Current situation and perspective for HABs Monitoring on the Russian Pacific Coast

Tatiana Orlova

A.V. Zhirmunskii Institute of Marine Biology,Far Eastern Branch,

Russian Academy of Sciences,

Palchevskogo Str., 17, Vladivostok 690041, Russia

Tel : 7 2432 317107, Fax: 7 4232 310900

e-mail: torlova@imb.dvo.ru

1. Introduction

Long-term observations that were performed for many years in the northern East/Sea show that there has been an apparent increase in the frequency, intensity and geographical distribution of harmful algal blooms during the last two decades in the Russian coastal waters. HABs monitoring program was conducted by the Institute of Marine Biology in the coastal waters of Amurskii Bay since 1993. The objectives of HABs monitoring were: monitor HAB species, tracking the blooms, early warning of potentially harmful species, to document ecological harm or dysfunction. Current situation and perspective for HABs Monitoring on the Russian Pacific Coast are presented.

2. Method

Monitoring on HABs has been conducted by Laboratory of the Ecology of Shelf Communities of Institute of Marine Biology (FEB RAS) in the coastal waters of Amurskii Bay. The samples were collected once to three times a month. One-liter bathometric samples were collected at different depths with sampling intervals of 2–5 m. Plankton net with the mesh size of 20 mkm was used only for qualitative analysis. Samples were fixed immediately after the collection with Utermöhl's solution. The numbers of nanoplankton (2.0–20 mkm) were counted using Nojotta type Cell (0.05 mL) at total magnification of 300-400, and those of microplankton (> 20.0 mkm), using Sedgewick Rafter Cell (1 mL) at 100 X under a light microscope. The cell biovolume was calculated based on cell linear dimensions using appropriate geometric formulae. HABs monitoring data were stored using standard forms including the following fields: sampling site, sampling depth, data, volume of sample, counting cell type, ID of the responsible person.

3. Result and Discussion

Two types of HAB were observed in the study area. The first type is "red tide", when the water is discolored by high algal biomass. The second type is blooming of toxin-producing phytoplankton. In the Russian NOWPAP area, 11 potentially toxic species were found belonging to dinoflagellates and diatoms. Diatoms of the genus *Pseudo-nitzschia* are known as domoic acid–producing species. Electron microscopy revealed the presence of ten *Pseudo-nitzschia* species in the Russian coastal waters (Orlova, Stonik., 2001; Stonik et al., 2001). Four of them, *P. pungens, P. multiseries, P. pseudodelicatissima,* and *P. calliantha,* are known to be potentially toxic. *Pseudo-nitzschia* species are the most common species. The density of *Pseudo-nitzschia* spp. varied from 2 044 to 35 000 000 cells/l. Strong blooms of *Pseudo-nitzschia* species were registered between 1991 and 1997. The maximum density of the *Pseudo-nitzschia multiseries/pungens* complex (35 million cells/l) was registered in June 2002 in Amurskii Bay (Orlova et al., 1996). Some *Dinophysis* species are known as ocadaic acid–producing species, causing the syndrome of diarrhetic shellfish poisoning (DSP). Four of them, *D. acuminata, D. acuta*, *D. fortii,* and *D. rotundata,* were observed (Orlova et al., 2002). These species occurred in plankton in March–December. Its density reached a peak in summer. *D. acuminata* is one of the most widespread and abundant species in the Russian NOWPAP area. In Amurskii Bay its maximum density was 11 000 cells/l. The maximum concentration (3000 cells/l) of *D. fortii* was observed in the coastal waters in August. *D. rotundata* was common in the however, its concentration didn't exceed 400 cells/l.

Dinoflagellates of the genus *Alexandrium* may cause paralytic shellfish poisoning (PSP). Seven *Alexandrium* species were found in this part of the Russian coastal zone (Konovalova, 1998; Selina, Konovalova, 2001). Four of them, *A. tamarense, A. acatenella, A. pseudogonyaulax, and A. ostenfeldii,* are potentially toxic species. *A. tamarense* was widespread in this zone and the density of this species varied between 300 and 51 360 cells/l. *A. acatenella* was observed at a low concentration (200 cells/l) in the Peter the Great Bay (Morozova et al., 2002). The highest density of *A. pseudogonyaulax* (5600 cells/l) was registered in the coastal waters of Primorye (Selina, Konovalova, 2001. Our recent examination of living dinoflagellate cysts from recent sediment samples collected along the eastern Russian coasts revealed cysts of potentially toxic species, *Alexandrium* cf. *minutum* and *A. tamarense* (Orlova et al., 2004). Ellipsoidal *Alexandrium tamarense* cysts were widespread in the survey area and predominated in many localities. The density of cysts varied from 100 to 11,000 g^{-1}. The above data suggest that the distribution of toxic algal blooms, causing paralytic shellfish poisoning, is more widespread than it was previously considered.

The HABs monitoring revealed the appearance and massive blooms of new, uncommon for this area raphidophytes and dinoflagellates of the genera *Karenia* and *Prorcentrum.* Every year we observed recurrent blooms of nontoxic species (*Sceletonema, Chaetoceros, Thalassionema* and other) at numbers of more than dozens millions cells per liter in the hypereutrophic coastal waters of during the summer-autumn period. The majority of harmful species which are known for this area can produce cysts (hypnozygotes like *Alexandrium* spp.) and resting cells (like *Pseudo-nitzschia* spp.). Currents and ballast waters to the new location and remaining dormant until conditions are right for germination may distribute the cysts and resting cells.

Most of the harmful species and their blooms events occurred in the coastal waters subjected to the most powerful anthropogenic influence. In our opinion, 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.

For solving the problem of biological safety of the Russian marine waters the Center of Monitoring of HABs & Biotoxins was established in September 2007 in the Institute of Marine Biology, FEB RAS. The DSP, ASP and PSP toxins were analyzed in the tissues of mollusk, water samples and cultures of potentially toxic species, which were established form Peter the Great Bay. Samples were analyzed for toxins by the immunoassay method ELISA using the test-systems «RIDASCREEN^{R} FAST Saxitoxin», okadaic Acid ELISA (Abraxis LLC) and ASP direct ELISA (Bioscence Laboratory AS). ASP, PSP and DSP toxins were detected both in mollusks and water samples. Total DSP content in the mullucs exceeded toxic level > 160 mkg/kg.

The perspective for HABs monitoring in Russian waters are:
to assess actual or potential anthropogenic effects on HAB events, such as aquaculture activities or the introduction of novel species through discharge of ballast water; to estimate the pre-existing normal (baseline) conditions and their variability; distinguish anthropogenic changes from those attributable to natural variance. It's particularly important for biodiversity and stability of coastal marine ecosystems.

Arrangement of toxin analysis in water samples, cultures and shellfish continue to be among main national priorities, though some progress had been made. Development and implementation of schemes of observation upon plankton communities using the remote sensing techniques should be the one of national priorities in the HABs issues. The national priority to cope with HABs is prevention of HABs through obligatory monitoring and proper arrangement of aquaculture strategy. Increase of high skilled specialists for the investigation in the biology and ecology of the plankton species leading to HABs events continues to be the national priority also.

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