C.I.P.S.

MATHEMATICAL MODEL
OF THE POLLUTION IN THE NORTH SEA

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A STUDY ON THE SUBLITTORAL MEIOBENTHOS OF THE SOUTHERN BIGHT AREA

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A study on the sublittoral Meiobenthos of the Southern Bight area

1. Introduction

As part of the I.K.W.B. program on the Southern Bight, the meiobenthic fauna (animals of ± 1 mm length) was studied in the Laboratorium voor Morfologie en Systematiek of the Gentse Rijksuniversiteit.

We thank Prof. Dr. L. De Coninck, Dr. C. Heip, Dr. E. Schockaert, J. Govaere and Daniël Degadt for the use of their unpublished notes and E. Corijn for treating the samples of 1971-1972.

2. Methods

2.1. During the last three years (june 1971 - oktober 1973) 326 samples were collected from 133 stations in the Southern Bight (fig. 1). The stations M01-M25 and some of the M52-M72 stations have been sampled every 5 to 6 months, the other only once or twice.

We arbitrarily divided the area into four zones (fig. 2) :
The Belgian Westerscheldt Coastal Zone : counting 45 stations, 6 to 18 km distant from the coast and with a depth varying from 6 to ± 18 m. The Dutch Coastal Zone, counting 23 stations, with a distance from the coast varying from 8 to ± 20 km and a depth from ± 9 m to ± 20 m. The Belgian (& Westerscheldt) Offshore Zone counting 25 stations with a depth of 25 to ± 50 m although stations M02 and M52 are closer to the French coast than some of the Belgian coastal stations, their greater depth decided me to put them in the Offshore Zone).
The Dutch Offshore Zone counting 40 stations, with a depth varying from 25 to ± 50 m.

2.2. Quantitative sampling

The stations were sampled with a Van Veen Grab (0,1 m^2), used for macrobenthic studies, but known to be an inaccurate device for meiobenthic sampling, due to his bowwave effect and waterloss when taken on deck (Wells, 1971). Contents of the grab were put in buckets, preserved in formalin (5 %) and afterwards subsampled with a core-tube (7,07 cm^2). At each station four Van Veen samples were taken each time.

In September 1972, the "Mechelen" remained four days at the same station (M14) and twelve samples were taken while the ship turned slowly around its anchor. Biomass and population density showed distinct fluctuations (fig. 3) which could only be explained by the method of sampling. The mean biomass for twelve samples was 804,083 mg/m^2 with a standard error of 101,6 mg/m^2. Extrapolating we obtain a standard error of 114 mg (16 %) for six samples, 176 mg/m^2 (20 %) for four samples and 248,7 mg/m^2 (31 %) for two samples. The mean population density was 238 783 ind/m^2 with a standard error of 4338 ind/m^2 for twelve samples, an error of 61303 ind/m^2 for six samples, 75081 for four samples and 106181 (almost 50 %) for two samples. These are of course errors in the samples we receive, meaning the original population minus the individuals lost through bowwave effect minus individuals lost with waterloss minus individuals lost by mixing of Van Veen content. Elmgren (1973) states that the population density of mud samples from a Van Veen grab is only 66 % of the value of a box sampler. We therefore calculated means of biomass and densities with the highest values found at each station, not with the mean values. To the resulting figures 34 % of their value must be added to obtain the real densities for mud samples; since sand samples are not so drastically disturbed by a Van Veen, a lower value (± 25 %) has been added.

3. Population density (fig. 4, fig. 5)

In total a mean of 166700 ind/m^2 (s.e. = 31497) was found at Belgian & Westerscheldt Coastal Zone with 97 % Nematods, 1,6 % Harpacticids and 0,6 % other groups. With correction for sampling (34 %) = 233378 ind/m^2. A mean of 245500 ind/m^2 (s.e. = 58206) was found at the Dutch Coastal Zone (93,2 % Nematods) with correction for sampling (25 %) = 306875 ind/m^2. A mean of 479960 ind/m^2 (s.e. = 202841) was found at the Belgian Offshore Zone; with correction for sampling (25 %) = 599950 ind/m^2 (91,9 % Nematods) and a mean of 498462 ind/m^2 (s.e. = 42259) for the Dutch Offshore Zone (77,6 % Nematods) with correction for sampling = 623077 ind/m^2.

4. Groups-diversity (fig. 6; fig. 7)

4.1. In analogy with population-diversity the term groups-diversity is used to indicate the number of distinct taxonomic groups found at each station. The taxonomic groups taken into account are : Hydrozoa, Turbellaria, Nemertina, Gastrotricha, Kinorhyncha, Nematoda, Polychaeta, Oligochaeta, Archiannelida, Gastropoda, Bivalvia, Harpacticoidea, Ostracoda and Halacarida. A study of living samples revealed the presence of all above mentioned groups at offshore sandy stations (M14, M25), but only five groups (Nematods, Harpacticids, Ostracods, Polychaetes and Bivalves) could be found in living samples from muddy coastal samples (M01, M06).

The mean of groups-diversity of the Belgian & Westerscheldt Coastal Zone is 2,605 (V = 2,959, s.e. = 0,25) (predominantly Nematods and Harpacticids). The mean of groups-diversity at the Dutch Coastal Zone is 4,727 groups/station (V = 4,113, s.e. = 0,42) while the Belgian & Westerscheldt Offshore Zone and the Dutch Offshore Zone respectively possess a diversity of 6,208 (V = 6,667; s.e. = 0,525) and 8,50 groups/station (V = 5419, s.e. = 0,359).

4.2. Different Taxonomic groups

4.2.1. Hydrozoa : only the interstitial genus Halammohydra REMANE could be found. Their average density is 1000 to 2000 ind/m^2 at the stations where it occurs (Maximal density 9000 ind/m^2). Rare in the coastal zones (fig. 8). Density at Firemore Bay (NE. Scotland) 43000/m^2 (Mc Intyre, 1973).

4.2.2. Turbellaria : Mr. D. Degadt studied the Turbellaria for his licentiate paper (Lab. Morf. & Syst. R.U.G.). The most abundant species seem to belong to the Acoela (Nemertoderma sp., Macrostomiidae) the Proseriata (Monocelididae, Goelogynoporidae, Otoplanidae) the Typhloplanoida (Promestomidae), the Kalyptorhynchia (Schizorhynchidae, Diascorhynchidae, Carcinorhynchidae). The Turbellarians reach their lowest densities at the Belgian coast and their highest in the Dutch Offshore Zone. The average density ranges around 5000 ind/m^2 and a maximal density

of 45.000 ind/m^2 was noted (st. M67) (fig. 9).
Density at Firemore Bay, in subtidal zone : 389000/m^2 (Mc Intyre, 1973).

4.2.3. Nemertina : not taxonomically studied; these predators on crustaceans and polychaetes are rare at the Belgian coast (even offshore). Average density ± 1000 to 2000 ind/m^2 at stations where they occur (fig. 10).

4.2.4. Gastrotricha : small species are easily overlooked in fixed samples and larger ones are usually deformed. The phylum is totally lacking near the Belgian coast (except at M06). Average density 2000 to 3000 ind/m^2; max. density : 55000 ind/m^2 (st. 1492) (fig. 11).
Density at Firemore Bay : 108000/m^2 (Mc Intyre 1973).

4.2.5. Kinorhyncha : Although this phylum is supposed to be one of the most common on muddy bottoms, we did not find it in any of our coastal samples. It is even extremely rare in the whole Southern Bight area.
Since the animals live in the surface layer, it may not be excluded that our sampling technique instead of collecting, disperses them (fig. 12).

4.2.6. Nematoda : studied by Prof. Dr. L. De Coninck.
Many stations in the Belgian coastal zone show a surprisingly low density of less than 100.000 ind/m^2. At most stations the density seems to fluctuate between 100.000 and 500.000 ind/m^2. Abnormally high densities were recorded at station M05 (5 mill.ind/m^2) (September 1971), station M21 (1,1 million ind/m^2) (August 1971), station M68 (1 million ind/m^2) (September 1971) and station 1344 (1,5 million ind/m^2) (September 1972). Such high numbers could indicate processed organic pollution (L. De Coninck, C.I.P.S. report 1971) (fig. 13, fig. 14).

4.2.7. Polychaeta : The most common largest meiobenthic species belongs to the Hesionidae, while Oridia armandi (CLAPAREDE) seems to be the most common smallest species (det. J. Govaere). On soft bottoms only large species occur, usually in low densities (Belgian coast; density estimated at ± 100 ind/m^2). In the offshore zones densities vary from 5000 up to 30.000 ind/m^2 (fig. 15). (Max. density at Firemore Bay : 29000/m^2 (Mc Intyre, 1973)).

4.2.8. <u>Oligochaeta</u> : meiobenthic oligochaetes are estimated to be be one of the most common groups in subtidal (muddy) bottoms (LASSERRE, 1971), they are not very common in the Southern Bight, neither in mud nor in sand samples. Their density averages around 1000 to 2000 ind/m^2 at the stations where they occur (not found at the Belgian coast) (fig.16).

4.2.9. <u>Archiannelida</u> : only the large species belonging to the genera <u>Polygordius</u>, <u>Saccocirrus</u> and <u>Protodrilus</u> were counted in fixed samples. Although the average density of the archiannelids is not high (± 2000 ind/m^2), they occur in most offshore stations. (Highest density at station 1916; 21.000 ind/m^2) (fig. 17). (Max. density at Firemore Bay : 50000/m^2 (Mc Intyre, 1973)).

4.2.10. <u>Bivalvia</u> : postlarval stages of Spisula, Macoma, Mytilus a.o. with a length varying from 0,1 mm to 1,0 mm were counted. Average densities lie between 2000 to 3000 ind/m^2. This low density is remarkable since adult bivalves of above mentioned genera occur in large numbers. (fig. 18).

4.2.11. <u>Harpacticoidea</u> : In the Belgian Coastal Zone only two large species <u>Ectinosoma sarsi</u> and <u>Canuella perplexa</u> occur, in the other zones a number of smaller interstitial species are found, most of them belonging to the <u>Cylindropsillidae</u>. The average density in the Belgian coastal zone is 1000 to 3000 ind/m^2 at the stations where they occur. In the other zones most stations have values of 20.000 to 120.000 ind/m^2 (max. density 470.000; station M20) (fig. 19). (Max. density at Firemore Bay : 3.880.000/m^2 (Mc Intyre, 1973)).

4.2.12. Ostracoda : seem to be rare in the Southern Bight. Their density in the few stations where they occur is around 1000 to 2000 ind/m^2 (fig. 20).

4.2.13. Halacaridae : Newell (1971) considers the marine mites as a very important group in the intertidal zone.
In our samples they are practically completely missing in the undeep coastal waters and only appear in deeper offshore stations with sandy bottom and rich fauna.
Average density around 1000 to 2000 ind/m^2 (fig. 21)

4.2.14. Other groups : Gastropoda are not very common in living samples and are very hard to distinguish in fixed material. Most common are Caecum glabrum, Microhedyle sp. Pseudovermis papillifer and Philinoglossa helgolandica. Interstitial Echinodermata are very rare (Leptosinapta minuta at M14). Of Gwynnia capsula (Brachiopoda) only a few empty shells were found at some coastal stations, hence it is not impossible that the phylum Brachiopoda has become extinct in other area studied.

5. Biomass of Meiobenthos

5.1 . Estimation of biomass

Biomass for some taxonomic groups was calculated in the tradition of LOHMAN (1908), calculating the weight from the volume multiplied with the density (1.0) (cfr. Elmgren 1972). For Hydrozoans, Nemertineans, Gastrotrichs and Halacarids we calculated a weight based on body proportions found in literature. Thus we obtaines for Halammohydra a wet weight of 0.001 mg/ind; for Nemertina with their highly variable length a mean of 0,2 mg/ind has to be chosen, while for a large Gastrotrich (Turbanella plana) a weight of 0,001 mg/ind was accepted and for a Halacarid of moderate size 0,03 mg/ind. For Turbellaria and Polychaeta a mean was calculated from bodyweights of the largest most common species and the smallest ones, giving respectively a wet weight of 0,08 mg/ind for one Turbellarian (most species are rather large) and a wet weight of 0,03 mg/ind for one Polychaete. For the large Archiannelids a wet weight of 0,03 mg/ind was accepted (Protodrilus sp.; N. Hickman, Univ. Coll. of Swansee; pers.comm.).

Since the Oligochaetes in the samples are approximatively of the same size, 0,03 mg/ind. was also taken for their individual wet weight. Very small Bivalvia were estimated at 0,01 mg/ind wet weight. For Nematods, Harpacticids, Ostracods and Kynorhynchs we used weight values given in literature. For Nematods we used 0,001 mg/ind wet weight, for Harpacticids 0,006 mg/ind, 0,018 mg for Ostracods (Wieser uses this value as dry weight = ¼ wet weight) and 0,012 mg wet weight for Kynorhynchs.

Table 1
Biomass of various meiobenthic groups in literature (mg/ind)

	Krogh & Sparck	Wieser	Stripp	Wigley & McIntyre	Elmgren	Present work
Hydrozoa	-	-	-	-	-	0,001 mg
Turbellaria	0,75 mg	-	-	-	0,004 mg 0,001 mg	0,08 mg
Nemertina	0,1 mg	-	-	-	-	0,2 mg
Gastrotricha	-	-	-	-	-	0,001 mg
Kinorhyncha	-	0,012 mg	-	0,02 mg	0,004 mg	0,012 mg
Nematoda	-	0,01 mg	0,001 mg	0,002mg	0,0006mg 0,0001mg	0,001 mg
Polychaeta	-	-	0,005 mg	0,14 mg	-	0,03 mg
Oligochaeta	-	-	-	-	-	0,03 mg
Archiannelida	-	-	-	-	-	0,03 mg
Bivalvia	-	-	-	-	0,027 mg	0,01 mg
Harpacticoidea	-	0,0068 mg	0,006 mg	-	0,005 mg	0,006 mg
Ostracoda	-	0,07 mg	-	-	0,064 mg 0,943 mg	0,018 mg
Halacaridae	-	-	-	-	-	0,03 mg

5.2. Zonation of biomass (fig. 22; fig. 23)

A mean biomass of 0,306 gr/m^2 wet weight was calculated for the Belgian & Westerscheldt Coastal Zone (V = 0,181; s = 0,426; s.e. = 0,06 gr/m^2) a mean of 1,03 gr/m^2 for the Dutch Coastal Zone (V = 0,846, S = 0,921, s.e. = 0,19 gr/m^2) a mean of 1,368 gr/m^2 was calculated for the Belgian Offshore Zone (V = 1,567, s = 1,252; s.e. = 0,25 gr/m^2), while the Dutch Offshore Zone reached a mean of 3,0 gr/m^2 wet weight (V = 4,2, s = 2,0, s.e. = 0,3 gr/m^2).

All Coastal Stations (68) have a mean of 0,516 gr/m^2 (V = 0,509; s = 0,713; s.e. = 0,09 gr/m^2), all Offshore stations (65) a mean of 2,393 gr/m^2 (V = 3,8; s = 1,956; s.e. = 0,2 gr/m^2).
Using a test to control if these means are significantly different with the formula $t = \frac{x_1 - x_2}{\sigma\sqrt{1/N_1 + 1/N_2}}$ with

$$\sigma = \frac{N_1 S_1^2 + N_2 S_2^2}{N_1 + N_2 - 2}$$

; N being the number of stations, S the standard deviation and X the mean of biomass; we found when comparing the means for Belgian & Westerscheldt Coastal Zone/Belgian Offshore Zone : t = 5,1085; for the Dutch Coastal Zone/Dutch Offshore Zone : t = 4,3685 and for Total Coastal Zones/Total Offshore Zones : t = 7 ,1631; these three values indicating a highly significant difference in the three relations.

5.3. Correction of biomass for loss through sampling technique.
A loss of population density of 34 % for muddy bottoms was calculated by ELMGREN 1973; this does not mean that there occurs a loss of 34 % of the calculated biomass. Since for the Belgian Coastal Zone 97,8 % of the population consists of Nematods and 1,6 % of Harpacticids, 34 % of the population (= 56678 ind/m^2) has a biomass of 60 mg, bringing the biomass of the Belgian Coastal Zone up to 0,366 gr/m^2 wet weight. For the other zones correction is complex since all the mean percentages of the different taxonomic groups have to be calculated. We estimated the maximal biomass when corrected to amount to 1,039 + 0,142 = 1;181 gr/m^2 wet weight for the Dutch Coastal Zone; to 1,368 + 0,344 = 1,712 mg/m^2 for the Belgian & Westerscheldt Offshore Zone and to 3,0 + 1,216 = 4,216 mg/m^2 for the Dutch Offshore Zone.

5.4. Correction due to different turn-over of biomass (number of generations/year/species) will have to be perfected at further stage of the investigation.

5.5. Biomass correlated with the sediment (fig. 24; 25; 26; 27)
From a small number of stations we obtained some sedimentological data (J. Govaere):the median phi values (φ = - log 2 of classes of grainsize; φ = 62 = very coarse sand; φ = 5 = very fine sand; Wentworth); the median grainsize in um, the sand/mud ratio and the % organic carbon

Table 2

Station	Md φ	Md μm	sand/ mud	% org.C	biomass mg/m²	zone
M01 11.10.72	2,53	163	624	0,26	915	B.C.Z.
M041 06.09.72	2,71	153	2,12	0,39	613	B.C.Z.
M16 27.09.72	1,77	294	713	0,06	913	D.O.Z.
M22 26.09.72	2,08	235	2499	-	708	D.O.Z.
M59 28.09.72	1,90	267	1999	-	2080	D.C.Z.
M61 14.09.72	1,04	480	9999	-	4093	D.O.Z.
M65 13.09.72	1,80	285	3332	0,13	770	D.O.Z.
M67 07.09.72	1,84	280	1427	-	1200	D.O.Z.
M72 12.09.72	2,05	241	1427	-	650	B.C.Z.
M1034 13.02.72	5,41	23	0,7	1,4	37	B.C.Z.
M1050 13.02.72	2,50	176	0,06	3,16	141	B.C.Z.
M1067 30.08.72	2,38	192	587	0,32	684	B.C.Z.
M1096 30.08.72	2,50	177	199	0,43	736	B.C.Z.
M1097 06.09.72	5,65	19	0,18	2,02	138	B.C.Z.
M1114 07.02.72	5,95	16	0,05	2,25	197	B.C.Z.
M1148 30.08.72	5,33	24	0,57	2,33	110	B.C.Z.
M1172 30.08.72	2,47	179	2,99	1,59	440	B.C.Z.
M1186 21.08.72	2,55	170	9,28	0,78	300	B.O.Z.
M1257 27.02.72	1,70	307	3332	0,26	1467	B.O.Z.
M1348 13.04.72	1,40	376	998	0,25	1985	B.O.Z.
M1352 11.09.72	1,47	355	3332	0,13	2748	B.O.Z.

Station	Md φ	Md μm	sand/ mud	% org.C	biomass mg/m^2	Zone
M1358 12.09.72	1,47	360	475	-	1133	B.O.Z.
M1486 28.09.72	2,01	248	768	0,13	511	D.C.Z.
M1634 17.04.72	1,33	393	2499	-	2260	D.O.Z.
M1693 18.04.72	2,00	250	433	0,39	890	D.O.Z.
M1699 14.04.72	1,55	340	2499	-	2606	D.O.Z.

Biomass correlated with the phi value of the grainsize shows a steady mounting curve, quickly ascending in the lower phi values (coarse to medium sand). The lowest biomass values are found at high phi values (fine sand-silt) (fig. 24). Correlation with the median grainsize expressed in u again gives approximatively the same result (fig. 25). Biomass is also lowest at stations with a sand/mud ratio lower than 100 (fig. 26) and at stations with a high % of percentage of organic carbon (biomass sharply goes down at organic carbon values of 4-5 %) (fig. 27).

6. General conclusions

6.1. Sampling : sampling with a Van Veen grab is a technique which gives rather good quantitative (group-or species-diversity data) but rather poor quantitative (numbers of individuals + biomass) The important effects of seasons and tides cannot be estimated due to this sampling technique and our values may not be considered as mean annual values of density and biomass. We tried to correct the error by taking the maximum values found at each station and by adding 34 % of total population-density from muddy bottoms and 25 % of the population from sandy bottoms.

6.2. Zonation : The stations were divided in four zones, according to their nearness to the coast and to depth. The four zones differ significantly in population density, groups-diversity and biomass. The poorest zone in the Belgian & Westerscheldt Coastal Zone with 223378 ind/m^2; (97,8 % Nematods) a biomass of 0,366 gr/m^2 wet weight and a groups-diversity of 2,6 per station. The Dutch Coastal Zone follows with 306875 ind/m^2 (93,2 % Nematods), a biomass of 1,181 gr/m^2 wet weight and a groups-diversity of 4,7 per station.

The Belgian & Westerscheldt Offshore Zone has a population density of 599950 ind/m^2 (92 % Nematods); a biomass of 1,712 mg/m^2 and a groups-diversity of 6,2 per station, while the Dutch Offshore Zone has a mean of 623077 ind/m^2 (77 % Nematods) with a biomass of 4,216 mg/m^2 and a groups-diversity of 8,5 per station.

Table 3

	Mean population density	Mean Biomass	Mean group diversity	% Nematods
Belgian & Westerscheldt Coastal Zone (45 stations)	223378 ind/m^2	0,336 gr/m^2	2,6	97,8
Dutch Coastal Zone (23st.)	306875 ind/m^2	1,181 gr/m^2	4,7	93,2
Belgian & Westerscheldt Offshore Zone (25 st.)	599950 ind/m^2	1,712 gr/m^2	6,2	92
Dutch Offshore Zone (40st.)	623077 ind/m^2	4,216 gr/m^2	8,5	77

6.3. Correlation with sediment: Biomass is lowest at stations with small grainsize, muddy bottom and high organic Carbon content (detritus). No clear correlation could be found with the population-densities.

6.4. Results compared with data from diverse authors : For substidal mudflats a minimum of 177000 ind/m^2 and a max. of 3.163.000 ind/m^2 is given by McIntyre (1971), with only Krogh & Sparck (1935) (88.000 ind/m^2) and Purasjoki (1947) (41.000 ind/m^2) mentioning lower figures (due to sampling) respectively for the Baltic and the Gulf of Finland. Hence the values found at the Belgian coast can only be considered as very low. For sandy bottoms McIntyre (1971) gives values from 95.000 to 1.269.0000 ind/m^2. The values of the Dutch Coastal Zone and the Offshore Zones may be considered as relatively normal. Since higher values are noted in literature for muddy bottoms compared to sandy ones, we seem to have an inversed situation in the Southern Bight.

The lowest figures for subtidal mudflats given in literature are 0,4-2,5 gr wet weight/m^2 (Wieser, 1960). Hence the biomass from sand is not known.

6.5. Pollution : since the low values found at the Belgian & Westerscheldt Coastal Zone (and to a lesser degree at the Dutch Coastal Zone) can only partially be explained through faulty sampling and nature of the sediments, we may assume that pollution of the coastal waters plays an important role in diminishing the meiobenthic fauna as well quantitatively as qualitatively.

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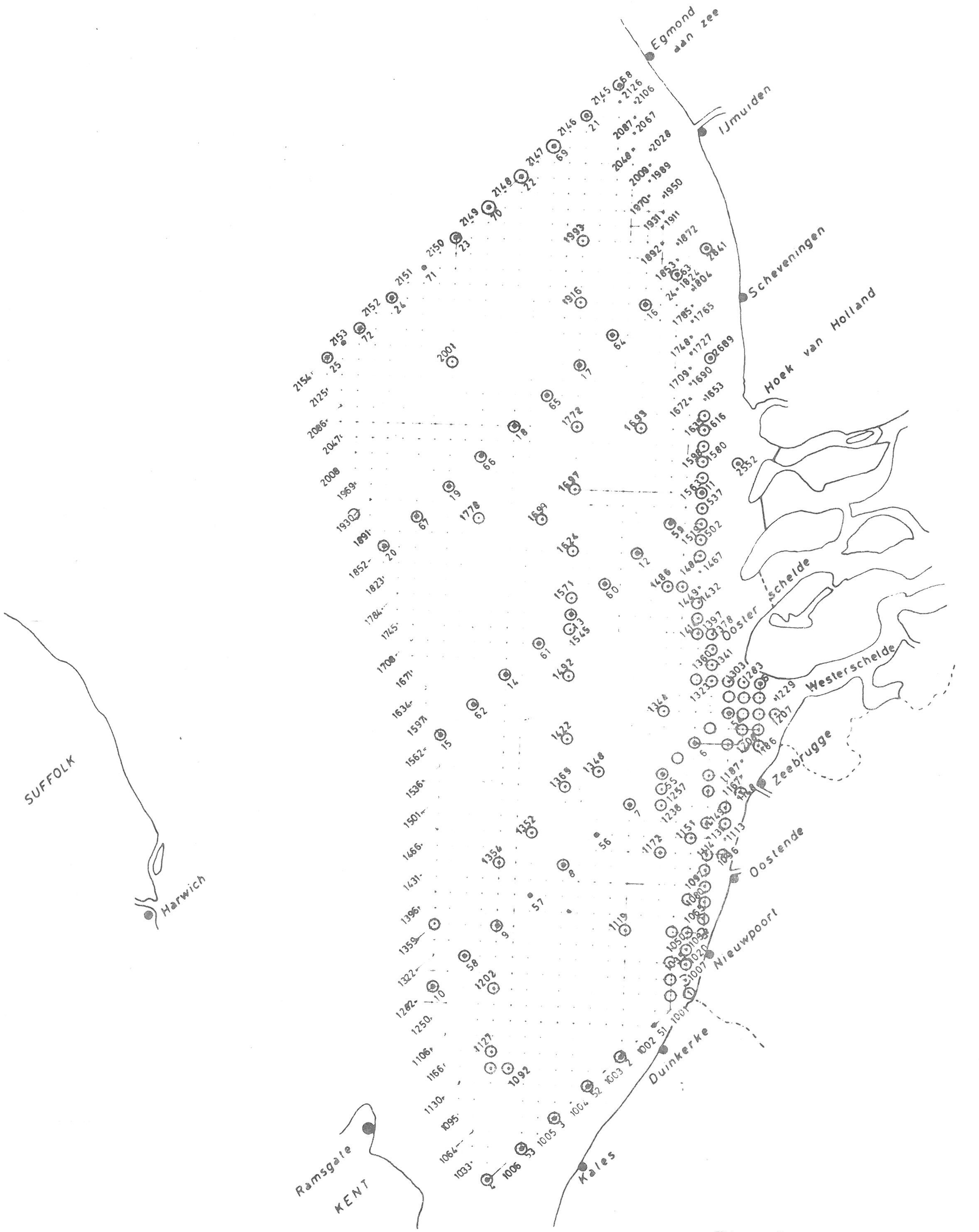


Egmond aan zee
IJmuiden
Scheveningen
Hoek van Holland
Ooster Schelde
Westerschelde
Zeebrugge
Oostende
Nieuwpoort
Duinkerke
Kales
SUFFOLK
Harwich
Ramsgate
KENT

Fig 1

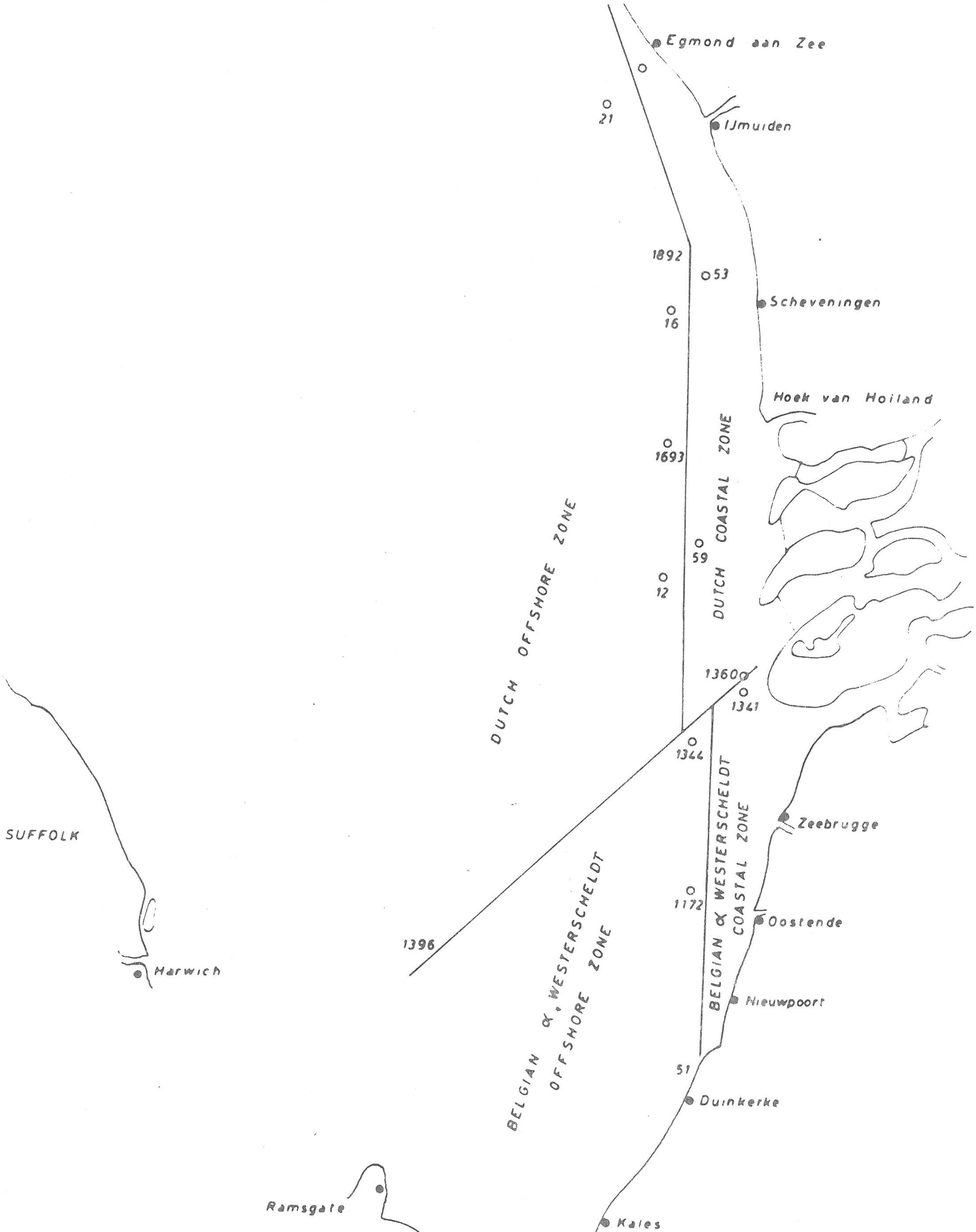
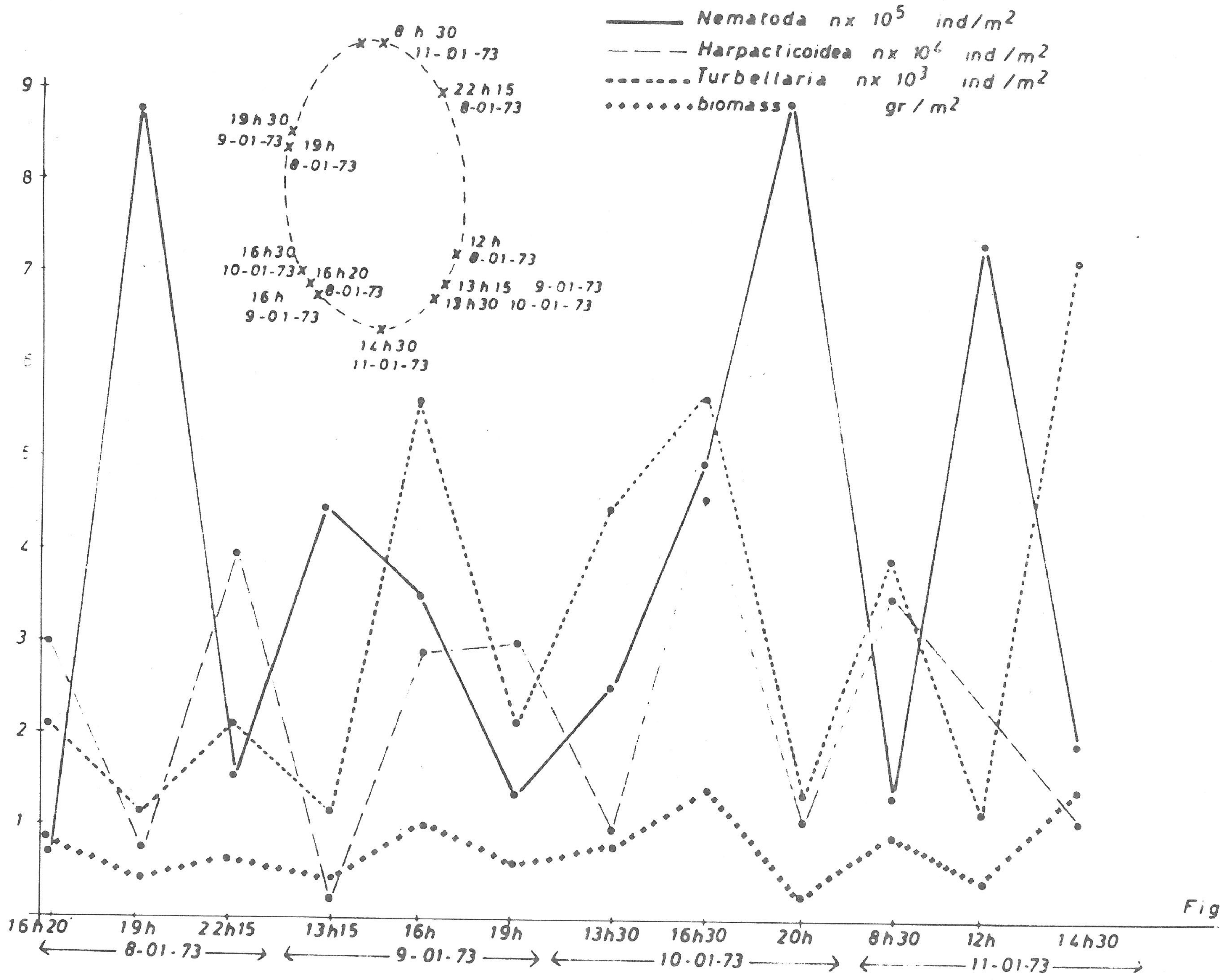

Egmond aan Zee
21
IJmuiden
1892
53
Scheveningen
16
Hoek van Holland
1693
DUTCH COASTAL ZONE
DUTCH OFFSHORE ZONE
59
12
1360
1341
1344
BELGIAN & WESTERSCHELDT COASTAL ZONE
Zeebrugge
SUFFOLK
1172
Oostende
BELGIAN & WESTERSCHELDT OFFSHORE ZONE
1396
Harwich
Nieuwpoort
51
Duinkerke
Ramsgate
KENT
Kales

Fig. 2



Nematoda nx 10^5 ind/m²
Harpacticoidea nx 10^4 ind/m²
Turbellaria nx 10^3 ind/m²
biomass gr/m²
8 h 30 11-01-73
22 h 15 8-01-73
19 h 30 9-01-73
19 h 8-01-73
12 h 8-01-73
16 h 30 10-01-73
16 h 20 8-01-73
16 h 9-01-73
13 h 15 9-01-73
13 h 30 10-01-73
14 h 30 11-01-73
9
8
7
6
5
4
3
2
1
16h20
19h
22h15
13h15
16h
19h
13h30
16h30
20h
8h30
12h
14h30
8-01-73
9-01-73
10-01-73
11-01-73

Fig. 3

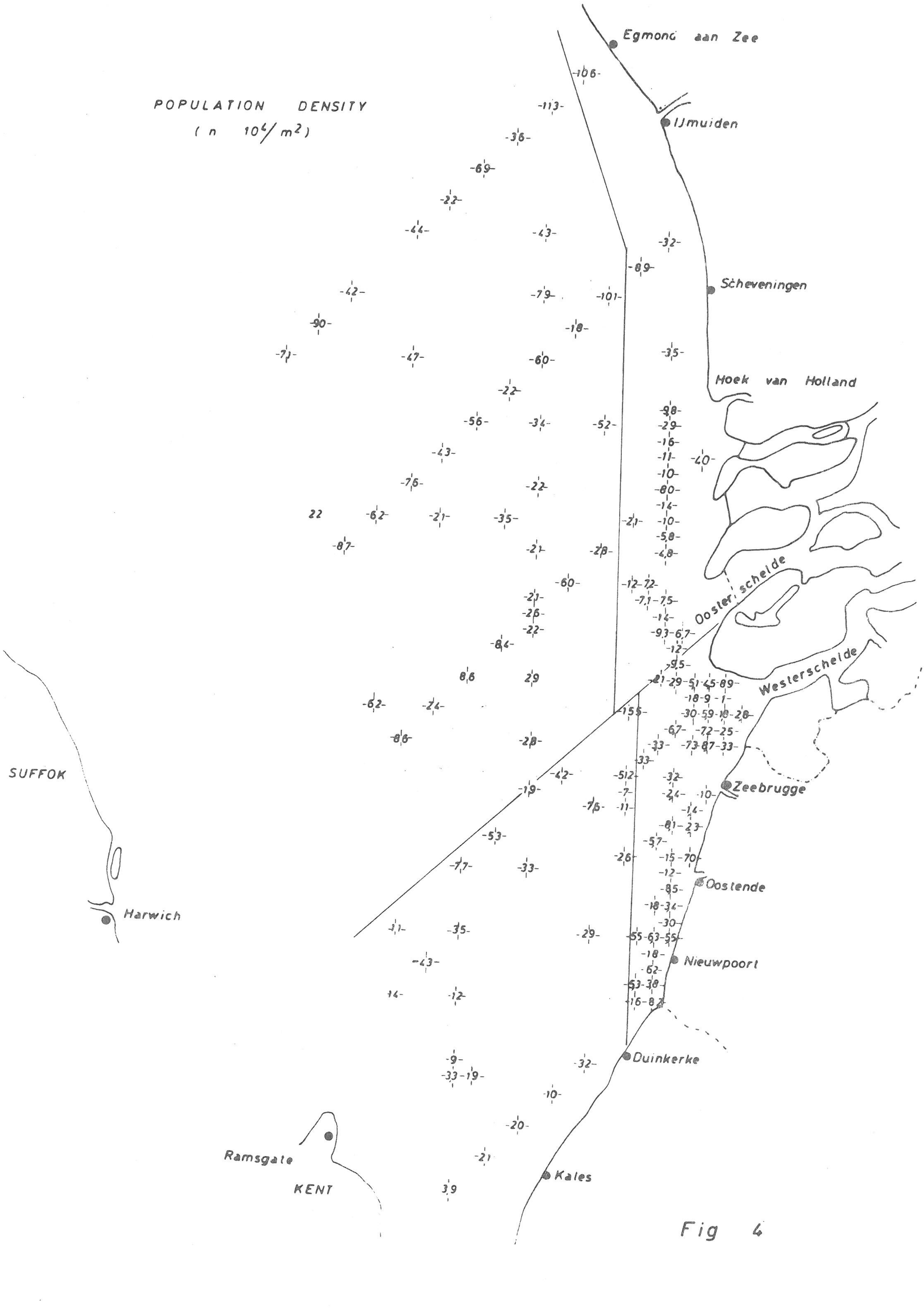
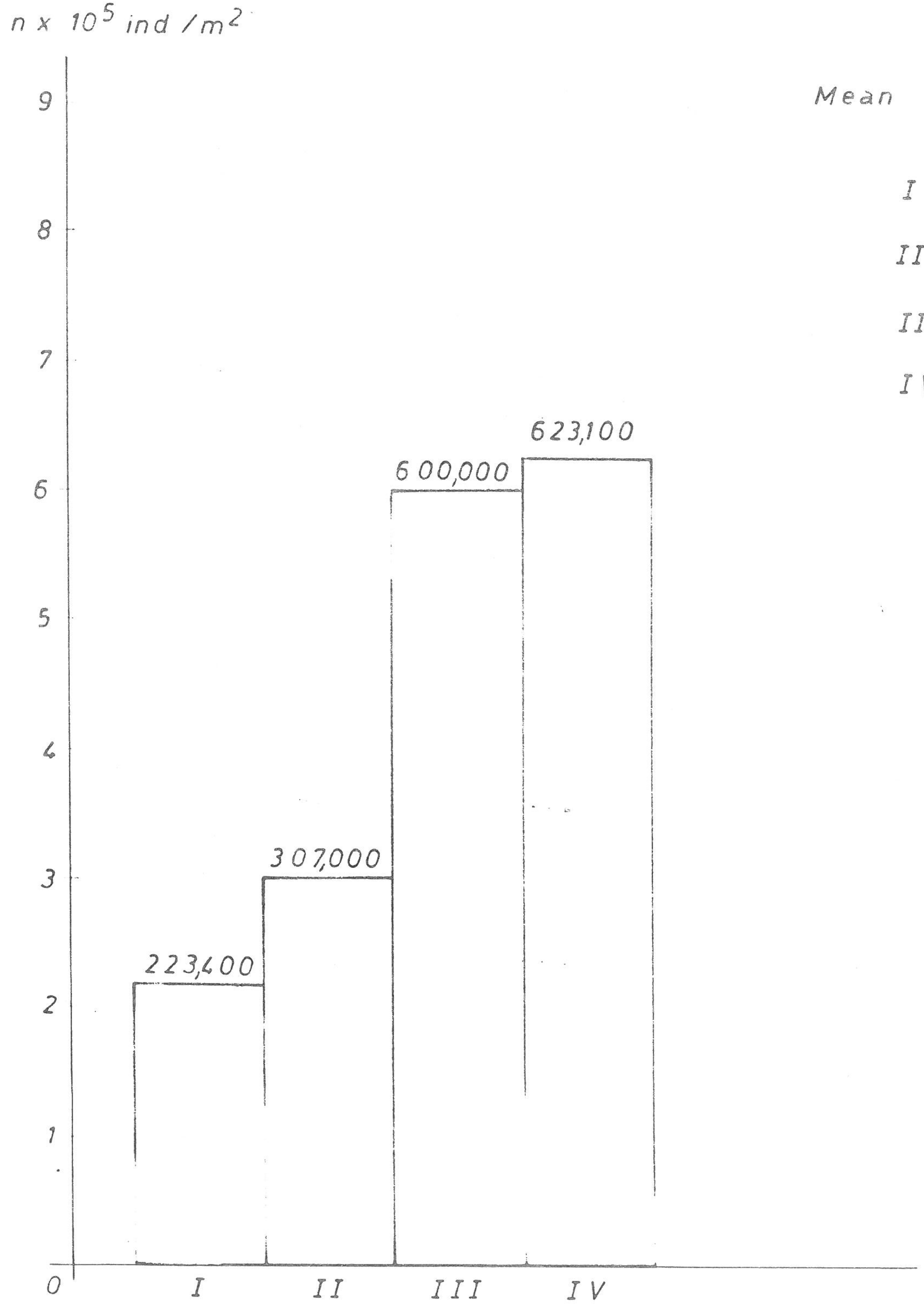

POPULATION DENSITY
(n $10^6/m^2$)
Egmond aan Zee
IJmuiden
Scheveningen
Hoek van Holland
Oosterschelde
Westerschelde
Zeebrugge
Oostende
Nieuwpoort
Duinkerke
Kales
SUFFOK
Harwich
Ramsgate
KENT

Fig 4



Mean Populationdensity n x 10^5 ind / m^2

I Beligian & Westerscheldt Coastal Zone

II Dutch Coastal Zone

III Belgian & Westerscheldt Zone

IV Dutch Offshore Zone

Fig. 5

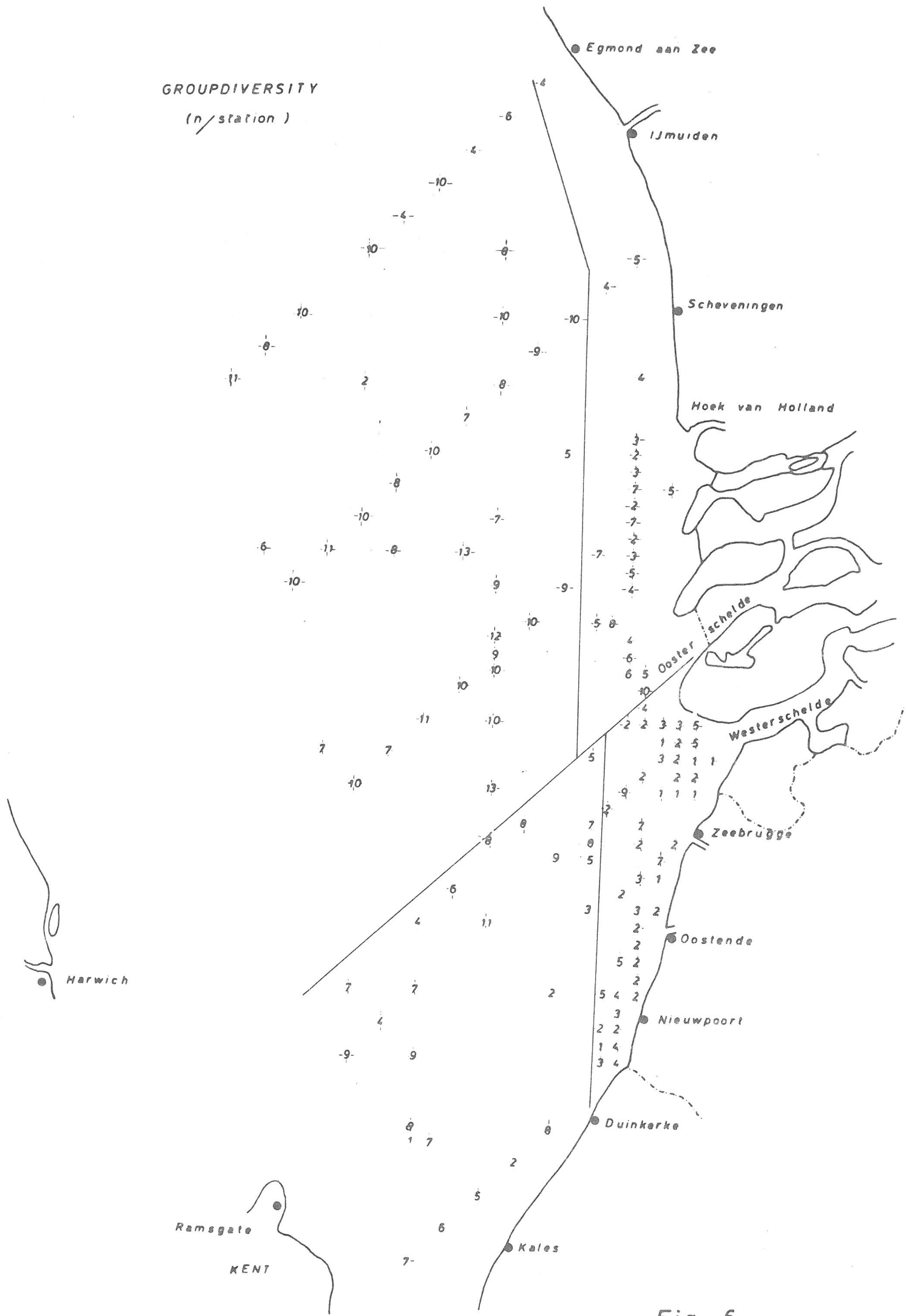
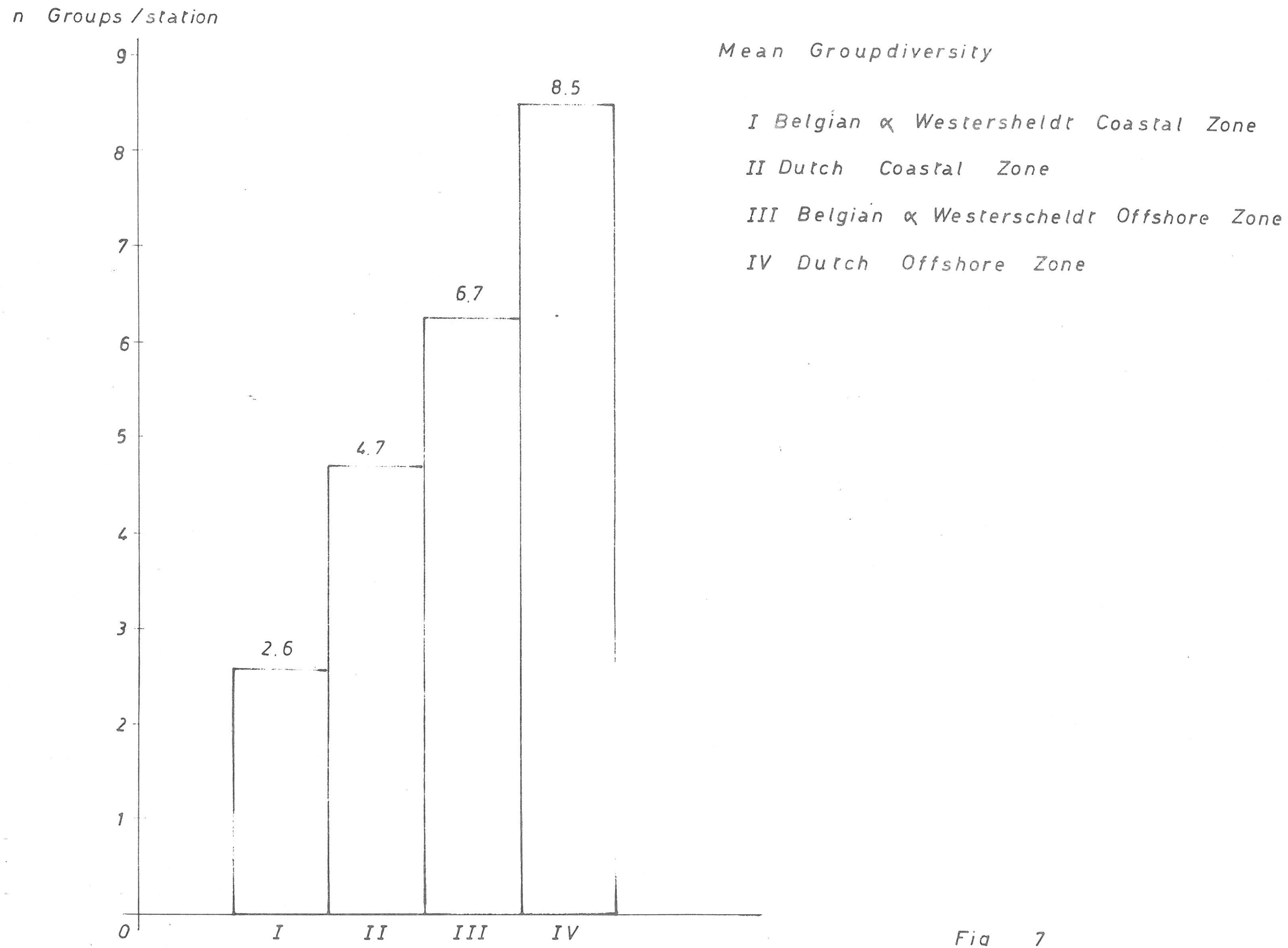

GROUPDIVERSITY
(n/station)
Egmond aan Zee
IJmuiden
Scheveningen
Hoek van Holland
Oosterschelde
Westerschelde
Zeebrugge
Oostende
Nieuwpoort
Duinkerke
Kales
Harwich
Ramsgate
KENT

Fig. 6



n Groups / station
9
8
7
6
5
4
3
2
1
0
8.5
6.7
4.7
2.6
I
II
III
IV
Mean Groupdiversity
I Belgian α Westersheldt Coastal Zone
II Dutch Coastal Zone
III Belgian α Westerscheldt Offshore Zone
IV Dutch Offshore Zone

Fig 7

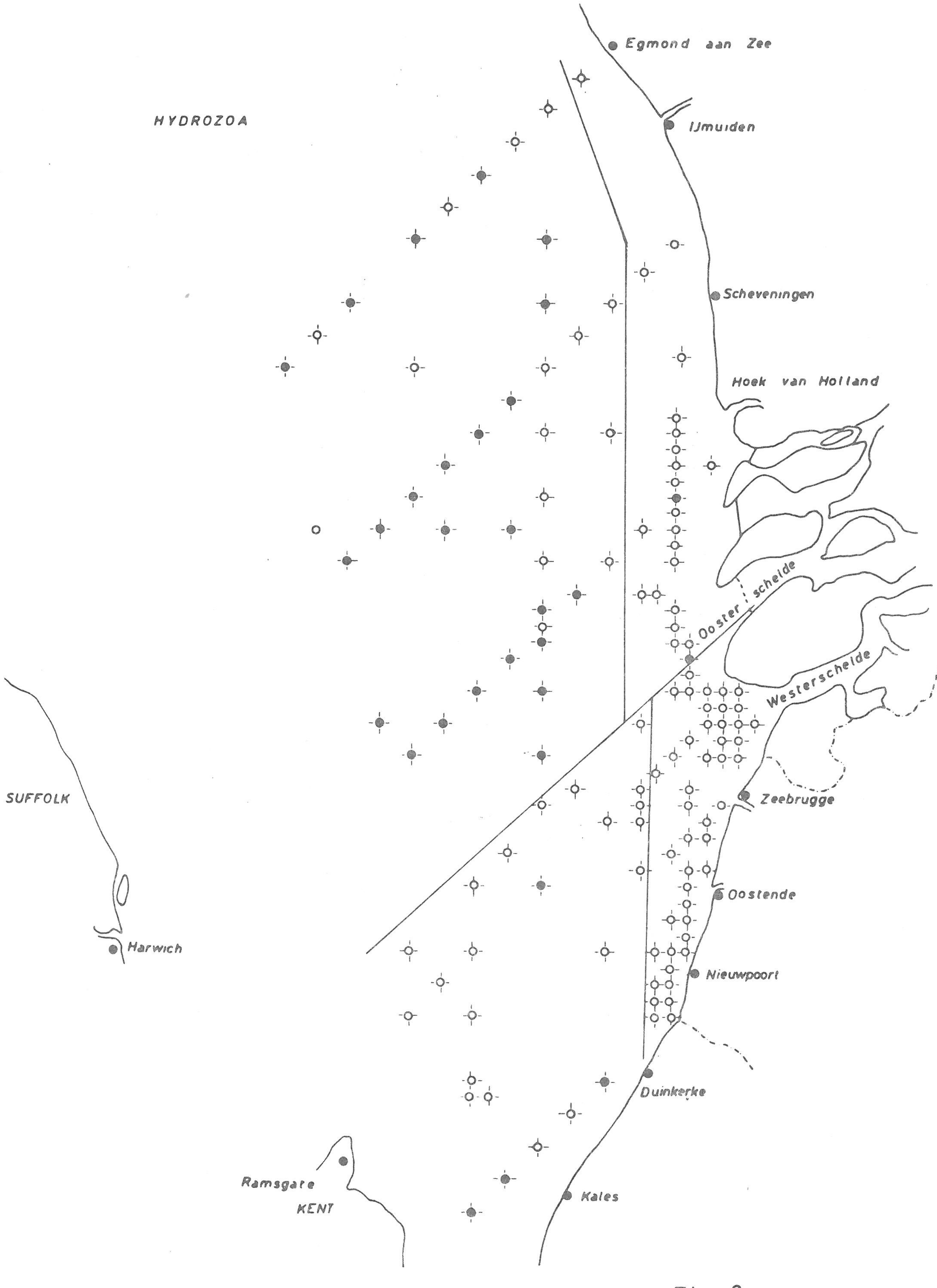

HYDROZOA
Egmond aan Zee
IJmuiden
Scheveningen
Hoek van Holland
Oosterschelde
Westerschelde
Zeebrugge
Oostende
Nieuwpoort
Duinkerke
Kales
SUFFOLK
Harwich
Ramsgate
KENT

Fig 8

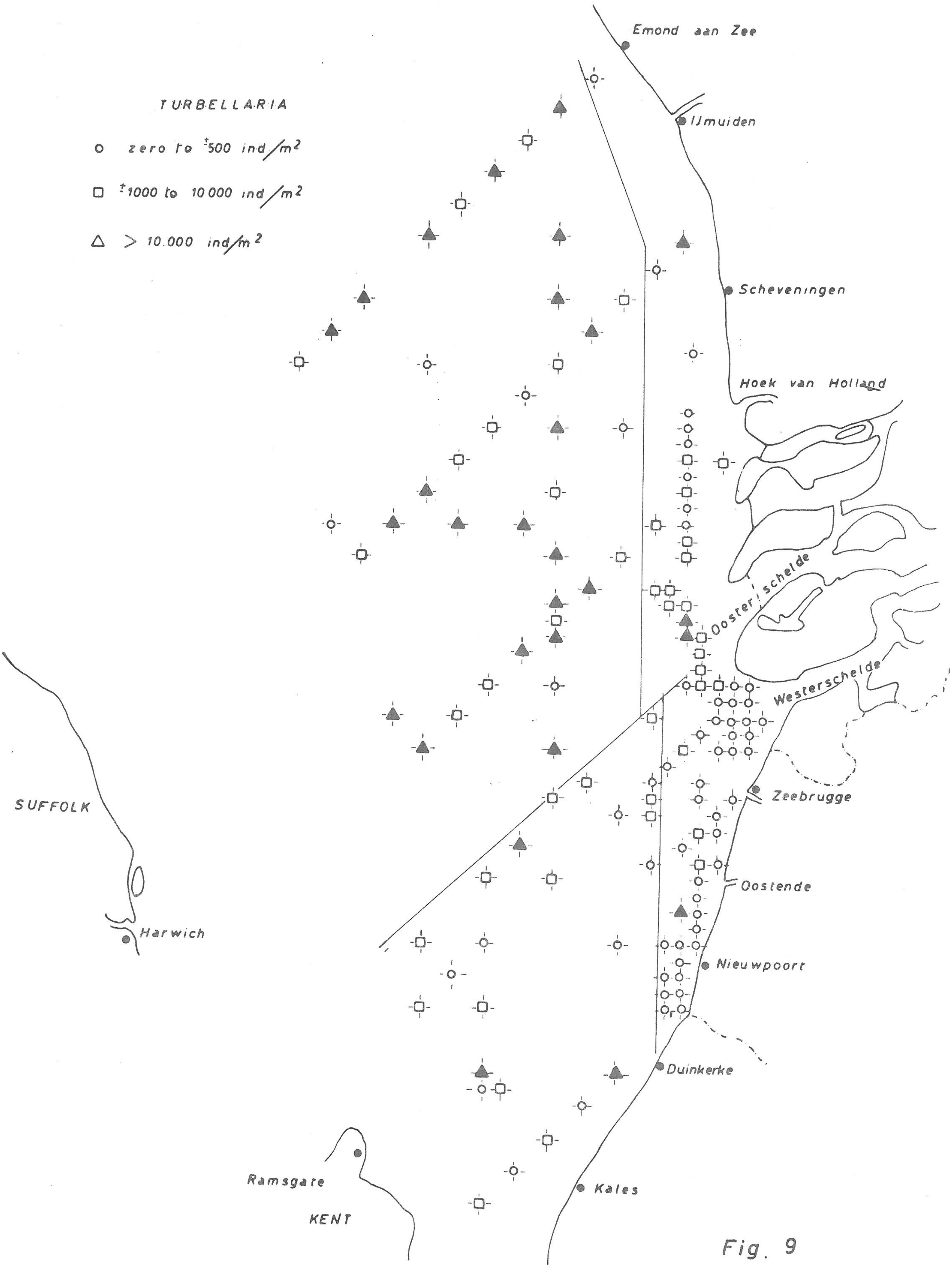

TURBELLARIA
zero to ±500 ind/m2
±1000 to 10 000 ind/m2
> 10.000 ind/m2
Emond aan Zee
IJmuiden
Scheveningen
Hoek van Holland
Oosterschelde
Westerschelde
Zeebrugge
Oostende
Nieuwpoort
Duinkerke
Kales
SUFFOLK
Harwich
Ramsgate
KENT

Fig. 9

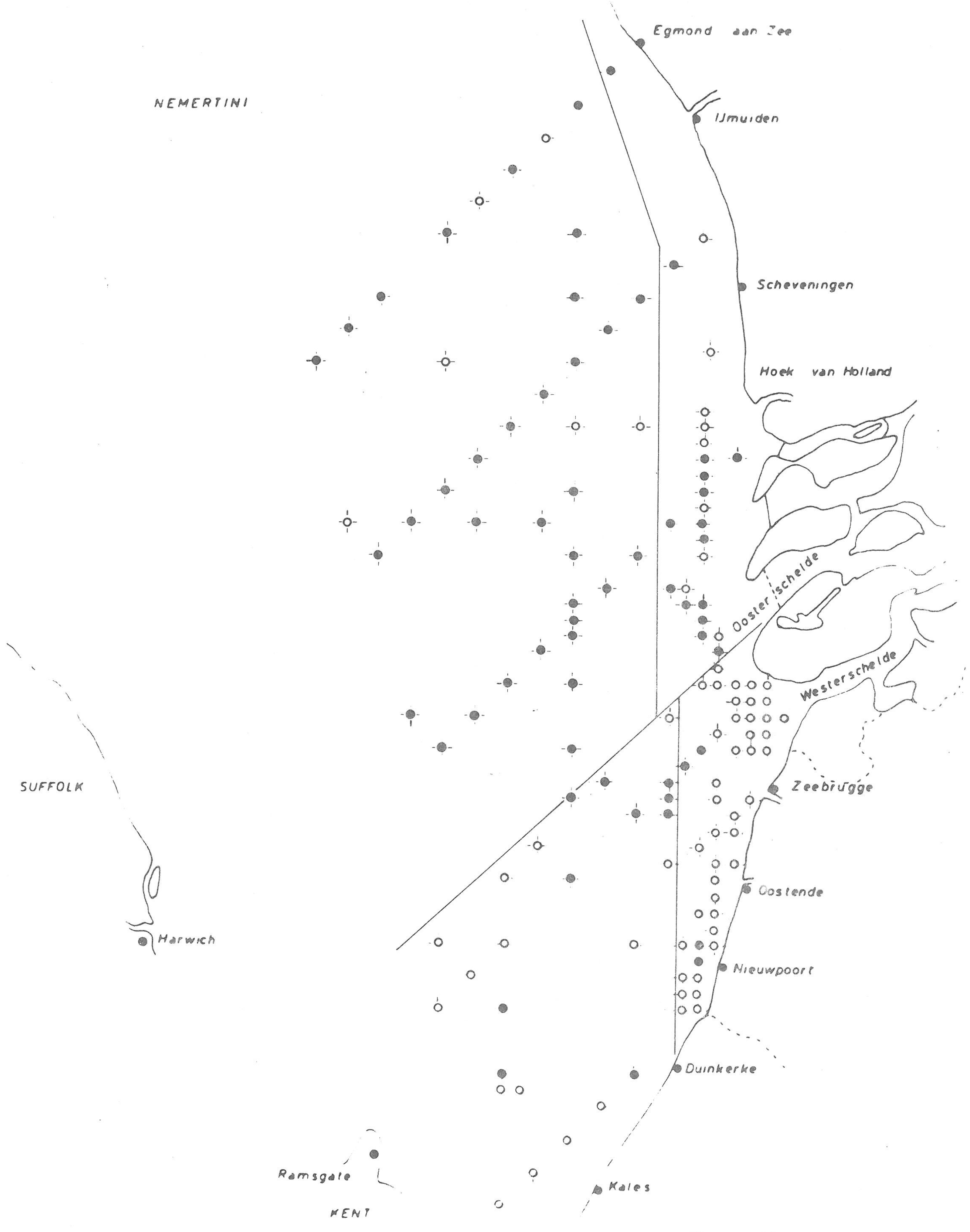

NEMERTINI
Egmond aan Zee
IJmuiden
Scheveningen
Hoek van Holland
Oosterschelde
Westerschelde
Zeebrugge
Oostende
Nieuwpoort
Duinkerke
Kales
SUFFOLK
Harwich
Ramsgate
KENT

Fig. 10

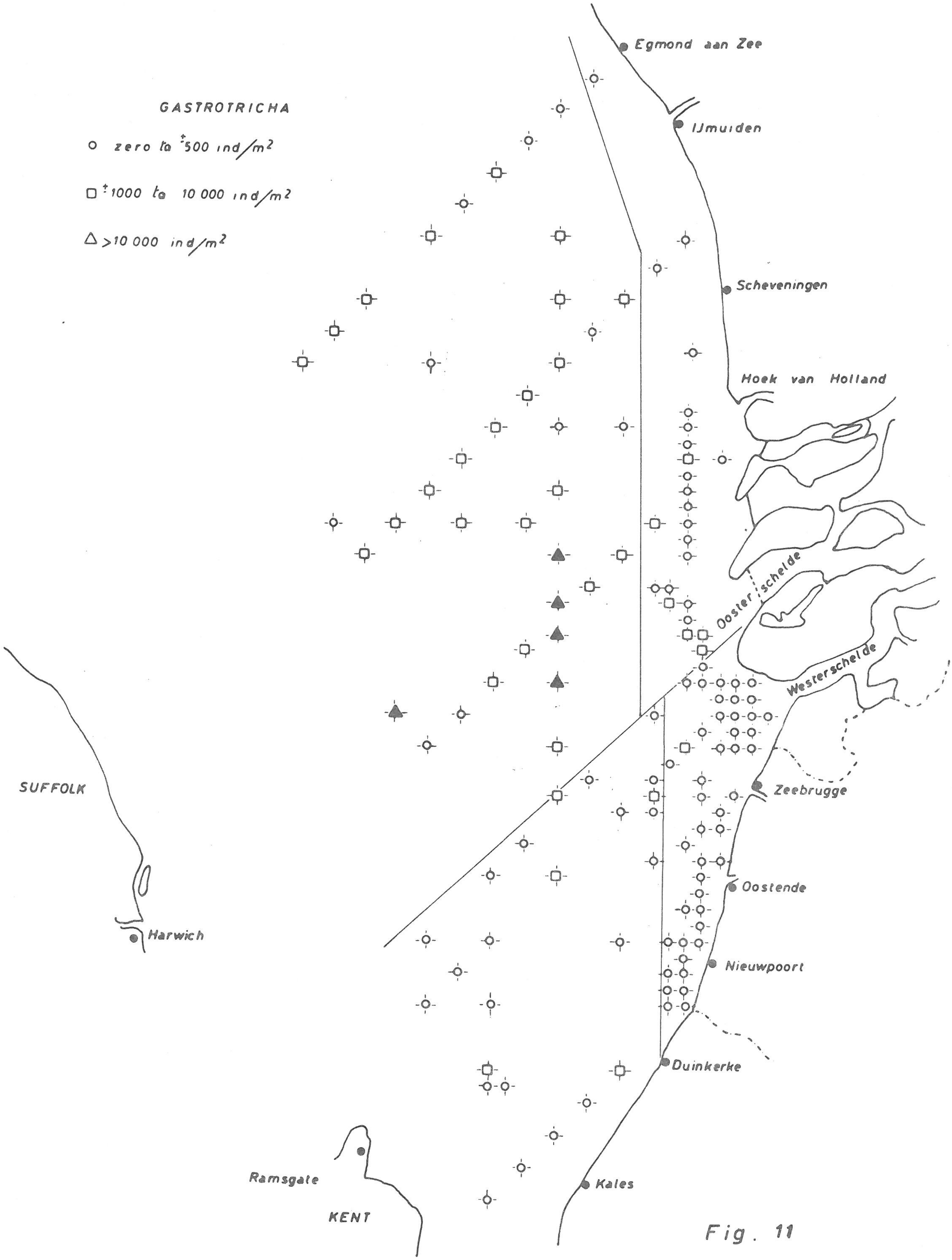

GASTROTRICHA
○ zero to ± 500 ind/m²
□ ± 1000 to 10 000 ind/m²
△ >10 000 ind/m²
Egmond aan Zee
IJmuiden
Scheveningen
Hoek van Holland
Oosterschelde
Westerschelde
Zeebrugge
Oostende
Nieuwpoort
Duinkerke
Kales
SUFFOLK
Harwich
Ramsgate
KENT

Fig. 11

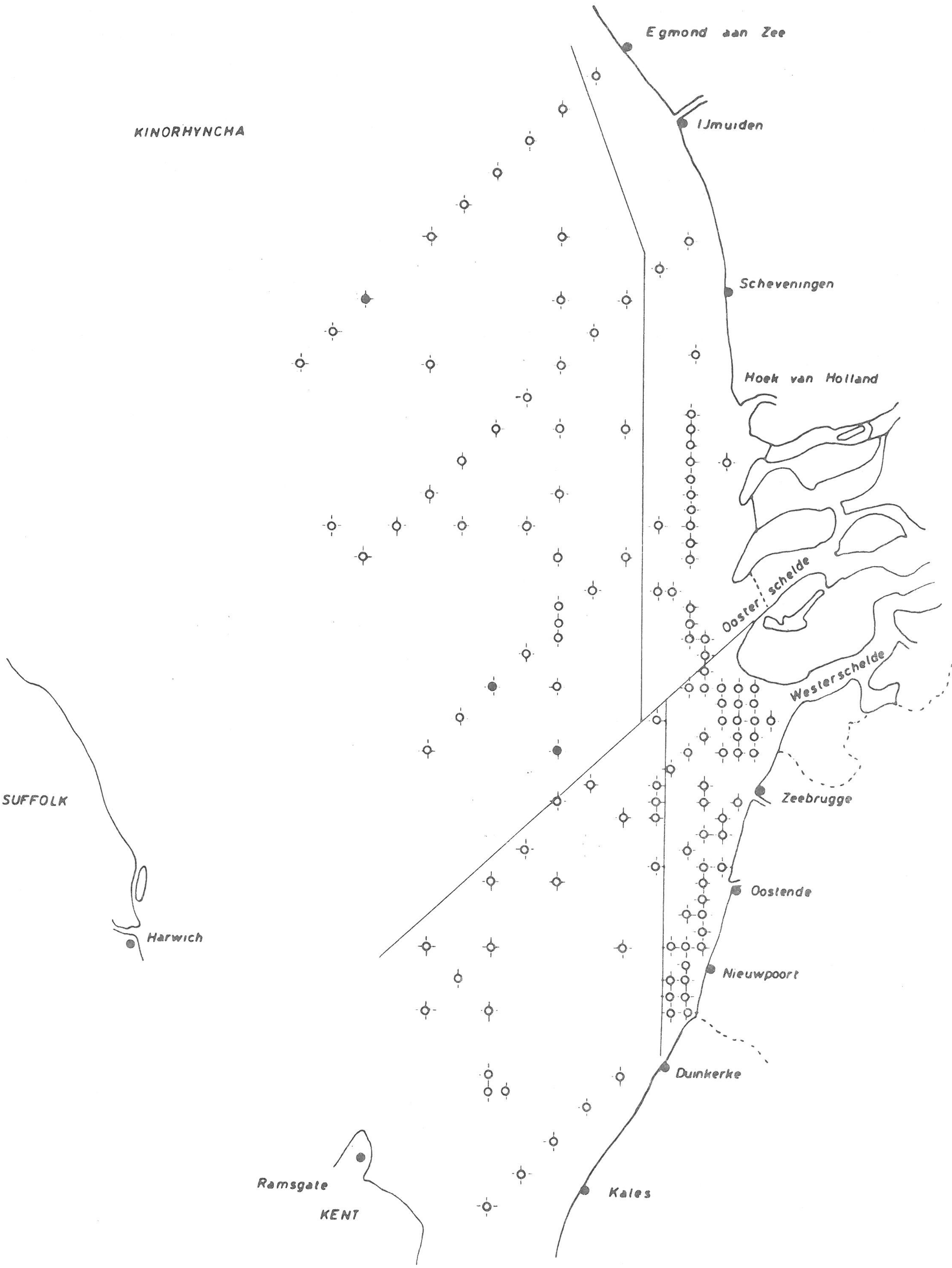

KINORHYNCHA
Egmond aan Zee
IJmuiden
Scheveningen
Hoek van Holland
Ooster schelde
Westerschelde
Zeebrugge
Oostende
Nieuwpoort
Duinkerke
Kales
SUFFOLK
Harwich
Ramsgate
KENT

Fig. 12

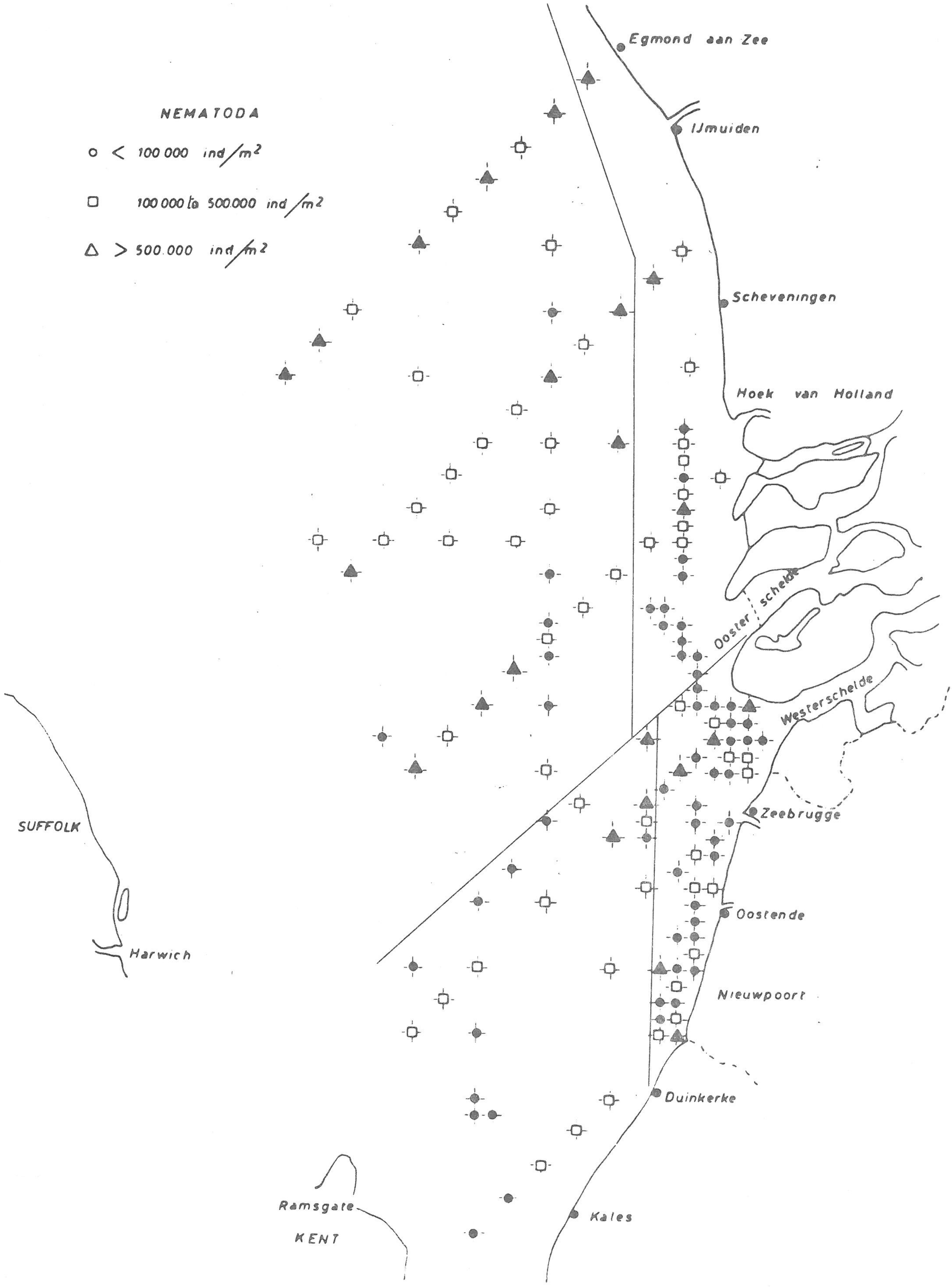

NEMATODA
< 100 000 ind/m2
100 000 to 500.000 ind/m2
> 500.000 ind/m2
Egmond aan Zee
IJmuiden
Scheveningen
Hoek van Holland
Oosterschelde
Westerschelde
Zeebrugge
Oostende
Nieuwpoort
Duinkerke
Kales
SUFFOLK
Harwich
Ramsgate
KENT

Fig. 13

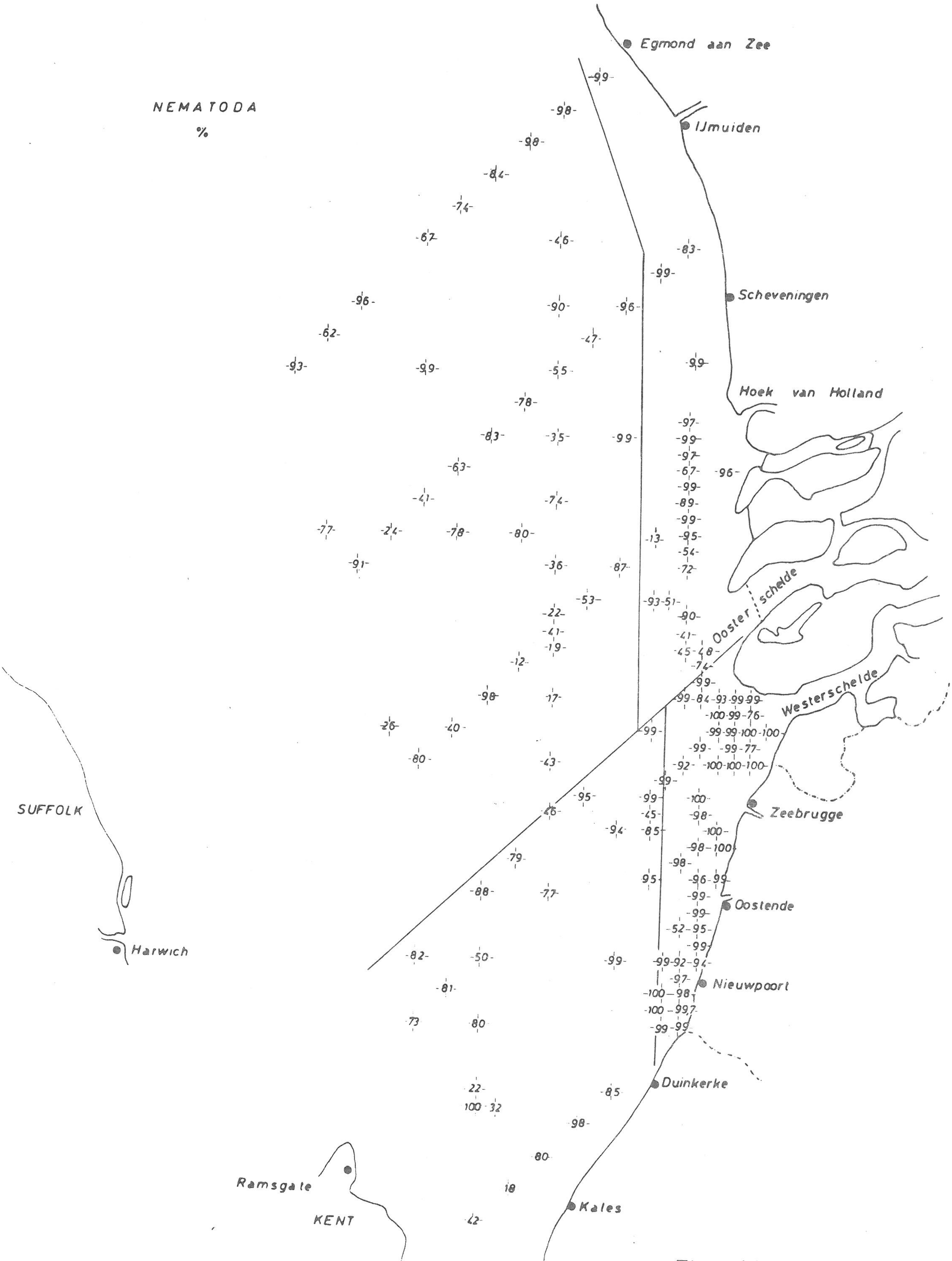
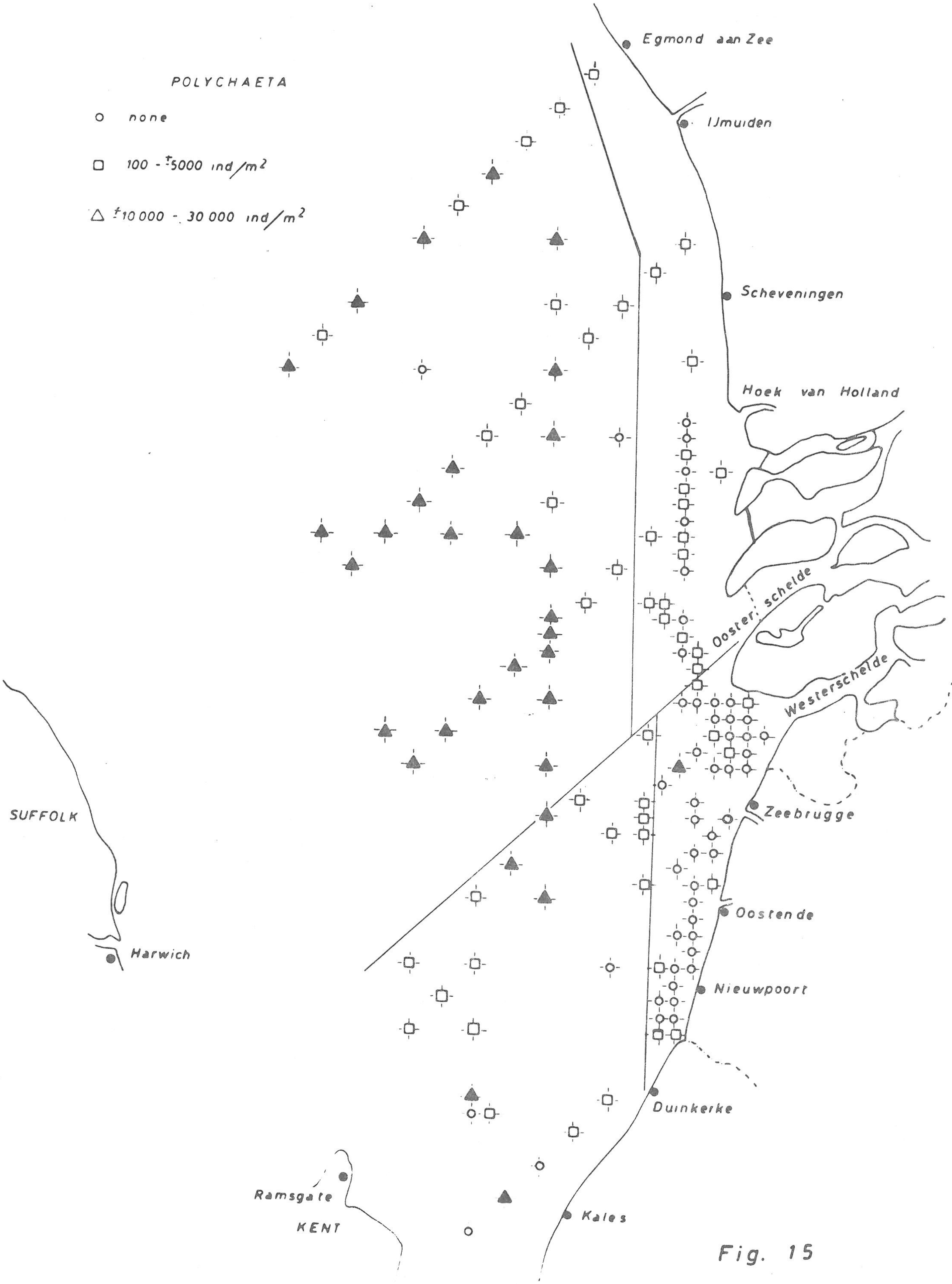

NEMATODA
%
Egmond aan Zee
IJmuiden
Scheveningen
Hoek van Holland
Oosterschelde
Westerschelde
Zeebrugge
Oostende
Nieuwpoort
Duinkerke
Kales
SUFFOLK
Harwich
Ramsgate
KENT

Fig. 14



POLYCHAETA
none
100 - ±5000 ind/m²
±10 000 - 30 000 ind/m²
Egmond aan Zee
IJmuiden
Scheveningen
Hoek van Holland
Oosterschelde
Westerschelde
Zeebrugge
Oostende
Nieuwpoort
Duinkerke
Kales
Ramsgate
KENT
SUFFOLK
Harwich

Fig. 15

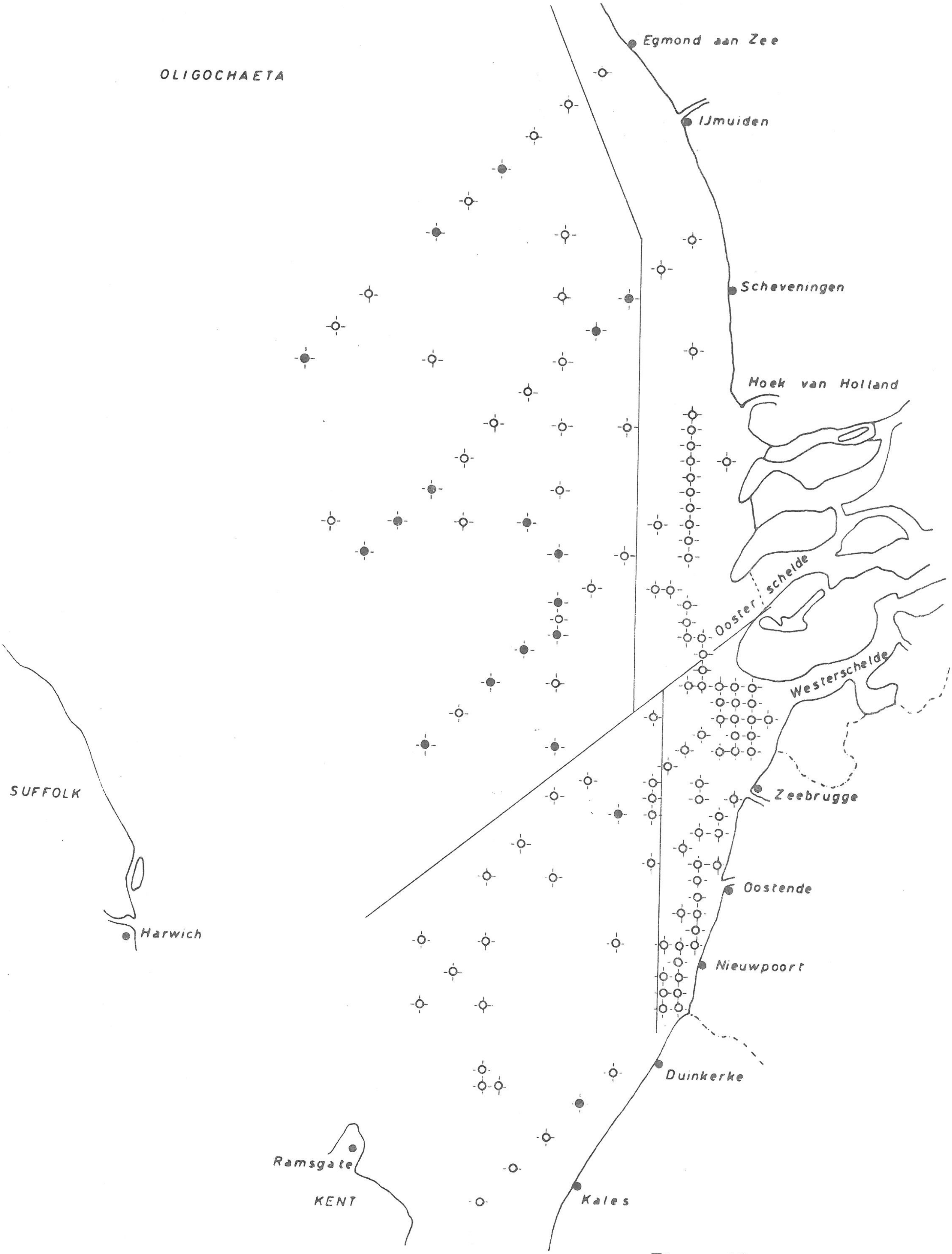

OLIGOCHAETA
Egmond aan Zee
IJmuiden
Scheveningen
Hoek van Holland
Oosterschelde
Westerschelde
Zeebrugge
Oostende
Nieuwpoort
Duinkerke
Kales
SUFFOLK
Harwich
Ramsgate
KENT

Fig. 16

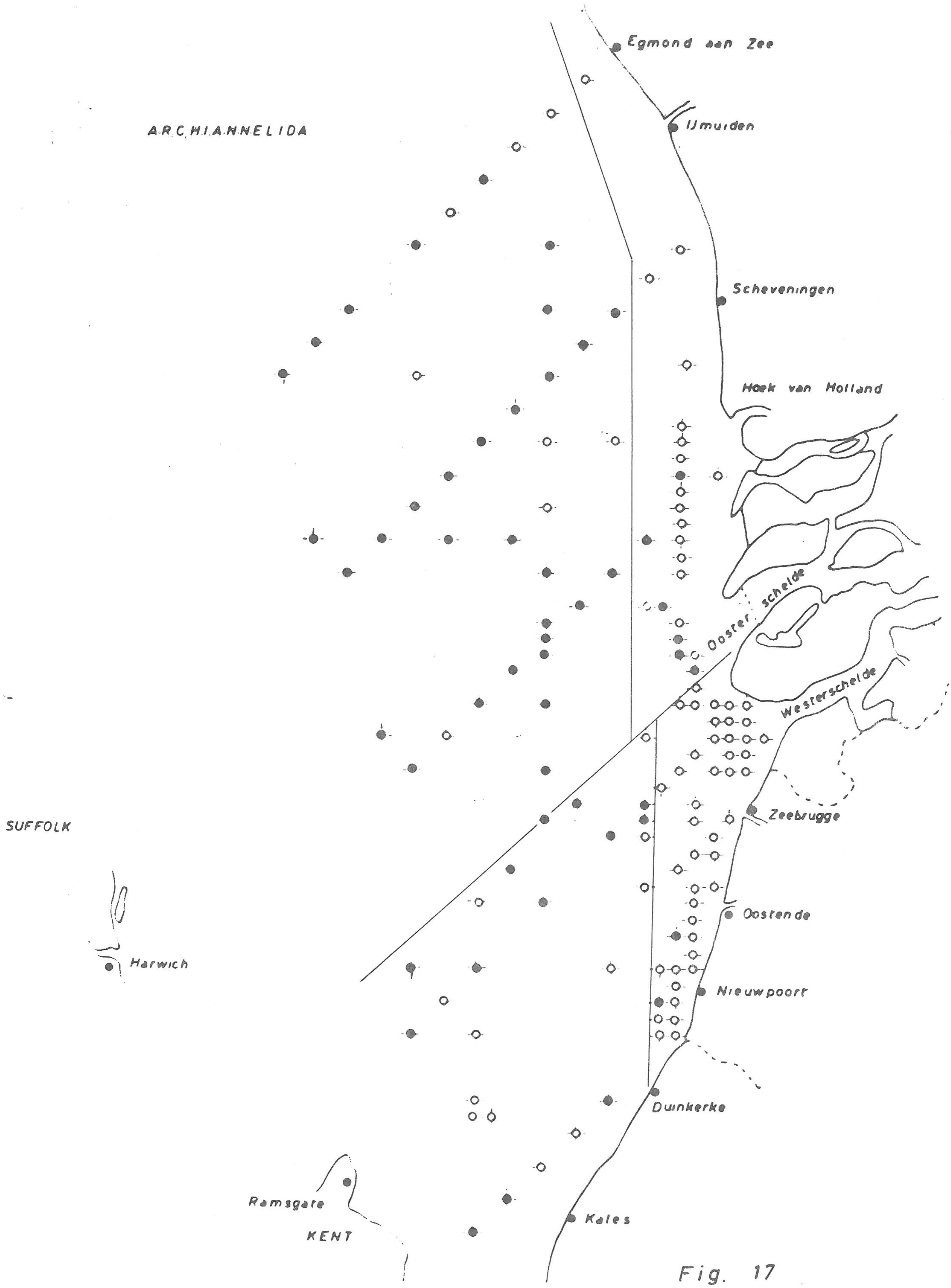

ARCHIANNELIDA
Egmond aan Zee
IJmuiden
Scheveningen
Hoek van Holland
Ooster schelde
Westerschelde
Zeebrugge
Oostende
Nieuwpoort
Duinkerke
Kales
SUFFOLK
Harwich
Ramsgate
KENT

Fig. 17

BIVALVIA

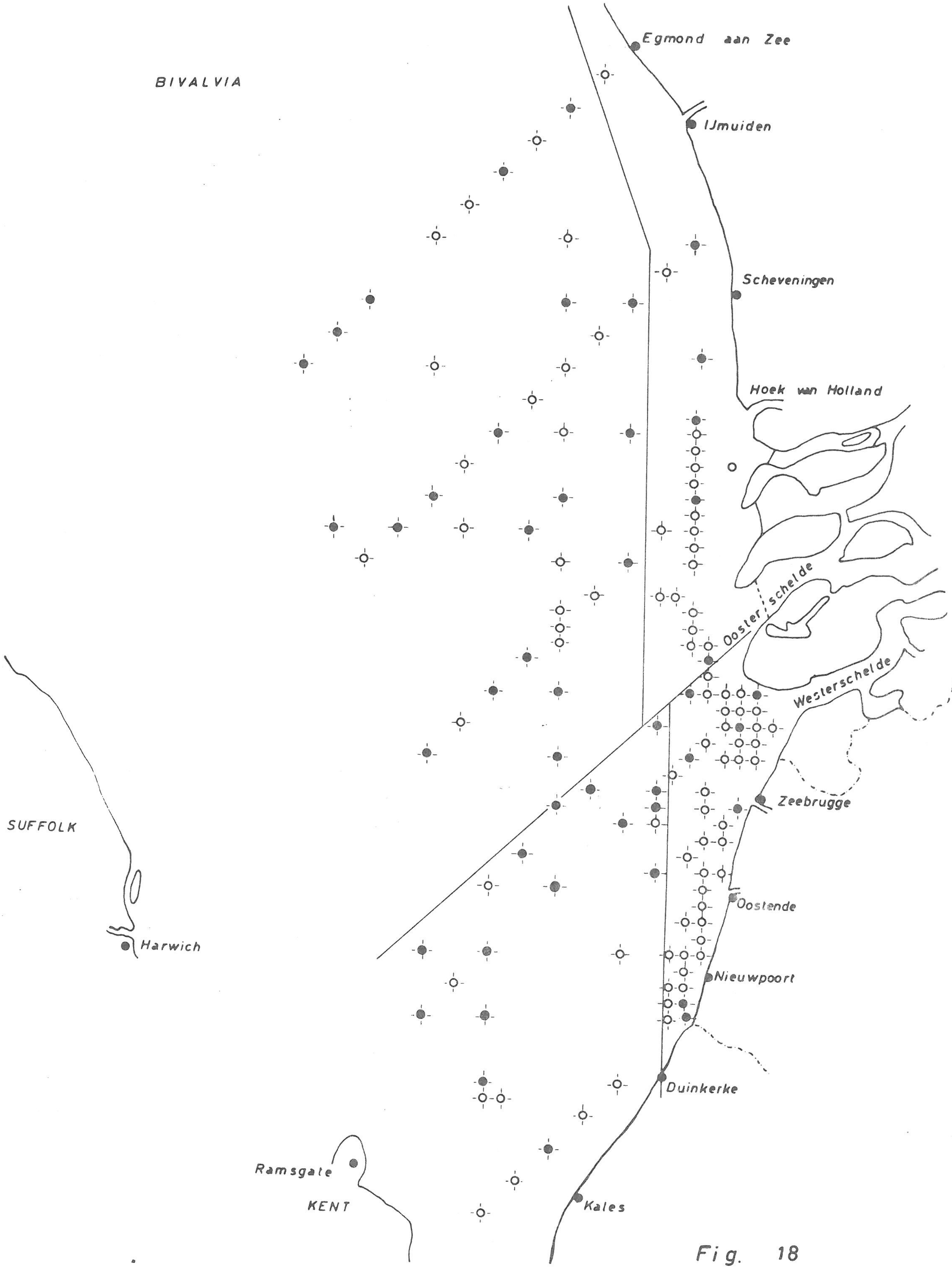


Fig. 18

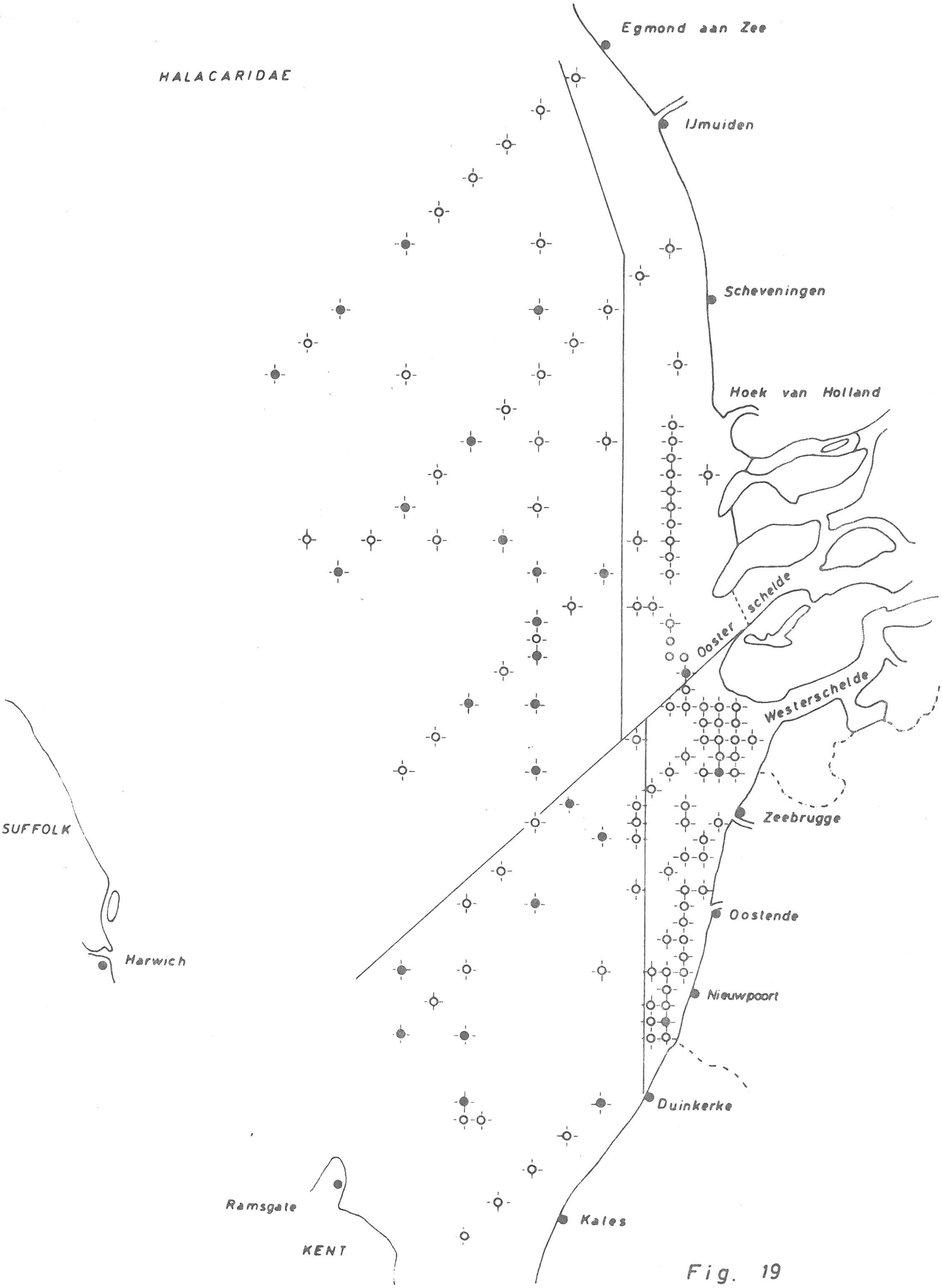

HALACARIDAE
Egmond aan Zee
IJmuiden
Scheveningen
Hoek van Holland
Oosterschelde
Westerschelde
Zeebrugge
Oostende
Nieuwpoort
Duinkerke
Kales
SUFFOLK
Harwich
Ramsgate
KENT

Fig. 19

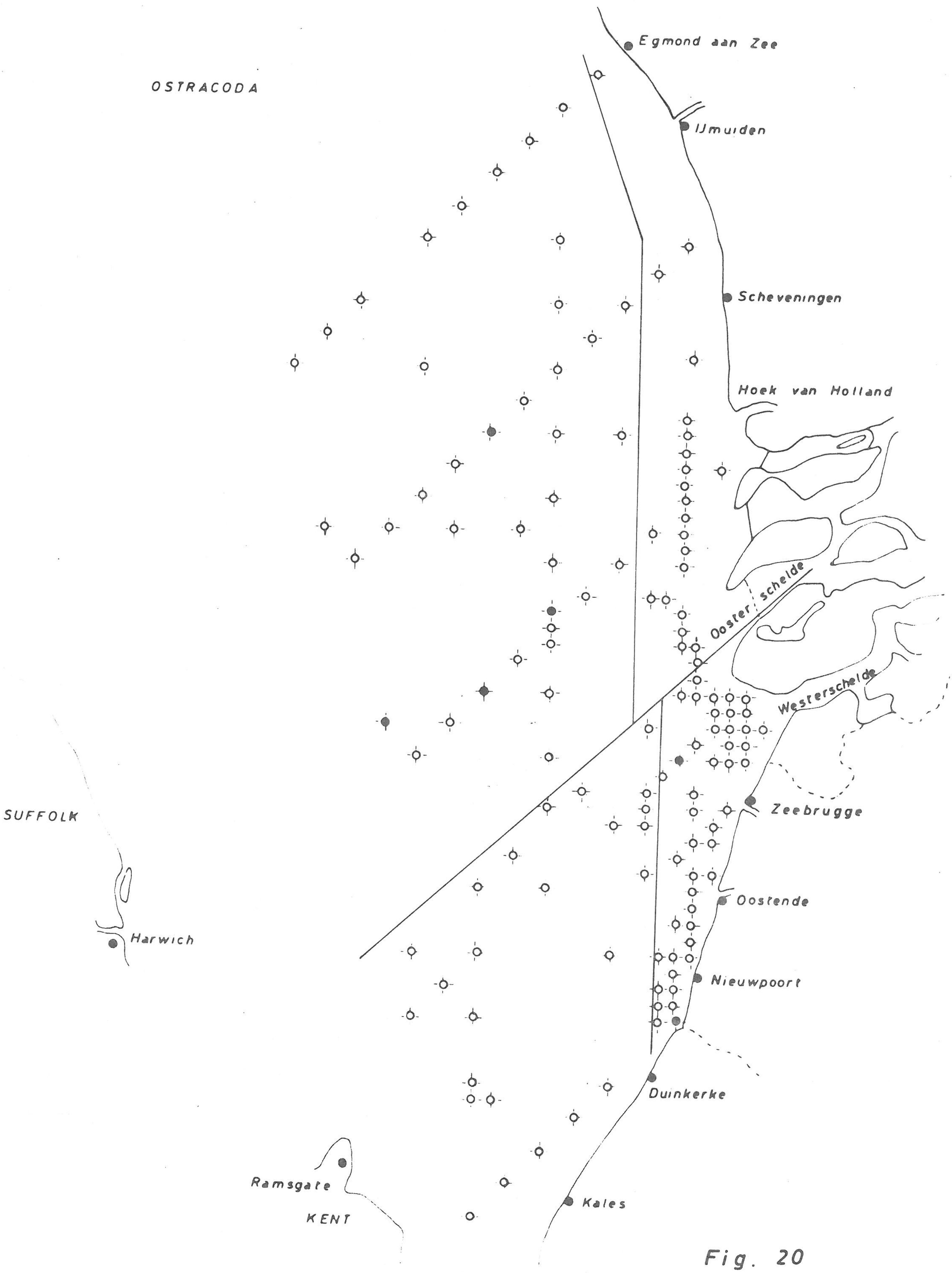

OSTRACODA
Egmond aan Zee
IJmuiden
Scheveningen
Hoek van Holland
Oosterschelde
Westerschelde
Zeebrugge
Oostende
Nieuwpoort
Duinkerke
Kales
SUFFOLK
Harwich
Ramsgate
KENT

Fig. 20

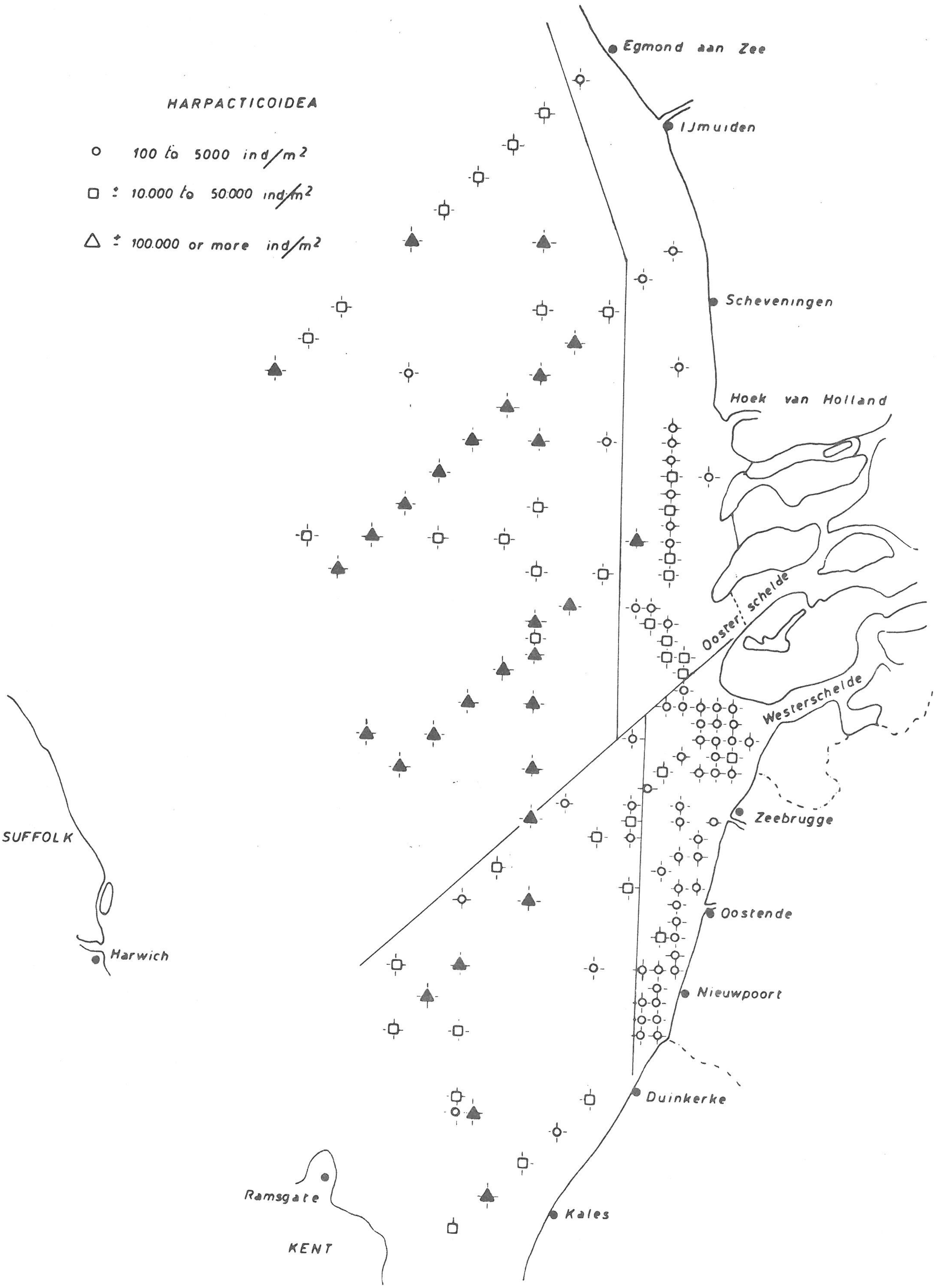

HARPACTICOIDEA
100 to 5000 ind/m2
± 10.000 to 50.000 ind/m2
± 100.000 or more ind/m2
Egmond aan Zee
IJmuiden
Scheveningen
Hoek van Holland
Oosterschelde
Westerschelde
Zeebrugge
Oostende
Nieuwpoort
Duinkerke
Kales
SUFFOLK
Harwich
Ramsgate
KENT

Fig. 21

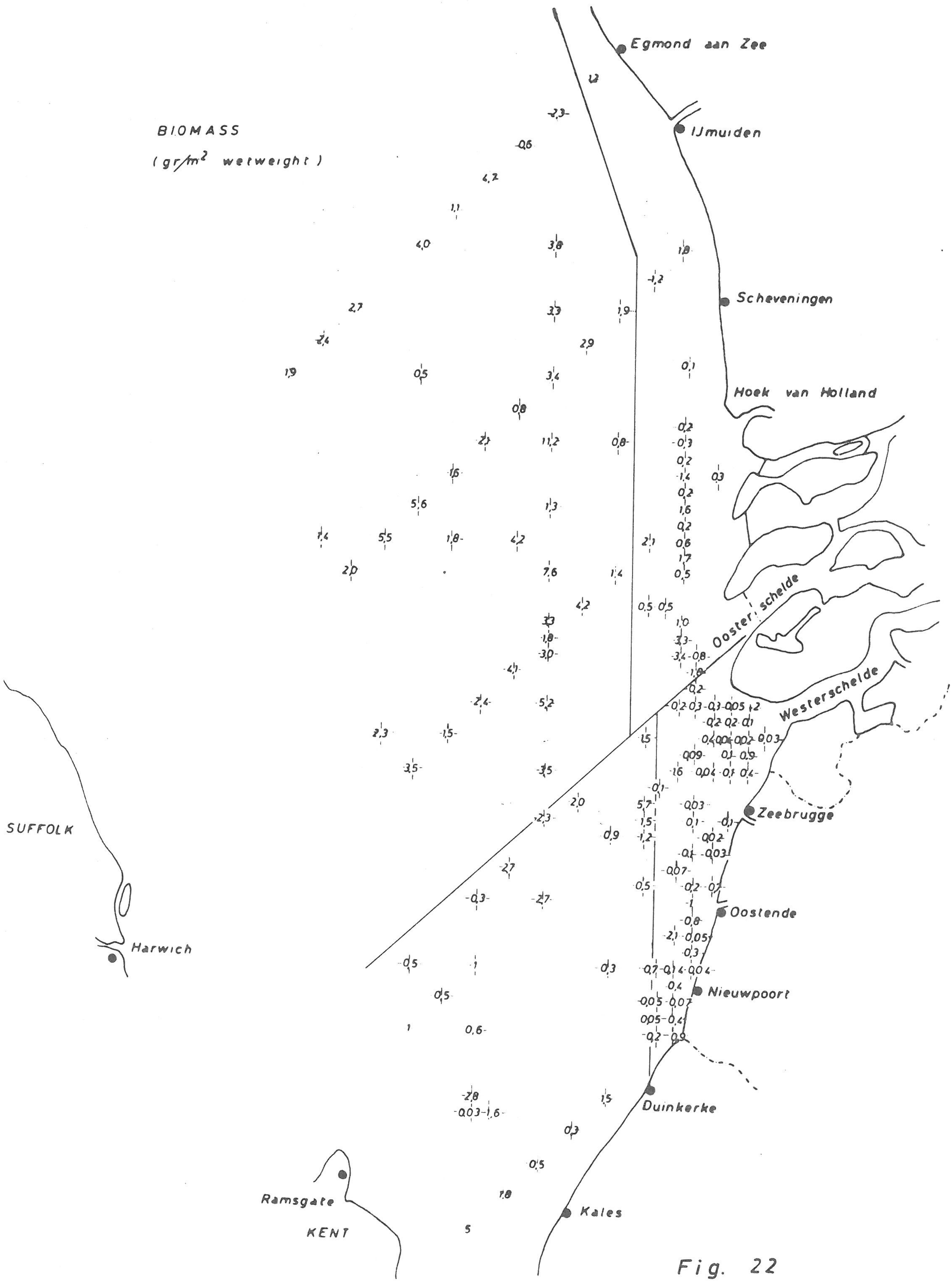
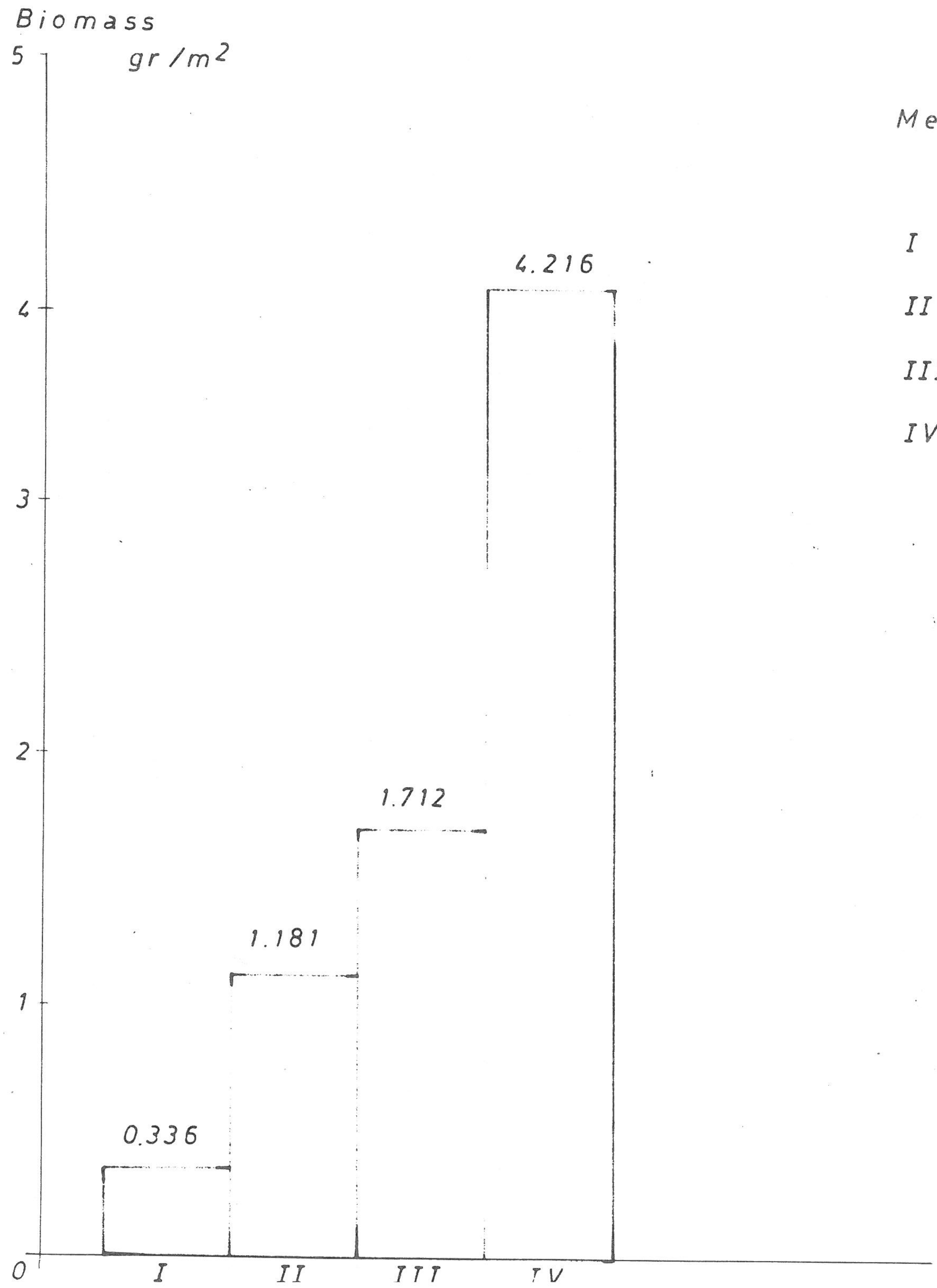

BIOMASS
(gr/m2 wetweight)
Egmond aan Zee
IJmuiden
Scheveningen
Hoek van Holland
Oosterschelde
Westerschelde
Zeebrugge
Oostende
Nieuwpoort
Duinkerke
Kales
SUFFOLK
Harwich
Ramsgate
KENT

Fig. 22



Mean Biomass gr / m^2 wetweight

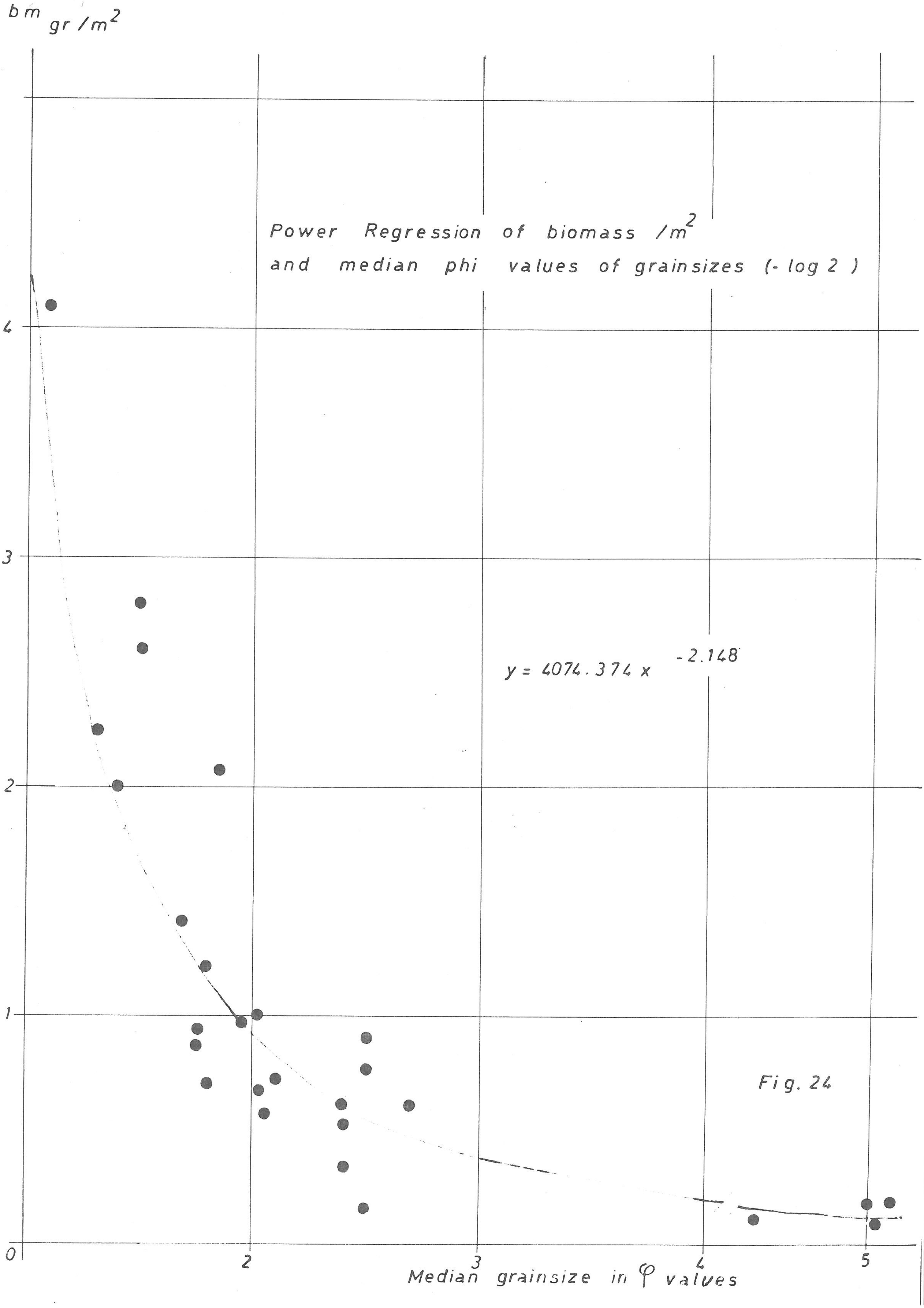
I Belgian α Westerscheldt Coastal Zone

II Dutch Coastal Zone

III Belgian α Westerscheldt Offshore Zone

IV Dutch Offshore Zone

Fig. 23



bm gr /m2
Power Regression of biomass /m2
and median phi values of grainsizes (- log 2)
y = 4074.374 x -2.148
4
3
2
1
0
2
3
4
5
Median grainsize in φ values

Fig. 24

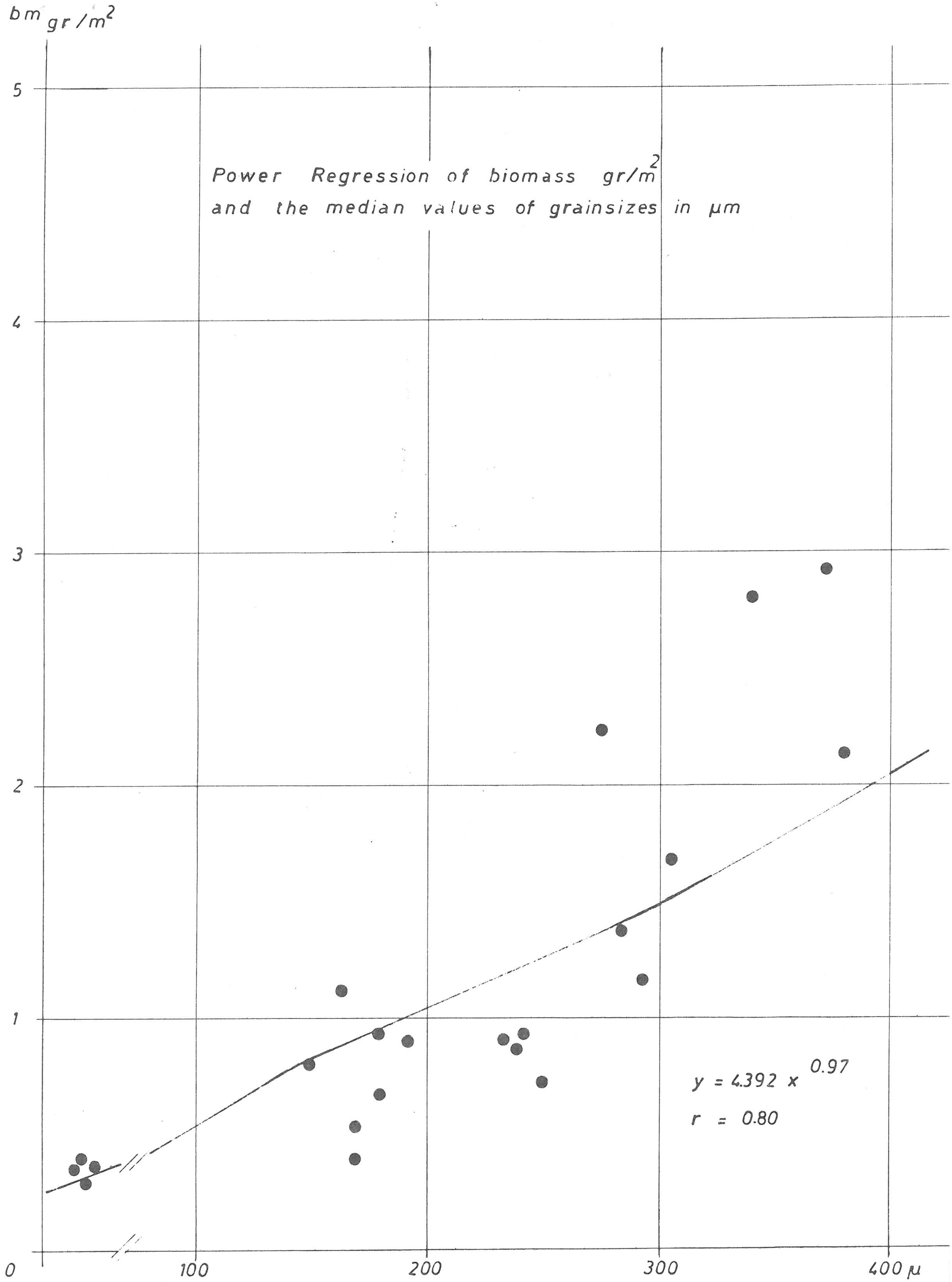

bm gr/m2
Power Regression of biomass gr/m2
and the median values of grainsizes in µm
y = 4.392 x 0.97
r = 0.80
0
1
2
3
4
5
100
200
300
400 µ
Median grainsizes in µm

Fig 25

Linear Regression of
Biomass (gr/m^2) and
Percentage Organic Carbon
in Sediment

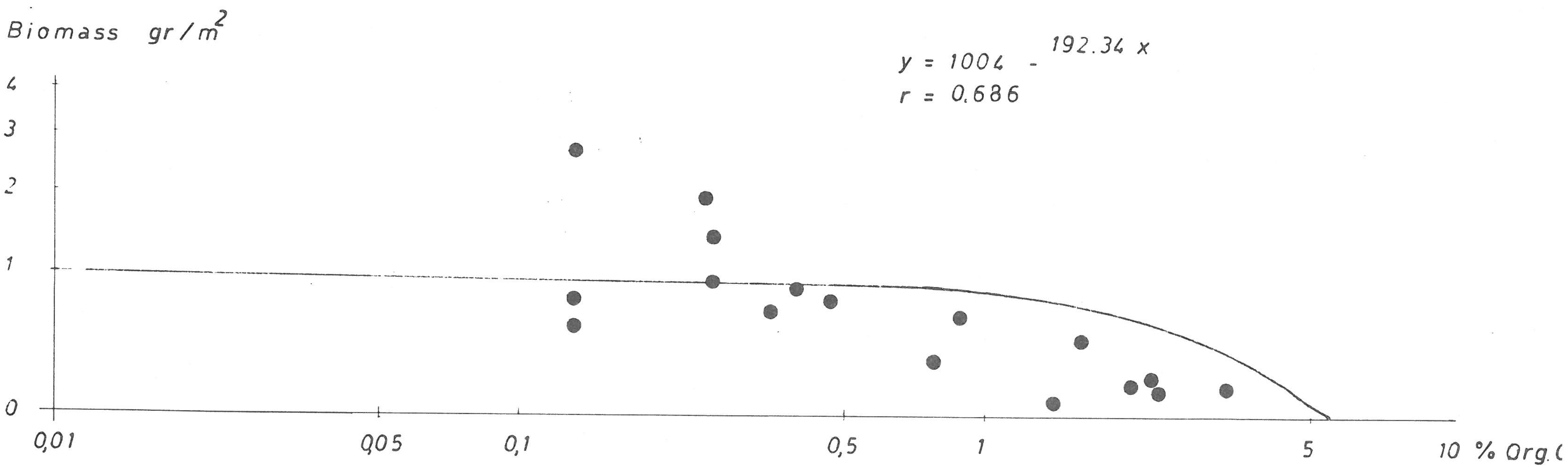
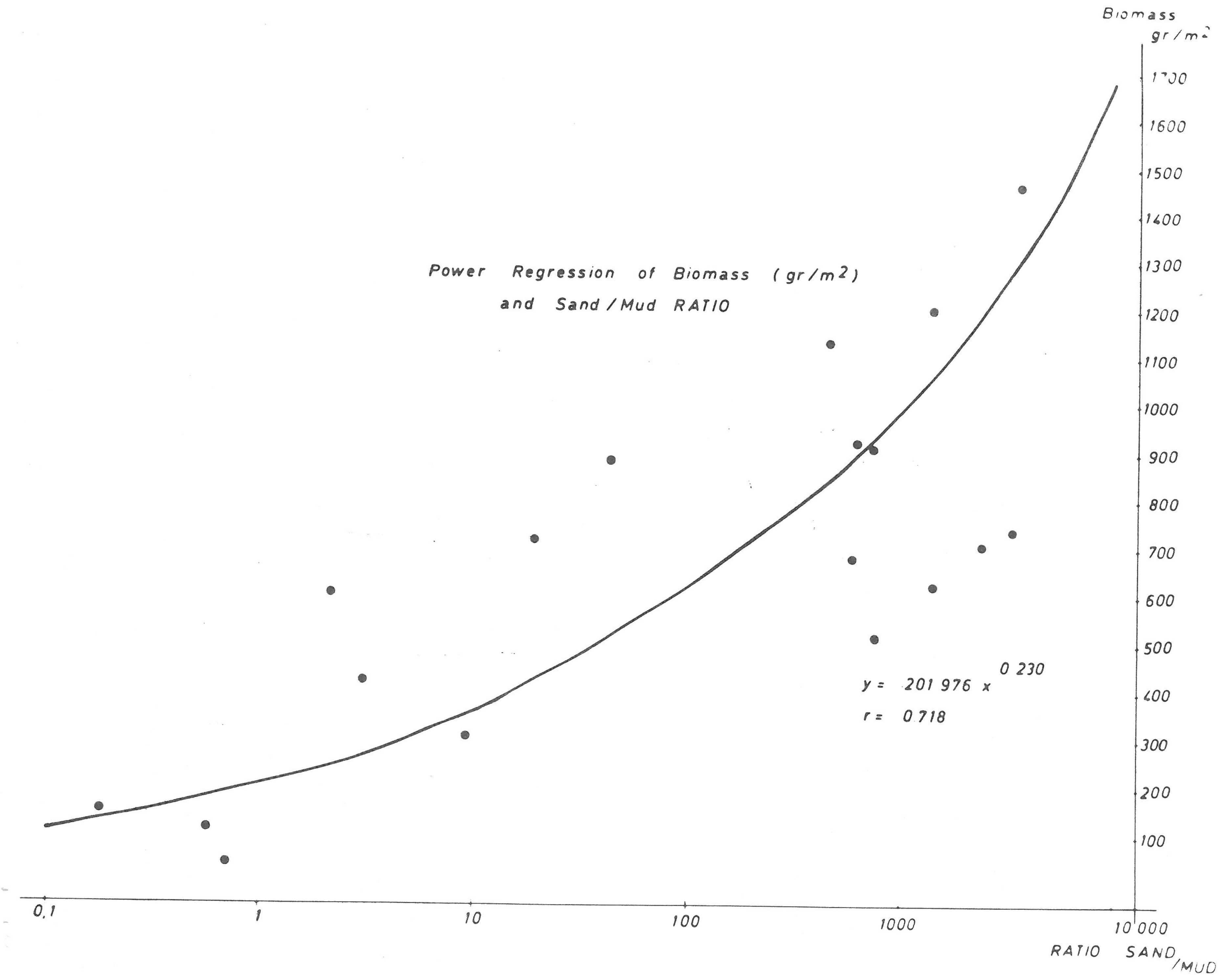


Fig. 26



Power Regression of Biomass (gr/m2)
and Sand / Mud RATIO
y = 201 976 x 0 230
r = 0 718
Biomass
gr/m
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
0,1
1
10
100
1000
10 000
RATIO SAND/MUD

Fig. 27

ERRATA

- The comma's must be changed into points and vice versa in all figures in the text, fince this paper is in English (0,1 mg -- 0.1 mg).
- p. 5; fig. 19 is fig. 21.
- p. 6; fig. 21 is fig. 19; extinct in other area = extinct in the area.
- p. 10; rather poor quantitative = rather poor quantitative results
  ; poorest zone in the Belgian = poorest zone is the Belgian.
- p. 11; Hence the biomass = Minimal biomass.