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BONUS briefing

SCIENCE FOR A BETTER FUTURE OF THE BALTIC SEA REGION

BAZOOCA
Baltic zooplankton cascades

BAZOOCA team's results on the BAltic ZOOplankton CAscades indicate that the earlier concerns regarding American comb jelly *Mnemiopsis* feeding on cod eggs are unsupported and that it constitutes no threat to the Baltic cod population. Low salinity in the Baltic prevents explosive outbreaks, but adaptation to low salinity by *Mnemiopsis* may change this in the future. Sprat and herring are still the main predators on zooplankton and because of that, fisheries continues to be the largest regulatory factor for the pelagic food web in the Baltic. The fishery policy thus remains the key tool for the management of the Baltic from higher trophic levels. Eutrophication and inflow of salty water continues to be the main factors determining the trophic state of the Baltic Sea.

The American comb jelly, *Mnemiopsis leidyi*.

OVERVIEW

The project set out to study BAltic ZOOplankton CAscades where jellyfish and fish would act as controlling animals for the food web in the Baltic Sea. Fears of the invasion by the American comb jelly, *Mnemiopsis leidyi*, and growth of other jellyfishes led to the design of BAZOOCA. The effects that the increased number of jellyfishes would have on the ecosystem were examined in the light of experiments, filming and field studies. Predation on cod eggs and larvae, changes in water clarity leading to regime shifts from fish to jellyfish and couplings between plankton and microbes were studied.

The project is transnational (Denmark, Finland, Norway and Sweden) with 18 scientists engaged. BAZOOCA has used infrastructures from the Gulf of Finland to Skagerrak to test hypothesises of cascading effects under very different environmental constraints within the Baltic. The Department of Marine Ecology, University of Gothenburg hosts the project.

OUTLINE OF KEY RESULTS

THE *MNEMIOPSIS* CASE

The recent invasion of the comb jelly *Mnemiopsis leidyi* into northern European waters is of major public and scientific concern. One of the key features of *M. leidyi* is its high fecundity and fast growth. According to the BAZOOCA, the reproduction of *M. leidyi* essentially stops under the low salinities that are characteristic of the central Baltic Sea. Hence, low salinity prevents a population expansion into

the Baltic proper. The Kattegat and the south western Baltic with slightly higher salinities seem to act as source regions for the *M. leidyi* population while no self-sustaining population was found in the Baltic proper.

For six months of the year *Mnemiopsis* is a major zooplankton predator In the Skagerrak and Kattegat with seasonal peaks in September-November (Fig. 1). During this period, the predation on mesozooplankton may reach 15% per day resulting to a conclusion that predation by *Mnemiopsis* has drastically reduced the zooplankton community in this region. This reduction has in at least one case led to an increased chlorophyll concentration typical of a trophic cascading effect in the food web. **In the Baltic proper, however, abundances and predation rates from *Mnemiopsis* are at present too low to affect the zooplankton community.**

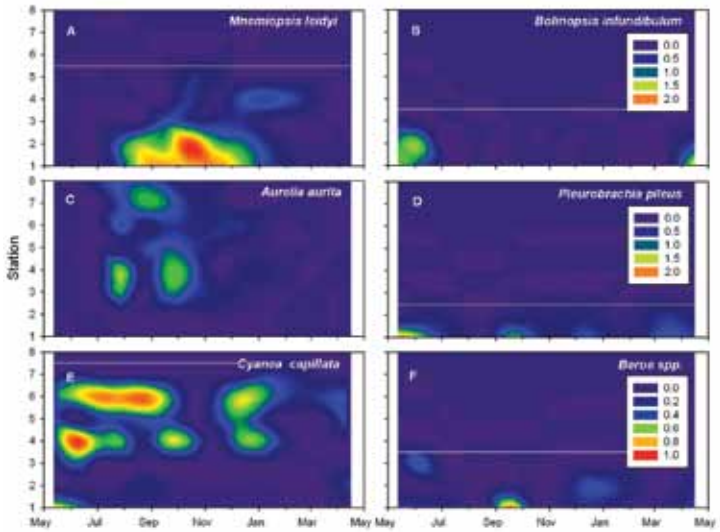

Figure 1. Abundance of different species of gelatinous plankton (ind m-2) plotted on log scale against time (month) and station. The horizontal line represents the geographical boarder of occurrence. Skagerrak and Kattegat area: 1 Släggö, 2 Anholt. Baltic Proper: 3 Arkona, 4 Bornholm deep, 5 BCSIII10, 6 Gotland deep, 7 Norrköping and 8 RefM1V1. Note the different scale for Cyanea capillata and Beroe spp.

When *Mnemiopsis* was first observed in the Baltic Sea in 2006, there were fears of serious predation on cod eggs and larvae because it was found at the same depths as the eggs and larvae in the most important cod spawning ground, the Bornholm Basin. However, the feeding rates of *Mnemiopsis* on cod egg and larvae are negligible according to the new results. ***Mnemiopsis* constitutes no direct threat to the Baltic cod population as predator, although it may compete with larval cod for zooplankton prey.**

THE GELATIONUS BALTIC

The gelatinous zooplankton in the Baltic differed remarkably from those in the Skagerrak and Kattegat. During our investigation, Skagerrak and Kattegat were dominated by ctenophores (*Mnemiopsis leidyi, Bolinopsis infundibulum, Pleurobrachia pileus, Beroe spp.)* while scyphomedusae *(Aurelia aurita and Cyanea capillata)* were more common in the Baltic Sea (Fig. 1). This is an unusual situation since the larger jellyfishes normally dominate on the Swedish west coast. Since the introduction of Mnemiopsis, virtually no Aurelia has been observed on the Swedish west coast. Highest biomasses are found between August and November. In April 2011, a new species for the Baltic Sea area *(Euplokamis dunlapae)*, was found in the Gullmar fjord.

The Baltic Sea gelatinous zooplankton display a complex pattern of intraguild predation (the killing and eating of potential competitors), which has been further extended with the arrival of new ctenophore species.

Aurelia aurita

NEXT STEPS AND FUTURE PLANS

Jellyfish dynamics

High densities of jellyfish can lead to problems for humans, such as clogged industrial cooling systems, destroyed trawling equipment and disturbed leisure activities. The predation impact by highly abundant jellyfish will reduce the populations of their zooplankton prey, including young stages of fish. **Our limited sampling period needs to be extended by quantitative monitoring of gelatinous plankton in order to understand jellyfish dynamics, and the potential predation impact in the Baltic Sea.**

Salinity tolerance

Our critical finding that Mnemiopsis does not reproduce below 6‰ needs to be further investigated. Even a slightly increased tolerance to low salinity can change the picture radically. **Studies on adaptation over several generations are needed.**

Interactions among jellyfishes

Intraguild predation might have created the population dynamics seen in the Skagerrak with *Aurelia* disappearing after the invasion of *Mnemiopsis*. **Further studies are needed to understand the complex pattern of how species act both as prey and predators for each other.**

Light regime

A decreased water clarity due to eutrophication might affect the competitive relationship between fish (which are visual predators) and jellyfish (which are tactile). **Thus the light regime is one of several factors that need more attention in analyses of Baltic Sea ecosystem changes.**

No food for the fish

The high predation on zooplankton by *Mnemiopsis* in the Skagerrak and Kattegat should have negative effects on fish feeding on the same zooplankton (e.g. sprat and herring). **Analysis of condition and growth of these fishes would clarify the ecosystem effects of *Mnemiopsis*.**

IN BRIEF

BAZOOCA
BAltic ZOOplankton CAscades

Fears of invasion by the American comb jelly, *Mnemiopsis leidyi,* and growth of other jellyfishes led to the design of BAZOOCA. It studied the BAltic ZOOplankton CAscades where jellyfish and fish act as controlling animals for the food web in the Baltic Sea. The effects that the increased number of jellyfishes has on the ecosystem were examined in the light of experiments, field studies and filming. Predation on cod eggs and larvae, changes in water clarity leading to regime shifts from fish to jellyfish and couplings between plankton and microbes were observed.

KEY RESULTS

- Sprat and herring remain the main predators on zooplankton and because of that, fisheries continues to be the largest regulatory factor for the pelagic food web in the Baltic. The fishery policy thus remains the key tool for the management of the Baltic from higher trophic levels. Eutrophication and inflow of salty water are the other factors determining the trophic state of the Baltic Sea.

- Predation impact from gelatinous predators is modest in the Baltic. The moon jelly *(Aurelia)* is the most important jellyfish and it reproduces throughout the Baltic Sea. Also, the lions mane *(Cyanea)* has recently been shown to reproduce in salinities as low as 12‰, but it is less common than *Aurelia*. In contrast, *Mnemiopsis* cannot reproduce at salinities below 6‰ and therefore it is confined to the western parts of the Baltic.

- Earlier concerns regarding *Mnemiopsis* feeding on cod eggs were unsupported; the experiments showed that the jellyfish do not eat cod eggs. Thus, it constitutes no threat to the Baltic cod population. Due to its limited dispersal, it is not likely that the Baltic will experience a drastic change in the pelagic ecosystem from the introduced *Mnemiopsis.*

WHO NEEDS THE INFORMATION

The setting of fish quotas will benefit from the BAZOOCA findings. The results are useful for scientists, legislators, policy makers and provide scientific and political support for better management of the Baltic Sea.

PROJECT PARTNERS AND COORDINATOR

BAZOOCA utilises a broad range of infrastructures in and around the Baltic Sea to fulfil its goals. Research is conducted at eleven academic and governmental research institutes in four countries, with 18 researchers engaged.

Project partners

Sweden
University of Gothenburg
Swedish meteorological and hydrological institute
Linnaeus University
Umeå University

Denmark
National Institute of Aquatic Resources, Technical University of Denmark
University of Copenhagen

Norway
University of Bergen
University of Oslo
Institute of Marine Research

Finland
University of Helsinki
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