The impact of a mixotrophic chrysophyte on toxic and colony-forming cyanobacteria

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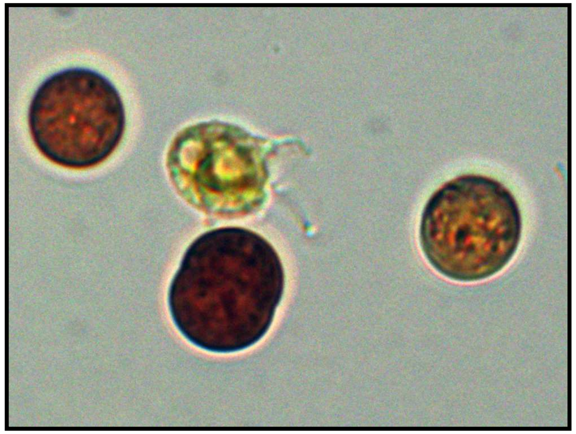
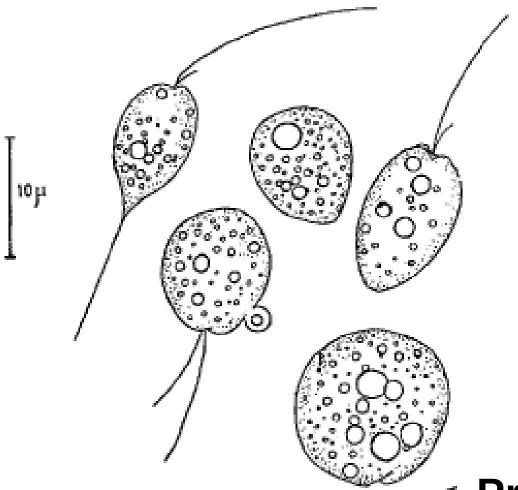
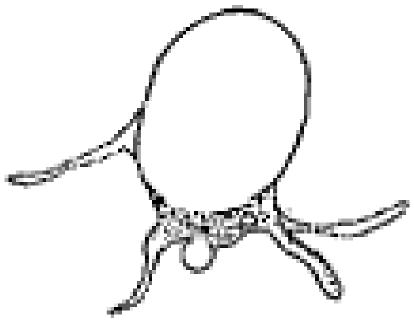
Limnotrons

Ochromonas grazing



Ochromonas globosa





Pringsheim 1952

Mixotrophy

Ability of phototrophic and heterotrophic nutrition in the same organism

Primarily autotrophic mixotrophs ⟷ Primarily heterotrophic mixotrophs

Ratio of both pathways is variable and depends on environmental conditions such as:

- Prey availability
- Nutrient concentrations
- Light intensity

Systems with mixotrophy

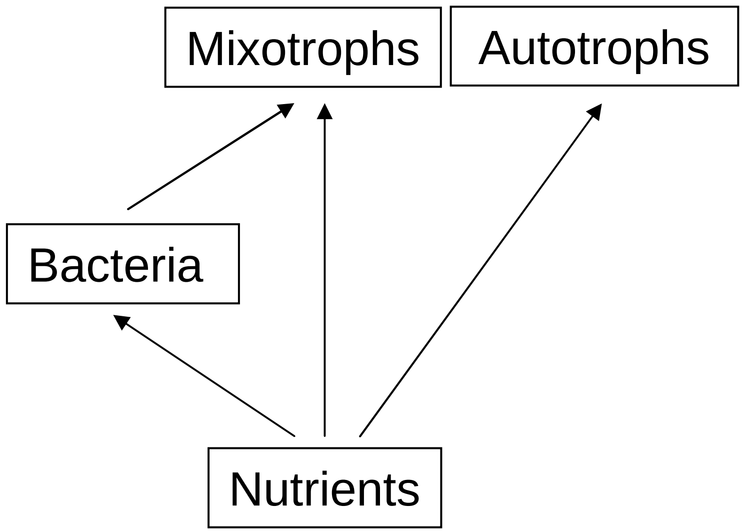
Freshwater

- Oligotrophic and humic lakes (Bergström *et al*. 2003; Domaizon *et al*. 2003)
- Eutrophic lakes (Bennet *et al*. 1990)
- Metalimnetic peaks (Bird & Kalff, 1987)
- During winter, under icecover (Wiedner & Nixdorf, 1998)

Marine

- From brackish and coastal systems to oligotrophic ocean
- High percentage of bacterivory by small eukaryotic phytoplankton (Zubkov & Tarran, 2008)
- Harmful algal bloom species in eutrophic areas (Burkholder *et al*. 2008)

Mixotrophs in the food web
- the traditional view -



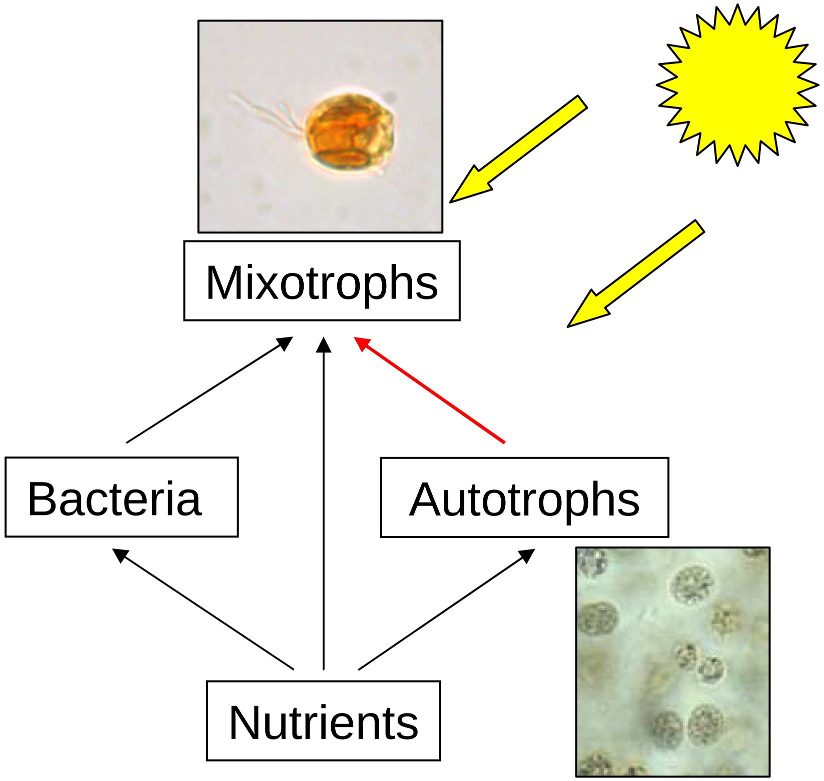
Substitutable resource use

Mixotrophs can outcompete specialists in oligotrophic systems

Maintenance of machinery for both pathways

Mixotrophs are outcompeted during periods of high resource abundance

Mixotrophs in the food web



Mixotrophs comparable to intraguild predators

<u>Condition for stability:</u>

Resource use efficiency of prey higher than that of intraguild predator

Aim of study

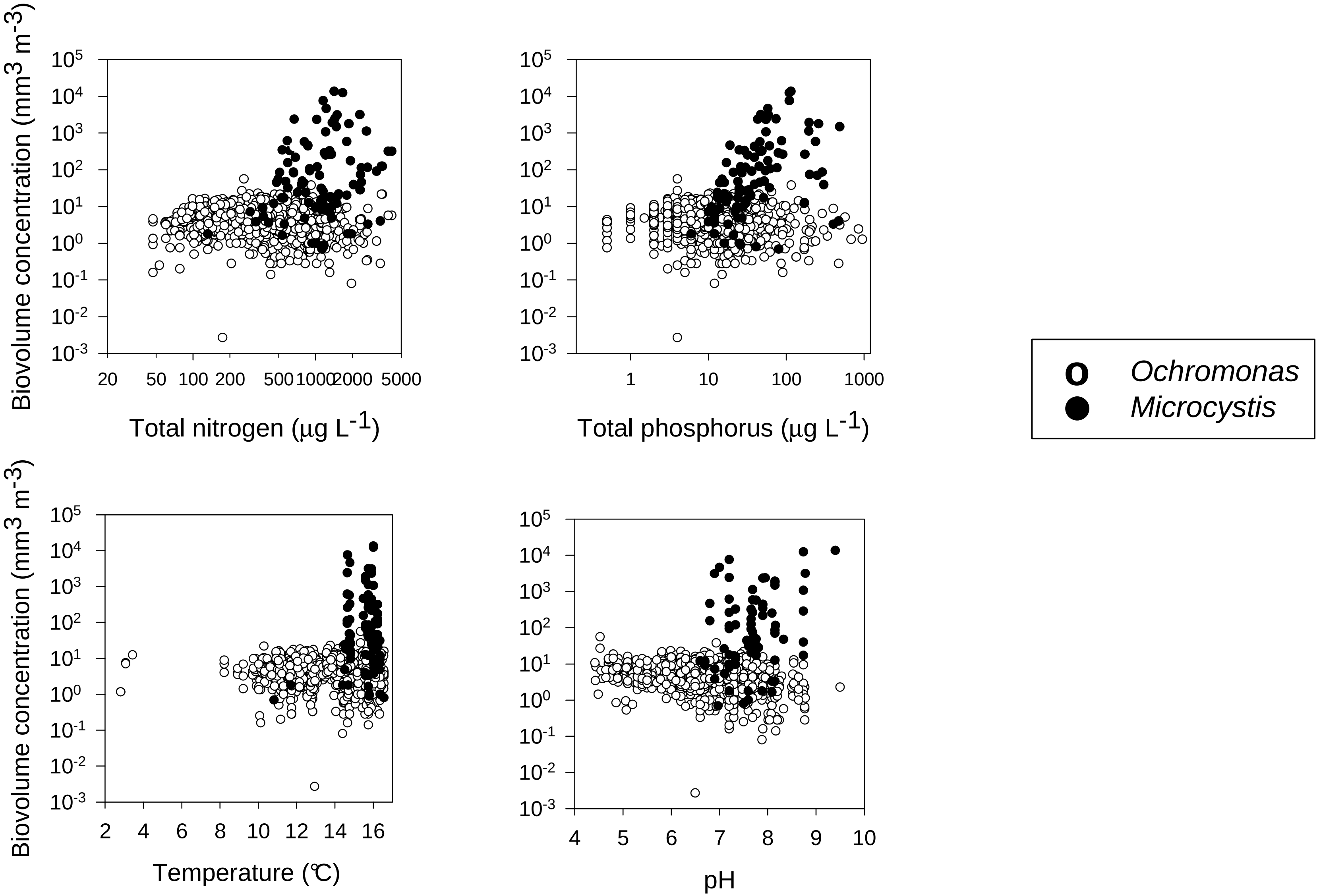
To analyze impact of *Ochromonas globosa,* feeding on different strains of cyanobacteria, varying in toxicity and degree of colony formation.

Methods

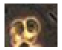
- *Field*: Co-occurrence of *Ochromonas* and *Microcystis*. Data from 460 lakes in Norway

- *Laboratory*: Grazing experiments

Norwegian lake data



Cyanobacteria characteristics

Cyanobacteria	MPV (μm^3)	Microcystin content ($\mu g\ \mu m^{-3}$)
	Mean	**Mean**
Microcystis aeruginosa **PCC 7806** 	**9**	**4.12×10^{-6}**
Microcystis aeruginosa **Spring CJ** 	**153**	**6.06×10^{-7}**
Microcystis aeruginosa **Bear AC** 	**810**	**9.81×10^{-7}**
	Filament length (µm)	
Pseudanabaena sp. **CCY 9704** 	**78**	**7.89×10^{-8}**

Grazing experiments

Erlenmeyer flasks 250 mL

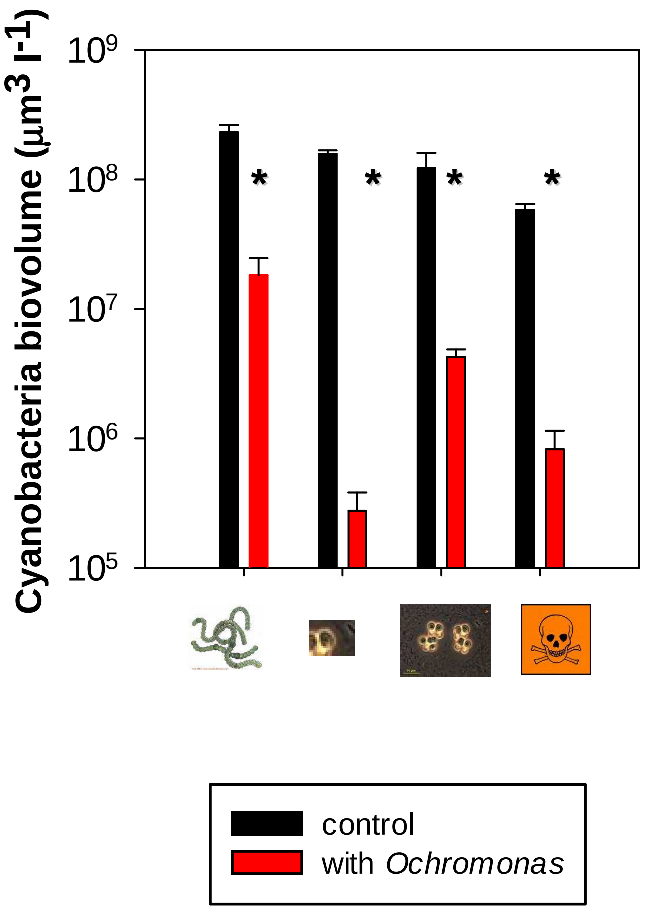
- Controls: 50 mL of cyanobacteria (1.5×10^{7} µm3 mL^{-1}) + 50 mL of COMBO medium.
- Treatments: 50 mL of cyanobacteria (1.5×10^{7} µm3 mL^{-1})+ 50 mL of *Ochromonas* culture (2.4×10^{6} µm3 mL^{-1})
- Triplicates
- Incubation: 4 days
- Light: dark cycle: 14 h: 10 h

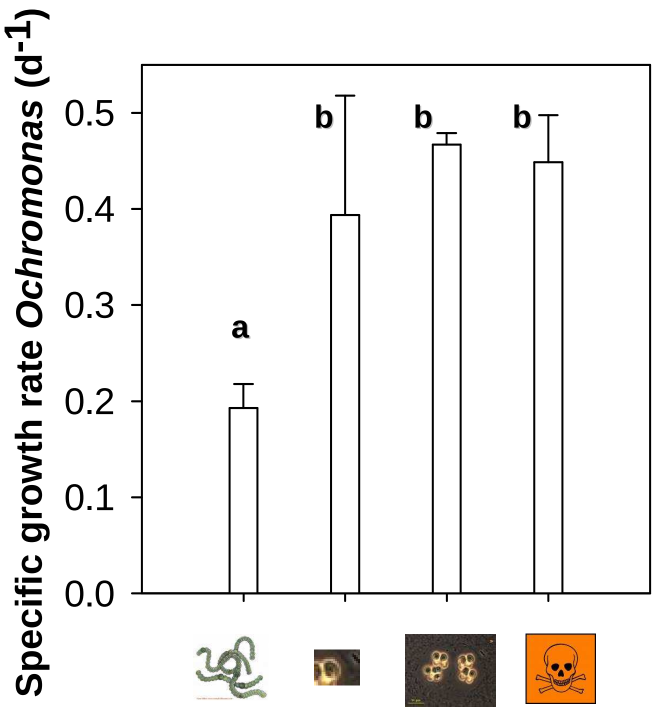
  Light intensity: 125 *µ*mol quanta [PAR] s^{-1} m^{-2}
- Temperature: 25℃.

Grazing experiments

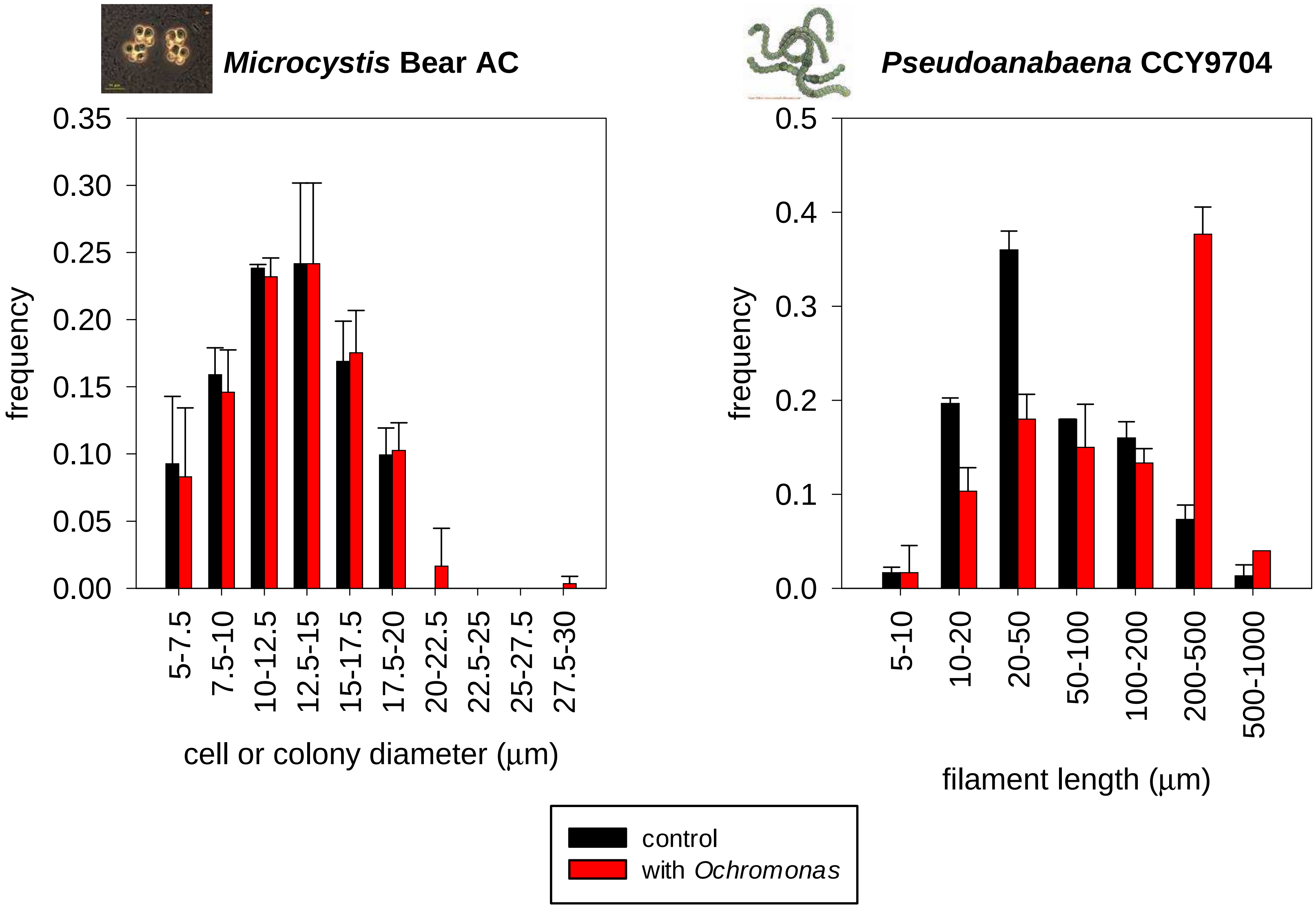
- Growth and biovolume of cyanobacteria
- Growth of *Ochromonas globosa*
- Size distribution of cyanobacteria
  (linear dimension of 100 cells or colonies)
- Microcystin concentration

Grazing experiments

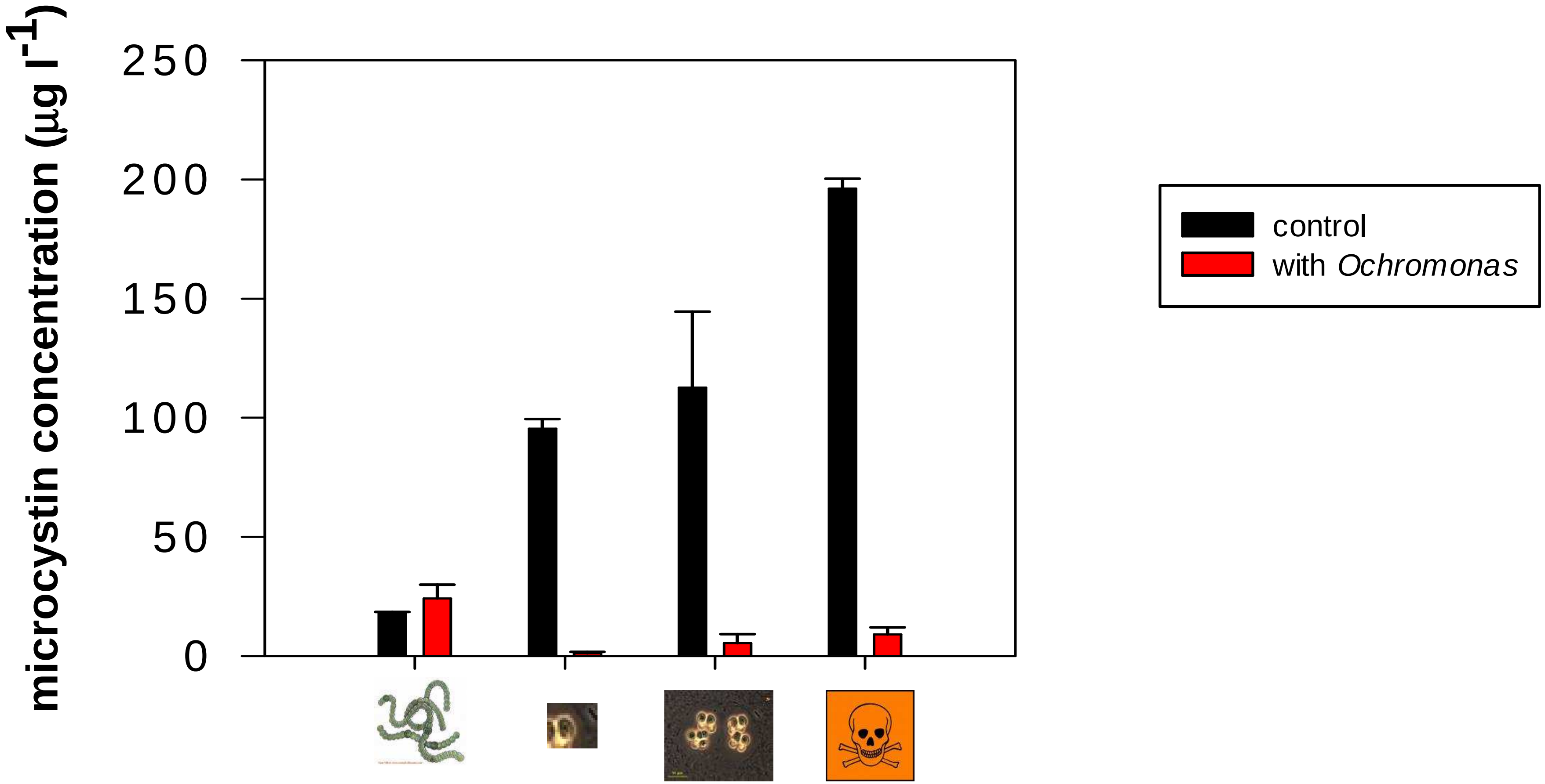




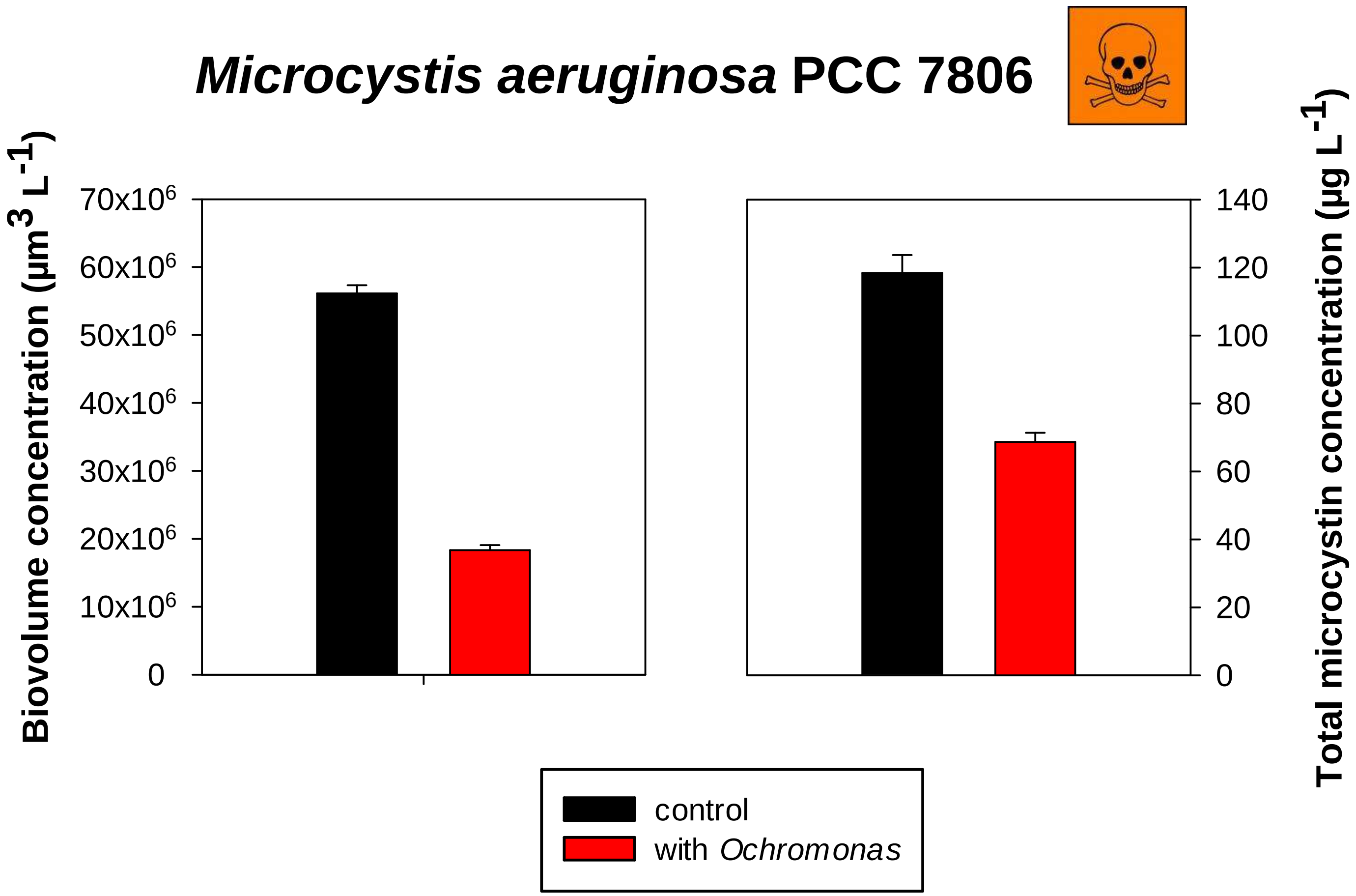
Size distributions



Microcystin concentrations



Grazing experiment (in situ biovolumes)



Main conclusions

- *Ochromonas* co-occurred in 94% of the lake samples in which *Microcystis* was present.

- *Microcystis* occurred only at higher TN, TP, temperature and pH values, its densities were often several orders of magnitude higher than the *Ochromonas* densities.

- From our study it is not clear whether *Ochromonas* may control *Microcystis* blooms in natural lakes.

- Yet our study does demonstrate that *Ochromonas* can strongly reduce the *Microcystis* biomass and toxins in small-scale experiments.

Thank you for your attention