Copepod reproduction during an iron-induced phytoplankton bloom in the Southern Ocean

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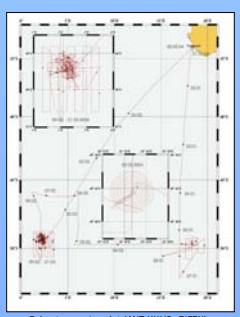


Polarstern cruise plot (ANT XXI/3: EIFEX)

Introduction

The Southern Ocean is characterised by low temperatures and a short growth season for primary producers, which potentially limit zooplankton growth and reproduction. Different copepod species seem to exhibit a spectrum of adaptations and life cycles are diverse. However, the association of spawning events with phytoplankton concentration are not clearly demonstrated yet.

Is spawning seasonally timed or

induced by enhanced phytoplankton concentrations?

Material and Methods

Egg production experiments were performed with three dominant copepod species during the iron fertilization experiment EIFEX in the beginning of 2004. In response to the iron fertilization a diatom bloom developed with chl a concentrations up to 3,1 µg Chl a/L. Samples were taken inside and outside the fertilized patch, subsequently referred to as „in patch“ and „out patch“.

Rhincalanus gigas, *Calanus simillimus* and *Pleuromamma* sp. females were caught with Bongo nets and incubated individually for up to 48 hours in 100 ml beakers with filtered seawater. All females were included in the calculation of the egg production rates, whether they spawned or not.

Incubation beakers for egg production experiments

The three different copepod species showed different responses to the induced phytoplankton bloom:

Pleuromamma sp.

Number of egg producing females:

In patch <10%

Out patch <10%

Pleuromamma sp. produced almost no eggs, with no differences between the “in” and “out patch” stations.

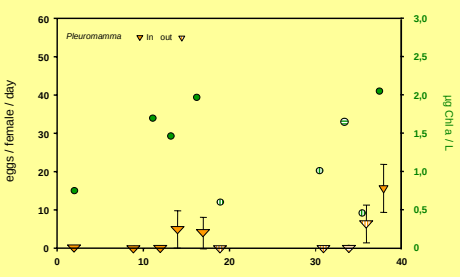


Fig.1: Egg production rate of *Pleuromamma* sp. in patch (filled symbols) and out patch (striped symbols). Corresponding chlorophyll a concentrations are given (green symbols).

Hatching success in patch 70%

(determined at one in patch station only)

Fig.4a: Egg *Pleuromamma* sp.

Egg diameter:

Inner membrane: 171±1µm

Outer membrane: 212±3µm

(n=57)

Fig.4b: N1 *Pleuromamma* sp.

Body length: 195±1,5µm

Width: 120±0,7µm

(n=11)

Calanus simillimus

Number of egg producing females:

In patch 50-85%

Out patch 50-60%

C. simillimus produced ~18 eggs female^{-1} day^{-1} during the entire cruise with no significant differences between the “in” and “out patch” stations.

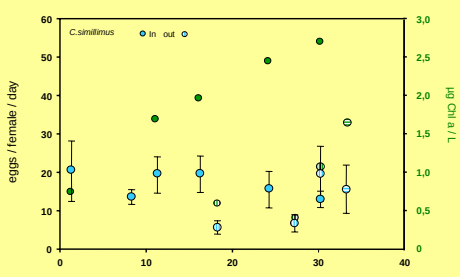


Fig.2: Egg production rate of *Calanus simillimus* in patch (filled symbols) and out patch (striped symbols). Corresponding chlorophyll a concentrations are given (green symbols).

Hatching success out patch 0-50%

in patch 0-85%

Fig.5a: Egg *C. simillimus*

Egg diameter:

Inner membrane: 149±1µm

Outer membrane: 376±9µm

(n=17)

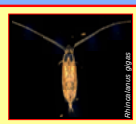
Fig.5b: N1 *C. simillimus*

Body length: 184±3,2µm

Width: 98,9±1,3µm

(n=11)

Rhincalanus gigas



Number of egg producing females:

In patch 60-90%

Out patch 0-15%

R. gigas did not produce eggs at the start of the experiment. Egg production increased “in patch” until day 30 after fertilization with an average of 50 eggs female^{-1} day^{-1}. The egg production rate “out patch” remind close to zero during the entire experiment.

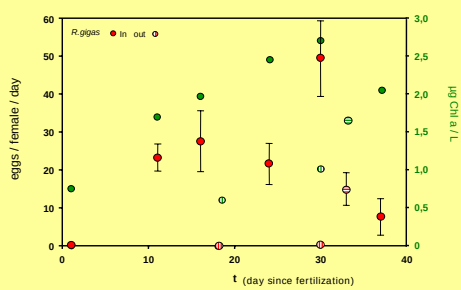


Fig.3: Egg production rate of *Rhincalanus gigas* in patch (filled symbols) and out patch (striped symbols). Corresponding chlorophyll a concentrations are given (green symbols).

Hatching success in patch 44±1,5%

Fig.6a: Egg *R. gigas*

Egg diameter:

221,3±1µm

(n=110)

Fig.6b: N1 and N2 *R. gigas*

Body length N1: 286±2µm

Width: 122±1µm (n=22)

Body length N2: 505±8µm

Width: 162±2µm (n=16)

Life cycles of Antarctic copepods are diverse and especially the strategy of *R. gigas* is still under debate. *Pleuromamma* sp. and *C. simillimus* showed no responses in egg production rates to increasing chlorophyll concentrations. The observation that *R. gigas* showed a clear reproductive response to increasing chlorophyll concentrations in autumn suggest that this species can react on favourable conditions and that their reproduction is not only dependent on seasonal aspects. The survival of the nauplii in winter month and therefore the advantage of this ability is questionable and further investigations are needed.

Future work...

Eggs and Nauplia from water samples will be enumerated and classified to determine the distribution and the development within the field.

The development of the copepod gonads will be analysed over the time of the experiment to underline the data from the egg production experiments.

Long term experiments are needed to understand the advantage or disadvantage of the ability to react on high phytoplankton concentrations at every time of the year.

Can the nauplii survive in the post bloom situation?