ICES 1989 PAPER C.M. 1989/E:36 REF L

THE INFLUENCE OF THE WESTERN SCHELDT ON THE MEIOBENTHOS OF THE BELGIAN COASTAL AREA

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ABSTRACT

A difficult aspect of pollution research is that of assessing the chronic, ecological effects of small amounts of pollutants discharged over long periods of time. These effects have to be distinguished from the natural variability of the populations.

The spatial and temporal variability of the meiobenthos of six subtidal stations along the Belgian coast is examined seasonally from 1977 onwards. The sediment of the western part is characterized by fine to medium sands; the eastern zone is characterized by very fine to fine sands with a high mud content. The bulk of these fine materials emanates from the loads in pollutants of the Western Scheldt waters. The mud content in the eastern zone shows significant seasonal fluctuations; this fluctuation has no effect on the structure of the meiobenthic communities in this area. Despite the strong relationship between the characteristics of the meiobenthic communities and the sediment structure, the influence of the Western Scheldt is reflected in a clear decrease in trophic, family and species diversity of meiobenthic communities.

The eastern zone of the Belgian coast is one of the most impoverished areas in benthic life, so far known.

INTRODUCTION

The study of the benthos in the Southern Bight of the North Sea started in 1971. The data of both macro- and meiobenthos are published in Heip et al., 1979; Govaere et al., 1980, Vincx, 1981, Vanosmael, et al.,1982, Vincx et al., 1982; Willems et al., 1982a & b; Heip et al., 1983; Vincx, 1983, Vincx et al., 1984; Herman et al.,1985, Vincx, 1986 and Vincx (in press a,b & c).

This works concentrates on the state of knowledge of the benthic communities of the Belgian coastal zone and the impact of the Western Scheldt on these communities.

2 MATERIAL AND METHODS

2.1. Study area

Benthic samples have been examined from the stations shown in Fig.1. The numbers indicate the official station numbers of the Belgian benthic monitoring program (see Vincx, 1986 for exact localities).

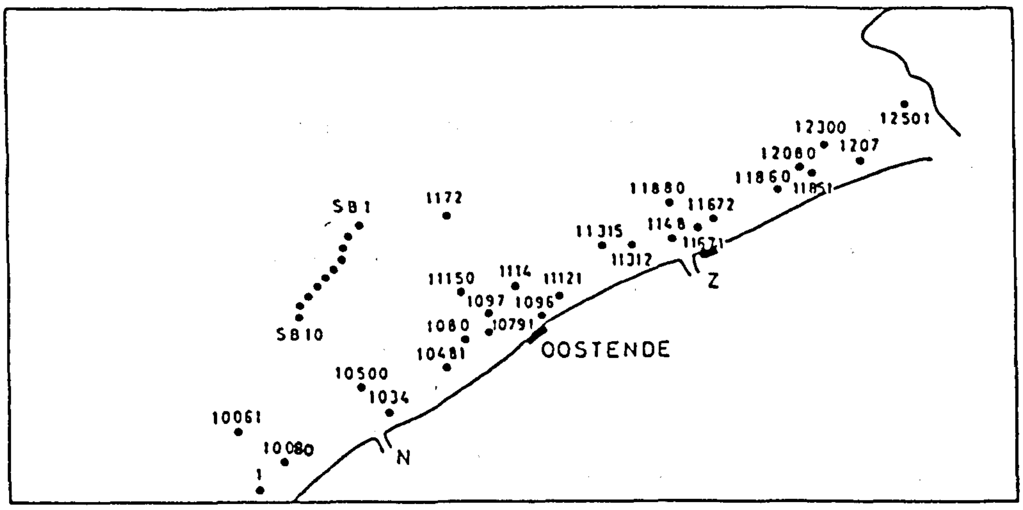


Fig.1. Map of the stations examined for benthic life along the Belgian coast

2.2. Sampling methods

The meiofauna samples were taken by subsampling a Reineck–boxcorer (surface 170 cm²) (Farris & Crezée, 1976) . From October 1984 onwards, meiofauna was sampled using a box–corer (sampling area=0.25 m²) from which 10.2 cm² subsamples were taken from the Belgian Oceanographic Research Vessel 'Belgica'.

2.3. Extraction techniques

The extraction techniques of meiobenthos from sediments differ with sediment type. Simple decantation on a sieve (38 μm) is satisfactory for sand with low amounts of detritus or silt (Hulings & Gray, 1971). The trough–method (Barnett, 1968; Heip, 1976) is also applicable for sand samples. The extraction from muds or detritus (after the sand has been removed by decantation or other methods) is done using a density–gradient centrifugation technique. In the beginning, sugar was used to build a density gradient (Heip et al., 1974) but later on a method using Ludox (Heip et al., 1985) proved to be more convenient.

3. RESULTS AND DISCUSSION

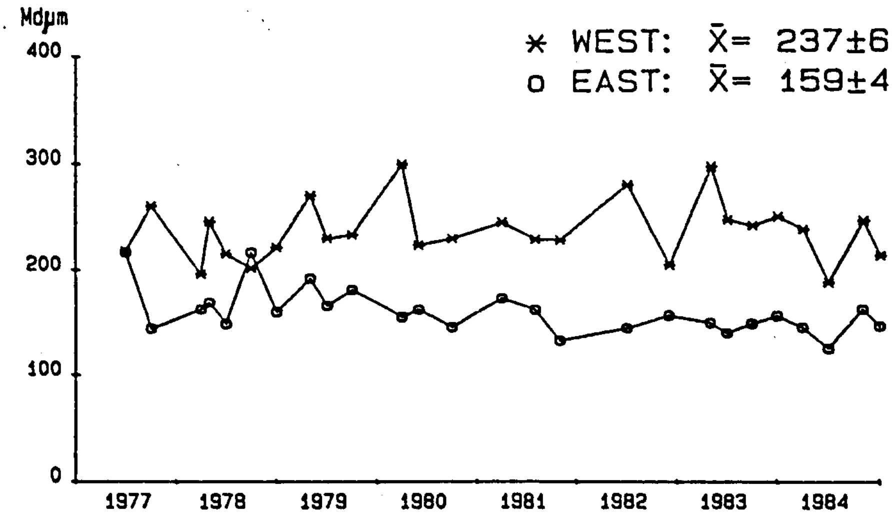
3.1. Sediment

It is well known that the sediment structure is the most important factor to determine the nature and the structural aspects of the benthic communities, such as density, biomass and diversity.

The Belgian coastal subtidal area can roughly be divided into a muddy eastern part and a more sandy western part (boundary Ostend region), mainly originating from the current pattern in the eastern part and the precipitation of finer polluted materials out of the Western Scheldt waters.

The temporal variation of the sediment composition has been examined seasonally for six stations in the period 1977−1984. Two sand stations (10080 & 11150), two muddy sand stations (10500 & 12510) and two muddy stations (10500 & 11880) were examined.

Temporal evolution Median grain size



Temporal evolution mud-content (%)

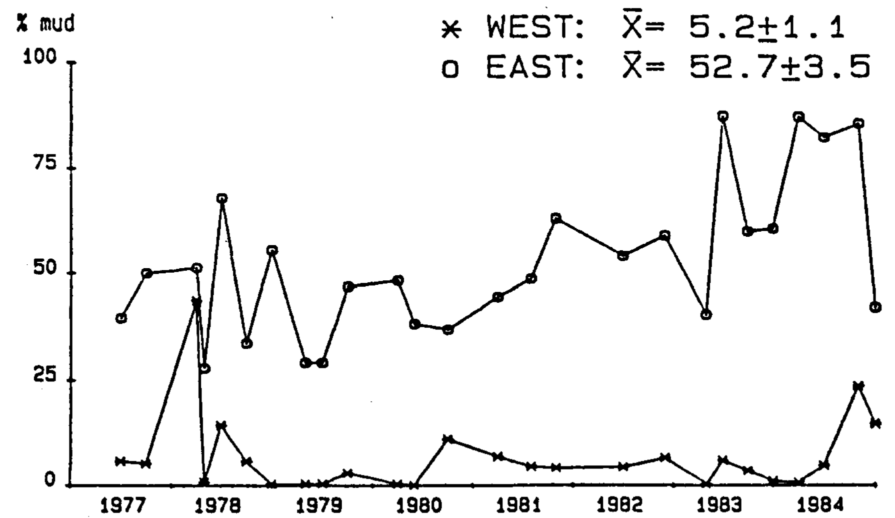


Fig. 2. Temporal evolution of the median grainsize of the sand fraction and the content along the west coast (asterisks) and along the east coast (open circles).

The most important sediment characteristics are summerized as follows :

	Median grain size		% Mud	
	Mdμm	range	< 62 μm	range
SAND	260 μm	164 - 456	4.2 %	0 - 22.4
MUDDY SAND	189 μm	136 - 299	11.7 %	0.2 - 70.9
MUD	150 μm	81 - 228	68.3 %	10.9 - 98.4
WEST COAST	237 μm	135 - 456	5.2 %	0 - 55.1
EAST COAST	159 μm	81 - 317	52.7 %	0.3 - 98.4

Following trends are observed (Fig. 2): along the west coast, variation in the median grain size is higher than along the east coast. Although the median shows no clear seasonal pattern, there is a tendency that the lowest values occur in the summer period for each year separately. The western part of the coastal area is dominated by fine to medium sands. The eastern zone is characterised by very fine to fine sands with a high mud content. The mud content in the eastern zone shows significant fluctuations from 25% till 75%. These fluctuations have no seasonal relationship, but are more induced by weather conditions. This variability seems to have little effect on the structure of the meiobenthic communities (see further). Within this eight year period, there is no significant trend in the evolution of the sediment composition.

3.2. Meiobenthos

Seasonal monitoring of the meiobenthos was carried out between 1978 and 1984, two to four times a year.
Within that period, 16 meiobenthic taxa were found (range 1 to 12 taxa per 10 cm^2), with the Nematoda, the Copepoda and the Turbellaria as the most important ones. Taxa regularly reported from sandy sediments are Gastrotricha, Ostracoda, Tardigrada, Hydrozoa, Halacarida and Oligochaeta. The remaining taxa occurred very rare or are found sporadically in a few stations : Nemertini, Bryozoa, Kinorhyncha, Rotatoria, Sipunculida and Mollusca. The taxon diversity (i.e. the number of higher taxa such as nematodes, copepods, turbellarians,...) increases clearly on the west coast (Fig. 3); on the east coast the taxon diversity is almost constant and very low.

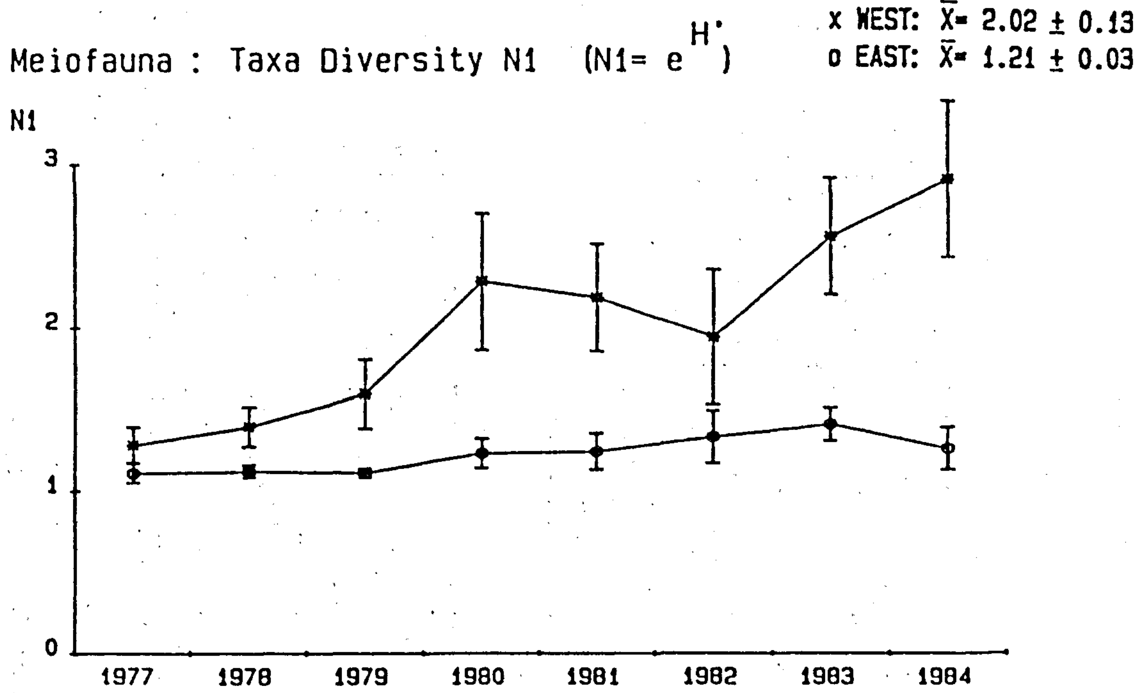


Fig. 3 Temporal evolution of the mean taxon diversity N_1 in the western (*) and eastern (o) zone off the Belgian coast.

The whole area is dominated by nematodes and the other groups become less important as the sediment becomes much finer and also more polluted. This is illustrated in Fig. 4, wherein the temporal evolution of the dominant taxa is presented separately for the sandy west coast stations and for the silty east coast stations.

The overal mean density is 13.10^6 individuals per m^2 (min: 13.10^3 ind; max: 19.10^6 ind. m^{-2}) and shows a stable constant trend in both zones (Fig. 4). The mean density values for the different meiobenthos taxa are significantly higher in the sandy stations than for the muddy stations (Fig.5). Similar observations were obtained from biomass-data, but the very few, but larger organisms such as copepods, turbellarians and polychaetes play an important role in terms of biomass. The overall dominance of nematodes in the eastern part of the coast indicates the aberrant, stressed characteristics of the sediments (see next chapter).

3.3. Seasonal fluctuation of the nematode communities

Because the meiobenthos is a complex functional group of species within the ecosystem, with different requirements to the environment, we examined the species composition of the nematode communities from monthly samples in more detail (see also Vincx, 1986 and Vincx in press c). Up to now, only data of station 702 (i.e. 11860 in Fig.1), a station which is influenced by pollution of the Western Scheldt are available for the monthly samples during 1983-1985. The characteristics of the station are summarized as follows: 9 m depth, the silt content varies between 35 and 81% and the median grain size ranges between 25 and

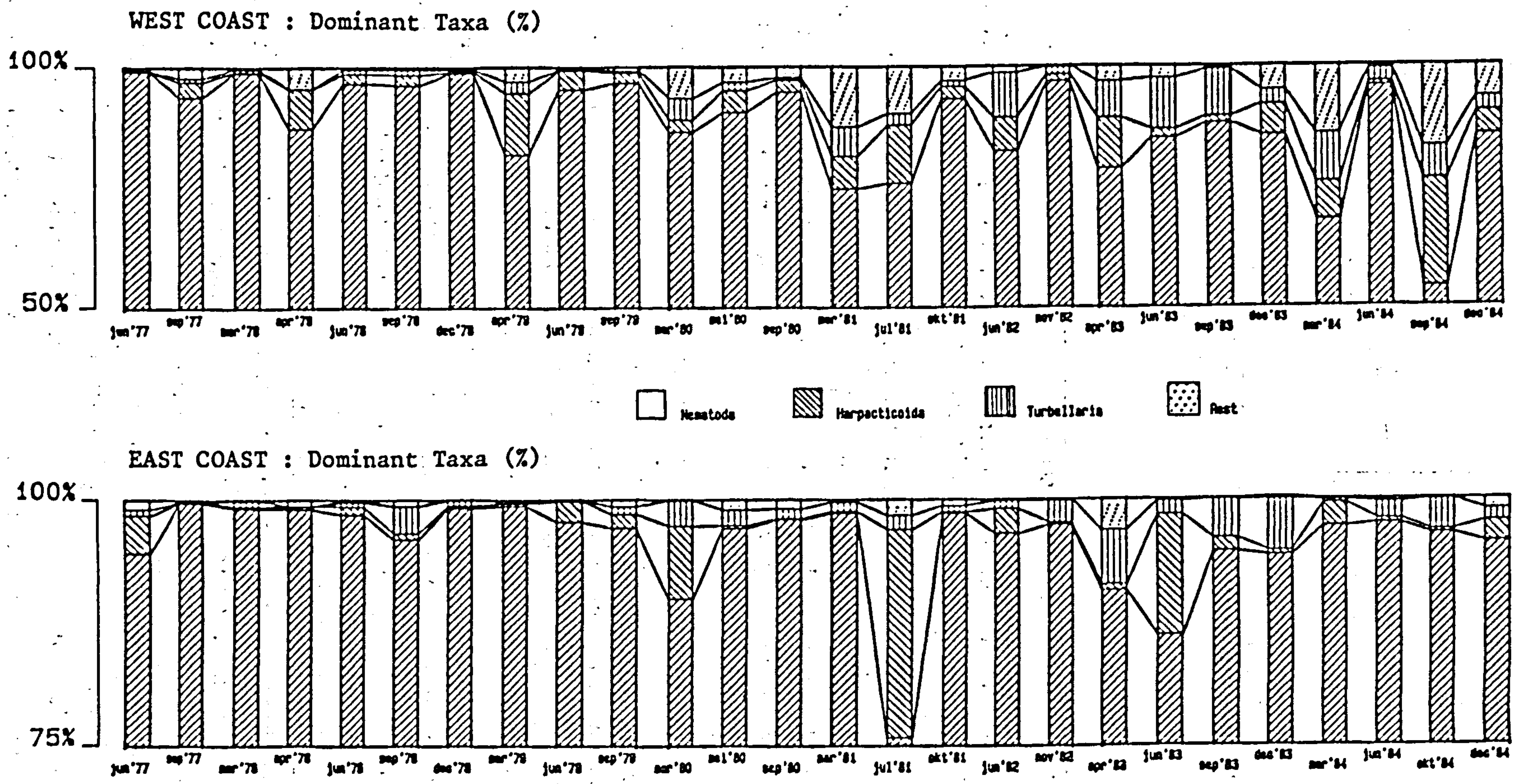


Fig. 4. Temporal evolution of the dominant taxa of the meiofauna communities along the west and east coast from June 1977 till December 1984.

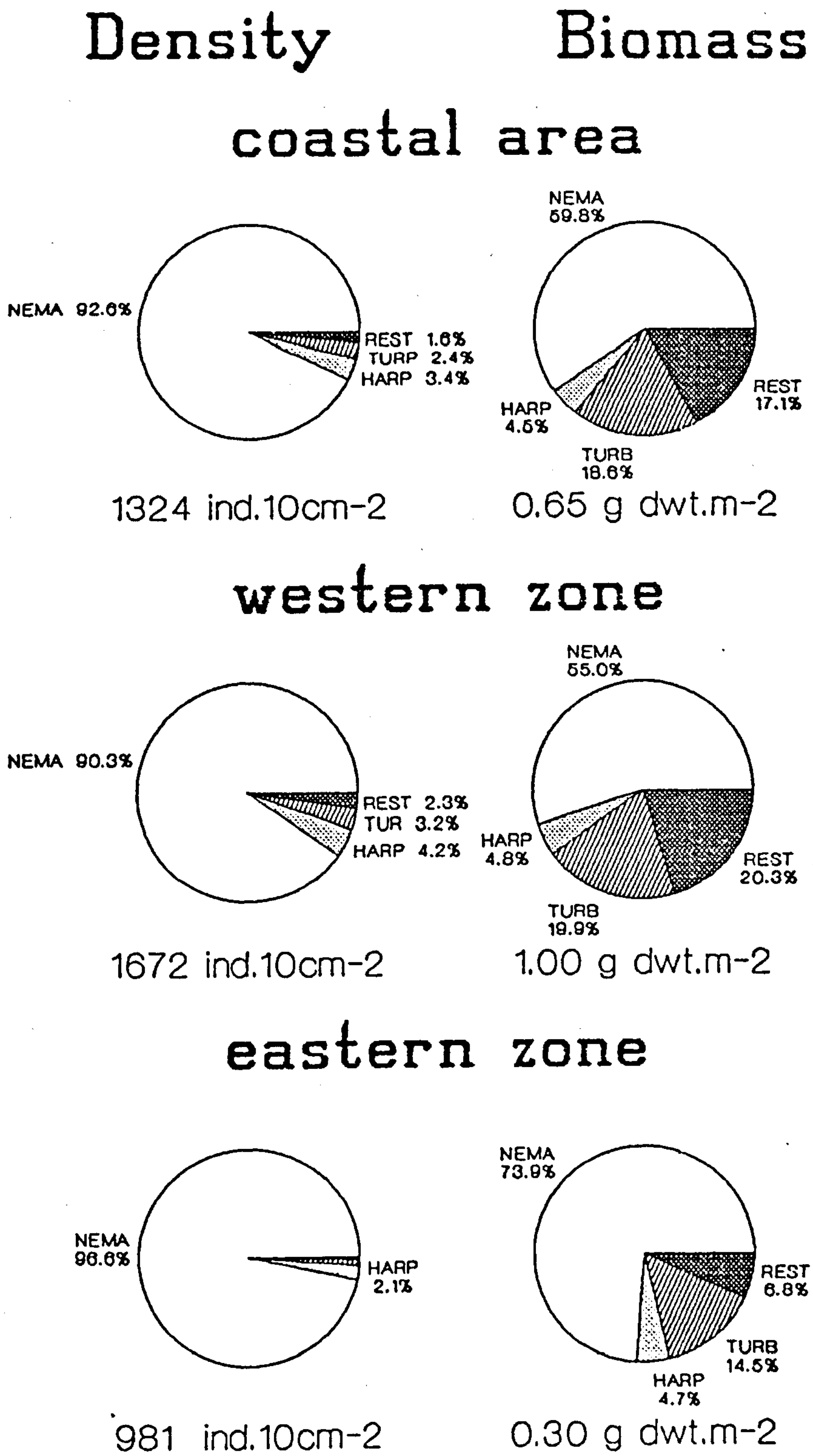


Fig. 5. Mean density (ind.10 cm^{-2}) and mean biomass (g dwt.m^{-2}) of the meiofauna communities and the relative importance of the dominant taxa Nematoda, Harpacticoida and Turbelaria along the Belgian coast.

138 µm; salinity varies between 29.8 and 33.9‰, O_2 content between 5.5 and 15.5 ppm and temperature between 5.5 and 16.8°C.

The mean density of the total nematode community varied between 55 ind./10 cm² (Feb 1983) and 5610 ind./10 cm² (Jun 1985) (Fig.6). Over the three year period, we found 32 species and only one of them, Sabatieria punctata occurs in all samples. Only four species have a frequency higher than 50%. They are all non-deposit-feeders. We will only discuss the temporal fluctuation of the most important species S. punctata, which is an important species of the coastal area of the North Sea (Fig.7). The monthly fluctuation of the densities are shown in Fig.6. Density maxima are noted in Mar, Sep and Nov 1983, Apr and Oct 1984 and Feb, Apr and Jun 1985. These increases in densities are not the result of a sudden increase in temperature. The fluctuation of three age classes of juveniles (<700 µm,700–1100 µm, <1100 µm), plus males and females has also been determined.

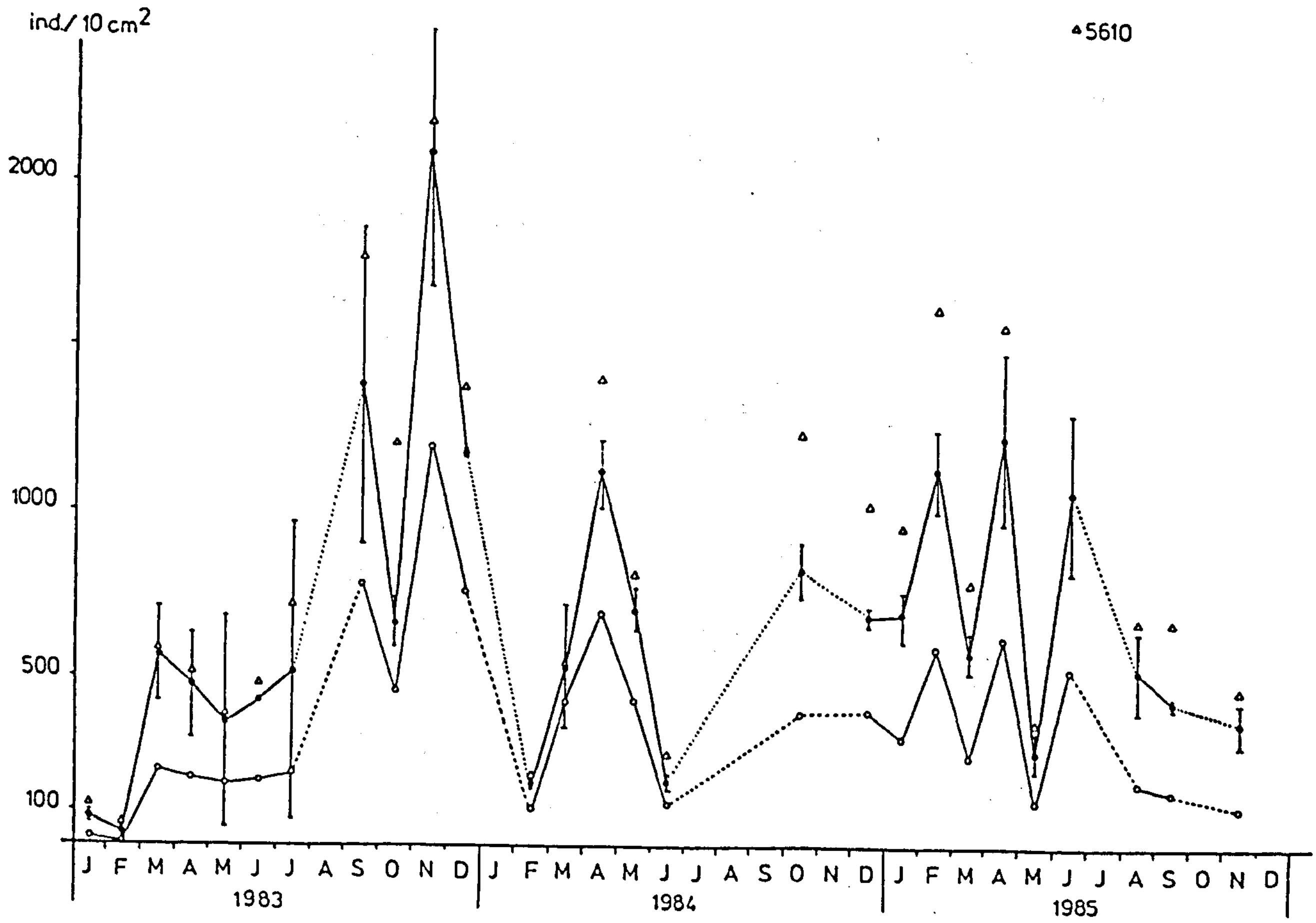


Fig. 6. Density (ind./10 cm²) of the nematode community (▵), of Sabatieria punctata (ad+juv) (•; + SE) and of S.punctata (juv. (○)) over 3 years.

Out of these data, we conclude that: - the population consists always at least for 50% of juveniles; - the sex-ratio is about 1 in most periods; - reproduction is continuous, with peaks from March till May, and October; - juveniles born in this period become adult two to three months later; - last adults produce juveniles in autumn (Sep-Oct); in this period, the adults of the older generation die (visible by a clear decrease in density on that moment, with a higher decrease of the adults than of the juveniles); - last juveniles become adult in next spring and reproduce immediately.

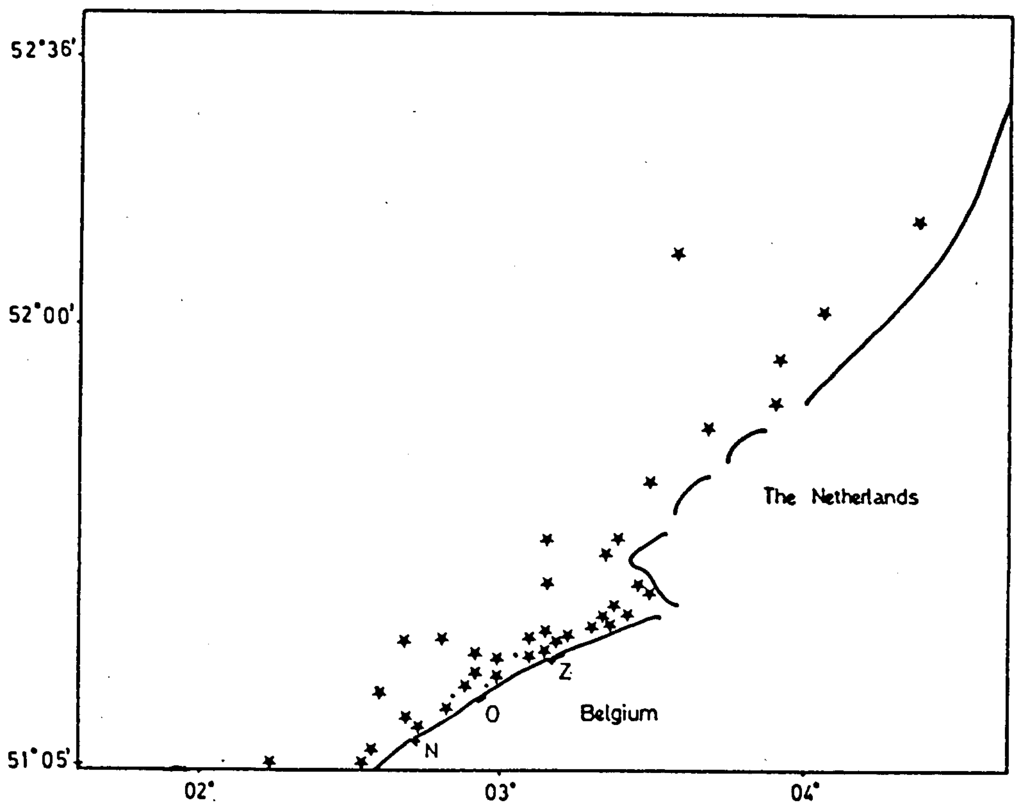


Fig. 7. Distribution of <u>Sabatieria punctata</u> in the Southern Bight of the North Sea.

3.4. <u>Production of the nematode communities</u>

Out of the former population data, production of the nematode community can be calculated with the regression equation relating egg-to-egg development time (T min) to temperature (t) and adult female body weight (W in µg):

$\log T\ min = 2.202 - 0.0461t + 0.627 \log W$ (Vranken <u>et al</u>.,1986).

The P/B for each month is calculated as 1/TminxDx3 (with D=number of days per month). Biomass structure (males, females and juveniles) is determined for each month and so monthly the production for the species is calculated. A P/B = 3 per generation is assumed and the rate of development 1/T min is a good estimation for the daily P/B. Total production for one year divided by the average biomass (w=wet weight) gives the annual P/B for the species. The yearly P/B for Sabatieria punctata varies between 14.1 (1985) and 16.9 (1983; for Daptonema tenuispiculum (a smaller nematode) between 28.5 (1985) and 31.9 (1983); for Ascolaimus sp.1 between 11.5 (1985) and 14.8 (1983) and for the whole community between 16.2 (1985) and 18.1 (1983) (Vincx, in press, b). The annual production is calculated for every nematode species encountered in the years 1983 and 1985. The sum of all the specific production values yields the annual production for the whole community which is 20.6 g ww/m^2.y for 1983 and 28.9 g ww/m^2.y for 1985. The three dominant species mentioned above contribute together for more than 95% of the yearly production of the whole community.

For the period 1977–1979, Heip et al. (1984) calculated the production of the nematode communities for several coastal stations. The average biomass of the nematode community in station 702 for this period equals 0.15 gC/m^2 which is 4 to 4.5 times lower than for 1985 and 1983 respectively. For the period 1977–1979, only the high density months were sampled, and no information was available on the fluctuation of the biomass over the year. P/B=9 (Gerlach, 1971) was used to calculated the annual production and a value of 1.37 g C/m^2 was obtained. Whan we use the annual P/B=17, which is the mean value of 1983 and 1985, for the nematode community in station 702, an annual value of 2.55 gC/m^2.y is obtained for the period 1977–1979, which is twice as high as the value estimated by Heip et al. (1984).

Temperature and food are the most abvious factors explaining the density changes in marine nematodes. Deposit-feeders (as the three dominant species of station 702) tend to reach maximum numbers in autumn, winter and early spring, due to the incorparation of primary production into the sediment.

3.5. Diversity of the nematode communities

The nematode communities from 102 stations in the Southern Bight of the North Sea, sampled between 1972 and 1984 are described in Vincx (in press a & b). On the whole, 456 species, belonging to 159 genera and 37 families were found. Diversity is determined at different levels of the nematode community; i.e. species diversity of the whole community, species diversity of eight dominant families, species diversity of the four feeding types, family diversity and trophic diversity within the whole community. On the basis of the nematode species composition, the

Southern Bight is divided into six areas (Vincx, 1986) (Fig.8).
The open sea stations (region 1 to 4) are characterized by nematode communities which are comparable is terms of species diversity. The number of species S is about 30-35 per sample with H'(Brillouin diversity index) between 4-4.5 bits/ind.

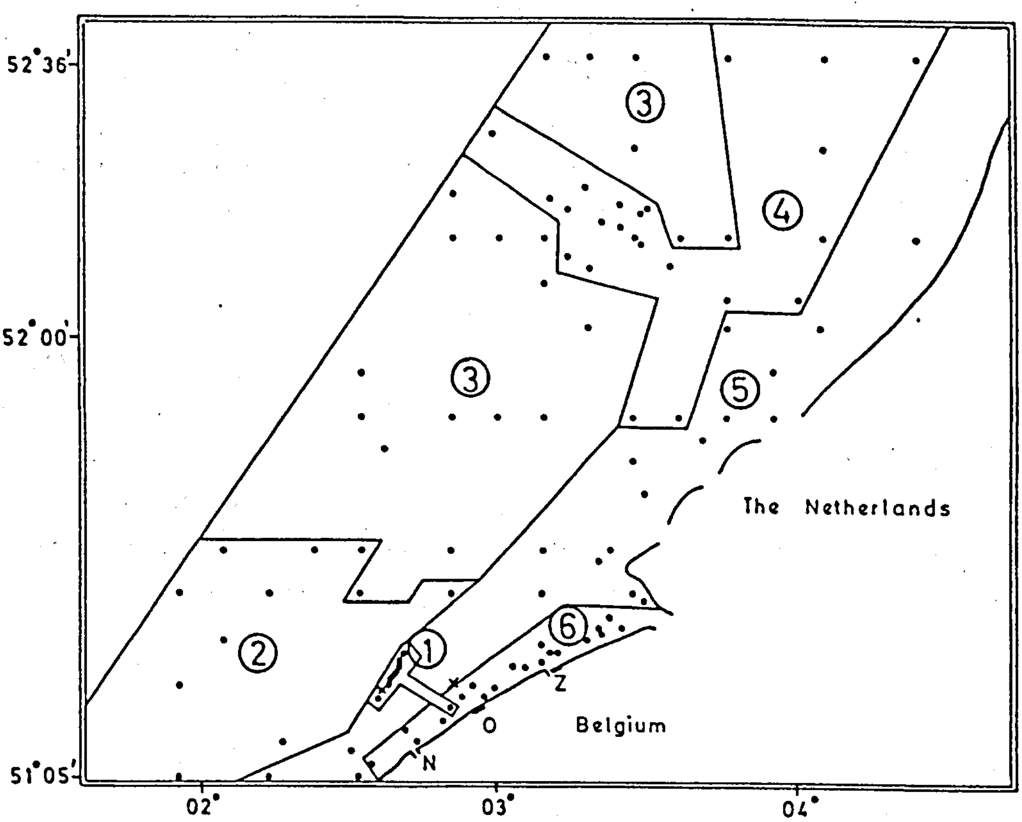


Fig. 8. Position of the six stationgroups based on the nematode species composition in the Southern Bight of the North Sea.

The communities in the coastal stations (region 5 and 6) are less diverse (S=7-22; H'=1.4-3.5 bits/ind.). The stations along the Belgian east coast (main part of region 6) have communities with low diversity (S=7; H'=1.41 bits/ind.) and with a pronounced dominance of a few species; the diversity of all the levels considered is also very low (Vincx, in press a).
The relationship between environmental stability (or disturbance) and stability and diversity of the nematode communities can be explained by the following factors: habitat heterogeneity, food availability, productivity, density, population growth rate and pollution (Vincx, 1986).
The impoverishment of the eastern part of the belgian coastal area is mainly striking when we compare it with other areas in the North Sea and in Europe which have the same type of sediments:

TABLE 1: Species diversity (H') of nematode communities from different localities

	SAND	MUD
1. Southern Bight (this study)	4.4 - 4.5	1.4 - 1.6
2. German Bight (Lorenzen,1974; Juario, 1975)	4.3 - 5.3	2.6
3. French Channel (Boucher, 1980)	4.3 - 5.5	-
4. Bay of Morlaix (Gourbault, 1981)	4.2 - 5.0	2.7 - 3.2
5. Atl.W.coast (Tietjen, 1977,1980)	-	2.1 - 3.1

The diversity of nematode communities of the eastern part of the Belgian coast is the lowest in comparison with any other European coast.

4. REMARK

An important problem is the finding of adequate reference areas of the same sedimentological characteristics, for the interpretation of pollution impact. Proposal for future research in this field will be monitoring of the benthic communities in the dumping areas of the North Sea. When dumping activities will stop soon, we think indeed that an unique experiment will be provided in the field and it will be very interesting to see in which way the benthos has adapted to that changing environment within a few years.

5. ACKNOWLEDGEMENTS

This paper results from research under contracts from the Ministry of Scientific Policy (Concerted Actions Oceanography), the Fund for Collective Fundamental Research (grant 2.9007.82).
D. Van Gansbeke, A. Braeckman and Guy De Smet are grately acknowledged for their technical assistance.

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