A less saline Baltic Sea promotes *Dolichospermum* spp. growth, hampers intracellular microcystin production, and leads to strain-specific differences in allelopathy

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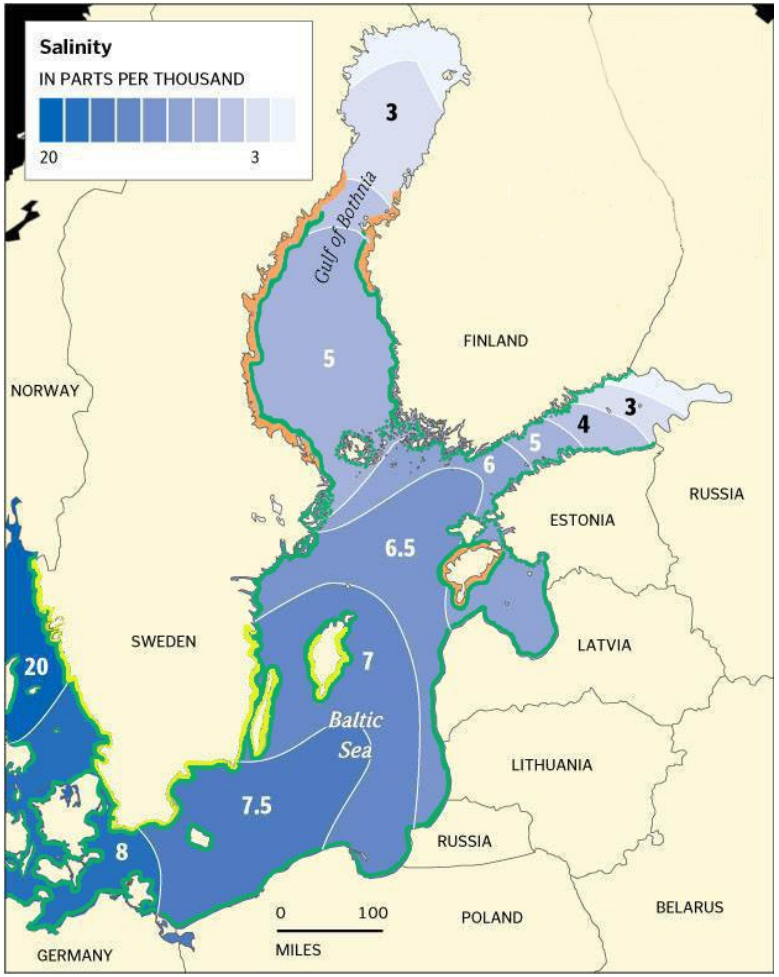
The Baltic Sea



http://balticseaweed.com

- One of the largest brackish water basins on earth
- Wide range in salinity
- Climate change is expected to increase precipitation and river runoff in the drainage area → increased freshwater inflow to BS
- Also substantial annual variation in the amount of saline water entering the BS
- A decreasing salinity trend in some basins

Cyanobacterial blooms

- Filamentous diazotrophs: *Aphanizomenon* sp., *Nodularia spumigena* and *Dolichospermum* spp. (ex. *Anabaena* spp.)
- *N. spumigena* produces hepatotoxin, nodularin
- *Dolichospermum* occasionally hepatotoxic in the Baltic Sea, producing microcystins
- A reduced salinity may provide a competitive advantage to *Dolichospermum*

N Baltic proper, July 2014. Photo:Finnish Frontier Guard

Nodularia spumigena

Aphanizomenon sp.

Dolichospermum sp.

Photos: M. Huttunen, S. Hällfors

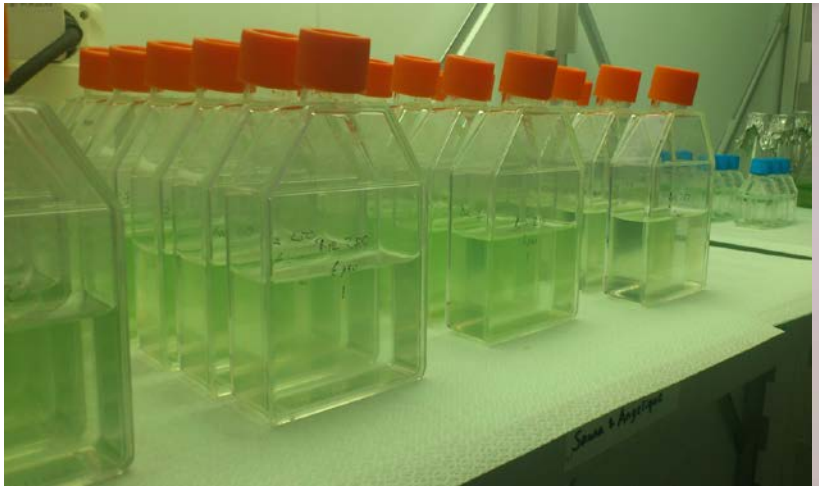
Aims

- To determine the effect of salinity (0-3-6 psu) on *Dolichospermum* spp. growth, intracellular microcystin concentrations and allelopathic* properties
- To assess 34-year trends in salinity and *Dolichospermum* spp. biomass in the N Baltic Sea

*Allelopathy = the production of chemical compounds to kill or limit growth of competitors

Methods

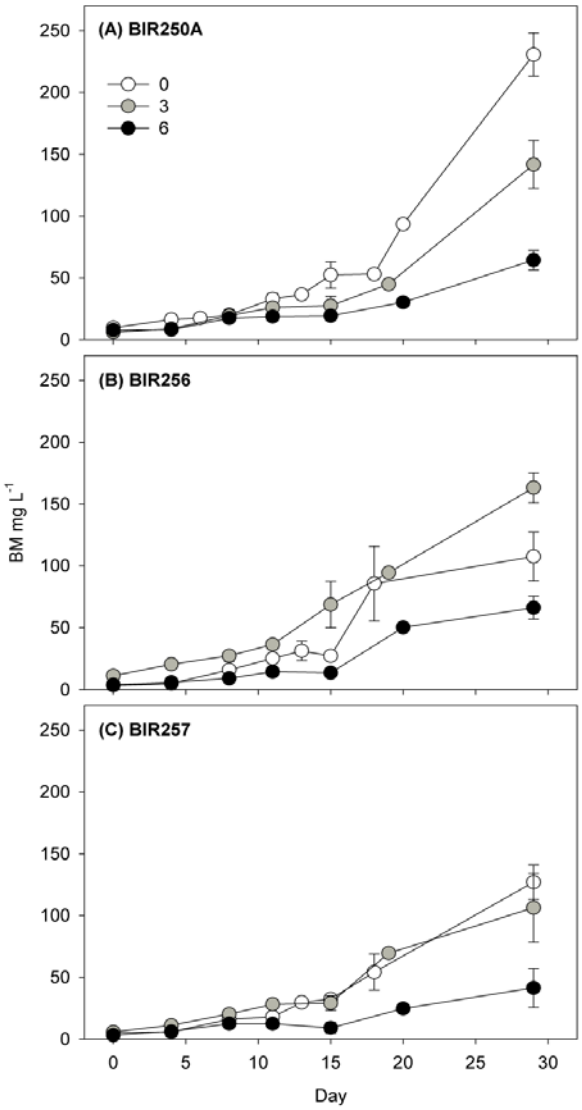
- 3 toxic strains of *Dolichospermum* sp. from the N Baltic, acclimatized to the different salinities for >1 year
- Growth and toxicity in batch cultures were monitored for 29 days
- Separate experiments in mid-exponential and stationary phase to study allelopathic effects of cell-free filtrates
- Statistics: GLM, LME
- Long-term data analysis (Mann-Kendall trend test) of summer surface salinity and *Dolichospermum* biomass in 1979-2013



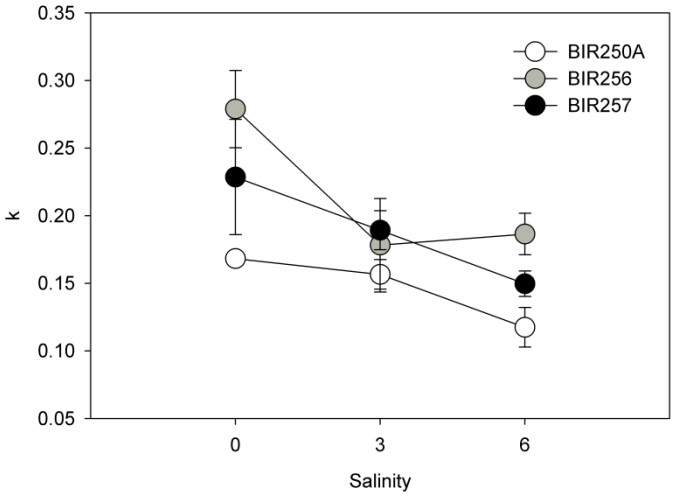
Results

- Biovolume and growth
- Microcystin concentrations
- Allelopathy
- Long-term trends

Biovolume and growth



Biomass development of the *Dolichospermum* strains in the experimental salinities

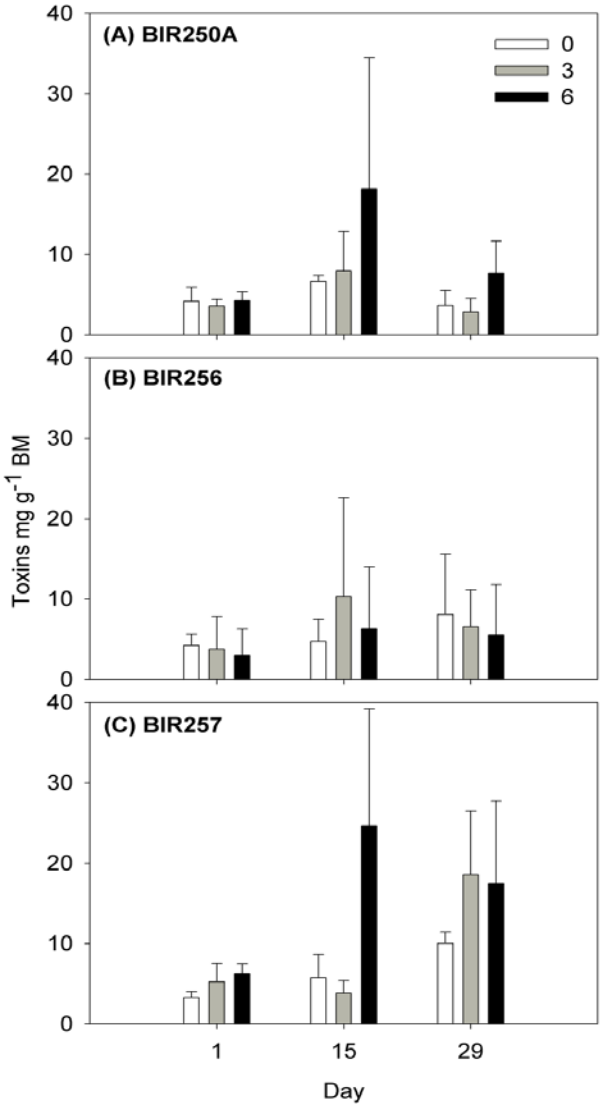


Biomass based growth rates

→ Growth rates differed significantly between strains and salinities, being highest in freshwater

Microcystin concentrations

Dolichospermum spp. intracellular microcystin concentrations in different salinities at the start, middle and end of the experiment (ELISA)



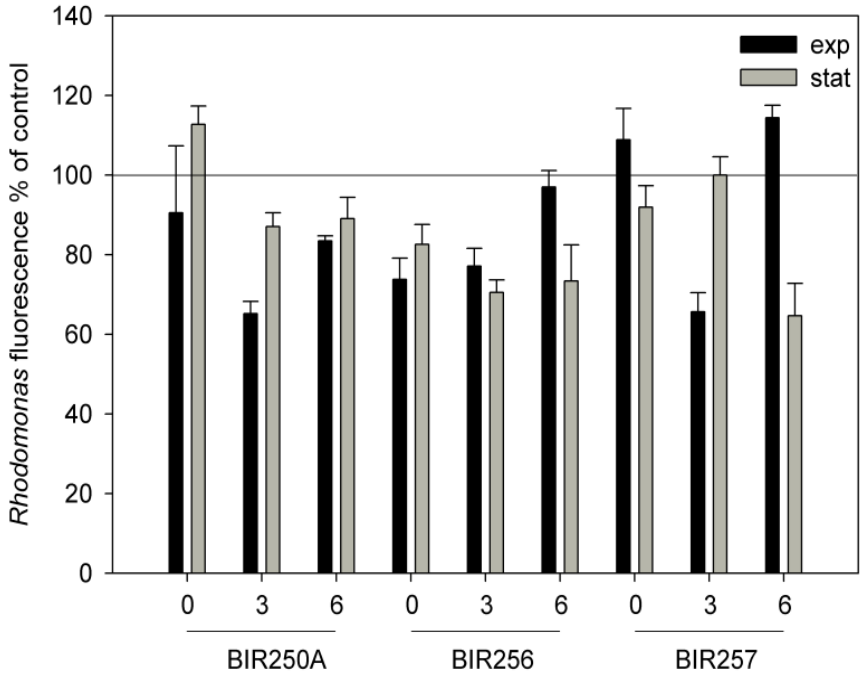
→ Significant differences between salinities and days, but not between strains

→ For all strains on average highest at salinity 6 and lowest on day 1

→ No direct relationship between growth rate and toxin concentration

Allelopathy

Percentage chl a fluorescence of *R. nottbecki*, cultured in filtrates of exponential and stationary phase *Dolichospermum* spp. in relation to control

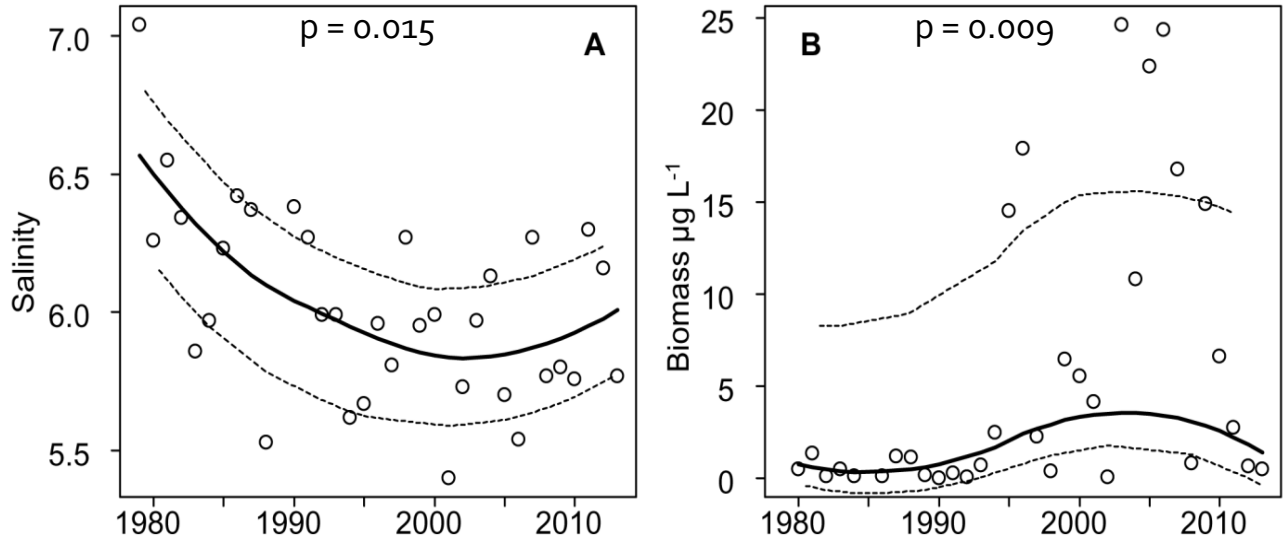


→ All strains showed allelopathic potential (up to 35 % reduction in *R. nottbecki*)

→ Allelopathic potency differed significantly between strains and salinities, but not between growth phases

→ On average, the allelopathic effects were most pronounced at salinity 3, and did not correlate with the extracellular microcystin concentration

Long-term trends



Annual mean summer (A) salinity and (B) *Dolichospermum* spp. biomass in the northern Baltic Sea at 0-10 m depth in 1979-2013 (with Loess, span = 0.75, and 95% confidence interval)

→Significant decreasing trend in surface water salinity, and significant increasing trend in biomass of *Dolichospermum* spp.

Conclusions

- In the 0-6 salinity range, Baltic *Dolichospermum* spp. grew best in freshwater
- Intracellular microcystin concentration was highest at salinity 6, maybe as a result of elevated oxidative stress
- Intermediate salinity seemed to stimulate allelopathy in *Dolichospermum*
- Summertime surface water salinity decreased and *Dolichospermum* spp. biomass increased in 1979-2013

→ Decreased salinity, together with increased temperature and phosphate levels may result in a more favourable environment for potentially toxic *Dolichospermum* spp. and lead to its range expansion in the Baltic Sea