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A qualitative and quantitative study on the invertebrates in the catches of experimental shrimp fishing in the Westdiep

by

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INTRODUCTION

In April 1973 qualitative and quantitative analyses of the epibenthic and benthic fauna in the catches of experimental shrimp fishing were started. These investigations are part of a study in population dynamics of the macrobenthic invertebrates in the coastal waters. The ultimate objective of this study is the evaluation of the predative and interspecific competitive relations between the populations of the most important macrobenthic species. At the same time attention will be paid to the relations between these populations of the other species in the trophic chain of the shallow water biocoenosis.

A conditio sine qua non for such a study is the knowledge of the dominant macrobenthic species in the community under review. Only a few contributions giving some information on this subject are known. Some of them were mainly faunistic (Leloup and Gilis, 1965), while in others the quantitative research on invertebrates was restricted to some generally distributed Crustacea (Meyer-Waarden and Tiews, 1965 and Tiews, 1971).

In this contribution the main results of the first research-period (April 1973 - March 1974) are summarized.

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MATERIAL AND METHODS.

Five fixed stations in the Westdiep were monthly sampled (figures 1 and 2). The samplings were mostly performed with an otter trawl. Within the framework of the half-yearly stock surveys of April and October 1973, including the whole Belgian coast and of which the Westdiep forms a part (figure 1), a beam trawl was used. Experimental fishing always took place by day. The mesh size of the net was 18 mm and each haul lasted 15 minutes.

After grading the commercial and non-commercial fishes, the catch was washed down for impurities and divided into two fractions with a crabsieve. The fraction remaining on the sieve contained the great by-catch species ; the fraction falling through the sieve consisted of shrimps and small by-catch species. From each fraction a sample was taken for analysis. According to the size and to the heterogeneity of the complete fractions, the volumetric relation between samples and fractions varied from 1/1 to 1/30 for the samples with the great by-catch species and from 1/1 to 1/20 for the samples with shrimps and small by-catch species. The minimum volume of these samples was respectively 3000 and 1000 cc.

Laboratory analyses of the samples involved determination of the collected species, counting of the number of individuals per species and measurement of the total wet-weight per species. The planktonic Scyphozoa and Ctenophora were not studied.

From the measured weights monthly mean densities for the whole area (in kg/hour fishing) were calculated for each species. Yearly procentual weight contributions (YWC) to the average total monthly catch were derived from these data and are mentioned in table 1.

The months during which the different species were observed are also noted in table 1. This table gives a qualitative picture of the seasonal distribution of the species. Monthly density data made it also possible to add a quantitative interpretation of the seasonal distribution for some species.

RESULTS AND DISCUSSION.

The yearly mean weight of the catches was 84.2 kg/hour fishing. From April 1973 till October 1973 the average weight of the catches showed a steady increase to a maximum of 206.2 kg/hour fishing. From October 1973 the weight of the catches decreased sharply and reached a minimum of 12.4 kg/hour fishing in January 1974 (figure 3).

The following phyla, in order of importance (YWC-values), were observed (table 1) : Arthropoda (YWC = 78.31 %), Mollusca (YWC = 9.80 %), Echinodermata (YWC = 9.14 %), Coelenterata (YWC = 1.31 %), Bryozoa (YWC = 1.01 %), Annelida (YWC = .41 %) and Porifera (YWC = .006 %).

The most important species (YWC .1 %) were (table 1) : Macropipus holsatus (YWC = 40.06 %), Crangon crangon (YWC = 36.79 %), Sepia officinalis (YWC = 9.56 %), Asterias rubens (YWC = 6.55 %), Ophiura texturata (YWC = 2.42 %) Pagurus bernhardus (YWC = 1.38 %), Hydrozoa (considered as a whole : YWC = 1.25 %), Alcyonidium gelatinosum (YWC = .720 %), Lanice conchilega (YWC = .190 %), Psammechinus miliaris (YWC = .115 %), Aphrodite aculeata (YWC = .105 %) and Flustra foliacea (YWC = .105 %).

The high weight contribution of Hydrozoa (YWC = 1.25 %) was mainly caused by the abundance of this classis in April 1973. During the first half-yearly stock survey large quantities of Hydrozoa were observed, especially along the West coast (figure 4). At this moment the catches of Hydrozoa in the Westdiep were 6.8 kg/hour fishing on the average, which corresponds to a procentual weight contribution of 16.8 %. Probably these dense concentrations can be explained by the stormy weather preceding the April-samplings. It is possible that the material has been brought down from more Western areas by the dominant SW-NE coastal current (Leloup and Gilis, 1963). From May 1973 large quantities of Hydrozoa were seldom fished (figure 5). Consequently Hydrozoa probably are mainly allochtonous in the Westdiep.

Actinia equina, Natica catena, Sepia officinalis, Sepiola atlantica, Allotheutis subulata, Loligo vulgaris, Asterias rubens and Psammechinus miliaris are carnivores of a medium or a higher order (Barnes, 1968 ; Hardy, 1970 ; Jones, 1973 and Newell, 1970). These carnivores represented 17.7 % of the catches. Sepia officinalis (YWC = 9.56 %) and Asteria rubens (YWC = 6.55 %) were the most important of this group.

Sepia officinalis is a distinctly migratory species remaining only in the coastal waters during spawning period (May-July). After the reproduction period the spent males and females die while the animals who did not take part in a copulation leave the coastal waters (Richard, 1971). In the course of May and June 1973 (in July no sampling was performed) the densities of Sepia officinalis reached respectively 68.6 and 19.2 kg/hour

fishing on the average (figure 6). These values correspond to respectively 64.9 and 17.7 % of the total catches of these months. As a matter of fact in August and September only 0 year-old cuttle-fishes were observed.

The smaller species Sepiola atlantica appeared in the catches in quantities worth mentioning only during spring and summer (table 1). The more pelagic squids Allotheutis subulata and Loligo vulgaris are also migratory species. Consequently the Cephalopoda do not belong to the permanent endemic fauna of the Westdiep.

Apparently Actinia equina, Natica catena, Asterias rubens and Psammechinus miliaris are the only invertebrate predators which can be considered as indigenous in the Westdiep.

Aphrodite aculeata, Buccinum undatum, Pandalus montagui, Crangon crangon, Pontophilus trispinosis, Pagurus bernhardus, Macropipus holsatus, Carcinus maenas, Ophiura texturata and Echinocardium cordatum are omnivores (Barnes, 1968 ; Jones, 1973 ; Newell, 1970 ; Plagmann, 1939 and Tait, 1968). Some of these species like Aphrodite aculeata, Crangon crangon and Macropipus holsatus play a part as detritophages and as carnivores of a lower or a medium order (Barnes, 1968 ; Hardy, 1970 and Plagmann, 1939). Other species, like Pagurus bernhardus, Ophiura texturata and Echinocardium cordatum are mainly detritophagous (Barnes, 1968 and Newell, 1970).

The yearly total procentual weight contribution (YWC) of the omnivores was 80.8 %. Macropipus holsatus (YWC = 40.06 %) and Crangon crangon (YWC = 36.79 %) were the most important representatives of this group. In spite of their repeatedly nummerous presence Ophiura texturata (YWC = 2.42 %) and Pagurus bernhardus (YWC = 1.38 %) were much less important in the composition of the macrobenthic fauna.

An important conclusion from these observations is that there exists a great discrepancy between the observed numbers of carnivores and omnivores on the one hand and the observed numbers of suspension and deposit feeders on the other hand. The main food-organisms for invertebrate and vertebrate carnivores, namely Annelida and Lamellibrachia, only constituted .47 % of the catches (table 1).

The reason for this probably can be found in the sampling method. The rigging of the fishing gear does the net glide over the bottom as smoothly as possible. The penetration of the groundrope into the bottom is reduced

to a minimum by fastening rolls to it. A consequence of this might be that the net would only take up the organisms living on or immediatly under the bottom surface. Moreover small organisms like most Polychaeta and Lamellibranchia have a considerable chance to be washed out of the net during hauling. The use of a shrimp net with a mesh size of 18 mm as benthos-sampler, consequently does not give enough guarantees for justified quantitative investigations on the population densities of smaller organisms.

Yet the sampling method is appropriate for quantitative population analyses of most Anthozoa, some Polychaeta (f.e. Aphrodite aculeata), some Gastropoda (f.e. Buccinum undatum), Cephalopoda, Bryozoa, most Crustacea Decapoda, Asteroidea, Ophiuroidea and most Echinoidea.

In order to follow the monthly evolution of the most important autochtonous species, namely Crangon crangon, Macropipus hosatus, Pagurus bernhardus, Asterias rubens and Ophiura texturata, monthly average procentual weight contributions (MWC) to the total catches of indigenous species (= total catch minus Hydrozoa and Cephalopoda) were calculated for each month and for each species (table 2).

During summer and autumn (August 1973 - December 1973) Crangon crangon and Macropipus holsatus dominated the macrobenthic fauna. At least 90 % of the catches consisted of both these omnivore species. During this period the carnivores and detritophages only formed a minority group.

During spring (April 1973 - June 1973) and winter (January 1974 - March 1974) there exists a co-dominance between omnivores, detritophages and carnivores. A dominant species can not be indicated because Crangon crangon, Macropipus holsatus, Pagurus bernhardus, Asterias rubens and Ophiura texturata appear in variable concentrations. At least 80 % of the catches consisted of these five species. The relative density (MWC) of Asterias rubens during spring was smaller than during winter, but this was largely compensated by the immigration of the equally carnivore species Sepia officinalis.

CONCLUSIONS.

From the indigenous species that can be studied in a representative way by means of the sampling method used, Aphrodite aculeata, Alcyonidium gelatinosum, Flustra foliacea, Crangon crangon, Macropipus holsatus, Pagurus

bernhardus, Asterias rubens, Ophiura texturata and Psammechinus miliaris take a more or less important part in the composition of the macrobenthos in the Westdiep.

The majority of the observed organisms are omnivores, detritophages or carnivores of a lower or a medium order. In the trophic chain several of these species form the link between the benthic epi- and infauna and the demersal zooplankton on the one hand and the predatory fishes on the other.

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Table 1 - Yearly procentual weight contributions (YWC) to the average total monthly catch of the species observed in the Westdiep.

Species	YWC	Distribution in time (*) A M J A S O N D J F M
Phylum PORIFERA	.006	. . X . X . . . X . .
Phylum COELENTERATA (excl. Scyphozoa)	1.310	X X X X X X X X X X X
Classis HYDROZOA	1.250	X X . X X X X X X X X
Tubularia species	-	. . . . X X
Laomedea species	-	X X . X X X X X X X X
Abietinaria abietina (L.)	-	X X . X X X . X X X X
Hydrallmania falcata (L.)	-	X X . X X X X X X X X
Sertularia species	-	X . . . X X X X X X X
Classis ANTHOZOA	.066	X X X X X . . X X X X
Actinia equina L.	.061	X X X X X . . X X X X
Metridium senile (L.)	.005	 X
Phylum ANNELIDA	.410	X X X X X . X X X X X
Aphrodite aculeata (L.)	.105	X X X X . . . . X X X
Lanice conchilega (Pallas)	.190	X . X X X . X X X . .
Pectinaria koreni (Malmgren)	.018	X X X X . . . X . . .
Other Annelida	.100	. X X X X . . X . . .
Phylum MOLLUSCA	9.800	X X X X X X X X X X X
Classis GASTROPODA (**)	.018	X X . . . . X X X X X
Natica catena (Da Costa)	1d .001	X . . . .
Crepidula fornicata (L.)	.006	. X . . . . X . X X X
Buccinum undatum L.	.011	 X
Acanthodoris pilosa (O.F. Müller)	1d .001	. . . . X . X .
Classis LAMELLIBRANCHIA (**)	.062	X X X X X . X X X X .
Mytilus edulis L.	.013	. . . X . . . X . X .
Chlamys opercularis (L.)	1d .001	. . . . . . X . . . .
Cardium edule L.	.004	. . . . X . . . . . .
Venerupis pullastra (Montagu)	1d .001	. . . X . . . .
Spisula subtruncata (Da Costa)	1d .001	. . X . . . .
Mactra corallina cinerea Montagu	.027	. X . X . . . . X . .
Abra alba (W.Wood)	1d .001	. . X . . . .
Angulus tenuis (Da Costa)	.005	. . X X X . . . X . .
Angulus fabula (Gmelin)	.001	. . X . . . .
Donax vittaltus (Da Costa)	.012	X . X X . . . .
Classis CEPHALOPODA	9.720	X X X X X X . . X X X
Sepia officinalis L.	9.560	. X X X X . . . . . .
Sepiola atlantica d'Orbigny	.044	. X X X X . . . X . .
Loligo vulgaris Lamarck	.026	. X X . . . .
Allotheutis subulata (L.)	.087	X X X X X X . . . X X

Table 1 (continued)

Species	YWC	Distribution in time (*) A M J A S O N D J F M
Phylum BRYOZOA	1.010	X X X X X X X X X X X
Alcyonidium gelatinosum (L.)	.720	X X X X X X X X X X X
Alcyonidium polyoum (Hassall)	1d .001	. X . . . . . X . . X
Flustra foliacea (L.)	.105	X X X . . . . X X X X
Other Bryozoa	.185	. . X X X . X . . X .
Phylum ARTHROPODA	78.310	X X X X X X X X X X X
Classis CRUSTACEA		
Ordo Cumacea	1d .001	. . . . X X . .
Ordo Isopoda	.001	X . . . . . . X X X .
Idotea linearis (L.)	.001	X . . . . X X .
Idotea balthica (Pallas)	1d .001	. . . . X . . .
Ordo Amphipoda	.005	X X . X . . X X X X .
Ordo Decapoda	78.300	X X X X X X X X X X X
Pandalus montagui Leach	.017	X X X X X X X X . . .
Hippolyte varians Leach	1d .001	. . X . X . . . . . .
Processa canaliculata Leach	.001	. . X . . . X X . . .
Crangon crangon (L.)	36.790	X X X X X X X X X X X
Pontophilus trispinosus (Hailstone)	.001	X X X X X . . X X . .
Pagurus bernhardus (L.) (**)	1.380	X X X X X X X X X X X
Porcellana longicornis (L.)	1d .001	. . . X . . . X . X .
Macropipus holsatus (Fabricius)	40.060	X X X X X X X X X X X
Carcinus maenas (L.)	.011	. . X X
Pinnotheres pisum (Pennant)	1d .001	. . . . X . .
Macropodia rostrata (L.)	.033	X X X X X X . X X X X
Phylum ECHINODERMATA	9.140	X X X X X X X X X X X
Classis ASTEROIDEA	6.550	X X X X X X X X X X X
Asterias rubens (L.)	6.550	X X X X X X X X X X X
Classis OPHIUROIDEA	2.420	X X X X X X X X X X X
Ophiura texturata Lamarck	2.420	X X X X X X X X X X X
Classis ECHINOIDEA	.180	X X X X . . X X X . X
Psammechinus miliaris (Gmelin)	.115	. X X X . . X . . . X
Echinocardium cordatum (Pennant)	.062	X . . . . . . X X . X

The YWC-values larger than .1 were rounded off to the nearest .005 ; the values larger than 1. were rounded off to the nearest .01.

1d .001 = less than .001 %.

(*) : Months during which the different species were observed (X). In July 1973 no sampling was performed.

(**) : Weight contributions including shell.

Table 2 - Monthly average procentual weight-contributions (MWC) of the most important species.

Species / Month	IV	V	VI	VIII	IX	X	XI	XII	I	II	III
Crustacea Decapoda	80.0.	69.9	63.6	93.2	97.2	98.9	92.5	93.2	42.6	66.3	55.8
Crangon crangon	53.0	13.6	8.2	6.1	71.5	51.9	49.4	62.9	27.8	50.4	48.7
Pagurus bernhardus	1.2	6.3	5.9	.3	.2	.1	2.0	.3	4.8	2.7	3.0
Macropipus holsatus	26.1	49.8	49.1	86.7	25.4	46.8	41.1	30.0	9.9	13.2	4.0
Echinodermata	16.5	26.3	34.0	4.9	1.2	.6	6.8	2.6	45.6	28.5	40.7
Asterias rubens	9.6	18.2	26.1	3.1	.8	.1	4.1	1.6	38.3	25.5	26.5
Ophiura texturata	6.7	6.8	7.9	1.7	.4	.5	2.4	.6	4.8	3.0	13.6

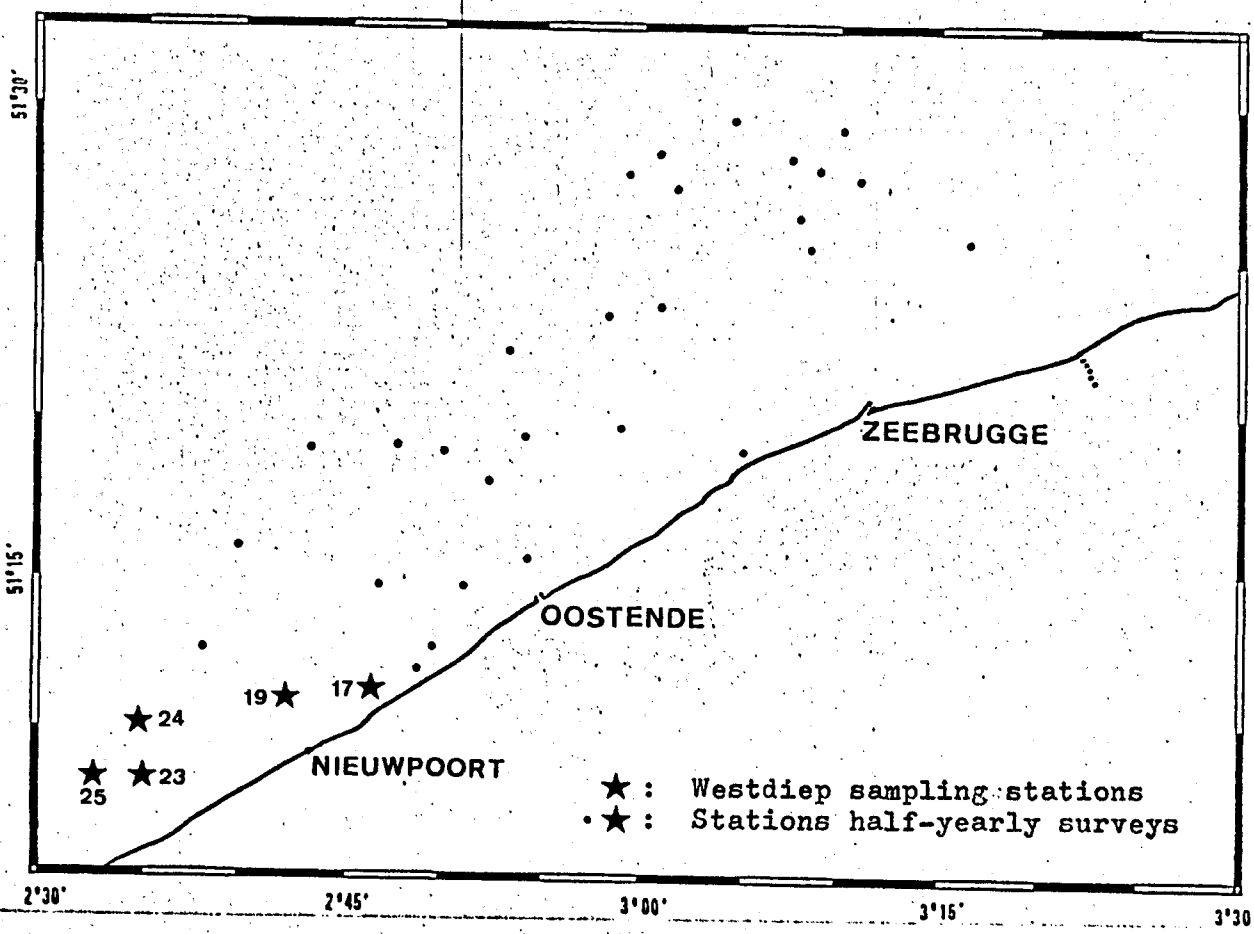


Figure 1. Positions of the sampling stations along the coast.

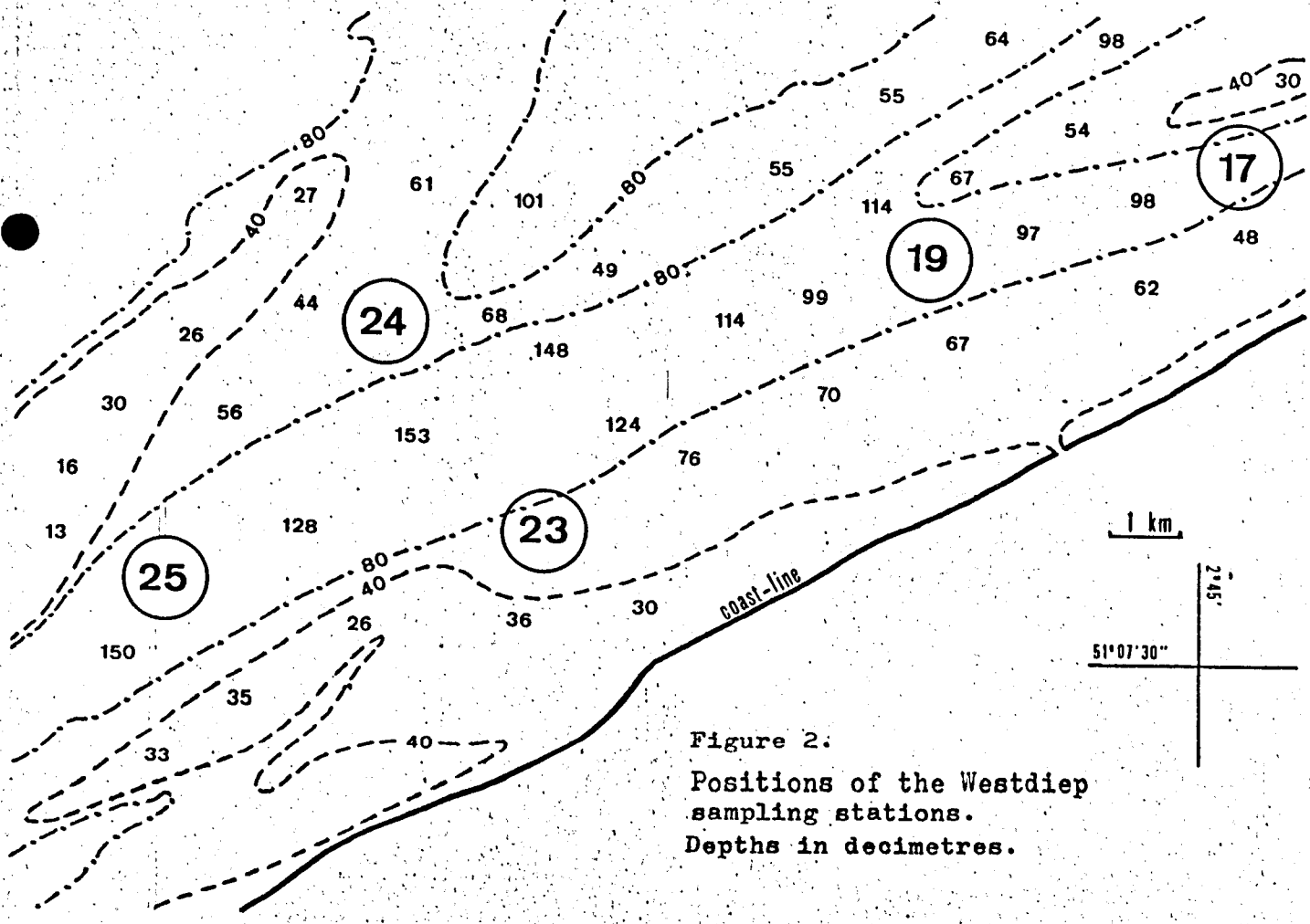


Figure 2.
Positions of the Westdiep sampling stations.
Depths in decimetres.

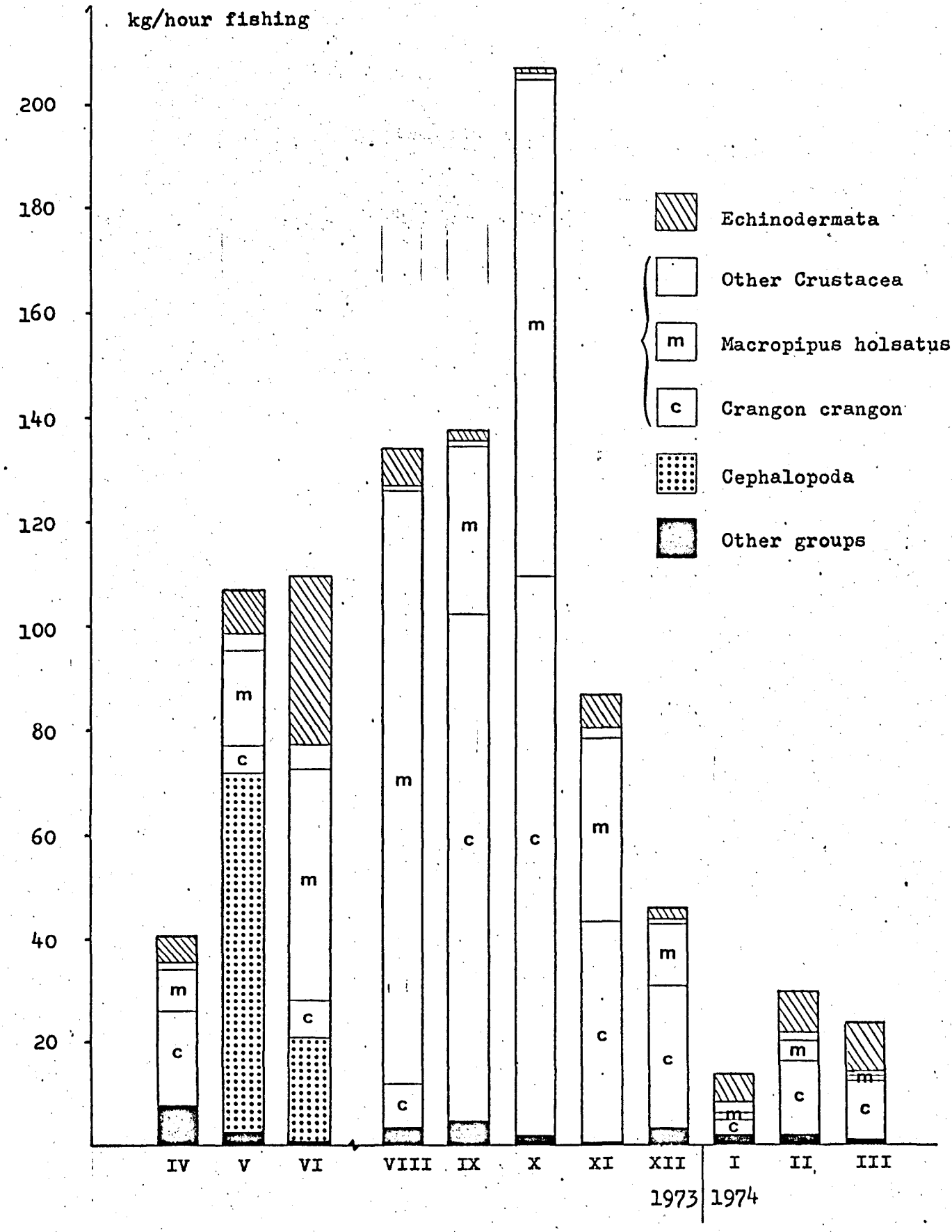
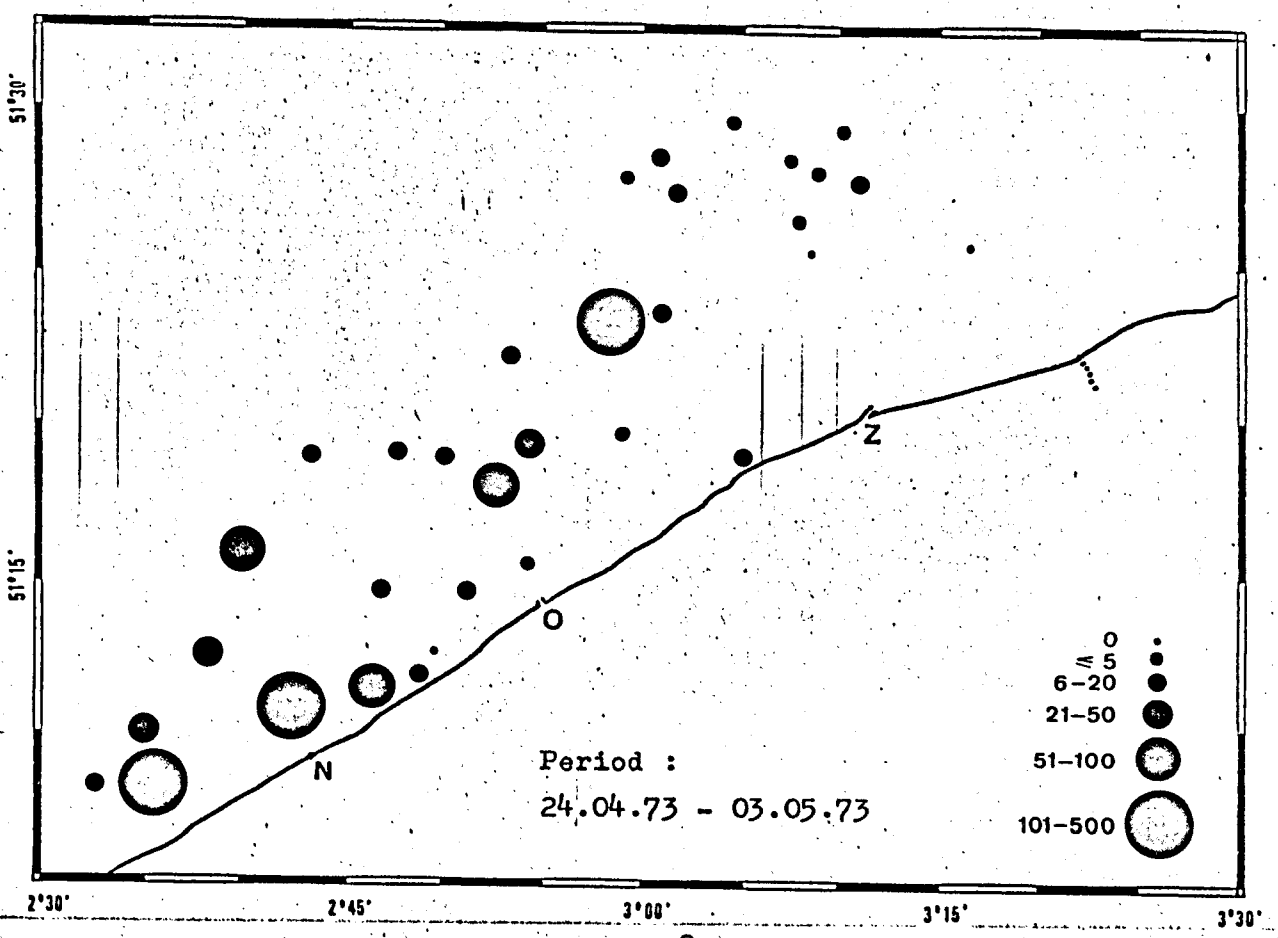


Figure 3. Evolution and composition of the catches in the Westdiep.



Distribution and density (gram/1000 m^2) of Hydrozoa.
Figure 4.

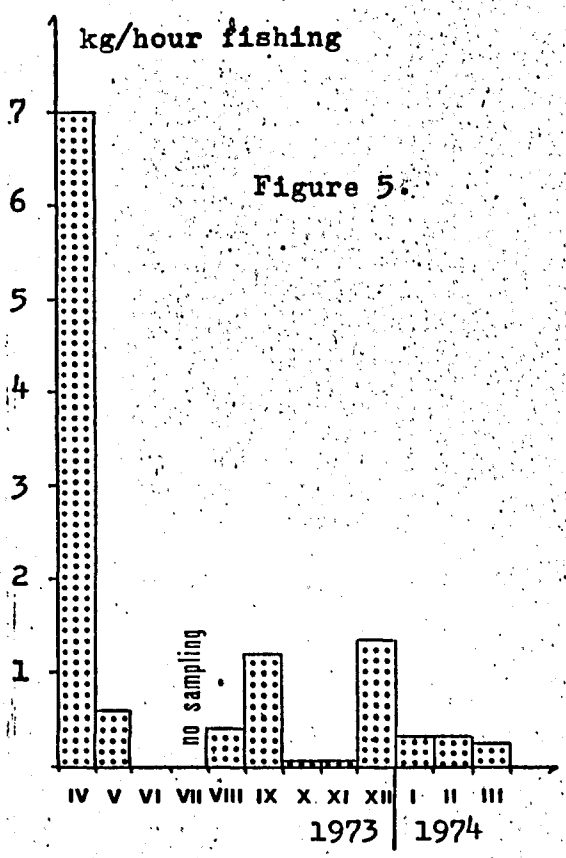


Figure 5.

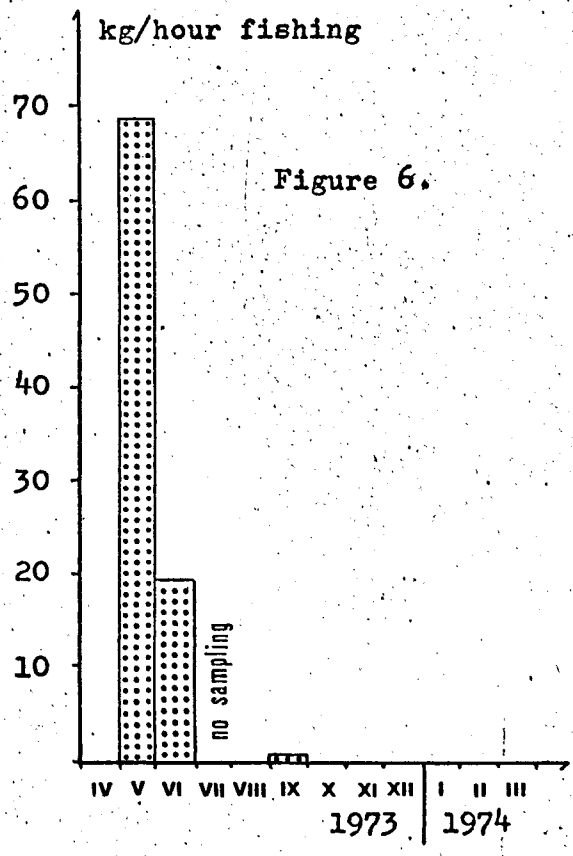


Figure 6.

Abundance of Hydrozoa (left) and Cephalopoda (right) in the Westdiep.