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THE MEIOBENTHOS OF THE NORTH SEA : PRELIMINARY RESULTS OF THE NORTH SEA BENTHOS SURVEY

by

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ABSTRACT

During a synoptic survey carried out in April-May 1986, 171 localities were sampled in the North Sea as delimited by the Strait of Dover in the south and approximately by the 100 m isobath in the north. Meiofauna includes Nematoda, Copepoda, Turbellaria, Gastrotricha, Polychaeta, Oligochaeta, Priapulida, Kinorhyncha, Ostracoda, Halacarida, Isopoda, Tanaidacea, Bryozoa, Cnidaria, Sipunculida, Echiurida, Nemertini and Tardigrada. Nematodes are virtually the dominant group in all stations, their densities ranging from 61 to 4167 ind/10cm^2. Only in the Southern Bight, where nematode numbers are low, harpacticoids sometimes represent the dominant meiofaunal taxon.

A total of 278 copepod species belonging to 105 genera and 22 families were identified. Over 40% of the species are new to science; new taxa are particularly found among the interstitial families which are the most important families qualitatively. Five distinct communities could be recognised on the basis of the copepod composition: (1) the Southern Bight assemblage shows high densities of predominantly interstitial species (Cylindropsyllidae, Paramesochridae, Cyclopinidae) and a few characteristic taxa from coarse sediments; (2) the second community is found in the coastal zone of the Netherlands, Germany and Denmark, and in the Dogger Bank, and is dominated by large Ectinosomatidae and Ameiridae and interstitial Leptastacinae; (3) an impoverished community north of the Dogger Bank consists of large pelophilic species of the Diosaccidae, Laophontidae and Ameiridae; (4) between the scottish coast and Norwegian Deeps and in the Silver Pits Zosimidae, Cletodidae and Idyanthidae are the most important families; (5) the Norwegian Deeps, Devil's Hole and Farne Deep show a typical deepwater fauna with Ancorabolidae, Cerviniidae, Stenocopiinae and bathyal cletodid genera.

INTRODUCTION

Since Smidt's (1951) early work on the Danish Wadden Sea and McIntyre's (1964) study of the Fladen Ground meiofauna, much information has been gained on the species composition, density and biomass of meiofaunal assemblages. However, Heip et al. (in press) summarized the knowledge, resulting from 40 years of meiobenthos research in the North Sea, and concluded that only the coastal areas of Belgium, the Netherlands and Germany are relatively well known (Fig. 1). Large areas of the North Sea have not been investigated and particularly the lack of basic data from deeper localities makes it impossible to present a comprehensive picture of North Sea meiofauna. There are several attempts to define biological regions within the North Sea but these are all based on planktonic communities or more recently on macrobenthic infauna and epifauna. The question remains whether meiofauna can also be applied to define communities on a large scale.

A synoptic survey of the North Sea benthos was organized during April-May 1986 in the area delimited by the Strait of Dover in the south and by the 100 m isobath in the north. . This sampling programme involved the cooperation of ten laboratories from France, Belgium, The Netherlands, Germany and the U.K. During this survey we sampled a grid of 171 localities for meiofauna and for various physico-chemical sediment parameters. This paper reports on the preliminary results of the analysis of the meiofauna in general, and the copepods in particular.

MATERIAL AND METHODS

Sediment samples were taken either with a box corer or with a Van Veen grab or with both methods. Originally, 196 stations were included in the survey, but only 171 have been sampled for meiofauna. Stations not being sampled primarily include localities along the Danish coast (102, 144, 164, 165, 174, 176, 183) and in the German Bight (64, 73, 82), in the Dutch Wadden Sea (26), in the mouth of the Humber and The Wash (27, 28, 32, 47), and in the Fladen Ground off the northeastern coast of Scotland (188-193). Some of these are shallow localities and were for that reason not accessible by the research vessels used. Others were not taken into account because of the unfavourable weather conditions at the time of sampling.

With respect to the copepods, samples taken with a box corer were preferred above those collected with a Van Veen grab, in order to prevent an overestimation of the relative abundance of the surface-dwelling species and an underestimation of the relative abundance of the interstitial small-sized types which often represent the bulk of the copepod density in

sandy bottoms. Of the 171 stations surveyed in spring 1986, 134 were sampled twice or more and thus provide two or more replicates. Localities sampled by the NIOZ (Texel) and by the Forschungsinstitut Senckenberg (Wilhelmshaven) provided only one replicate. Organisms were extracted by use of the centrifugation-floatation technique or by decantation.

The meiofauna of all 171 stations is identified at the higher level and a second replicate was processed of the stations (134) that were (sub)sampled at least twice.

The sampling grid, as well as the densities and distribution of the various groups of the meiofauna are shown in Fig. 2. The radius of the black circles is proportional to the log(density + 1) within the range of the box and whisker plots at the top of each map. Outliers have the same radius as the maximum or minimum on this plot, and are indicated by points in the B&W plot. The position of these outliers is not proportional to their value due to space limitations.

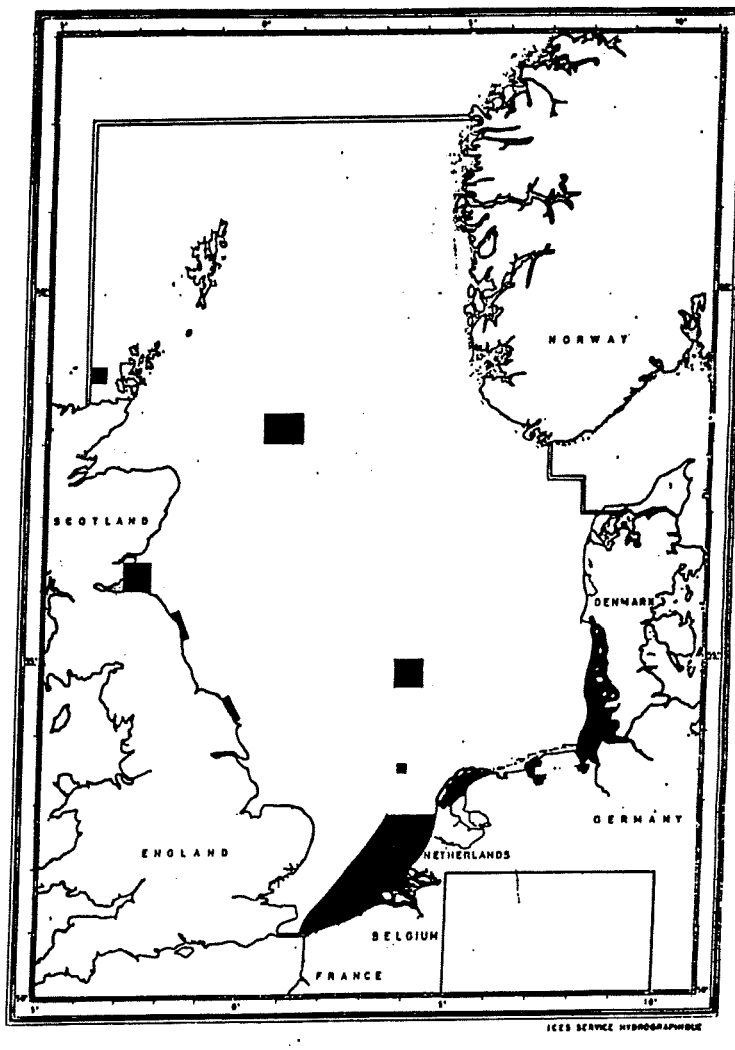

Fig. 1

RESULTS AND DISCUSSION

TOTAL MEIOFAUNA

Meiofauna included Nematoda, Copepoda Harpacticoida, Turbellaria, Gastrotricha, Polychaeta, Oligochaeta, Priapulida, Kinorhyncha, Ostracoda, Halacarida, Isopoda, Tanaidacea, Bryozoa, Hydrozoa, Sipunculida, Echiurida, Nemertini and Tardigrada. When abundant, copepod nauplii were counted as well although these will not be included in the final analysis. Nematodes are without exception the dominant group in the meiofauna, their densities ranging from 61 to 4167 ind/10cm^2. In the Southern Bight harpacticoids sometimes equal nematodes in terms of density or are even the dominant taxon of the meiofauna whereas in the remaining localities nematodes are always superdominant. Alternatively, Harpacticoida or Turbellaria (in a few cases Gastrotricha) were next in abundance. The other

groups were present especially in medium coarse or coarse sands but they were far less common than the main taxa.

The most striking result is the presence of a specialized meiofauna community in the central part of the Southern Bight (south of 53°30′ N). This community extends to the coastal zone of Belgium and the Netherlands but is apparently absent in the shallow offshore area of Britain although the sediment type is virtually the same (median grain size averages 250–300µm). This meiofauna assemblage is characterized by relatively low nematode numbers but high densities for mesopsammic copepods were recorded. The Southern Bight community seems almost to be unique for the entire North Sea; only a few localities along the western coast of Denmark and around the Isle of Sylt give indication of a similar composition. However, it seems that these data reflect only local situations and not a condition on a larger scale. Although coarse sediments generally favour the development of a characteristic interstitial fauna it is striking that the mesopsammic harpacticoids are not typical for the German Bight and the westcoast of Denmark. Particularly in the entrance to the Skagerrak where very coarse sediments are found, these tiny copepods seem to be outnumbered by others. On the other hand the high densities of gastrotrichs in this area is remarkable.

Another interesting fact is presented by the distribution of the Kinorhyncha. Four genera have been recorded, and these can be assigned to two ecological groups. Echinoderes and Semnoderes are typical representatives of sandy sediments and particularly the latter genus is known to inhabit coarse substrates. These genera were found only in the Southern Bight of the North Sea and in the entrance to the Firth of Forth. The latter find is not surprising as the sediments in this isolated area are fine or medium sands in contrast to the very fine sediments (below 200 µm) of the surrounding waters. A similar case is found in de German Wadden Sea (station 46). Species of the genera Pycnophyes and Kinorhynchus were recorded in the central part of the North Sea and never in the Southern Bight. Their distribution is largely confined to eastern part of the central area. It is known from the literature that these genera are associated with very fine sediments. The same area is also characterized by the occurrence of Priapulida (larvae of Priapulus caudatus), a taxon that is entirely absent in the Southern Bight and occurs only sporadically in the western part of the North Sea.

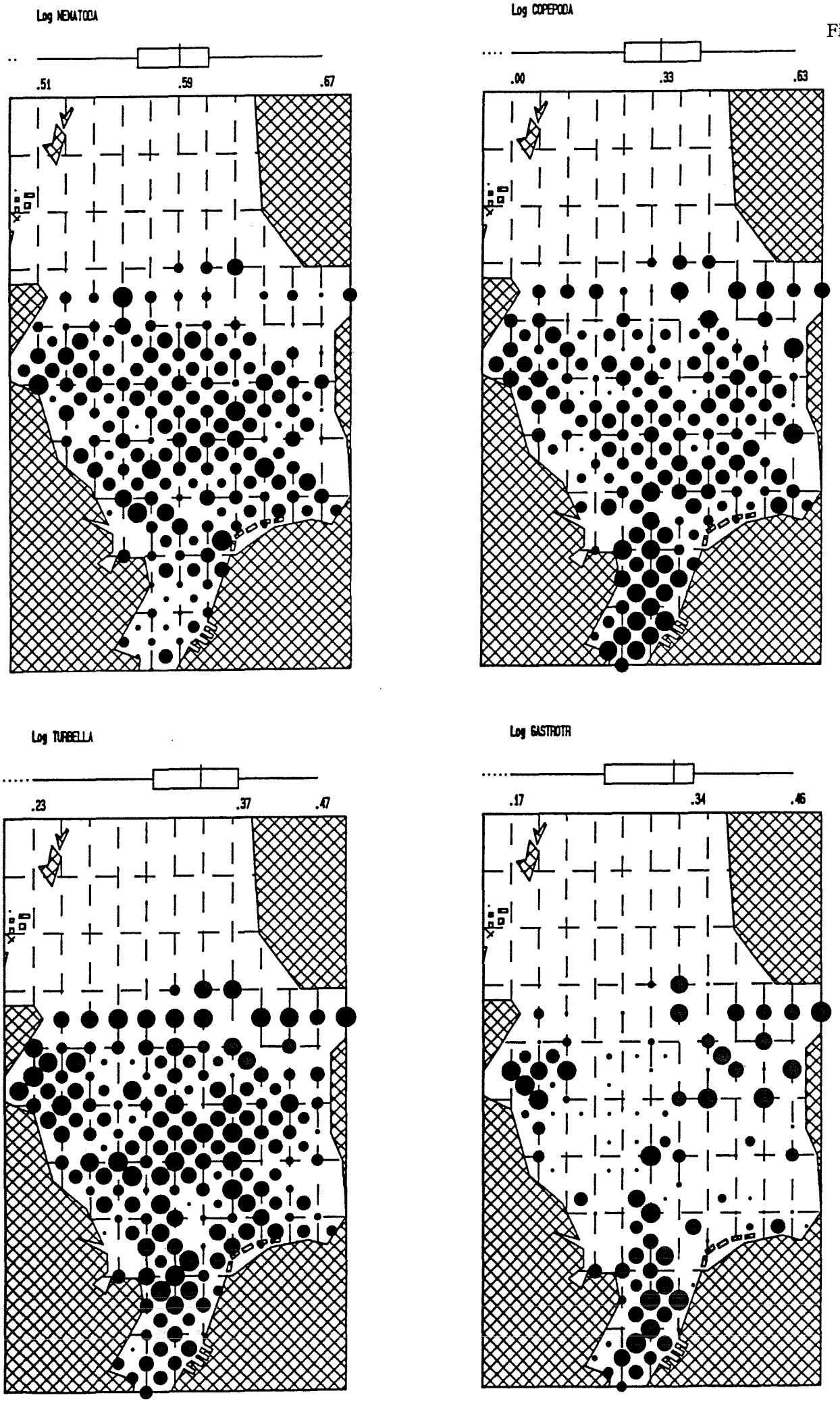
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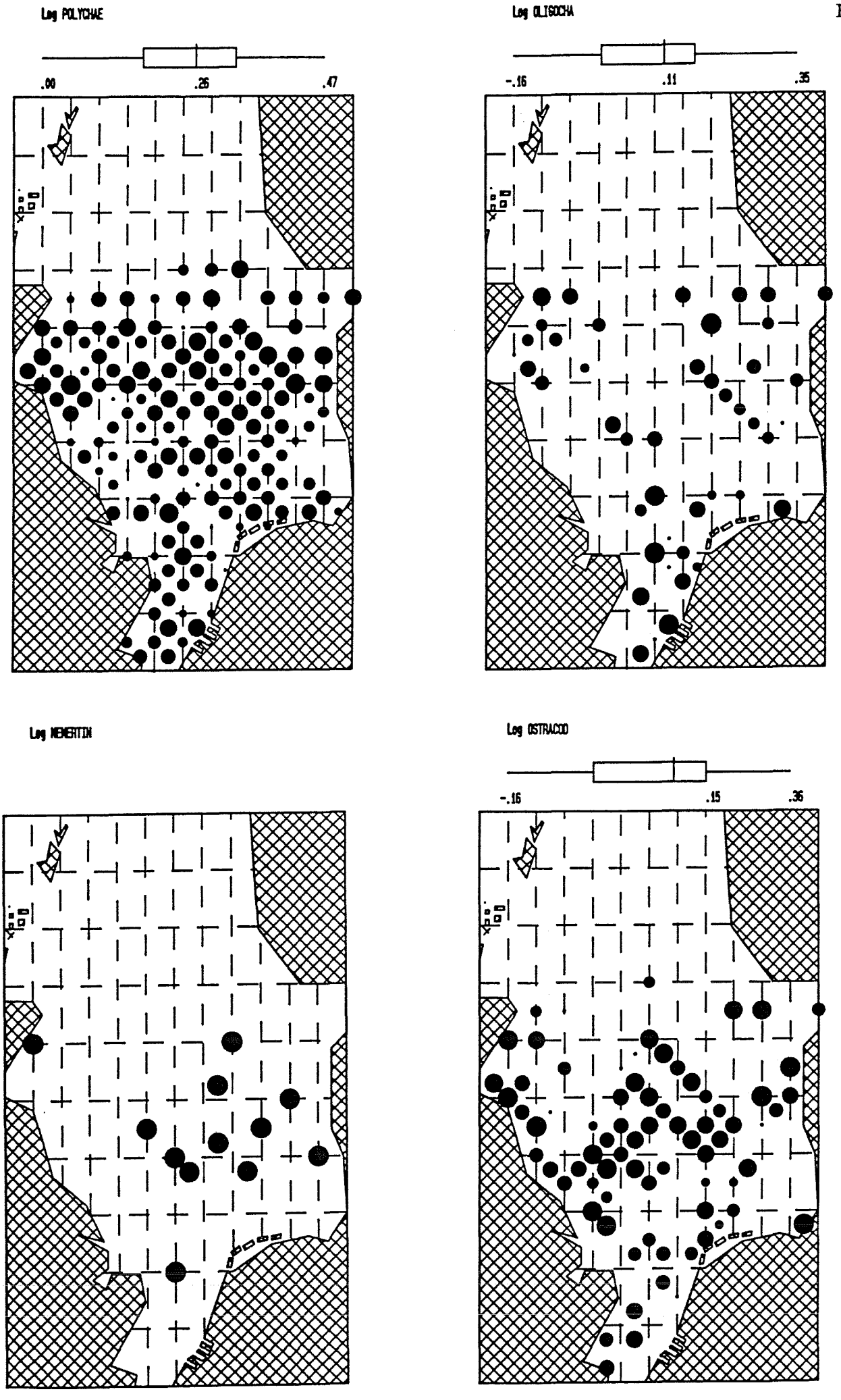
Fig. 2.

Fig. 2.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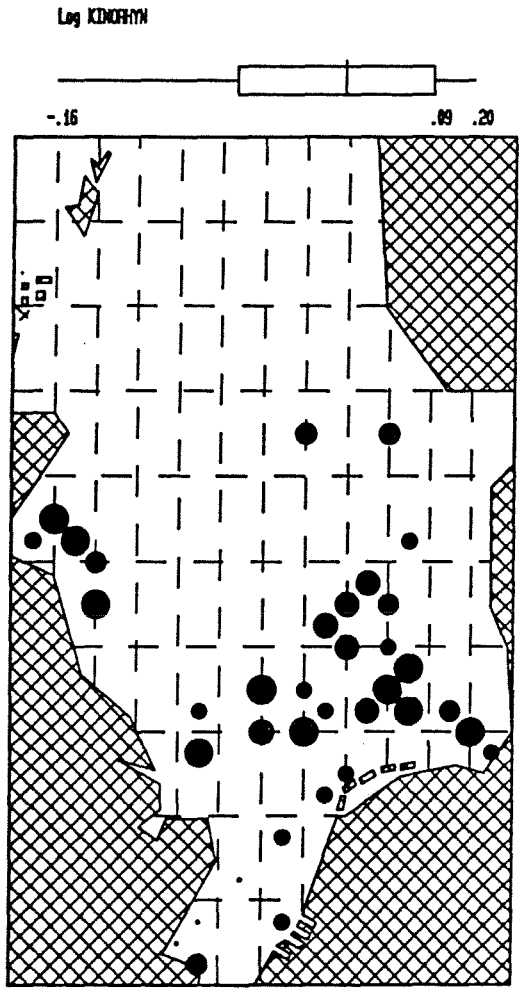
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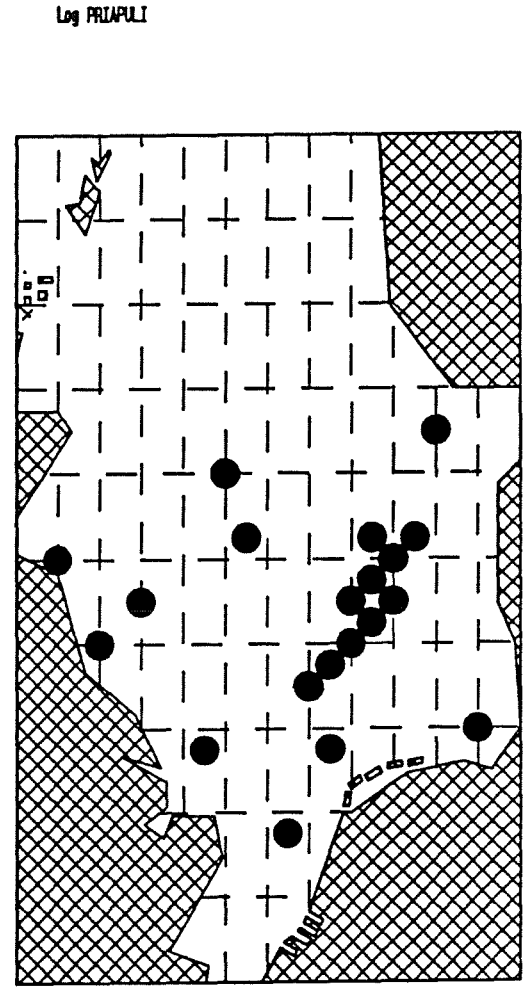
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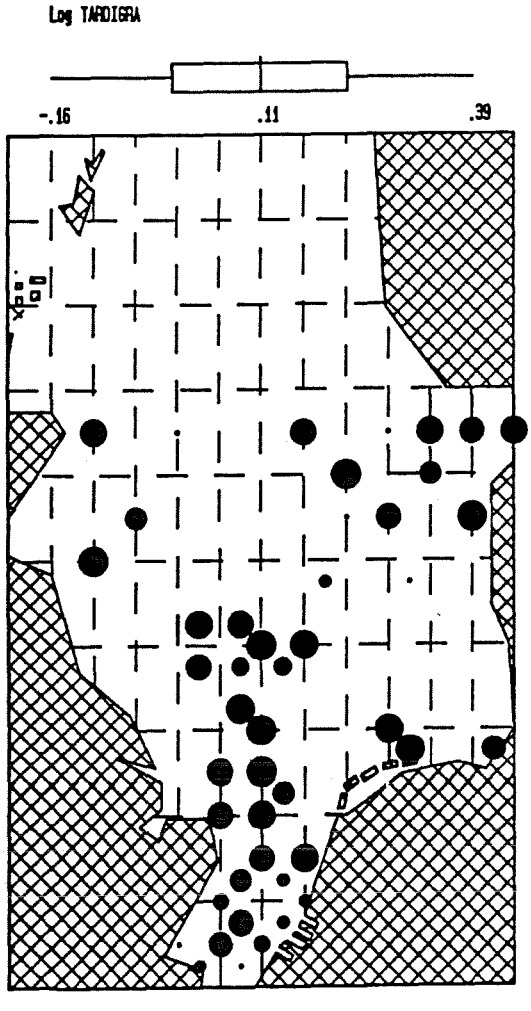
Fig. 2.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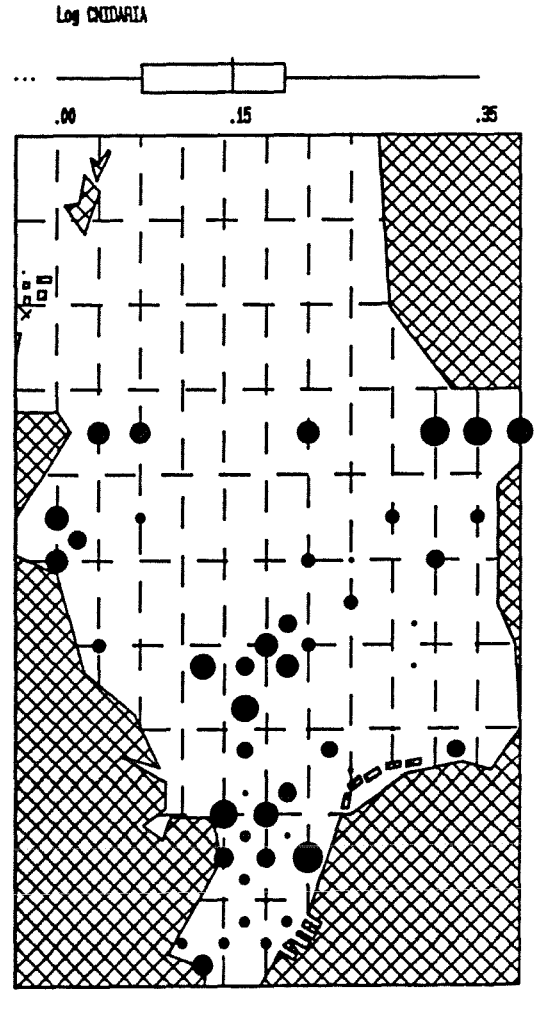
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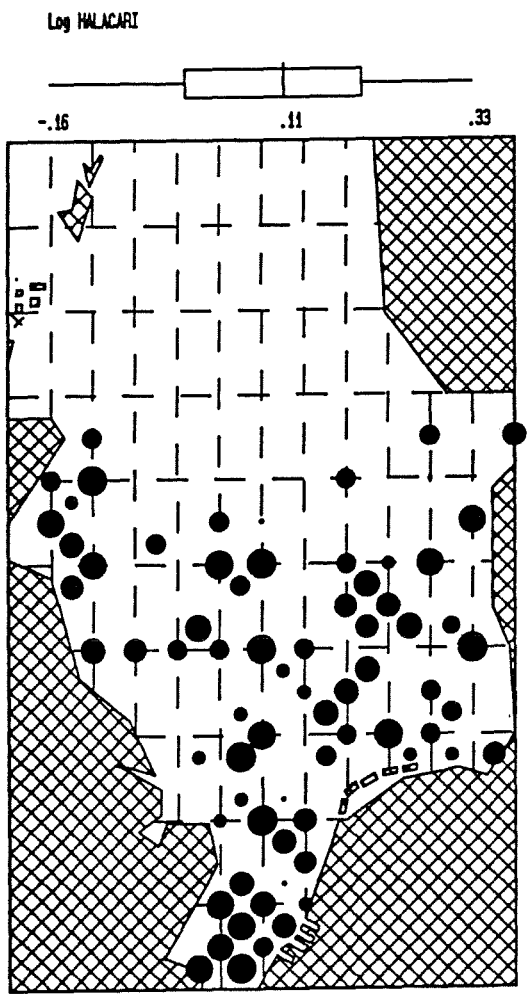
Fig. 2.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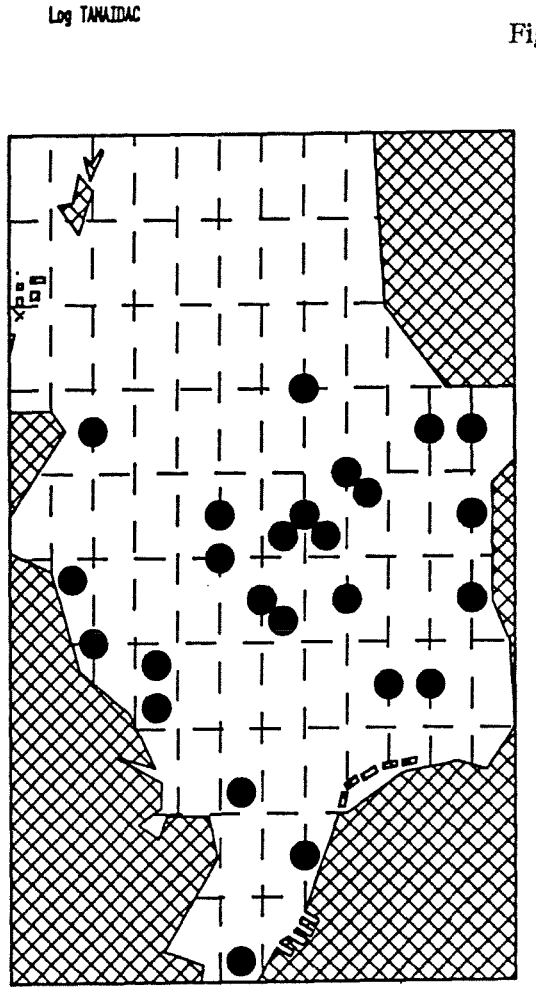
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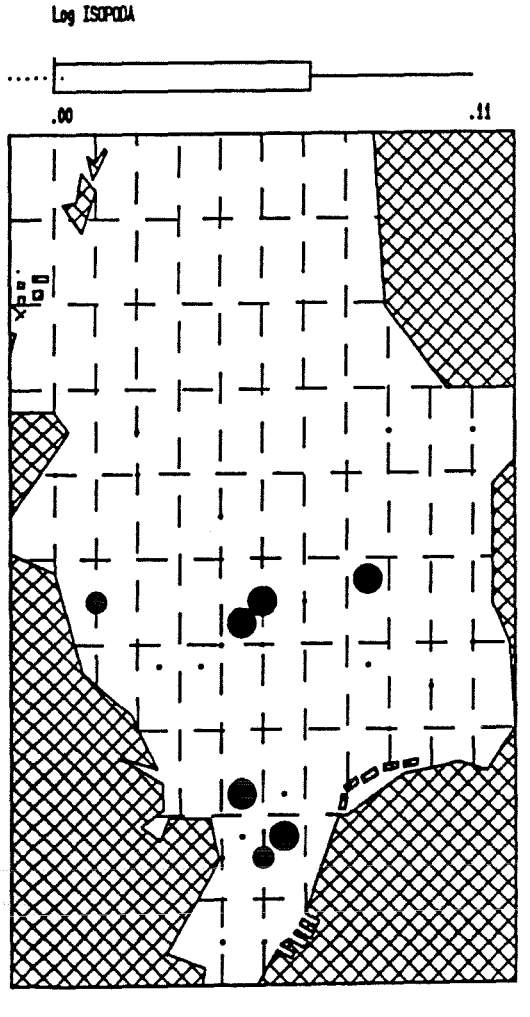
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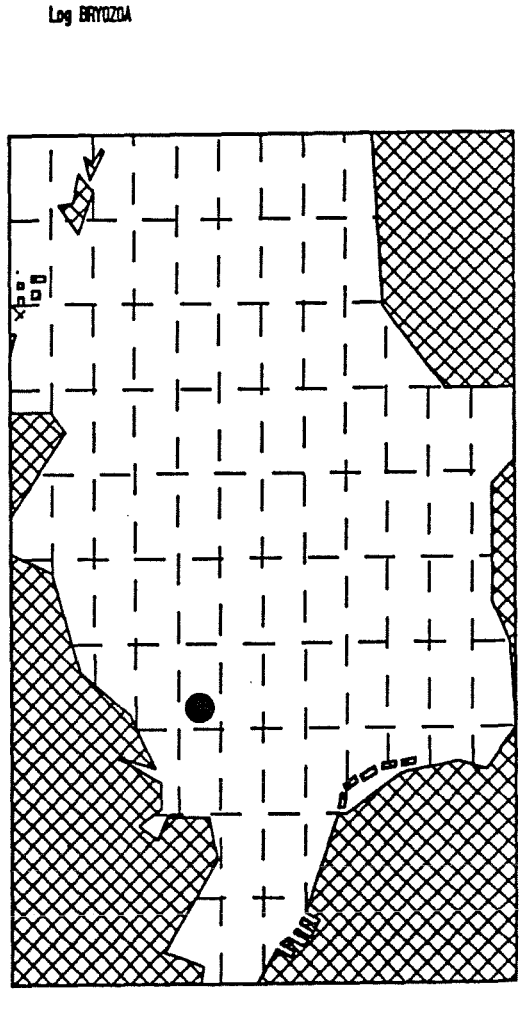
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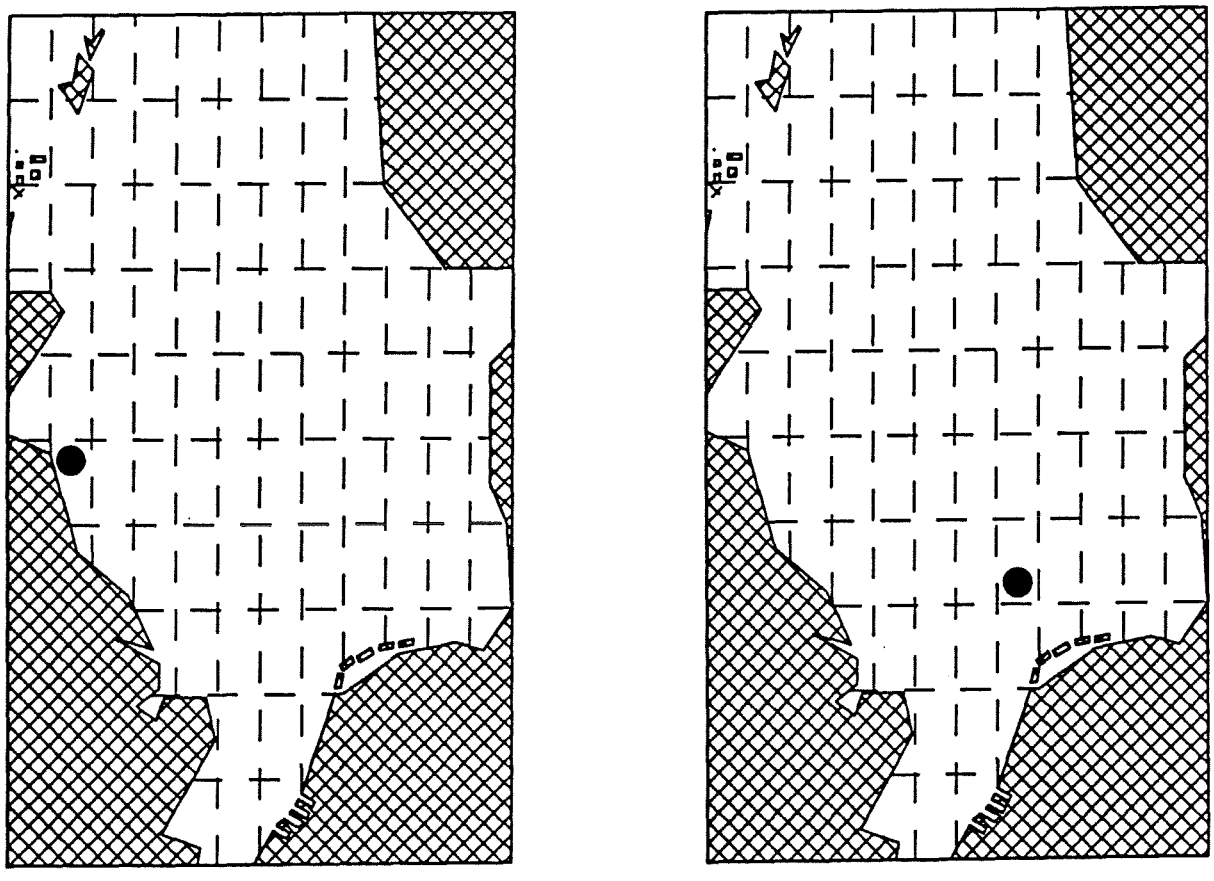
Fig. 2.



COPEPODA

The harpacticoid community predominantly includes adults and post-metamorphose stages (copepodites). On some occasions nauplii were abundant as well but these will not be considered any further. The lack of suitable identification keys makes the allocation of these larvae to distinct species or even families impossible. Furthermore their importance in terms of biomass is negligible.

Species composition

Examination of the copepod fauna from one sample ($10cm^2$) of each of the 171 selected stations reported here resulted in a total number of 7710 individuals. All copepods were identified down to species level. The complete faunal data cannot be listed here but they are available from the authors on request. A total number of 278 species belonging to 105 genera and 22 families were identified. Surprisingly, 121 species (= 43.5% of the total number) turned out to be new to science. A high number of novel species was recorded for the Paramesochridae (27), Cylindropsyllidae (24), Ectinosomatidae (17) and Ameiridae (14). For both the Paramesochridae and the Cylindropsyllidae, the North Sea Benthos Survey has resulted in a doubling of the species number for the North Sea area as delimited by the ICES boundaries. The examination of the interstitial copepod fauna revealed also 9 new genera.

The vast majority of the fauna belonged to the Harpacticoida. The Cyclopoida were represented by the primarily mesopsammic family Cyclopinidae (6 species). Calanoids and naupliar stages were not taken into account in the analysis.

Qualitatively important families are Paramesochridae (44 species), Cylindropsyllidae (38), Ameiridae (35), Ectinosomatidae (34), Cletodidae (26), Laophontidae and Diosaccidae (21). A total number of 105 genuinely interstitial species were recorded, including the Paramesochridae, Cylindropsyllidae, Cyclopinidae and small-sized representatives of the Ameiridae, Canthocamptidae, Diosaccidae and Ectinosomatidae. The remainder consisted mainly of large epibenthic or burrowing harpacticoids; planktonic species (Euterpina acutifrons, Microsetella norvegica) were less important.

Communities

Pending an in-depth statistical analysis of the data matrix, only a preliminary account of the distribution of the major station groupings is presented here. Five groupings (communities) could be recognized at first hand (Fig. 3).

Community I: An extremely diverse assemblage was found in the Southern Bight,

roughly demarcated in the north at 53.5°N. This area extends to the Belgian coast and Dutch Delta area in the east and the coast of Norfolk in the west, but excludes The Wash and the coastal area off the rivers Thames and Rhine/Meuse. Overall, the Southern Bight consists of fine (>200µ) to coarse (250-500µ) sandy sediments with a low silt clay content reaching a maximum of 2.6% in station 19. Copepod densities ranged from 24 to 651 (mean = 178) individuals/10cm^2. With few exceptions density values are much lower in the rest of the North Sea. On the average copepods accounted for 25% of the meiofauna, occasionally contributing as much as 50% of the total density at some stations. The Southern Bight (19 stations) harbours approximately 50% of the total number of species found during the NSBS. The great majority of the fauna are interstitial (mesopsammic) species inhabiting the space between sand particles. These animals crawl or swim within the lacunae with no, or only negligible, disturbance to the arcade structure of the sediment. The harpacticoid species from this area can be said to have adapted to the interstitial habitat primarily by miniaturization of the body (Paramesochridae) or by the alternative means of the adoption of extreme vermiformity (cylindrical habitus) and reduction of the appendages (Cylindropsyllidae). They form a homogeneous ecological group together with a few species belonging to diosaccid, tetragonicipitid and ameirid genera but because of their small size the average biomass is low. This assemblage poses great difficulties as to accurate identification because nearly half of the species (± 60) are new to science. The assemblage contains all North Sea Cylindropsyllidae (38 species) and all but two (Wellsopsyllus gigas, Apodopsyllus listensis) of the 44 recorded Paramesochridae species. Representatives of these two families are associated with small Ameiridae (Interleptomesochra, Leptomesochra, Parevansula, Sicameira) and vermiform Diosaccidae (Psammotopa, Protopsammotopa) and Ectinosomatidae (Hastigerella, Arenosetella). A typical component of the Southern Bight community is the cyclopoid family Cyclopinidae. Due to their adaptations to the mesopsammic lifestyle, these tiny cyclopoids (Metacyclopina, Cyclopina, 3 new genera) show a remarkable convergence with the paramesochrid harpacticoids. In many stations the interstitial community is accompanied by characteristic coarse sediment inhabiting-species such as Rhizothrix spp. (Cletodidae) and various Tetragonicipitidae (Pteropsyllus, Tetragoniceps).

The species composition strongly resembles the mesopsammic assemblage of the coarse sands of the Kwinte Bank described in earlier studies. The resemblance between the harpacticoid associations from the Southern Bight and that of the coarse sands of the French Catalonian coast and the coarse sand association of the Irish Sea suggests that the copepod faunas of medium and coarse (> 300 µm) offshore deposits are similar, provided that the sands are well-sorted and clean. Comparison with earlier studies in the Southern Bight also reveals that the community is stable in time.

A similar community dominated by interstitial species was found in two localities along the Danish coast. Station 92 (427 individuals/10cm^2) is situated near the Isle of Sylt.

Mielke (1975) already reported on a diverse mesopsammic assemblage from the coarse sandy sediments in this area whilst Herbst (1974) described several interstitial cyclopinids from the same deposits. The second station (155) is associated with the Jutland Bank in the north; the coarse sandy sediment is inhabited by a high number (390 individuals/10cm²) of interstitial species, however, Paramesochridae are less abundant and are primarily replaced by vermiform Ectinosomatidae and Diosaccidae.

The faunistic picture of the Southern Bight is disturbed by the river plumes of the Rhine-Meuse and Thames. Stations (5, 8, 11, 13) located in the respective mouth areas are devoid of interstitial species; instead low densities and few species are recorded. In all these stations Microarthridion littorale and/or Canuella perplexa are the common species. Earlier studies revealed a similar situation for the Westerscheldt estuary.

Community II: This community is found along the eastern coastline of the Central North Sea. It extends from the Terschelling Bank in the south, over the German Bight and the Danish westcoast, to the entrance to the Skagerak in the north. This area groups shallow stations with fine to very fine sandy sediments with a low amount of silt and clay. The fauna is characterized by a mixture of minute interstitial species and large burrowing forms. The mesopsammic component is dominated by Cylindropsyllidae and a few interstitial representatives of the families Ectinosomatidae and Ameiridae; Paramesochridae and Cyclopinidae are virtually absent. It should be remarked that the Cylindropsyllidae association is basically different from the Southern Bight proper. Here, only Leptastacinae (Arenocaris, Leptastacus, Paraleptastacus) are present, whilst the diverse Cylindropsyllinae-Leptopontiinae Reihe (Cylindropsyllus, Stenocaris, Boreopontia, Arenopontia, Leptopontia, Evansula) seems to be confined to the Southern Bight and a few Danish coastal localities. The majority of the community, however, consists of fusiform Ectinosomatidae (Ectinosoma, Halectinosoma, Pseudobradya) and, to a lesser extent, Ameiridae (Ameira, Proameira, Pseudameira). Densities are low, ranging from 3-81 individuals/10cm².

An analogous fauna is found north of The Wash between 53° and 54°N. and in the shallow stations located at the Dogger Bank. The latter two regions are separated by a complex of deep trenches ("Silver Pits") which harbour a different copepod fauna (see community IV).

Community III: This is a transition community between the coastal Ectinosomatidae-Leptastacinae association (II) and the deepwater community (IV) north of the Dogger Bank. This area is impoverished both qualitatively and quantitatively. Interstitial copepods are completely lacking. In general, densities range between 0 and 45 individuals/10cm². The fauna consists of large pelophilic species belonging to the Diosaccidae (Paramphiascopsis, Stenhelia, Bulbamphiascus, ...), Laophontidae (various genera) and

Ameiridae (Ameiropsis, Pseudameira, Sarsameira, Pseudosarsameira). Within the Ectinosomatidae, the larger species are still important with the smaller burrowing forms being replaced by bigger representatives of the same genera (Halectinosoma, Pseudobradya) or of Bradya. The polyarthran genus Longipedia is abundant throughout the transition zone with L. minor and L. helgolandica in the south and L. coronata and L. scotti in the north.

A mixture of the latter two communities was encountered off the Firth of Forth. Deepwater animals are interspersed with interstitial forms and burrowing species of various size classes. This assemblage probably reflects the heterogeneous nature of the bottoms in this area: deep vs. shallow; muddy vs. coarse sediments.

Community IV: The northern part of the North Sea, situated between the Norwegian Deeps and the Scottish coastline is defined by a characteristic harpacticoid fauna. The most important families, both in terms of diversity and density, are the Cletodidae, Zosimidae and Idyanthidae. These three families nearly always co-occur in every station of the area. The Cletodidae are represented by various species of the genera Cletodes, Enhydrosoma and Stylicletodes which are typical faunal elements of deep (40-80m) muddy bottoms. The Zosimidae (Zosime, Tachidiella) occupy the same depth range and like the Cletodidae are adapted for an endopelic existence. The Idyanthidae, on the other hand, are known from the flocculent upper layer and encompasses epibenthic genera (Idyella, Idyanthe, Tachidiopsis). This assemblage was also found in stations 99 and 120 which are located in a deep trench penetrating the transition zone and coinciding with the incision of the Pleistocene River Elbe estuary. Finally, two characteristic species for this area are the giant mud-dwelling paramesochrid Wellsopsyllus gigas, originally described from the Fladen Ground (Wells, 1967), and the diosaccid Typhlamphiascus confusus.

The deep Silver Pits (stations 49, 56, 57) have low densities but the community consists exclusively of Zosimidae and Idyanthidae.

Community V: This assemblage is found in the northeastern part of the study area (Norwegian Deeps). The deepwater stations 184, 185, 186, 195 and 196 can be allocated to this region where the depth varies between 84 and 100 m. To a large extent the sediments consist of fine to medium sand. The silt clay content of the sediment over most of this area ranged between 1.3 and 3.3%, reaching a maximum of 12.4% in the deepest station 196. Copepods occurred in densities ranging from 23-128 individuals/10 cm^2. The community is dominated by the families Cletodidae and Ancorabolidae, and by the deepwater species Pseudotachidius coronatus (Pseudotachidiinae). The genera Eurycletodes, Mesocletodes, Argestes and Heteropsyllus accounted for more than 90% of the Cletodidae and seem to have replaced the genera Cletodes, Stylicletodes and Enhydrosoma of the adjacent area (community IV). The Ancorabolidae, consisting exclusively of Ancorabolinae, is a typical

component of the deepwater fauna of fjords and is represented here by 3 species (Ancorabolus mirabilis, Echinopsyllus normani and Ceratonotus pectinatus); they represented >35% of the copepod fauna in most of the stations. Other characteristic faunal elements of this assemblage, not found in any of the others, are the deepwater Stenocopiinae (Ameiridae) represented by 3 genera (Stenocopia, Malacopsyllus, Anoplosoma), and the Cerviniidae represented by the continental shelf genera Cervinia, Eucanuella and Cerviniopsis. In contrast to the previous community, the relative abundance of Zosimidae and Idyanthidae is negligible. Typhlamphiascus gracilis seemed to have replaced T. confusus in this deeper area; this phenomenon was also recorded by Por (1964).

It is worthy of note that an analogous community was found in 2 other stations being remote from the Norwegian Trench. Both stations have a sediment consisting of very fine sand with a silt clay content being in excess of 9%. Station 137 (91 m) is located in the Devil's Hole, a deep extension of the Fladen Ground, penetrating the Central North Sea. Its copepod fauna is a mixture of "Nordic" cletodid genera, cerviniids and Stenocopiinae. Station 103 is the deepest locality sampled during the survey (107 m) and is situated in the Farne Deep, a depression off the coast of Northumberland. A similar fauna was found here, however, the Stenocopiinae are replaced by Ancorabolinae.

ACKNOWLEDGEMENTS

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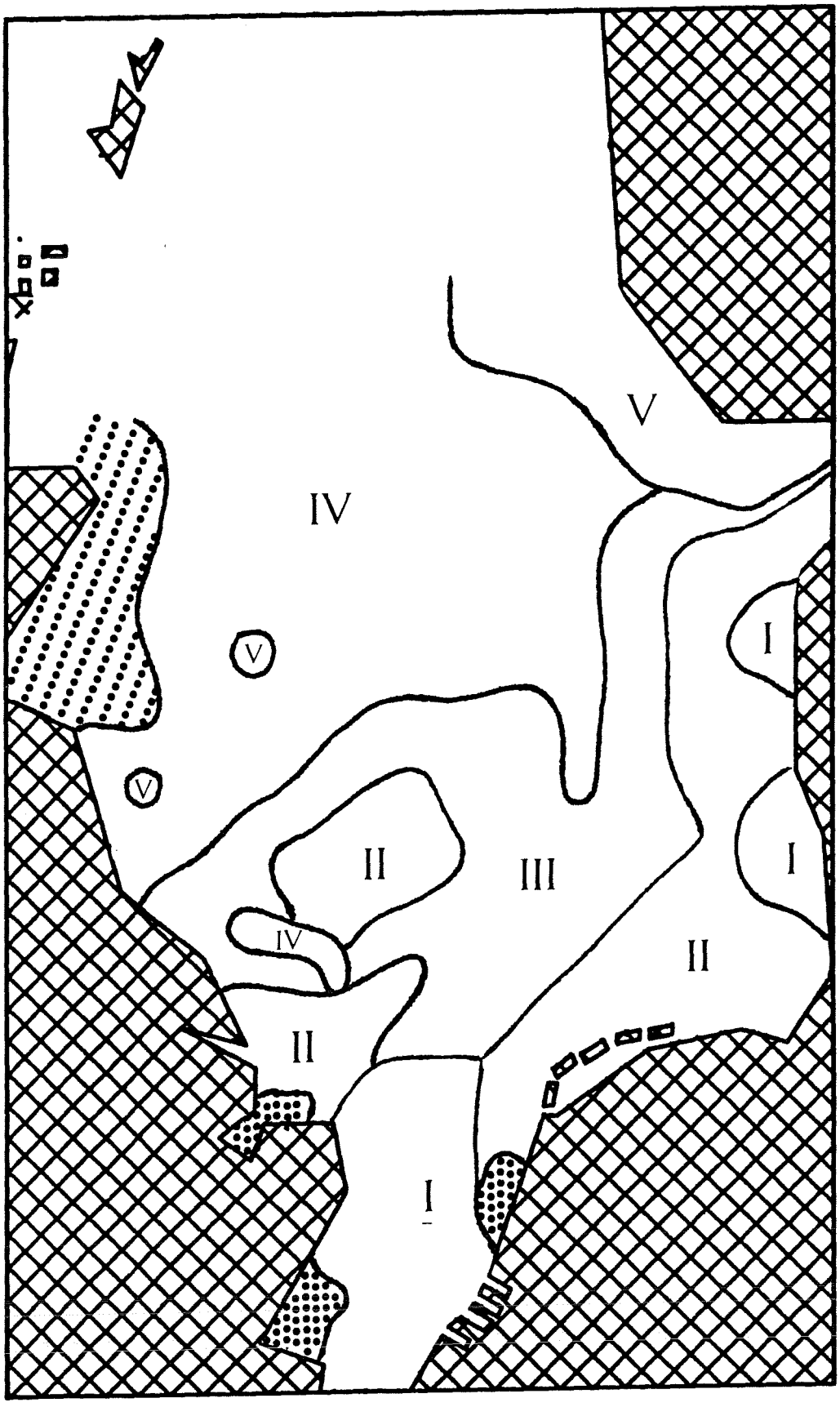
Fig. 3: Various North Sea communities based on abundance, species composition and diversity of copepods. Explanation see text.



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