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Predation of Pomatoschistus microps Krøyer and P. minutus Pallas (Gobiidae, Pisces) on macro- and meiofauna in the brackish fjord Schlei

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Abstract

From April to September 1978 benthos and plankton samples were taken at three different sites in the Schlei fjord (German Baltic coast) with different salinity (ca. 15, 10 and below 5 ‰). Abundances of benthos and plankton taxa were compared with abundances of the taxa occurring in the guts of *Pomatoschistus microps* and *P. minutus*, caught at the same places at the same time. Main food were calanoids, oligochaetes and harpacticoids. Calculations showed that young gobies most probably regulate the population of harpacticoids to a large extent by grazing.

Introduction

The importance of meiofauna as food for fish was recognized much later than the importance of macrofauna in the food chain of commercially exploited fish. Studies on the food of small-sized fish make an important contribution to this phenomenon. A list of studies dealing with this problem is compiled in BODIOU and VILLIERS (1978).

This paper considers the influence of two species of gobies – the common goby, *Pomatoschistus microps*, and the sand goby, *P. minutus*, on the abundances of their main prey organisms.

Material and methods

The investigations were performed at the Schlei fjord (Fig. 1), which extends from the Baltic Sea about 40 km westward to the town of Schleswig. The Schlei is approx. 4000 years old and looks more like a chain of lakes than a bay of the Baltic Sea. Salinity decreases continuously from the mouth to the inner parts of the Schlei. It ranges from 1 ‰ in the inner Schlei to 15 or even more than 20 ‰ in the Western Baltic. Especially in the inner Schlei, the ground is covered with mud, containing sulphur dioxide (NELLEN 1967). This rotting sludge is the consequence of eutrophication caused by extensive sewaging. Only the littoral fringe shows more favourable conditions.

Samples were taken monthly from April to September 1978 at three different sites: Haddeby, Missunde and Olpenitz. The salinity at Haddeby is mostly below 5‰. At Missunde it ranges from 3 to 12 ‰ and at Olpenitz from 9 to 19 ‰. No other gobies than *Pomatoschistus microps* and *P. minutus* were caught; these two are abundant in the Schlei.

Generally, *P. microps* reaches a standard length of about 30 to 35 mm, the similar *P. minutus* reaches about 60 mm.

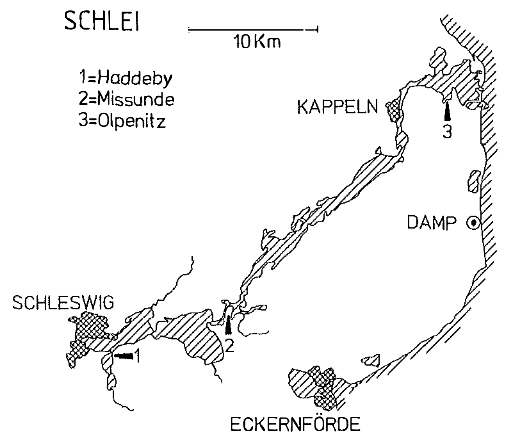


Figure 1

The fish were caught with a push-net at the shore, where the water was not deeper than 1 m and immediately fixed in 4 % formalin. Samples of plankton and benthos were taken at the same places. To gain the plankton samples, 50 l of water were filtered through a net of 100 μm mesh width.

The benthos samples were taken with a corer of 20 cm² diameter. We used only the upper 3–5 cm, fixed the sample in 4 % formalin and elutriated it in a modified Boisseau-apparatus (63 μm sieve) as described by McIntyre (UHLIG et al. 1973). The numbers of benthos organisms were calculated to 1 m². Regarding the plankton samples, we based our calculations on the fact that the gobies generally exploit only the first 15 cm above the ground.

Results and discussion

From April to July, relatively few specimens of *P. microps* and *P. minutus* were caught (Fig 2). For analysis we pooled both, since WESTPHAL (1979) found that these two species have a strong overlapping niche regarding their food.

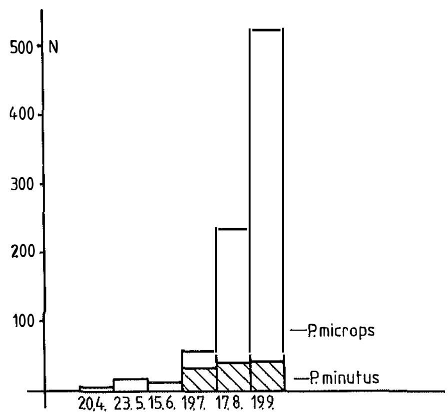


Figure 2

Total catch of *P. microps* and *P. minutus* for all three sites.

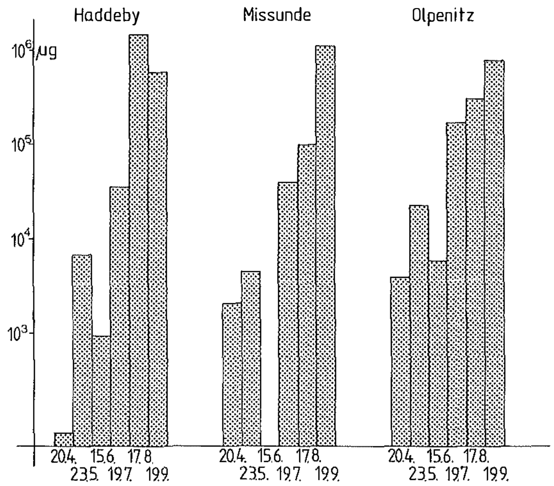


Figure 3

Ingested food, expressed as dry-weight for all caught gobies. (15.6. Missunde: no fish were caught)

Fig. 3 shows the increasing consumption of food after the young gobies appeared at all three sites. From April to September, the consumption rises to a factor of about 1000. Doubtlessly this is due to the massive appearance of young gobies.

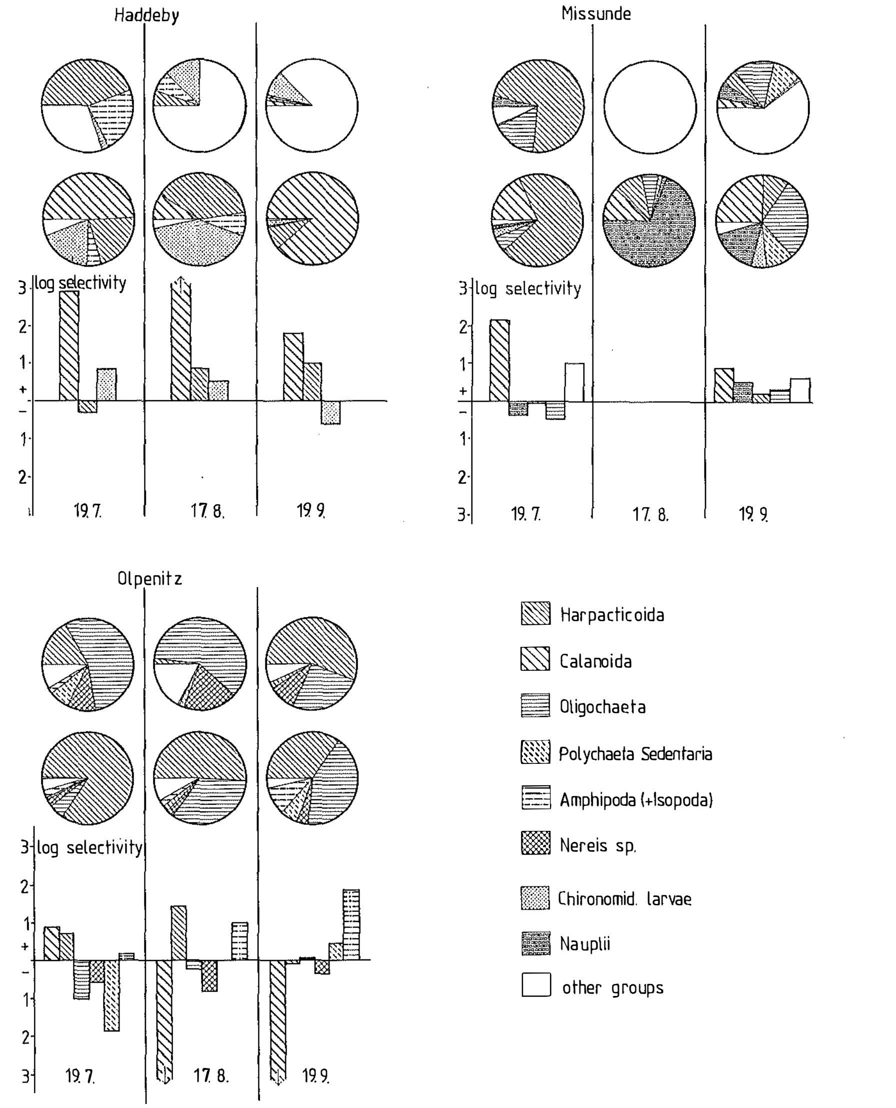
Comparing the percentage of numbers of some important food items in the available food with that consumed by gobies (Fig. 4, 5 and 6), some correlations can be shown. Only the months July, August and September are considered, because only at that time are the abundances of fish high enough to show a possible grazing effect. Owing to the appearance of young gobies in August, the portion of chironomid larvae and especially of harpacticoids increased in the consumed food, while the portion of harpacticoids among the available food decreased (Fig. 4). This is shown by a clear positive selectivity (sel = percentage in consumed/percentage in available food; JONES 1952).

The selectivity for calanoids is positive throughout the sampling period, even increasing after the young gobies occurred. This is due to the decreasing portion of calanoids in the available food.

„Other groups" are some pooled taxa (*Rotatoria*, *Ostracoda* etc.) which were eaten rarely or in very low quantities although they constituted a considerable part of the available food.

In Missunde (Fig. 5), the same phenomenon as in Olpenitz (Fig. 6) is obvious: Young gobies prefer harpacticoids; selectivity and portion of consumed food rise, whereas their percentage of available food decreases. Generally, the selectivity for calanoids is clearly positive, although low abundance in Olpenitz leads to results of less relevance. The importance of oligochaetes as food rises from Haddeby to Olpenitz, but from July, when young gobies are predominant, selectivity is mostly negative. In September, when the standard length of most gobies reaches more than 20 mm, selectivity for oligochaetes becomes positive again.

The selectivity for chironomid larvae, amphipods, and isopods varies to a large extent, probably caused by their low quantities in the available food, in the consumed food or in both of them. These results are therefore of no relevance.



Figures 4, 5, 6

Percentual portion of numbers of important taxa in available food (above) and consumed food (below). Beneath the selectivity for some taxa. (17.8.78 Missunde: one sample was missing)

Beside gobies other small-sized or young fish appear in high quantities, as well as shrimps and prawns like *Crangon* and *Leander*, gammarids and mysids, which all partially feed on the same organisms as the gobies. At the same sites, WESTPHAL (unpubl.) mainly found three-spined sticklebacks (*Gasterosteus aculeatus*) which additionally feed on calanoids, harpacticoids and chironomid larvae. Thus, grazing by gobies is only one component among others which may cause fluctuations in the abundances of prey organisms.

In late summer, i.e. August and September, however, young *P. microps* and *P. minutus* are by far the most common predators.

Only harpacticoids, oligochaetes and calanoids are regularly fed on in high quantities, varying from site to site. Therefore, a possible grazing effect can be expected only in these three groups. In order to evaluate a grazing effect, we had to compare the available food and the ingested food found in the fish for a defined area (e.g. 1 m^2). This was simple, regarding plankton and benthos samples, whereas it proved difficult to determine the abundance of fish in their natural environment.

The fish of our investigations were caught with a push-net. We sampled in an area of about 25 m^2, beginning in very shallow water to a depth of 1 m. Using this method, only a small part of the really existing fish were caught. Therefore, the real abundance of the gobies had to be estimated. EVANS and TALLMARK (1979) compared the efficiency of the push-net and the drop-net method. They found an efficiency of only 17 % using the push-net, compared to the drop-net method. For our purpose we assumed an efficiency of 20 %, because we could not avoid sampling twice in parts of the area. Consequently, all numbers had to be multiplied with the factor 5 to come to an estimation of the real abundance of gobies.

Moreover, when large numbers of young fish occurred, it took a long time to pick the small gobies out of the push-net, so that only a third to a half of the sampling area could be fished. So the amount of caught fish had to be multiplied additionally with the factor 2 or 3 from July to September. During summer, we found 10 – 80 young gobies m^{-2}, calculating in the aforementioned way. On the 19th of September in Missunde we found even about 200. In Dievengat/Belgium, VAES (1977) found similar abundances for a population of *P. microps*: 100/m^2.

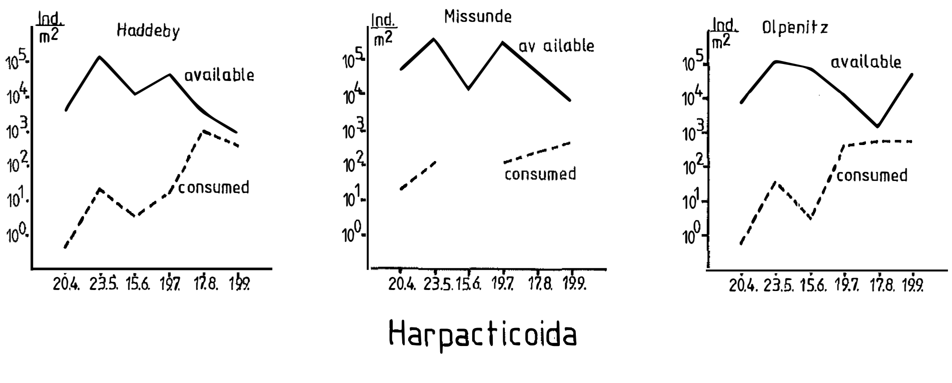


Figure 7

Comparison of available and consumed invlduals · m^{-2}, expressed as absolute numbers (15.6.78 Missunde: no fish were caught)

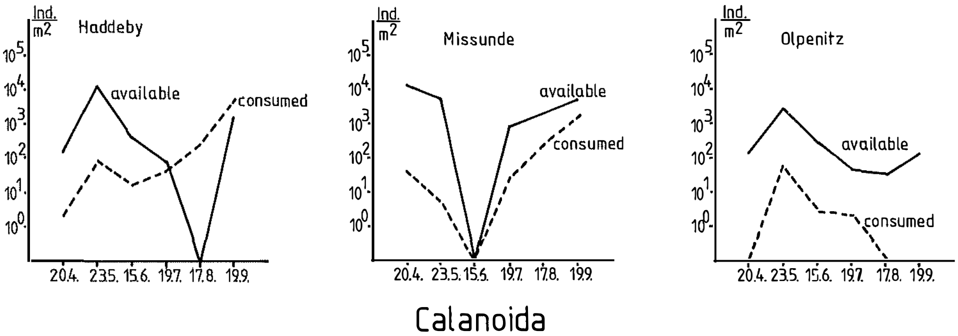


Figure 8
Comparison of available and consumed inviduals · m^{-2}, expressed as absolute numbers (15.6.78 Missunde: no fish were caught)

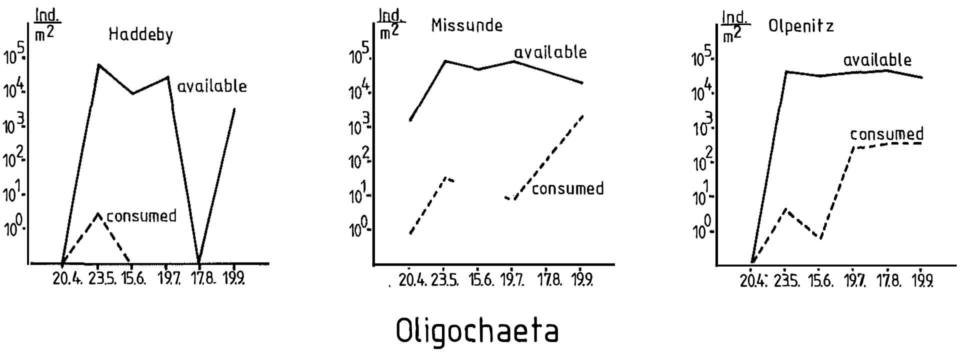


Figure 9
Comparison of available and consumed inviduals · m^{-2}, expressed as absolute numbers (15.6.78 Missunde: no fish were caught)

Based on these abundances, we are able to calculate the numbers of organisms fed on per m^2. Thus it is possible to compare potential food per m^2 with consumed food per m^2 for several taxa, respectively (Fig. 7, 8, 9).

In Haddeby the decrease of harpacticoids (Fig. 7) in late summer is set against an increased grazing by gobies. Not only the percentage (Fig. 4), but also the abundance of harpacticoids diminishes, from July to September to less than 2 %. A causal correlation is obvious.

Regarding calanoids (Fig. 8), a clear influence of a grazing effect by gobies cannot be proved, although especially this taxon is dominant in Missunde and Haddeby. Probably the feeding behaviour of the gobies follows the abundance of a prey taxon. This is what the parallel progress of the graphs of available and consumed food seems to indicate. Owing to the extensive consumption of calanoids by gobies, which even exceeds the available numbers in Haddeby, a more obvious decrease should be expected. Consumed calanoids may be replaced by others, swimming actively or being drifted by currents and wind onto the shore line where gobies prey on them. The frequent exchange of water masses and therefore of plankton may be an explanation for the fact that gobies consumed more calanoids than were found in the plankton samples.

In Haddeby oligochaetes are largely avoided (Fig. 9). Only on the 23rd of May we found some of them in the guts of the gobies. In Missunde and Olpenitz, however, great amounts of oligochaetes were eaten, especially by young gobies. Nevertheless, an influence on the oligochaete population is not obvious. The numbers of oligochaetes are more or less constant in spite of increasing consumption by gobies.

Grazing by gobies probably influences population dynamics of many prey organisms. Our investigations made this phenomenon evident only in harpacticoids, the population of which was reduced by a strong grazing effect.

ZANDER and HARTWIG (1981), too, found *P. microps* to regulate the population of harpacticoids in the Wadden Sea near the German island of Sylt.

On the other hand, BERGE and HESTHAGEN (1981) could not prove any significant change in the abundance of benthos prey organisms. They enclosed 3 or 10 *P. microps*, resp., in 0.7 m^2 net cages in Oslo Fjord and recorded the changes in the benthos community. REISE (1979) found only „moderate predation on meiofauna by the macrobenthos of the Wadden Sea''. He also used net cages and enclosed or excluded *P. microps*, which in inclusion experiments preferred small polychaetes.

If highly unnatural interferences can be excluded, these experiments in the field seem to be suitable for estimating interspecific grazing effects. However, on the basis of our data, which were obtained by field sampling, a certain correlation of cause and effect cannot be made yet. According to ELMGREN (1978) "such proof is not likely to be found in evidence from field surveys, but will require experimental work, in the laboratory or in the field." Only then natural fluctuations are clearly to be attributed to their various causative factors.

Acknowledgements

We would like to thank Prof. Dr. C.-D. Zander for critical reading of the manuscript and for kind advice during the study, as well as our colleagues for helpful discussions.

References

BERGE, J. A. and I. H. HESTHAGEN, 1981. Effects of epibenthic macropredators on community structure in an eutrophicated shallow water area, with special reference to food consumption by the common goby *Pomatoschistus microps*. Proc. 15th Europ. Mar. Biol. Symp., Kieler Meeresforsch., Sonderh. **5**, 462–470.

BODIOU, J.-Y. and L. VILLIERS, 1978. La predation de la méiofaune par les formes juvéniles de Deltentosteus quadrimaculatus (*Teleostei*, *Gobiidae*). Vie Milieu 1978–79, **28–29**, 143–156.

ELMGREN, R., 1978. Structure and dynamics of Baltic benthos communities, with particular reference to the relationship between macro- and meiofauna. Kieler Meeresforsch. Sonderh. **4**, 1–22.

EVANS, S. and B. TALLMARK, 1979. A modified drop-net method for sampling mobile epifauna on marine shallow sandy bottoms. Holarctic Ecol. **2**, 58–64.

JONES, N.S., 1952. The bottom fauna and the food of flatfish of the Cumberland coast. J. Anim. Ecol. **21**, 182–205.

NELLEN, W., 1967. Ökologie und Fauna der brackigen und hypertrophen Förde Schlei. Arch. Hydrobiol. **63**, 273–309.

REISE, K, 1979. Moderate predation on meiofauna by the macrobenthos of the Wadden Sea. Helgol. Wiss. Meeresunters. **32**, 453–465.

UHLIG, G., H. THIEL, and J. S. GRAY, 1973. The quantitative separation of meiofauna. Helgol. Wiss. Meeresunters. **25**, 173–195.

VAES, F., 1977. Host-parasite relationships in a brackish-water habitat. Biol. Jb. Dodonaea **45**, 171–180.

WESTPHAL, D., 1979. Nahrungsuntersuchungen an Pomatoschistus-Arten der Schlei. Dipl.Arbeit, Zool. Inst. Univ. Hamburg. 113 pp.

ZANDER, C.–D. and E. HARTWIG, 1981. On the biology and food of small sized fish from the North and Baltic Sea Area. IV. Investigations of an eulittoral mud flat at Sylt. (In press.)