Grazing, egestion and egg production of prominent zooplankton species during a dinoflagellate bloom in the North Sea

Sandra Jansen[1]*, Christian Wexels Riser[2], Ulrich Bathmann[1], Paul Wassmann[2]

[1] Alfred Wegener Institute for Polar and Marine Research, Am Handelshafen 12, 27570 Bremerhaven, Germany

* Corresponding author: sjansen@awi-bremerhaven.de

[2] Norwegian College of Fishery Science, University of Tromsø, 9037 Tromsø, Norway

BIOHAB

INTRODUCTION

Toxic dinofagellate blooms are a common phenomenon in the North Sea, but the fate of the toxins in the food web is largely unknown. Zooplankton, mainly copepods, are abundant grazers in marine plankton in coastal oceans. It is unknown if such grazers may regulate blooms of toxic dinoflagellates, especially those of *Ceratium* spp. and *Dinophysis* spp. Copepods may play a key role in the transport of toxins through the food web, but it is still uncertain to what extent toxic algae are grazed and how toxic algae effect copepods.

Toxic phytoplankton cells are frequently thought to be less attractive to zooplankton grazers and toxic cells should be selectively avoided by zooplankton when feeding in mixtures of different prey species.

Area of investigation (August 2001)

Fig.1: Geographical area of the cruise HE-152, with R/V Heincke in the North Sea. The approximate location of the experimental area is shown.

GRAZING

on *D. norvegica* on *C. furca*

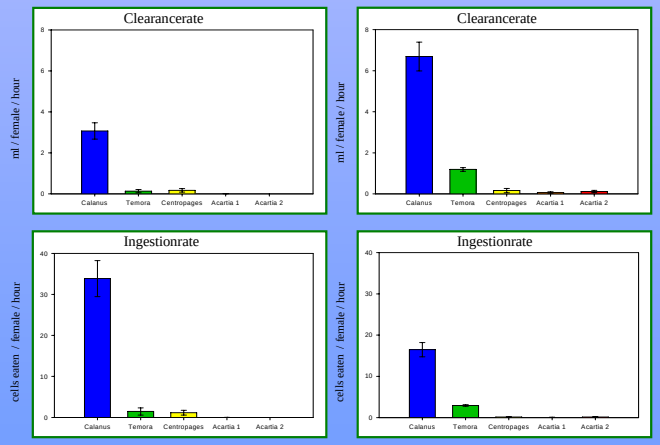

Fig.2: Results from the 24 hours grazing experiments with the prominent copepod species, feeding on the natural plankton community.

Grazing experiments with copepods feeding on the natural plankton community were performed in 1180 ml bottles on a plankton wheel. Cells were counted before and after the experiments.

T. longicornis, *Centopages* sp. and *Acartia* sp. were not able to ingest *D. norvegica* in measurable amount.

Only *C. helgolandicus* was able to feed in great extent on *D. norvegica* (33.8 cells female^{-1} hour^{-1}) as well as on *C. furca* (16.5 cells female^{-1} hour^{-1}).

ACKNOWLEDGEMENT

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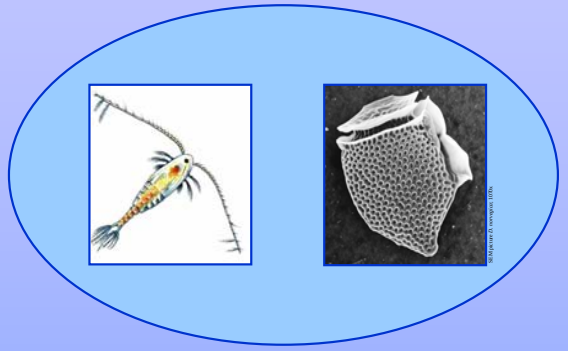
MATERIAL AND METHODS

The present work was carried out during a Lagrangian experiment on board R/V Heincke in the North Sea. Copepods were collected from vertical net tows from 30 m to surface, using a WP2 zooplankton net (180 µm).

Experiments were performed with the abundant mesozooplankton species (*Acartia* sp., *Calanus helgolandicus* and *Temora longicornis*) with natural plankton. *Dinophysis norvegica* and *Ceratium furca* were the abundant dinoflagellate species during the cruise. The total cell concentration of dinoflagellates (*Dinophysis* spp. and *Ceratium* spp.) ranged between 1.000 and 18.000 cells l^{-1} during the time of the cruise.



EGG PRODUCTION

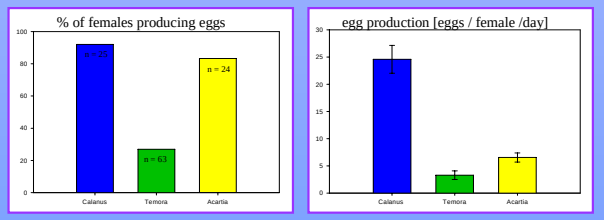


Fig.3: Egg production rates of the prominent mesozooplankton species during the cruise after an incubation time of 24 hours in natural phytoplankton from the chlorophyll maximum

The results from the egg production indicate that *C. helgolandicus* was in good condition, with more than 92% of the incubated females producing eggs and an egg production rate of 24.6 eggs female^{-1} day^{-1}. In contrast, only 27% of the *T. longicornis* females produced eggs and egg production was low with 3.3 eggs female^{-1} day^{-1}. 83.3% of the incubated *Acartia* sp. produced eggs within 24 hours, but egg production was rather low with 6.5 eggs female^{-1} day^{-1}.

Egg production experiments were carried out two times during the cruise. Fig.3 summarizes the results of both because there is no significant difference between both experiments.

Dinoflagellate concentration during the time of the egg production experiments [cells/l]:

	1st attempt	2nd attempt
Dinophysis spp.	475	300
Ceratium spp.	3700	1850

CONCLUSIONS

C. helgolandicus can feed very efficiently on *Dinophysis* spp. under natural conditions

C. helgolandicus can play an important role

- for the transport of DSP toxins through the food web
- for the impact on the structure or development of a *Dinophysis* spp. bloom
- for the fate of *Dinophysis* spp. blooms

Egg production proved *C. helgolandicus* to be in good condition.

Due to the relatively low density of *C. helgolandicus* found during the time of the drift experiment, it can be concluded that their grazing had no great impact on the structure or development of the bloom in the present case. The abundance of *C. helgolandicus* was about 2200 animals m^{-2} (upper 25 meter) at the time of the grazing experiment. With an ingestion rate of 400-800 *D. norvegica* copepod^{-1} day^{-1} it can be calculated that *C. helgolandicus* were able to feed daily 1-2 % of the total standing stock of *D. norvegica*.

C. furca was not detected in the faecal pellets, but grazing experiments showed an ingestionrate of ~16 cells female^{-1} hour^{-1} for *C. helgolandicus*. This implies that *C. helgolandicus* were able to graze 7 % of the standing stock of *C. furca* during one day of the experiment.

Results from the grazing experiment as well as from the egestion experiment showed, that *T. longicornis* and *Acartia* sp. were not able to feed efficiently on *D. norvegica* or on *C. furca* during the time of the experiments. The low egg production measured for both species indicates that they were not in good condition.

FAECAL PELLET PRODUCTION

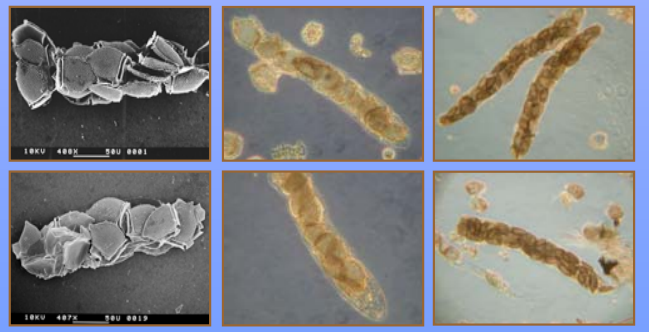


Fig.4: Pictures (Electron microscope and Light microscope) from the faecal pellets of *Calanus helgolandicus*, after feeding for 24 hours on the natural plankton community.

The egestion experiment was carried out for 24 hours in 1180 ml bottles on a plankton wheel with *C. helgolandicus* feeding on the natural plankton community. At the time of the experiment the concentration of *D. norvegica* was 9580 cells l^{-1}, while the concentration of *C. furca* was 1140 cells l^{-1}. Faecal pellet production rate was measured to be ~24 faecal pellets female^{-1} day^{-1}.

98% of the faecal pellets produced during the experiment contained *D. norvegica*. The number of *D. norvegica* cells within one faecal pellet ranged from 0-30, with an average of 16 (n =10). This result implies a mean ingestion rate of about 400 *Dinophysis* spp. cells per *C. helgolandicus* per day (~17 cells female^{-1} hour^{-1}). However, no *Ceratium* spp. cells were detected within the faecal pellets.

Egestion experiments with *T. longicornis* were carried out in 6 hours intervals using 400 ml chambers. The mean faecal pellet production for *T. longicornis* was measured to be 1.2 faecal pellets female^{-1} hour^{-1}

Only single *Dinophysis* spp. cells were detected within some *T. longicornis* faecal pellets under the microscope.