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# THE TROPHIC POSITION OF *POMATOSCHISTUS LOZANOI* (PISCES: GOBIIDAE) IN THE SOUTHERN BIGHT

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ABSTRACT Sand gobies of the genus *Pomatoschistus* are the most abundant fish in the shallow coastal areas of the North Sea. *P. lozanoi* has a somewhat specialised diet feeding mainly on a few pelagic and hyperbenthic species: *Temora longicornis*, *Schistomysis* species and juvenile *Pomatoschistus minutus* together supply more than 70% of the energy in most months. In August the species shifts to benthic and epibenthic feeding: juvenile *Crangon crangon* and radioli of *Lanice conchilega* are the main food. Numerically the same species are dominant in most months. In December and August the amphipods *Microprotopus maculatus* and *Pariambus typicus*, in June cypris larvae and the harpacticoid *Microarthridion littorale* are most frequently eaten. Thus, *Pomatoschistus lozanoi* is an unusual demersal fish, dependent throughout its life on the secondary and tertiary production in the water column.

## INTRODUCTION

The gobiid fish *Pomatoschistus lozanoi* classified with *P. norvegicus* in the *P. minutus* complex (Webb, 1980), is common on sandy bottoms in most northeastern Atlantic coastal areas southwards at least to Portugal, north to the Wadden Sea and around the British Isles (Miller, 1986). Many recent studies still ignore the existence of *P. lozanoi* despite the fact that the species is present in the area studied, e.g. Boddeke *et al.* (1986), Doornbos & Twisk (1987), Henderson (1989), or only split up the species complex for part of the study period, e.g. Claridge *et al.* (1985). Without detailed knowledge of the ecology of both species, lumping them in a "sand goby" superspecies seems unwise. Fonds (1973) suggested that in comparison with the sympatric *P. minutus*, *P. lozanoi* is a more neritic species, which avoids estuaries because of a lower tolerance for low temperature and salinity, feeds on nekto-benthos rather than benthos, and has a different spawning season: May to August, rather than March to June. This study was undertaken to establish the trophic position of *P. lozanoi* in the food web of a shallow coastal area.

## MATERIALS AND METHODS

Gobies were obtained more or less monthly from the by-catch of a commercial shrimp trawler O62 operating at 10 to 20-m depth in the Westdiep-Trapegeer area (Fig 1), from May through December 1984. In April 1985 fish were obtained from the same area through the Fisheries Research Institute, Ostend. In June and August 1985 two more samples were obtained from the O62. Mesh size was 20 mm stretched in the cod end. On board all fish were immediately anaesthetised in a benzocaine (ethylamino-4-benzoate) solution in sea water to prevent regurgitation of stomach contents. Within 15 min after capture the fish were preserved in neutralised formaldehyde 7% final concentration. At least three months after capture standard length was measured and the fish divided into 5 mm-length classes. From the most abundant size classes a maximum of 30 fish was selected at random for stomach analysis. All food items in the entire gastrointestinal tract, excluding the rectum, were

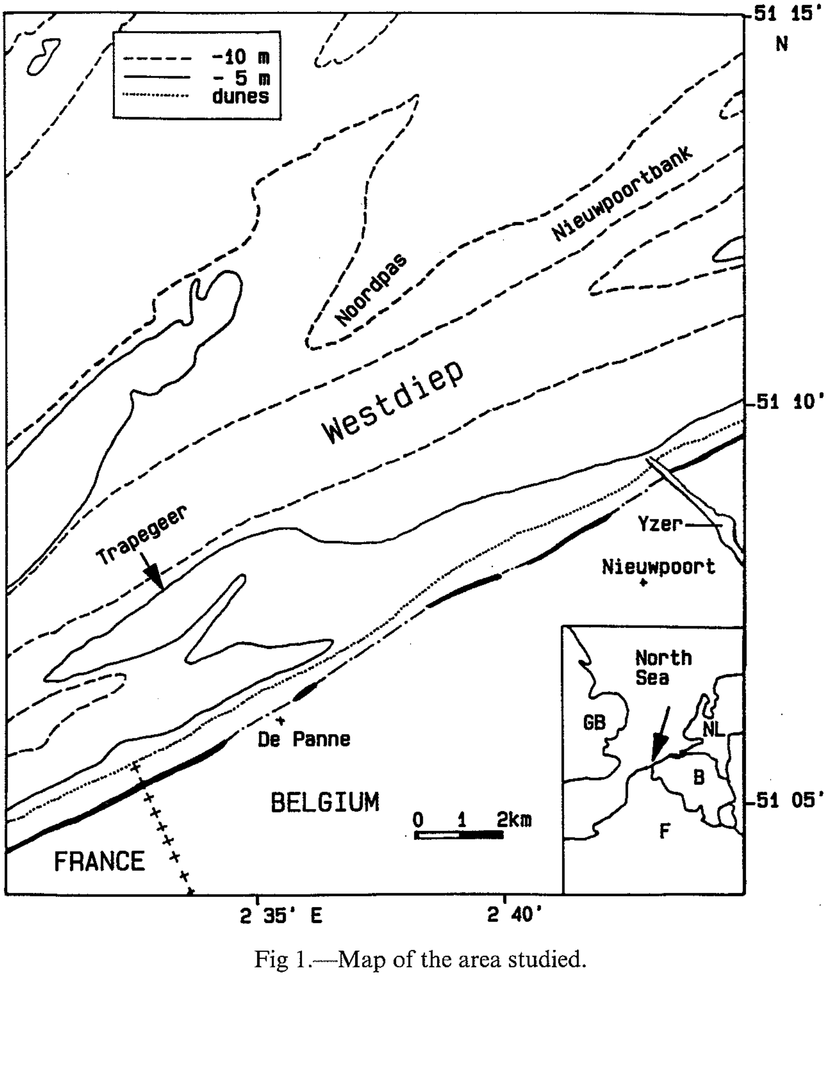


Fig 1.—Map of the area studied.

identified, if possible, to species level. For calanoids, harpacticoids, and chaetognaths assigned ash free dry weight (AFDW) values were used. All other animals were measured, and their AFDW prior to digestion calculated from regressions established for animals from the same area. The original size of incomplete prey was calculated from regressions relating unbroken parts, e.g. a telson or an antennal scale, to total length. For the radiole crowns of *Lanice conchilega* a visual volumetric estimate was compared with a volume of undigested radioles of known AFDW. Only species representing more than 4% either numerically or gravimetrically in a single size class or a single month are discussed (Field *et al.*, 1982).

## RESULTS

A total of 3327 fish were examined and the contents of 537 stomachs were analysed. It is impossible to estimate density and biomass from this kind of data; they will be the subject of other papers. There is very little variation in mean length of the gobies throughout the year as the lower limit of gear selection is close to the maximum size of the fish. Data on the parasites found in the fish have been published elsewhere (Hamerlynck *et al.*, 1989).

Results are presented in a hypothetical sequence from first capture of the juveniles in September to the last 1+ adults caught in August, although the samples were taken in a different order and contain fish from different year classes (1983 and 1984). The August result is a mixture of samples from 1984 and 1985.

Gravimetric food composition is shown in Table I and summarised in Figure 2. In autumn the O-group *Pomatoschistus lozanoi* derive nearly all their energy from mysids, of which more than 90% are *Schistomysis spiritus*. In the following spring the maturing fish feed mainly on juvenile *Pomatoschistus minutus*, *Temora longicornis*, gammaridean amphipods, and some mysids. Larvae of Clupeidae, mainly *Clupea harengus* are important in June.

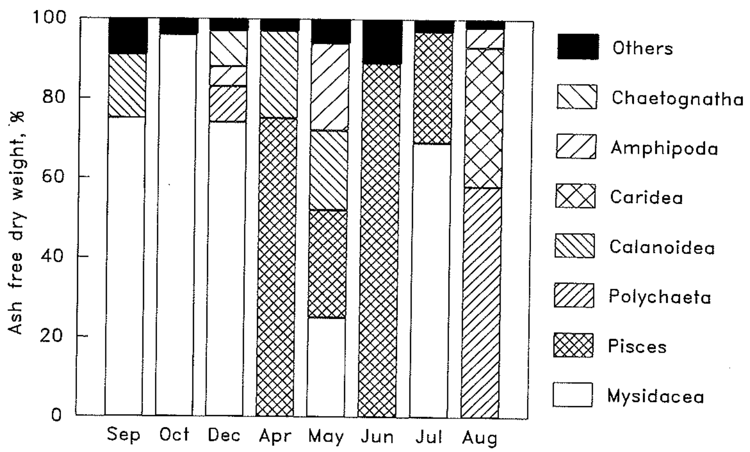


Fig 2.—Gravimetric food composition (percentage AFDW) over the year.

TABLE I

Size classes of fish and number of stomachs examined, number of prey items and numerical and gravimetric food composition (main species) over the year

| Month | Sept | Oct | Dec | Apr | May | June | July | Aug |
|---|---|---|---|---|---|---|---|---|
| Fish size (mm) | 25–55 | 35–50 | 40–50 | 45–50 | 45–55 | 40–50 | 40–55 | 40–50 |
| Number of stomachs | 110 | 81 | 36 | 30 | 52 | 60 | 79 | 89 |
| Number of items | 4426 | 1236 | 135 | 955 | 1491 | 2805 | 286 | 449 |
| Prey species | | | Numerical percentage | | | | | |
| *Temora longicornis* | 85 | 68 | 35 | 98 | 93 | 17 | 3 | 7 |
| *Centropages* species | | | | | | 1 | 19 | 1 |
| *Microarthridion littorale* | | | | | | 58 | | |
| Cirripedia larvae | | | | 1 | | 21 | | |
| *Microprotopus maculatus* | 5 | 1 | 19 | | | | 2 | 14 |
| *Pariambus typicus* | 3 | 1 | 14 | | | | 5 | 25 |
| *Pseudocuma longicornis* | | 1 | 7 | | | | | 18 |
| *Schistomysis spiritus* | 5 | 27 | 11 | | 1 | | 60 | |
| *Crangon crangon* | | | | | | | 1 | 10 |
| *Lanice conchilega* | | | 5 | | | | 3 | 20 |
| Prey species | | | Gravimetric percentage | | | | | |
| *Temora longicornis* | 16 | 3 | 2 | 22 | 20 | 1 | | |
| *Gammarus* species | | | | | 18 | | | |
| *Diastylis* species | | | | | | 4 | | |
| *Schistomysis spiritus* | 74 | 96 | 74 | | 18 | | 69 | |
| *Gastrosaccus spinifer* | | | | | 7 | | | |
| *Crangon crangon* | 1 | | | | 1 | 1 | 1 | 34 |
| *Nephtys* species | | | | | 3 | 2 | | 6 |
| *Lanice conchilega* | | | 7 | | | | | 49 |
| *Pectinaria koreni* | | | 1 | | | | | 4 |
| *Pomatoschistus minutus* | | | | 75 | 27 | 38 | 28 | |
| Clupeidae larvae | | | | | | 50 | | |

In July *Schistomysis spiritus* is again prominent, with juvenile gobies still important. In August a drastic change occurs and radioles of *Lanice conchilega* and small postlarval *Crangon crangon* are the main sources of energy.

Numerical food composition differs quite substantially from the gravimetric results (Table I, Fig 3). Here *Temora longicornis* gradually decreases in importance from September to December, replaced first by mysids and then by amphipods, 60% gammaridean, mainly *Microprotopus maculatus* and 40% caprellids: *Pariambus typicus*. In April and May *Temora longicornis* is dominant, to be replaced by other calanoids, mainly *Centropages* species, harpacticoids, mainly *Microarthridion littorale*, and cypris larvae of Cirripedia in June. In July small mysids figure prominently. In August the picture is quite diverse with equal proportions of gammaridean amphipods, mainly *Microprotopus maculatus*, caprellids: *Pariambus typicus*, sedentary polychaetes: *Lanice conchilega*, cumaceans, mainly *Pseudocuma longicornis* and some carideans, mostly *Crangon crangon*.

Only in September were enough fish of six different size classes (from 25 to 55 mm) collected within the same trawl to compare food consumption at different lengths. The numerical and gravimetric percentages of all species

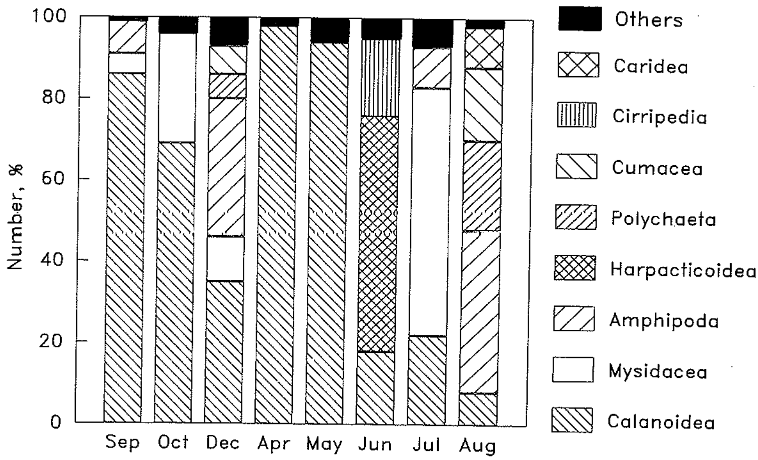


Fig 3.—Numerical food composition (percentage number) over the year.

representing more than 4% in a single size class are shown in Table II. The gravimetric composition is shown in Figure 4.

TABLE II

Number of stomachs examined, number of prey items and numerical and gravimetric food composition (main species) in different size classes of fish in September

| Fish size (mm) | 25–30 | 30–35 | 35–40 | 40–45 | 45–50 | 50–55 |
|---|---|---|---|---|---|---|
| Number of stomachs | 4 | 13 | 30 | 30 | 24 | 9 |
| Number of items | 237 | 674 | 847 | 1188 | 1219 | 253 |
| Prey species | | | Numerical percentage | | | |
| *Temora longicornis* | 95 | 90 | 83 | 85 | 85 | 81 |
| *Schistomysis spiritus* | 1 | 3 | 6 | 5 | 5 | 6 |
| *Microprotopus maculatus* | 3 | 4 | 5 | 6 | 5 | 8 |
| Prey species | | | Gravimetric percentage | | | |
| *Temora longicornis* | 46 | 21 | 12 | 15 | 18 | 11 |
| *Schistomysis spiritus* | 51 | 75 | 80 | 74 | 73 | 68 |
| *Crangon crangon* | | 1 | | | | 11 |
| *Pomatoschistus* species | | | 4 | | | |
| *Diastylis* species | | | | | | 5 |

## DISCUSSION

Data from the analysis of stomach contents are commonly used for tracing the food web. The results should be expressed in convertible units (Berg, 1979). Most methods that pretend to quantify the energy pathways use gravimetric data based on weighing the stomach contents as present in the fish (Hyslop, 1980). Our method of calculating the original AFDW has

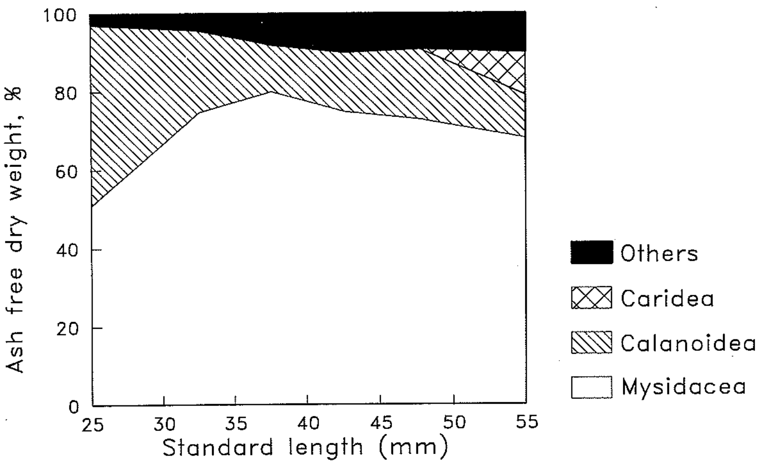


Fig 4.—Gravimetric food composition of different size classes of fish in September.

the advantage of reducing the bias introduced by the rapid digestion of soft bodied animals, e.g. chaetognaths.

The large differences between the numerical and the gravimetric percentage for many species points to a large size range in the prey consumed. One may wonder about the profitability of eating large numbers of *Microathridion littorale* if they contribute less than 1% to the total energy intake in the June sample.

In the shallow coastal zone *Pomatoschistus lozanoi* feeds predominantly on hyperbenthic animals, mainly *Schistomysis spiritus*, pelagic copepods, mainly *Temora longicornis*, and juvenile gobies, mainly *Pomatoschistus minutus*. Thus the species must forage in the water column close to the bottom. This is similar to the feeding mode suggested for *P. norvegicus* (Gibson & Ezzi, 1981). As most animals are found undamaged in the stomach *P. lozanoi* clearly prefers suction feeding to biting, although the August result shows it to be perfectly capable of biting off the radioles of *Lanice*, just like *Pomatoschistus minutus* (Hamerlynck *et al.*, 1986). Thus the restricted feeding mode of *P. lozanoi* is probably not due to anatomical constraints. The food resource partitioning with *P. minutus* may be a behavioural response which avoids competition.

Unlike *P. minutus* there is very little tendency towards more benthic feeding at larger sizes. Progenesis is common in the family Gobiidae (Miller, 1984) and in a sense the feeding of the adult *P. lozanoi* can be seen as a progenetic character: juvenile *P. minutus*, and most other juvenile gobies feed to a large extent on pelagic and hyperbenthic animals (Lebour, 1920; Hamerlynck unpubl. data).

A substantial proportion of the energy required for the ripening of the gonads in spring is obtained through predation on the juveniles of its possible competitor, *P. minutus*. Thus losing the competition for spawning sites, due to the smaller size of the male, may have some advantages.

The northward extension of *P. lozanoi* may be limited by the total duration of the breeding season for both species taken together. At a certain latitude the season may become too short for *P. lozanoi* juveniles to profit from the autumn copepod and mysid bloom.

In view of the resource partitioning between *P. minutus* and *P. lozanoi* putting them in a single "sand goby" category may lead to incorrect conclusions in ecological studies. In general, taxonomic grouping leads to greater errors than establishing functional guilds (Sugihara *et al.*, 1986). In a functional guild analysis of the inshore fish community, grouping according to similar size and food, *P. lozanoi* would probably be grouped with juvenile herring and sprat rather than with *P. minutus*. When calculating fluxes to and from the gobies in a coastal area this must be taken into account. The results of Doornbos & Twisk (1987) for the saline Lake Grevelingen will be more or less valid as *P. lozanoi* is only common in the westernmost part of the Lake (Hamerlynck, unpubl. data). The spring data of Boddeke *et al.* (1986) for the Dutch coastal area almost certainly concern *P. lozanoi* and not *P. minutus* which has a very low catchability at the time of spawning (Hamerlynck *et al.*, 1986). When calculating fluxes to gadoids (Redant, 1977), *Trachinus vipera* (Creutzberg & Witte, 1989), and other fish that consume large quantities of gobies, identifying the species seems important. The energy derived from *Pomatoschistus lozanoi* comes from secondary and tertiary production in the water column rather than indirectly through the benthic component as in *P. minutus*.

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## REFERENCES

Berg, J., 1979. Discussion of methods of investigating the food of fishes, with reference to a preliminary study of the prey of *Gobiusculus flavescens* (Gobiidae). *Mar. Biol.*, **50,** 263–273.

Boddeke, R., Driessen, G., Doesburg, W. & Ramaekers, G., 1986. Food availability and predator presence in a coastal nursery area of the brown shrimp (*Crangon crangon*). *Ophelia*, **26,** 77–90.

Claridge, P. N., Hardisty, M. W., Potter, I. C. & Williams, C. V., 1985. Abundance, life history and ligulosis in the gobies (Teleostei) of the Inner Severn estuary. *J. Mar. Biol. Assoc. U.K.*, **65,** 951–968.

Creutzberg, F. & Witte, J. I., 1989. An attempt to estimate the predatory pressure exerted by the lesser weever, *Trachinus vipera* Cuvier, in the southern North Sea. *J. Fish Biol.*, **34,** 429–449.

Doornbos, G. & Twisk, F., 1987. Density, growth and annual food consumption of gobiid fish in the saline lake Grevelingen, The Netherlands. *Neth. J. Sea Res.*, **21,** 45–74.

Field, J. G., Clarke, K. R. & Warwick, R. M., 1982. A practical strategy for analysing multispecies distribution patterns. *Mar. Ecol. Prog. Ser.*, **8,** 37–52.

Fonds, M., 1973. Sand gobies in the Dutch Wadden Sea (*Pomatoschistus*, Gobiidae, Pisces). *Neth. J. Sea Res.*, **6,** 417–478.

Gibson, R. N. & Ezzi, I. A., 1981. The biology of the Norway goby, *Pomatoschistus norvegicus* (Collett), on the west coast of Scotland. *J. Fish Biol.*, **19,** 679–714.

Hamerlynck, O., Heip, C. & Redant, F., 1986. Life history, food consumption and food resource partitioning in two sympatric gobies *Pomatoschistus minutus* and *P. lozanoi* in the Belgian coastal waters. *ICES C.M.* 1986/L:14 (mimeo).

Hamerlynck, O., Geets, A. & Van Damme, P., 1989. The parasites of two sympatric gobies, *Pomatoschistus minutus* and *P. lozanoi* in the Belgian coastal waters. In, *Proc. Symp. Invertebrates of Belgium*, edited by K. Wouters & L. Baert, KBIN, Brussels, pp. 27–30.

Henderson, P. A., 1989. On the structure of the inshore fish community of England and Wales. *J. Mar. Biol. Assoc. U.K.*, **69,** 145–163.

Hyslop, E. J., 1980. Stomach contents analysis—a review of methods and their application. *J. Fish Biol.*, **17,** 411–429.

Lebour, M. V., 1920. The food of young fish. No. III. *J. Mar. Biol. Assoc. U.K.*, **12,** 261–314.

Miller, P. J., 1984. The tokology of gobioid fishes. In, *Fish Reproduction: Strategies and Tactics*, edited by G. W. Potts & R. J. Wootton, Academic Press, London, pp. 119–153.

Miller, P. J., 1986. Gobiidae. In, *Fishes of the North-eastern Atlantic and the Mediterranean, Vol. III*, edited by P. J. P. Whitehead *et al.*, UNESCO, Paris, pp. 1019–1085.

Redant, F., 1977. Het epibenthos en de door haar veroorzaakte fluxen. In, *Project Zee (Mathmodelsea) Eindverslag*, edited by J. C. Nihoul & P. Polk, ICWB, Brussels, pp. 199–244 (in Dutch).

Sugihara, G., Garcia, S., Gulland, J. A., Lawton, J. H., Maske, H., Paine, R. T., Platt, T., Rachor, E., Rothschild, B. J., Ursin, E. A. & Zeitschel, B. F. K., 1986. Ecosystems dynamics, Group Report. In, *Exploitation of Marine Communities*, edited by R. M. May, Springer-Verlag, Berlin, pp. 131–153.

Webb, C. J., 1980. Systematics of the *Pomatoschistus minutus* complex (Teleostei: Gobiidae). *Philos. Trans. R. Soc. London Ser. B*, **291,** 201–241.