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Bioturbation by cyprinid fish affecting the food availability for predatory water mites

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Summary. Field observations suggested that benthivorous fish, causing bioturbation, are able to effect the food availability for predacious water mites feeding on bottom dwelling chironomid larvae. This hypothesis was tested in the laboratory. In an undisturbed situation the predation rate exercised by the water mites on the tube dwelling chironomid *Cladotanytarsus mancus* was very low. However, when the sediment was disturbed, the predation rate increased substantially. The relevance of this for the field situation is discussed.

Introduction

From field experiments with fish-exclosures (unpublished data) is was found that the density of *Cladotanytarsus mancus* decreased significantly in the non-caged area. Cyprinids, the most important bottom foraging fish in lake Maarsseveen I, however, could not be responsable for this decrease because the sorting efficiency for this small prey item is very low (about 1%, as experiments indicated). The only other abundant predators of chironomid larvae, occurring in the litoral zone, are the water mites *Hygrobates nigromaculatus* and *H. trigonicus*. Due to the sturdy tubes *Cladotanytarsus* constructs out of sand grains the mites appeared to have great difficulties in catching sufficient prey laboratory experiments.

In autumn and winter densities of *C. mancus* of over 20,000 m^{-2} occur in the wave exposed shoreline of the lake, while alternative food sources for *Hygrobates* hardly are available. However body-weight increased throughout the winter, which indicates that the mites were actually eating.

Benthic feeding bream sucks sediment in to the mouth. A good description of this feeding and selection process is made by Sibbing et al. (1985) for carp. In the field the results of this activities can be found as numerous pits with diameters up to 9 cm and depths up to 10 cm.

It is thought that this way of feeding by bream, causing bioturbation there by exposing tube dwelling chinonomids, might facilitate predation by water mites. This hypothesis was tested in the laboratory.

This paper is a part of a study on the role of chironomid larvae in the food-web of the litoral zone of lake Maarsseveen I (The Netherlands).

Methods

In order to test the hypothesis, predation by mites was studied with and without sediment disturbance. Prey mortality was used as a criterion and compared with the mortality in the absence of predation. Both, predators (*Hygrobates nigromaculatus* and *H. trigonicus*) and prey (*Cladotanytarsus mancus*) were caught in Lake Maarsseveen I in January 1984. They were kept and fed in the laboratory for two weeks before the start of the experiments. Temperature and light conditions were kept constant at 10 °C and a 12:12 dark-light cycle with low light intensity.

Preliminary experiments were carried out in small vials, while later on larger tanks were used. Vials and tanks were filled with a two centimeter layer of sand. Selected *Cladotanytarsus* larvae with a length of about 3 mm were added. On the next day, when the larvae had burried and build sand tubes, the water mites were introduced.

Sediment disturbance as created by bream feeding was imitated by using a pipe to suck the sediment and by spreading it equally over the bottom. This was done twice a day in such a way that daily an arbitrary chosen rate of about 30 percent of the bottom was disturbed.

Field rates of disturbance during 1983 were obtained by counting and measuring the diameter of the feeding pits created in marked and smoothout areas after one or several days.

Results and discussion

Table 1 gives the results of the experiments. The results of the preliminary experiments (serie I) were the same as for those of series II. Sediment disturbance alone does not affect the prey mortality. Predation alone causes a low mortality, while both predation and disturbance combined respectively show a 2.5 and 4.7 fold increase in prey mortality. Tubes constructed of sand grains also gave problems for larvae of the stonefly *Kogotus* when preying on *Stempellina* larvae (Tanytarsinii) (Walde and Davies 1984). The same phenomenon is described by Paterson (1970) for the silk spinnings of the chironomid *Glyptotendipes* that partially protected the larvae from attack by the water mite *Piona carnea*. Our experiments show that sediment disturbance has a positive effect on the *Hygrobates* feeding rate. This must be caused by the fact that, when disturbed, the larva of *C. mancus* is rapidly leaving its tube and is no longer protected against predation. The predation-rate in the field must be comparable to the optimal feeding-rate since the growth of the mites in the field is not different from that in the laboratory under optimal feeding conditions (unpublished data).

In Fig. 1 the grazing rate of benthic feeding bream in the field in percent per day during 1983 is given. We consid-

Table 1. The influence of sediment disturbance on the predation by *Hygrobates nigromaculatus* and *Hygrobates trigonicus* on the tube dwelling chironomid larvae *Cladotanytarsus mancus*

	Series	A	B	C	D	E
Number	I	45.0	41.0	35.0	44.0	44.3
of larvae	II	110.0	102.1	72.8	109.3	109.2
Prey mite-1	I	A:0.067 (0.032)		B:0.167 (0.020)		
day-1	II	A:0.032 (0.014)		B:0.152 (0.015)		

Column A: start of experiment, B: predation only, C: predation and disturbance, D: disturbance only, E: no disturbance no predation. Serie I, bottom surface 35 cm^2, 20 mites, 3 days; serie II respectively 125 cm^2, 35 mites and 7 days (in parathesis standard deviation, $N=20$). All combination except AD, AE and DE are significant different ($P<0.01$)

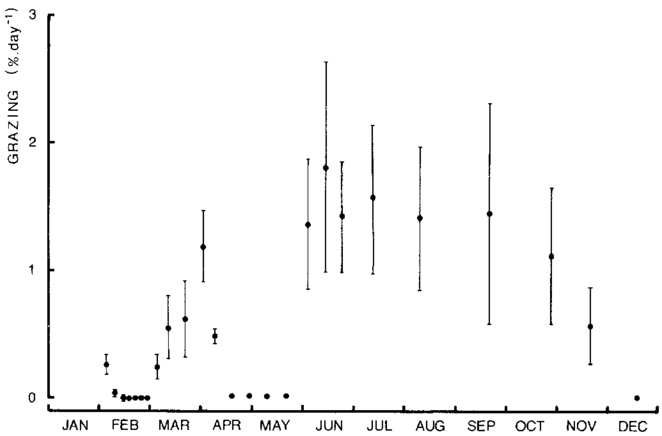

Fig. 1. Percentage of the bottom grazed per day by bream in a shallow part of lake Maarseveen during 1983

er grazing to be the digging for food. The pattern of activity fits well that described by (Backiel & Zawisza 1968). Throughout the year 300 to 400 percent of the bottom is digged by bream. In the period from October to May, when *Hygrobates* is dependent on *C. mancus* larvae for food, bream feeding causes a disturbance of about 100 percent of the bottom surface in the shallow lake parts.

Of course, next to bioturbation wave action can play a role in disturbing the sediments at shallow places. From our fish exclosure experiments, carried out in the litoral zone in the lake, evidence was found that for the period from October to January 50 percent of the *C. mancus* population was preyed by the watermite due to fish feeding only.

Recent data obtained from fish-excluding experiments gave more weight on the extrapolation of the outcomings of the laboratory experiments to the field situation. It appeared that the *Hygrobates* density was about twice as high in the lake as it was in the fish-excluded area. Kajak (1977) as a rule found higher densities of predatory invertebrates in enclosures were fish feeding was imitated by stirring the mud. He states that bottom feeding fish can increase the availability of prey for invertebrate predators by their digging activities. Eriksson et al. (1980) found that the watermite density was related positively with that of fish in a number of lakes with or without fish.

A negative effect on the watermite population caused by the feeding of bream must be considered as negligable since *Hygrobates* was never found in bream guts (unpublished data). Avoidance of unpalatable watermite as prey by fish was found by several authors, for instance Eriksson et al. (1980) and Kerfoot (1982).

Using laboratory obtained prey rates in a field situation, when sediment disturbance affects this prey rate, may by far beyond reality, specially when tube building prey is considered. The same disadvantage is met using small enclosures, excluding fish, to measure preyrates of added invertebrates under conditions 'similar' to those found in the natural environment (for instance Dusoge 1980; Kajak 1980). The use of cages to exclude fish has become an important tool to measure the impact of its predation on benthos. Many authors already have discussed all kinds of difficulties the worker, who uses this technique, might meet. Evaluations on this theme are made by Virnstein (1978) and Walde & Davies (1984). Additional to the problems described by these authors our experiments show that the predation rates of small invertebrates may be different between an undisturbed cage and field. This difference might biass the measurement of this fish consumption.

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