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Seasonal abundance off the Belgian coast of some Teleostomi preying upon brown shrimp (C. crangon)

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Introduction.

From the results of food analyses on Crangon on the one hand and on Teleostomi on the other clearly appears that Crangon occupies an intermediary place in the trophic chain of the coastal water biocoenosis (TIEWS, 1967 and REDANT, 1975c). The population density and population size of such a species is determined, not only by (endogenous) physiological and (exogenous) climatological factors ; the biotic environmental factors, like the amount of available food, fishery-mortality and especially predation-mortality, play a major part in it.

For the Crangon-population of the German Bight a proper evaluation of the quantitative influence of predation was made by a combination of the data on the stock strength of the different shrimp-predators and on the relative

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importance of Crangon as a food organism for these predators (TIEWS, 1965). One of the most striking conclusions of this study is that along the German coast the predation-mortality of C. crangon is 2.5 to 12.9 times larger than the fishing-mortality (TIEWS, 1965).

For the shrimp-population off the Belgian coast a similar study is actually carried out. When this study was started quantitative data on the distribution and abundance were not available for the major part of the Crangon-predators. The only predators which had been studied at that moment were those with a commercial value : Anguilla anguilla, Gadus merlangus, G. morhua, Trigla species, Scophthalmus maximus and Limanda limanda.

On the so-called non-commercial Crangon-predators only some faunistic or semi-quantitative data were available (LELOUP and GILIS, 1965 and DE CLERCK, 1973). In the present report the first results of a study about the occurrence and seasonal abundance of these non-commercial predators are mentioned. In addition a comparison between the results of this study and the results of similar studies in the German Bight is made.

Material and methods.

Monthly fourteen fixed stations were sampled, namely five in the Westdiep, five on the Vlakte van de Raan and four on the Thornton Bank. These samplings were started in April 1973. The positions of these stations are illustrated in figure 1.

Samplings were performed with an otter trawl (head line 12.2 meters). The mesh size of the net was 18 mm. Experimental fishing always took place by day. Each haul lasted 15 minutes.

For further information on the sampling-technique reference is made to earlier reports (REDANT, 1974a and 1974b).

Results and discussion.

Table 1 reviews all the Teleostomi observed in the samples during the period April 1973 - March 1975. From this table appears that the following Crangon-predators regularly occur off the Belgian coast : Anguilla anguilla, Gadus merlangus, G. morhua, Trisopterus luscus, Ciliata mustela, Callionymus lyra, Pomatoschistus minutus, Trigla gurnadus, T. lucerna, Cottus scorpius, Agonus cataphractus, Liparis liparis, Scophthalmus maximus and Limanda limanda. After elimination of the commercial species, already investigated (cf. Introduction) seven species remain : T. luscus, C. mustela, C. lyra, P. minutus, C. scorpius, A. cataphractus and L. liparis. The monthly average densities of these species in the Westdiep, Vlakte van de Raan and Thornton Bank (period April 1973 - March 1975) are illustrated in the figures 2 to 7.

In table 2 the yearly average densities of all the Crangon-predators (commercial and non-commercial species) are summarized.

a. Results per species (non-commercial species).

Trisopterus luscus.

The food of T. luscus mainly consists of Decapoda, Mysidacea and Pisces (TODD, 1907 and REDANT, 1975b). C. crangon is a very important foodorganism for this species (REDANT, 1975b). C. allmanni, Pontophilus trispinosus, Hippolyte varian Processa species and Pandalus montagui also were found in the stomachs but always in few numbers (REDANT, 1975b).

T. luscus is rather common off the Belgian coast (figure 2). From the year-cycles (figure 2) it cannot be concluded that the presence of T. luscus in the coastal waters is seasonal. This species prefers deeper water (POLL, 1947). That is probably why T. luscus was observed in larger numbers on the Vlakte van de Raan and the Thornton Bank than in the Westdiep (figure 2).

Due to its abundance in the coastal waters and to the great importance of C. crangon in the composition of its food, T. luscus must be considered as belonging to the most important predators of the Belgian shrimp stock.

Ciliata mustela.

C. mustela feeds on Decapoda, Amphipoda, Mysidacea, Pisces, frey of Decapoda (Carcinus) and Polychaeta. C. crangon was found in 83 % of the stomachs of C. mustela (KUHL, 1961).

Along the Belgian coast this species was only recorded in small numbers (figure C. mustela has a preference for shallow water (POLL, 1947). This statement completely harmonizes with observations of this species in the Ostend harbour (LEFEVERE, LELOUP and VAN MEEL, 1956). Thus it cannot be excluded that C. mustela occurs more frequently in shallow waters dose to the shore.

Though C. mustela largely feeds on C. crangon its destructive influence on the Belgian shrimps stock probably is restricted to a minimum for this species is too rare to be harmfull for the shrimp-population.

The related species Onos cimbrius and O. tricirratus, described as being rare in the Belgian coastal waters (POLL, 1947 and LELOUP and GILIS, 1965), were not observed during the investigations.

Cottus scorpius.

C. scorpius is a very voracious predator which mainly preys upon Decapoda and Pisces (TODD, 1907 ; BLEGVAD, 1917 ; LARSEN, 1936 and KUHL, 1961). Crangon species were found in 28 to 72 % of the stomachs, according to the area (TODD, 1907 ; LARSEN, 1936 and KUHL, 1961).

Along the Belgian coast, C. scorpius was observed almost exclusively during the wintermonths (figure 3). Nearly all the specimens were collected in the Westdiep (namely 92 %). This species prefers shallow water, especially during the spawning period (POLL, 1947). This explains the limitation in time and space of its distribution as it was recorded during the period April 1973 - March 1975.

The same remark can be made about the influence of C. scorpius on the Belgian shrimp stock as for C. mustela.

3 specimens, probably belonging to the related species C. bubalis were observed in the Westdiep (February 1974).

Callionymus lyra.

The food of C. lyra never has been studied in detail (POLL, 1947 and WHEELER, 1969). For the moment it is not surely known if this species really feeds on Caridea. Awaiting the results of further studies in this field C. lyra was retained in this report as a possible shrimp-predator.

C. lyra was found locally in large numbers. The largest densities were recorded in summer and autumn (figure 4). The seasonal distribution of this species in the Belgian coastal waters seems to be related to its spawning migration. C. lyra concentrates in the coastal waters from March till August to spawn (POLL, 1947).

The geographical distribution of C. lyra is sharply outlined. During the period April 1973 - March 1975 this species was observed almost exclusively in the Westdiep and on the Thornton Bank (figure 4). The geographical distribution of C. lyra in the Westdiep was remarkable : 98.5 % of all specimens were caught in the western part of the Westdiep (stations 23, 24 and 25). Up to now no explanation was found for this phenomenon.

Pomatoschistus minutus.

P. minutus feeds on Polychaeta, Decapoda, Mysidacea and Amphipoda (BLEGVAD, 1917 ; KUHL, 1961). C. crangon was recorded in 32 % of the stomach contents (KUHL, 1961).

P. minutus is the most common fish species in the Belgian coastal waters. In October 1973 densities up to 37,000 individuals/hour fishing were noted. The evolution of the density was similar in the three areas investigated : the density was minimal in spring and summer and maximal in the months September November (figure 5). In the three areas a great difference between the maximal densities of 1973 and 1974 was ascertained (figure 5). The reason for this is probably the abnormal high predation by Gadus merlangus in 1974. The stock

of G. merlangus was in 1974 about 2.5 to 4.5 times larger than in 1973 (REDANT and DE CLERCK, 1975). This species feeds mainly on Decapoda and Pisces (Clupea and Pomatoschistus) (REDANT, 1975a). In this way the abundance of G. merlangus off the Belgian coast caused in 1974 a considerable predation-mortality of P. minutus. This can explain the low densities of P. minutus in 1974.

Although the stomachs of P. minutus on the average only contain a few C. crangon, this species is, due to its abundance in the coastal waters, able to cause a substantial predation-mortality of C. crangon.

Agonus cataphractus.

The food of A. cataphractus includes Decapoda, Amphipoda, Cumacea (in some seasons) and Pisces. C. crangon was observed in 68 % of the stomachs (KUHL, 1961).

This species is very common off the Belgian coast (figure 6). Very large densities were observed locally : up to 3,000 specimens/hour fishing (Thornton Bank, October 1974). In the three investigated areas the density of A. cataphractus was minimal in the period January - June and maximal in the period July - December (figure 6). This seasonal distribution is probably related to the reproduction cycle and behaviour of this species. From January till April A. cataphractus migrates into very shallow waters (Laminaria zone) to spawn. In autumn and winter this species retires into deeper water (POLL, 1947).

Because of the important contribution of C. crangon to the food composition of this species as well as because of its abundance in the coastal waters, A. cataphractus must be considered as one of the most important enemies of the Belgian shrimp stock.

Liparis liparis.

The food of L. liparis is rather uniform, mainly consisting of Crangon and Amphipoda. C. crangon was found in 88 % of the stomachs (KUHL, 1961).

An apparent regularity could not be recognized in the seasonal distribution of this species but in the Westdiep where it was recorded almost exclusively during autumn and winter (figure 7). On the Vlakte van de Raan and the Thornton Bank a permanent but small or moderate stock of L. liparis was present. Just like C. mustela this species has a pronounced habitat preference for shallow coastal waters (POLL, 1947). It is thus possible that L. liparis is much more abundant in the shallow waters near the shore.

Although L. liparis is not so abundant as T. luscus, P. minutus or A. cataphractus, it should be considered as an important predator of the Crangon-population along the Belgian coast. The main reason for this being the uniformity of its food.

b. Comparison German Bight - Belgian coast.

In comparison with the German investigations (TIEWS, 1965)(cf. Introduction) the quantitative study of the influence of different predators on the Crangon-population along the Belgian coast, still is in a preliminary stage. Yet it is possible to compare some of the results of both investigations.

The study in the German Bight is based on the results of stomach analyses on the one hand and on the results of quantitative analyses of the catches of the commercial shrimp fishery on the other hand (TIEWS, 1965). Afterwards some complementary studies on the occurrence and distribution of by-catch fishes and by-catch Crustacea have been performed (TIEWS, 1971). Within the framework of the present study the results of these quantitative catch-analyses are of special interest.

Since the results of the German and Belgian by-catch analyses are expressed in different unities (respectively total yearly catch per species in 10^6 individuals and yearly average densities in numbers per hour fishing) an immediate comparison of the results of both investigations is impossible. For this reason the Crangon-predators first were grouped into four arbitrary frequency-categories : very abundant, abundant, less abundant and rare.

The Crangon-predators of the German Bight can be classified into these different categories as follows (after the original data from MEYER-WAARDEN and TIEWS, 1965 and TIEWS, 1971) :

Very abundant	: Pomatoschistus species.
Abundant	: Limanda limanda, Osmerus eperlanus, Agonus cataphractus, Gadus merlangus and Liparis liparis.
Less abundant	: Zoarces viviparus, Gadus morhua, Cottus scorpius, Anguilla anguilla, Callionymus lyra, Pholis gunellus, Ciliata mustela and Trigla species.
Rare	: Trisopterus luscus and Scophthalmus maximus.

For the Belgian coast the following classification of the Crangon-predators was obtained, according to their yearly average densities (table 2) :

Very abundant	: Pomatoschistus minutus.
Abundant	: Gadus merlangus, Limanda limanda, Agonus cataphractus, Trisopterus luscus and Callionymus lyra.
Less abundant	: Trigla species, Liparis liparis, Gadus morhua, Ciliata mustela, Anguilla anguilla and Cottus scorpius.
Rare	: Scophthalmus maximus.

From a comparison of both groupings it clearly appears that P. minutus, L. limanda, A. cataphractus and G. merlangus belong to the most abundant Crangon-predators, as well in the German Bight as off the Belgian coast.

There also exist some deeplying differences between the two areas. In the German Bight six species with a distinct habitat preference for shallow waters occur, namely O. eperlanus, L. liparis, Z. viviparus, C. scorpius, P. gunellus and C. mustela. Two of them belong to the most abundant Crangon-predators. Along the Belgian coast only three Crangon-predators with such a habitat preference were observed, namely Liparis liparis, C. mustela and C. scorpius (tables 1 and 2). O. eperlanus, Z. viviparus and P. gunellus never were recorded in the catches of the experimental fishery during the period April

1973 - March 1975. These species however may occur in large numbers in the very shallow coastal waters close to the shore (depths less than 4 meters). Indications for this can be found in the observations of Z. viviparus and P. gunellus in the Ostend harbour (LEFEVERE, LELOUP and VAN MEEL, 1965) and in the recent observations (February - March 1975) of Z. viviparus in the Ostend sluice dock. The range of these shallow water species probably will be restricted to a narrow band along the Belgian coast.

T. luscus on the other hand, which prefers deeper water (POLL, 1947), belongs to the most common Crangon-predators along the Belgian coast (table 2) whereas it is rarely recorded in the German Bight (MEYER-WAARDEN and TIEWS, 1965).

These differences in the qualitative and quantitative composition of the Crangon-predator-fauna could be foreseen. The German Bight is a typical wadden-area. In the major part of this area the depth does not exceed 5 meters and even at large distances from the coast depths of 20 meters or more are rare. Such an area is very well suited for species prefering shallow waters. The situation off the Belgian coast is different. Even close to the shore relatively large depths are recorded. In the Westdiep and the Vlakte van de Raan depths range from 5 to 16 meters. On the Thornton Bank these depths are 16 and 24 meters. This explains why, off the Belgian coast, some typical shallow water species are rare or are missing and why some species, prefering deeper waters, are found in large numbers. Thus the observed faunistic differences ultimately can be attributed to differences in the hydrographical structure of both areas.

Conclusions.

During the period April 1973 - March 1975 fourteen Teleostomi species, preying upon shrimps (C. crangon) were observed off the Belgian coast. These species are (in taxonomic order) : Anguilla anguilla, Gadus merlangus, G. morhua, Trisopterus luscus, Ciliata mustela, Callionymus lyra, Pomatoschistus minutus, Trigla gurnardus, T. lucerna, Cottus scorpius, Agonus cataphractus, Liparis liparis, Scophthalmus maximus and Limanda limanda (tables 1 and 2). From C. lyra it is not surely known if this species really feeds on C. crangon (POLL, 1947 and WHEELER, 1969).

In general the following conclusions concerning these species can be formulated. P. minutus, G. merlangus, L. limanda, A. cataphractus, T luscus and C. lyra are the most abundant Crangon-predators off the Belgian coast. The other species are less abundant or rare (tables 1 and 2). This does not mean that the destructive influence of these less abundant species ipso facto can be neglected. Some of them (e.g. L. liparis) are feeding intensively on C. crangon (KUHL, 1961) and thus can cause great damage to the shrimp stock, in spite of their small numbers. Other species (e.g. G. morhua) might be so numerous in the coastal waters during certain years that they cause a considerable reduction of the shrimp stock (DE CLERCK and REDANT, 1974).

The differences in the qualitative and quantitative composition of the Crangon-predator-fauna of the German and the Belgian coast clearly are due to differences in the hydrographical conditions of these areas.

5. Bibliography.

BLEGVAD, H. (1917) : On the food of fish in the Danish waters within the Skaw. Rep. Dan. Biol. Stat., XXIV, pp. 17-72.

BRABER, L. and DE GROOT, S.J. (1973) : The food of five flatfish species (Pleuronectiformes) in the Sourthern North Sea. Neth. Journal Sea Res., VI, 1/3, pp. 163-172.

DAAN, N. (1973) : A quantitative analysis of the food intake of North Sea cod (Gadus morhua). Neth. Journal Sea Res., VI, 4, pp. 479-517.

DE CLERCK, R. (1973) : Studie van de vis- en garnaalpopulaties in de visgronden van het Westdiep gedurende de periode mei 1970 - mei 1972. Ed. Comm. Toegep. Wetensch. Onderz. Zeeviss., Werkgroep Biologie, nr. 73/46, 51 pp.

DE CLERCK, R. and REDANT, F. (1974) : The evolution of the shrimp stock along the Belgian coast in 1969 - 1973. ICES, Shellfish and Benthos Committee, report C.M. 1974/K : 23.

GILIS, Ch. (1952) : De garnalenvisserij op de Belgische kust : haar evolutie in de loop van de jaren 1935 - 1951 en haar invloed op de garnalenstapel. Ed. Zeewetensch. Instit., nr. 8, 56 pp.

JONES, R. (1954) : The food of whiting and a comparison with that of the haddock. Scott. Home Dept., Marine Research, 2, 34 pp.

KUHL, H. (1956) : Untersuchung der Nahrung von jungen Seehasen (Cyclopterus lumpus L.) im Mündungsgebiet der Elbe. Arch. Fischwiss., VII, 1, pp. 40-47.

KUHL, H. (1961) : Nahrungsuntersuchungen an einigen Fischen im Elbe-Mündungsgebiet. Ber. Dt. Wiss. Komm. Meeresforsch., XVI, 2, pp. 90-104.

KUHL, H. (1963) : Uber die Nahrung der Scharbe (Limanda limanda). Arch. Fischwiss., XIV, 1/2, pp. 8-17.

LARSEN, K. (1936) : The distribution of the Invertebrates in the Dybsö Fjord, their biology and their importance as fish food. Rep. Dan. Biol. Stat., XLI, pp. 3-36.

LEFEVERE, S., LELOUP, E. and VAN MEEL, L. (1956) : Observations biologiques dans le port d'Ostende. Kon. Belg. Inst. Natuurwetensch., verhandeling 133, 157 pp.

LELOUP, E. and GILIS, Ch. (1965) : Zeedieren waargenomen in de experimentele garnalenvangsten (1949-1964). Ed. Comm. T.W.O.Z., Zeewetensch. Instit., 1965/2, 26 pp.

MEYER-WAARDEN, P.F. and TIEWS, K. (1965) : Der Beifang in den Fängen der deutschen Garnelenfischerei in den Jahren 1954-1960.
Ber. Dt. Wiss. Komm. Meeresforsch., XVIII, 1, pp. 13-78.

POLL, M. (1947) : Faune de Belgique : Poissons marins.
Ed. Kon. Belg. Instit. Natuurwetensch., Brussels, 452 pp.

REDANT, F. (1974a) : A qualitative and quantitative study on the invertebrates in the catches of experimental shrimp fishing in the Westdiep.
ICES, Shellfish and Benthos committee, report C.M. 1974/K : 21.

REDANT, F. (1974b) : The benthic and epibentic fauna of the Thornton Bank area.
ICES, Shellfish and Benthos Committee, report C.M. 1974/K : 22.

REDANT, F. (1975a) : The importance of post-larval Caridea in the food of Gadus merlangus L. (in preparation).

REDANT F. (1975b) : The importance of post-larval Caridea in the food of Trisopterus (Gadus) luscus (L.) (in preparation).

REDANT, F. (1975c) : Study of the epibenthos along the Belgian coast.
(in preparation).

REDANT, F. and DE CLERCK, R. (1975) : Unfavourable prospects for the Belgian shrimp fishery in 1975.
ICES, Shellfish and Benthos Committee, report C.M. 1975/K : 43.

REDEKE, H.C. (1906) : Verslag omtrent onderzoekingen over het voedsel van eenige visschen.
Jaarb. Rijksinstit. Onderz. Zee, 1905, pp. 88-111.

TIEWS, K. (1965) : Lichtung des Nordseegarnelenbestandes (Crangon crangon) durch Wegfrass.
Arch. Fischwiss., XVI, 2, pp. 169-181.

TIEWS, K. (1967) : Synopsis of biological data on the common shrimp Crangon crangon (L.).
FAO, Fisheries Synopsis no. 91, 58 pp.

TIEWS, K. (1971) : Weitere Ergebnisse von Langzeitbeobachtungen über das Auftreten von Beifangfischen und -krebsen in den Fängen der deutschen Garnelenfischerei (1961-1967).
Arch. Fischwiss.,XXII, 3, pp. 214-255.

TODD, R.A. (1907) : Second report on the food of fishes (North Sea, 1904-1905).
Mar. Biol. Ass. UK, Intern. Fish. Invest., Second Report on Fishery and Hydrograph. Invest. in the North Sea and adjacent waters, 1904-1905, volume II, part 1, pp. 49-163.

WHEELER, H. (1969) : The fishes of the British Isles and North-West Europe.
Ed. Macmillan, London, 613 pp.

Table 1.

Relative abundance (RA), commercial value (CV) and importance as shrimppredator (SP) of the Teleostomi observed in the catches of experimental shrimp fishing during the period April 1973 - March 1975.

Family	Species	RA	CV	SP
Clupeidae	Clupea harengus L.	1	+	-
	Sprattus sprattus (L.)	1	+	-
	Alosa fallax (Lacépède)	4	-	-
Engraulidae	Engraulis encrasicolus (L.)	3	-	-
Anguillidae	Anguilla anguilla (L.)	2	+	+
Belonidae	Belone belone (L.)	3	±	-
Gadidae	Pollachius pollachius (L.)	4	-	-
	Gadus merlangus L.	1	+	+
	Gadus morhua L.	2	+	+
	Trisopterus luscus (L.)	1	±	+
	Merluccius merluccius (L.)	4	-	-
	Ciliata mustela (L.)	2	-	+
Gasterosteidae	Gasterosteus aculeatus L.	3	-	-
Syngnathidae	Syngnathus acus L.	2	-	-
	Syngnathus rostellatus Nilsson	1	-	-
Zeidae	Zeus faber L.	4	-	-
Atherinidae	Atherina presbyter Cuvier	3	-	-
Carangidae	Trachurus trachurus (L.)	1	±	-
Mullidae	Mullus surmuletus L.	4	-	-
Trachinidae	Trachinus vipera Cuvier	4	-	-
Ammodytidae	Ammodytes lanceolatus (Lesauvage)	4	-	-
	Ammodytes lancea Yarrell	2	-	-
Callionymidae	Callionymus lyra L.	1	-	+(?)
Scombridae	Scomber scombrus L.	2	+	-
Gobiidae	Aphya minuta (Risso)	2	-	-
	Pomatoschistus minutus (Pallas)	1	-	+
Triglidae	Trigla gurnardus L.	2	+	+
	Trigla lucerna L.	3	±	+
Cottidae	Cottus scorpius L.	2	-	+
	Cottus bubalis Euphrasen (?)	4	-	+
Agonidae	Agonus cataphractus (L.)	1	-	+

Cyclopteridae	Liparis liparis (L.)	2	-	+
	Cyclopterus lumpus L.	4	-	-
Bothidae	Scophthalmus maximus (L.)	4	+	+
	Scophthalmus rhombus (L.)	4	+	-
Pleuronectidae	Limanda limanda (L.)	1	+	+
	Platichthys flesus (L.)	1	±	-
	Pleuronectes platessa L.	1	+	-
Soleidae	Solea solea (L.)	1	+	-

RA : 1 : abundant
2 : less abundant
3 : rather rare
4 : rare

CV : + : great commercial value
± : some commercial value
- : no commercial value
} for the fishery in the Belgian coastal waters

SP : + : shrimps important as food-source
- : shrimps unimportant as food-source or not eaten at all

The SP-appreciations are based on the results of food analyses published by BLEGVAD (1917), BRABER and DE GROOT (1973), DAAN (1973), DE CLERCK (1973), GILIS (1952), JONES (1954), KUHL (1956, 1961 and 1963), LARSEN (1936), POLL (1947), REDANT (1975a and 1975b), REDEKE (1906) and TODD (1907).

Table 2.

Yearly average densities (in numbers/hour fishing) of Teleostomi preying upon shrimps in the Westdiep (WD), Vlakte van de Raan (VR) and Thornton Bank (TB).

Species	Period	WD	VR	TB
Anguilla anguilla (L.) (*)	01.73-12.73	1.6	1.3	0.3
	01.74-12.74	1.4	0.4	0.0
	Average	1.5	0.8	0.2
Gadus merlangus L. (*)	01.71-12.71	71.0	-	-
	01.72-12.72	47.7	-	-
	01.73-12.73	47.7	69.1	81.9
	01.74-12.74	138.2	298.3	222.6
	Average	76.2	183.7	152.2
Gadus morhua L. (*)	01.71-12.71	54.8	-	-
	01.72-12.72	6.3	-	-
	01.73-12.73	6.1	6.1	3.6
	01.74-12.74	0.8	1.8	0.7
	Average	17.0	4.0	2.2
Trisopterus luscus (L.)	04.73-03.74	33.4	47.9	120.5
	04.74-03.75	12.8	64.6	197.0
	Average	23.1	56.2	159.0
Ciliata mustela (L.)	04.73-03.74	3.5	0.4	0.1
	04.74-03.75	0.7	1.8	2.2
	Average	2.1	1.1	1.1
Callionymus lyra L.	04.73-03.74	144.3	7.6	66.3
	04.74-03.75	68.9	6.5	30.7
	Average	106.6	7.0	48.5
Pomatoschistus minutus (Pallas)	04.73-03.74	2417.8	2750.3	5087.1
	04.74-03.75	761.0	1013.7	524.2
	Average	1589.4	1882.0	2805.6
Trigla species (*)	01.71-12.71	4.6	-	-
	01.72-12.72	8.7	-	-
	01.73-12.73	19.6	18.4	12.5
	01.74-12.74	13.5	1.4	3.1
	Average	11.6	9.9	7.8
Cottus scorpius L.	04.73-03.74	0.7	0.0	0.0
	04.74-03.75	2.7	0.3	0.0
	Average	1.7	0.2	0.0
Agonus cataphractus (L.)	04.73-03.74	88.9	58.8	174.7
	04.74-03.75	37.6	101.3	156.0
	Average	63.2	80.0	165.4
Liparis liparis (L.)	04.73-03.74	8.4	2.4	15.6
	04.74-03.75	4.0	10.4	8.9
	Average	6.2	6.4	12.2

Scophthalmus maximus (L.)(*)	01.73-12.73	0.2	0.1	0.0
	01.74-12.74	0.3	0.2	0.0
	Average	0.2	0.2	0.0
Limanda limanda (L.) (*)	01.71-12.71	197.2	-	-
	01.72-12.72	100.6	-	-
	01.73-12.73	149.3	83.6	45.4
	01.74-12.74	369.4	136.7	87.6
	Average	204.1	110.2	66.5

(*) : after original data from REDANT and DE CLERCK (1975).

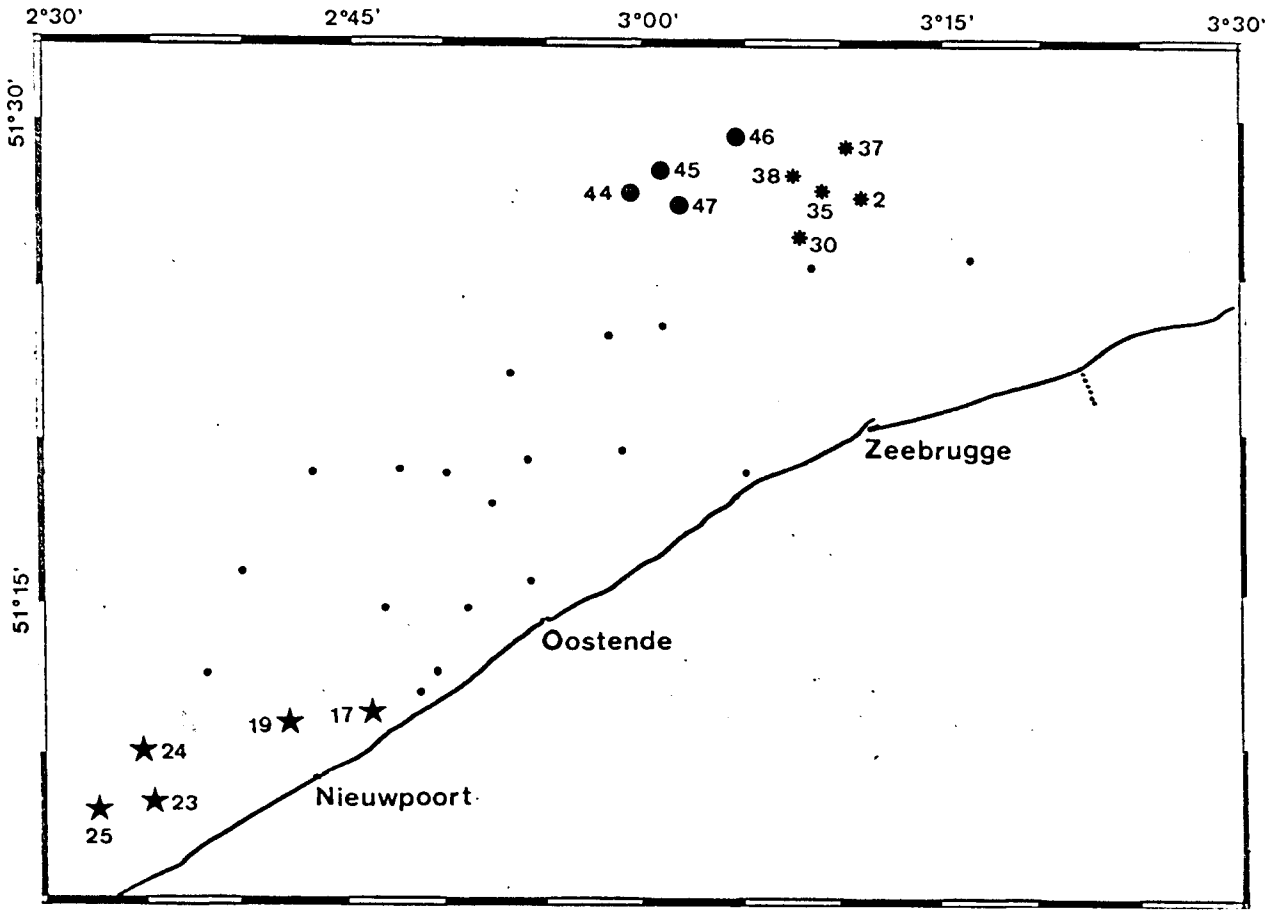


Figure 1.

Positions of the sampling stations in the Westdiep (★), Vlakte van de Raan (✱) and Thornton Bank (●).

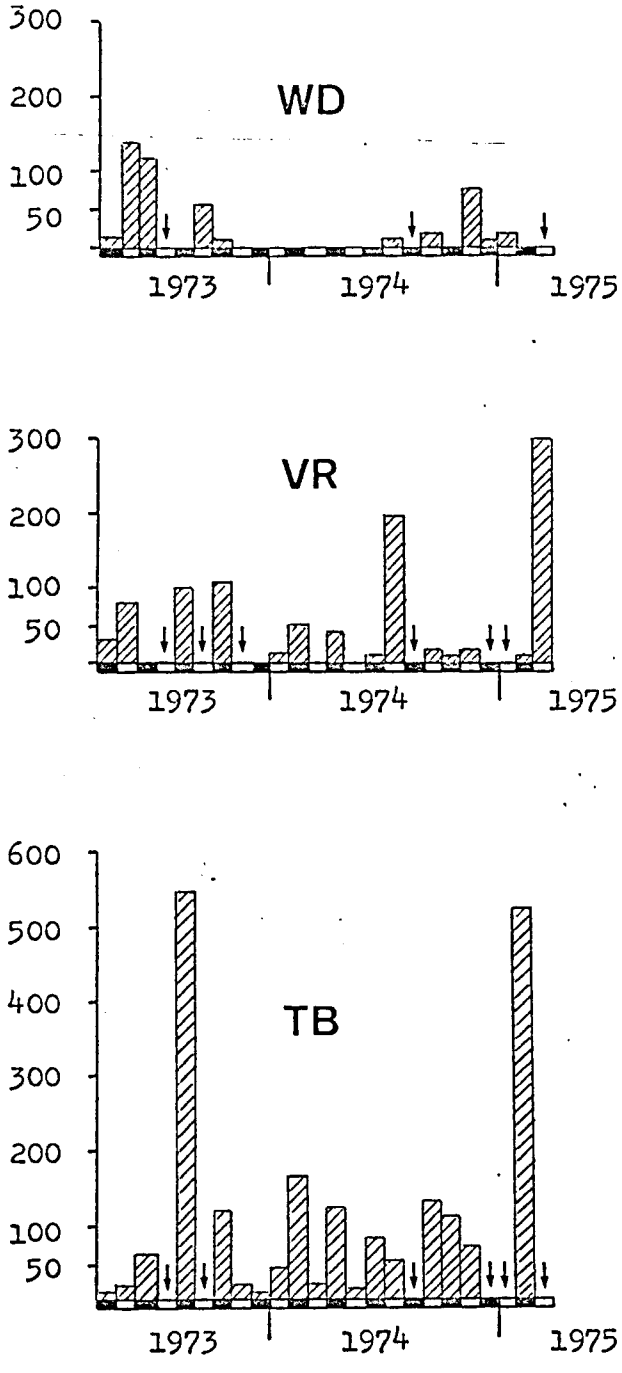


Figure 2.

Monthly average densities (in numbers/hour fishing) of Trisopterus (Gadus) luscus in the Westdiep (WD), Vlakte van de Raan (VR) and Thornton Bank (TB).

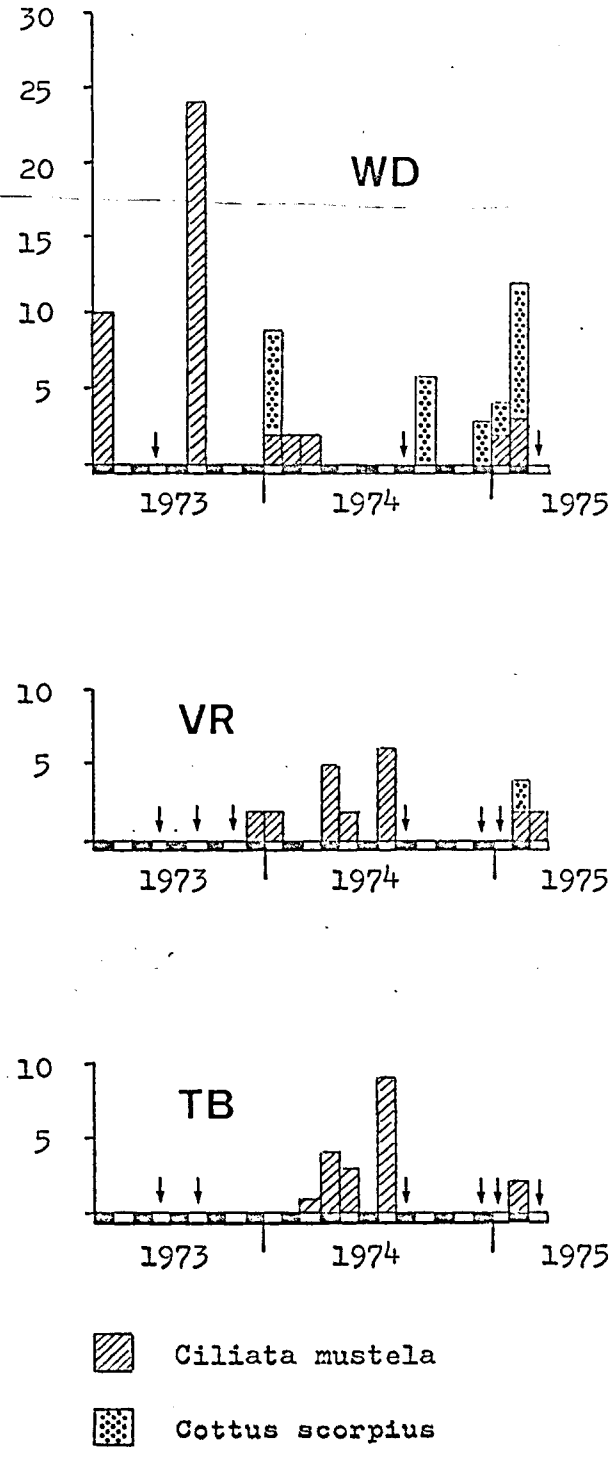
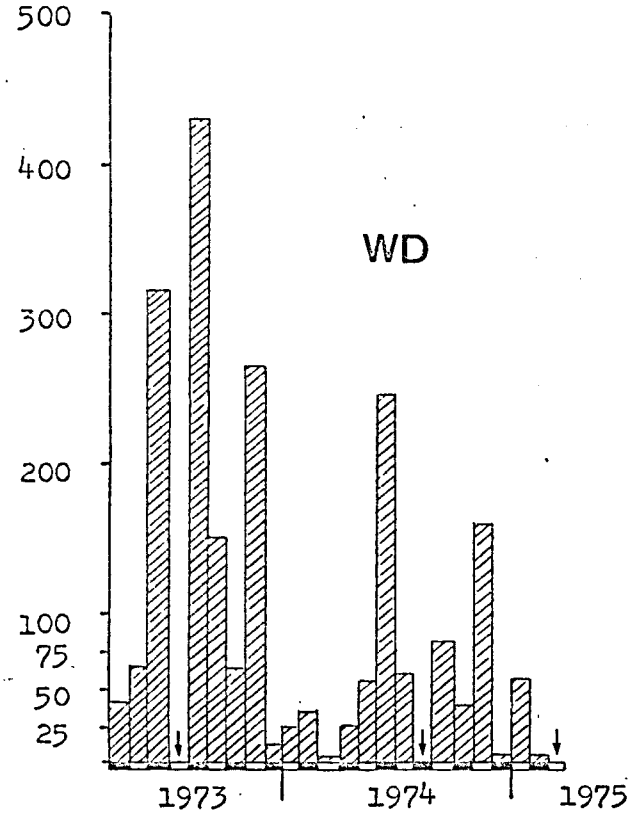
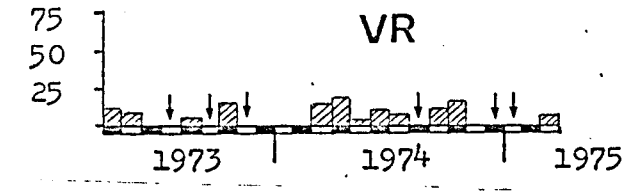


Figure 3.

Monthly average densities (in numbers/hour fishing) of Ciliata mustela and Cottus scorpius in the Westdiep (WD), Vlakte van de Raan (VR) and Thornton Bank (TB).

(→ : months during which no sampling was performed).





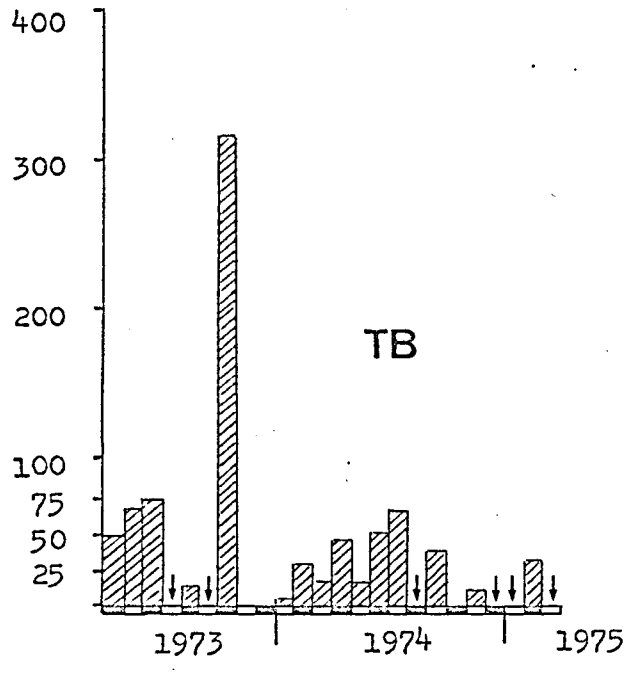
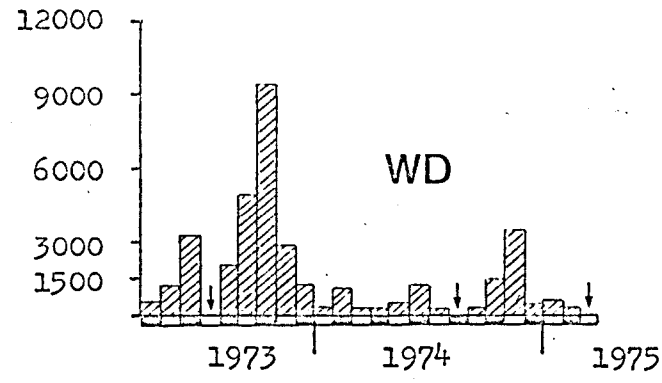
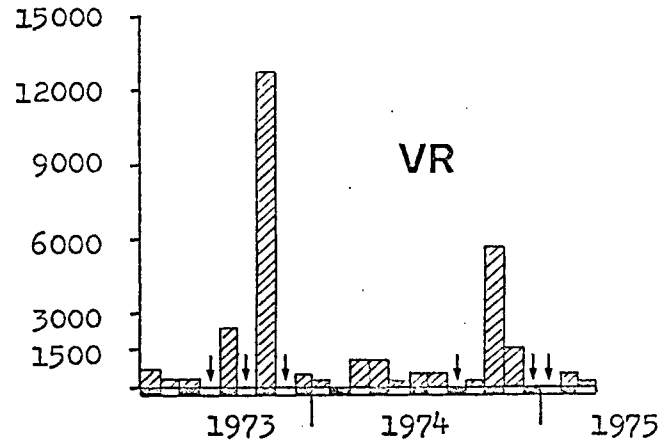


Figure 4.

Monthly average densities (in numbers/hour fishing) of Callionymus lyra in the Westdiep (WD), Vlakte van de Raan (VR) and Thornton Bank (TB).





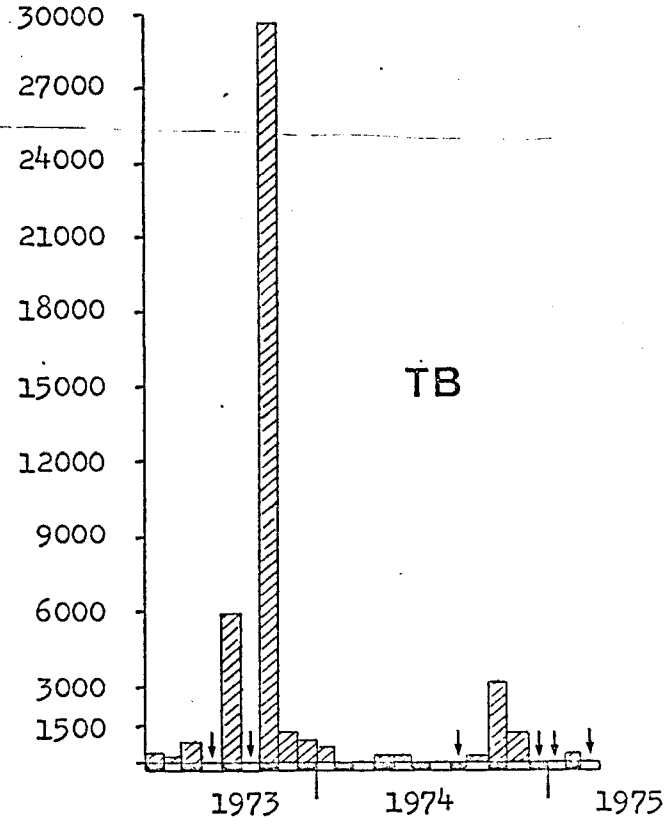


Figure 5.

Monthly average densities (in numbers/hour fishing) of Pomatoschistus minutus in the Westdiep (WD), Vlakte van de Raan (VR) and Thornton Bank (TB).

(→ : months during which no sampling was performed).

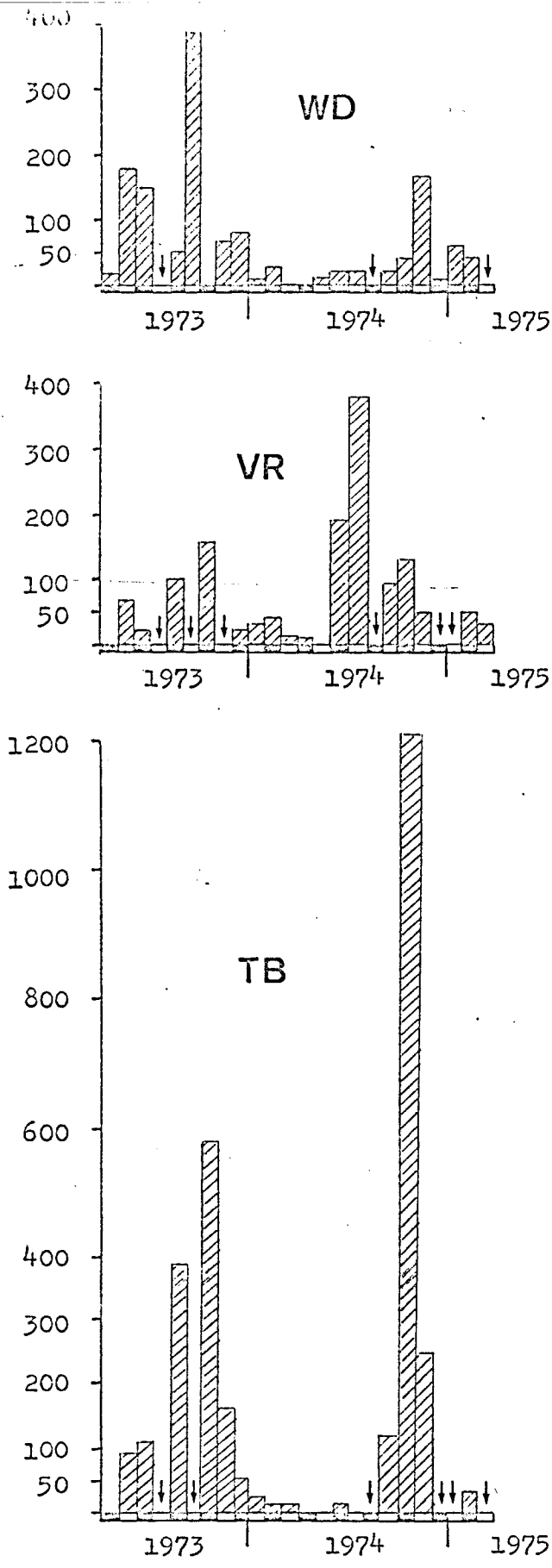


Figure 6.

Monthly average densities (in numbers/hour fishing) of Agonus cataphractus in the Westdiep (WD), Vlakte van de Raan (VR) and Thornton Bank (TB).

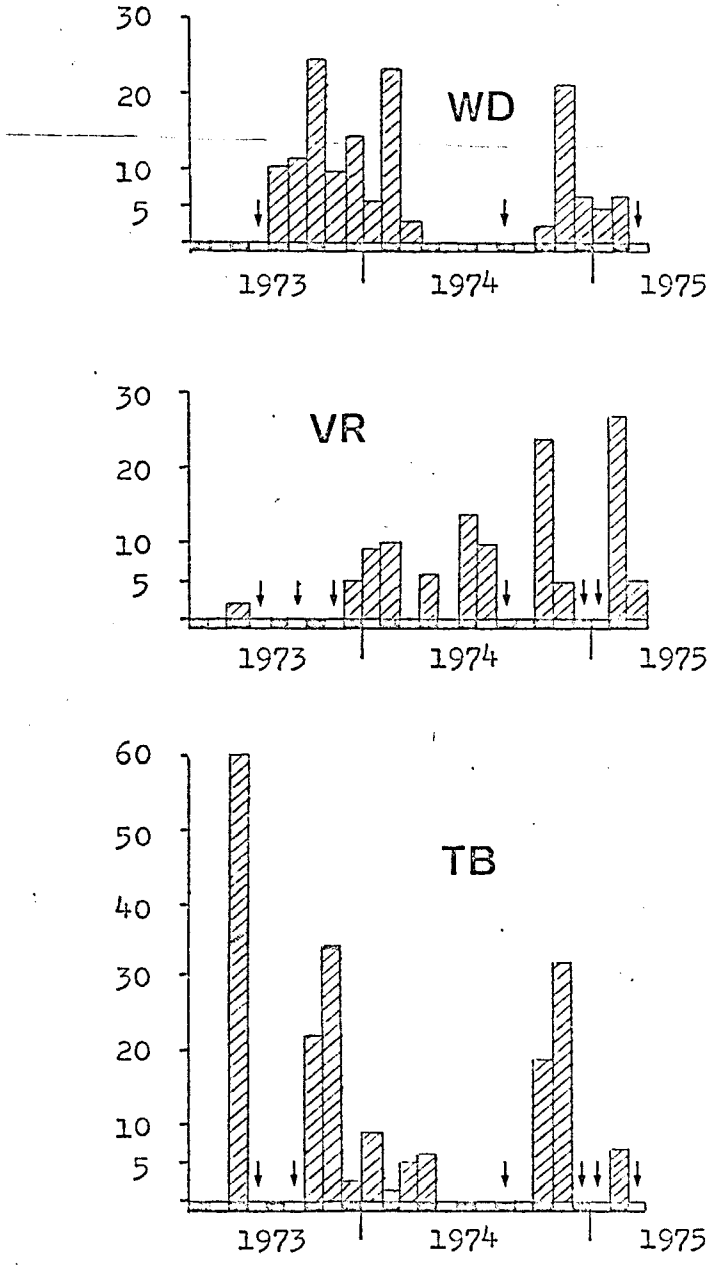


Figure 7.

Monthly average densities (in numbers/hour fishing) of Liparis liparis in the Westdiep (WD), Vlakte van de Raan (VR) and Thornton Bank (TB).

(→ : months during which no sampling was performed).