UNIVERSITEIT GENT

FACULTY OF BIOSCIENCE ENGINEERING

Shifting N:P ratios do not affect the competitive traits of dinoflagellates under present and future climate scenarios

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GhEnToxLab

Environmental Toxicology

Harmful Algal Blooms and Climate change – Scientific Symposium – 21st of May 2015

Laboratory of Environmental Toxicology and Aquatic Ecology, Environmental Toxicology Unit (GhEnToxLab)

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"Present and future threat of harmful algal blooms towards Human Health and aquaculture practises in the North Sea"

Belgian part of the

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Spuikom

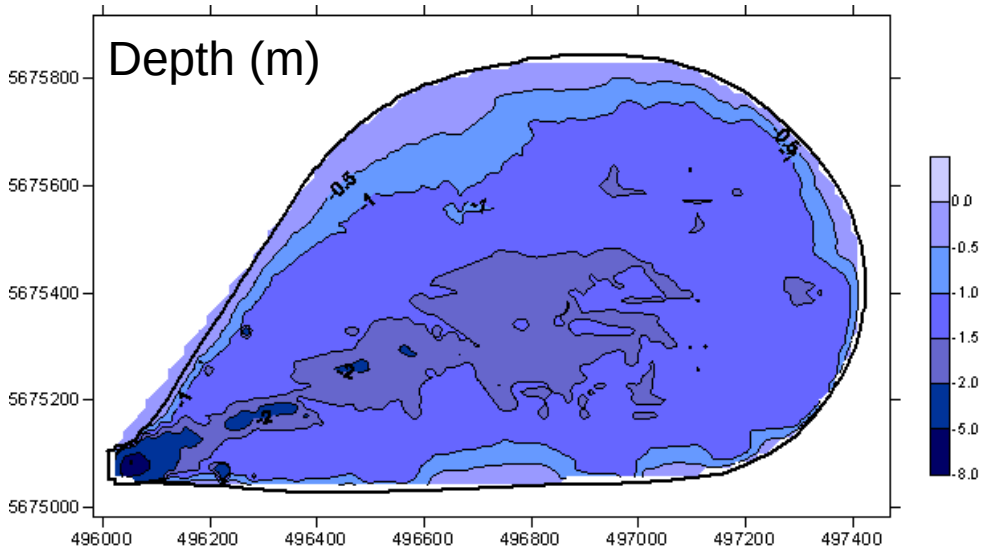
Shallow coastal lagoon (0.8 km²)

Built 1900-1910
Ceased operations in 1913

Only legally designated
"Shellfish water" in Belgium

Gradual eutrophication
- N:P ratios up to 50

Relatively hot
- Av. Summer temperature: 20°C



Spuikom

Observed:

Prorocentrum micans
Scrippsiella trochoidea
Prorocentrum lima
Dinophysis spp.
Pseudo-nitzschia spp.
Karenia spp.

Mesodinium rubrum

LIPOPHILIC TOXINS PROFILE IN MARINE TROPHIC LEVELS FROM THE NORTH SEA, BELGIUM USING UHPLC HR-Orbitrap MS

Gabriel Orellana[1,2], Lieven Van Meulebroek[1], Maarten De Rijcke[2], Colin R. Janssen[2] and Lynn Vanhaecke[1*]

Azaspiracids (2,3,4,8,14,16,20)	⇐	*Azadinium* spp.
Yessotoxins (1,9, 22)	⇐	*Protoceratium reticulatum* (*Gonyaulax* spp.)
Spirolids (B,C,D,E,F,G,H,I)	⇐	*Alexandrium* spp.

Orellana et al. 2015 (in prep)

High diversity of potentially harmful algae

High temperatures

Nutrient load: 0.11 mg.l^{-1} total P – 1.8 mg.l^{-1} total N (mostly nitrate)

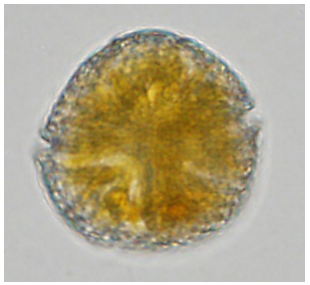
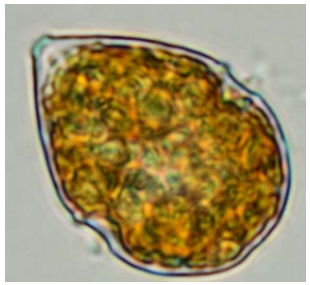
= N:P ratio of 16

Sporadic blooms of:

- *Pseudo-nitzschia* spp. (highest density on record: 59.000 cells.l^{-1})
- *Dinophysis acuminata* (highest density on record: 190 cells.l^{-1})
- *Ulva* spp.
- *Phaeocystis globosa*

Future prospects?

- Increased temperatures because of climate change
- Reduced riverine nitrogen inputs because of legislation?

4 dinoflagellate species (100 cells.m

P. micans, S. trochoidea, P. lima, P. reticulatum

10 N:P ratios (Modified L1 medium)

8-10-12-13-14-15-16-17-18-20-24 Natural for

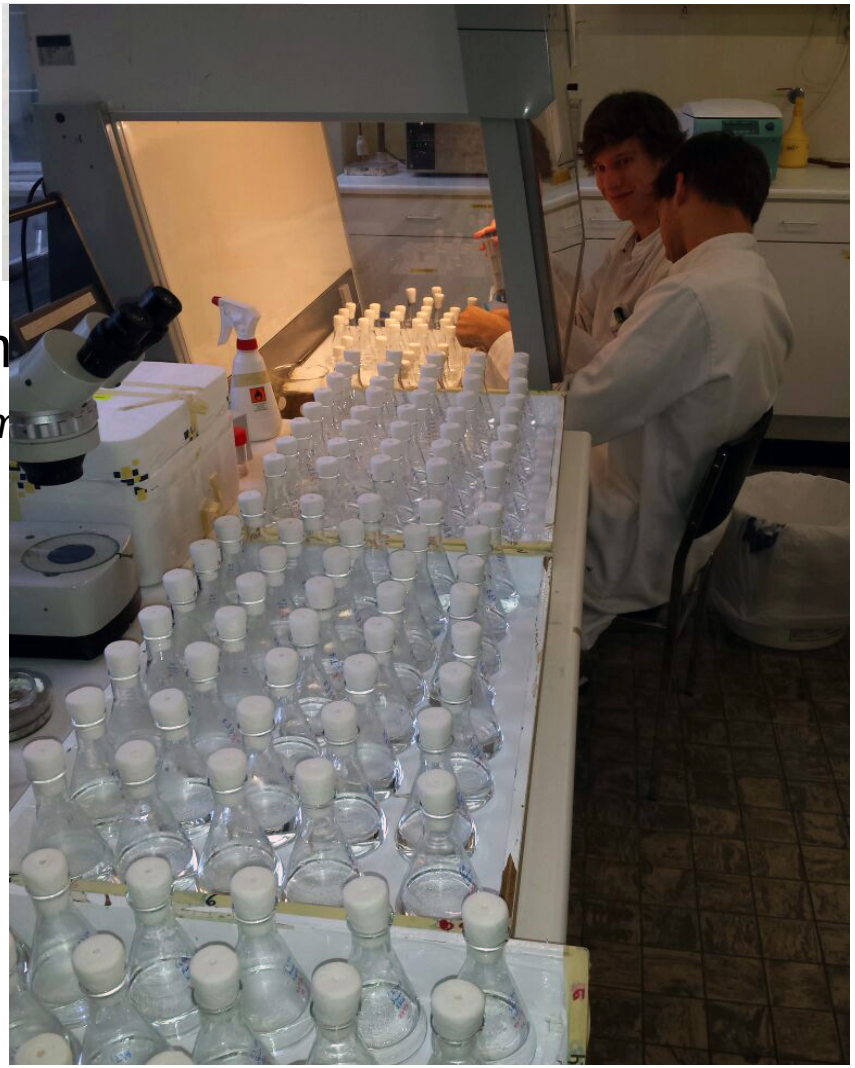
2 temperatures

20°C (current) – 24°C (IPCC's worst case)

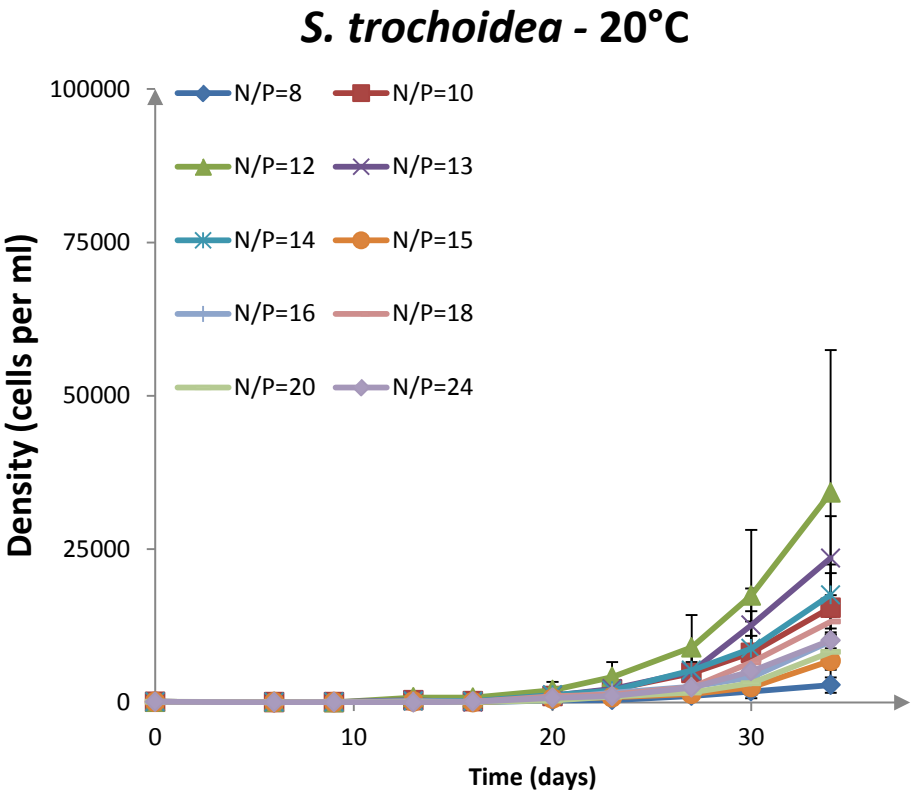
Light-dark cycle 12-12

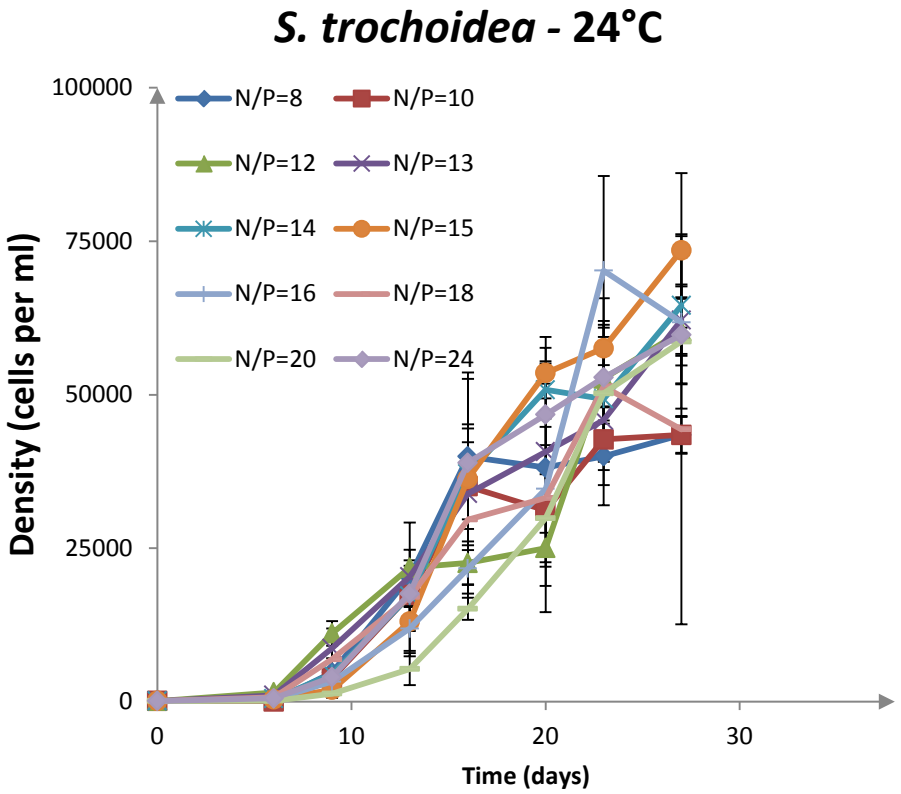
270-670 µmol.m^{-2}.s^{-1}

3 biological replicates



Results





Looks dreadful

Higher temperature - rapid onset of growth
Lower temperature – prolonged lag phase

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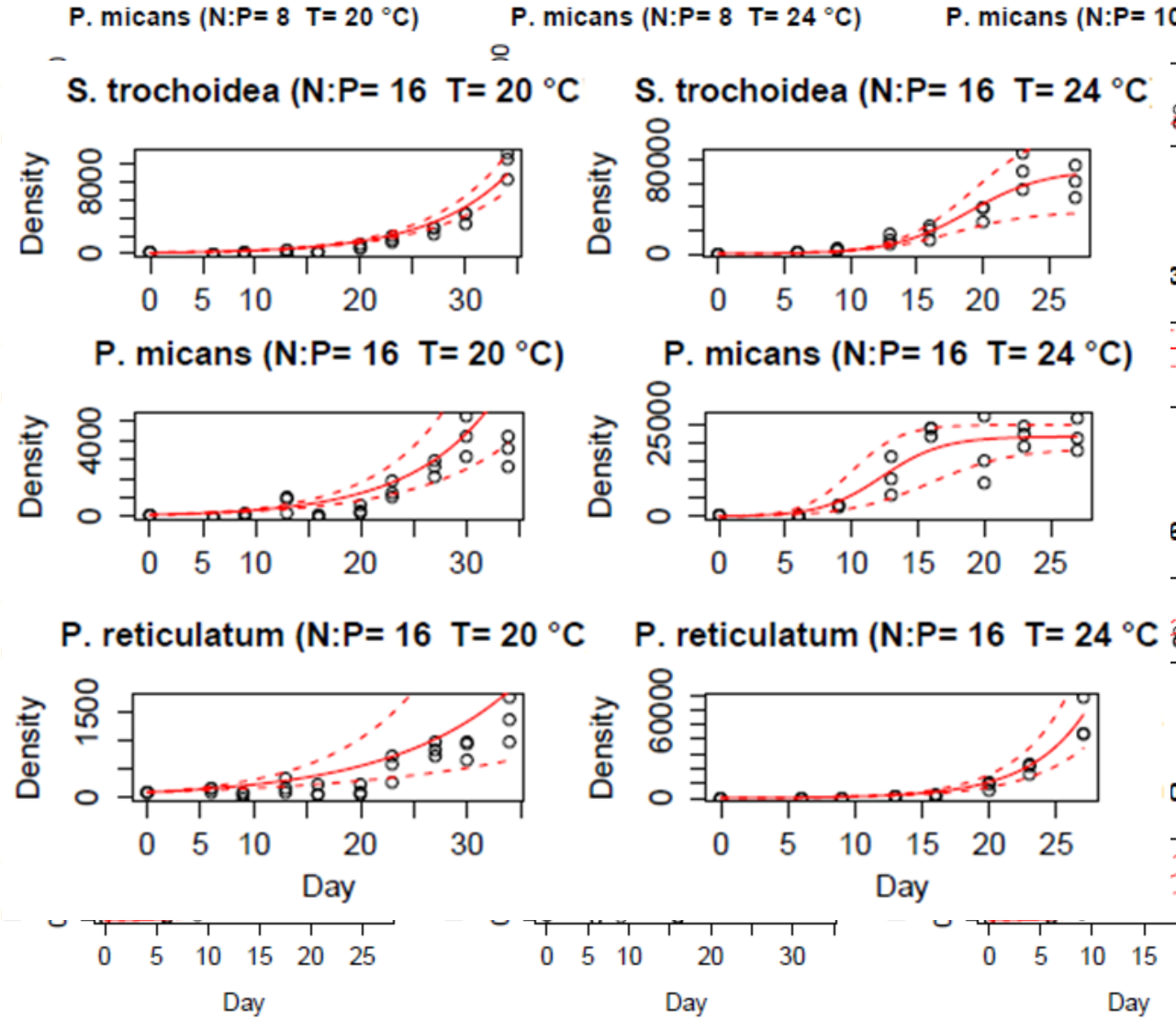
Growth



Carrying capacity?

Logistic growth model

$$\frac{dN}{dt} = \mu_{max} . N . \left(\frac{K - N}{K}\right)$$

N = number of cells

μ = growth rate

K = carrying capacity

If not?

Exponential growth model

$$\frac{dN}{dt} = \mu_{max} . N$$

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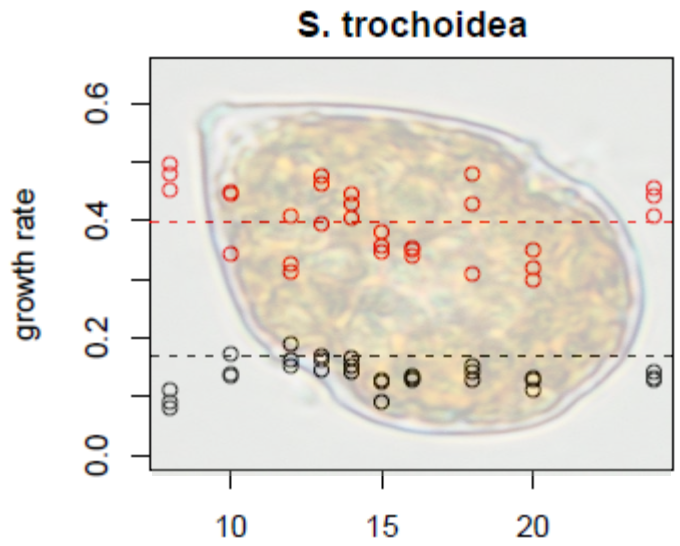
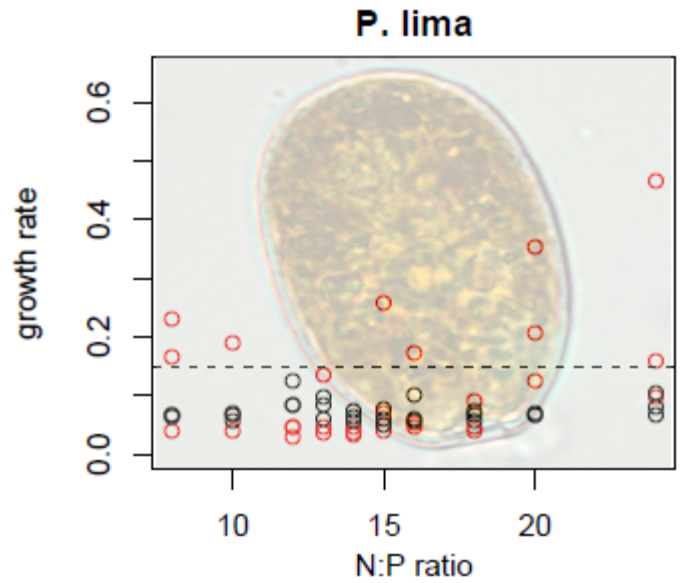
Growth

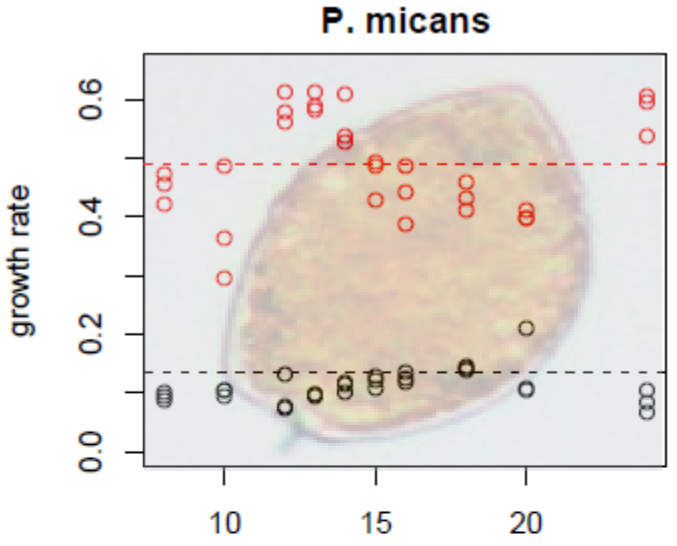


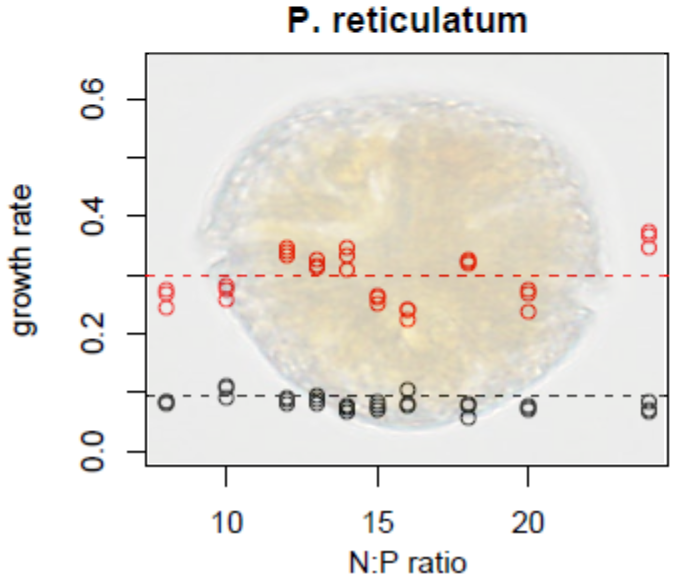


No evidence of an effect of N:P ratio

Significantly higher growth at climate change conditions

Exception:
P. lima





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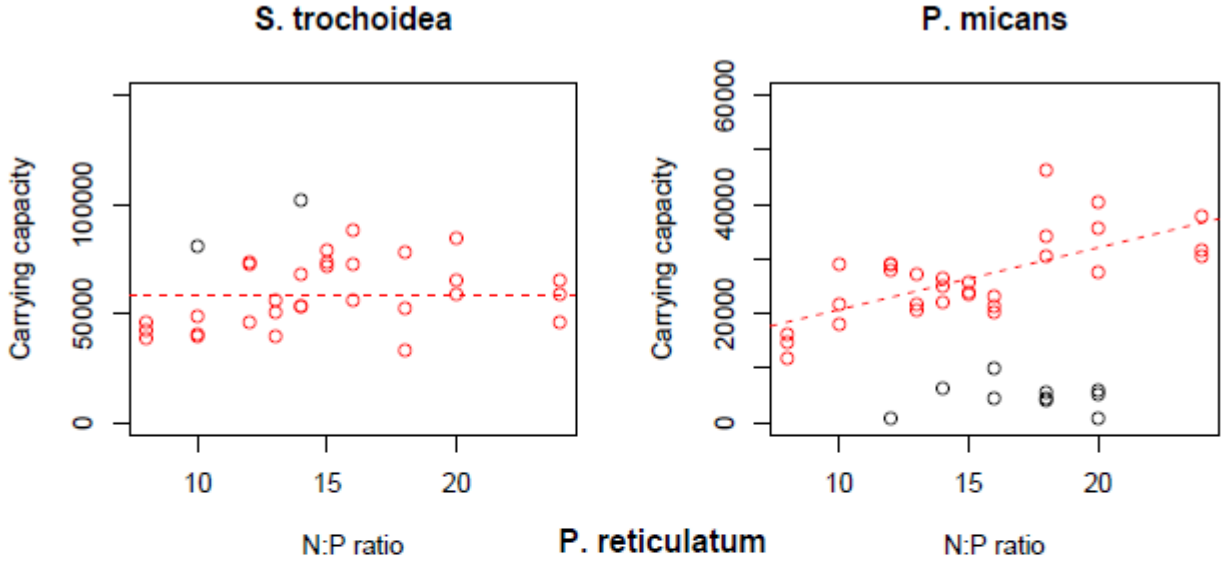
Carrying capacity



Phosphorus limitation
S. trochoidea
&
P. reticulatum

Nitrogen limitation
P. micans

$K \sim N:P = [NO_3^-]$

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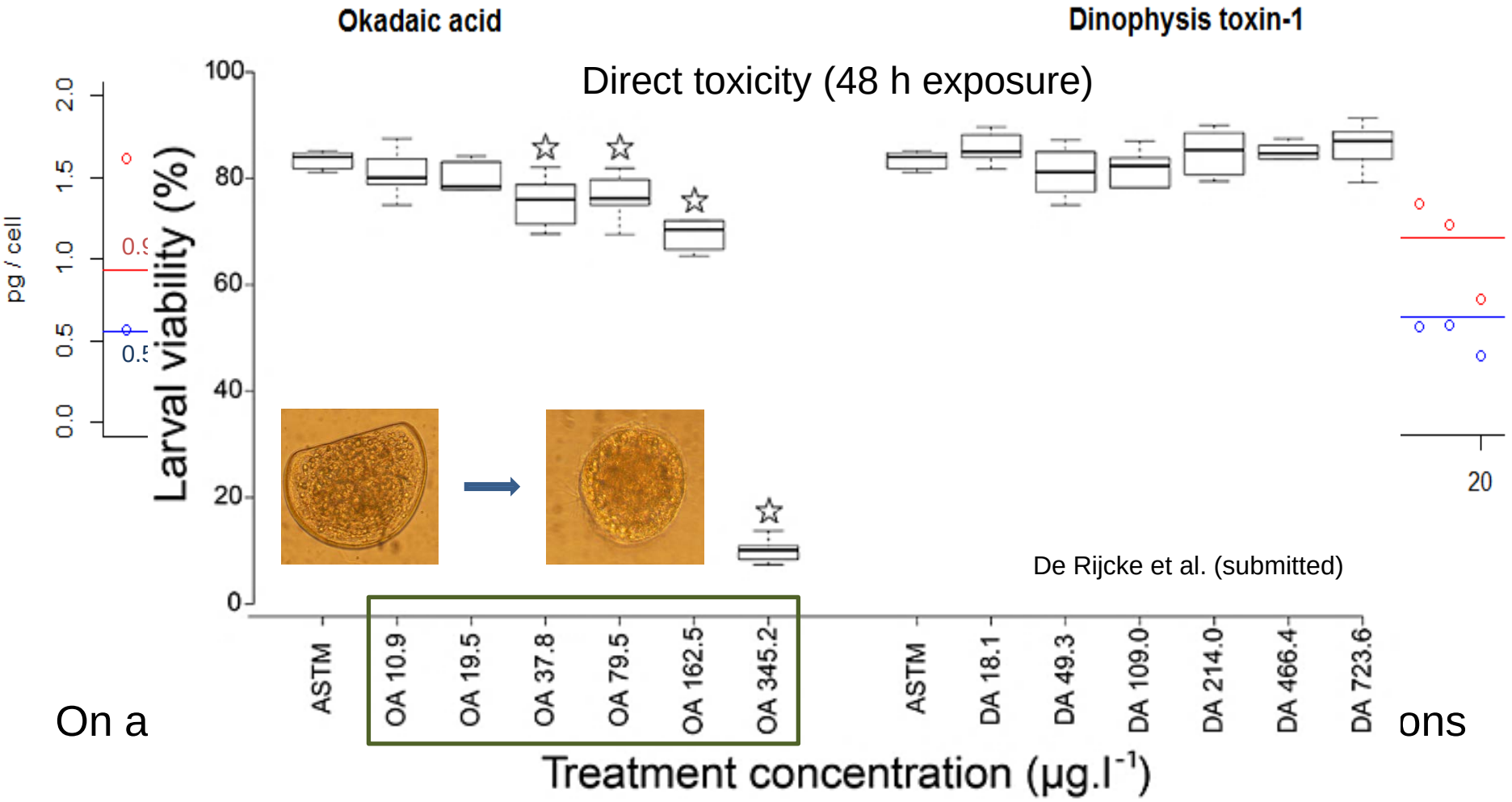
Toxin production



De Rijcke et al. (submitted)

On a ons

YTX content of *P. reticulatum* (CCMP404) negligible

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Competition

No evidence of an effect of N:P on intracellular toxin content and growth
= no effect on interspecific competition?

Temperature leads to higher growth rates (and toxin content)
= changes interspecific competition?

Empirical proof?

240 300 batch cultures of 50 ml

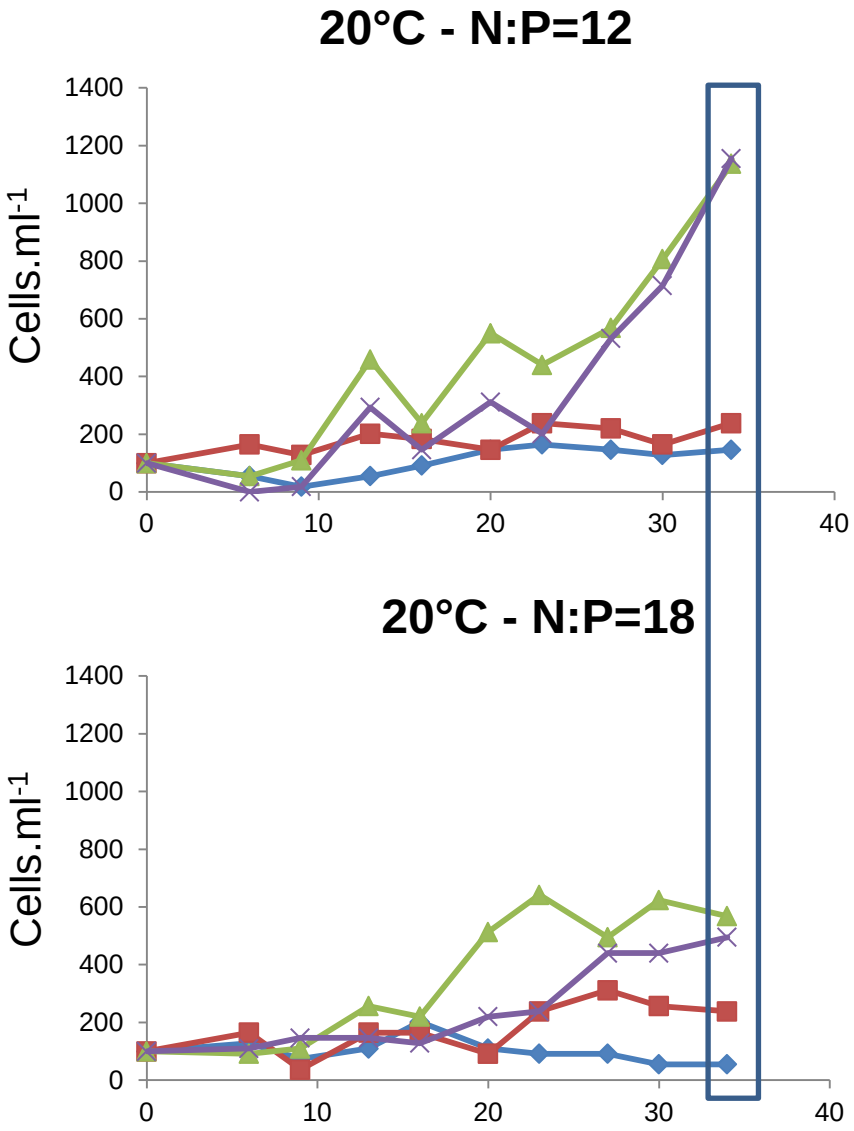
+ mixture of all species

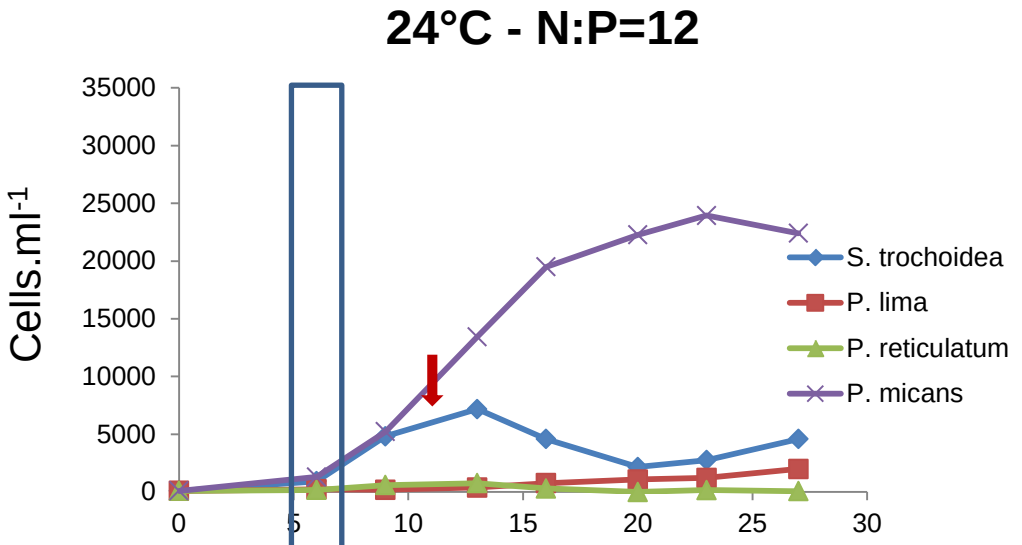
10 N:P ratios (Modified L1 medium)

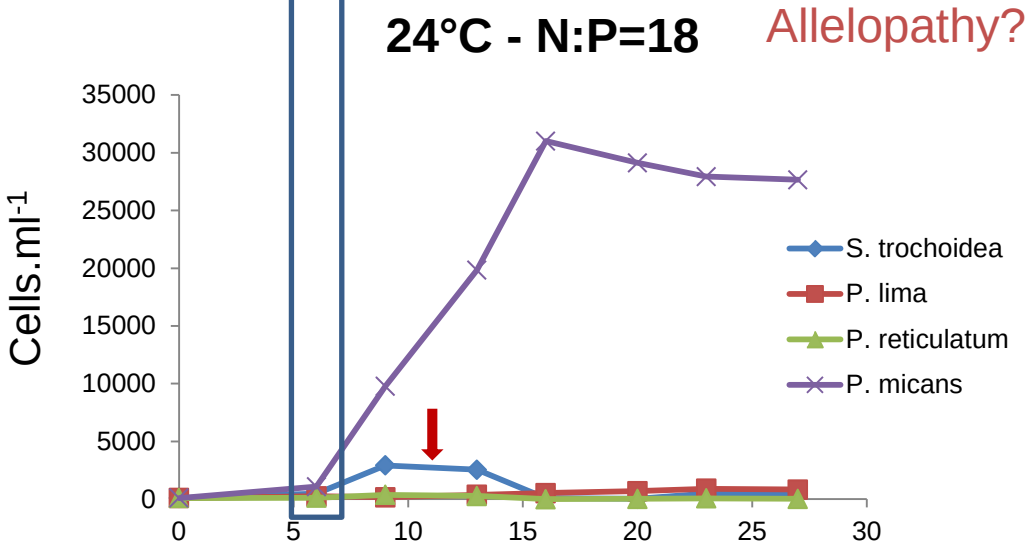
2 temperatures: 20 & 24°C

Light-dark cycle 12-12

3 biological replicates







Allelopathy?

No evidence of an effect of N:P ratio

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Competition (24°C)

Lotka-Volterra model of interspecific competition

$$\frac{dN_1}{dt} = \mu_1 . N_1 . \frac{(K_1 - N_1 - \alpha_{12}N_2 - \alpha_{13}N_3 - ..)}{K_1}$$

N_i = number of cells of species i
μ = growth rate
K = carrying capacity
α = competition coefficient

➡ **Single cultures**

α < 1

Intraspecific competition > interspecific

α = 1

Neutrality

α > 1

Interspecific competition > intraspecific

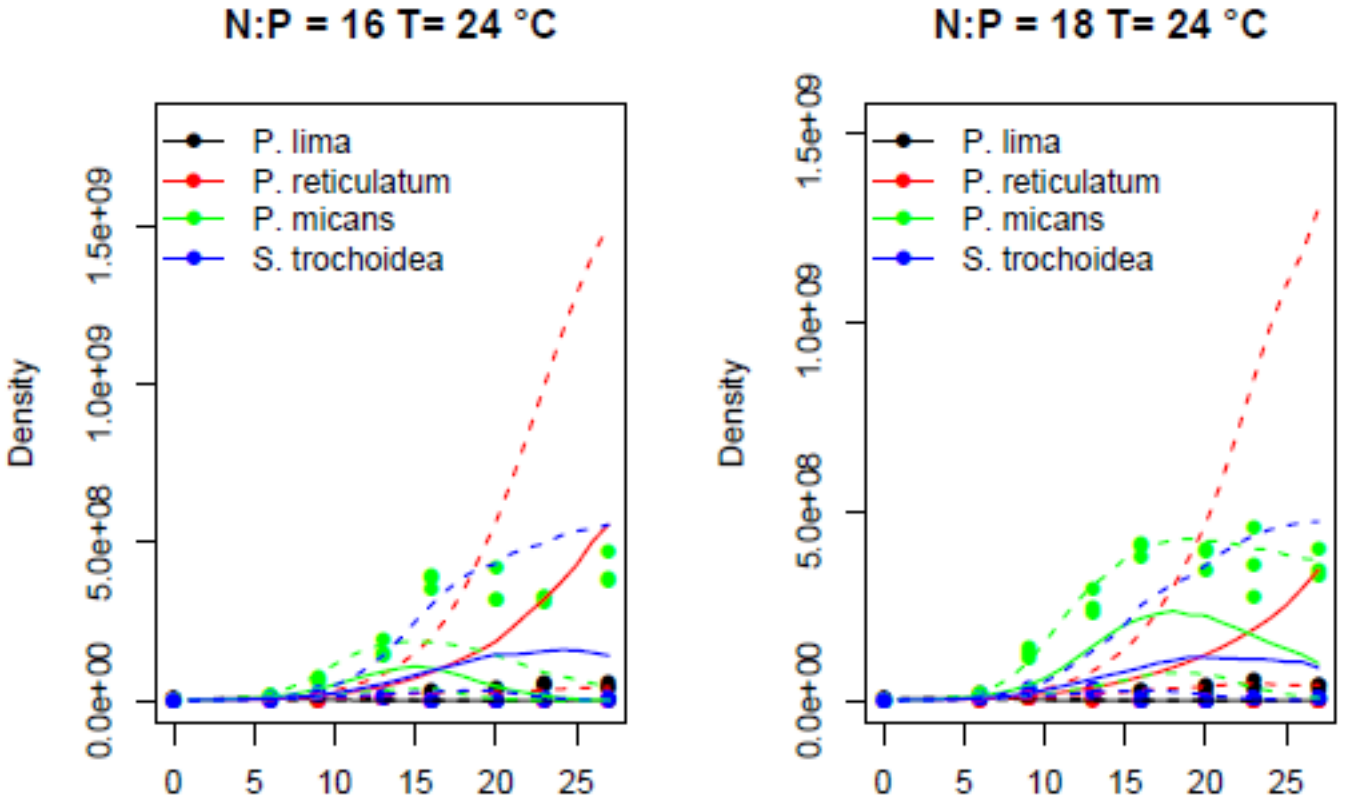
Allelopathy?

Competition (24°C)

α = 1

Lotka-Volterra model of interspecific competition

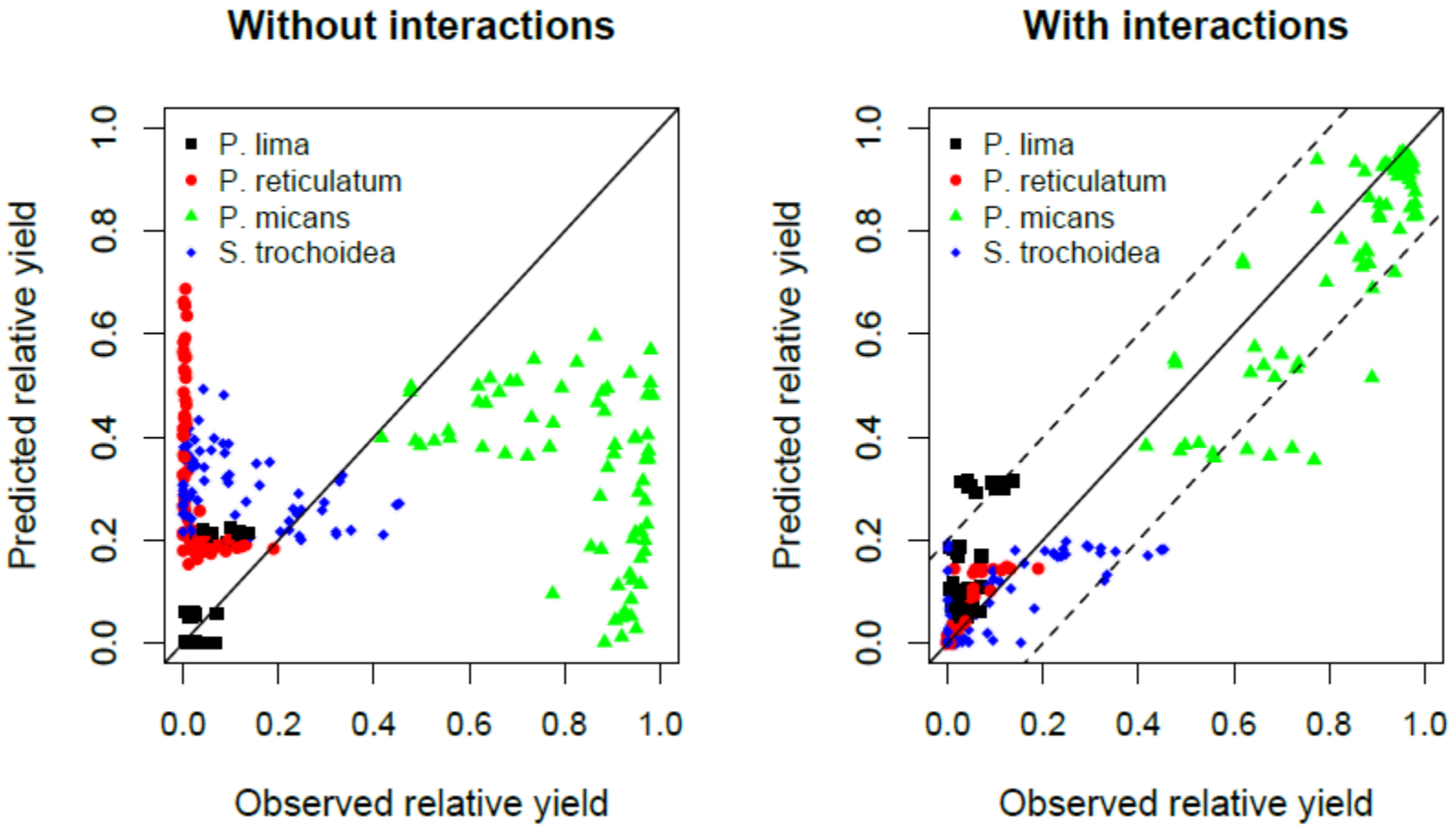
Neutrality



Under-
&
overpredictions

Competition (24°C)

α > 1



In summary

- ✓ Temperature may initiate bloom development
- ✓ Climate change may increase growth rates
- ✓ Toxin profiles may change under climate change
- ✓ N:P ratio has little effect on competitive traits

Allelopathic interactions needed to predict the result of interspecific competition under "climate change" conditions

⇅ Grazing pressure
Diatoms
Other nutrient sources

⇅ pH
Salinity
Current conditions?

Thank you for your attention