

Why do we have excessive blooming in the Baltic sea



*Nodularia spumigena*¹

¹ http://commons.wikimedia.org/wiki/File:Nodularia_spumigena.jpeg

Introduction

Cyanobacterial bloom has been considered a problem in the Baltic Sea for many years. Some believe that the fertilization from agriculture around the brackish and very sensitive sea has increased the intensity of the cyanobacteria, especially the nitrogen fixing species. The intense bloom of the cyanobacteria works as a fertilizer for the sea and may be toxic for domestic animals. The countries around the Baltic sea has done several attempts to lower the chemicals deriving from agriculture and sewers by filtering the water that is let out in this sensitive environment to create a more oligotroph sea.²

The phenomena of cyanobacterial blooms are common in sweet water lakes in the tropics but rare in brackish waters and this makes the Baltic blooms almost unique. The only place with similar blooms is Peel- Harvey estuary in Australia.³ The cause of the blooming are suspected to be related to the nitrogen- phosphate ratio in combination with the increased temperature in the summer months. Further investigations of what causes the increased concentrations of nitrogen and phosphor showed that the salinity of the water flowing in from the Danish straits has a great impact on the oxygenation of the bottoms where these compounds are bound.⁴

Species in the Baltic

The focus of most research is on the two species of cyanobacteria called *Nodularia spumigena* and *Aphanizomenon flos-aquae*. The *Nodularia spumigena* is hepatotoxic to most mammals; the toxin is called Nodularin and inhibits certain enzymes which are essential for the liver to function. Lethal dose of this toxin is 70µg/kg causes blood losses and death within a few hours. Nodularin produced by the *N. spumigena* in the Baltic reaches concentrations high enough to be harmful but not lethal during the blooming. In lower concentration the poisoning results in tumor formation in the liver. The *N. spumigena* growth is dependent on the temperature and irradiation, this makes it abundant during the warmer summer month and almost absent during the rest of the year. The distribution of *N. spumigena* is limited to the southern and

² Thomas S. Bianchi and Erika, Per Westman and Thomas Andren, Carl Rolff and Ragnar Elmgren Cyanobacterial blooms in the Baltic Sea: Natural or human-induced? *Limnol. Oceanogr.*, 45(3), 2000, 716–726 q 2000, by the American Society of Limnology and Oceanography, Inc.

³ Thomas S. Bianchi and Erika, Per Westman and Thomas Andren, Carl Rolff and Ragnar Elmgren Cyanobacterial blooms in the Baltic Sea: Natural or human-induced? *Limnol. Oceanogr.*, 45(3), 2000, 716–726 q 2000, by the American Society of Limnology and Oceanography, Inc.

⁴ M. Kahru, J.-M. Leppänen, O. Rud, O. P. Savchuk, Cyanobacteria blooms in the Gulf of Finland triggered by saltwater inflow into the Baltic Sea. *MARINE ECOLOGY PROGRESS SERIES Mar Ecol Prog Ser* Published November 22 Vol. 207: 13–18, 2000

middle Baltic, due to its preference of moderate salinity. How the environment is effected is not known.

The other species, *A. flos-aquae* is present in the waters of the Baltic during all seasons but have no toxin production. The nitrogen fixation rate is somewhat higher than in *N. spumigena* and decreased temperature makes the *A.flos-aquae* to fix nitrogen more effectively. The species grows better at a low irradiation, and can be found in the lower part of the surface waters. *A. flos-aquae* showed increase in growth rate when cultivated in lower salinity and this can explain the distribution of *A.flos-aquae*, which is more abundant in the northern Baltic with lower salinity than the rest of the basin.

Both species have an increased growth rate in phosphor rich environments. Nitrogen itself has little impact on the nitrogen fixation rate and nitrogen compounds such as ammonium has a negative effect on the growth.⁵

Baltic Sea has a large amount of both phosphate and nitrogen, which is liberated due to anoxic biochemical environment caused by the inflow of salt water, creating a division between the water oxygenated by the air and the bottom with its microbial activity. The blooming is self is not a new phenomenon; they have been more or less intensive ever since the formation of the Baltic Sea but after a great inflow of salt water in 1993 their intensity has increased.⁶

Methods

The cyanobacteria are visible on satellite when in bloom and a record of the spreading and intensity of blooming made the basis of some of the conclusion. (For satellite pictures of the blooms please see following link from the Ministry of the Environment in Sweden: <http://www.smhi.se/en/theme/algal-blooms-in-the-baltic-sea-1.11006>)

The distribution of the blooming cyanobacteria was investigated and it was discovered that areas with previously no or very low intensive blooming, e.g. Gulf of Finland shows an increase in the frequency of the cyanobacteria, the reason for this expansion could be the change of nitrogen phosphor ration as a result of the increased saltwater inflow in 1993.⁷ Samples from the bottom sediments where also investigated thoroughly and the pigment zeaxanthin and β , β -caroten. The pigments are known to be abundant in the nitrogen- fixing algae and in phytoplanktons with a correlation with the blooming. The pigments are stable and are suitable as indicators

⁵ Jaana Lehtima, Pia Moisander, Kaarina Sivonen, and Kaisa Kononen. Growth, Nitrogen Fixation, and Nodularin Production by Two Baltic Sea Cyanobacteria. American Society for Microbiology Applied and Environmental Microbiology, May 1997, p. 1647–1656 Vol. 63, No. 5

⁶ M. Kahru, J.-M. Leppänen, O. Rud, O. P. Savchuk, Cyanobacteria blooms in the Gulf of Finland triggered by saltwater inflow into the Baltic Sea. MARINE ECOLOGY PROGRESS SERIES Mar Ecol Prog Ser Published November 22 Vol. 207: 13–18, 2000

for the nitrogen-fixing cyanobacteria. The samples shows similar blooming 7000 years ago and observation records from the early 19th century tells us about the vast biomass of cyanobacteria.

Researchers has also compared the composition of the surroundings and sediments of some lakes to figure out what causes the liberation of nitrogen and especially phosphorous. In the lake areas the phosphor was bound in Calcium containing compounds where as in the sea sediments it seems to be bound to compounds with ferric iron and when reduced by the anoxic condition at the bottom liberation of phosphor is possible.⁸

Conclusions

The goal of restoring a more oligotroph environment in the Baltic Sea would not prevent the blooming completely since the cyanobacteria is a natural occurring species⁹, but maybe the intensity and accumulation of the floating biomass ending up on the beaches could be decreased. Their increased intensity is more connected to the anoxic bottom with its release of nutrients and building block materials from the sediments than the pollutions from the river outlets deriving from the agriculture. It is still important to decrease the fertilizers getting in to the Baltic because of other sensitive species survival and proliferation but it is probably not enough to save the unique conditions in the world's largest brackish sea.

Research on how to get more oxygen to the "dead" anoxic bottom sediments is in progress but the ideas coming from scientists are considered to be too complicated and far too expensive for the countries around the Baltic. Some models are at the moment under testing and construction. Here is one project from the University of Gothenburg in Sweden: http://www.science.gu.se/english/News/News_detail/oxygenation-at-a-depth-of-120-metres-can-save-the-baltic-sea.cid987268

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Own thoughts

The consequences of a Baltic sea with dead bottoms would probably cause more intense blooming of the toxic cyanobacteria and in the extension it might also diminish the economical profit of the fishing industry and the loss of a unique ecological environment. If the anoxic dead bottoms can be connected to an economic profit the countries involved might be more interested in financing a large scale project to get more oxygen to the bottom of the Baltic Sea. If the anoxity it-self is a natural phenomenon and just a "sign of old age" on the environment of the sea it could be discussed if the fight against nature will be successful and if it is would prevent a new stage of the Baltic sea to take place instead of saving it?