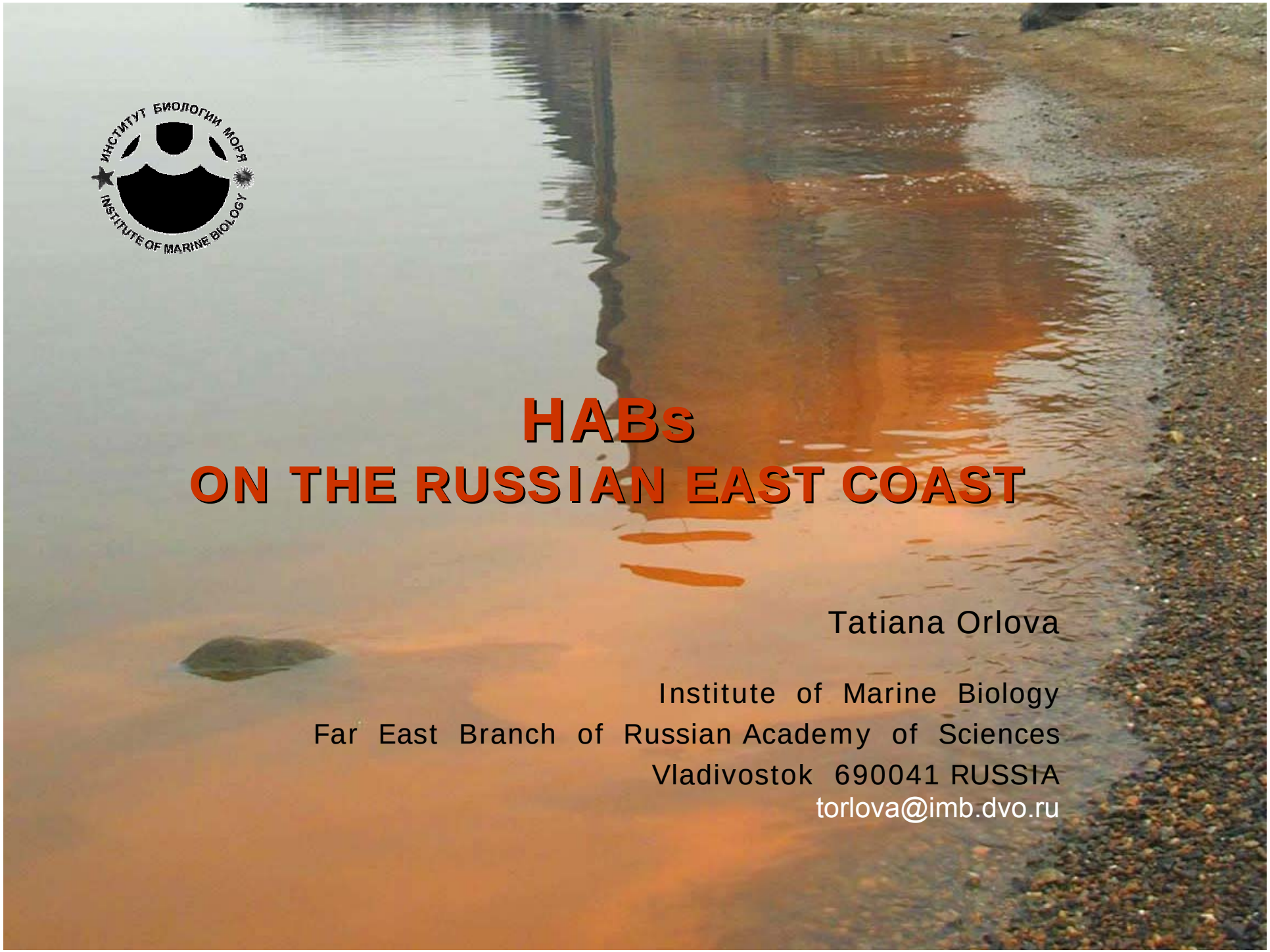

HABs
ON THE RUSSIAN EAST COAST

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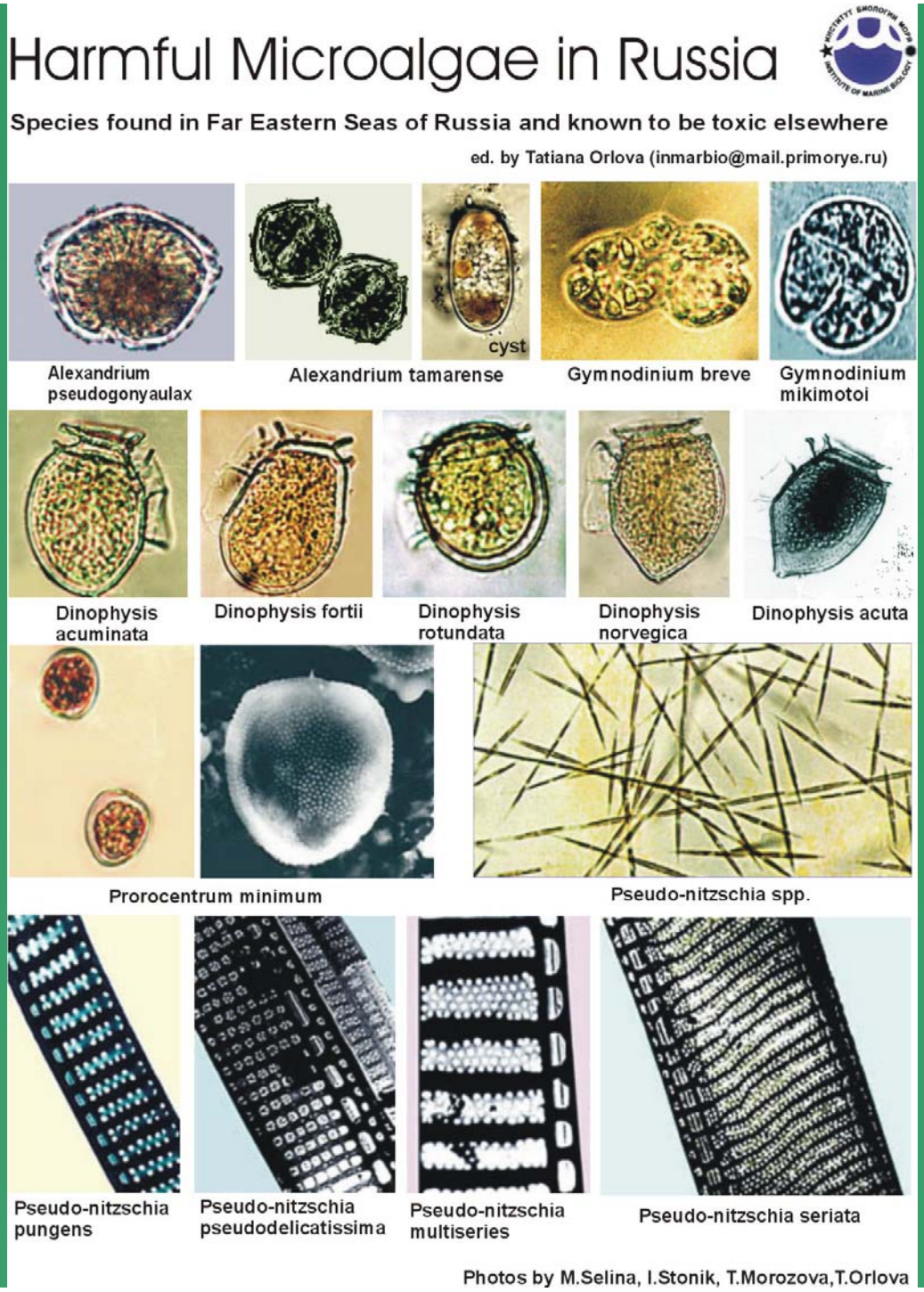
HAB species – 25

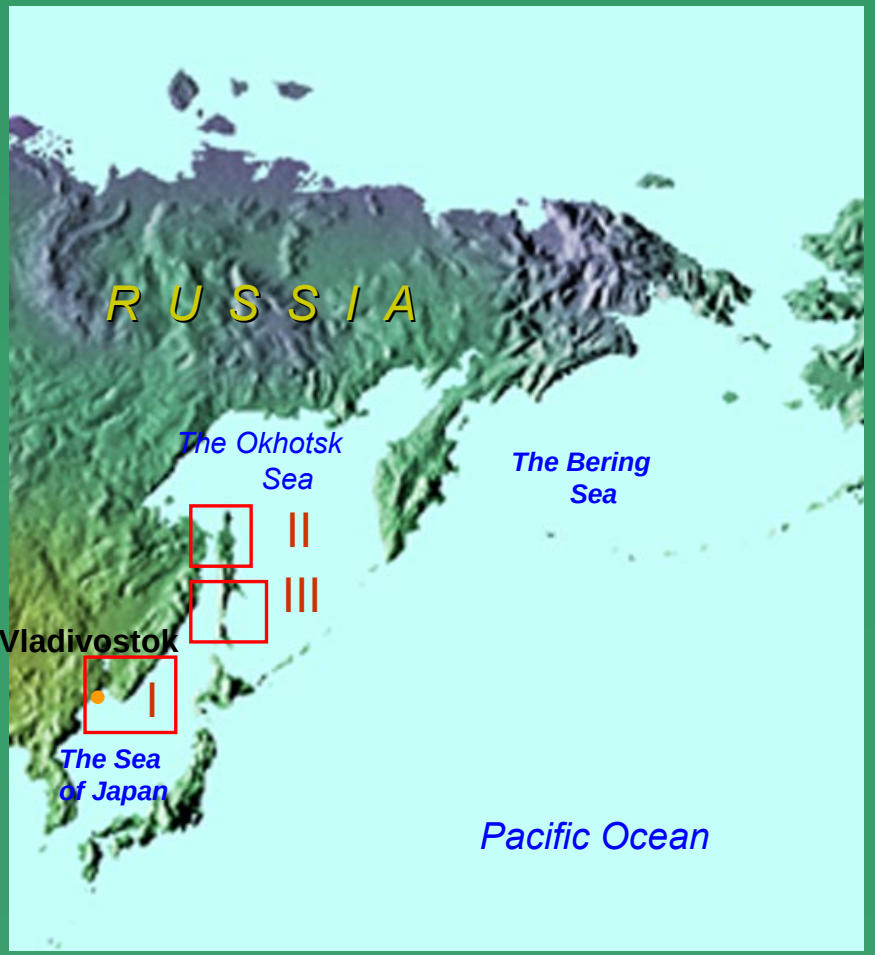
- dinoflagellates - 12
- diatoms - 8
- raphidophytes - 3
- euglenophytes - 2



Study Area

Far Eastern Seas of Russia occupy a vast zone of the north-western part of the Pacific ocean and include the Sea of Japan, the Okhotsk Sea and the Bering Sea. The eastern coast of Russia is an important social and economic zone with population about 6 million. It is an area that supports active fisheries (more than 80% of the total production in Russia).

Map showing the sampling regions on the Russian east coast.
(I) south Primorye, the Sea of Japan,
(II) northeastern coastal waters of Sakhalin Island, the Sea of Okhotsk
(III) South coastal waters of Sakhalin Island, the Sea of Okhotsk



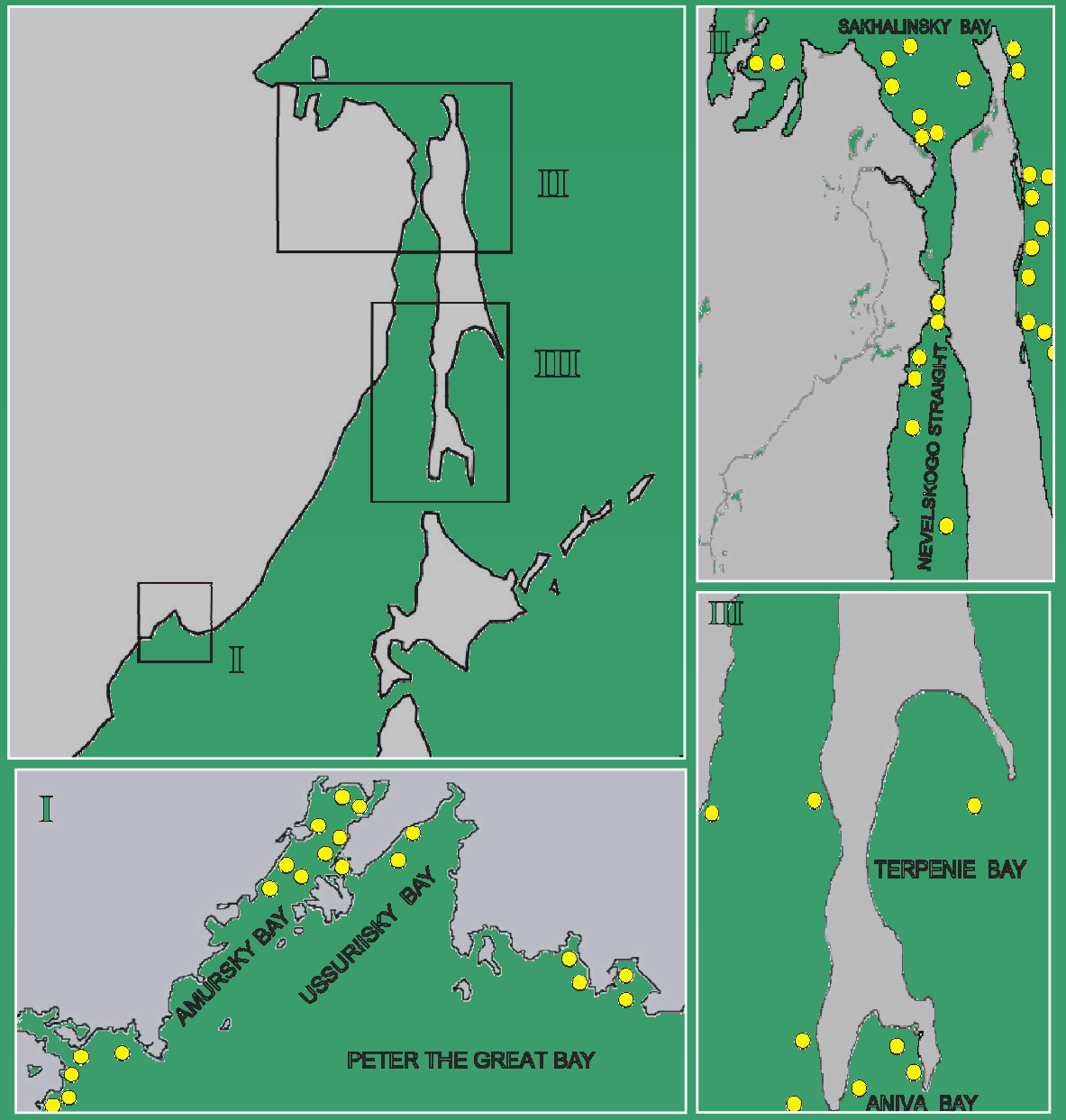
Objectives:

- species diversity of the genus *Pseudo-nitzschia* in the southeastern coastal waters of Russia;
- morphometric characteristis;
- occurrence and abundance
- toxicity

Material

Map showing the sampling regions and stations on the Russian east coast

Bottle and net phytoplankton samples were collected during the summer-fall periods 1991-2003.
A total of 578 samples from 54 stations were analyzed.



The earliest documented findings of *Pseudo-nitzschia* species in Seas of Russia

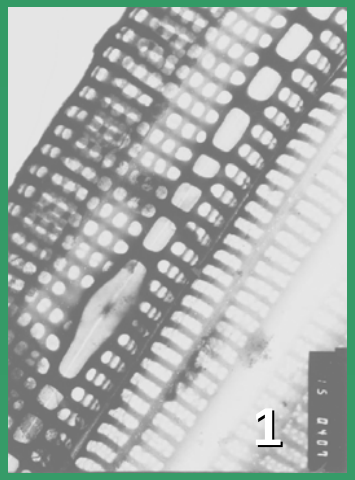
Until 1991, only two species of *Pseudo-nitzschia* found in the Seas of Russia by LM studies were given in the literature under the old names:

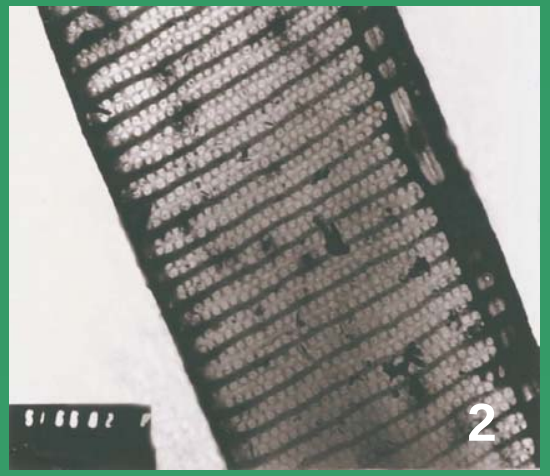
- *Nitzschia seriata*
- *Nitzschia delicatissima*

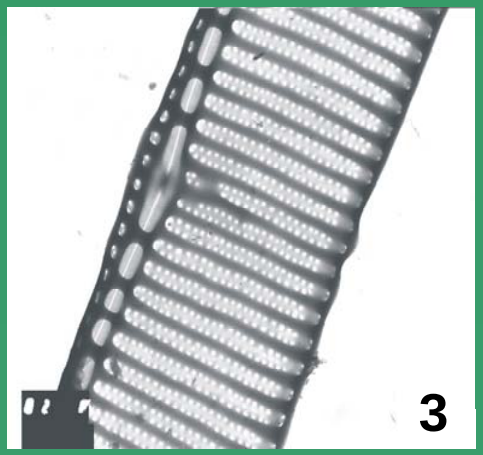
(from Kisselev, 1959; Gail, 1950; Smirnova, 1959; Semina, 1981; Konovalova *et al.,* 1989).

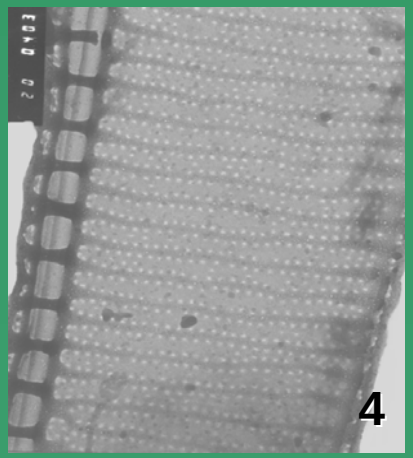
Species of the genus *Pseudo-nitzschia* in the southeastern coastal waters of Russia

- *P. americana*
- *P.* cf. *caciantha* (1)
- *P. calliantha*
- *P. delicatissima*
- *P. fraudulenta* (2)
- *P.* cf. *heimii* (3)
- *P. multiseries*
- *P. multistriata* (4)
- *P. pungens*
- *P. seriata* f. *seriata*







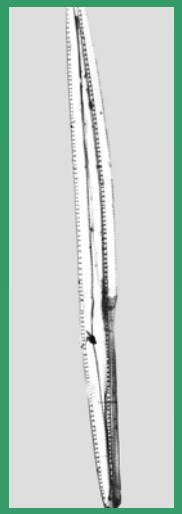


Morphometric characteristics of *Pseudo-nitzschia* from Russia

Species	References	Length	Width	Central nodulus	Fibulae /10 μm	Striae /10μm	Valve poroids /1μm	Bands poroids/striae number of poroids Width x height
Pseudo-nitzschia cf. *caciantha*	Own data	72-76	2,6-2,8	+	14-17	31-32(38)	4-5	2x4-5
P. caciantha	Lundholm (2003)	53-75	2,7-3,5	+	15-19	28-31	3,5-5	2x2-5
Pseudo-nitzschia cf. *heimii*	Own data	106	3,9-4,3	+	13-14	20	6-8	ND
P. heimii	Hasle, 1965	67-120 (90)	4-6	+	11-16	19-26	5-8	ND
P. heimii	Hasle et al., 1996	50-78	5-6	+	14-18	26-28	7-8	ND

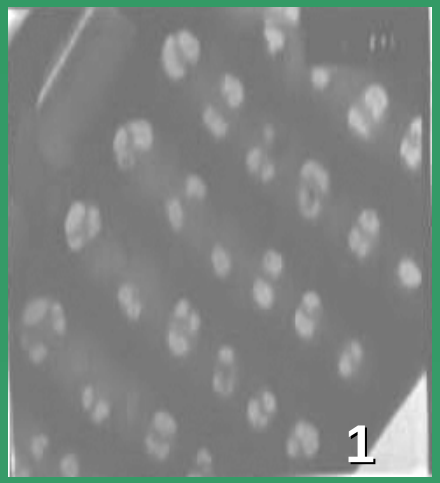
The morphology of all species found by us corresponds to the original descriptions. However, certain discrepancies exist in the morphometric characteristics of *Pseudo-nitzschia* cf. *caciantha* and *Pseudo-nitzschia* cf. *heimii*

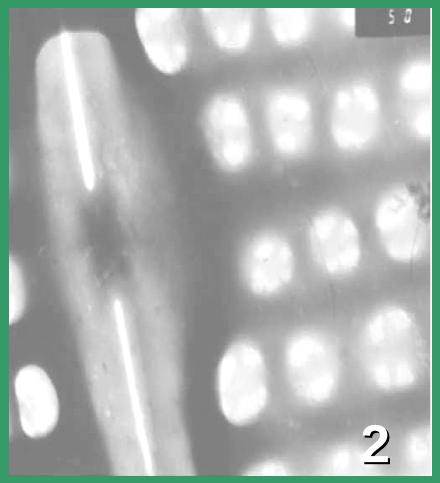
Pseudo-nitzschia cf. *caciantha*

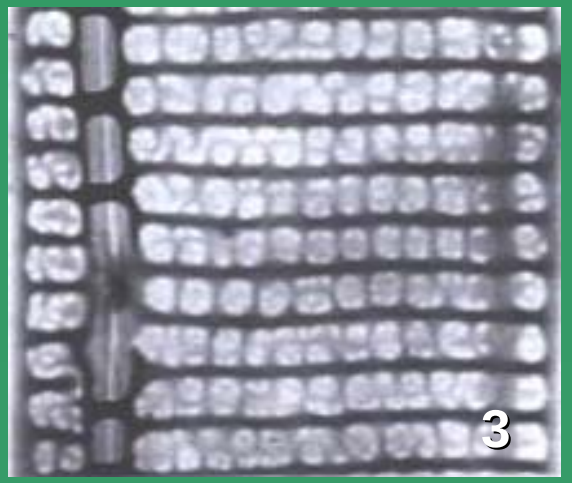


We found cells of *P.* cf. *caciantha* had a large density of band striae (44-46/ 10μm) when compared with the measurements of Lundholm et al. (2003) (33-38 / 10μm). However, taking into consideration the cell width and valve and band structure, cells studied by us to be closer to *Pseudo-nitzschia caciantha* Lundholm et al. (2003).

Variation of poroid sectors in *Pseudo-nitzschia* cf. *caciantha*



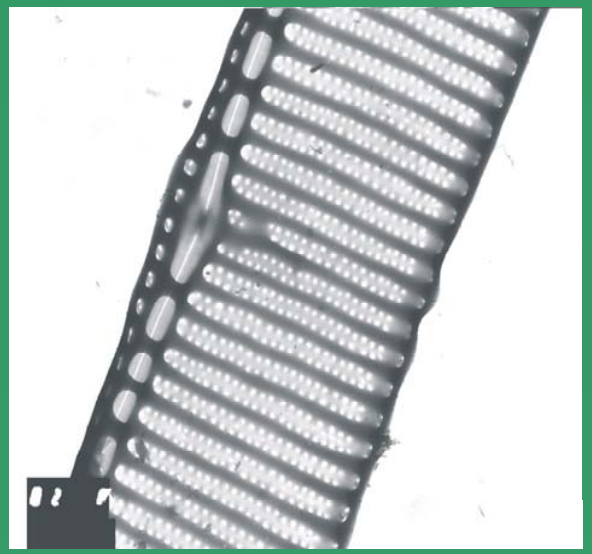




1-2 *Pseudo-nitzschia* cf. *caciantha* (original data);
3- *Pseudo-nitzschia* cf. *caciantha* (from Lundholm et al., 2003)

Poroid structure of *Pseudo-nitzschia* cf. *caciantha* demonstrates a variation of poroid sector number. Poroids divided into two - five sectors of variable size can be found on the same valve. It does not conform to the original description of *Pseudo-nitzschia caciantha,* in which hymen of poroids usually divided into four- five sectors (Lundholm et al., 2003). Similar results concerning morphological variability of poroid structure of *P. pseudodelicatissima* from the Bay of Fundy have been obtained by Kaczmarska et al., 2003. It is well known that the morphological, genetic and ecological variability of *P. pseudodelicatissima* has not been sufficiently examined (Hallegraeff, 1994; Lundholm et al., 2003).

Pseudo-nitzschia cf. *heimii*

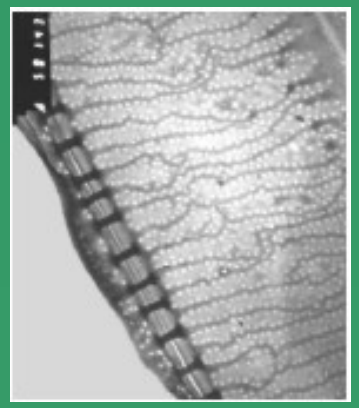


Cells of *P.* cf. *heimii* were slimmer (width 3,9-4,3μm) and had a smaller number of striae when compared with measurements of *P. heimii* from Skagerrak (width 5-6 μm in Hasle et al., 1996), althouth our cells were close to lowest value of range of variation indicated in Hasle (1965) for width of *P. heimii* from waters off Shetland (North Atlantic) and Subantarctic (width 4-6 μm) . These cell characteristics were close to measurements of *P. heimii* in Hasle (1965) in relation to number of valve striae and fibulae. Cells of *P.* cf. *heimii* found in Aniva Bay were asymmetrical in the central part of the valve with one valve margin almost straight as noted also by Hasle et al. (1996).

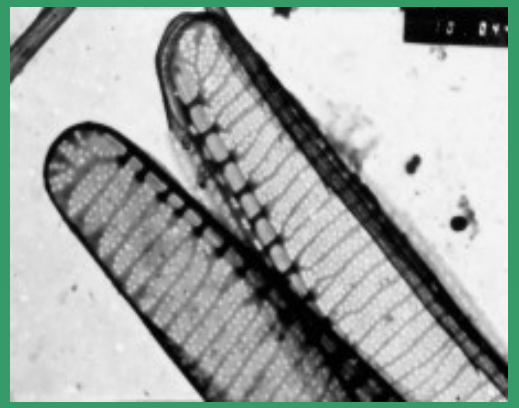
Aberrant cells of *Pseudo-nitzschia* species

P. pungens

P. multiseries



P. multistriata



P. americana

In field material from Amurskii Bay, one of the most eutrophic areas of the Far Eastern Seas, we found aberrant cells of *P. americana, P. multiseries* and *P. pungens.* Aberrant valves bearing curved striae occurred in field material and in cultures of *P. multistriata*. Similar phenomenon was previously found in some *Pseudo-nitzschia* species, both in their natural environment and *in vitro*, and was explained by changes in physiological conditions of the microalgae due to unfavorable conditions (Takano, Kikuchi, 1985; Subba Rao, Wohlgeschaffen, 1990). Similar observations were reported by Takano, 1993, who attributed the formation of aberrant cells in *P. multistriata* from the eutrophic bays of southern Japan to different nutrition conditions.

Bloom-forming *Pseudo-nitzschia* species on the Russian east coast

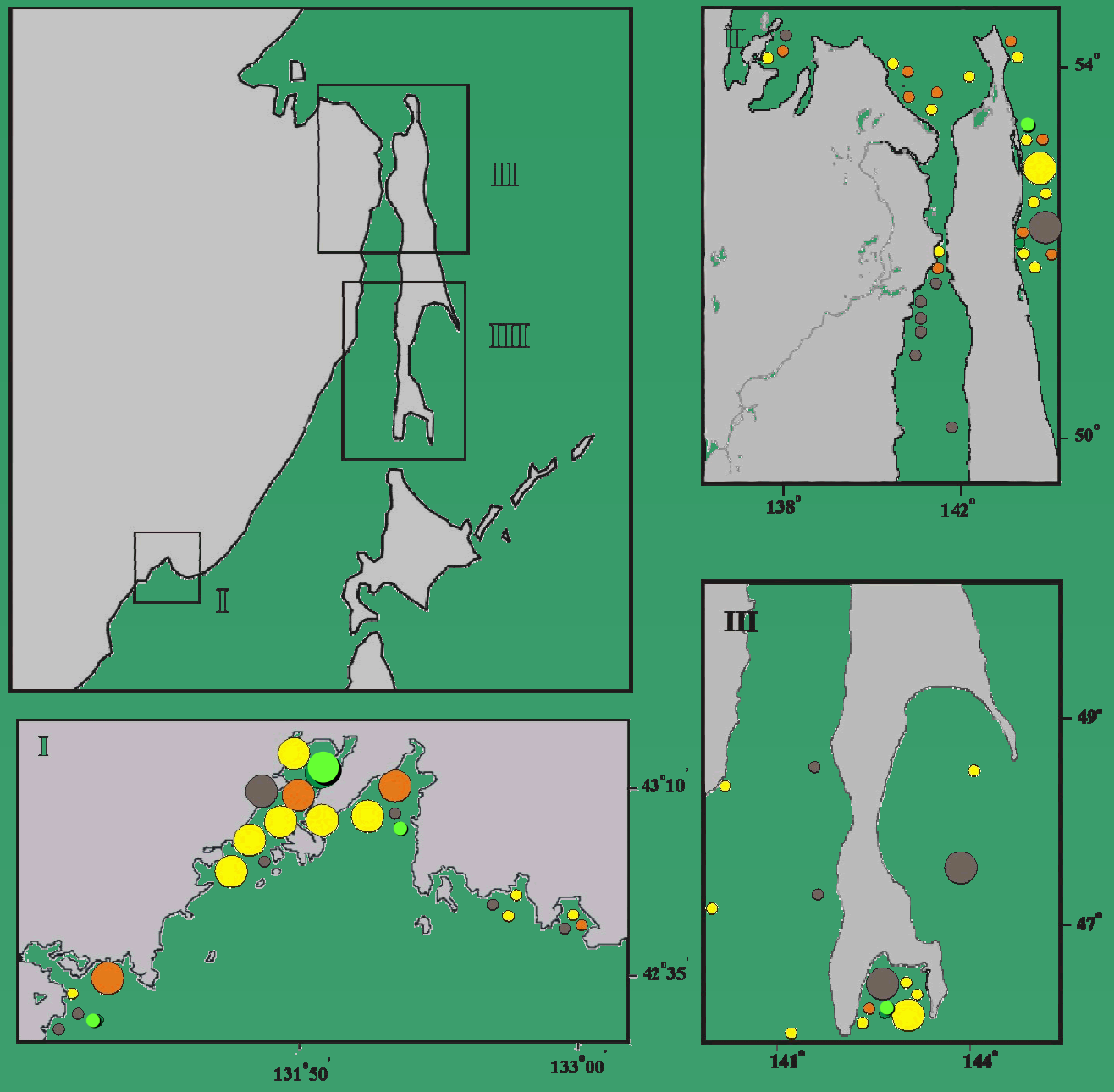
- *P. americana* up to 540 thousands of cells L^{-1}
- *P. calliantha* up to 2,7 millions of cells L^{-1}
- *P. multiseries* up to 35 millions of cells L^{-1}
- *P. multistriata* up to 1 millions of cells L^{-1}
- *P. pungens* up to 11 millions of cells L^{-1}

Distribution of bloom-forming species of *Pseudo-nitzschia*

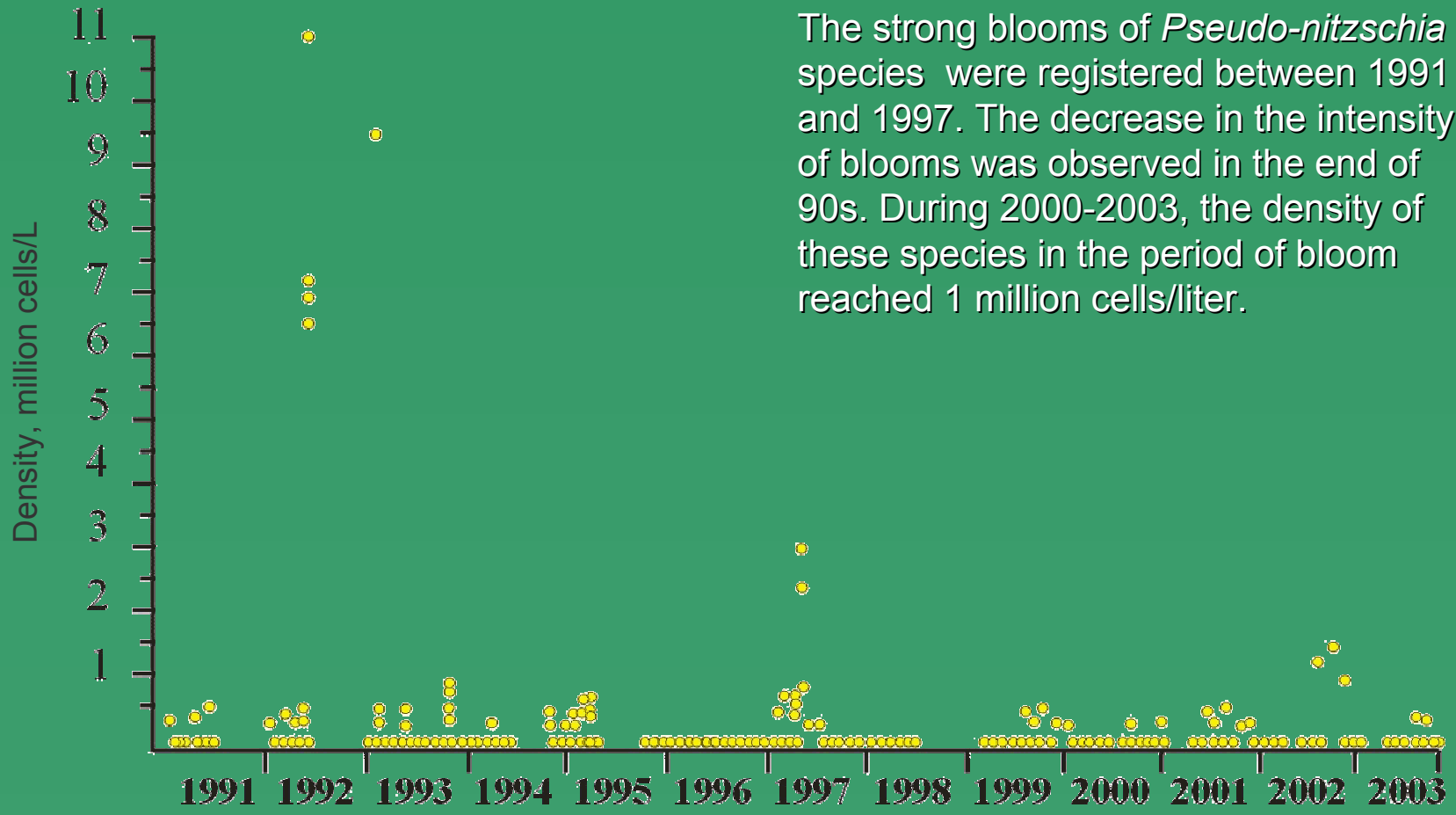
The highest concentrations of bloom-forming species were recorded in Amursky and Ussurissky Bays (the Sea of Japan) as well as in Aniva Bay (the Sea of Okhotsk) and in the northeastern coastal waters of Sakhalin Island. In the other sampling regions density of these species was markedly lower.

- Cell density > 10^5 cells.L^{-1}
- Cell density < 10^5 cells.L^{-1}

- *P. pungens/multiseries*
- *P. calliantha*/cf.*caciantha*
- *P. americana*
- *P. multistriata*

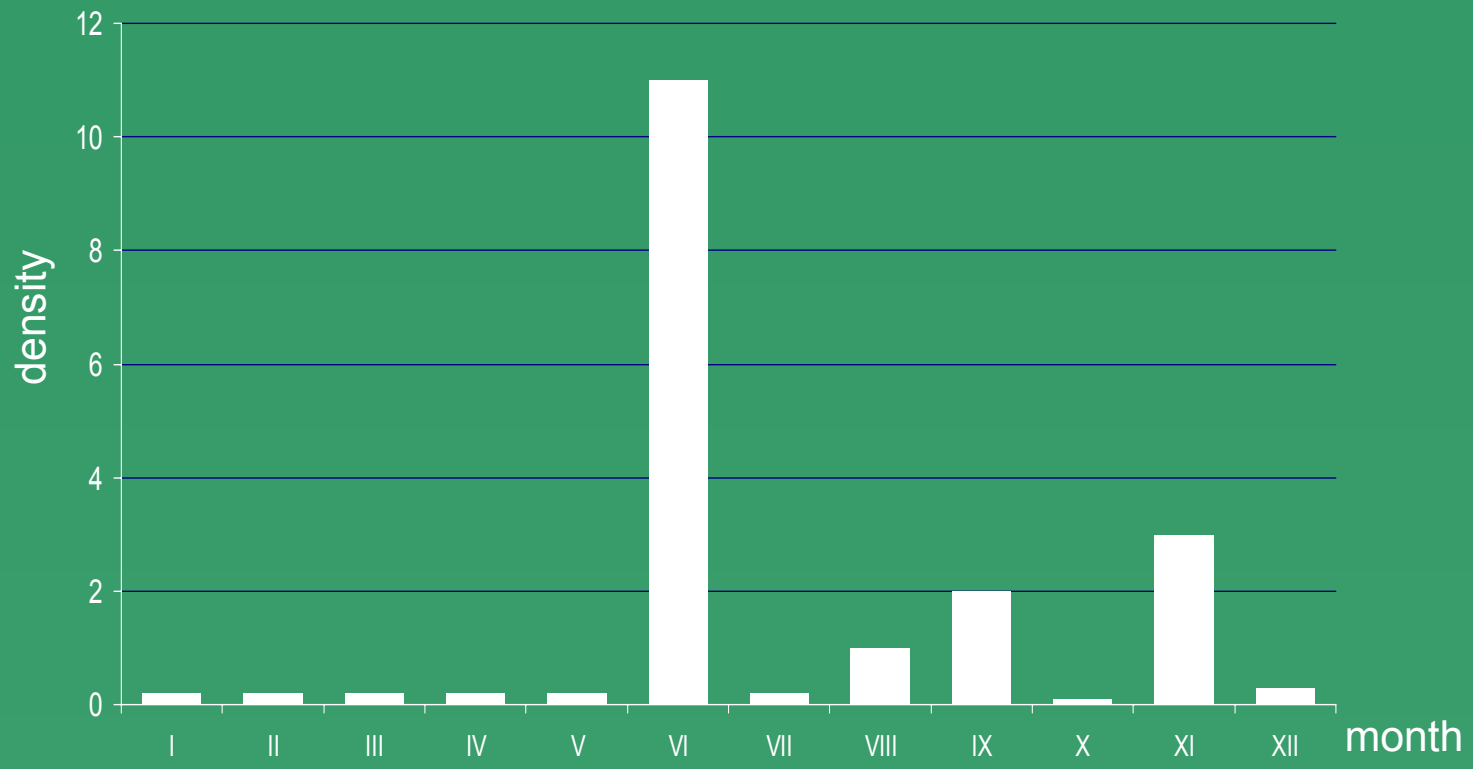


Blooms of *Pseudo-nitzschia* species in Peter the Great Bay 1991-2003



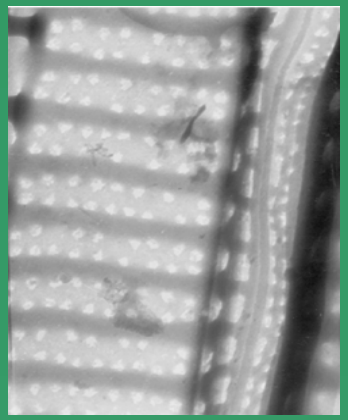
The strong blooms of *Pseudo-nitzschia* species were registered between 1991 and 1997. The decrease in the intensity of blooms was observed in the end of 90s. During 2000-2003, the density of these species in the period of bloom reached 1 million cells/liter.

Changes in density (million cells/L-1) of bloom-forming *Pseudo-nitzschia species* in Peter the Great bay



Our observations showed that *Pseudo-nitzschia* species are the most numerous in summer and in autumn. Blooms of *P. pungens /P. multiseries* were observed in summer, while mass development of *P. calliantha* (*pseudodelicatissima/cuspidata* complex) occurred in autumn.

Common but not numerous species



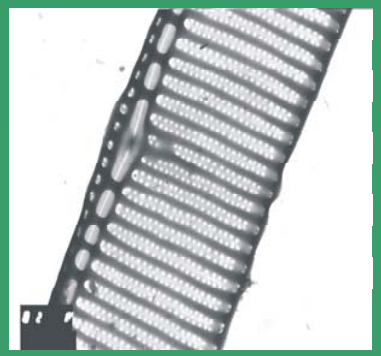
P. delicatissima

P. fraudulenta

P. cf. *caciantha*

Rare species

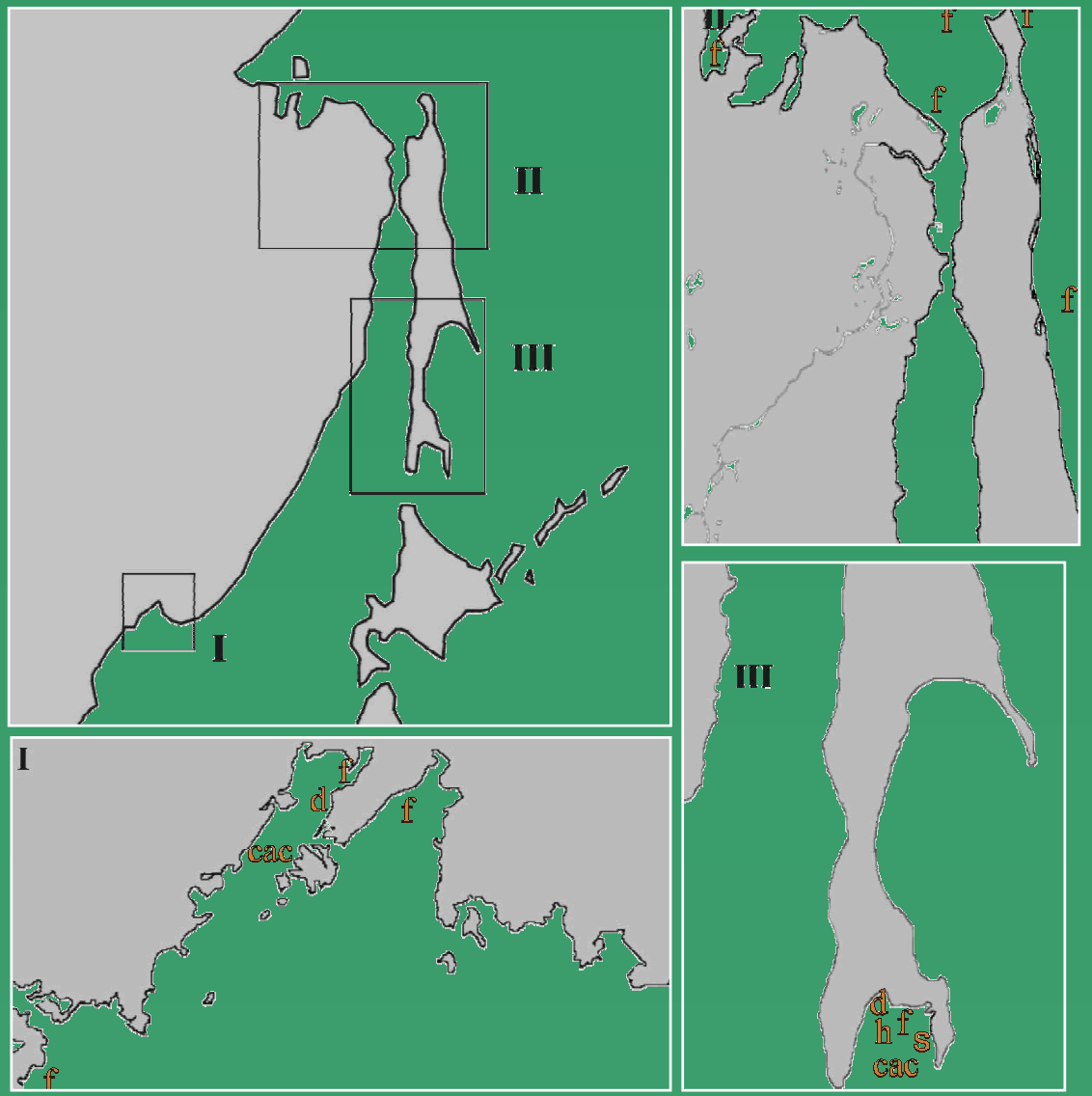
P. seriata f. *seriata*



P. cf. *heimii*

Distribution of *Pseudo-nitzschia* species on the south-eastern coast of Russia

cac- *P.* cf. *caciantha*
d - *P. delicatissima*
f - *P. fraudulenta*
h - *P.* cf. *heimii*
s - *P. seriata*



Maximum concentrations (cells·10^4· L^{-1}) of *Pseudo-nitzschia* from the southeast coast of Russia during 1991-2003

Species	Date	Area	Location	Concentration
P. cf. *caciantha*	November 2001	Aniva Bay	46^{0}03'33"N 142^{0}21'67" E	25
P. delicatissima	June 1997	Amursky Bay	43^{0}4'54" N, 131^{0}42'E	20
P. fraudulenta	November 2003	Amursky Bay	43^{0}4'54" N, 131^{0}42'E	2,4
P. cf. *heimii*	November 2001	Aniva Bay	46^{0}03'33"N 142^{0}21'67" E -	5
P.seriata f. *seriata*	November 2001	Aniva Bay	46^{0}03'33"N 142^{0}21'67" E	3

Global distribution of domoic acid poisoning - DAP

(From Manual on Harmful Marine Microalgae, Hallegraeff et al. eds, .IOC. UNESCO. 1995)

To date reports of domoic acid in seafood products have been mainly confined to North America and Canada. Toxic events have also been detected in other parts of the world such as Europe, Australia, Japan and New Zealand. Seas of Russia still remain as white spot on a map of distribution of DAP.

Cultures of *Pseudo-nitzschia* species

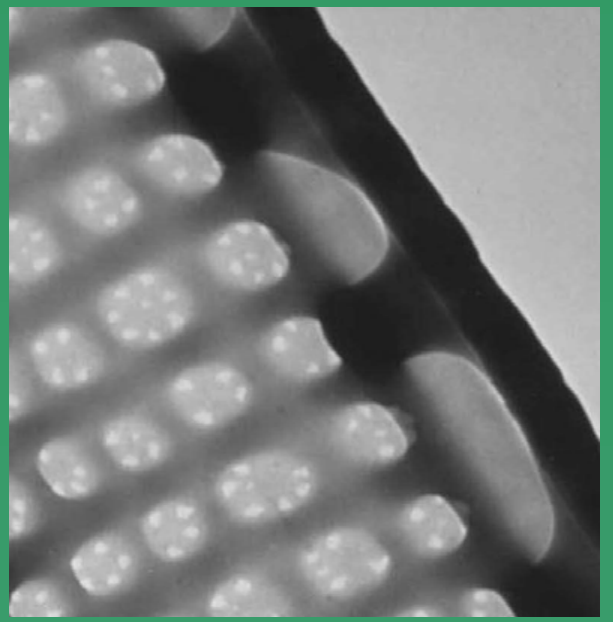
Species	Culture code	Isolation date
P.multistriata Takano	PM01	21.10.1999
P. multiseries (Hasle) Hasle	PM02	1.11.2002
P.calliantha Lundholm, Moestrup et Hasle	PPD02	21.11.2002

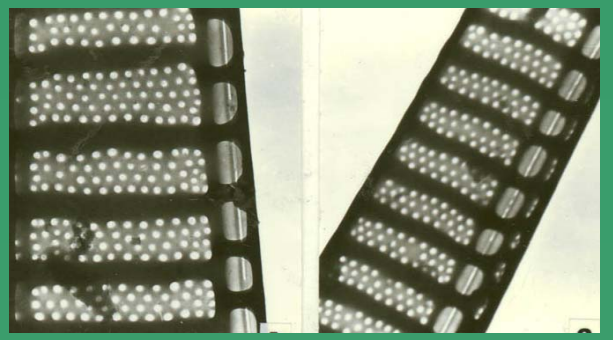
Laboratory cultures of three species were isolated from Peter the Great Bay, the Sea of Japan

Toxicity analysis of *Pseudo-nitzschia* species from the southeast coast of Russia

- *P. calliantha* (clone PPD02)
- *P. multiseries* (clone PM02)
- *P.multistriata* (clone PM01)

The study documents the toxicity of *Pseudo-nitzschia* from Russian marine waters for the first time. The highest domoic acid concentration was 760 ng mL-1 in a 27 day-old culture of *P. multiseries** (clone PM02). No domoic acid (<1 ng mL-1) was detected in the cultures of *P. calliantha** (clone PPD02) and *P. multistriata* (clone PM01).





* (by Stephen S. Bates, Gulf Fisheries Centre, New Brunswick, Canada)