Annex VI-4

Draft National Report on HAB in Russia

(Submitted in the Second Meeting of NOWPAP WG3)

Content

Abbreviation

HAB: Harmful algae blooms
HAE: Harmful algae events
NOWPAP: North-west Pacific Action Plan
CEARAC: Coastal Environmental Assessment Regional Activity Centre
FEB RAS : Far East Branch of Russian Academy of Sciences
PSP: Paralytic Shellfish Poisoning
DSP: Diarrheic Shellfish Poisoning
DAP: Domoic Acid Poisoning
TTR: Training Through Research
IOC: Intergovernmental Oceanographic Commission
WESTPAC: Western Pacific
UNEP: United Nations Environment Programme

I. INTRODUCTION

1.1. General explanation of present situation of HAB in Russian part of NOWPAP area

Microalgae in marine and brackish waters regularly cause "harmful effects", considered from the human perspective, in that they threaten public health and cause economic damage to fisheries and tourism. Harmful Algal Blooms are truly global phenomena, and evidence is mounting that the nature and extent of the problem has been expanding over the last several decades. HABs include discoloration of water by mass occurrences of microalgae (true algal blooms that may or may not be 'harmful") and toxin-producing species (toxic "blooms" that may be harmful even in low cell concentrations). In accordance with the definition of HAB that was agreed by WG3 Members at the meeting in Busan, October 2003, HABs in this report encompass both harmful and harmless red tides, and toxin-producing plankton blooms.

The solution of HAB problems in NOWPAP Region needs close coordination within WG members in this Region. It is essential to have a common platform to develop the research, mitigation measures and proper political proposals. In the WG 3 Meeting held in Busan, October 2003, guidelines for preparation of national report were proposed to prepare required information in a common format, which may make the compilation of Integrated Report easier. National reports should aim at the accumulation of reliable data and information to integrate knowledge on HAB in the NOWPAP region. The present report was compiled following the guidelines with some modification. According to requirement of the guidelines, the report was prepared using both existing and publishing data.

Eutrophication of marine and enclosed brackish waters is a problem in many NOWPAP countries. HABs tend to occur in such area more frequently, causing serious damage on fishery production through mass mortality of fish and shellfish, and on human health through fish/shellfish poisoning. Several anthropogenic forces might be considered to be involved in the formation of

HAB. Among them are increased utilization of coastal waters for aquaculture and stimulation of plankton blooms by cultural eutrophication. Russian area occupied a vast zone in the northern part of the NOWPAP region (Figures I.1., I.2). It is mostly unpopulated area and does not have so intensive aquaculture industry, as it is in other NOWPAP countries. The Russian Federation lags far behind other NOWPAP member countries in its approach to the management of problems caused by marine biotoxins. It there is no governmental organization responsible for toxicity monitoring in Russian waters and as results there are no official data on toxicity of seafood. So, some Russian data on HAB in NOWPAP area has not sufficient for the completion of recommended format for Integrated report. Nevertheless, the present report can be used as the basis to develop the complete understanding on HAB in NOWPAP Region.

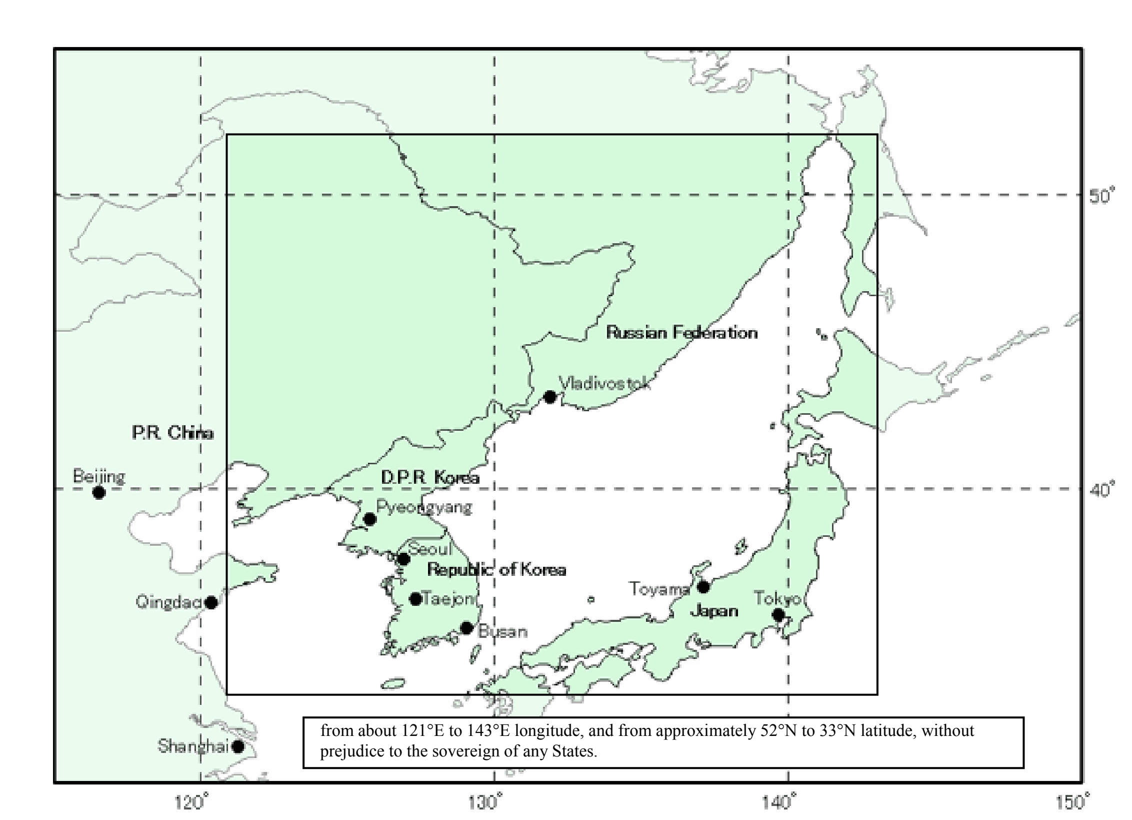

Figure I.1. Geographic coverage of NOWPAP Region

1.2. General description of characteristic of marine and coastal environment of Russian part of NOWPAP region

The Russian part of NOWPAP region includes Primorski Krai, southeast part of Khabarovski Krai, and southwest part of Sakhalin Is. with sea area between. Primorski Krai is the main from the point of view coast line length, watershed square, population, and economic production. The main geographic and social-economic characteristics of the different districts situated within this region are presented in Table 1 and Figure I.2.

About 80 per cent of the Primorski Krai and adjoining part of Khabarovski Krai is occupied by numerous mountain ridges belonging to the mountainous country of Sikhote Alin. The average height of mountains is 600 meters with highest up to 1855 meters. More than 2/3 of watersheds are covered by Ussury taiga in which coniferous and broad-leaved species are mixed up. Southwestern part of Sakhalin Is. is presented by low mountains and hills covered by forest, mainly coniferous. The coast line of south part of Primorski Krai (Peter The Great Bay) is rather indented, and north part is slightly indented.

Monsoon atmospheric circulation is a main climatic feature of the region. The pretty cold dry winter and moderate warm humid summer are typical for the mainland of Russian part of NOWPAP area – Primorski Krai. There is clear shift of air temperature decrease in winter and increase in summer in moving away from the coast to the west even for the distance 30-50 km. The average temperature in coastal zone in winter is -10-12º C, and in summer - +16º C.

Annual number of days with precipitations at the coast of Primorski Krai makes 100-115 days. Annual sums of precipitations increase southward: in Vladivostok average sum is 806 mm, maximal - 1276 mm. 80-95% annual precipitations fall out in the period from April to October, and 16-26% of annual precipitations fall out in the month of the maximum average monthly amount. Precipitations have frontal character as a rule.

Climate of southwestern part of Sakhalin Is. is more soft, the average temperature in winter is – 6º C, and in summer +19º C. Annual sums of precipitations varies from 600 to 1200 mm, that is close to Primorski Krai, but distribution through the year is more even, and distinct snow accumulation takes place.

Region is characterized by developed hydrographical net which density is in average about 0.9-1.0 km/km². In the south part of the Primorski Krai prevails rainwater feeding (50-70%), though in the north part of the region melting snow waters is very important too. A role of the underground water feeding changes in the interval of 5-15% from north to south. 80-90% of annual discharge falls to a warm period. This considerable river discharge unevenness makes some problems for providing population with fresh water. The main rivers of region are Tumen River (average discharge 214 m^3/s), Razdolnaya (Suifun) River (average discharge 72 m^3/s), Samarga River (average discharge 84 m^3/s), Koppi River (average discharge 69 m^3/s) and Tumnin River (average discharge 132 m^3/s), which summary provide about 53% of all river input from the Russian part of NOWPAP area. The numerous rather small rivers in the southwestern Sakhalin have water discharge from 0.2 to 19.4 m^3/s with average discharge about 6.7 m^3/s.

The water temperature in the coastal waters of Russian part of NOWPAP area is pretty changeable due to seasonal variation of weather. Winter northwestern monsoon leads to cooling of water along all Russian coast up to freezing in Tartar Straight and inner parts of Peter The Great Bay. Therefore in winter temperature difference in coastal waters within Russian coast is not very significant (Figure I.3). Tartar Straight between Sakhalin Is. and main land is a primary ice reservoir containing 90% of all ice cover of NOWPAP aquatory. Other 10% is observed in Peter The Great Bay. In summer the difference in water temperature between coastal waters of south and north parts of Russian sector of NOWPAP area is more clear and reach 10º C (Fig. I.3). In spring and fall the distribution of water temperature has the same but less contrast character as in summer (Figure I.3).

The formation of local seasonal upwelling is a regional feature of coastal waters south part of Primorski Krai coast. The upwelling with size up to 300 km and temperature gradient up to 9º C are generated in fall due to change of monsoon direction and prevailing of strong northwestern winds. Later, in the beginning of winter the water stratification disappears and upwelling ceases.

The water circulation and currents in coastal zone are determined by the wind action first of all, but general features of water movement in the different parts of Russian sector of NOWPAP are stipulated by stationery currents (Figure I.4). Large part of Primorski Krai coast is under the influence of cold Primorski Current, which called Shrenk Current in its north segment. This is a part of big cyclonic water circle occupied all area between Primorsli Krai and Sakhalin Is. In its east part near Sakhalin this regional West Sakhalin current is presented by a branch of worm Tsusima current incoming through the Korean Straight (Figure I.4). In the north part of Tatarski Straight West Sakhalin Current converts to Shrenk Current, which turns into Primorski Current. South off Peter The Great Bay Primorski Current divides on two big branches. Northern one combining with East Korean Current creates main frontal zone setting apart rather cold water of Russian part of NOWPAP area from warm waters adjoining to Japan Islands and Korea peninsula. These features of water circulation are maintained through the year, but as a rule velocity and flux of currents in summer is twice higher than in winter.

Table I.1. Social-economical characteristics of the coastal regions of Russian sector of NOWPAP area

Regions	Square, $*10^3$ km^2	Shore line, km	Population $*10^3$ person	Population density, per./km^2	Volume of industrial production $*10^6$ USD	Volume of agriculture production, $*10^6$ USD	Volume of all production USD per capita
1	4.13	467.0	37.7	9.1	9.4	4.5	369
2	2.65	102	769.5	292.4	404.8	87.2	639
3	7.51	361.5	275.0	37.6	243.4	26.3	981
4	15.32	432.4	59.0	3.9	61.6	11.8	1244
5	5.34	18	50.4	9.4	50.8	4.3	1093
6	42.7	760.2	73.8	1.7	54.9	2.9	783
7	15.64	725	117.8	7.5	215.6	18.1	1984

* The regions studied includes: 1 – Khasanski district; 2 – Nadezhdinski district plus Vladivostok and Artem cities, 3 – Shkotovski and Partizanski districts plus Nakhodka and Fokino cities, 4 – Lazovski, Olginski and Kavalerovski districts, 5 – Dalnegorski district, 6 -Terneiski and Sovgavanski districts, 7 – south-western districts of Sakhalin Island.

Figure I.2. The Russian part of NOWPAP area with districts different by their geographical and socio-economical characteristics. Number of districts coincides with number from Table I.1.

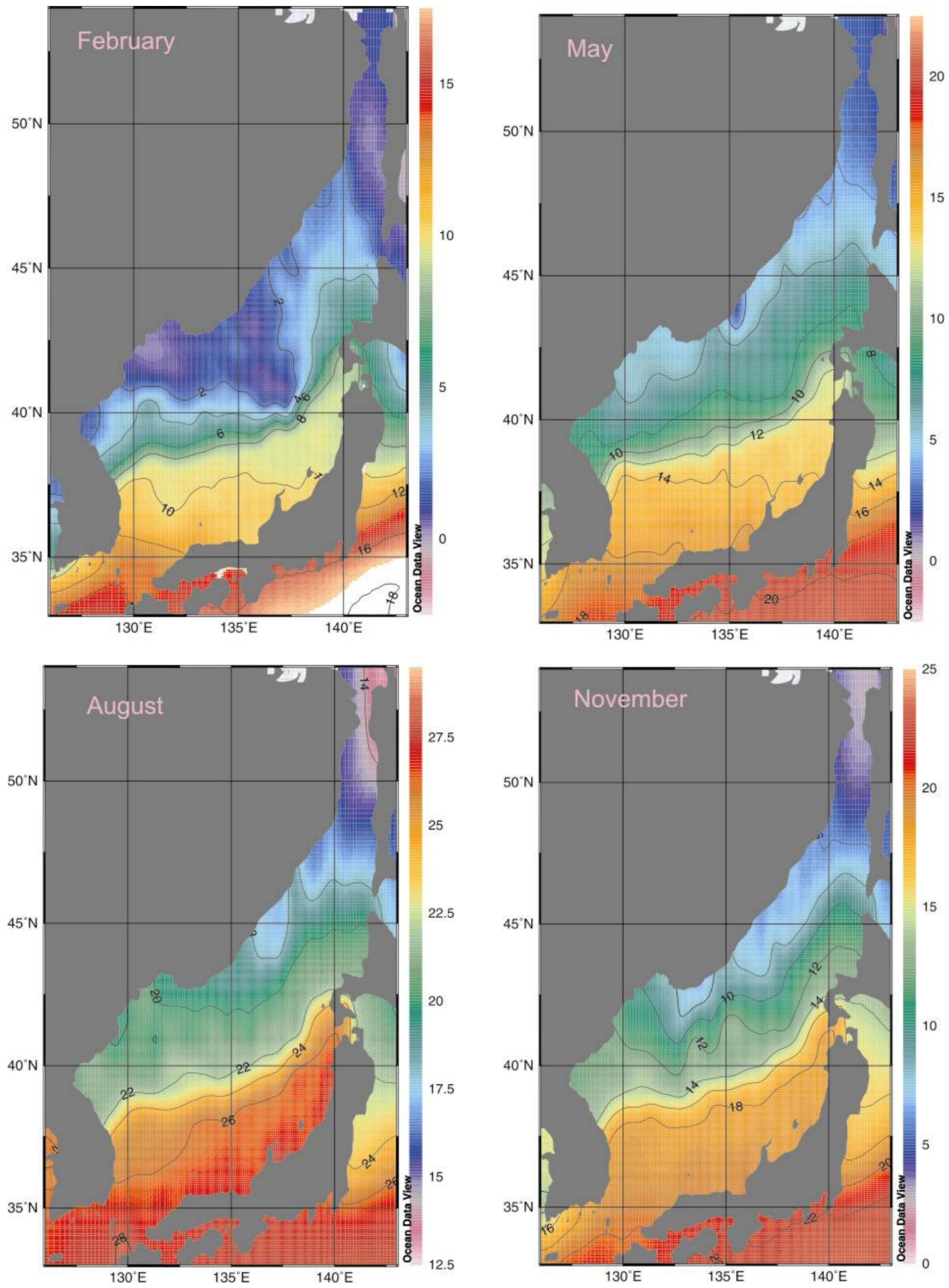

Figure I.3. Temperature in the surface layer of sea area of north NOWPAP region in different seasons.

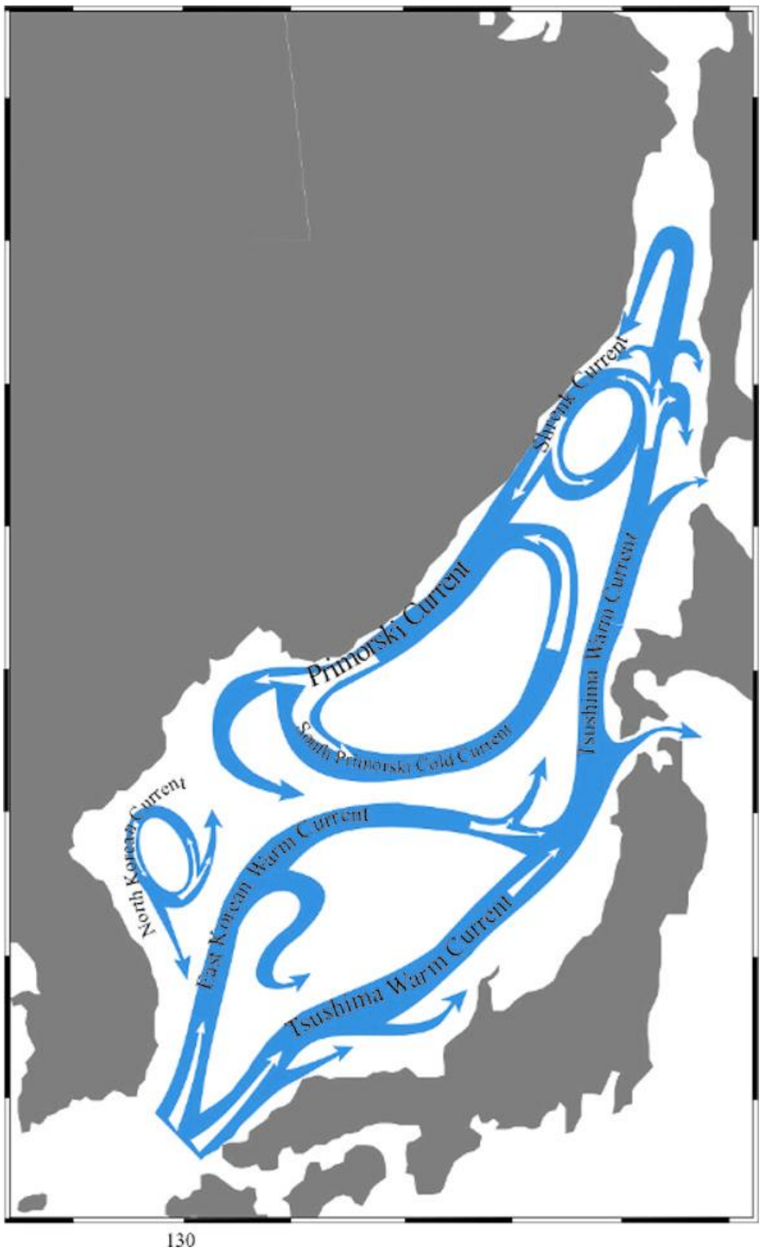

Figure I.4. The scheme of general currents within sea area of north NOWPAP region.

II. DATA AND INFORMATION USED

In order to prepare the present report, data and publications issued by relevant organizations were utilized.

1. Situation of HAB Occurrence

Two types of HAB are known in Russian coastal waters. The first type is "red tide", in which the water is discolored by high algal biomass. The second type is blooming of toxin-producing phytoplankton. This chapter introduces situation on Red tide occurrence in Russian part of NOWPAP region based on the table III.1 recommended by guideline. The data on Situation of Red tide in Russian NOWPAP area is originated from publications of the Institute of Marine Biology of Far Eastern Branch of Russian Academy of Sciences (IMB FEB RAS).

2. Monitoring

This chapter introduces results of monitoring on potentially toxic species, which observed in Russian part of NOWPAP region. It there is no governmental organization responsible for Toxin-producing Plankton Monitoring and Monitoring on Shellfish Poisoning Fishery Products in Russia. As results there are no official data on toxin-producing plankton and toxicity of seafood in Russian NOWPAP region. In this report we presented data on potentially toxic species, which observed in Russian NOWPAP region and known to be toxic in other NOWPAP countries. The data on toxin-producing plankton in Russian NOWPAP area are originated from publications of the Institute of Marine Biology of Far Eastern Branch of Russian Academy of Sciences (IMB FEB RAS).

3. Progress of Researches and Studies to Cope with HABs

Present research and studies about HAB in Russian part of NOWPAP area are introduced in this chapter. Publications of Institute of Marine Biology of the Far East Branch of Russian Academy of Sciences on the current progress of HAB studies were collected for recognizing the directions of researches and studies of HAB in Russian marine waters in the future.

4. Literature Including Newly Obtained Information

Information of literatures about HAB was obtained by using HAB Reference Database which has been constructed by CEARAC/WG3. Section indexes conform to the categories in HAB Reference Database. Literatures including newly obtained information are presented.

5. Training Activities to Cope with HABs

This section describes the international training courses attended by Russian scientists in 1995-2003.

6. National Priority to Cope with HAB

Interviews with researchers and scientists of the relevant field were conducted to collect their ideas on necessary efforts to cope with HABs. The Federal Legislative Act (SanPIN 2.3.4.050-96) concerning of food quality was used for the identification of national priorities.

7. Suggested Activity for the NOWPAP Region

Interviews with researchers and scientists of the relevant field were conducted to collect their ideas on necessary efforts to promote the solution of HAB problems.

III. RESULTS

1. Situation of HAB Occurrence

This chapter introduces situation of HAB in Russian NOWPAP region. Two types of HAB are known in Russian coastal waters. The first type is "red tide", in which the water is discolored by high algal biomass. The second type is blooming of toxin-producing phytoplankton.

1.1 Red Tide

Bloom-forming species may produce basically harmless red tide events; however, under exceptional conditions in sheltered bays, blooms can grow so dens that they cause indiscriminate kills of fish and invertebrates due to oxygen depletion.

1.1.1. Type of HAB

In Russia, red tide refers to phenomena in which the coloring of sea water is observed due to the proliferation of plankton algae (so-called "algal blooms", up to millions of cells per liter).

A total of 23 red tide events were observed during 1992–2002 in Russian NOWPAP area coastal waters. All 23 red tide events were harmless. No any cases of human poisoning or mass mortality of fish and shellfish were recorded (Data on Situation of HAB Occurrence in Russian NOWPAP area in 1992-2002 is presented in Table III.1).

1.1.2. Causative Species

A total of 12 species caused red tides in Russian coastal area during 1992 to 2002. Those species are belonging to 4 taxonomic groups of phytoplankton: dinoflagellates, diatoms, raphidophytes and euglenophytes.

Twelve species that caused red tide events were listed in Table III.2. Diatoms and dinoflagellates are the most common bloom-forming algae in

Russian coastal waters. Dinoflagellates caused 10 red-tide events. *Noctiluca scintillans* has caused most of the visible red tides recorded in Russian NOWPAP area. *Prorocentrum minimum* has brought red tide events twice during the period of observations. *Oxyrrhis marina* caused water discoloration only once during 1992-2002 in this area. 7 events were caused by diatoms. Electron microscopy revealed the presence of four species of *Pseudo-nitzschia*, which caused 3 events of water discoloration: *Pseudo-nitzschia pungens, P. multiseries, P. pseudodelicatissiam* and *P. calliantha. Skeletonema costatum* has caused 3 red-tide events. *Ditylum brightwellii* brought water discoloration event only once during 1992-2002 in this area. Raphidophytes caused 4 red-tide events: those algae were *Heterosigma akashiwo* and *Chattonella globosa*. Two cases of water discoloration were caused by euglenophytes: *Eutreptiella gymnastica* and *Eutreptia lanowii*.

Table III.2. Species caused red tide events in Russian waters

Species name	Red tide events in 1992-2002
Pseudo-nitzschia pungens/multiseries	2
Pseudo-nitzschia calliantha/pseudodelicatissima	1
Skeletonema costatum	3
Ditylum brightwellii	1
Noctiluca scintillans	7
Prorocentrum micans	2
Oxyrrhis marina	1
Heterosigma akashiwo	3
Chattonella globosa	1
Eutreptiella gymnastica	1
Eutreptia lanowii	1

1.1.3. Cell Density

The maximum cell density was observed in 1992-2002 was 30 900 000 cells/l of *Eutreptiella gymnastica* in April 2001 in Primorye coastal area. The usual number of maximum cell density in the red tide events in this area remains at the level of several million cells/l (Table III.1).

1.1.4. Location

Registrations of red tide events in Russia in 1992-2002 were conducted by: Laboratory of the Ecology of Shelf Communities of Institute of Marine Biology of the Far Eastern Branch of Russian Academy of Sciences. Only this laboratory is reported to carry out red tide observations in Russian NOWPAP area. Laboratory of the Ecology of Shelf Communities IMB FEB RAS carries out the HABs observations both in the coastal waters of Primorye in the western part of Russian NOWPAP and in the coastal waters of South Sakhalin Island, which is the eastern part of Russian NOWPAP area. Study areas are small and limited to enclosed bays. Red tides events were registered sporadically. Data is reported in this chapter based on different schemes of sampling. It is, therefore, impossible to draw a map on annually and monthly basis. The area that experienced red tide events in 1992-2002 shows on Figure III.1. This reveals that the red tide events were registered only in the western part of Russian NOWPAP area.

The occurrence of red tide in coastal waters of Primorye in the western part of Russian NOWPAP region is presented in Table III.1 and Figure III.1. This reference material is summarized from publications and annually working reports on HABs by Laboratory of the Ecology of Shelf Communities of IMB FEB RAS. According these data 23 red tide events were registered in the western part of Russian NOWPAP region. Red tides events were observed sporadically from April to September and peaks of red tides were in July, August and September. Flagellates are dominated as species that caused red-tide in the western part of Russian NOWPAP area in 1992-2002.

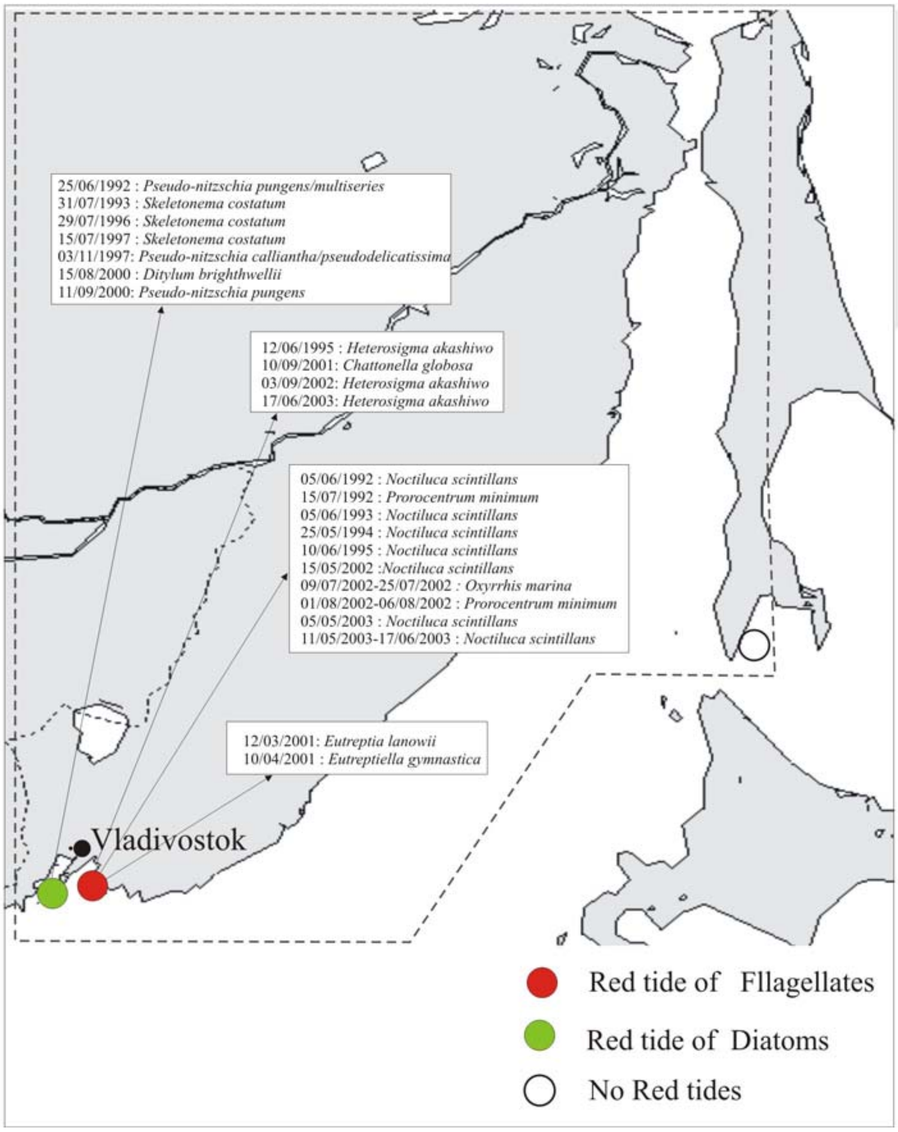

Figure III. 1. Occurrence of red tide in Russian NOWPAP area during 1992-2002.

1.1.5. Approximate suffered Area

The area that red tides observed varies extremely depending on oceanographic, meteorological, and biological conditions. The red tides that exceed the area of 1 km^2 rarely occur in the Russian NOWPAP Region. Only red-tides caused by *Noctiluca scintillans* spread areas that exceeded dozens of kilometers square (Table III.1).

1.1.6. Duration

(1) Continuous days of red tide event.

Red tide events tend to last around one week. Only red tide events caused by *Noctiluca scintillans* and *Oxyrrhis marina* lasted more than 20 days (Table III.1).

(2) Seasonal characteristics of red tide occurrence.

Red tide events were observed from March to September in Russian NOWPAP area in 1992-2002. The main months of red tide events are July, August and September in the investigated area. Red tides, caused by *Noctiluca scintillans* were registered in May-June. Euglenophytes *Eutreptiella gymnastica* and *Eutreptia lanowii* caused water discoloration in March-April (Table III.1).

1.1.7. Mitigation activity and effectiveness

There are no any data on mitigation activity and effectiveness in Russian NOWPAP area.

1.1.8. Damage

There are no any data on damage in Russian NOWPAP area.

2. Monitoring

This chapter introduces situation on potentially toxic species, which observed in Russian NOWPAP region and known to be toxic in other NOWPAP countries. Some microalgae have ability to produce potent toxins that can find their way through the food chain to humans, causing a variety of gastrointestinal and neurological illnesses, such as Paralytic Shellfish Poisoning (PSP), Diarrheic Shellfish poisoning (DSP) and Domoic Acid Poisoning (DAP). Data on occurrence and maximum density of species which are known as producers of toxin are summarized separately for DAP, DSP and PSP (Table III.3; Figures III.2-III.4). Results on toxin analysis of cultures of some species are also presented.

2.1. Regular monitoring on HAB

In Russia, the regular monitoring on HAB has been conducted by two laboratories: Laboratory of the Ecology of Shelf Communities of Institute of Marine Biology (FEB RAS) and Laboratory of Hydrobiology of SakhNIRO. Laboratory of the Ecology of Shelf Communities IMB FEB RAS carries out the observations on potentially toxic species since 1992. Laboratory of Hydrobiology SakhNIRO started toxin-producing plankton observations in the coastal waters of Sakhalin Island since 2003 year.

2.1.1. Methodology

Quantification of potentially toxic species is one of the basic routines in HABs monitoring. The samples were collected one to three times a month and weekly for summer, daily – during development of HABs. One-liter bathometric samples were collected at different depths with intervals between sampling 2-5-m. Plankton net with mesh size 20 mkm was used only for qualitative analysis. Samples were fixed immediately after the collection by

Acid Lugol's. Compound microscope was used for nanoplankton (2.0-20 mkm) Nojotta type Cell (0.05 mL) 300-400 X; for microplankton (> 20.0 mkm) – Sedgewick Rafter Cell (1 mL) 100 X. Biovolume calculated from measurements of linear dimensions cells using appropriate geometric formulae. Standard form used for storage of HABs monitoring data. This form include: sampling site, sampling depth, data, volume of sample, counting cell type, ID of the responsible person. The form stored in paper file for the calculated concentrations and biomasses. After calculation the file stored in electronic form – in Excel.

2.1.2. Causative Species

Data on potentially toxic species, which are known as causative organisms for Paralytic Shellfish Poisoning (PSP), Diarrheic Shellfish poisoning (DSP) and Domoic Acid Poisoning (DAP) are presented for 1992-2002 (Table III.3). According these data 11 species, which are know to be toxic were observed in Russian NOWPAP area. Potentially toxic species are belonging to 2 groups of phytoplankton: dinoflagellates and diatoms. Diatoms of the genus *Pseudo-nitzschia* are known as domoic producing species. Accumulating in the tissues of filter-feeding mollusks, this acid is transferred via the food chain and, when passed to humans, may cause serious neurological disorders. According to the symptoms, these cases were classified as Amnesic Shellfish Poisoning (ASP) or Domoic Acid Poisoning (DAP). Four species *Pseudo-nitzschia pungens, P. multiseries, P. pseudodelicatissima* and *P. calliantha* were monitored in Russian NOWEPAP area.

Species of the genus *Dinophysis* are capable of producing ocadaic acid, which accumulates in the tissues of filter-feeding mollusks, causing the syndrome of diarrhetic shellfish poisoning (DSP). Four species, which are known as DSP producing species, were observed in RUSSIAN NOWPAP area in 1992-2002. These species are *Dinophysis acuminata, D. acuta*, *D. fortii* and *D. rotundata* (Table III.3).

Species of the genus *Alexandrium* may cause the paralytic shellfish poisoning (PSP). PSP is most harmful because of its acuteness of symptoms and high fatality cases. Three species of the genus *Alexandriu*: *A. tamarense, A. acatenella* and *A. pseudogonyaulax,* which are known as PSP-producing species, were observed in Russian NOWPAP area in 1992-2002 (Table III.3).

2.1.3. Cell Density

Cell density of potentially toxic plankton has been recorded, while the toxicity of shellfish is not being monitored. Cell density of potentially toxic plankton varied from 200 to 35 000 000 cells/l. Potentially toxic species of the genus *Pseudo-nitzschia* were most abundant species in the study area. It is known that only broad categories of *Pseudo-nitzschia* containing several species can be identified using LM. In present work by the cell concentration of species is meant the total numbers of *P. multiseries* and *P. pungens* (*Pseudo-nitzschia multiseries/pungens*), as well as *P. calliantha* and *P. pseudodelicatissima* (*Pseudo-nitzschia calliantha/pseudodelicatissima*). Density of *Pseudo-nitzschia* varied from 2 044 to 35 000 000 cells/l. Species

The density of DSP producing species varied from 30 to 11 000 cells/l. The density of PSP producing species was 30-40 000 cells/l (Table III.3).

A. tamarense was the most common species in Russian NOWPAP area (Figure III.3). Density of *A. tamarense* varied from 300 to 51360 cells/l in Russian NOWPAP area in 1992-2002. Density of *A. acatenella* varied from 1376 to 5200 cells/l. Highest density of *A. pseudogonyaulax* was 5 600 cells/l.

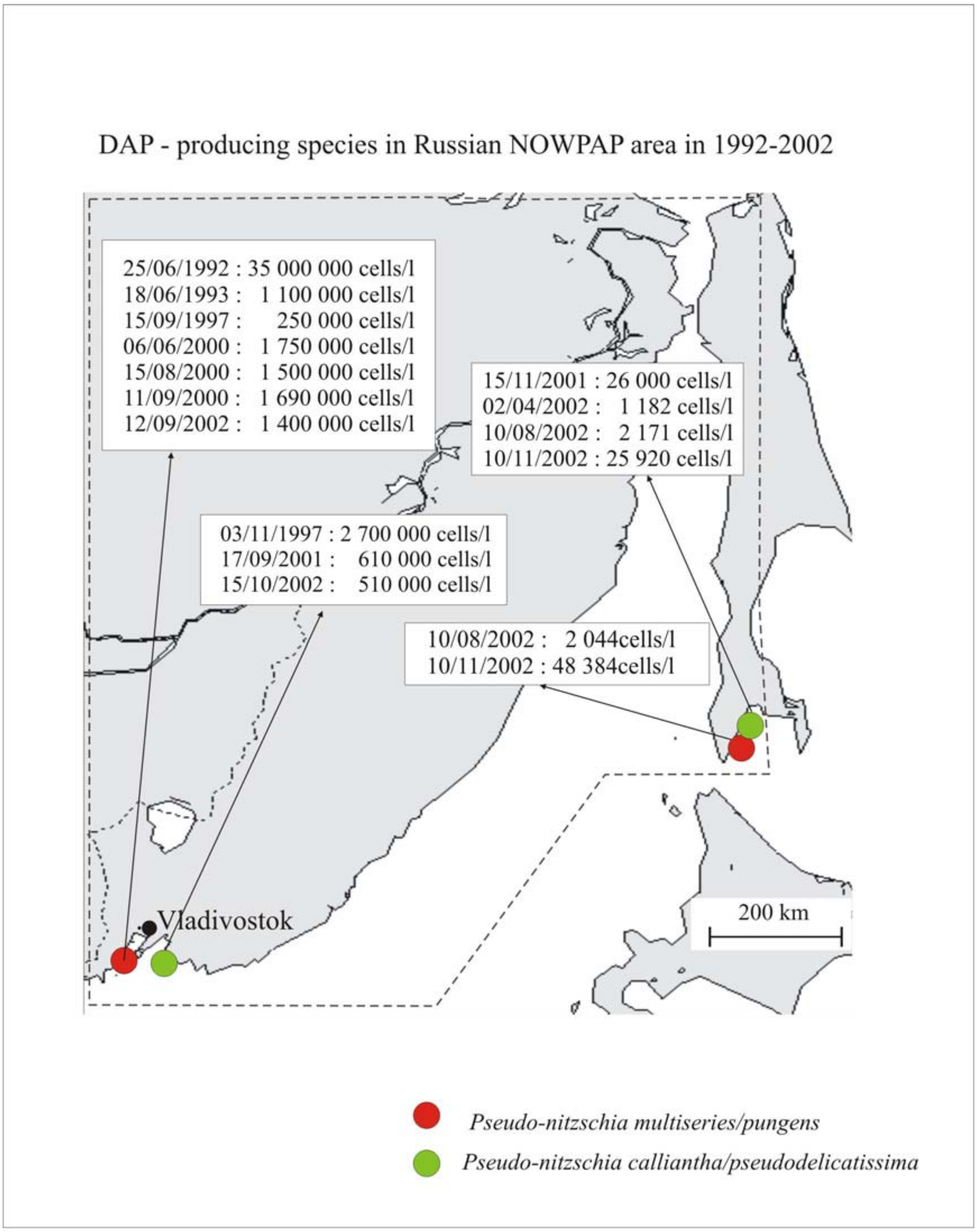

Figure III.2. Date on occurrence and maximum density of potentially toxic *Pseudo-nitzschia* species in Russian NOWPAP area in 1992-2002.

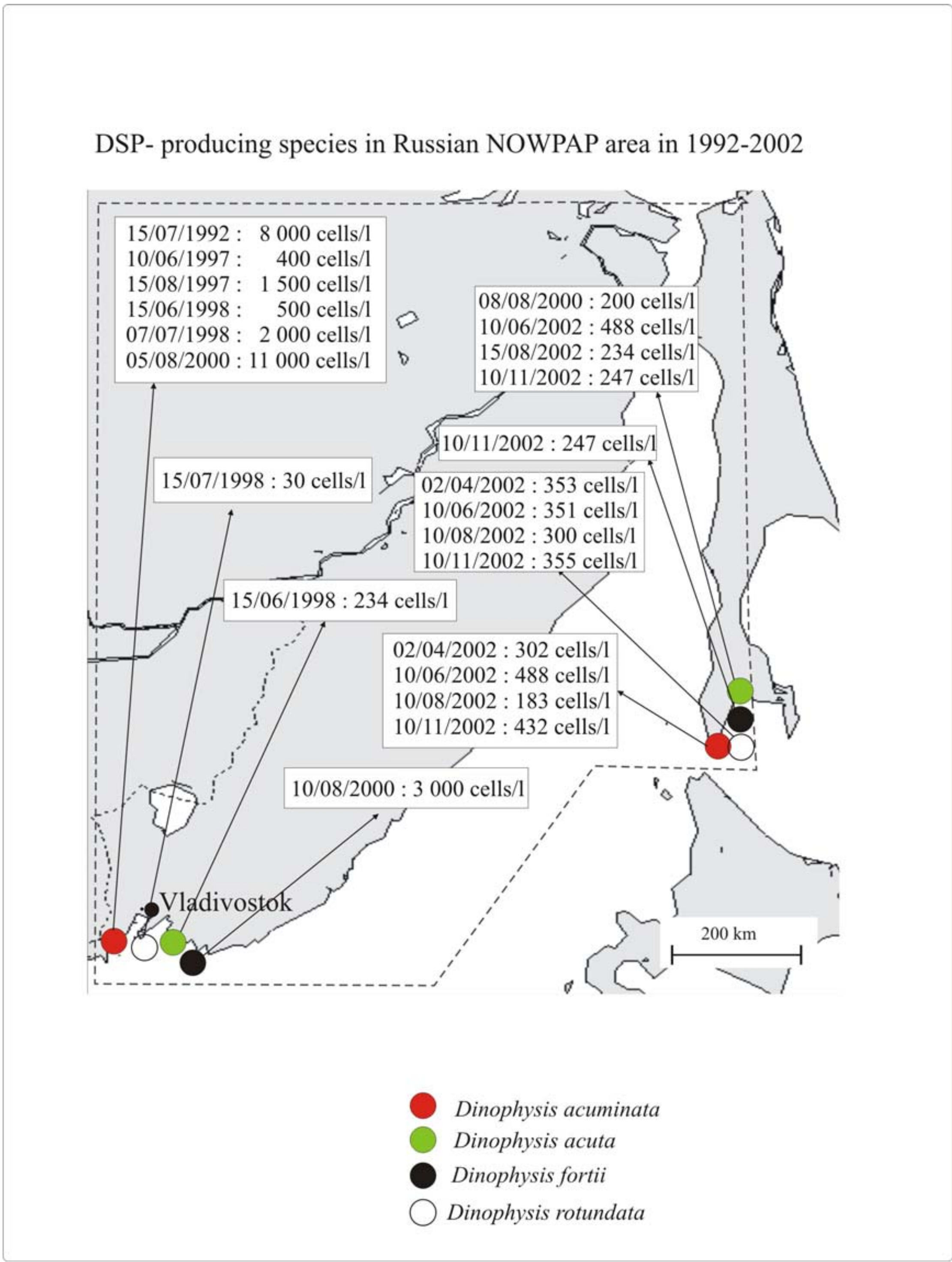

Figure III.3. Date on occurrence and maximum density of potentially toxic *Dinophysis* species in Russian NOWPAP area in 1992-2002.

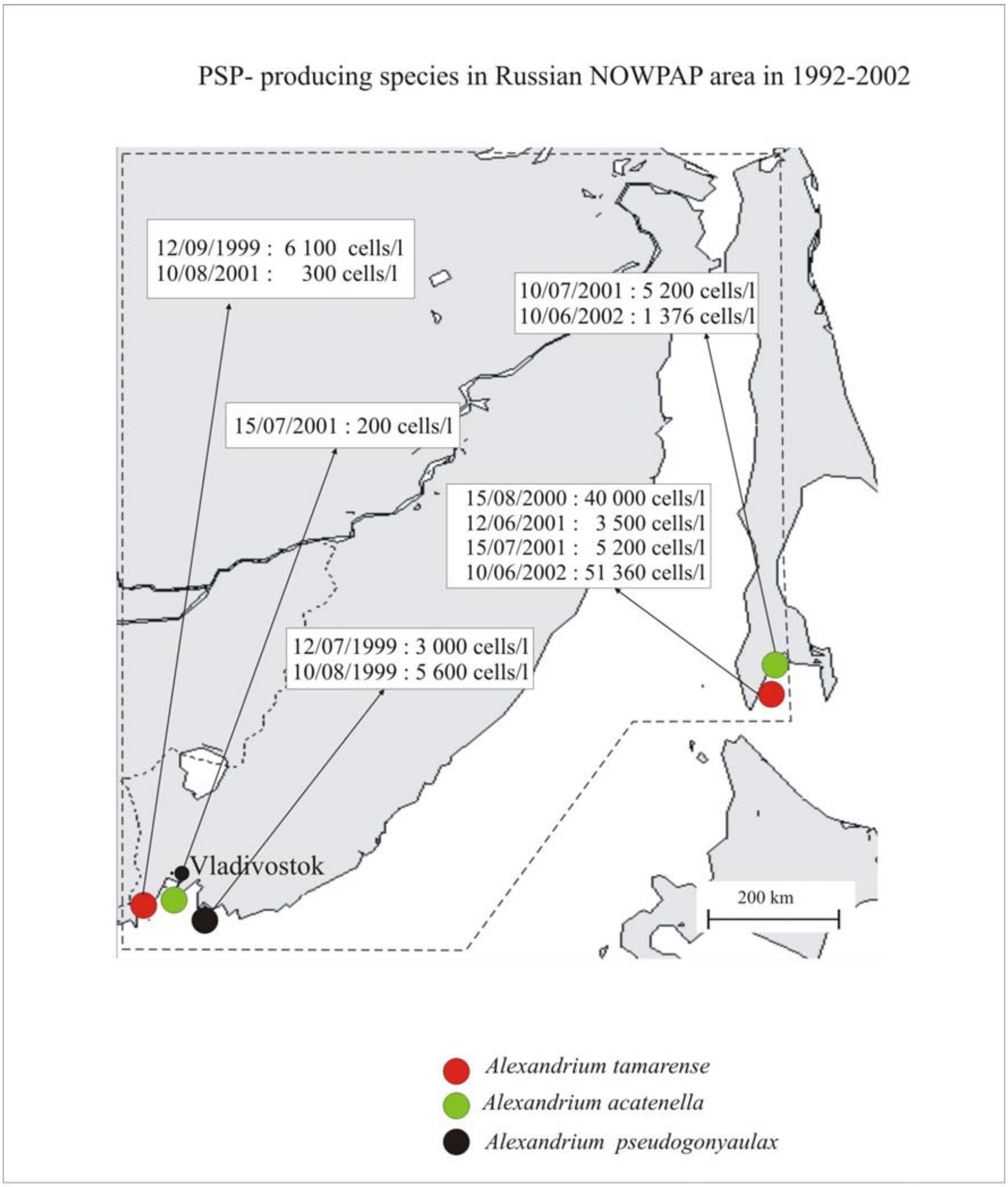

Figure III.4. Date on occurrence and maximum density of potentially toxic *Alexandrium* species in Russian NOWPAP area in 1992-2002.

2.1.4. Location

Location of potentially toxic species in Russian NOWPAP area is summarized separately for DAP, DSP and PSP (Table III.3, Figures III.2-III.4). Results reveal that potentially toxic species were observed in all study areas.

(DAP). Diatoms of the genus *Pseudo-nitzschia* are known as domoic acid producing species. *Pseudo-nitzschia* species were common in Russian NOWPAP area (Table III.3; Figure III.2). Density of *Pseudo-nitzschia multiseries/pungens* group varied from 250000 up to 35000000 cells/l in the western part of Russian NOWPAP area in 1992-2002. Maximum concentration (2700000 cells/l) of *Pseudo-nitzschia calliantha/pseudodelicatissima* group was found in the western part of Russian NOWPAP area in 1997. Highest density (48384 cells/l) of potentially toxic *P. multiseries/pungens* group was observed in the eastern part of Russian NOWPAP in 2002. *P. calliantha/pseudodelicatissima* group was observed in the coastal waters of South Sakhalin Island at highest density of 26000 cells/l.

(DSP). Dinoflagellates of *Dinophysis* are known as ocadaic acid producing species, which causing the syndrome of diarrhetic shellfish poisoning (DSP). Four species *D. acuminata, D. acuta*, *D. fortii* and *D. rotundata* were observed in Russian NOWPAP area in 1992-2002 (Table III.3; Figure III.3). *D. acuminate* was the most common species in Russian NOWPAP area. Density of *D. acuminata* varied from 400 to 11000 cells/l in 1992-2002. Maximum concentration of this species was registered in the coastal waters of Primorye in 2000. Density of this species in the eastern part of Russian NOWPAP area varied from 183-488 cells/l in 1992-2002. Maximum concentration (3000 cells/l) of *D. fortii* was observed in the western part of Russian NOWPAP area in 2000. Density of potentially toxic *D. acuta* in Russian NOWPAP area varied from 183 to 432 cells/l. Minimum concentration of *D. rotundata* (30 cells/l) was registered in the eastern part of Russian NOWPAP area.

PSP. Dinoflagellate of the genus *Alexandrium* may cause the paralytic shellfish poisoning. Three potentially toxic species of the genus *Alexandrium*: *A. tamarense, A. acatenella* and *A. pseudogonyaulax* were observed in Russian NOWPAP area in 1992-2002 (Table III.3, Figure III.4). *A. tamarense* was the most common species in Russian NOWPAP area (Figure III.3). Density of *A. tamarense* varied from 300 to 51360 cells/l in Russian NOWPAP area in 1992-2002. Maximum concentration of this species was observed in the eastern part of Russian NOWPAP area in 2002. Potentially toxic species *A. acatenella* was more abundant in the study area and concentration of this species varied from 1376 to 5200 cells/l. *A. pseudogonyaulax* was observed only in the western part of the Russian NOWPAP area. Highest density of this species was 5 600 cells/l.

2.1.5. Approximate suffered Area

Suffered area is unknown.

2.1.6. Mitigation activity and effectiveness

There are no any data on mitigation activity and effectiveness in Russian NOWPAP area.

2.1.7. Damage

There are no any data on damage in Russian NOWPAP area.

2.1.8. Toxicity

It there is no governmental organization responsible for Toxin-producing Plankton Monitoring and Monitoring on Shellfish Poisoning Fishery Products in Russia. Data on toxin analysis of cultures of some species, established from cysts and plankton from the Russian coastal are presented (Figure III.5, Table III.4, III.5).

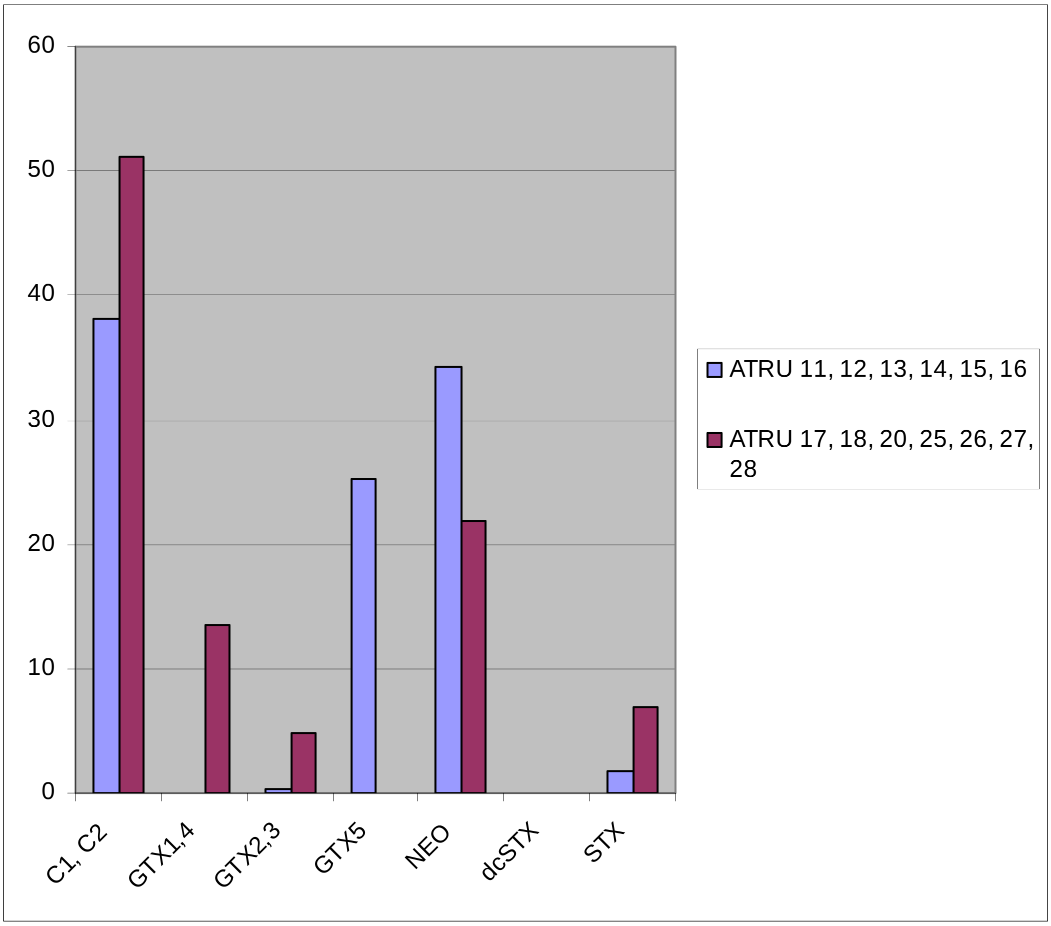

Figure III.5. Toxicity of clones of *Alexandrium tamarense* isolated from coastal waters of Russian part of NOWPAP region.

Thirteen clones were established from elongated *Alexandrium* sp. cysts collected in the coastal waters of Primorye and in Aniva Bay in the coastal waters of Sakhalin Island. All isolates were identified as *Alexandrium tamarense* via detailed microscopy of thecal plates. A series of thirteen clones was by HPLC toxin analyses showed that all isolates are toxic and demonstrated variability in toxin content and composition among different populations of *A. tamarense.* These data document the significant risk of shellfish contamination with PSP toxins from blooms of *A. tamarense* in Russian marine waters.

Laboratory cultures of *P. multiseries* and *P. calliantha* were isolated from the coastal waters of Primorye (the Sea of Japan) and analyzed for domoic acid content (Table III.4). Domoic acid was found in 20 day-old culture of *P. multiseries* at a level of 183.2 ng/ml. No domoic acid was detected in culture of *P. calliantha*. No events of poisoning and mass mortality of sea birds and mammals due to the presence of toxic species have been reported.

Table III.4. Domoic acid (DA) content in cultures of *Pseudo-nitzschia* isolated from coastal waters of Russian part of NOWPAP region.

Species	Place of isolation Latitude/ longitude	Culture code	Isolation date	Isolation location	Toxin test	DA (ng/ml)
Pseudo-nitzschia multiseries	43.15 N / 131.90 2E	PM02	1.11.2002	Amursky Bay	+	183,2
Pseudo-nitzschia calliantha	43.15 N / 131.90 2E	PPD02	21.11.2002	Ussurisky Bay	+	< 1

Table III.5. Toxicity of clones of *Alexandrium tamarense* isolated from coastal waters of Russian part of NOWPAP region.

Clone code	Isolation location	Latitude, N	Longitude, E	Isolation data	PSP Toxicity
ATRU11	Amurskii Bay	43.15	131.90	12/08/2000	+
ATRU12	Amurskii Bay	43.15	131.90	15/08/2000	+
ATRU13	Amurskii Bay	43.15	131.90	12/06/2001	+
ATRU14	Amurskii Bay	43.15	131.90	15/07/2001	+
ATRU15	Amurskii Bay	43.15	131.90	10/08/2001	+
ATRU16	Amurskii Bay	43.15	131.90	10/06/2002	+
ATRU17	Aniva Bay	46.320	142.260	12/08/2001	+
ATRU18	Aniva Bay	46.320	142.260	17/06/2001	+
ATRU20	Aniva Bay	46.320	142.260	12/08/2001	+
ATRU24	Aniva Bay	46.320	142.260	17/06/2001	+
ATRU25	Aniva Bay	46.320	142.260	12/08/2001	+
ATRU26	Aniva Bay	46.320	142.260	17/06/2001	+
ATRU28	Aniva Bay	46.320	142.260	17/06/2001	+

3. Progress of Researches and Studies to Cope with HAB

Institute of Marine Biology shows some issues, as cited below, to be studied in future to cope with HAB in Russian coastal marine waters.

3.1. Analysis of Causative Species

Molecular biological approach is being developed to distinguish the population of toxic plankton. Molecular biology may clarify whether the occurrence is due to anthropogenic (ballast waters) transportation or natural process. Twenty-six strains of *Alexandrium. tamarense* were established from cysts collected along the east coast of Russia. A genetic comparison was performed among the different strains using RFLP analysis of large subunit ribosomal DNA. Three subpopulations were identified that correspond to the Japanese Temperate Asian and both Eastern and Western North American ribotypes. The genetic relationship between these strains of *Alexandrium* and those from other geographically distant regions was discussed.

Using improved methods of investigation such as electron microscopy, epifluorescence, laboratory cultures and others methods, harmful algae previously unknown in Russian waters were observed. These species belong to different taxonomic groups of microalgae: dinoflagellates, diatom, prasinophytes, raphidophytes and euglenophytes.

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・ Orlova, T. Yu., Selina, M.S., Lilly, E.L., Kulis, D.M. and Anderson, D.M. (2002). Morphogenetic and toxin composition intraspecific variability of *Alexandrium tamarense* from the Russian East coast. Abstract 10th Inter. Conference on Harmful algae, Florida, USA, 21-25 October, 2002, p. 220.

・ Orlova, T.Y., Zhukova, N.V. and Stonik, I.V. (1996). Bloom-forming diatom *Pseudo-nitzschia pungens* in Amurskii Bay (the Sea of Japan):

Morphology, ecology and biochemistry. In "Harmful and Toxic Algal Blooms (eds by T. Yasumoto, Y. Oshima and Y. Fukuyo)", IOC of UNESCO, 147-150.

- Selina, M.S. (1993a) Raphidophyta of the Peter the Great Bay (the Sea of Japan). Algologia, 3(2), 60-66. (in Russian).
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3.2. Toxicity Analysis

Twenty-six strains of *Alexandrium. tamarense* were established from cysts collected along the east coast of Russia. Toxin analyses of these isolates were conducted, using post-column derivatization HPLC with fluorescence detection. Analyses showed that all isolates are toxic and demonstrated variability in toxin content and composition among different genetic populations of *A. tamarense.* Data obtained in this study indicate the potential risk of mussel contamination and intoxication during blooms of *A. tamarense* in Russian marine waters.

\- Reference List –

Orlova, T. Yu., Selina, M.S., Lilly, E.L., Kulis, D.M. and Anderson, D.M. (2002). Morphogenetic and toxin composition intraspecific variability of *Alexandrium tamarense* from the Russian East coast. Abstract 10th Inter. Conference on Harmful algae, Florida, USA, 21-25 October, 2002, p. 220.

3.3. Mechanism of HAB Occurrence

Institute of Marine Biology is studying the mechanism of red tide occurrence targeting bloom-forming and toxic species. It is essential to understand the life cycle of the target plankton species including cyst formation in order to predict the occurrence. Survey of living dinoflagellate cysts from recent sediment samples collected along the eastern coast of Russia revealed presence of cysts of the potentially toxic species. *Alexandrium tamarense* cysts were widely distributed and dominated many localities in the study area. Cyst abundance varied from 100 to 45,000 g^{-1}. These data suggest that additional cyst surveys should be conducted in areas of the eastern Russian coastline not yet investigated, and that the potential for paralytic shellfish poisoning (PSP) toxicity as a result of blooms of toxic species may be more widespread than previously documented.

The peculiarities of development in bloom-forming diatom *Chaetoceros salsugineus* from Amurskii Bay were studied in laboratory culture. It is shown that there is a resting (bottom) stage including both resting cells and spores in the life cycle of the bloom-forming diatoms.

- Reference List -

・ Orlova, T., Morozova, T.V., Gribble, K.E., Kulis D.M (2004). Dinoflagellate cysts in recent marine sediments from the east coast of Russia, Botanica Marina, (47)3, 184-201.
・ Orlova, T. Yu. and Aizdaicher, N.A. (2000). Development in Culture of the Diatom *Chaetoceros salsugineus* from the Sea of Japan. Russian Journal of Marine Biology, (26)1, 8-11.

3.4. HAB Monitoring

Qualitative and quantitative composition of phytoplankton in the scallop culture area was studied in Minonosok Bay in Primorye during the spring-autumn period of 1997 and 1999. Nine species known to be toxic were observed. Species of the genera *Pseudo-nitzschia, Alexandrium* and *Dinophysis* were more abundant and exceeded the harmful concentration during the summer. It was recommended establishing a permanent HAB monitoring in the Russian coastal waters. The primary goal of this program would be to understand the location and frequency of HAB events in order to protect the human consumers from intoxication and to prevent losses in the aquaculture industry due to harmful algal blooms.

-Reference List-

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・ Morozova, T.V. and Orlova, T.Yu. (2005). Plankton Monitoring in the Scallop Culture Area in Vostok Bay of the Sea of Japan. (in press).

4. Literature including newly obtained information

Following sections show summaries of major papers published after 2000, which are stored in HAB Reference Database.（All papers that are published after 2000 and stored in HAB Reference Database are listed in appendices.） Section indexes conform to the categories in HAB Reference Database.

4.1. Occurrence and Monitoring

The qualitative and quantitative composition of phytoplankton in the Tumen river mouth and the adjacent waters in summer-autumn 1995-1998 was studied by Orlova et al. 2001. 13 species of harmful microalgae were recorded. Potentially toxic species were most abundant in June-September. Their density ranged from 200 to 12000 cells/l. Dinoflagellate *Prorocentrum minimum* was most abundant species.

Stonik et al. (2001) described three species of the genus *Pseudo-nitzschia*, which are known as potentially toxic species, were found in coastal waters of Primorye. These species are: *P. pungens*, *P. multiseries*, and *P. pseudodelicatissima*. A bloom of *P. pungens/P. multiseries* was observed in June, 1992 in Amurskii Bay. The maximum population density (11 million cells/l) was found at the surface layer after heavy rains. Short-term bloom of *P. pseudodelicatissima* (2,7 million cells/l) was observed in November, 1997 in Amurskii Bay. Possible reasons for the blooms of *Pseudo-nitzschia* species in Peter the Great Bay were discussed.

Orlova et al. (2002) reviewed the available data pertaining to harmful algae on the coasts of the Russia Far East. The information reviewed here indicates that, in the last two decades, there has been an apparent increase in the frequency, intensity and distribution of harmful algal blooms in the Russian coastal waters. a complex of factors favorable for the outbreaks of harmful algae exists in those areas. The major factors are high levels of mineral and dissolved organic substances, as well as the vertical stability of the water layers, associated with the substantial freshening and warming-up of the surface waters during the summer period.

Morozova et al., (2002) studied the qualitative and quantitative composition of phytoplankton in the scallop culture area in Minonosok Bay in Primorye during the spring-autumn period of 1997 and 1999. Nine species known to be toxic were observed. Species of the genera *Pseudo-nitzschia, Alexandrium* and *Dinophysis* were more abundant and exceeded the harmful concentration during the summer.

Orlova et al., (2004) published results of long-term studies of the species structure of microalgae plankton of the coast of the Sea of Okhotsk of Sakhalin Island. There were 227 species and 4 intraspecific taxa attributed to 8 divisions. The greatest number of species was represented by the divisions Bacillariophyta (112 species and 3 intraspecific taxa) and Dinophyta (96 and 1 respectively). Distribution of potentially toxic species *Pseudo-nitzschia*, *Dinophysis* and *Alexandrium* is presented.

A bloom of water caused by the dinoflagellate *Oxyrrhis marina* was recorded for the first time (Begun et al. 2004). The highest density of this species in the bloom area was 443.3 million cells/liter. The abundant development of microalga occurred in July and September 2002 at a water temperature of 17-24.5^{0}C and salinity 7-18 $^0/_{00}$. The maximum density of was found in blooms area near the water surface. Changes in the density of *O. marina* and other phytoplankton species during the bloom period are analyzed. Possible reasons for "blooms" of *O. marina* in Amursky Bay are discussed.

- Reference List –

・ Stonik, I.V., Orlova, T.Yu. and Schevchenko, O.G. (2001). Morphology and ecology species of genus *Pseudo-nitzschia* (Bacillariophyta) from Peter the Great Bay, Sea of Japan. Russian Journal of Marine Biology, 27(6), 416-420.

・ Orlova, T.Y., Selina, M.S. and Stonik, I.V. (2001). Phytoplankton of the Tumen River mouth and the adjacent waters of Peter The Great Bay. In: "The State of Environment and Biota of the SouthWestern part of Peter the Great Bay and Tumen River mouth (ed. by B.L. Kasyanov)", Vladivostok, Dalnauka, 1, 125-142.

・ Morozova, T.V., Orlova, T.Yu. and Selina, M.S. (2002). Phytoplan kton in the Scallop Culture Area in Minonosok Bight (Pos'eta Bay, Sea of Japan). Russian Journal of Marine Biology, 28(2), 94-99.

・ Orlova, T.Yu., Konovalova, G.V., Stonik, I.V., Selina, M.S., Morozova, T.V. and Shevchenko, O.G. (2002). Harmful algal blooms on the eastern coast of Russia, in "Harmful Algal blooms in the PICES Region of the North Pacific (eds by F.J.R."Max" Taylor and V.L. Trainer)", PICES Scientific Report, No.23, North Pacific Marine Science Organization, 47-73.

- Orlova, T.Yu., Selina, M.S. and Stonik, I.V. (2004). Species Structure of Plankton Microalgae on the Coast of the Sea of Okhotsk on Sakhalin Island Russian Journal of Marine Biology, 30(2), 77-86.
- Begun, A.A., Orlova, T.Yu. and Selina, M.S. (2004). A "bloom" of water in Amursky Bay (Sea of Japan) caused by the dinoflagellate *Oxyrrhis marina*. Russian Journal of Marine Biology, 30(1), 68-71.

4.2. Mechanism and Environment

Orlova et al., (2004), studied the dinoflagellate cysts from recent sediment samples collected along the eastern coast of Russia. Cysts of the potentially toxic species *Alexandrium* cf. *minutum*, *A. tamarense* and *Gymnodinium* cf. *catenatum* were found in this survey. Ellipsoidal *Alexandrium tamarense* type cysts were widely distributed and dominated many localities in the study area. These data suggest that additional cyst surveys should be conducted in areas of the eastern Russian coastline not yet investigated, and that the potential for paralytic shellfish poisoning (PSP) toxicity as a result of blooms of toxic species may be more widespread than previously documented.

The germination of dinoflagellate cysts isolated from the surface sediment from Primorye (the Sea of Japan) provided motile cells of *Gyrodinium instriatum* (Orlova et al., 2003). This is the first report on this species for the seas of Russia. The morphology of both collected and germinated cysts and motile cells is described, and data on the ecology and distribution of this are provided.

- Reference List –

- Orlova, T., Morozova, T.V., Gribble, K.E., Kulis D.M (2004). Dinoflagellate cysts in recent marine sediments from the east coast of Russia, Botanica Marina, (47)3, 184-201.
- Orlova, T. Yu., Selina M.S and Shevchenko O.G. (2003). The morphology of cysts and motile cells of *Gyrodinium instriatum* (Dinophyta), a species new to the Seas of Russia. Russian Journal of Marine Biology, (29)2, 120-122.

4.3. Physiology, Taxonomy

Orlova and Stonik (2001) described morphology of three potentially toxic species of the genus *Pseudo-nitzschia* using light and electron microscopy. Morphometric data and geographic distribution in the Far Eastern seas of Russia are presented for each species.

Morphological characteristics of *Alexandrium pseudogonyaulax* from the Sea of Japan and the Sea of Okhotsk was studied by Selina and Konovalova, 2001. The vegetative cells were observed from July to September to be in low concentration at water temperature 20.3-23.7 ^{o}C. The maximum concentration (6000 cells/l) was recorded in August 1999 in the coastal waters of Primorye of the Sea of Japan. This is the first record of occurrence of *A. pseudogonyaulax* in the sea of Russia.

Ponomarenko et al., (2004) determined the free sterol compositions of two marine microalgal species *Pyramimonas* cf. *cordata* (Prasinophyta), *Attheya ussurensis* sp.nov. (Bacillariohyta) by gas chromatography, gas chromatography-mass spectrometry and (for some sterol constituents) using nuclear magnetic resonance spectra. A variety of sterol profiles were found. The principal sterol in bloom-forming species *P.* cf. *cordata*, which is known as bloom-forming species in the coastal waters of Primorye, was 24(*R*)-ethylcholesta-5,22*E*-dien-3ß-ol (poriferasterol).

- Reference List -

- Orlova, T.Yu. and Stonik, I.V. (2001). The species of the genus *Pseudo-nitzschia* (Bacillariophyta) found in the Far Eastern seas of Russia. Russian Journal of Botany, 86(4), 47-52.

- Selina, M.S. and Konovalova, G.V. (2001). Morphology of *Alexandrium pseudogonyaulax* (Dinophyta) from the Far Eastern Seas of Russia. Russian Journal of Botany, (86)10, 22-25.

- Ponomarenko L.P., Stonik I.V., Aizdaicher N.A., Orlova T.Yu., Poplavskaya G.I., Pomazkina G.V., Stonik V.A.(2004). Sterols of marine microalgae *Pyramimonas* cf. *cordata* (Prasinophyta), *Attheya ussurensis* sp. nov. (Bacillariophyta) and the Baikalian spring diatom bloom. Comparative Biochemistry and Physiology. Part B. 138, 65-70.

- Khardin, A.S. and Morozova, T.V. (2003). Appliance of the method of marker fatty acids for study the seasonal dynamics of species composition of phytoplankton in Vostok Bay, the Sea of Japan. Izvestiya TINRO, 135, 266-271.

5. Training Activity to Cope with HAB

There are no any governmental organizations that have training activity to cope with HAB on Federal or local basis in Russia. This section describes the international training courses attended by Russian scientists in 1995-2003 (Table III.4). Russian scientists have participated in 14 training courses, which were organized by IOC, IOC/DANIDA, IOC/WESTRAC, Overseas Fishery Cooperation foundation with the support of the Government of Japan, Ministry of Science and Technology (MOST) of the People's Republic of China, European Graduate College in Marine Sciences (ECOLMAS) and others. Objectives of the training course were improvement of the participant skills in taxonomy, biology and chemistry of harmful microalgae in order to enable them to detect their occurrence and mitigate their harmful effects. The training activity included lectures, laboratory and field practice and focused on improving related human resources as well as technology and knowledge transfer in order to develop capability in WESTPAC countries for management of HAB events. The obtained experience was used in designing and conducting laboratory study and field research on harmful microalgae. No Russian trainer, however, has participated in the international training programs. The training program planed by IOC–WESTPAC could be the first case to involve Russian scientists as trainers on identification of harmful algae.

6. National Priority to Cope with HAB

The Federal Legislative Act (SanPIN 2.3.4.050-96) concerning of food quality from the point of view shellfish toxicity has been published in 1996. This Act called "The production of fisheries and shellfish products, sanitary regulations and requirement" and describes maximal permissible concentration of saxitoxin (PSP) as 80 ug/100 g wet mollusk tissue, and analytical absence of domoic acid (DSP). Moreover system of plankton monitoring should be implement in the aquaculture and/or catching areas for the control of possible occurrence of toxin microalgae and their density. Control of toxicity must be conducted once per month during winter/spring period and twice per month during summer/fall time. Implementation of administrative measures and structures providing fulfillment of this legislative basis is a first national priority for the time being in the field to cope with shellfish poisoning and toxicity.

Present level of aquaculture production in Russian Far East is not so advanced as in the other NOWPAP countries, and practical damage from HAB events is not significant so far. Therefore, research activity continues to be in the center of national priorities in HAB problem in Russia.

Cysts analysis is one of the promising research area because sampling and pretreatment procedure for cysts analysis don't require so high skilled specialists as plankton research. This circumstance enhances possibility to get samples from the different regions that is especially important for the very spacious and rather unpopulated Russian sector of NOWPAP area. Another advantage of cysts analysis is a potential to forecast risk of HAB events and to create the integrated scheme of HABs risk along broad areas.

Arrangement of toxin analysis in the algae cultures and shellfish continue to be a among main national priorities, though some progress had been made

7. Suggested Activity for the NOWPAP Region

The Government of Russian Federation supports the activities of international organizations related to the problem of HAB. The Action Plan for the Protection, Management and Development of the Marine and Coastal Environment of the Northwest Pacific Region (NOWPAP) and Intergovernmental Oceanographic Commission (IOC) have special activities or programs concerning HAB problems. North Pacific Marine Science Organization (PICES) also has working group concerning about different HAB issues in the different regions of North Pacific.

NOWPAP is one of the Regional Seas Programme of the United Nations Environment Programme (UNEP). NOWPAP established The Special Monitoring & Coastal Environmental Assessment Regional Activity Centre (CEARAC) in 1999 in Toyama, Japan. CEARAC set the first target for coastal environmental assessment on HAB.

The IOC subcommittee for the Western Pacific (IOC/WESPAC) has Harmful Algal Blooms Program. The program aims at providing capacity building and producing documents related to HAB IOC/WESTPAC also conducts NEAR GOOS program, a regional program of the Global Ocean Observing System (GOOS) implemented by China, Japan, Koran, and Russia.

PICES Working Group "MEQ Section on HABs and their impacts" was created to facilitate studies in HABs in the north Pacific, to assess the scale and magnitude of these problems, to identify the various species involved and the timing, frequency and duration of bloom events, to seek links between bloom events and oceanographic (physical, chemical and biological) factors and possible anthropogenic stress (e.g. eutrophication).

The Government of Russian Federation expects NEAR GOOS program and PICES activity as well to help study HAB in the NOWPAP region in future.

The successful bilateral cooperation program is implemented between Sakhalin Scientific Research Institute of Fisheries & Ocenography (SakhNIRO) and Hokkaido Central Fisheries Experimental Station (HCFES) with special attention on toxic species *Alexandrium tamarense.*

The joint trainings on HAB issues conducted in PICES and IOC format were very successful and could be recommended for the continuation. The including for the schedule of future training more issues connected with arrangement and management of HAB and toxicity monitoring could be recommended and appreciated by Russian experts.

References:

Begun, A.A., Orlova, T.Yu. and Selina, M.S. (2004). A "bloom" of water in Amursky Bay (Sea of Japan) caused by the dinoflagellate *Oxyrrhis marina*. Russian Journal of Marine Biology, 30(1), 68-71.

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Orlova, T.Y., Selina, M.S. and Stonik, I.V. (2001). Phytoplankton of the T umen River mouth and the adjacent waters of Peter the Great Bay. In: "The State of Environment and Biota of the SouthWestern part of Peter the Great Bay and Tumen River mouth (ed. by B.L. K asyanov)", Vladivostok, Dalnauka, 1, 125-142.

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Orlova, T.Yu., Konovalova, G.V., Stonik, I.V., Selina, M.S., Morozova, T.V. and Shevchenko, O.G. (2002). Harmful algal blooms on the eastern coast of Russia, in "Harmful Algal blooms in the PICES Region of the North Pacific (eds by F.J.R."Max" Taylor and V.L. Trainer)", PICES Scientific Report, No.23, North Pacific Marine Science Organization, 47-73.

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Ponomarenko L.P., Stonik I.V., Aizdaicher N.A., Orlova T.Yu., Poplavskaya G.I., Pomazkina G.V., Stonik V.A.(2004). Sterols of marine microalgae *Pyramimonas* cf. *cordata* (Prasinophyta), *Attheya ussurensis* sp. nov. (Bacillariophyta) and the Baikalian spring diatom bloom. Comparative Biochemistry and Physiology. Part B. 138, 65-70.

Selina, M.S. (1993a) Raphidophyta of the Peter the Great Bay (theSea of J apan). Algologia, 3(2), 60-66. (in Russian).

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Stonik, I.V., Orlova, T.Yu. and Schevchenko, O.G. (2001). Morphology and ecology species of genus *Pseudo-nitzschia* (Bacillariophyta) from Peter the Great Bay, Sea of Japan. Russian Journal of Marine Biology, 27(6), 416-420.

Appendices

i: Table III.1.Situation of HAB Occurrence in Russian NOWPAP Region in 1998-2002.
ii :Table III.3. Results of Monitoring on Toxin –producing plankton in Russian NOWPAP Region in 1992-2002.
iii: Table III.4. International Training courses attended by Russian scientists in 1995-2003.
iv. List of references stored in HAB Reference Database, from period after 2000.

Table III.1. Situation of HAB Occurrence in Russian NOWPAP Region

Event No.	Location (name of the sea area)	Latitude N	Longitude E	Approximate area suffered (km^2)	Type of HAB Red tide or Toxic	Data / Duration dd/mm/yy-dd/mm/yy	Causative species	Max. cell density cells/l	Mitigation activity and effectiveness	Damage Fishery resources / Human health
1	Peter the Great Bay	43 11 7	132 16 6	<1	Red tide	15/06/1992	*Noctiluca scintillans*	450 000	no data	no data
2	Amurskii Bay	43 15 3	131 90 2	< 1	Red tid	25/06/1992	*Pseudo-nitzschia pungens/multiseries*	35 000 000	no data	no data
3	Amurskii Bay	43 15 3	131 90 2	< 1	Red tide	15/07/1992	*Prorocentrum minimum*	8 000 000	no data	no data
4	Peter the Great Bay	43 11 7	132 16 6	<1	Red tide	05/06/1993	*Noctiluca scintillans*	500 000	no data	no data
5	Amurskii Bay	43 15 3	131 90 2	< 1	Red tid	31/07/1993	*Sceletonema costatum*	17400000	no data	no data
6	Peter the Great Bay	43 11 7	132 16 6	< 1	Red tide	25/05/1994	*Noctiluca scintillans*	550 000	no data	no data
7	Peter the Great Bay	43 11 7	132 16 6	< 1	Red tide	10/06/1995	*Noctiluca scintillans*	400 000	no data	no data
8	Amurskii Bay	43 15 3	131 90 2	< 1	Red tide	12/06/1995	*Heterosigma akashiwo*	5 000 000	no data	no data
9	Amurskii Bay	43 15 3	131 90 2	< 1	Red tid	29/07/1996	*Sceletonema costatum*	12 700 000	no data	
10	Amurskii Bay	43 15 3	131 90 2	< 1	Red tide	15/07/1997	*Sceletonema costatum*	3 000 000	no data	no data

11	Amurskii Bay	43 15 3	131 90 2	< 1	Red tid	03/11/1997	*Pseudo-nitzschia calliantha/pseudodelicatissima*	2 700 000	no data	no data
12	Rynda Bay	43 2 5	131 78 7	<1	Red tide	11/09/2000	*Pseudo-nitzschia pungens*	1 690 000	no data	no data
13	Rynda Bay	43 2 5	131 78 7	<1	Red tide	15/08/2000	*Ditylum brigthwellii*	1 400 000	no data	no data
14	Golden Horn Bay	43 10 67	131 88 2	< 1	Red tide	12/03/2001	*Eutreptia lanowii*	15 600 000	no data	no data
15	Golden Horn Bay	43 10 67	131 88 2	< 1	Red tide	10/04/2001	*Eutreptiella gymnastica*	30 900 000	no data	no data
16	Golden Horn Bay	43 10 67	131 88 2	< 1	Red tide	10/09/2001	*Chattonella globosa*	6 000 000	no data	no data
17	Rynda Bay	43 2 5	131 78 7	5	Red tide	15/05/2002	*Noctiluca scintillans*	700 000	no data	no data
18	Amurskii Bay	43 15 3	131 90 2	< 1	Red tide	09/07/2002 - 25/07/2002	*Oxyrrhis marina*	20 000 000	no data	no data
19	Amurskii Bay	43 15 3	131 90 2	< 1	Red tide	01/08/2002– 06/08/2002	*Prorocentrum minimum*	11 940 000	no data	no data
20	Amurskii Bay	43 15 3	131 90 2	< 1	Red tide	03/09/2002	*Heterosigma akashiwo*	7 000 000	no data	no data
21	Vostok Bay	42 88 7	132 72 9	< 1	Red tide	05/05/2003	*Noctiluca scintillans*	970 000	no data	no data
22	Amurskii Bay	43 15 3	131 90 2	2	Red tide	11/05/2003 - 17/06/2003	*Noctiluca scintillans*	800 000	no data	no data
23	Amurskii Bay	43 15 3	131 90 2	< 1	Red tide	17/06/2003	*Heterosigma akashiwo*	25 000 000	no data	no data

Table III.3. Results of Monitoring on toxin –producing plankton in Russian NOWPAP Region in 1992-2002

Types of shellfish poisoning	Causative species	Location (name of the sea area)	Latitude, N	Longitude, E	Data / Duration dd/mm/yy-dd/mm/yy	Max. cell density cells/l	Toxicity	Damage Fishery resources / Human health
DAP	*Pseudo-nitzschia multiseries/pungens*	Amurskii Bay	43.15 3	131.90 2	25/06/1992	35 000 000	no data	no data
DAP	*Pseudo-nitzschia multiseries/pungens*	Amurskii Bay	43.15 3	131.90 2	18/06/1993	1 100 000	no data	no data
DAP	*Pseudo-nitzschia calliantha/pseudodelicatissima*	Amurskii Bay	43.15 3	131.90 2	03/11/1997	2 700 000	no data	no data
DAP	*Pseudo-nitzschia multiseries/pungens*	Minonosok Bay	42.60	130.85	15/09/1997	250 000	no data	no data
DAP	*Pseudo-nitzschia multiseries/pungens*	Rynda Bay	43.2 5	131.78 7	06/06/2000	1 750 000	no data	no data
DAP	*Pseudo-nitzschia multiseries/pungens*	Golden Horn Bay	43.10 67	131.88 2	15/08/2000	1 500 000	no data	no data
DAP	*Pseudo-nitzschia multiseries/pungens*	Rynda Bay	43.2 5	131.78 7	11/09/2000	1 690 000	no data	no data
DAP	*Pseudo-nitzschia calliantha/pseudodelicatissima*	Ussuriiskii Bay	43.75	132.26 66	17/09/2001	610 000	no data	no data
DAP	*Pseudo-nitzschia calliantha/pseudodelicatissima*	Aniva Bay	46.320	142.260	15/11/2001	26 000	no data	no data
DAP	*Pseudo-nitzschia multiseries/pungens*	Aniva Bay	46.320	142.260	10/08/2002	2 044	no data	no data
DAP	*Pseudo-nitzschia multiseries/pungens*	Amurskii Bay	43.15 3	131.90 2	12/09/2002	1 400 000	no data	no data
DAP	*Pseudo-nitzschia calliantha/pseudodelicatissima*	Aniva Bay	46.020	143.140	02/04/2002	1181	no data	no data
DAP	*Pseudo-nitzschia calliantha/pseudodelicatissima*	Aniva Bay	46.020	143.140	10/08/2002	2 171	no data	no data
DAP	*Pseudo-nitzschia calliantha/pseudodelicatissima*	Amurskii Bay	43.15 3	131.90 2	15/10/2002	510 000	no data	no data
DAP	*Pseudo-nitzschia calliantha/pseudodelicatissima*	Aniva Bay	46.320	142.260	10/11/2002	25 920	no data	no data
DAP	*Pseudo-nitzschia multiseries/pungens*	Aniva Bay	46.320	142.260	10/11/2002	48 384	no data	no data
PSP	*Alexandrium acatenella*	Aniva Bay	46.320	142.260	10/07/2001	5 200	no data	no data
PSP	*Alexandrium acatenella*	Aniva Bay	46.020	143.140	10/06/2002	1376	no data	no data
PSP	*Alexandrium acatenella*	Vostok Bay	42.83 3	132.76 66	15/07/2001	200	no data	no data
PSP	*Alexandrium pseudogonyaulax*	Amurskii Bay	43.15 3	131.90 2	12/07/1999	3 000	no data	no data

PSP	*Alexandrium pseudogonyaulax*	Minonosok Bay	42.60	130.85	10/09/1999	6 100	no data	no data	
PSP	*Alexandrium tamarense*	Minonosok Bay	42.60	130.85	12/08/1999	5 600	no data	no data	
PSP	*Alexandrium tamarense*	Aniva Bay	46.320	142.260	15/08/2000	40 000	no data	no data	
PSP	*Alexandrium tamarense*	Aniva Bay	46.320	142.260	12/06/2001	3 500	no data	no data	
PSP	*Alexandrium tamarense*	Aniva Bay	46.320	142.260	15/07/2001	5 200	no data	no data	
PSP	*Alexandrium tamarense*	Vostok Bay	42.83 3	132.76 66	10/08/2001	300	no data	no data	
PSP	*Alexandrium tamarense*	Aniva Bay	46.020	143.140	10/06/2002	51 360	no data	no data	
DSP	*Dinophysis acuminata*	Amurskii Bay	43.15 3	131.90 2	15/07/1992	8 000	no data	no data	
DSP	*Dinophysis acuminata*	Minonosok Bay	42.60	130.85	10/06/1997	400	no data	no data	
DSP	*Dinophysis acuminata*	Amurskii Bay	43.15 3	131.90 2	15/08/1997	1 500	no data	no data	
DSP	*Dinophysis acuminata*	Amurskii Bay	43.15 3	131.90 2	15/06/1998	500	no data	no data	
DSP	*Dinophysis acuminata*	Amurskii Bay	43.15 3	131.90 2	07/07/1998	2 000	no data	no data	
DSP	*Dinophysis acuminata*	Rynda Bay	43.2 5	131.78 7	05/08/2000	11 000	no data	no data	
DSP	*Dinophysis acuminata*	Aniva Bay	46.020	142.130	10/08/2002	183	no data	no data	
DSP	*Dinophysis acuminata*	Aniva Bay	46.020	143.140	02/04/2002	302	no data	no data	
DSP	*Dinophysis acuminata*	Aniva Bay	46.320	142.260	15/06/2002	488	no data	no data	
DSP	*Dinophysis acuminata*	Aniva	46.320	142.260	10/11/2002	432	no data	no data	
DSP	*Dinophysis acuta*	Amurskii Bay	43.15 3	131.90 2	15/06/1998	234	no data	no data	
DSP	*Dinophysis acuta*	Aniva Bay	46.320	142.260	08/08/2000	200	no data	no data	
DSP	*Dinophysis acuta*	Aniva Bay	46.320	142.260	15/06/2002	488	no data	no data	
DSP	*Dinophysis acuta*	Aniva Bay	46.320	142.260	10/11/2002	247	no data	no data	
DSP	*Dinophysis fortii*	Vostok Bay	42.83 3	132.76 66	10/08/2000	3 000	no data	no data	
DSP	*Dinophysis fortii*	Aniva	46.320	142.260	10/11/2002	247	no data	no data	
DSP	*Dinophysis rotundata*	Amurskii Bay	43.15 3	131.90 2	15/07/1998	30	no data	no data	
DSP	*Dinophysis rotundata*	Aniva Bay	46.210	142.330	15/06/2002	351	no data	no data	
DSP	*Dinophysis rotundata*	Aniva Bay	46.020	142.130	02/04/2002	353	no data	no data	
DSP	*Dinophysis rotundata*	Aniva Bay	46.210	143.060	10/08/2002	300	no data	no data	
DSP	*Dinophysis rotundata*	Aniva Bay	46.020	142.550	10/11/2002	355	no data	no data	

Table III.4. International Training courses attended by Russian scientists in 1995-2003.

No.	Name of Training course	Objectives	Content	Organization/sponsor	Trainees	Date and venue
1	IOC/WESTPAC Training Workshop on Monitoring of PSP Plankton and Shellfish Toxicity Ecology	Improvement of the participant skills in designing and implementing a monitoring programme. Improvement of the participant taxonomic skills in order to enable them to make reliable identification of phytoplankton species causative of harmful algal events.	The training course included field practical work, laboratory exercises, and round table discussion on PSP monitoring technology. Lectures were focus on taxonomy and identification of harmful microalgae, ecology, toxin chemistry.	IOC/UNESCO, Asian Natural Environmental Science Centre (ANESC) of the University of Tokyo, School of Fisheries Sciences, Kitasato University and Faculty of Agriculture, Tohoku University	Tatiana Yu. Orlova, Senior Scientist, Laboratory of the Ecology of Shelf Communities of Institute of Marine Biology of the Far Eastern Branch of Russian Academy of Sciences (IMB FEB RAS)	17/07/1995-21/07/1995 School of Fisheries Sciences, Kitasato University, Iwate, JAPAN
2	IOC/WESTPAC Training Course on Species Identification of Harmful Microlgae	Improvement of the participant skills in identification of harmful microalgae in order to enable them to detect their occurrence and mitigate their harmful effects. The training activity was focused on improving related human resources as well as technology and knowledge transfer in order to develop capability in WESTPAC countries for management of HAB events.	The training course included lectures, laboratory exercises, and round table discussion on monitoring technology and species identification of marine microalgae.	IOC/WESTPAC, Asian Natural Environmental Science Center, the University of Tokyo, JAPAN	Inna V. Stonik, Researcher of Laboratory of the Ecology of Shelf Communities of Institute of Marine Biology of the Far Eastern Branch of Russian Academy of Sciences (IMB FEB RAS)	28/02/1997-08/03/1997, Asian Natural Environmental Science Center, the University of Tokyo, JAPAN

3	IOC-DANIDA Training Course on the Taxonomy and Biology of Harmful Marine Microalgae,	Improvement of the participant taxonomic skills in order to enable them to make reliable identification of phytoplankton species causative of harmful algal events.	The training course included practical work in the laboratory, microscopy, lectures, and discussion of selected topics in smaller group; light microscopes, electron microscopes, and video-equipment for demonstration of specimen features and preparation techniques. Lectures were focus on taxonomy and identification, include ecology, toxin chemistry and monitoring.	IOC- DANIDA . IOC Science and Communication Centre on Harmful Algae, Botanical Institute, University of Copenhagen, DENMARK	Tatiana Yu. Orlova, Senior Scientist, Laboratory of the Ecology of Shelf Communities of Institute of Marine Biology of the Far Eastern Branch of Russian Academy of Sciences (IMB FEB RAS)	23/07/1997-06/08/1997 IOC Science and Communication Centre on Harmful Algae, Botanical Institute, University of Copenhagen, DENMARK
4	IOC/WESTPAC Training Course on PSP Toxin Monitoring	Improvement of the participant skills in designing and implementing a PSP monitoring programme.	The training course included lectures, laboratory exercises, and round table discussion on PSP monitoring technology Lectures were focus on plankton and shellfish toxicity ecology and toxin chemistry.	IOC/WESTPAC School of Fisheries Sciences, Kitasato University, Iwate, JAPAN	Natalia V. Zhukova, Senior Scientist, Laboratory of Comparative Biochemistry of Institute of Marine Biology of the Far Eastern Branch of Russian Academy of Sciences (IMB FEB RAS)	24/08/1998-30/08/1998 School of Fisheries Sciences, Kitasato University, Iwate, JAPAN

5	IOC-DANIDA Training Course on the Taxonomy and Biology of Harmful Marine Microalgae	Improvement of the participant skills in taxonomy and biology of harmful marine microalgae in order to enable them to detect their occurrence and mitigate their harmful effects.	The training course included practical work in the laboratory, microscopy, lectures, and discussion of selected topics in smaller group. Lectures were focus on taxonomy and biology of harmful marine microalgae.	IOC-DANIDA IOC Science and Communication Centre on Harmful Algae Botanical Institute, University of Copenhagen, DENMARK	Inna V. Stonik, Researcher of Laboratory of the Ecology of Shelf Communities of Institute of Marine Biology of the Far Eastern Branch of Russian Academy of Sciences (IMB FEB RAS)	14/08/2000-27/08/2000 IOC Science and Communication Centre on Harmful Algae Botanical Institute, University of Copenhagen, DENMARK
6	IOC-DANIDA Training Course on the Taxonomy and Biology of Harmful Marine Microalgae	Improvement of the participant skills in taxonomy and biology of harmful marine microalgae in order to enable them to detect their occurrence and mitigate their harmful effects.	The training course included practical work in the laboratory, microscopy, lectures, and discussion of selected topics in smaller group. Lectures were focus on taxonomy and biology of harmful marine microalgae.	IOC-DANIDA IOC Science and Communication Centre on Harmful Algae Botanical Institute, University of Copenhagen, DENMARK	Olga G. Shevchenko, Researcher of Laboratory of the Ecology of Shelf Communities of Institute of Marine Biology of the Far Eastern Branch of Russian Academy of Sciences (IMB FEB RAS)	14/08/2000-27/08/2000 IOC Science and Communication Centre on Harmful Algae Botanical Institute, University of Copenhagen, DENMARK

7	The Fifth IOC/WESTPAC Training Course on Ecology and Physiology of Harmful Algae	Improvement of the participant's research capability on ecology and physiology of harmful microalgae. The obtained experience will be used in designing and conducting laboratory study and field research on harmful microalgae	Training course focused on development of monitoring skills to detect PSP causative dinoflagellates and PSP toxins contaminated in shellfish. The training course included lectures, laboratory exercises, and round table discussion on ecology and physiology of harmful algae.	IOC/WESTPAC Chulalongkorn University and Burapha University, Bangkok, THAILAND	Tatiana V. Morozova, Ph.D. Student of Laboratory of the Ecology of Shelf Communities of Institute of Marine Biology of the Far Eastern Branch of Russian Academy of Sciences (IMB FEB RAS)	19/03/2001-24/03/2001 Chulalongkorn University and Burapha University, Bangkok, THAILAND
8	IOC-DANIDA Advanced Training Workshop on the Taxonomy of Harmful Marine Microalgae	Further improvement of the skills of the participants in taxonomy and practical monitoring in harmful algal blooms.	Mandatory workshop focusing on practical monitoring, including species intercalibration, different counting techniques, statistics, comparison and interpretation of data, and data presentation. Transmission electron microscopy, ultrastructure including fixation techniques, sectioning, practical me-work, interpretation of observations.	IOC-DANIDA Science and Communication Centre on Harmful Algae. Botanical Institute, University of Copenhagen, DENMARK	Tatiana Yu. Orlova, Senior Scientist, Laboratory of the Ecology of Shelf Communities of Institute of Marine Biology of the Far Eastern Branch of Russian Academy of Sciences (IMB FEB RAS)	06/08/2001-17/08/2001 IOC Science and Communication Centre on Harmful Algae. Botanical Institute, University of Copenhagen, DENMARK

9	The Sixth IOCWESTPAC-HAB Training Course on Advance Techniques on Characterization of Harmful Algae Species - Chemistry and Biology	Improvement of the participant's research capability on ecology and physiology of harmful microalgae. The obtained experience will be used in designing and conducting laboratory study and field research on harmful microalgae.	The training course included lectures and technical sessions on biology, taxonomy and chemistry of harmful marine microalgae. Technical session are included plankton identification by LM, cysts processing, cysts observations.	IOC/WESTPAC	Olga G. Shevchenko, Researcher of Laboratory of the Ecology of Shelf Communities of Institute of Marine Biology of the Far Eastern Branch of Russian Academy of Sciences (IMB FEB RAS)	13/05/2002-18/05/2002 Marine Science Institute, University of the Philippines, Manila, PHILIPPINES
10	The Sixth IOCWESTPAC – HAB Training Course on Advance Techniques on Characterization of Harmful Algae Species - Chemistry and Biology	Improvement of the participant's research capability on ecology and physiology of harmful microalgae. The obtained experience will be used in designing and conducting laboratory study and field research on harmful microalgae.	The training course included lectures and technical sessions on biology, taxonomy and chemistry of harmful marine microalgae. Technical session are included preparation of samples for HPLC analysis, analysis of toxin composition by HPLC.	IOC/WESTPAC	Tatiana V. Morozova, Ph.D. Student of Laboratory of the Ecology of Shelf Communities of Institute of Marine Biology of the Far Eastern Branch of Russian Academy of Sciences (IMB FEB RAS)	13/05/2002-18/05/2002 Marine Science Institute, University of the Philippines, Manila, PHILIPPINES

11	Technical Training for Fisheries "Biological study and research method of toxic phytoplankton".	The main focus of this course is biological study and research method of toxic phytoplankton.	The training course included lectures and practical works on biological study and research method of toxic phytoplankton, especially PSP-producing species *Alexandrium tamarense.*	Overseas Fishery Cooperation foundation with the support of the Government of Japan.	Tatyana A. Mogilnikova – Researcher of Laboratory of Hydrobilogy, Applied Ecology Department of Sakhalin Scientific Research Institute of Fisheries & Oceanography (SakhNIRO).	16/10/2002-18/11/2002 Hokkaido Central Experimental Station (HCFES), JAPAN
12	Training Workshop on Healthy Aquaculture and Disease Control in Shrimp and Mollusk	Improvement of the participant skills in disease control in shrimp and mollusk	The training course included lectures and round table discussion on healthy aquaculture and disease control in shrimp and mollusk.	Department of International Cooperation of Ministry of Science and Technology (MOST) of the People's Republic of China	Tatiana V. Morozova, Ph.D. Student of Laboratory of the Ecology of Shelf Communities of Institute of Marine Biology of the Far Eastern Branch of Russian Academy of Sciences (IMB FEB RAS)	10/09/2002-21/09/2002 Institute of Oceanology, Chinese Academy of Sciences (IOCAS), Qingdao, People's Republic of CHINA

13	Dinoflagellates – their biologic characteristics, ecology, and use for paleoclimate reconstruction	The main focus of this course is the biology and ecology of cysts forming dinoflagellates., effects of environmental conditions on encystment process and cyst morpohology, new developments in molecular palaeontology (genetic research, biogeochemistry and fossil biomarkers).	Lectures and practical work on dinoflagellate life cycles and environmental effects on encystment and excystment processes; environmental influence on cysts related to environmental conditions in the upper water column, benthic dinoflagellates, recent developments in genetic research.	ECOLMAS European Graduate College in Marine Sciences	Tatiana V. Morozova, Ph.D. Student of Laboratory of the Ecology of Shelf Communities of Institute of Marine Biology of the Far Eastern Branch of Russian Academy of Sciences (IMB FEB RAS)	01/12/2003-04/12/2003, Research Centre Ocean Margins, University of Bremen, GERMANY
14	Technical Training for Fisheries "Research method of vegetative cells and cyst of toxic phytoplankton".	The main focus of this course is research method of vegetative cells and cysts of toxic phytoplankton.	The training course included lectures and practical works on dinoflagellate life cycles, vegetative cells and cysts of toxic phytoplankton, especially PSP-producing species *Alexandrium tamarense.*	Overseas Fishery Cooperation foundation with the support of the Government of Japan	Irina V. Motylkova-Researcher of Laboratory of Hydrobilogy, Applied Ecology Department of Sakhalin Scientific Research Institute of Fisheries & Oceanography (SakhNIRO).	03/09/2003-06/10/2003 Hokkaido Central Experimental Station (HCFES), JAPAN

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