

# Species composition and long-term dynamics of potentially toxic dinoflagellate species in benthic assemblages of Peter the Great Bay, Sea of Japan

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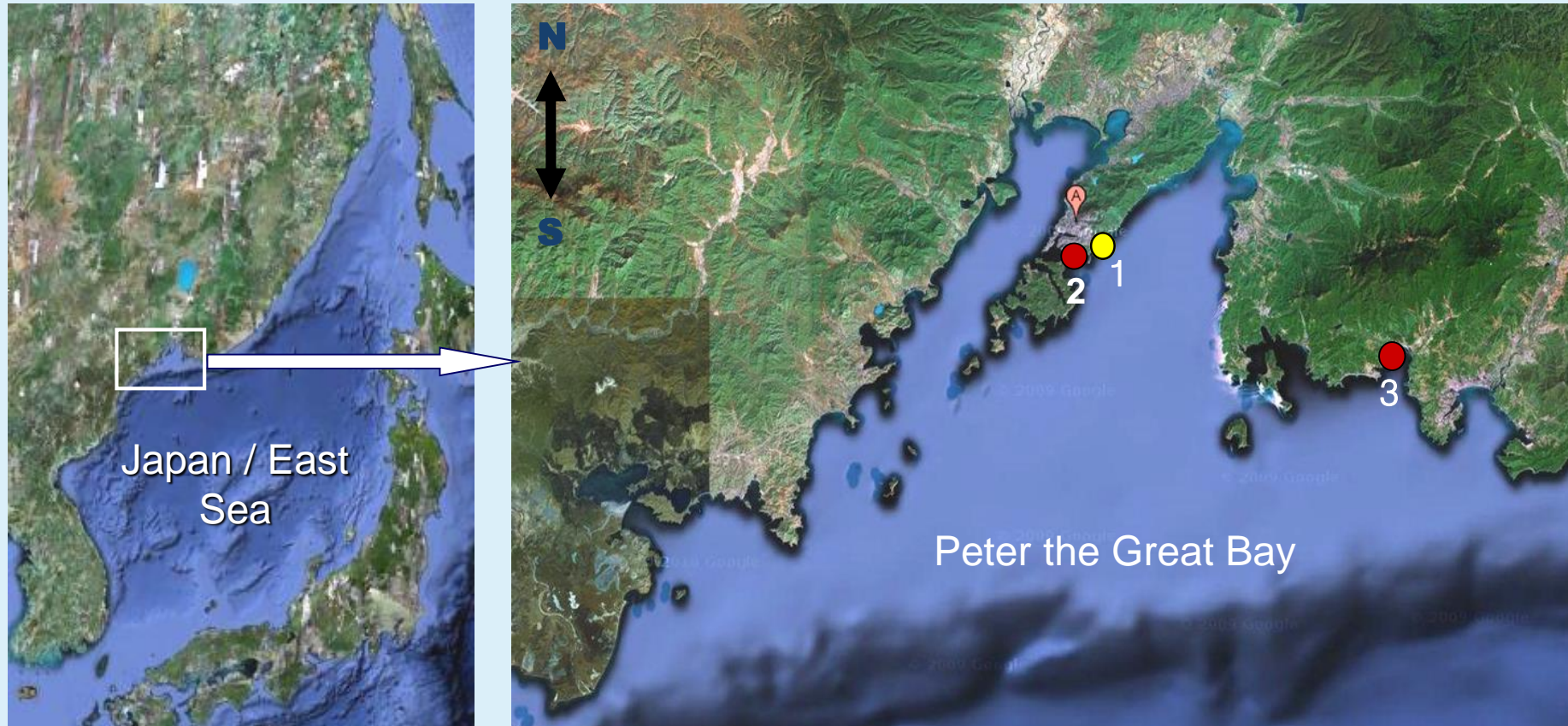
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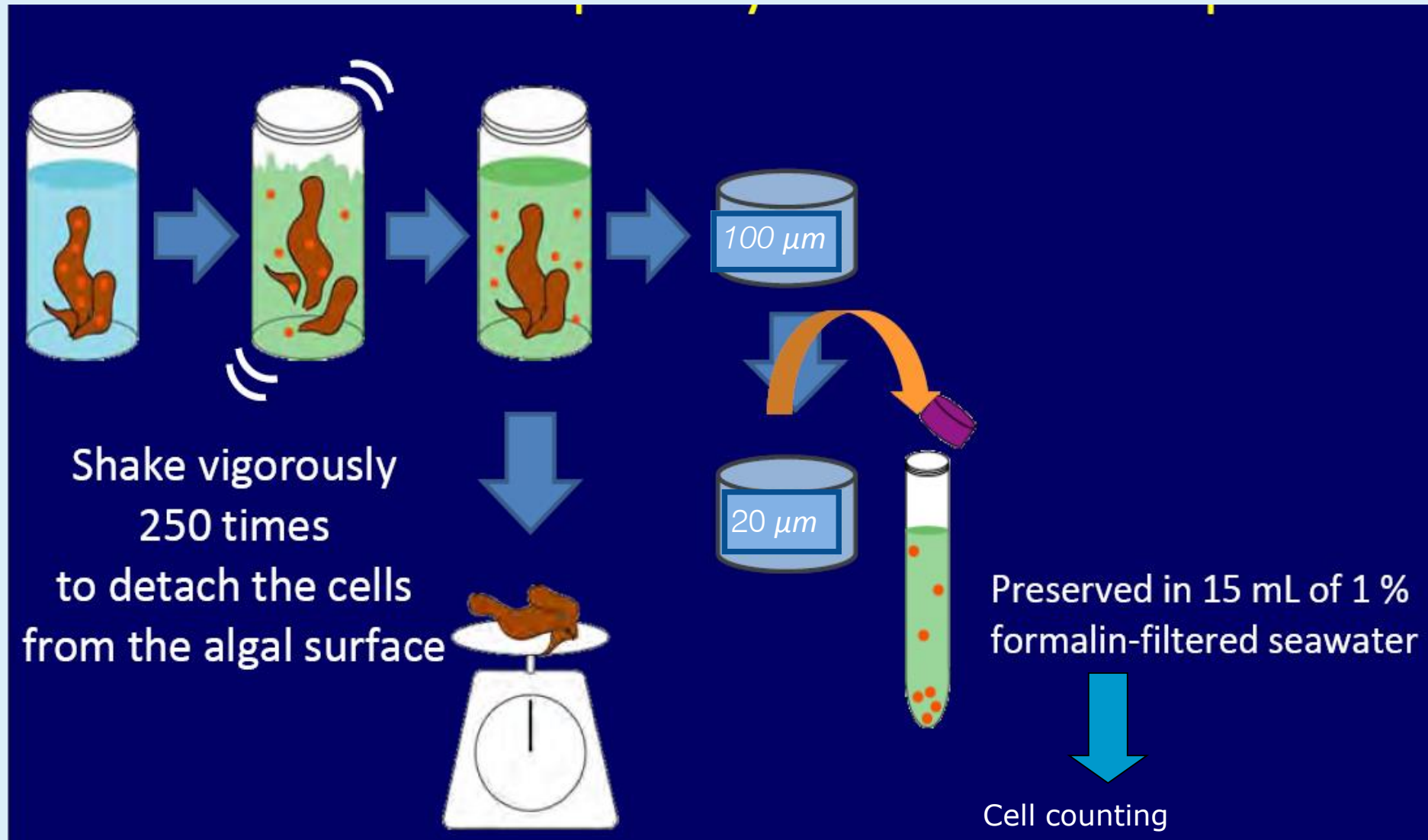
# Introduction

- Benthic dinoflagellates include about 190 species and 45 genera. About 60 species of all dinoflagellates can produce various toxins. Among them 30 species are benthic.
- Recently the study of benthic dinos focuses on the species diversity. Abundance, temporal and spatial changes are known mainly for epiphytic communities, which is basically connected with the ciguatera. Information about sand-dwelling dinos are limited by some areas of World Ocean.
- The present work represents the species composition, long-term dynamics and the maximum abundance of benthic dinoflagellates in Peter the Great Bay (Sea of Japan) including toxic species

# Materials and methods



- - Station 1, epiphytic dinoflagellates, from 2008
- - Stations 2 & 3, sand-dwelling dinoflagellates, from 2005



**Epiphytic dinos abundance - cells/g dry weight of macrophyte**

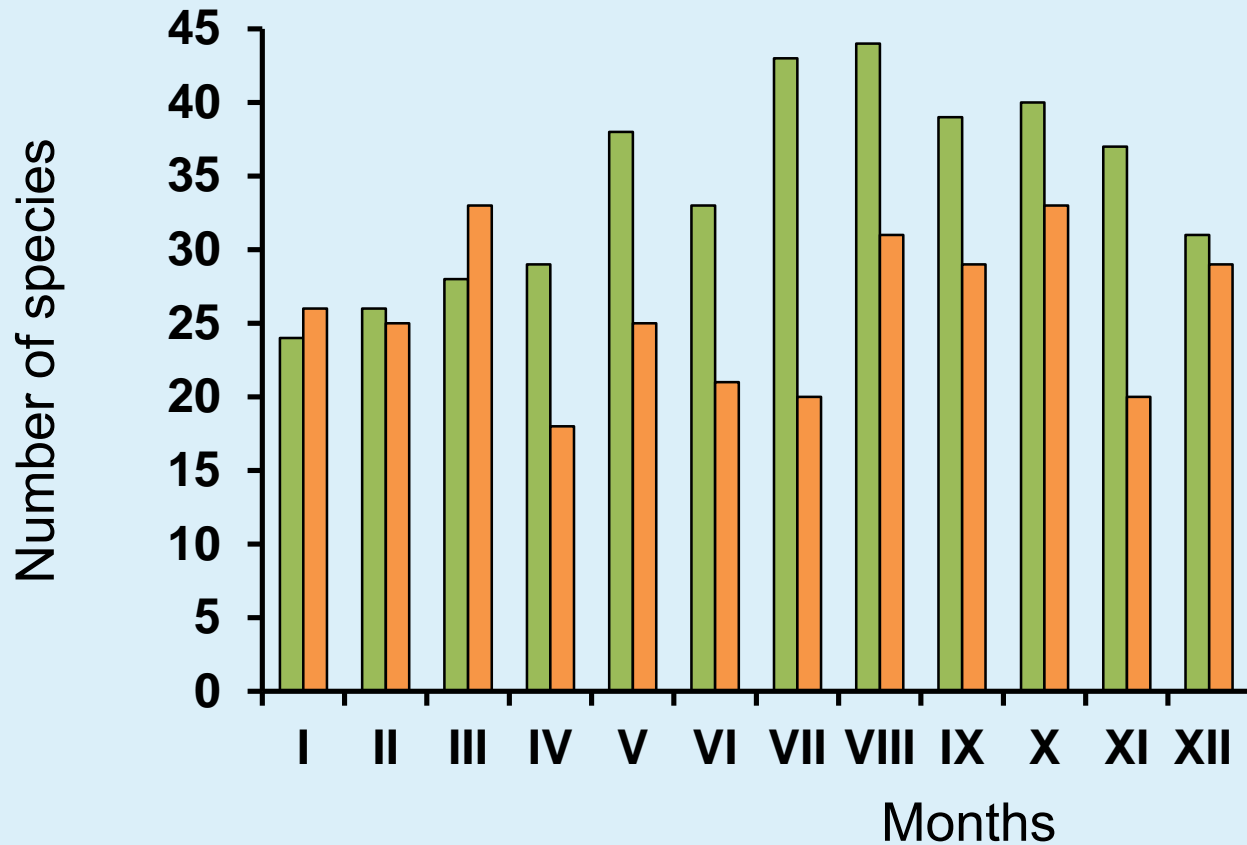
**Sand-dwelling dinos abundance - cells/cm<sup>3</sup> of sand**

# Results

## World biodiversity of benthic species

Region	Number of species	Reference
Elba, Italy	90	Hoppenrath et al.,2014
Brittany, France	78	Hoppenrath et al.,2014
<b>Sea of Japan, Russia</b>	<b>67</b>	<b>Selina, 2016</b>
North German Wadden Sea, Germany	67	Hoppenrath et al.,2014
Arabian Gulf, Kuwait	55	Hoppenrath et al., 2014
British Columbia, Canada	52	Hoppenrath et al.,2014
North-Eastern Australia	50	Hoppenrath et al.,2014
Jeju, South Korea	37	Shah et al.,2013
Botany Bay, Australia	36	Hoppenrath et al.,2014
Pacific coast of Japan	32	Hoppenrath et al., 2014
Malaysia	24	Hoppenrath et al., 2014

Number of species	Sand-dwelling dinos	Epiphytic dinos
Total	67 species (25 genera)	15 species (7 genera)
Annual fluctuations	18 (winter) – 44 (summer)	1 (winter) – 8 (autumn)

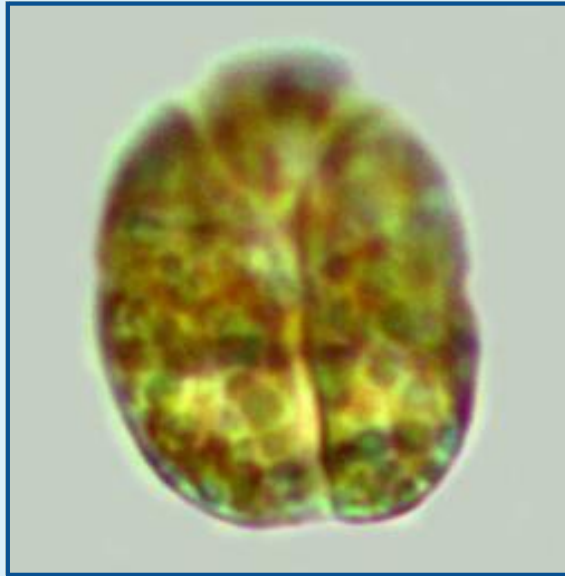


The seasonal dynamics of the total species richness of sand-dwelling dinoflagellates

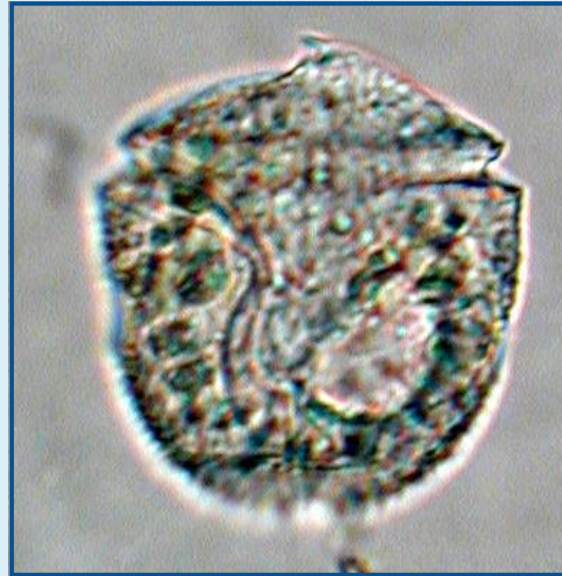
- Station 3
- Station 2

67 benthic species of dinoflagellates:

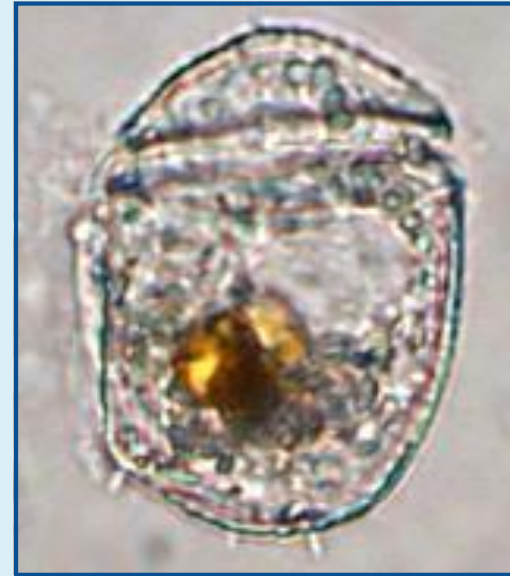
- 17 taxa - undetermined taxonomic status,
- 31 species – new for the seas of Russia,
- 8 species - new for Far Eastern seas of Russia.



*Amphidinium*  
9 species



*Amphidiniopsis*  
9 species

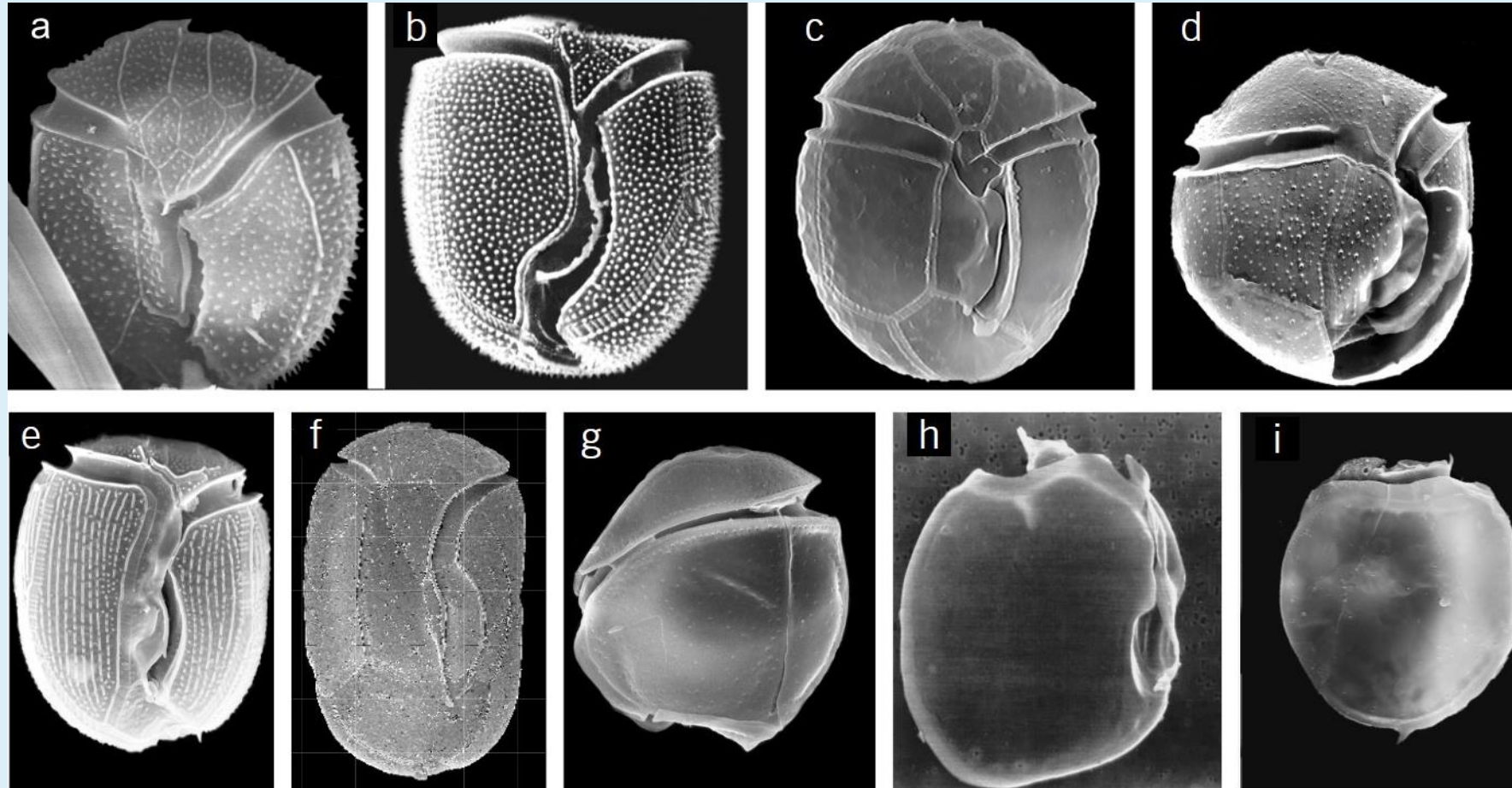


*Thecadinium*  
6 species



*Sinophysia*  
4 species

Six new species from the genus *Amphidiniopsis* (a-f), one species from the genera *Cabra* (g) and *Sinophysis* (h), and one intraspecific taxa of *Sabulodinium undulatum* (i) were described during the study period.

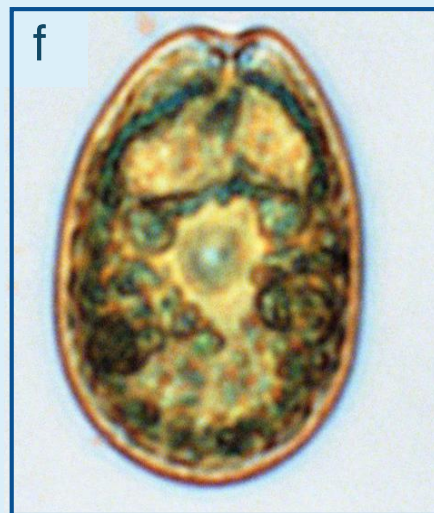
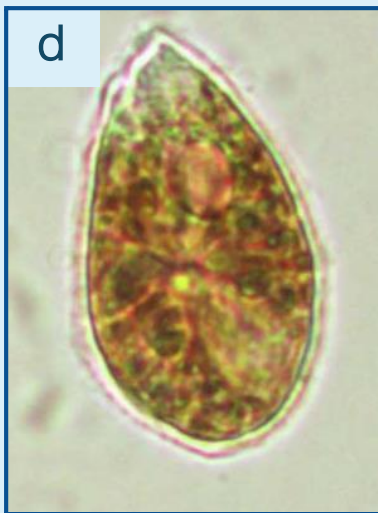


- a - *Amphidiniopsis hoppenrathae*<sup>1</sup>,  
 b - *A. konovalovae*<sup>2</sup>,  
 c - *A. ovalis*<sup>1</sup>,  
 d - *A. rotundata*<sup>3</sup>,  
 e - *A. striata*<sup>2</sup>,  
 f - *A. elongata*<sup>1</sup>,  
 g - *Cabra levis*<sup>4</sup>,  
 h - *Sinophysis minima*<sup>5</sup>,  
 i - *Sabulodinium undulatum* var. *glabromarginatum*<sup>6</sup>

1 – Selina, Morozova, 2016; 2- Selina, Hoppenrath, 2013; 3 – Hoppenrath et al., 2012; 4- Selina et al., 2015; 5- Selina, Hoppenrath, 2004; 6 - :Hoppenrath et al., 2007



## Potentially toxic benthic dinoflagellates



*a* - *Amphidinium operculatum*  
Claparede et Lachmann,

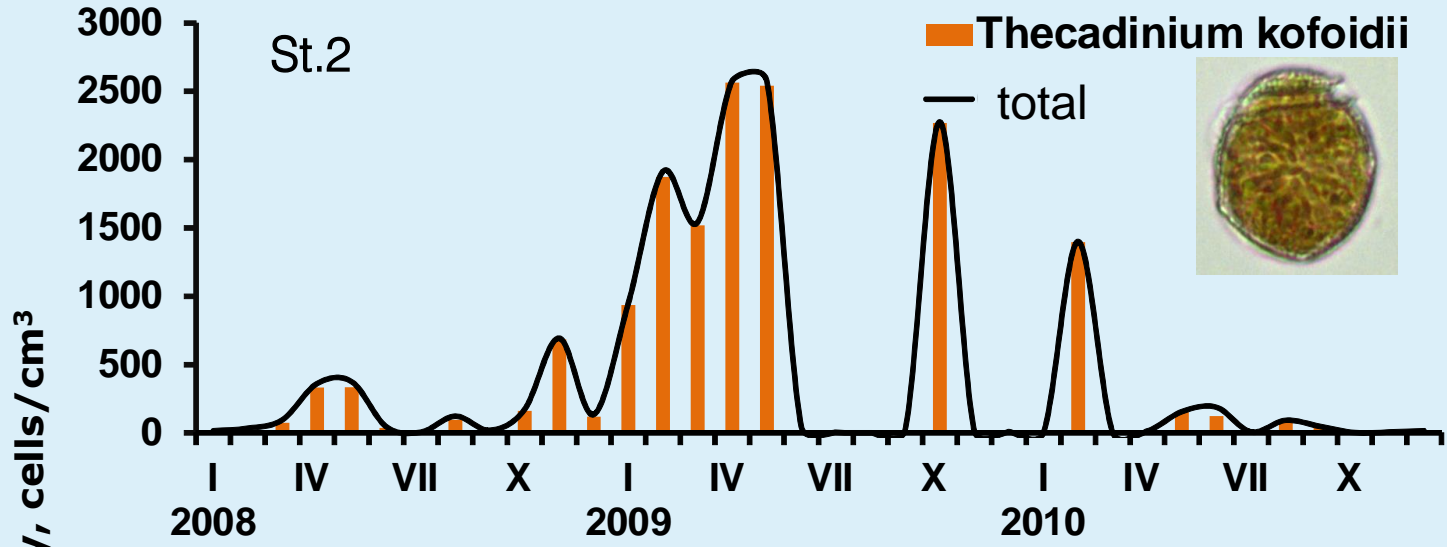
*b* - *A. carterae* Hulbert,

*c* - *A. gibbosum* (Maranda et Shimizu)  
Murray et Flø Jørgensen,

*d,e* - *Ostreopsis ovata* complex Fukuyo,

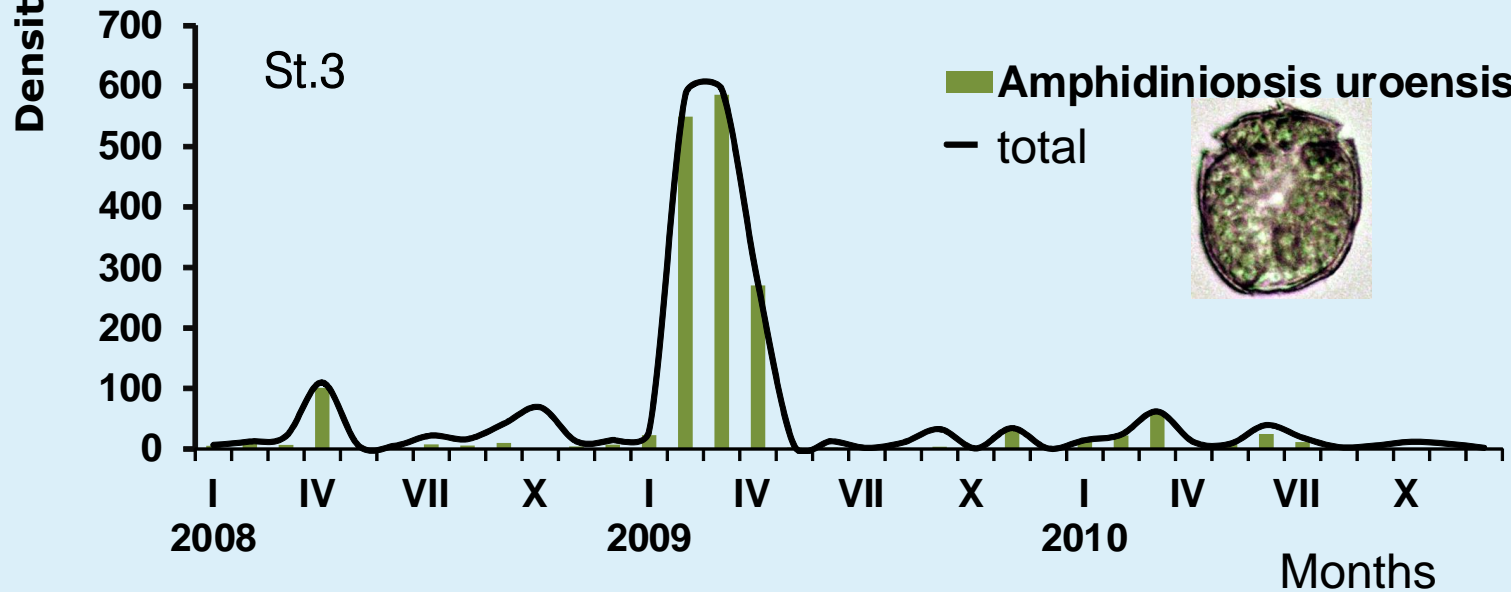
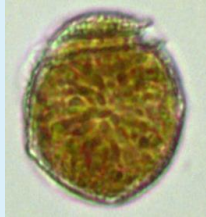
*f* - *Prorocentrum foraminosum* Faust

# The seasonal dynamics of cell density of sand-dwelling dinoflagellates and the main dominant species



The proportion of the main dominant species during the year:

*Thecadinium kofoidii* - 77–99%

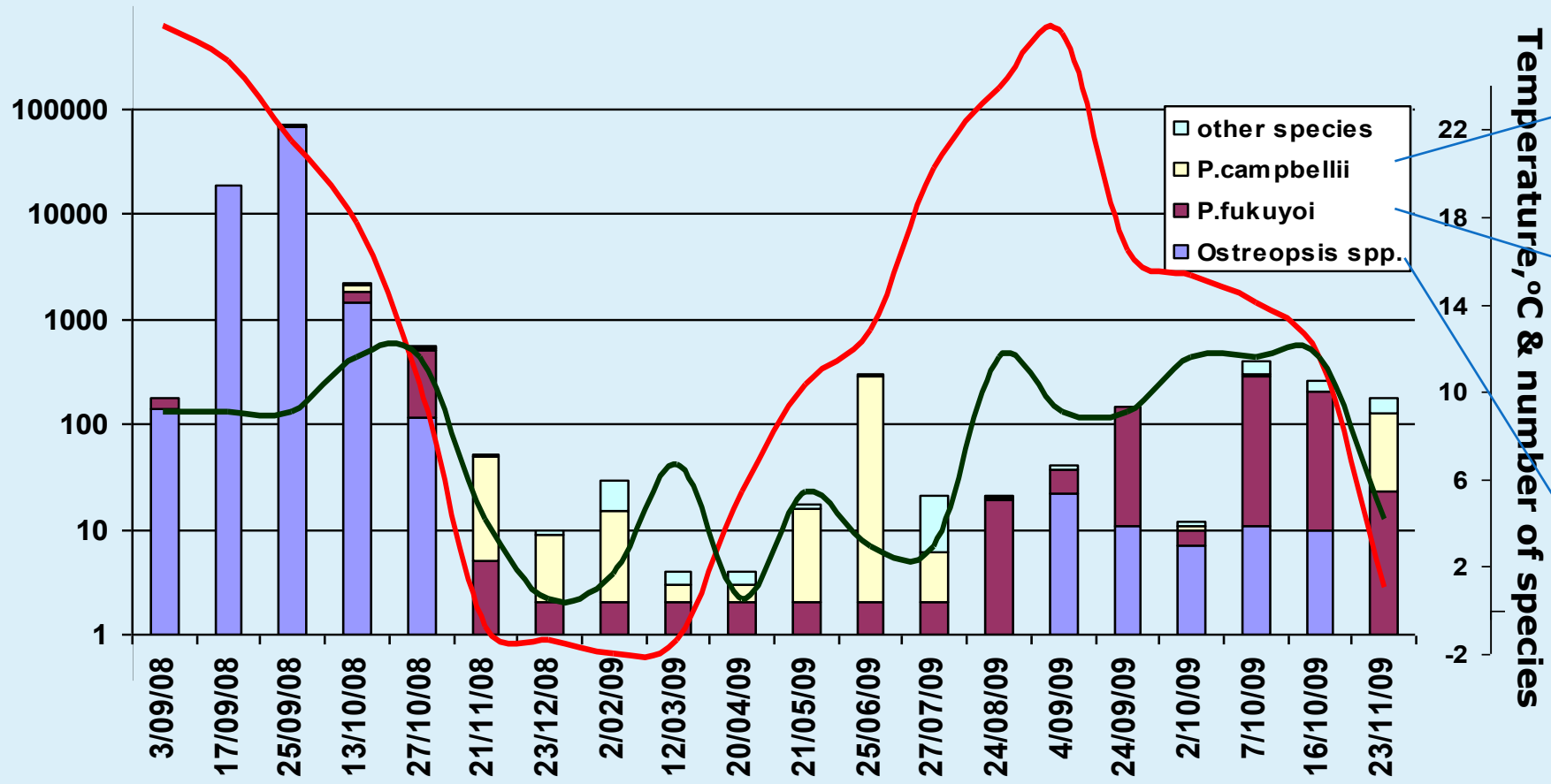


*Amphidiniopsis uroensis* - 19–98%.



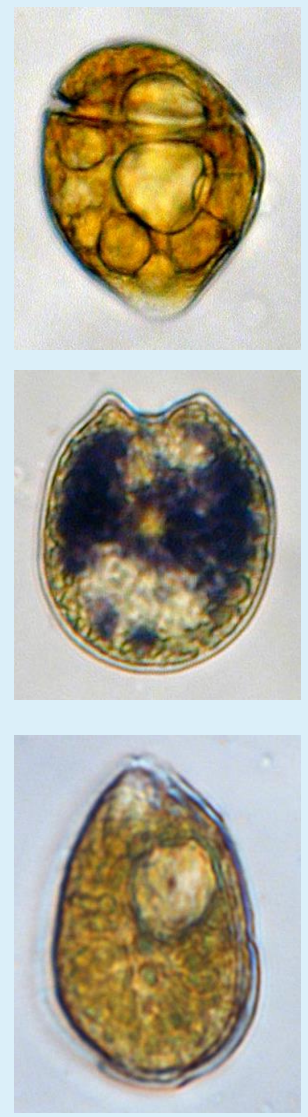
# The seasonal dynamics of cell density of epiphytic dinoflagellates and the main dominant species

Density, cells/g dry weight of macrophyte

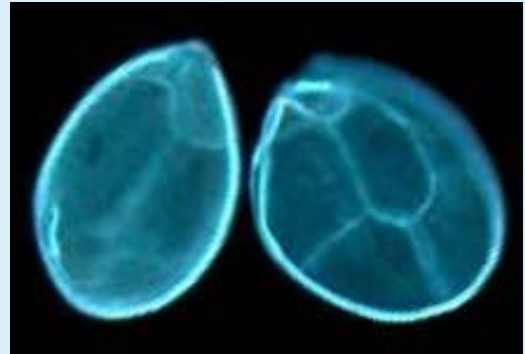
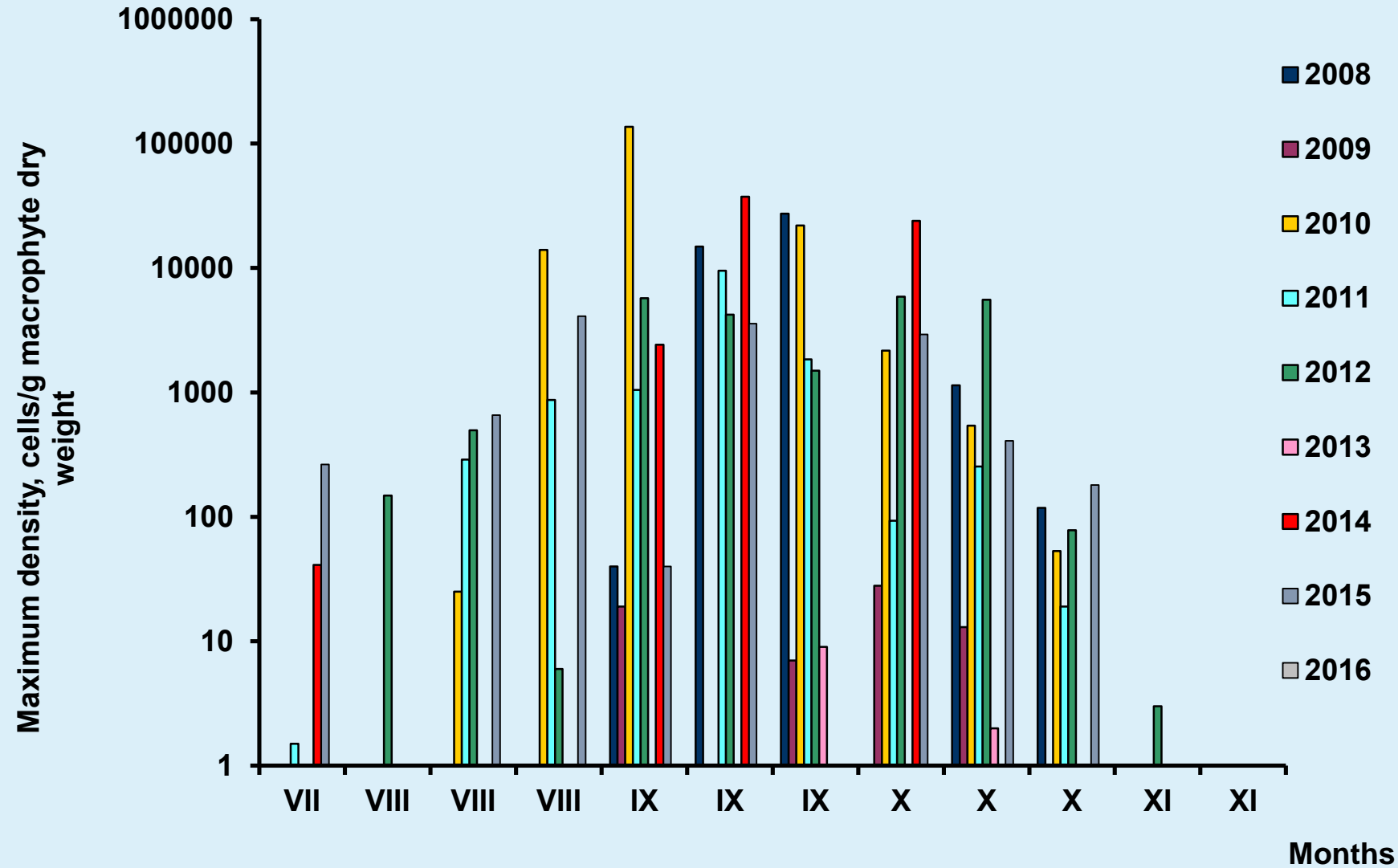


— Water temperature, °C      — Number of species

Temperature, °C & number of species

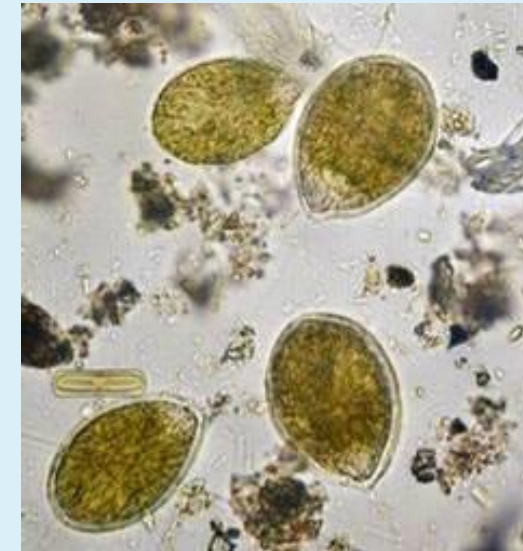
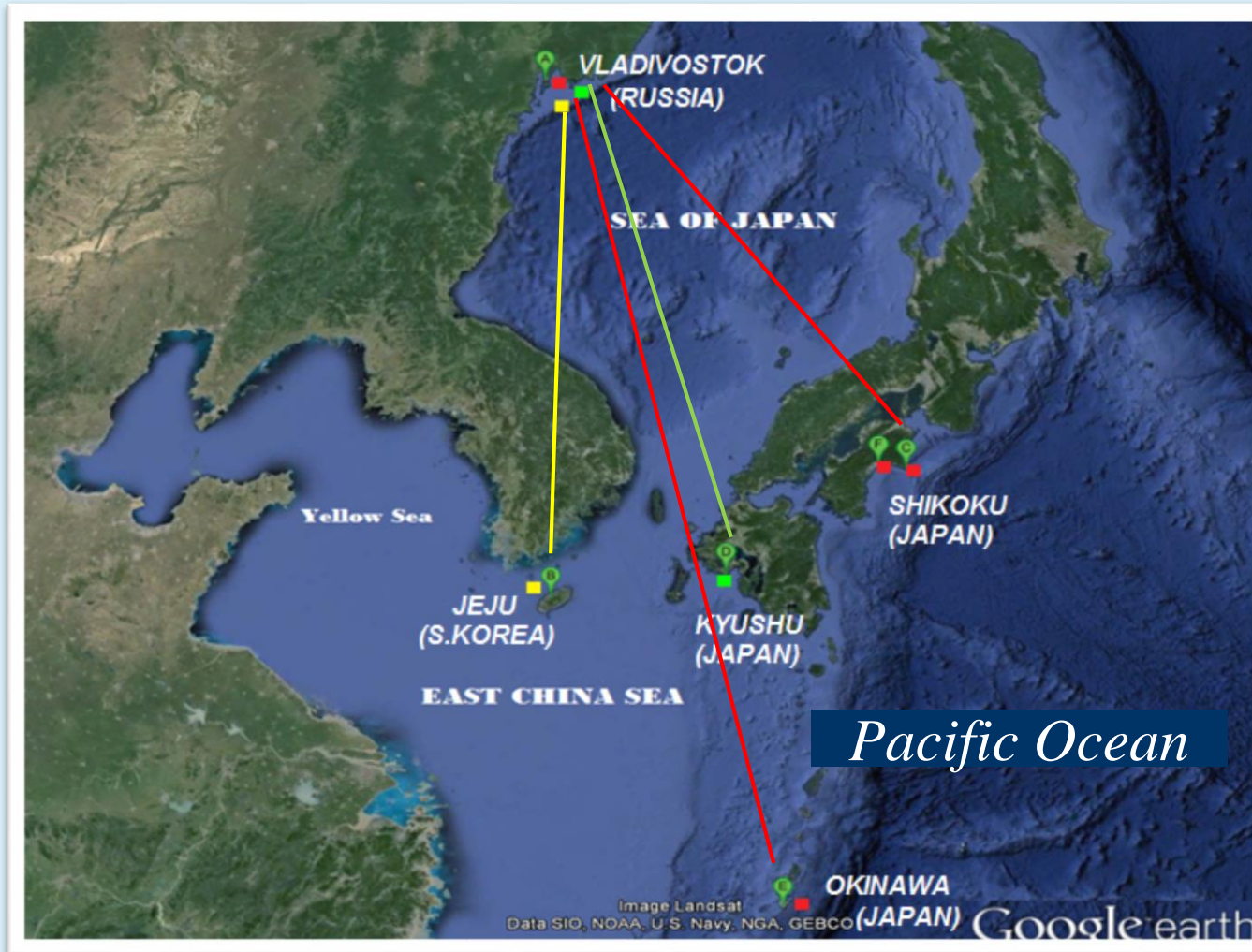


# The long-term dynamics of *Ostreopsis* spp. density on macrophytes



*Ostreopsis* is the only genus of potentially toxic dinoflagellates, which is regularly reported to bloom in waters of Peter the Great Bay

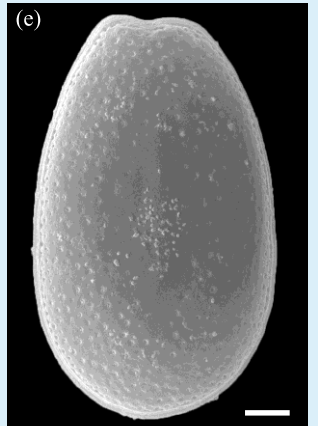
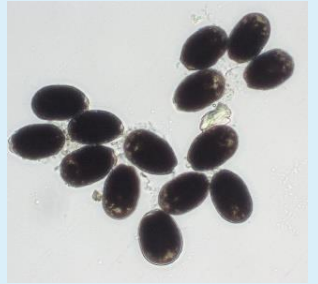
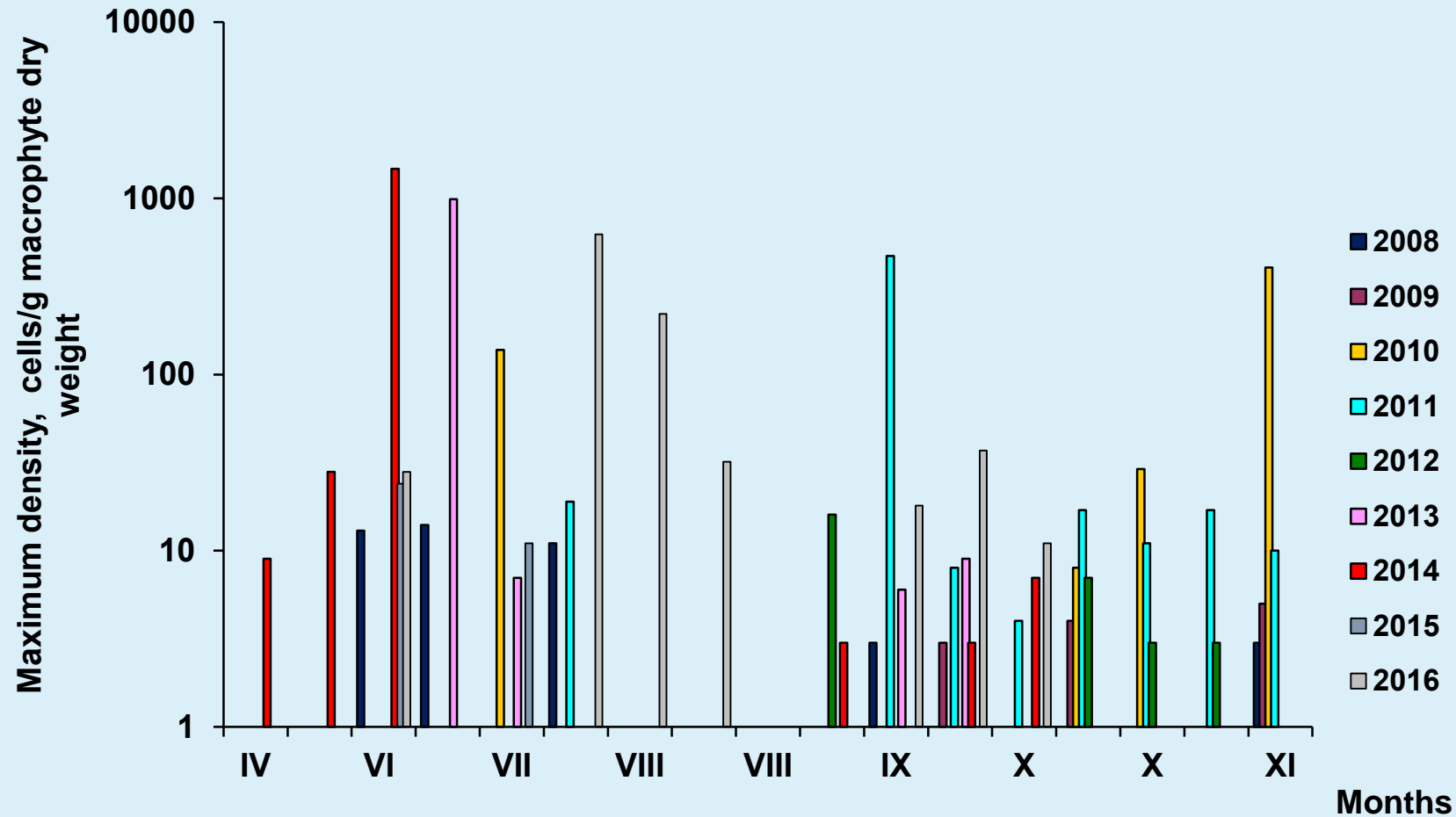
# Distribution of the *Ostreopsis* ribotypes registered in Russian waters



Efimova K.V. et al. Phylogenetic characterization of cryptic species of the marine dinoflagellate, *Ostreopsis* sp. Schmidt, 1902, from Russian coastal waters, the Sea of Japan // J. Biodiversity and Environmental Sciences. 2014. Vol. 5, no. 4. P. 317-332.

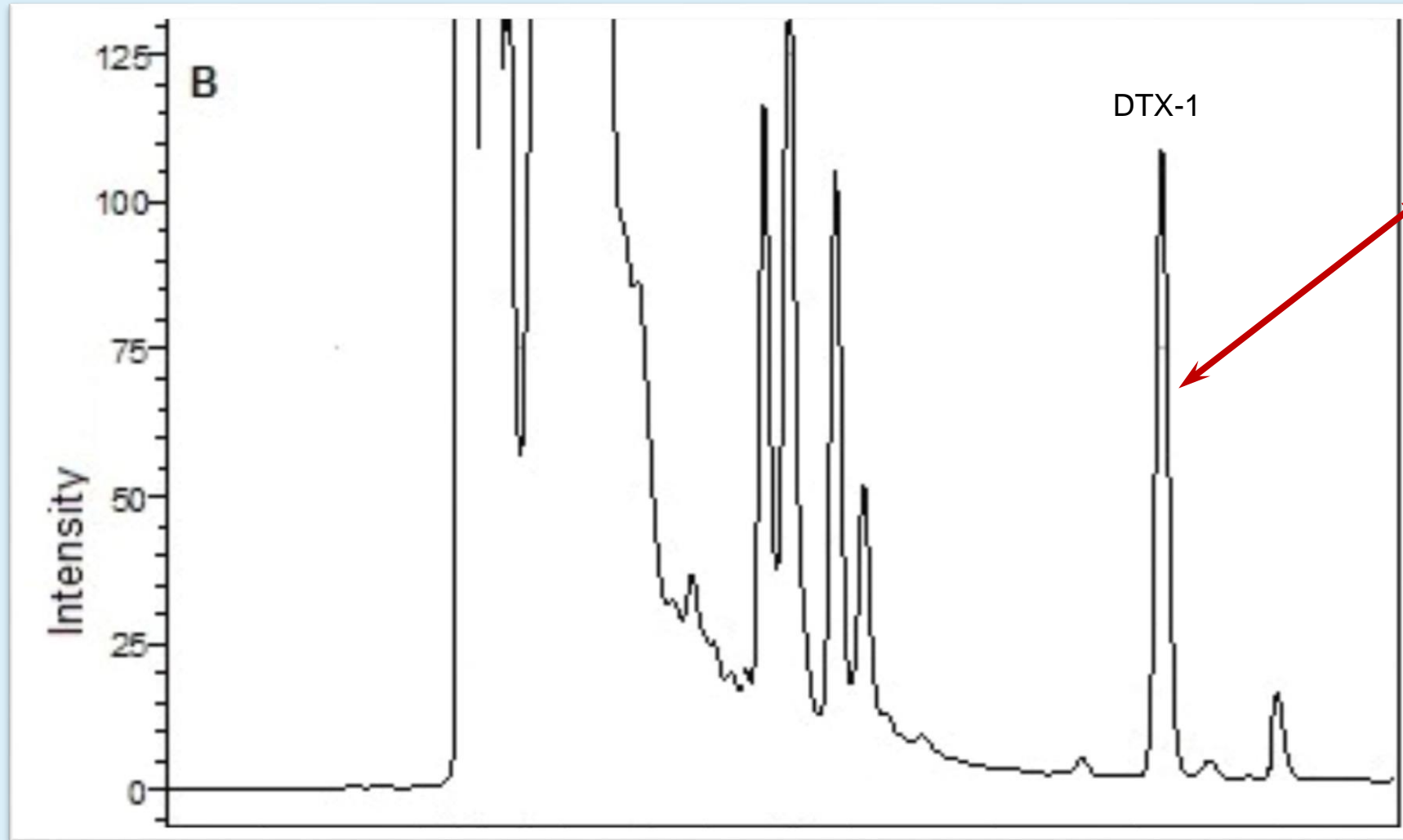
Identical ribotypes are depicted in one color.  
Phylogenetic analysis of clonal cultures and single cells of *Ostreopsis* spp., isolated from the Peter the Great Bay, showed three distinctly different ribotypes according to the nucleotide sequences of ribosomal DNA (rDNA).

# The long-term dynamics of *Prorocentrum foraminosum* density on macrophytes



*P. foraminosum* occurred regularly from April to November in the epiphytic assemblages of Peter the Great Bay (Sea of Japan).

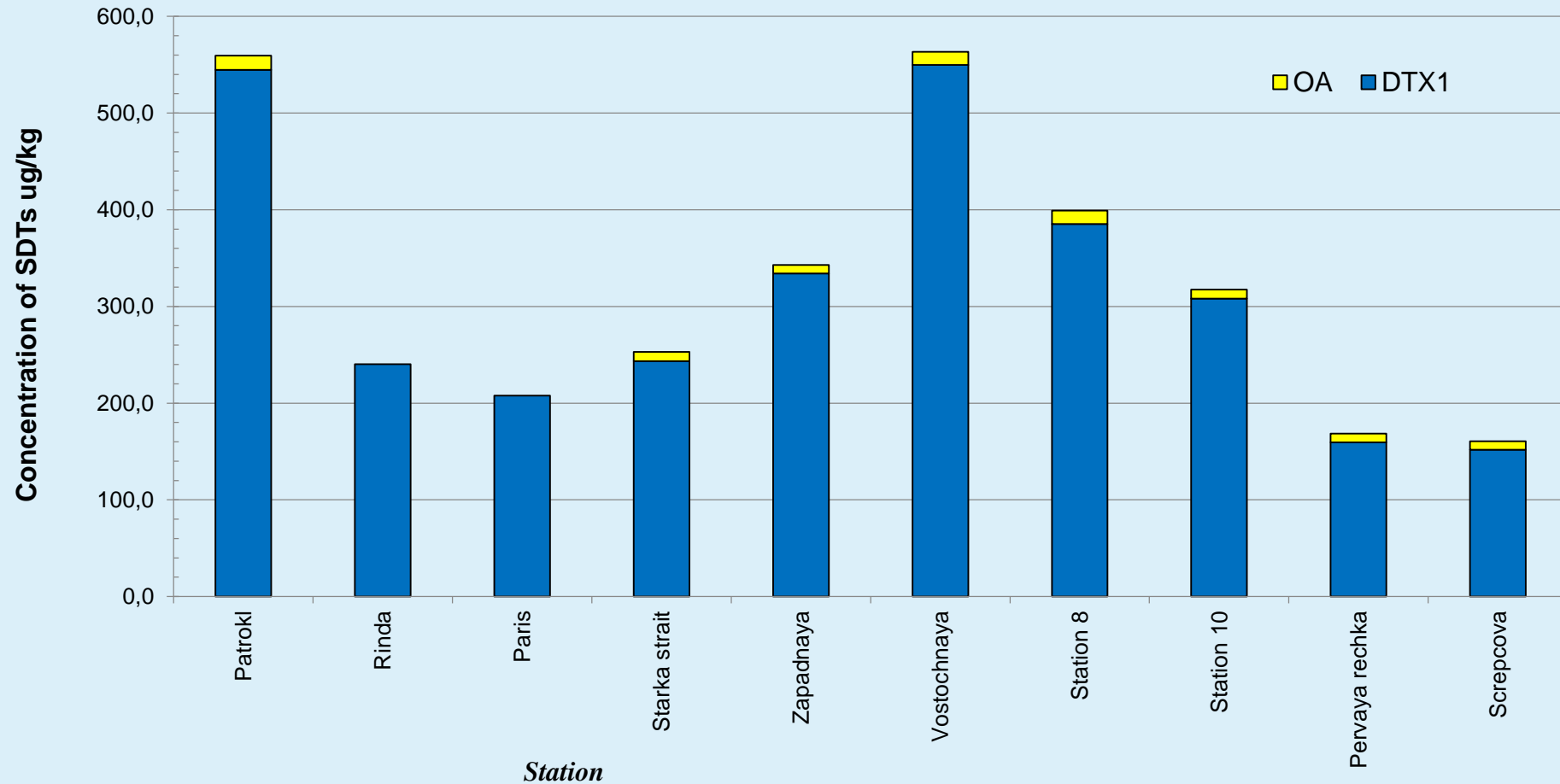
## *Prorocentrum foraminosum*



In culture of *P. foraminosum* containing 3500-5000 cell/mL **DTX-1** was determined  **$8.4 \pm 2.5$  pg/cell**  **$27.9 \pm 14.7$   $\mu$ g/mL of cell-free media** (HPLC with high-resolution tandem mass-spectrometry)

Kameneva P.A. et al. Detection of dinophysistoxin-1 in clonal culture of marine dinoflagellate *Prorocentrum foraminosum* (Faust M.A., 1993) from the Sea of Japan // *Toxins*. 2015. Vol. 7(10). P. 3947-3959.

## Qualitative composition of DSTs in mussels in Peter the Great Bay (2012)





## Conclusions

- **The species richness of benthic dinoflagellates in Peter the Great Bay exceeds that of many parts of the World Ocean.**
- **Potentially toxic dinoflagellates are constant and abundant in the epiphyton during the summer-autumn period.**