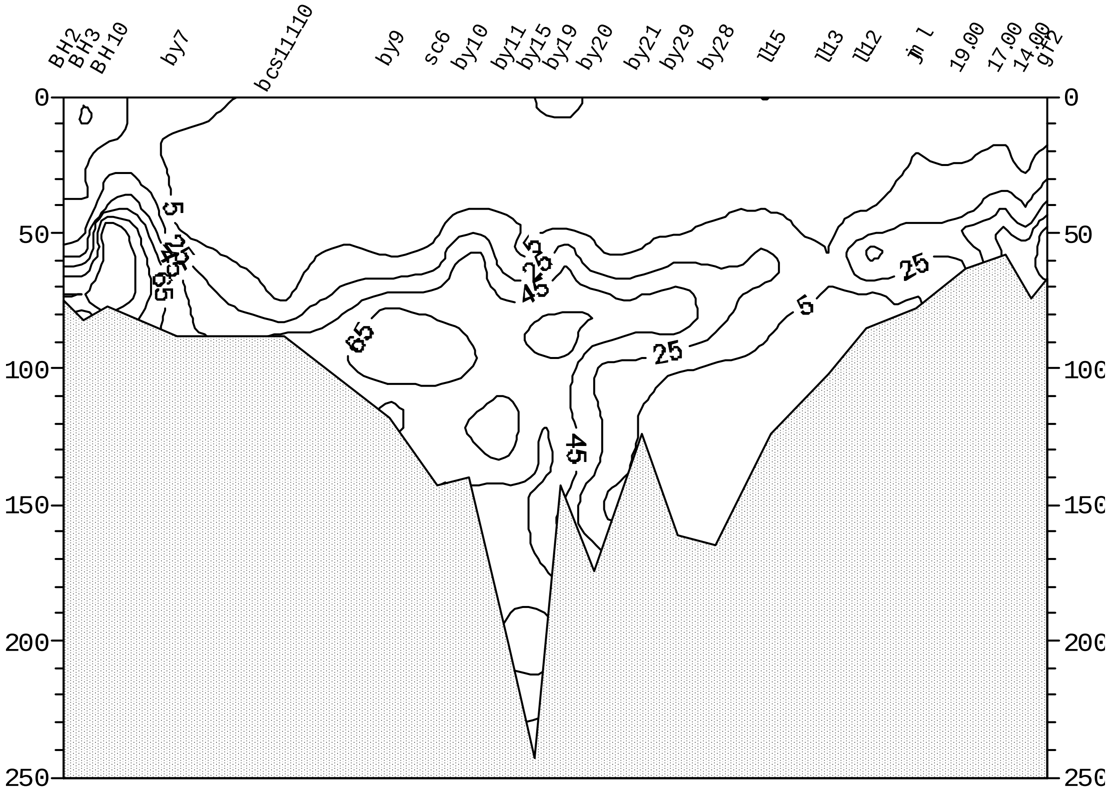

Figure 2. Vertical distribution of nitrates µg/l, 2003.

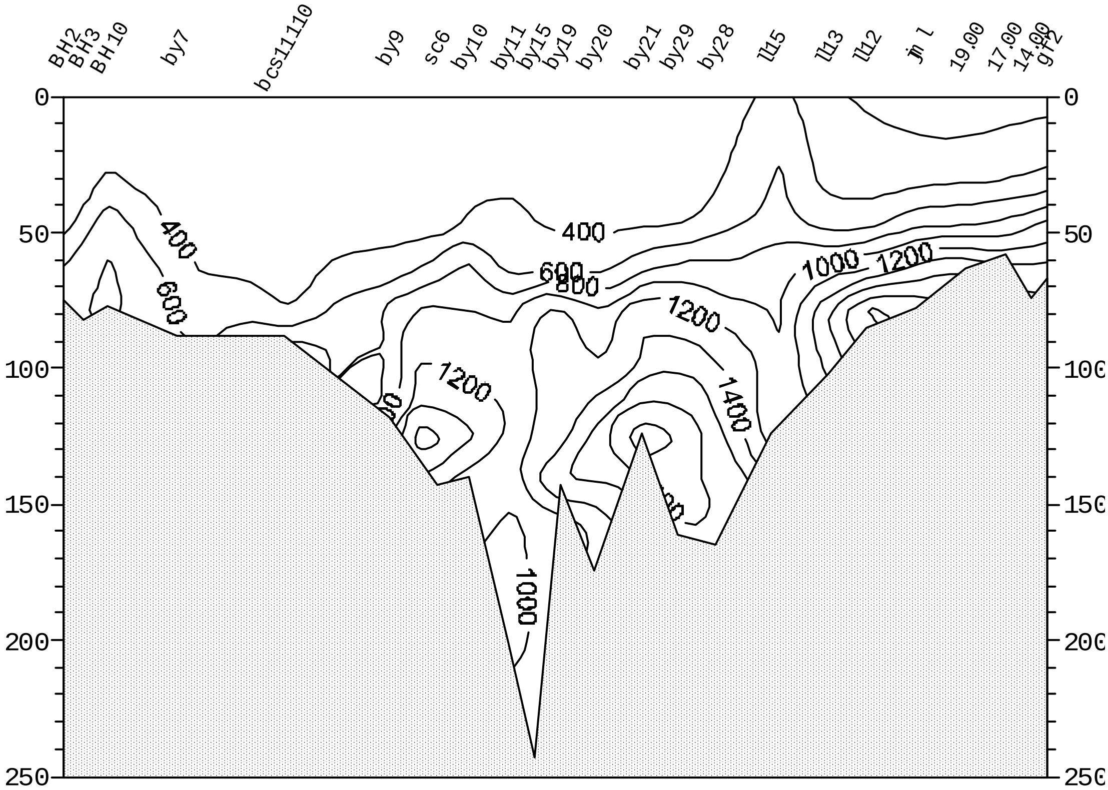

Figure 3. Vertical distribution of silicates µg/l, 2003.

Silicon

Figure 3 shows the vertical concentration of silicates. The water of the Baltic Sea has a high content of silicates, due to significant influence of freshwater [5]. The trend in 2001 was that the highest concentrations were found in the deeper parts (1200 – 2000 µg/l). In 2003 the highest concentrations are found at 150 m depth (1600 µg/l). In the deep waters the concentration is 1000 µg/l (station by 11 and by 15).
This supports the theory that there has been an uplift of the "old water" towards more easterly parts.

Conclusions

The results from the 2003 expedition support the fact that there has been a deep-water renewal process in the Baltic Sea. The intruding water is rich in oxygen and this has a clear effect over nitrates and silicates concentrations, which is clearly shown in both oxygen and nitrate concentrations. The intrusion has oxygenated the deeper parts of the Baltic proper, but has also shifted the areas of high concentrations for nitrates and silicates. The movement has been traced towards the Northeast.

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General description of the Baltic Sea and its biological problems due to eutrophication

Francisco Jesús Arjona Madueño and María del Mar Ruiz Núñez

Introduction

The Baltic Sea is a basin that can be classified as a regional sea. A regional sea has the following characteristics:

- it is surrounded by land;
- it is restricted from the global oceanic circulation. Thus, this type of sea has its own and characteristic circulation.

When we are studying the circulation in this type of seas (regional seas), we have to analyse the following factors:

- hydrological budget - defined as the difference between annual freshwater input (river and precipitation) and evaporation ;
- water volume of the sea: if it is deep or shallow or if it is big or small;
- connection with the Ocean.

These two last characteristics determine the renewal time of water in the sea.

In case of the Baltic Sea it is a basin with the following characteristics:

- Positive hydrological budget. The freshwater input is higher than the water loss due to evaporation. This high freshwater input is a consequence of the approximately 200 rivers, which flow into the Baltic Sea. In this way we can say that the Baltic Sea is a brackish water sea being the salinity in this one far lower than in the North Sea, which connects to the Baltic Sea. For most Baltic basin salinity is about 8‰ while in the Gulfs of Bothnia and Finland water is just about fresh.
- Low depth. The average depth in the Baltic Sea is 55 meters with a minimum in the Danish Strait and a maximum of 459m in the Landsort Deep.
- Very limited connection with the ocean.

Circulation

Due to positive hydrological budget the Baltic Sea usually exports brackish water to conserve its water volume. Besides, there is a saline water input from the North Sea. All these flows occur through the Danish Straits.

The brackish water exit from the Baltic Sea to the North Sea takes place in the upper layer due to the low density of the brackish water, whereas the saltier water entries from the North Sea to the Baltic Sea occur in the lower layer.

Therefore, in the Danish Strait a halocline appears approximately at 15 meters of depth, which becomes deeper and deeper when we are going to the inside of the Baltic Sea (see Fig.1).

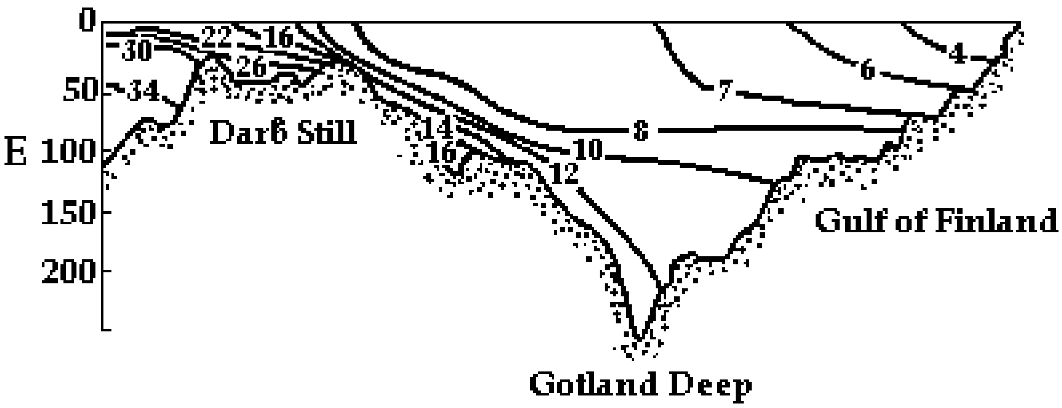

Figure 1. Salinity on a section along the axis of the Baltic Sea.

We can observe a tongue of saline water, which enters from the North Sea and moves by the lower layer due to its high density.

Nutrients balance
In the Baltic Sea appears a nutricline, which coincides with the pycnocline and the halocline. In the upper layer, the nutrient concentration is lower than in the lower layer due to the phytoplankton consumption. In the lower layer, the nutrients concentration is higher because of the regeneration of nutrients by bacteria, the input of deep water from the North Sea and the vertical mixing damping by the halocline, which impedes the flow of nutrients to the upper layer. In this way, we can say that in the Baltic Sea there is an upper layer not as rich in nutrients as the lower layer.
Therefore, the upper layer of the Baltic Sea is very capable of eutrophication, because in the lower layer there is water rich in nutrients that can ascend in strong wind situations for example. This problem can be worse if we have pollution in the upper layer that increases the nutrient concentration in this layer.

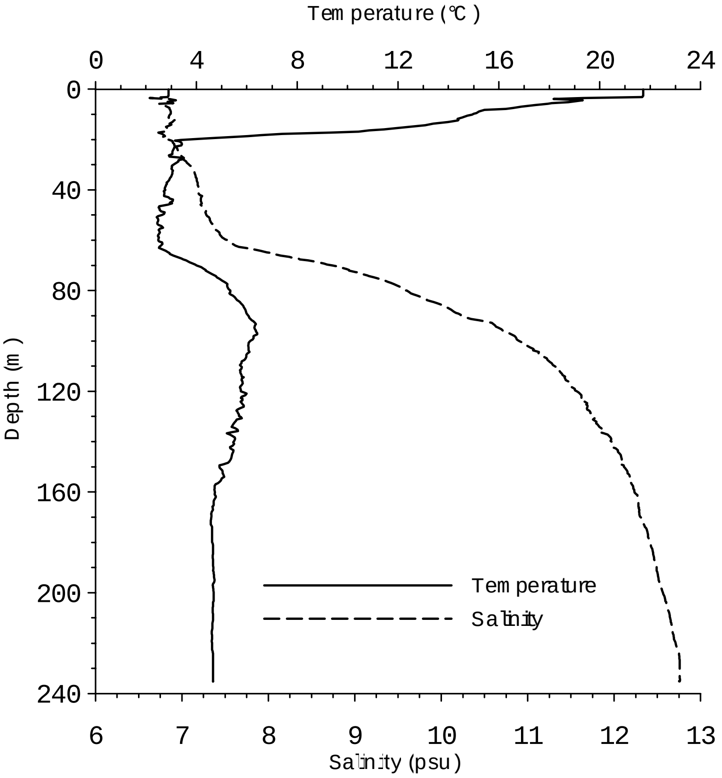

Figure 2. Temperature and salinity profiles on a station near the Gotland Island.

Temperature
With regard to the temperature, in the Baltic Sea there is a reversed thermic situation that is generally stable, due to the density of different water layers being determined by salinity (Fig.2).

Biology
Fauna and flora composition in the Baltic Sea is quite interesting. A lot of marine groups are absent or slightly represented and in the latter case, only in the areas near the North Sea. Species, which penetrate in the Baltic Sea, for example, the Eglefine or Cephalopoda, are not able to breed there. Besides, most algae, above all the Rodophyceae, very reduced in number, disappear in the inside of the Baltic Sea. On the other hand, the Chlorophyceae are abundant. In internal areas, marine fauna and flora mixes with continental fauna and flora. There are insect larvae, Gasteropoda like Lymnacea and Bythinia, lake Isopoda like Asel-

	Noth Sea	Baltic Sea
[1] of feoficeae	~100 sp	20 sp approximately
[1] of bivalva	~200 sp	4 sp in the Galf of Finland
Macro and micro fauna	~1500 sp	150→80→50. This is the gradient from near the Noth Sea to inside of the Baltic Sea.
[1] of fish species	~80 sp	55→20. This is the gradient from near the Noth Sea to inside of the Baltic Sea.

lus aquaticus and, between the plantae, Potamogeton pectinatus. Typical species of brackish waters are abundant too.
Besides this mix of marine and freshwater elements, the Baltic Sea is interesting because of the existence of artic relicts which were introduced during the glaciations and have been able to survive because of the low water temperatures, for example, the specie of Amphipoda Gammaracanthus lacustris, the specie of Isopoda Mesidotea entomon and the specie of Pinnipeda Phoca hispida.

The endemic species are few, due to the recent origin of the Baltic basin. We can name three plankton species: Keratella quadrata paltei (Rotiphera), Bosmina corregoni maritime (Cladocera) or Anabaena baltica (Cyanobacteria).
Biodiversity in the Baltic Sea is relatively low. We can observe it in the following table, which is a comparison between the Baltic Sea and the North Sea.

Eutrophication problems in the Baltic Sea
Returning to the Baltic basin morphology, in this sea, there are typical deep basins where the water renewal depends on the water exchange through the Danish Straits.
The water exchange in the Danish Straits is not a continuous process, in this area there are water exchange episodes when winds from the East blow, flowing seawater from the Baltic Sea to the North Sea; and water retention episodes when are winds from the West blow. The water retention episodes provide massive saline water entry from the North Sea through the lower layer, which involves the water renewal in the basins. This is of great biological importance due to this renewal process involving the oxygenation of these deep basins.
These layers that have been named before are distinguished around the halocline: upper layer on the halocline and lower layer down the halocline.
Through the halocline there is no turbulent exchange process, there are only molecular diffusion processes, which are a very slow transport mechanism. In this way, we can say that the halocline is a barrier against mixing between both layers.
In the upper layer there is an abundance of oxygen because of:
- gas exchange with the atmosphere;
- primary production by the phytoplankton.

In the lower layer there is an entry of organic matter from the upper layer, which is able to cross the halocline due to its density. Then, the biological oxidation of this organic matter can produce an anoxic situation if there is no water renewal. Because of this, the water retention episodes are very important. In this way, if in the upper layer there is an eutrophic event, the water retention episodes are not able to prevent an anoxic situation in the lower layer, because in eutrophication conditions the renewal time of water required to avoid the anoxic conditions is much shorter than the timescale of water retention episodes.

Table 1.

Station	Biomass(mg/m^3)	Station	Biomass(mg/m^3)	Station	Biomass(mg/m^3)
10F	406	35F	404.2	BN9	218.8
11F	753.3	36F	375.3	BY20	46.1
18F	440.0	38F	292.1	GS3	117.3
19F	460.5	40F	231.9	BY29	123.1
20F	47.3	43F	312.3	BY19	184.2
27F	196.4	14	345.7	BY7	65.5
28F	591.3	4F	442.0	BSCIII10	51.8
29F	356.9	9F	625.1	GF2	962.3
2F	1280.5	BH7	26.2	LL12	130.4
3F	980.5	BH18	139.1	GS4	424.8
33F	329.9	BH20	57.7	SC5	327.3
34F	390.5	BN3	149.4	LL13	109.9
				BY21	132.7

This situation is worse when in the Baltic Sea strong winds blow, causing upwelling: nutrients from the lower layer come to the surface leading to eutrophication caused by two effects: normal eutrophication in the upper layer and the eutrophication because of the nutrients from the lower layer.
Then, the anoxic situation reached in short time causes biological problems like fish or benthic animals mortality.

During the oceanographic campaign, the authors (Francisco Jesús Arjona Madueño and María del Mar Ruiz Nuñez), Dr Michael Shilin and Prof. Grigory Frumin, took phytoplankton samples from the photic layer. To do this, we took three samples at each station, the first at water transparency depth (measured with the Secchi Disc), the second at twice water transparency depth and the third at threefold water transparency depth. In this way, at each station we obtained a representative sample of the photic zone. Values of phytoplankton biomass at different stations are indicated in the table 1 below.

The average of all the stations is 349.4135mg/m^3 corresponding to an integrated vision of the Baltic photic zone. In this way, we can conclude through chlorophyll data at each station that, in general, the Baltic Sea is mesotrophic.
This involves a great biological problem that we hope can be solved by the corresponding environmental laws.

Acknowledgements

The BFU program was an excellent way of exchange of ideas between students, professors and researchers from different countries and also a good chance to learn about fieldwork.
From our personal point of view was a fantastic experience too, living in a vessel with so kind people (special thanks to the crew of the RV 'Sibiriakov') - it is unforgettable!
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Relationships between Chlorophyll a concentrations and chemical variables in the Baltic Sea during summer 2003

Grigory Frumin & Holly Coombes

Introduction

The Baltic Sea is a shallow inland sea which is surrounded by countries of North Eastern Europe and Scandinavia. As well being bordered by these nine countries it also receives drainage water from a further five countries so the drainage area of the Baltic is so large that it covers approximately 15% of Europe and accounts for a large part of Northern Europe [1]. The Baltic Sea is very sensitive due to its natural conditions and this fragile environment is threatened by pressure related to the vast amount of anthropogenic activities that are carried out by the 85 million people who live and work in its drainage basin [2] .Due to the fact that the Baltic Sea is largely enclosed by land, its environmental conditions are very much defined by the fresh water input from rivers and precipitation [3]. Considering the physical nature of the Baltic Sea and the residence time of any substance that ends up in the sea, it is no wonder that it its ecological balance is so fragile and constantly under threat from the huge amount of anthropogenic pressure which is put on it. At the present time the main ecological problems of the Baltic Sea are associated with eutrophication, pollution by harmful and toxic substances, oil spill accidents, alien species and chemical weapons dumped in the sea after the Second World War. Excessive nutrient concentration, of phosphorus and nitrogen, leads to eutrophication of the water bodies and this, in extreme cases, can lead to oxygen depletion when the increased amount of algal material decays. The excess of nutrients which enter the Baltic Sea can originate from point sources or from more diffuse sources. The environmental quality of the Baltic Sea is largely influenced by the inputs of pollutants and hazardous substances from industrial and municipal wastewater, atmospheric deposition, run-off from arable land via rivers and leachate from deteriorating stockpiles as in the case of obsolete pesticides [2].

Chlorophyll is a key light harvesting pigment which is used by phytoplankton. It is central to the introduction of energy into oceanic ecosytems and mediation of biogeochemical cycles of Carbon, Nitrogen and Oxygen. It is for this reason that chlorophyll "a" is a unique and convenient biochemical marker of phytoplankton biomass and can be used to determine the trophic status of a body of water [4].

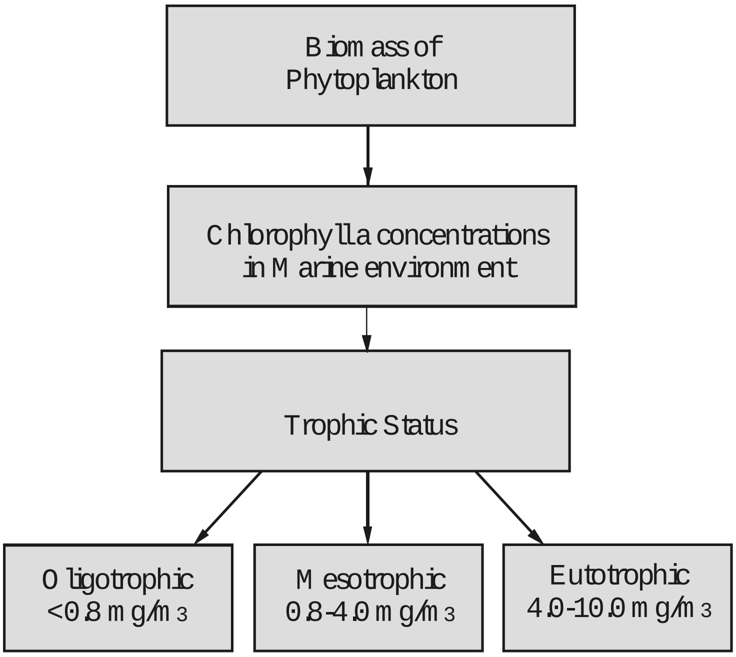

Figure 1. The way in which chlorophyll a concentration can be used to investigate the trophic status of a water mass [5].

MODEL	EQUATION
Linear	Y = a + bx
Powermode	Y = ax exp(b)
Logarithmic	Y = a + bLn(x)
Exponential	Y = a exp(bx)
Polynomial	$Y = a + bx + cx^2$

Table 1. Mathematical models used to examine the relationship between Chlorophyll a concentration and several chemical variables. Equations shown describe the models used and were applied to the data to find the highest correlation. Y = Chlorophyll a concentration, x = chemical parameter.

This report will use a series of mathematical models for the purpose of investigating the relationship between chlorophyll "a" concentrations and eight different chemical variables (salinity, alkalinity, % oxygen saturation, pH, inorganic phosphorus, silicon, nitrates and nitrites).

Materials and Methods

During the summer expedition of 2003 measurements were taken of chlorophyll a concentration at a total of 54 stations in the Gulf of Finland and the Baltic Sea. These measurements were taken from the surface water using a mini-backscatter fluorometer. The principle of the action of this device is based on a comparison of the intensity of a light beam which is directed at and reflected from the water medium in a range of wavelengths which are appropriate to the spectrum of chlorophyll a. The intensity of this reflected beam therefore determines the concentration of chlorophyll a in the water.

At these stations and a further 55 stations throughout the Baltic Sea data were collected and analysed for various parameters including temperature, salinity, pH, dissolved oxygen, alkalinity, and various nutrients. This was carried out using the conductivity-temperature-density (CTD) profiler which had an automatic-bottle rosette sampler, which took water samples over depth at every station. Water samples from each of these depths were then further analysed in the hydrochemical laboratory. On board the 'Sibiriakov' I worked as one of a group of students in the laboratory analysing water samples specifically for silicon and phosphorus. Data was taken from a series of depths, however for the purpose of this investigation the focus is mainly based on the surface readings, since that is where the phytoplankton biomass is found and where chlorophyll a measurements were taken from.

Results and Discussion

Chlorophyll a concentration was plotted against the eight different hydrochemical parameters (salinity, alkalinity, pH, Dissolved oxygen, and nutrients) and the graphs were analysed using the models previously discussed. This involved fitting a different trendline to the scatter plots in order to find the highest correlation coefficient. Generally it was found that the parameters that had the best correlation with chlorophyll a were salinity and alkalinity.

MODEL	S ‰	Alk	% O_2	pH	IP	Si	N-NO_3	N-NO_2
Linear	0.79	0.58	0.39	0.33	0.08	0.14	0.10	0.62
Powermode	0.69	0.50	0.33	0.20	-	0.11	-	-
Logarithmic	0.83	0.61	0.38	0.32	-	0.08	-	-
Exponential	0.67	0.47	0.34	0.20	0.12	0.08	0.12	0.48
Polynomial	0.85	0.72	0.42	0.47	0.08	0.24	0.23	0.73

Table 2. The correlation coefficients for each of the eight chemical variables and the mathematical models that were applied to them.

Table 2 shows the correlation coefficients for the relationships between chlorophyll a and the chemical parameters at stations in the Gulf of Finland only. The values denoted in red show the highest correlating parameters are salinity and alkalinity and the models which produce these correlations are logarithmic and polynomial.

Figure 2 and 3 show the parameters, which demonstrated the best correlation with chlorophyll concentration. They suggest that as salinity, and therefore alkalinity, increases the concentration of chlorophyll a in the water decreases. There is an overall increase in salinity from East to West (towards the Baltic Proper) and thus, these results suggest that as the stations move away from the most enclosed areas of the Gulf of Finland where they are subject to high riverine input, and towards the Baltic Proper, the chlorophyll a present in the water decreases. The results of these analyses may, however, be misleading as they appear to suggest that the concentration of chlorophyll a, and therefore the biomass of phytoplankton, is controlled by salinity; this is not necessarily the case.

According to a study of the trophic status of the Baltic carried out by Wasmund et al (2001) [5] it was found that in the plumes of the rivers flowing into the Baltic the main limiting factor of phytoplankton growth was phosphorus concentration, and in the open Baltic Proper it was nitrogen concentration. In this study salinity was used in order to define the borders of these plumes, thus demonstrating why there is a relationship between chlorophyll a concentration and salinity. The reason that there was not more correlation between chlorophyll a concentration and these nutrients was that readings were taken from the surface where levels of nutrients are likely to be low due to the fact that they are readily used by the large amount of algae which is present.

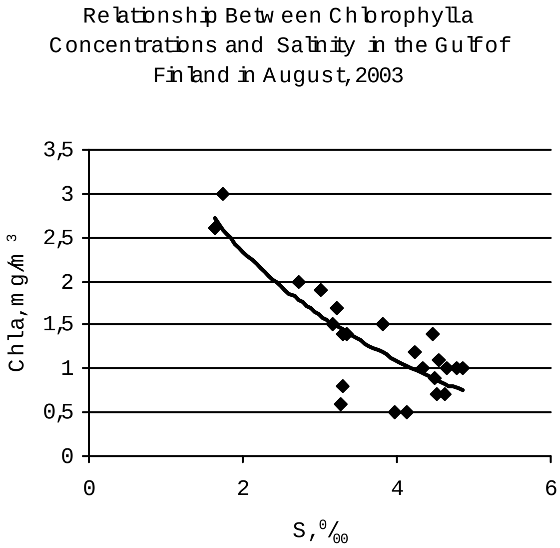

Figure 2. Graph showing chlorophyll a concentration and salinity with a logarithmic trendline, of regression R = 0.83, fitted to it.

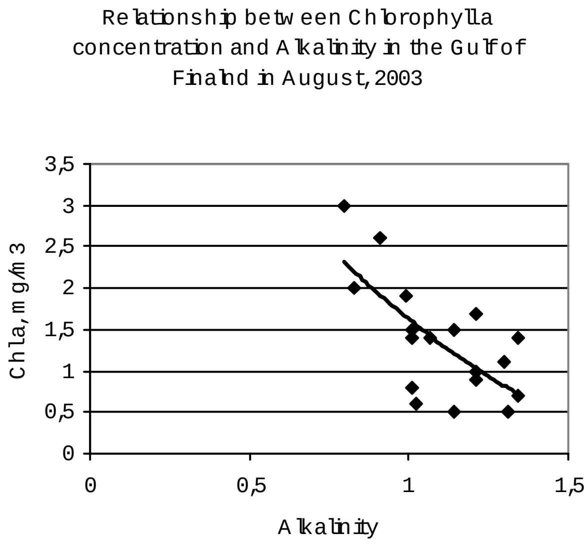

Figure 3. Graph showing chlorophyll a concentration and alkalinity with a logarithmic trendline, of regression R = 0.70, fitted to it.

When comparing these results to those found in the open Baltic Proper, a different relationship is found to be the case. Figure 4 indicates the large increase in salinity between the Gulf of Finland and the Baltic Proper and with this is the expected decrease in chlorophyll a concentration, as happened throughout the Gulf of Finland.

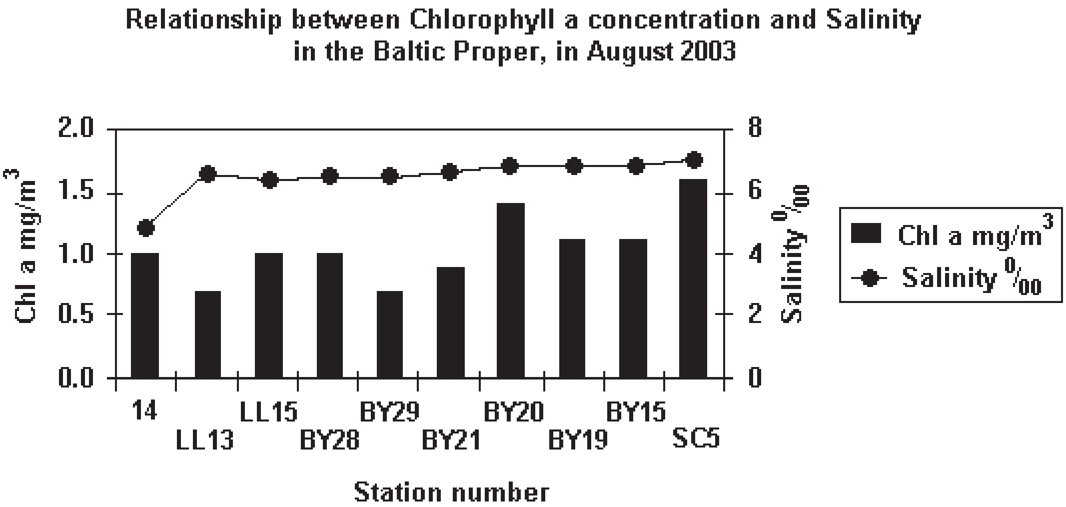

Figure 4. Graph showing the results of stations leading from the Gulf of Finland into the more open Baltic Proper.

However with the subsequent stations there is an overall increase in the concentration of chlorophyll a present as the salinity increases. It is likely that this is just due to a natural variation in distribution of phytoplankton biomass however a possibility is that the areas of higher salinity favour the growth of another species of phytoplankton. This could be due to the change from P-limited growth of phytoplankton to N-limited growth. Wasmund et al (2001).

Conclusions

In conclusion it was found that the most significant chemical parameters according to our analysis were salinity and alkalinity, as are shown by the high correlation coefficients in table 2. In both cases the logarithmic and polynomial models produced the best correlation to the data. There was a significant increase in salinity in the Baltic Sea from the Gulf of Finland to the more open Baltic Proper due to the large influx of fresh water from rivers, and it is for this reason that there is such a high correlation between chlorophyll a and salinity. Chlorophyll a is a useful and convenient method or assessing the trophic status of a water body but is slightly inconclusive if used on its own as demonstrated by the increase in chlorophyll a concentration with salinity in the Baltic Proper. To draw conclusions as to the reason for this, additional information on the species of phytoplankton present is really needed. In the afore-mentioned study by Wasmund et al it was found that the coastal waters of the Baltic Sea could be classified as being eutrophic and the more open waters as being mesotrophic. This is slightly higher than the findings of this investigation but overall it found that the trophic status of the inner coastal waters, especially in the Gulf of Finland, is significantly higher than the open sea and this is probably due to the favourable conditions of the high freshwater input from the rivers and run off from land; thus indicating the anthropogenic effects of excessive nutrient input.

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Ecological state of the marine environment at the chemical weapons dumping site in the Bornholm Deep

Alexandra Yershova

The problem of German trophy munitions dumped after the World War II is one of the most urgent ecological problems of the Baltic Sea.

Since 2001 geoecological research is being conducted regularly by RSHU jointly with 'Sevmorgeo' at the sites with dumped chemical shells and bombs containing poisonous substances.

During these investigations Bornholm Deep is considered to be of utmost importance (see schemes of stations on p.4 and p.8).

Physical and chemical conditions in bottom layers of Bornholm Deep are strongly affected by presence of oxygen in the near-bottom water and oxygen regime is determined by the North Sea waters inflow through the Danish straits. The basic feature of geoecological conditions in sediment-water interface is considered to be oxygen conditions, evaluated by redox-potential of near-bottom waters and sediments. So the investigations are carried out with bottom sediments, near-bottom and silt waters to assess the geochemical processes in sediment-water interface. The estimation of physical and chemical parameters in this area lets make conclusions on chemical elements migration and also it lets evaluate the reality of near-bottom water pollution by the products of chemical weapons destruction. This can be estimated by concentrations of arsenic, constituent of some poisonous substances, and also by high concentrations of several heavy metals, that can penetrate to near-bottom waters after metallic shells corrosion.

The main problem during the geoecological research at Bornholm site in 2002 and 2003 was to characterize environmental conditions and to compare received values with the previous years results for revealing the changes of geochemical parameters in sediment-water interface, connected with possible destruction of dumped chemical weapons and revealing the areas of possible release of the weapons destruction products from bottom sediments. So the observations included also measuring of arsenic concentration in near-bottom waters and sediments.

Redox-potential

In summer 2002 anaerobic conditions were dominating in Bornholm Deep (Fig. 1). There was no station with oxidation zone, redox-potential of near-bottom waters ranged from +60 to –131 mw with negative values prevailing in depths more then 80m. According to the observations in summer 2003 situation in the Baltic Sea has sharply changed due to big inflow of North Sea waters, happened in January 2003. Geochemical data showed, that oxygen conditions have changed and all the measured redox-potential values have become positive.So it can be concluded that the oxidation zone have appeared

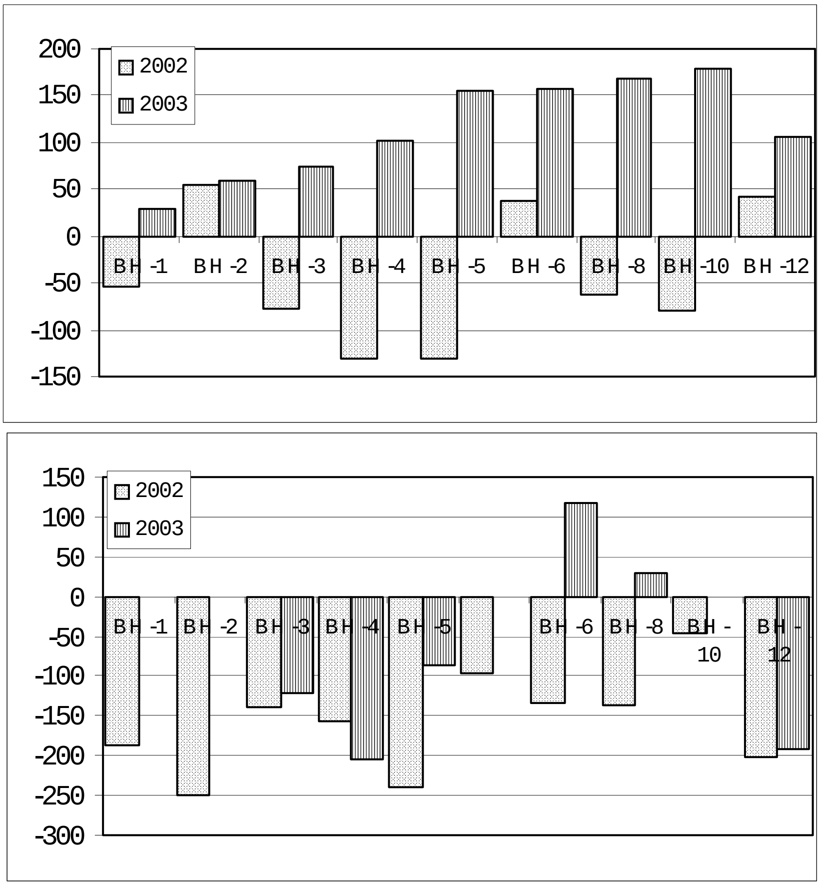

Figure 1. Eh values in near-bottom waters (a) and sediments (b) of Bornholm deep in 2002 and 2003, mV.

on sediment surface on the bottom of Bornholm Deep, preventing free migration of the elements through the bottom-water barrier zone.

Changes in redox-potential values were not so essential in the upper layer of bottom sediments. In 2002 all samples had negative Eh values. The lowest Eh values were measured in stations BH2 and BH5, situated on maximum depths. In 2003 Eh values have increased and in stations BH6 and BH8 they have even become positive.

Heavy metals

In assessing pollution of the environment with products of poisonous substances and shells destruction the most interesting are high concentrations of heavy metals and arsenic, constituent of some poisonous substances.

Yearly measurements of heavy metals concentrations in chemical weapons dump site show that mean values of heavy metals in the near-bottom water of Bornholm polygon are tens and hundreds times higher the maximum allowed concentration. Maximum concentrations were measured in 1995 and 2003. However in 1995 heavy metals owed their high values almost exclusively to anomalous high concentrations of zinc. In 1994 general increase of measured concentrations (Cd, Pb, Cu, Zn) have been noted. In 1995 heavy metals values in the near-bottom waters were maximum with Pb and Cu contributing mostly.The same structure remained in 2001 and 2002, but average year values decreased slightly.The situation have changed sharply in 2003, general mean level of heavy metals concentrations reached the level of the year 1995 and the leading role in this group of metals belongs to copper and lead [1].

It can be concluded that changes of physical and chemical parameters in the near-bottom layers have essentially influenced the conditions of heavy metals migration from the sediment. So these results confirm the ongoing infiltration of poisonous substances destruction products from bottom sediments to the near-bottom waters.

Arsenic

Arsenic measurements in bottom sediments conducted during summers 2001-2003 showed that concentrations of As reach and exceed the background level in the upper layers (Fig.2). This serves as an evidence of poisonous substance release from chemical weapons to sediments. In 2003 measurements were also conducted in near-bottom water and showed the presence of As almost at all the stations. Its values ranged from 1.8 to 15mg/l, being lower the maximum allowed concentration except station BH2 (15mg/l). These data confirm the ongoing process of arsenic infiltration from sediment to the near-bottom waters.

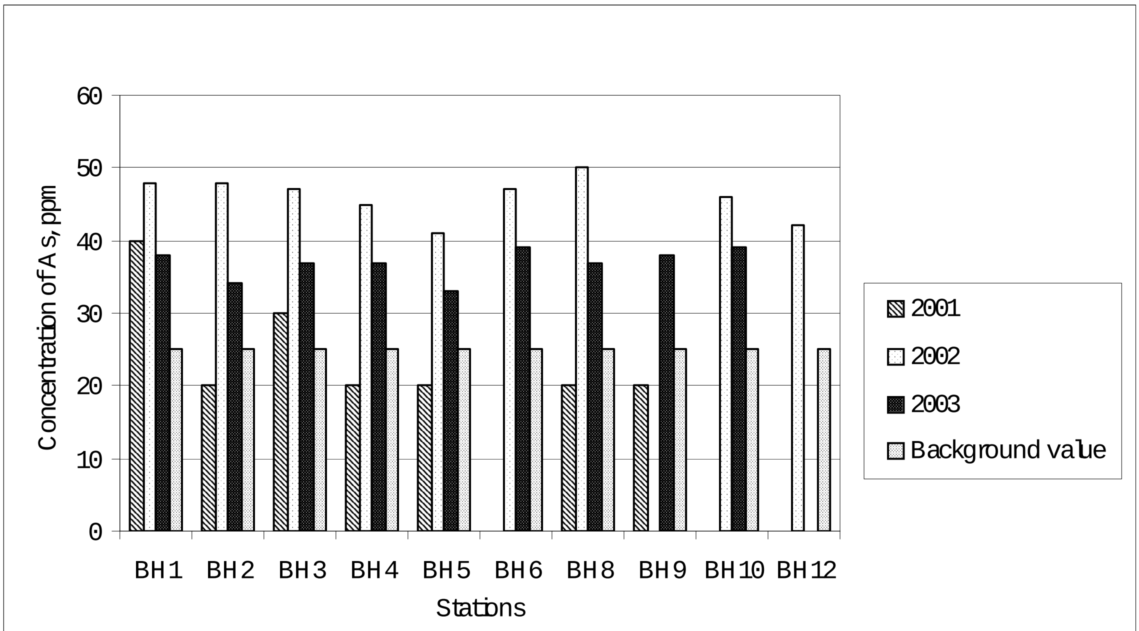

Figure 2. Arsenic distribution in the uppermost layer of bottom sediments at Bornholm site in 2001, 2002, 2003.

Analyzing the data on redox-potential, heavy metals and arsenic concentrations it can be concluded that the process of chemical munitions decomposition in bottom sediments of Bornholm deep continues. At the same time the appearance of oxidation zone on the sediment surface, being natural barrier for release of chemical components to water, indicates the change of unfavorable ecological conditions in the deep to favorable. And probably the only ecological risk of this area will be the lift of bombs with poisonous substances.

Acknowledgements

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Bioconcentration and toxicity effects of surfactants

Monica Sáez

Introduction

Surfactant is the abbreviation of surface active agent. These compounds are extensively used in many different fields: domestic and industrial cleaning products, pesticides, painting, fire retards, coating surfaces and are consumed at enormous amounts. Linear alkylbenzene sulphonate (LAS) is the most used anionic surfactant used worldwide (Britton, 1998). Its molecular structure is shown in Figure 1.

Although they are greatly biodegraded in the wastewater treatment plants, surfactants have been detected in the marine environment (González-Mazo et al, 1997; León et al, 2002), showing concentration in sediments up to three orders of magnitude higher than in water (González-Mazo et. al, 1998) as a consequence of the hydrophobic character of their molecule. So they are expected to present a high affinity for biological tissues and, therefore, can exert a risk to the aquatic organisms (Sáez et al, 2001).

In order to provoke a toxicity effect, a compound needed to be incorporated by an organism and accumulated up to a certain concentration. Therefore, bioconcentration is the first step in the toxicity process, being a relevant tool in the assessment of environmental risk and fate. (Sáez et al, 2003). The bioconcentration is represented by the bioconcentration factor (BCF), which is defined as the concentration of the chemical in/on the organisms or specified tissue thereof divided by its concentration in the surrounding medium when the steady state is reached (Hawker & Connell, 1986).

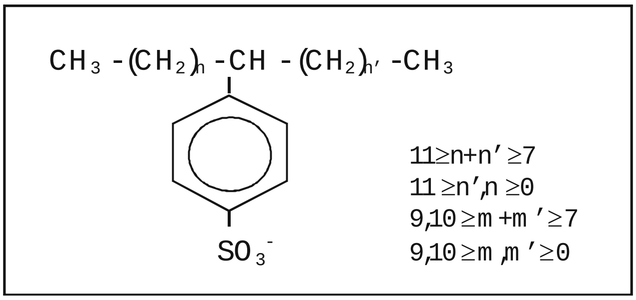

Figure 1. General structure of the linear alkybenzene sulphonate molecule.

Toxicity effects can be generally divided in acute and chronic. Acute toxicity refers to high concentration but short time exposure; meanwhile chronic toxicity does to lower concentrations and long exposure time. The damage may be reversible or irreversible and the response will depend on some factors like tissue importance and its functional capacity to regenerate or repair the damage. Histopathology has been described as a suitable methodology to determine damage as a sublethal toxicity response to chemical compounds (Sáez, 2002). Although any organ can be damaged, toxic compounds frequently affect a specific organ. In the case of the anionic surfactant linear alkylbenzene sulfonate (LAS), due to its hydrophobicity, the damage could be higher in organs with larger exposure surface or high lipid content.

The toxicity of LAS has been widely studied, but mainly in fresh water organisms, existing an important lack in marine environments. Bioconcentration test of LAS are scarce, and analysis were mostly performed with non selective methods, leading to an overestimation of the concentration data due to the lack of separation between parent and metabolite compounds. (Sáez et al, 2003)

Firstly it is necessary to possess an accurate and precise method to detect the presence and quantify the concentration of the compounds of interest, as well as their transformation products if any. Not only the analytical method is essential but also a validated bioassay to test the incorporation, accumulation and possible toxicity effects. Several governmental institutions, OECD (1982), EPA (1996), ASTM (1985), have reported some guidelines in order to obtain reliable and comparable results. In this research work both and analytical and testing bioassays methodology have been designed and developed with the objective of obtain reliable data on surfactants bioconcentration and toxicity.The study has been focused in the marine environment.

Material and methods

Standards of several homologues of linear alkylbenzene sulphonate (LAS), with alkylchain lenght varying from 10 to 14 carbon atoms, were supplied by the Company PETRESA. Standards of LAS intermediate degradation products, the sulfophenyl carboxylic acids (SPCs), were also employed in the range of C_4 to C_{13} homologues. All standards were of purity higher than 95%.

Several organic solvents (methanol, butanol, hexane, ethyl acetate) of analytical grade purity were employed in the analytical procedure optimization, in different steps: Soxhlet extraction, solid phase extraction,

ultrasonic bath. The compounds were quantified using liquid chromatography (HPLC) with fluorescence detection. C_{18} and strong anionic exchange (SAX) minicolumns were employed at the solid phase extraction step, and reverse phase C_8 column in the chromatographic step as described somewhere else (Sáez et al, 2000).
The analytical method was optimized for different matrices: marine water and marine organisms, the clam *Ruditapes semidecussatus* and the fishes *Sparus aurata*, and *Diplodus vulgaris*. All these species were chosen based on their commercial and economical importance and their presence in the area of study (Cádiz Bay, South of Spain).
Bioconcentration assays were designed following the OECD guidelines for testing bioconcentration in aquatic organisms under flow through conditions (OECD, 1982). The experiment consists on an exposure phase and a depuration phase, differing only in the presence/absence of the surfactant in the water. The system was designed in such a way to keep the surfactant concentration constant during all the exposure period. Both water and organisms samples were collected at different times during all the experimentation (exposure and depuration phases) in order to obtain bioconcentration data and establish the kinetic of the process.
The second objective of this experimentation is to determine the level and the irreversibility of the damage in the most affected tissues; therefore the toxicological part of the study has been focused on the gills and the digestive gland of the tested organisms. Histopathology analyses were performed as described in the literature (Sáez, 2002).

Results

High-performance liquid chromatography (HPLC) with fluorescence detection (FLU) has been reported to be a successful method for the determination of LAS in water and sediment marine samples, but the isolation of LAS from biological tissues is a complicated and laborious task due to the complex nature of the matrix (de Voogt et al, 2003). For that reason, a precise and selective analytical procedure, including previous isolation and concentration steps, have been developed in order to obtain clear and reproductive chromatograms. The optimum method consists on a Soxhlet sequential extraction with hexane to removed lipid and fats which interference in the analysis, and latterly with methanol to extract the surfactants from the tissue. The methanolic extract is then evaporated and redissolved in warm water with the help of sonication, and passed through a C18 minicolumn and a SAX minicolumn, as a further isolation. The surfactants are eluted with methanol, and evaporated to reduce its volume and change the solvent into the mobile phase of the chromatographic analysis. This method is described with detail in Sáez et al (2000).
A flow-through device has been designed and developed to simultaneously study toxicity, bioconcentration and biotransformation of surfactants in different benthic species. The system allows performing experiments with different concentrations at environmental levels (ppb) and controls at the same time. All the conditions and characteristics have been extensively described in Sáez (2002). Several experiments have been performed with this bioassay structure and technique in order to obtain bioconcentration and toxicity information of different surfactants. All the results have been reported in Sáez (2002), and general trends have been deduced from them since chemical structure of a compound determines its bionconcentration factor value for a specific organism. Since the bioconcentration factor is obtained under equilibrium conditions, no further normalization is generally needed. In the case of toxicity, not only the chemical structure, but also the exposure concentration influences the results.
Further efforts should be made to improve the experimental methodology and to enlarge the reliable database, focusing mainly on the marine environment, which has received less attention.

Acknowledgments

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CIRCUM alternative sewage treatment of black water a preliminary life cycle assessment and comparison to conventional treatment 2001

Lubomira Blom

Introduction

The treatment of wastewater is a problem in society.Although the majority of phosphorous and half of the nitrogen is reduced in Swedish treatment plants this does not mean that the nutrients are being recycled or eliminated. Instead the nutrients accumulate in the urban areas and will cause diffuse non-point pollution in the future [1]. Ultimately the nutrients also find their way to the Baltic Sea.

The current system of wastewater treatment in industrial societies severely restricts the possibility of nutrient recycling. One of the largest constraints is the mixing of different sources of waste. The wastewater from municipal households is mixed with industrial wastewater and in addition to this there is storm water[1]. A consequence to this approach of MIx-First-and-Separate-LAter (MIFSLA) is that it makes it more difficult to retrieve nutrients from the dewatered sludge, because of contamination with pollutants [2].

Today there is an existing technique to make pellets from sewage sludge. By heating the sludge up to 75°C it is possible to kill all parasites and harmful bacteria. The pellets could be recycled back to the fields as fertilizers, but they also contain a high-energy value and may alternatively be used as fuel in heating stations [3]. The usability of the pellets will however always depend on the handling of the sludge.

One way to achieve good sludge quality is the CIRCUM system, which separates the blackwater[2] from households. The idea is to deal with the problem at the source and separate the sludge before it gets contaminated from other sources, such as the BDL-water[3] and industrial sewage. The aim of the ongoing project is to develop a whole system, which includes existing vacuum technique and a new sewage system.

Life Cycle Assessment (LCA) is a widely used tool to identify the environmental impacts of a product or process in society. LCA gives a cradle to grave perspective and is also used to evaluate these impacts through various weighting systems.

The LCA program SimaPro 5 was selected for the LCA. The weighting system used in SimaPro 5, the CML 2 baseline 2000, was selected for the evaluation of the environmental impacts. The CML 2 baseline 2000 method elaborates the problem-oriented (midpoint) approach, which is recommended for simplified studies.

Method and Results

Classification

In this step, all impacts are sorted into classes according to the effect they have to the environment. Certain impacts can be included in more than one class. The environmental impacts are aggregated within each class to produce an effect score. There are more then ten impact categories listed in different sources. In this study ten impact categories were used:

Abiotic depletion, acidification, aquatic toxicity (fresh water), aquatic toxicity (sea water), eutrophication, global warming, human toxicity, ozone layer depletion, photochemical oxidation and terrestrial toxicity [4]

Characterization

The characterization is to model categories in term of indicators. Characterization is mainly a quantitative step based on scientific analysis of the relevant environmental processes. The characterization has to assign the relative contribution of each input and output to the selected impact categories [5]. Characterization results are presented in Figure 1 below.

Discussion

By 2005 Swedish laws and regulations will put an end to the disposal of organic matter to the landfill sites. This alone is one strong reason for finding an alternative way of treating sewage sludge in society. It is very important that this solution does not create new problems in the future.

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[1] precipitation that does not infiltrate into the ground or evaporate due to impervious land surfaces but instead flows onto adjacent land or water areas and is routed into drain/sewer systems

[2] wastewater from toilets or latrines

[3] wastewater that comes from bathing, dishing and laundry in the household

The CIRCUM system aims to reduce the amount of sludge to the treatment plant. The blackwater, which contains most of the BOD in the wastewater, is separated before it enters the treatment plant and this will mainly reduce the volume of sludge for the biological treatment.
The volume that needs the biological treatment could be only 10-20 % of the volume that is treated today, depending on what type of industries that are connected to municipal treatment. This would also, as a bonus, cut the energy consumption for the treatment plants. The reduced amount of sludge will also cut the cost for transporting the sludge.

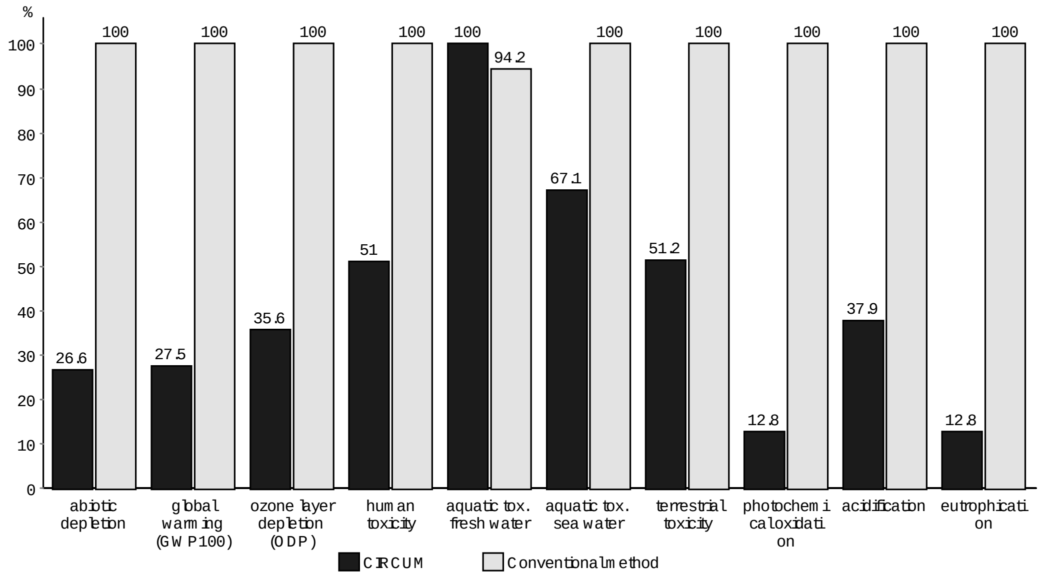

Figure 1. Comparing 1 person assembly "CIRCUM" with 1 person assembly "conventional method"
Method: CML 2 baseline 2000 (preliminary)/ West Europe, 1995 /cl.

It is very important to inform the users that they should not use the toilet as a garbage disposal, because the end product has to be clean enough to be used as fertilizer in agriculture. The pellets are greatly affected of what goes into the CIRCUM system and this is one weakness that can be found in this system.

Conclusions

The aim of the LCA analysis was to create a model of how two wastewater treatment and fertilizer production technologies – conventional system and new CIRCUM system, could be compared and evaluated.
CIRCUM is a new system, which has never been tested. So just few needed data were found and the rest was estimated using different handbooks, personal references, assumptions and calculations. Steps, which were included into this system: blackwater collection, aeration, drying, evaporation and pelleting of fertilizers; greywater, industry water and leakage water treatment in conventional treatment plant; transportation and energy use.
One of the biggest differences in these systems is the amount of used flush water in the toilet. It was the reason for incorporation of the energy consumption for increasing the water temperature from 5^{0}C to 20^{0}C during six months of building heating season.
From the results it's clearly seen, that new system is more environmentally friendly almost in all aspects. The few times smaller amounts of chemicals, energy, transportation, almost no solid emissions to the landfill (sewage sludge), the avoidance to produce relatively big amount of artificial fertilizers makes new CIRCUM system perspective in the future. This LCA model could be good background for further research and development of this system.
One of the areas, which should be pointed, is the development of new wastewater treatment where the biological treatment that is anymore needed could be replaced with new step taking care of heavy metal or other problems. The source of heavy metals is industry and leakage water. Heavy metal emissions to water from CIRCUM wastewater treatment are much higher than in conventional method, which dispose most of heavy metals to the landfill with sewage sludge.

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Influence of environmental salinity on fish growth

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E. Pérez Carrera, M.P. Martín del Río and J.M. Mancera

Introduction

Euryhaline teleosts can live and adapt to a large environmental salinity range thanks to the activity of their osmoregulator organs: gill epithelium, kidney, digestive tract and urinary bladder (Evans, 1993).

In freshwater euryhaline teleosts have a plasmatic osmolarity and ionic concentration bigger than the surrounding environment. So, teleosts are hyperosmotic and hyperionic respect to this environment. This fact originates two main problems: i) osmotic entry of water, and ii) ionic loss by diffusion. The osmoregulatory system try: i) to eliminate the water through a very diluted urine production, ii) to replace the lost electrolytes through food and an active ion intake using osmoregulatory surfaces, and iii) to decrease the permeability of gill and skin.

On the other hand, euryhaline teleosts in seawater are hypoosmotic and hypoionic respect to environment. This means two basic problems for the fish: i) a passive entry of ions by diffusion through respiratory surfaces, and ii) an osmotic loss of water through gills. Osmoregulatory system presents an active excretion of gained ions (ionic regulation) and the teleost drink seawater to replace the animals losses (osmotic regulation).

The maintenance of a stable internal medium (constant osmotic and ionic values) different to environment means an energetic cost for the animal. In marine teleosts, internal medium osmolality (~300 mOsm/l) is equivalent to 30% ± 2% of environmental salinity (~1000 mOsm/l) (Holmes and Donaldson, 1969). In waters with 10-12‰ of salinity (about 300 mOsm/l), fish are almost isoosmotic, therefore, we can assume that energetic cost in osmoregulation should be less than in water with higher or lower salinities, and this saved energy could be used for growth (Brett and Groves, 1979; Kirschner, 1995). In this way, the influence of environmental salinity on the growth has been analyzed in several euryhaline teleost species (see Morgan and Iwama, 1999; Boeuf and Payan, 2001). The results are different depending on the analyzed specie and even in the same specie there are differences. This suggests that the manipulation of the only factor, such as environmental salinity, to get a better growth in euryhaline teleosts should be taken with caution.

Sparus auratus: a practical example

Sparus auratus is an euryhaline teleost, able to live in waters with different salinities: littoral waters, estuaries (brackish water) and coastal lakes. Due to euryhalinity of this specie, we can select the optimum salinity culture in order to improve the growth of this specie.

Recently, our group has studied the influence of three different salinities (seawater, 38‰; brackish water, 12‰ and low salinity water, 6‰) on the growth, osmoregulation and metabolism in juveniles of *Sparus auratus* for a period of 100 days. 480 immature fish (20g of average weight) were randomly distributed in 6 tanks of 2500 litres (80 fish per tank) and kept in 3 different salinities (38‰, 12‰ and 6‰) in open circuit. Every 3 weeks, 10 fish of each tank were anaesthetized, weighed and sampled to obtain plasma, gills and liver. It was analyzed gill Na^+,K^+-ATPase activity, osmolality and ions (sodium and chloride), glucose, lactate, proteins and triglicerides in plasma, besides hepatosomatic index.

Our results showed that in the chronic regulation period (animals perfectly adapted to environmental salinity), osmoregulatory parameters in plasma (osmolality, Na^+ and Cl levels) were similar in seawater- and brackish water-acclimated fish but significantly lower than those of low salinity water-acclimated fish. These results agree with that previously reported for this species (Mancera et al., 1993a, b; Laiz-Carrión et al., 2003; Sangioa-Alvarellos et al., 2003). Gill Na^+,K^+-ATPase activity presents respect to environmental salinity a "U-shaped" curve (Table 1). Therefore, the highest activities were found in fish adapted to hypo- and hypersaline environments (6‰ and 38‰), whereas the lowest activities were found in fish adapted to intermediate salinity. Gill Na^+,K^+-ATPase activity is related with ions excretion processes through gills in hyperosmotic environment. This activity has also been related in some euryhaline species, including *Sparus auratus*, with ionic intake processes in hypoosmotic environments (Zadunaisky, 1984; McCormick, 1995; Jensen et al., 1998, Marshall, 2002). Na^+,K^+-ATPase activity is a process which requires energy to transport ions against gradient. In this way, a reduction in this activity could induce a reduction in the energy consumption, remaining this energy available for other processes, as for example, growth (Kirschner, 1995; Bouef and Payan, 2001).

Table 1. Osmolarity, sodium and chloride levels in plasma, and gill Na^+,K^+-ATPase activity in gilthead sea bream cultured in seawater (SW, 38 ‰), brackish water (BW, 12 ‰) or low salinity water (LSW, 6 ‰) over a period of 100 days. Each value is the mean ±? S.E.M. of n=15-20 fish per group. Different letters indicate significant differences among groups (One way ANOVA, P<0.05).

It is known that in fish, growth is affected by endogenous and environmental factors, as salinity, temperature, water quality, age, sex, etc. (Brett and Groves, 1979; Boeuf and Payan, 2001). Our results showed as brackish water adapted fish have a better growth in comparison with fish adapted to seawater and low salinity water (12‰>38‰>6‰) (see Fig. 1), being the growth about 7% and 19% higher in water with 12‰ of salinity respect to water with 38‰ or 6‰ of salinity. When the animal is living at 12‰ of salinity, it is almost isotonic respect to the medium which surround it, and energetic cost in osmoregulation would be less than in hyposaline (6‰) and hypersaline (38‰) environment, having the possibility to invest this energy in another physiological processes (as growth). In this way, the higher growth observed in *Sparus auratus* adapted to 12‰ of salinity may corroborate this hypothesis.

Parameter

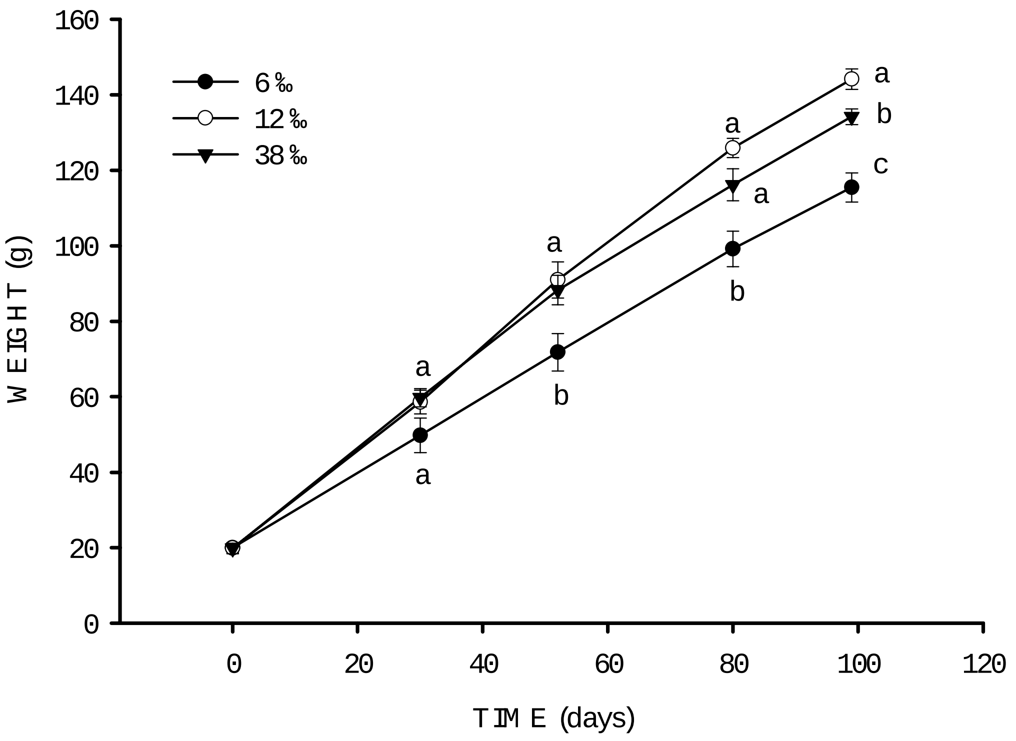

Figure 1. Weight changes in juveniles of *Sparus auratus* adapted to 3 different salinities for a period of 100 days. Different words indicate differences between the groups at each time (ANOVA one way, P<0.05).

In conclusion, our results indicate a better growth of juveniles of Sparus auratus (20 g of initial weight) growing at 12‰ of salinity for a period of 100 days, in comparison with that growing at 6‰ or 38‰ of salinity and indicate the possibility to use intermediate salinity in order to improve growth of this species.

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Assessment of hydrochemical conditions in the Gotland Basin

Ania Szyperska and Agnieszka Strzelczak

INTRODUCTION

Within the framework of the Baltic Floating University on July 9-12, 2003 onboard the catamaran "Centaurus-II" a scientific cruise was conducted in the Gotland Basin.

Observations were held along the HELCOM section [1]. This zone was covered with 19 sampling stations, arranged as shown in Fig.1. Water samples were taken from the standard depths of 0; 5; 10; 20; 30; 40 and 50m except point 117 (45m) for the sake of the seabed depth at a level of 47m. Sampling points formed three research profiles: the Profile 1 (stations 110-117), the Profile 2 (stations 117-124) and the Profile 3 (stations 124-128).

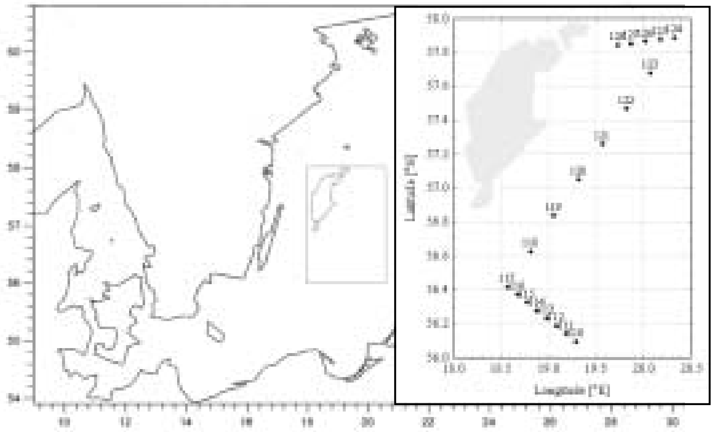

Figure 1. General scheme of the BFU sampling stations in the Gotland Basin. Summer cruise 2003.

METHODS

Four types of studies were performed during the BFU campaign: meteorological, hydrological, hydrophysical and hydrochemical. The catamaran "Cantaurus II" had a small laboratory where samples taken by a Nansen bottle system were analysed. In this paper results of the following analysis and hydrophysical are presented:

- oxygen: dissolved oxygen concentration in [ml/l] was determined using the Winkler [2] method and converted into dissolved oxygen saturation in [%];
- salinity: chloride concentration in [g/kg] was analysed by the Mohr method (argentometric method) [2] and converted into salinity in [‰]
- hydrogen parameter (pH);
- water temperature.

Data analysis we carried out on the basis of two types of graphs- 3D surface plots and 3D contour plots, available in StatSoft software- STATISTICA 6.0. 3D plots were generated in order to illustrate values or concentrations distributions in vertical profiles and helped to determine thermohaline structure of considered water mass. 3D graphs required data arranged as spatial series, where to value of a parameter in a sampling point the following co-ordinates were assigned- distance in [km] from the initial sampling station of considered profile and depth of the sampling point. Owing to equal distances between consecutive stations the first co-ordinate in spatial series was replaced by the station's number. Then a surface was fitted to the data represented by the z-axis and was shaded in colours corresponding to the values of the variable. The following data smoothing procedures were tested- quadratic, least squares, negative exponential and spline [2]. For all the cases the spline method gave the best results. Fit quality of the surface to the data was examined visually in 3D surface plots. A 3D contour plot was the projection of a 3D surface onto a two-dimensional plane [2] and it served as a final illustration of data vertical distributions.

RESULTS & DISCUSSION

Thermohaline structure

Thermohaline characteristics study allowed us to distinguish in the research area water masses typical of the Baltic Sea [3]:

- surface water mass (Upper Quasi-Homogeneous Layer- UQHL), freshened and warm;
- intermediate water mass (Cold Intermediate Layer- CIL) formed due to convective mixing during the autumn-winter period, with stable, lower temperature and insignificant salinity;
- deep-water mass- transformed north-sea water, usually warmer and with higher salinity level.

Those water masses are separated respectively by seasonal, summer thermocline (layer with considerable decrease in water temperature), main thermocline and also permanent halocline (layer with significant increase in salinity).

Temperature

Distribution of temperature in vertical fields were typical for summer period and determined by radiation heating in combination with wind and waves characteristics [3]. In the Profile 1 section the UQHL ranged the depth of 15-20m. Temperature decreased from almost 19°C near the surface to 13-14°C at the lower boundary of considered layer.The summer thermocline, 10-20m thick with temperature mean gradient of 0,7°C/m, was underlied by the CIL layer with fairly constant temperature about 3,2°C. As far as deep-water mass is concerned, it was not clearly visible in the thermal structure due to limited sampling depth. A smoothed view of the Profile 1 temperature distribution (Fig. 2) revealed isotherms almost horizontal from the surface to the lower boundary of sampling area telling about stable stratification conditions.

Thermal characteristics of the Profile 2 resembled situation in the profile discussed above. The UQHL ranged the level of 10-30m and water temperature dropped from 15-18°C to 12-13°C. The seasonal thermocline, with average gradient of 0,8°C/m, became thinner from sampling point 120 and reached considerable depth of allocation at station 124 (30-40m). This situation was connected to processes of strong wind-wave mixing preceding sampling. The CIL was the last observed layer.Temperature in that water mass changed insignificantly with mean value of 3,2°C. Contour plot of the Profile 2 (Fig. 3) confirmed stable stratification conditions and peculiar inclination of thermocline allocation discussed above.

Thermal characteristic of the Profile 3 is depicted in Fig. 4. The UQHL in this section ranged to the depth of 10-30m and its temperature decreased from 16-17°C to 13-15°C. Summer thermocline was fairly sharp and reached 20-40m as a result of stable weather conditions. Mean temperature gradient was 0,9°C/m. The CIL was characterized by average temperature of 3,1°C and the lowest values were noted at the depth of 50m at stations 125-126 (about 1°C). This substantial decrease in temperature might be connected with north-sea water originating from the January inflow. However it was unlikely taking into account that propagation of cold and oxygen-rich north-sea waters into the central Gotland Basin took place in August, while the western Gotland Basin was not influenced by the inflow up to the last decade of September [1].

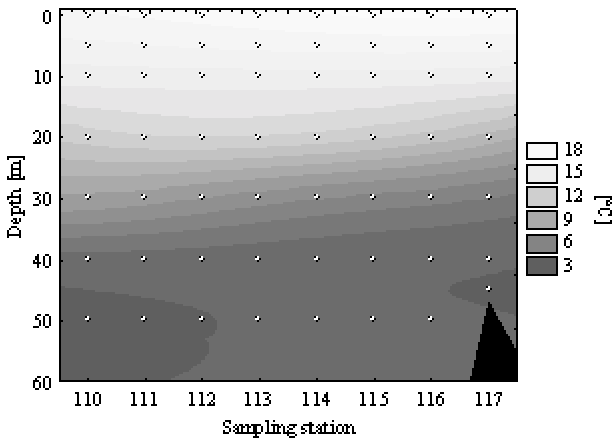

Figure 2. Temperature distribution in the Profile 1.

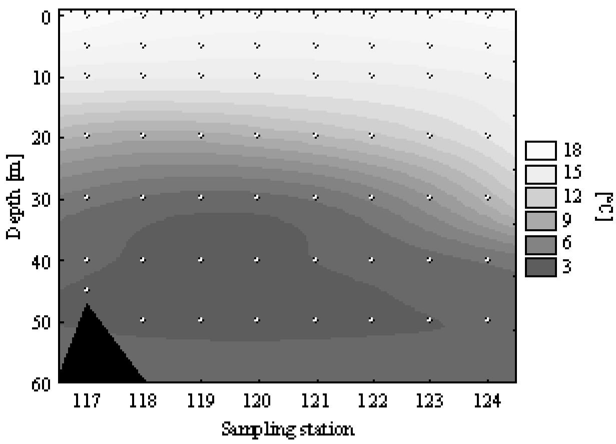

Figure 3. Temperature distribution in the Profile 2.

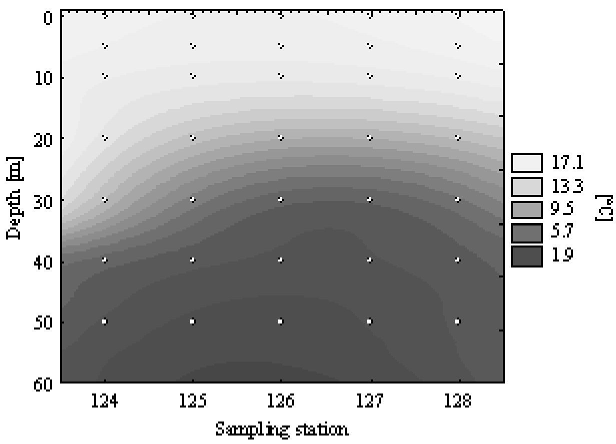

Figure 4. Temperature distribution in the Profile 3.

Salinity

Salinity in the first two of examined profiles reached values typical of the Baltic Sea [3,4]. Salinity fluctuations in the Profile 1 (Fig. 5) were both irregular and insignificant. Mean salinity in the UQHL was 7,8‰ and in the CIL 7,9‰.The deep-water mass was not unequivocally observed, however at station 110 there was quite significant salinity increment from 7,8‰ at the depth of 30m to 9,8‰ at 50m.

Salinity of the Profile 2 water column showed not large fluctuations. The UQHL mean salinity level was 7,4‰ and for the CIL it reached 8,2‰. The exception was concentration at sampling station 124 rapidly

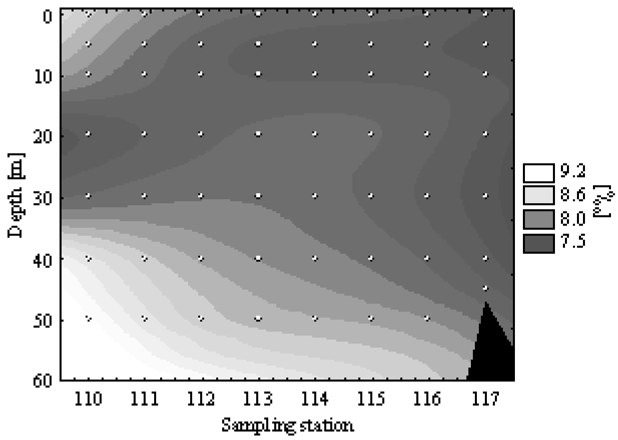

Figure 5 . Salinity distribution in the Profile

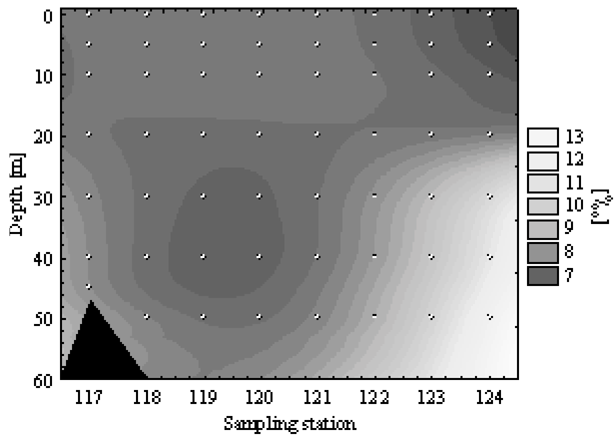

Figure 6 . Salinity distribution in the Profile

increasing to nearly 14‰ at the depth of 50m. That was probably connected to some saline water intrusion, which was clearly revealed in the contour plot (Fig. 6). Salinity distribution in the last profile revealed unexpected anomaly (Fig. 7). Extremely high salinity levels, up to 19‰, were noticed at stations 125-126 through all the sampled depths. As a result mean salinity level in the UQHL reached 11,8‰ and 13,7‰ in the CIL. Origin of that phenomenon is hard to explain without analysis of other pollutants concentrations.

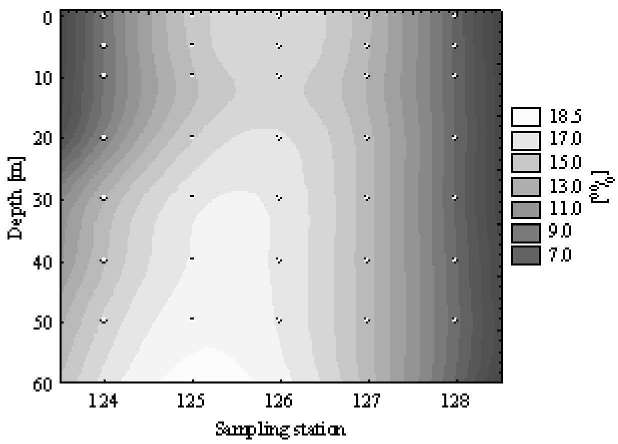

Figure 7. Salinity distribution in the Profile

Oxygen

Oxygen distribution characteristics in two first profiles were typical of the Baltic Sea [3,4] and indicated good water condition. One of the peculiarities of the studied section was presence of maximum dissolved oxygen content up to 8,5ml/l at the depth of 30-40m (Fig.8). It could be explained by two basic reasons: by intensive consumption of oxygen in the photic layer followed by decrease of its consumption underneath and also by temperature distribution. Lower temperature of the CIL favoured higher oxygen concentration. Moreover thermocline hindered mixing between surface and the CIL waters [3]. Dissolved oxygen saturation in the Profile 1 reached 100% near the surface and towards the depth of 50m gradually decreased to about 80%. A substantial area of well-saturated surface water (values exceeding 100%) at stations 115-117 was formed probably due to intensive mixing and aeration.

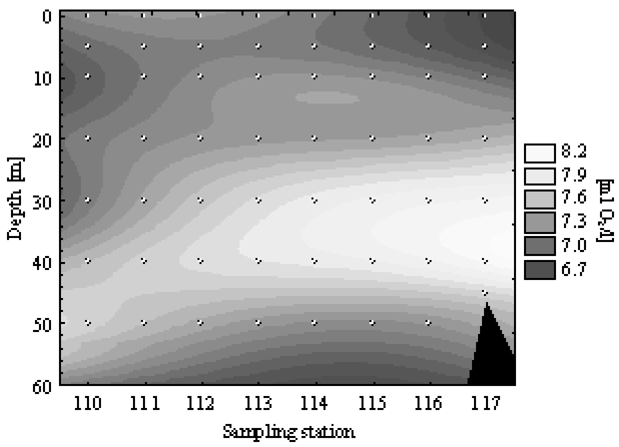

Figure 8 . Distribution of dissolved oxygen concentration in the Profile 1.

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Unforgettable combination between sailing and science

Ksawery Kuligowski

"...12th of June, 01:12 a.m., position: 58°61' N, 23°40' W, wind 6°B, there where Baltic Sea meets Gulf of Finland, we are pulling down the enormous mainsail and two forsails. It is not dark, the end of "white nights", warm. Wadim, Veronika and Ania are coming out on the deck. They are well equipped by various devices, which will help us to measure properties of Baltic water. After 2 minutes the first bathometer is disappearing under the blue water surface. Then every 10 meters we are pining on others. The entire steel rope hides in the depth. We are putting down the ballast and bathometers "are swallowing" the amounts of water from different depths. After that we are changing to pull up 60 meters of steel rope again using the crank. The obtained water is poured to the bottles, its properties will be determined by Ksawery and Masha, who will calculate the oxygen content and salinity. The second part of our shift is carrying out the measurements concerning air humidity, temperature, velocity and direction of the wind, cloudiness, size and frequency of the waves. It is quarter to 2 a.m., at 2 there is a shift's change. We are falling asleep in dank berths, there is only a fearsome sound of waves "dancing" with hulls of our brave catamaran".

HOW DID IT START ...

I am a student of Technical University of Lodz (Poland) at the Faculty of Process and Environmental Engineering. For the scientific expedition onboard the catamaran Centaurus II I was invited by Russian State Hydrometeorological University as a student of Baltic University – regional university network with the branch at my department. My adventure started since I have been pleasantly welcomed at the railway station in Kaliningrad by the students and professors from their university. After unpacking my luggage, Lena (student of geoecology) showed us many worth seeing places such as Amber Museum and original Indian pub, where we were listening to the traditional music and smoking tobacco. But the real adventure began when I put my feet on the net stretched between hulls of the amazing catamaran – Centaurus II.

All the crew without Sasha, who was taking the picture, I am the second from the left in the second row.

TO THE NORTH AGAINST THE WIND

The Baltic Sea welcomed us with the reserved wind, which was no more than 6 degrees in Beaufort scale. Each of us had to get used to new conditions. Actually I used to sail a lot but only on single – hulled boats, where I did not have an opportunity to feel the real speed, which can be achieved by the Centaurus II. I will never forget the moment when I was lying on the net with my head beetling out of the hatch and observing the wake between the hulls. First days of the cruise passed in nice atmosphere, we were singing, teaching each other national songs, playing the guitar or tabors. The crew was split up to the two shifts. I was in the shift, which operated the sails and carried out measurements from 8 am till 2 pm, and from 8 pm till 2 am, what was really convenient for each of us due to unforgettable observations of sunsets.

6 bathometers are ready to sink them to 60 meters under the water surface. Me and Wadim.

Our destination: Saint-Petersburg.

Before I move to describing the experiments, it is worth to see that even if we were sailing somewhere in the Baltic Sea, cut of from the world, our cuisine was very sophisticated. There is only one explanation for this, it must have been Dr. Galina who was cooking all the time for us even while the weather conditions did not allow to prepare varied meals in the kitchen.

As I told before I found this expedition as a quite unique combination between my biggest passion – sailing and my field of study. I have to admit that at the first time in my life I had an opportunity to carry out hydrochemical and oceanological measurements. Our experiments were being done several times per day, and obviously during the night also. Even if the conditions inside the laboratory in the hull were inconvenient to work we tried to do our best. Every time when I was titrating, pouring out the $AgNO_3$ solution from the burette I was forgetting about my seasick, which during first days was really troublesome. The basis to estimate the oxygen and chloride water was at first gathering the water samples from the bathometers, which were sank to the depth of 60 meters. The most demanding activity was to pull up six bathometers, which were filled with water, linked to the steel rope. Comparing results of our measurements in MS Excel and plotting various data we could make some conclusions. For instance, the deficit of oxygen in bottom layers of the sea can be explained as follows. Contaminants included in the wastewaters or rivers flowing to the sea cause the increment of microorganisms contained in plankton, which, due to huge amounts of nutrients grows rapidly consuming the oxygen and falls down to the sea ground. After this process the anaerobic bacteria occur and start producing hydrogen sulphide.

The Baltic Floating University training through the research cruise on board the Centaurus – II on the Baltic Sea and Gulf of Finland was uncommon experience, which let me meet hospitable Russian students and scientists, taught me how to behave in various situations, get to know some oceanological issues. Moreover, after this unusual cruise I believed that it had been possible to work and study onboard under stretched sails, which proved the connection between my sailing passion and environmental protection.

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Sailing catamaran 'Centaurus-II' in Kiel Week

Natalia Ivanova

In the summer of 2003 Russian sailing catamaran "Centaurus-II" has visited Kiel for the second time. Participation of the catamaran in one of the largest events in the northern Europe – Kiel Week (June 23 – 30) was provided by the UNESCO/IOC "Baltic Floating University" (BFU) program, which is carried out by the Russian State Hydrometeorological University (RSHU) since 1993. The invitation to come to Kiel was received from the Academic Service of International Relations at Christian-Albrechts Kiel University.

The initiative to invite the catamaran came from Hohe Tied - non-governmental organisation for environmental protection of the North and the Baltic Seas. This invitation provided a mooring place for the catamaran in the scientific fleet harbour of Kiel Institute of Marine Research (IfM), including supply of the vessel with water and fuel, and also participation of members of the expedition in joint with Hohe-Tied actions in context of the project "Kiel–Sailing City". The program of participation of the BFU expedition in this project was aimed at expansion of ecological knowledge and involvement of local population (first of all schoolchildren) in actions on studying and conservation of the environment. This program was developed and implemented together with the Hohe Tied, representatives of Centre of Applied Ecology (Sillamäe, Estonia) and of Cádiz University (Spain).

In order to get to small cosy town of Kiel from Saint-Petersburg the catamaran has passed the long way of 12 days across the whole Baltic Sea. Along the route the catamaran had to go against the wind, therefore it was impossible to develop full speed. However, it was a very wonderful travel cause the sea is beautiful in all of its manifestations. During last two days of travelling the catamaran was fighting through a storm and early morning overcoming all the difficulties entered the Kiel Bight. Despite cloudy weather Kiel was found to be a friendly city. By that time there were many moored yachts and ships carrying flags of many different countries. Unfortunately there were almost no Russian yachts, although two tall-ships were there: "Sedov" (Murmansk) and "Krusenstern" (Kaliningrad).

The main work of the RSHU expedition (together with the group of scientists-ecologists from Kiel University, from Institute of Marine Research and Hohe Tied) consisted in carrying out during each day of the Kiel Week two short (up to 4 hours) educational-demonstration cruises with groups of visitors onboard the catamaran. Many people took part in the cruises, mainly they were schoolchildren from Kiel and neighbouring places. During the cruises lecture material was given and demonstrational experiments with model of the Baltic Sea carried out and also sampling was done and hydrophysical, hydrochemical and hydro biological parameters measured in two points of the Kiel Bight: in the mouth of the Shventine River and in the area of the Falkenshtain pier.

In the end of each cruise taken samples were analysed and results of measurements demonstrated on a computer. All the visitors had the opportunity to take part in sampling and samples analysis. Groups of the demonstration cruises participants consisted of: 8th year students from real school in Raisdorf; 5th year students from Freiherr von Stein-Schule in Kiel; 4th year students from Friedrich-Junge-Schule in Kiel; students of biological course from gymnasium in Ekkernferde; representatives of Academic Service of

International Relations at Kiel University, of the IfM Assistance Society, of energetics company Camp24sieben, of HeiTel Digital Video company, of Bingo-Lotto lottery, of Kiel Environment Department, who co-sponsored the "Kiel-sailing city" project; members of coordination group of the scientific and technical program "Marine Research", which is jointly fulfilled by the IfM, GEOMAR scientific-research centre, Pedagogic Institute and Hohe Tied; representatives of mass-media (newspapers "Kieler Nachricnten" and "Kieler Woche online", radio station "Norddeutscher Rundfunk – Welle Nord", television channels SAT1 and RT1, international magazine "Multihulls" and two independent journalists from Hamburg). The guests were involved in practical work onboard the catamaran and showed significant interest. Due to great variety of visitors the program of the cruises varied depending on who was in the group.

The group of RSHU has been invited to take part in the exhibition onboard the IfM research vessel "Alkor", which was dedicated to oceanological research. On three posters materials were presented characterizing the activities of RSHU and BFU, their history and structure, types of field research onboard the RV "Sibiriakov" and the sailing catamaran "Centaurus-II", main results, international relations.

In agreement with IfM during the Kiel Week leaders of the expedition have appeared with lectures in the context of lecture cycle "Earth Planet", which took place in the building of the IfM aquarium. Aquarium is situated on the seashore. Professor Alexey V. Nekrasov has read the lecture entitled "Energy of ocean tides and its application" and Dr.Vadim T. Paka spoke about "Large inflow events of the north-sea waters into the Baltic and their consequences". The lectures were attended by representatives of IfM, Shirshov Institute of Oceanology (Kaliningrad), RSHU, by locals and guests of Kiel. Entrance has been free and open for the public.

In the context of Kiel Week meetings took place with the Head of Academic Service of International Relations at Kiel University Dr. M. Schmode, with coordinator of natural-scientific and technical program "Marine Research" Dr. J. Deng and professor of IfM D. Wallace, and issues of further cooperation were discussed.

Also members of the RSHU expedition were taking part in others actions. First of all, they had visited training sailing ships "Sedov" and "Krusenstern" where sailors provided excursions abound their ships, told about their travels. Secondly, the expedition took part in the evening of friendship, which was organised by the German-Russian society in Kiel (local sub-unit of German Society of Friendship East-West in Schleswig-Holstein). Program of the evening consisted of performance with participation of music and dancing ensembles from Germany, Russia and Ukraine. Dishes of German cuisine were proposed. Thirdly, a visit to historical complex of hydro engineering constructions has been organized, which is located on the shore of the North Sea in the region of Halling Nordstrandismoor serving to preserve the low seashore from destruction force of sea tides.

And in conclusion the catamaran "Centaurus-II" took part in the Parade of Sails, dedicated to the end of Kiel Week. During the parade all the sailings ships were going through the Kiel Bight, which was a fascinating view. There were ships designed in styles of different ages. Beautiful fireworks refracting on the water surface have marked the end of the festival. It was a fantastic sight. This was the end of Kiel Week – a big festival absorbing people from many countries in a fairy carousel of events.

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Alexander Sibiriakov- the Man and Ships

Vasily P. Shvets, Mikhail B. Shilin

On a boundary of XX and XXI centuries geopolitical value of the Northern part of Siberia and also of the Northern Seaway has sharply increased for Russia once again. In this connection, scientific developments of Alexander Mikhailovich Sibiriakov (1849-1933) - the Russian businessman, one of the first initiators of development of transport water routes system between Europe and Siberia - receive actuality again.

A.M. Sibiriakov was born October 8, 1849 in the family of an Irkutsk merchant and the gold-mines owner. His family was one of the richest in Irkutsk and consequently in whole Siberia. Only three - four merchant families, which members, as well as Sibiriakovs, were trading across all the Eastern Siberia, on Aleutian Islands and in the North America, could be comparable. After finishing men's gymnasia in Irkutsk, the successor of a huge father's fortune he has left to study at Polytechnic technical school in Zurich (Switzerland), and after finishing it has returned home. On outlook and political views he was close to "Siberian regionalists", who in perspective saw Siberia as a partly independent autonomous region of Russia with well-developed system of self-government. His most known book "About means of communication of Siberia and its marine relations with other countries", published in Saint Petersburg in 1907, he will start with chapter "About an autonomy of Siberia".

Figure1. Alexander Mikhailovich Sibiriakov (1849-1933)

All his long life Alexander Mikhailovich promoted exploration of Siberia and perspectives of its connection with Europe and the Far East through the system of the Northern Seaway. Thus he managed to happily combine romantic attraction to marine adventures with practical merchant grip. So, in 1876 A.I. Sibiriakov has allocated 1000£ for expedition of English captain Viggins on Kara seaway and research of mouths of Ob and Yenisei Rivers. The expedition has with interest paid the expenses, having taken out to Europe cargoes belonging to Sibiriakov.

In 1878-1880 the successful businessman has taken up 40% of total expenses of expedition of Swedish scientist A.E. Nordensheld on whaling steamship "Vega". By that time Nordensheld has already made a number of successful cruises in the Arctic Ocean due to Oscar Dickson's sponsoring support. This time Nordensheld has received help from Russia during the moment when he has already despaired to find sponsors in Europe, which has allowed him be the first in realisation of the dream of many sailors - to pass (in two navigations) along the Russian Arctic coast from Arkhangelsk to Vladivostok, actually having proved a reality of the Northern Seaway use (Pasetsky, 1979).

In 1880 À.M. Sibiriakov has built on his own money two vessels - "Nordensheld" and "Oscar Dickson". On these vessels he has made a number of sea expeditions along the Northern Seaway. In 1881 he started the construction of overland road between Ob and Yenisei, having connected it with a mouth of Pechora by the overland way, which has received the name of "Sibiriakov's road". From the mouth of Pechora Russian ships delivered Siberian cargoes to ports of the Western Europe. In 1864 Sibiriakov has transported by this road 20 thousand poods of cargoes, in 1885 - 75 thousand, 1887 - 210 thousand poods. Since 1884 Sibiriakov's ships, making trading cruises from the Western Europe through Arkhangelsk to the mouth of Pechora and further to Siberia, used the right of duty-free import of foreign table salt.

Since the second half of 1880s Alexander Mikhailovich is engaged in organisation of trade between Siberia and the Far East (and later also with China). He overcomes thousands kilometres on the rivers and land between Tobolsk and Taz, explores the Kolyma and Yakut lands, and also coast of the Okhotsk Sea, trying to study possible ways to connect Siberia with the East and the West. According to results of the researches a fundamental work "To a question on external markets of Siberia" (1893) is published.

In 1886 Sibiriakov allocates 1000 roubles to the Russian Academy of Sciences for establishment of the premium for scientific works about Siberia and Northern Seaway, published in Russian; in 1887 - 7000 roubles more for exploration of the Amur basin with the purpose of development of water connections. On a boundary of centuries he promotes establishment and formation of the University in Tomsk with the purpose of training of experts for regular researches of Siberia. Having allocated from personal means 112, 5 thousand roubles, Sibiriakov purchases for the University a unique book collection of 4674 volumes - library of a famous poet V.A. Zhukovsky. Since 1904 Sibiriakov is the honorary member of Tomsk University. For Irkutsk men's gymnasia À.M. Sibiriakov gets a marble sculpture "Ivan the Terrible" by Antokolsky, and then some paintings by Ayvazovsky.These masterpieces can be seen today in Irkutsk picture gallery. Shortly before the beginning of the World War I Sibiriakov moves to Petersburg where he lives for some time together with brother Innokenty. Brothers were like competing with each other in generosity of patron gifts. Alexander transfers significant money resources to the Petersburg Academy of Sciences for establishment of premiums for scientific works about Far North and Siberia. Innokenty leaves 420 thousand roubles for distribution as allowance to mine worker and becomes a monk. In 1914 brothers simultaneously leave to Europe. Innokenty goes to Saint Andrew's monastery on Athos, and Alexander reaches France where lodges in one of expensive hotels of Nice. However, the war followed by revolution completely bring him to ruin, he remains without means of subsistence: as well as many other Russian patriots, Sibiriakov has not taken out his actives to Europe during the war, has left them in Russia. In 1920 Russian community in Nice has addressed to the parliament of Sweden, reminding about great services of À.M. Sibiriakov for organization of Nordensheld's expedition, and the parliament has granted annual pension to him at a rate of 3 thousand Swedish crowns.

There is little information about the last years of Alexander Mikhailovich's life. He corresponds with the widow of A.E. Nordensheld Anna (nee Mannergeim), adopts and christens to Orthodoxy a boy - Buryat, whom he has met once during travels and who became since that time a constant companion of the getting old patron. In spite of the fact that Sibiriakov has given the boy his surname and patronymic, his destiny is unknown. Alexander Mikhailovich has died November 15, 1933.

For activities in the field of exploration and development of the Far North and Siberia À.M. Sibiriakov has been awarded with Swedish Order "Polar Star" and with French sign "Palm branch". An island and bay in the Arctic Ocean bear the name of Sibiriakov. Purchased in 1914 by the Marine Ministry of Russia for hunting purposes vessel "Bellaventure" in 1916 has received a new name - "Alexander Sibiriakov". Since then the name "Sibiriakov" is certainly borne by one of the ships of icebreaking fleet or Hydrographic Service of the Russian Navy. Such qualities of Alexander Mikhailovich as luck, enterprise, courage, ability to take quickly correct decisions after his death were inherited by ships bearing his name.

The icebreaking steamship "Alexander Sibiriakov" (former "Bellaventure", constructed in 1909 in Glasgow, with displacement of 1383 tons, speed 8 knots) in 1932 for the first time in history of navigation has passed along the Northern Seaway from the west to the east during one navigation (head of the expedition O.Yu Schmidt; scientific assistant V.Yu. Vize; captain of the icebreaker V.I. Voronin). The cruise was carried out in connection with participation of the USSR in the program of scientific researches of the 2nd International Polar Year. In the eastern part of the Russian Arctic heavy ice has broken "Sibiriakov's" propeller shaft, which has sunk together with the propeller, and the final part of the way the vessel has passed under black sails tailored by crew from empty bags in which coal was kept. For this navigation the crew was awarded by the Order of the Red Banner of Labour.

Figure2."Alexander Sibiriakov" in the Polar Ocean

During the Great Patriotic War the veteran of icebreaking fleet was included into icebreaking group of the White Sea military flotilla. In connection with the wartime 4 cannons have been installed on the "Sibirbiakov": two of calibre 45mm and two of 76 mm, and also some machine guns. August 25, 1942 in the Kara Sea near the Belukha Island the steamship under the command of captain A.A. Kacharava has joined unequal fight with German raider "Admiral Sheer", having sheltered a caravan of nine transport vessels and two icebreakers in area of the Vilkitski Strait. The radiogram sent from the board of the "Sibiriakov" by

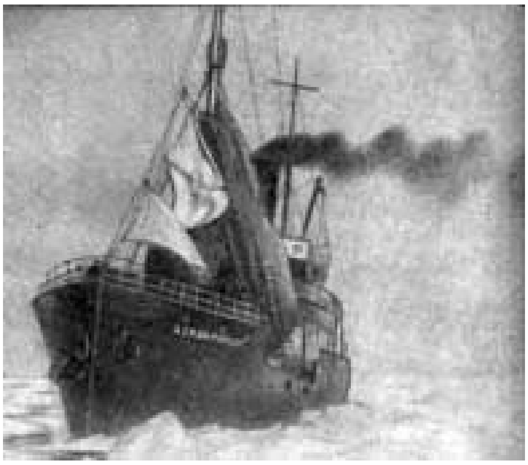

Figure3."Alexander Sibiriakov" under black sails

radio operator A. Shershavin unmasked the raider, which was searching for the caravan in a mode of special secrecy. After four shells from 280-mm cannons have hit the icebreaker the fire started. To avoid capture of the vessel by enemies senior mechanic N. Bochurko has opened Kingston valves. The burning steamship has sunk into the water. 19 persons including the hard wounded captain tried to leave on a boat, but have been captured and after passing through the system of camps for war prisoners have returned home after end of the war.

A stoker from the "Sibiriakov" A. Vavilov on other boat has reached the Belukha Island, where on uninhabited rocky coast has lived for 32 days, eating ship's biscuits. In early October crew of a seaplane has rescued the stoker. Up to the end of war he was considered to be the only survived member of the "Sibiriakov's" crew. In 1960 for faultless service on marine vessels he has been awarded with the Golden Star of the Hero of Socialist Labour.

After coming back home people from the "Sibiriakov's" crew found themselves in a difficult situation. On one hand, the government has been informed about their feat; on another - being captured was considered as a shame and a crime. Having avoided, fortunately, serious prosecutions, captain Kacharava has returned to his native Sukhumi where worked in the Sukhumi shipping company on land. In late 1950s I.D. Papanin took up his case proving to the government that by bringing the "Sibiriakov" into the battle Kacharava has rescued a caravan, i.e. has made a heroic deed. During the war Papanin was a Plenipotentiary of the State Committee of Defence on transportations in the North, and exactly by the order of his staff Kacharava was piloting by that time the "Sibiriakov" from port Dickson to the Northern Land. In 1964 in Military publishing house of the USSR Ministry of Defence a book by Ye.M. Suzyumov was printed, in which for the first time the appropriate evaluation has been given to the feat of crew of the icebreaking vessel (Suzyumov, 1964). Actually issue of this book has finished the process of rehabilitation of sailors from "Sibiriakov". In the second half of 1960s A.A. Kacharava comes back to active work at sea; in 1966 he is a captain of the passenger liner "Abkhazia".

Figure 4. Captain Kacharava onboard "Sibiriakov"

Now a participant of the heroic battle, the Party leader of the military crew M.F. Sarayev lives in Saint Petersburg.

In 1945 the name "Sibiriakov" is given to icebreaker of the Arctic fleet, which for many years has been piloting vessels in the seas of the Arctic Ocean.

Hydrographic vessel (HV) "Sibiriakov", launched on Gdansk shipyard April 28, 1989, is the third vessel in a dynasty of ships bearing the name of A.M. Sibiriakov. The vessel is intended to carry out geophysical and hydrographic research of the World Ocean. During the period of being in structure of the Navy has made 16 campaigns of various duration, more than 600 days was directly in the sea (ocean), has visited 19 times 13 ports of 12 states, having passed 90 thousand nautical miles. Since 1998 on the HV "Sibiriakov" under aegis of the Intergovernmental Oceanographic Commission of UNESCO Russian State Hydrometeorological University (RSHU) carries out multidisciplinary scientific-educational expeditions in the Baltic Sea under the program "Baltic Floating University" (BFU). During the period of joint RSHU and HV "Sibiriakov" activities researches according to a program of long-term monitoring of the Baltic Sea ecosystem are executed, conditions for summer educational field practice for 72 students from 16 countries of the world, including Spain, Portugal, Germany, the Great Britain, Poland, Sweden and Finland are created. In 1998, the International Year of the Ocean, 23 schoolchildren from 11 countries of the world participated in the BFU campaign. To participate in the International exhibition EXPO-98 the "Sibiriakov" made a call to Lisbon where the IOC Executive Secretary P. Bernal has come onboard.

Involvement of students and schoolchildren in the process of observations and analysis of the environmental data implements the UNESCO's principle "Training Through Research".

In 1992 and 1997, representing the Naval Hydrographic Service at conferences of the International Hydrographic Organization in Monaco, crew of the vessel tried to find the tomb of A.M. Sibiriakov, but unsuccessfully.At last, it turned out well, and March 24, 2000 during the next call to Monaco with assistance of employees of General Consulate of Russia in Marseilles and in principality of Monaco A.V. Shulgin and A.V. Zenin and support of the Chief of the Head Department for Navigation and Oceanography of Russia admiral A.L. Komaritsyn a wreath was put by the crew of the hydrographic vessel to the tomb of A.M. Sibiriakov on an orthodox cemetery in Nice (Shvets, 2003). The inscription on a ribbon said: "To Alexander Mikhailovich Sibiriakov from sailors-hydrographs of Russia". The inspector of the cemetery E.N. Verevkin, not hiding excitement, has told, that so representative delegation has visited A. Sibiriakov's tomb for the first time. On Russian custom a glass of vodka with a slice of black bread baked by ship cooks has been put on a tomb.

Figure 5. A special post envelope in honour of "Sibiriakov"

Ideas of A.M. Sibiriakov formulated as early as by the end of XIX century, have received at present new development and realisation in connection with planned exploitation in the Russian Arctic regions of oil and gas deposits and intensification of connection through the Northern Seaway.The very name "Sibiriakov" became a symbol of service to Russia, an appeal to joining up of science and industry in interests of sustainable development of coasts of the northern Russian seas.

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