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SEVENTH REPORT OF THE BENTHOS

ECOLOGY WORKING GROUP

Texel, 10-13 May 1988

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1. OPENING OF MEETING

The Benthos Ecology working Group met in Texel from 10-13 May 1988, under the chairmanship of Dr Heip. Dr Rees was appointed Rapporteur. A list of participants is given in Annex 1.

1.1. Terms of Reference

The Group was asked to consider the results of the intersessional activities outlined in Annex 2 of the sixth report (Doc. CM 1987/L:26) and in particular the following:

- (i) activities of interest in ICES and other organisations;
- (ii) cooperative studies in other areas;
- (iii) comparisons between different sampling gear;
- (iv) standard procedures;
- (v) impact of trawling, dredging and marine aggregate extraction;
- (vi) production of benthos and demersal fish;
- (vii) research on trophic links between benthos and demersal fish;
- (viii) procedures for benthos monitoring at point-source discharges (ACMP);
- (ix) North Sea benthos survey (1986): progress;
- (x) other North Sea studies;
- (xi) any other business.

2. ACTIVITIES OF INTEREST IN ICES AND OTHER ORGANISATIONS

2.1. ICES WG on the effects on fisheries of marine aggregate extraction

Dr Rees had attended on behalf of the Benthos WG. The meeting had concentrated on production of a first draft of a Cooperative Research Report - including a section on impacts on the benthos - and a "Code of Practice" for submission to MEQC.

2.2. Sea-going workshop on biological effects (ICES/IOC)

In his capacity as chairman of the Benthos Ecology WG, Dr Heip had been invited to organise the benthos sampling component of a proposed sea-going workshop in 1989 on board R.V. Meteor, designed to test a range of biological effects measures. Further details would be circulated to members, when available. The excercise was being co-ordinated by Drs. Dethlefsen and Stebbing on behalf of the ICES WG on Biological Effects of Contaminants.

2.3. Effects of bottom trawling (ICES)

An ad-hoc meeting sponsored by ICES, concerned with effects on the sea-bed of bottom trawling, will take place in IJmuiden at the end of May 1988 (see 6.1., below).

2.4. COST 647 CEC (Coastal Benthic Ecology)

The status of this project - concerned with the regional co-ordination of long-term monitoring studies of the benthos of rocky and soft-sediment inter- and sub-tidal habitats - had recently been enhanced by the CEC, though not to the extent of providing direct sources of funding for scientific work. A workshop will be held in Crete, in September 1988, at which progress to date and future direction would be assessed.

2.5. "Modern and ancient continental shelf anoxia"

A meeting on this topic, organised by Dr R. Tyson and Dr T. Pearson, on behalf of the Geological Society, will take place on 17-19 May, 1989, and will include a significant benthos component.

2.6. Council of Europe

This organisation had part-funded a taxonomic workshop on North Sea benthos at Helgoland in February, 1988. Similarly, support will also be provided for a workshop on the "practical taxonomy of meiofauna" in July, 1988, which is being organised by Dr Schockaert, Diepenbeck, Belgium.

2.7. "Euromar"

Also a CEC-sponsored initiative, this was (inter alia) sponsoring the development of a multi-box corer for more efficient sample collection. This device will have particular application in deep-sea studies.

2.8. Bedford Institute

A multi-disciplinary symposium on the Canadian Continental Shelf will take place at the above Institute in October 1989, with particular emphasis on studies of sea bed sediments and biota.

2.9. Baltic Marine Biologists

2.9.1. This Group held its 10th symposium at Kiel in 1987. A report entitled " A compilation of biometric conversion factors for benthic invertebrates of the Baltic Sea" (Publ. No. 9) had now been issued, and an up-dated document on recommended sampling methods for Baltic sediments was in preparation.

2.9.2. A "Group of experts for the second periodic assessment" (GESPA) had recently been set up by the Helsinki Commission, in order to review the second 5 year period of monitoring in the Baltic (Chairman: Prof. Gerlach).

3. CO-OPERATIVE STUDIES IN OTHER AREAS

3.1. No report had been received from Drs. Lilly and Sephton concerning Canadian benthic research (see Annex 2 of sixth WG report).

3.2. Dr Gordon reported on relevant activities in the Scotia/Fundy region. Recent re-organisation within Fisheries Laboratories had complemented a trend towards open-sea benthic work along the Scotian shelf, and away from inshore localities, e.g. Bay of Fundy. Presently, the Georges Bank was receiving increased attention, on account of potential threats to the scallop fishery resource arising from oil developments.

3.3. Work was underway to improve understanding of the role of benthos in connection with ecosystem modelling of the continental shelf. Deep- water benthos had been studied in relation to the possibility of radio-active waste disposal.

3.4. Dr Schwinghamer's recent interests extended to the Grand Banks and Labrador Shelf. Hitherto, benthos studies were very limited, and a need had been identified for extensive base-line surveys, in conjunction with the development of process-orientated work. A contract had recently been awarded to study an extensive selection of photographs of the sea bed/epifauna from Canada's Atlantic continental shelf.

3.5. Dr Monbet reported on studies relating to nutrient enrichment in the Bay of St. Brieuc (France), which supported an important scallop fishery. Factors controlling recruitment of target benthic organisms were being studied in the Bay de Seine. This also formed part of a wider project assessing the transport of pelagic larvae of benthic macrofauna along the French, Belgian and Dutch coasts, involving several laboratories.

3.6. Dr Heip referred to the forthcoming (1990) Joint Global Ocean Flux project. Benthos sampling will be undertaken by Dutch scientists during a pilot study from Iceland to Madeira in 1989.

4. COMPARISONS BETWEEN DIFFERENT SAMPLING GEAR

4.1. Beam trawl versus photographic sledge for assessment of epifauna

4.1.1. The results of a survey in 1987 of the epifauna in an area of the German Bight sampled by beam trawl and photo-sled was reported by Dr Soltwedel. This consisted of a series of 10 photo-sled transects, each about 8 km in length and - superimposed along parts of these - 20 minute tows using a 2 m-width beam trawl.

4.1.2. Comparisons of census efficiencies were not always possible for identical localities, due to effects of turbidity on the quality of still photographs (which were taken at a frequency of about 1 frame every 10 m). Nevertheless it was clear:
a) that the photosled produced a more regular pattern of spatial distribution of most of the major epifaunal species;
b) that generally higher densities were recorded by the photosled (e.g. up to 10 times higher in the case of the sea anemone Metridium);
c) of the dominant taxa, only the crab Corystes, the starfish Asterias and the polychaete Aphrodite were better sampled by beam trawl.

4.1.3. No statistical analysis had yet been done so it was not possible to dismiss small-scale patchiness in explanation e.g. for higher Asterias counts in beam trawls. Follow-up work was planned.

4.1.4. Dr Rumohr suggested that still and video cameras attached to a beam trawl would be the best means for resolving uncertainties about its behaviour at the sea bed.

4.2. Effects of altered fishing practises (beam trawls)

4.2.1. Striking differences in crustacean biomass estimates between two trawl surveys off the Dutch coast conducted in separate years, were reported by Dr Creutzberg. These could be directly attributed to differences in fishing practises by the ship's crews; the same trawl gear was used in both surveys.

4.2.2. Further evidence for the influence of variable practises on sampling efficiency was provided by Dr Dörjes, who compared 2 m and 4 m beam trawls, towed both with and against the prevailing tide. The 2 m trawl retained marginally greater numbers of species than the larger one, despite the same mesh sizes being used. Moreover, more individuals were retained by the 2 m trawl when towed with the tide than when against, but the reverse was true for the larger trawl.

4.3. Comparison of beam trawl and Kiel dredge

4.3.1. Dr Türkay reported on a preliminary comparison of beam trawl and the Kiel epibenthic dredge, as used on the 1986 North Sea benthos survey. Variability in results raised some doubts as to the validity of synoptic mapping using a combination of data from both devices.

4.3.2. Because of the issues raised in 4.1-4.3 above concerning sampling efficiency of epifauna, Dr Heip urged further work on this topic, so that problems of inter-comparability could be resolved.

4.4. Square versus round mesh sieves

Dr Creutzberg summarized the results of a comparative study on use of the above meshes for extracting macrofauna from sediments (see Annex 4). There were no significant differences between counts for the two treatments. However, the within-treatment variance was very high, and this aspect was difficult to control in a field sampling excercise. No support could therefore be provided for an intuitive feeling that round-mesh sieves would cause less damage, and retain higher numbers of macrofauna, than square-mesh sieves.

4.5. Comparison of Van Veen grab and Reineck box corer

4.5.1. Mr Smaal summarised the results of a comparative study at 71 randomly selected sites in the Dutch Voordelta (Annex 5). On average, the box corer sampled marginally greater numbers of individuals per unit area than the Van Veen. There were no significant differences between counts for most species; amphipods as a group were significantly under-represented in grab samples, possibly due to greater disturbance at the sea-bed at the point of impact.

4.5.2. The overall similarity of results from the 2 sampling devices was encouraging. Further comparative work was planned. It was considered that for this region, Van Veen grabs were suitable for geographically extensive surveys, while the box corer was appropriate for use in detailed follow-up work at representative sites.

4.5.3. Dr Lopez-Jamar expressed surprise at the lack of significant difference in counts e.g. for the bivalve Tellina fabula, in view of the capability of older individuals of living at depths greater than the range of the Van Veen grab. This might be reflected in size differences, and would be examined.

4.5.4. Mr Smaal also reported on the results of computer analysis of benthos distributions, from surveys between 1984 and 1986. The distribution of benthic assemblages was notably related to silt content.

4.5.5. A cooperative study of two areas - one of which was located near to a storm-surge barrier and also comparatively more exposed to currents and wave action - had recently been initiated, in co-operation with Dr Heip. This entailed regular sampling of the benthic fauna and demersal fish. Recruitment of selected benthic species was also being studied by means of one-monthly sampling with a small Reineck box-corer (see 3.5).

5. STANDARD PROCEDURES

The group reviewed a draft report on "Collection and treatment of soft bottom macrofauna samples" for North Sea surveys, prepared by Dr Rumohr. Final amendments were agreed at the meeting: the report would be submitted as an ICES paper in time for the 1988 Statutory Meeting.

6. IMPACT OF TRAWLING, DREDGING AND MARINE AGGREGATE EXTRACTION

6.1. Effects of bottom trawling (ICES)

6.1.1. Dr A. Rijnsdorp (RIVO, IJmuiden) - who attended for this session - explained the background to the proposed ad-hoc meeting on effects of trawling in the North Sea (see 2.3.). The main concern was attached to the use of beam trawls, many of which were now noticeably larger and heavier than previously used. An up-to-date assessment of impact was therefore required.

6.1.2. The ad-hoc group will aim to review existing knowledge concerning sea-bed impacts of fishing gear, to assess the extent of any problem, and identify gaps in knowledge for further work. Both immediate and longer term effects of trawling will be considered. The Benthos Ecology WG was an obvious source of advice, in order to achieve these aims.

6.1.3. Members of the Group identified several previous or on-going studies of impacts of fishing gear (trawls and dredges). It was noted that analogous concerns existed for some areas designated for marine aggregate extraction. Also that impacts could be manifested as a biological consequence of predator removal, which might be amenable to assessment using ecosystem models.

6.1.4. Dr Heip concluded that recent studies in the North Sea area were nevertheless limited in number and scope, and further work was to be encouraged. Details on fishing effort by ICES rectangle within the North Sea, would be valuable in targetting areas for special attention. The Benthos WG valued the opportunity for further contributing to assessments of the potential impact of fishing methods.

6.2. Effects of scallop dredging off Norway

Dr Aschan gave an account of the Norwegian fishery for *Chlamys islandica*, and an assessment of impact at the sea bed (Annex 6). Presently, there was uncertainty as to the potential for regeneration of stock following local exploitation, and research on sources and fate of larval recruitment was in progress. Further assessment of changes to the sea bed biota following dredging was planned.

6.3. Impact of dredging/spoil disposal

6.3.1. Dr Heip presented a paper - on behalf of Drs. Gaudencio and Guerra - concerning impact on the benthos of dredging and spoil disposal in the Tagus estuary, Portugal (Annex 7).

6.3.2. Benthic communities could be divided into 3 types, largely governed by natural environmental influences. Preliminary conclusions were that dredging effects were localised, and there was no evidence for widespread degradative effects due to other sources of pollution.

6.3.3. The WG expressed appreciation for this submission, in the authors' absence.

7. PRODUCTION OF BENTHOS AND DEMERSAL FISH

7.1. Production of epifauna

No report on this had been received from Dr Redant, whose unavoidable absence was regretted by the Group. It was hoped that his future attendance would be possible, to allow contributions on this and other issues.

7.2. Production of meiofauna

7.2.1. Dr Heip summarised a paper on this topic, prepared with Dr Herman, which would be submitted as an ICES paper in 1988. Conventional approaches to production estimation were reviewed, along with the special procedures necessary for meiofauna studies. In particular, most meiofauna species were not separable into cohorts often because of continuous breeding, necessitating the use of laboratory procedures notably for assessing growth or respiration rates of individuals, from which production estimates applicable to field populations could be derived.

7.2.2. Inevitably, dependance on the outcome of laboratory experiments introduced an element of uncertainty as to the accuracy of such derived measures. The use of generalised P:B ratios for estimating annual production from biomass data could not be advocated, without adequate prior knowledge notably of generation times of local populations.

7.2.3. More promising was the ratio of production : assimilation, which appeared to be relatively constant at about 0.4 for meiobenthic crustaceans. This may be used to estimate production from respiration rates. For nematodes, much higher figures are reported, but since the degree of anaerobic respiration is unknown, these are still uncertain. Further, it may be possible to indirectly evaluate energy consumption if constancy can be demonstrated for production : consumption ratios, though the data are presently too limited.

7.2.4. It was noted that few studies of the benthos had separately determined reproductive output: for copepods and nematodes this could account respectively for up to 30 and 90% of total production.

7.2.5. Attention was drawn to a forthcoming publication of the U.S. Smithsonian Institute, entitled "Introduction to the study of meiofauna", edited by R.P. Higgins and H. Thiel. This should be a very useful reference source for those wishing to initiate work in this field.

7.3. Production of macrofauna

7.3.1. Dr Brey had used the results of a literature survey to evaluate relationships between annual production, biomass, P:B ratios and mean individual weights. A paper would be submitted to ICES (1988).

7.3.2. It had not been possible to establish significant relationships between these estimates and available abiotic data.

7.3.3. From simple linear regressions, the most notable findings were a.) significant positive correlations between production and mean annual biomass of species combined into major taxonomic groups (polychaetes, crustaceans and molluscs, respectively) and for all data combined, and b.) significant negative correlations between P:B ratios and mean individual weights for the data grouped in the same manner as at a.), confirming the findings of previous workers.

7.3.4. Multiple linear regression of grouped and total data demonstrated significant dependance of production (but not P:B ratios) on biomass and mean individual weight. In the last case, the effect on production and on P:B ratio is similar. There was a weak negative relation between mean annual biomass and P:B ratio, which might be interpreted to suggest a density-dependent effect e.g. of food limitation. Dr Schwinghamer noted a similar relationship for microbial populations, which might lend support to this hypothesis.

7.3.5. A comparison of production values calculated from the multiple linear regression equation relating production, biomass and mean individual weight of combined data, with those of actual community estimates from 5 published studies, revealed a mean % deviation of 42%.

7.3.6. This suggested that such a relationship could reasonably be used to generate "first-order" assessments of macrofauna production on regional scales from spatial survey data, e.g. the North Sea benthos survey. However, "outlying" communities, i.e. those dominated by one species with very high biomass (e.g. mussel beds), those consisting of less than 5 species, and those exposed to extreme environmental stresses, would probably have to be excluded.

7.4. Production of Mytilus from Dutch waters

Mr Smaal reported that most beds were cultivated and harvested, and hence P:B ratios could not be applied to natural populations. Cockle beds might be more amenable to study as unexploited areas could be easily located: moreover, local data could be combined with those already published for other regions in order to attempt to establish empirical relationships for this community as a separate entity, given the limitation to application of the generalised equation noted in 7.3.6 (above).

8. RESEARCH ON TROPHIC LINKS BETWEEN BENTHOS AND DEMERSAL FISH

8.1. Predator/prey interactions in a Scottish loch

8.1.1. Dr Hall reported on progress in the evaluation of a subtidal location on the west coast of Scotland. Characterisation studies of the designated area included seasonal sampling of the macrofauna and epifauna, and sampling of fish populations using rod-and-line, Fyke and trammel nets.

8.1.2. The objectives were to define existing food chain relationships with emphasis on fish, identify seasonal effects and - subsequently - to permit controlled manipulative experiments on predator-prey interactions.

8.1.3. Preliminary results from 1 m^2 cage enclosures using the swimming crab Liocarcinus depurator as a top predator showed no effects on abundances of potential prey species which could be attributed to crab predation. However, there was some evidence for a shift in size structure of certain species, with smaller individuals predominating at high crab densities.

8.1.4. Results of initial studies will be published shortly. Cage enclosures using flatfish will be established during 1988.

8.2. Consumption of benthos by North Sea cod and haddock

8.2.1. Dr Cramer summarised the results of an analysis of stomach contents of cod and haddock from the southern, central and northern North Sea (see ICES C.M. 1986/G:56). Annual consumption rates of benthos per unit area by these two species were higher in the south (0.8 $g.C.m^{2}.y^{-1}$) than in the north (0.5 $g.C.m^{2}.y^{-1}$). A comparison of 1980 and 1981 data for cod suggested that these rates were reasonably constant between years. Cod fed mainly on decapod crustaceans, while haddock food was apportioned approximately equally between crustaceans, annelids and echinoderms.

8.2.2. There was a poor match between the variety and abundances of prey species in stomachs and those from epibenthic surveys by trawl (MAFF trawl by-catch data - see 11.3). Evidently, both predator and trawl were selective in the type of benthos caught. A similar survey of feeding habits was planned for 1989, by the Netherlands Institute for Fishery Investigations.

8.3. Other activities

8.3.1. Dr Aschan noted that research projects were underway at Tromsø, concerning the role of benthos as food for flatfish and cod. Dr Schwinghamer reported that possible links between epifauna assessments using stereo photography (see 3.4.) and fishing effort on the Grand Banks would be explored. Dr Rachor noted that intertidal predator-prey interactions were presently being examined using the Bremerhaven caissons.

8.3.2. Dr Rumohr gave preliminary results from the use of the "REMOTS" system in Kiel Bay. This is a method for in-situ photographic documentation of vertical profiles of soft sediments down to about 20 cm depth. Good images could be obtained, allowing interpretation of e.g. biogenic structures, redox discontinuity layer and colonising benthos. Software for image analysis is being prepared, and it was proposed to conduct a wide-scale survey of Baltic sediments in the near future. Progress would be reported to the next WG meeting.

8.3.3. Clearly, the ability to carry out regional surveys was substrate-dependent. Dr Schwinghamer questioned the validity of interpreting regional survey data based on a successional model for colonising benthic species, which had been evolved largely from studies of point-source impacts in Long Island Sound.

9. PROCEDURES FOR BENTHOS MONITORING AT POINT-SOURCE DISCHARGES (ACMP)

9.1. ACMP had responded favourably to a draft account from the BEWG on the use of benthic communities in monitoring point-source discharges, submitted in 1987. They had requested expansion of the section dealing with procedures, so that this could act as a "stand-alone" document which would form the basis of ACMP advice on this topic to the Oslo and Paris Commissions in 1988.

9.2. Accordingly, the Group reviewed an expanded draft by Drs. Rees and Heip. Amendments were agreed, and a final draft would be submitted to the next ACMP meeting in June 1988.

9.3. Regarding the entire account as submitted in 1987, ACMP had suggested publication in the ICES Co-operative Report Series, following attention to a series of proposed amendments. Updated drafts on the general utility of benthos for pollution monitoring, and on use of meiofauna, were circulated with a request that any comments should be forwarded to Drs. Heip and Rees within 4 weeks.

10. NORTH SEA BENTHOS SURVEY (1986)

10.1. Progress in sample analysis

10.1.1. Progress in the processing of samples from the 1986 North Sea benthos survey was greater than expected. All teams were in a position to provide weight data for the large taxonomic groups, either now or in the near future. Three teams had finished the macrofauna analysis to species level, and two had finished all the requisite analyses.

10.1.2. A CEC grant starting on August 15, 1988, had been awarded to Mr Rony Huys (Belgium) in order to study the meiofauna from the North Sea benthos samples.

10.1.3. It was agreed that Dr Heip would submit a new proposal for a scientist responsible for synthesising the data from all the participating teams, expected to be ready during 1988.

10.1.4. Publication of the results of the North Sea benthos survey in an appropriate form would be pursued.

10.2. Presentation of data

10.2.1. Dr Heip had presented preliminary data on physico-chemical determinations from sediment data, and on macrofauna distributions at the 1987 ICES Statutory meeting, and subsequently at 2 scientific meetings in France. An up-dated summary of progress would also be given at a meeting of the Joint Oceanographic Assembly in Acapulco in 1988. Dr Rumohr had presented a poster on photographic records of sediments and epifauna taken during the 1986 survey, at the 1987 ICES meeting, and also at the European Marine Biology Symposium (1987).

10.2.2. These presentations had stimulated a considerable degree of interest. Since 1986, some preliminary results from the co-operative survey had also been published in the open literature.

10.3. Macrobenthic community structure

10.3.1. The results of cluster analysis of presently available macrofauna data using the "TWINSPAN" programme - presented by Dr Künitzer - demonstrated four main groups. These broadly matched substrate type and could be allocated as follows: a deep muddy sand fauna north of the Dogger Bank, a shallow muddy sand fauna south of the Dogger Bank, a shallow fine sand fauna of the Dogger Bank, Dutch and Danish coasts, and a shallow medium sand fauna notably along the Belgian, Dutch, German and Danish coasts.

10.3.2. Dr Creutzberg noted that the assemblages could also be broadly matched with tidal current strengths.

10.3.3. The results of analysis of sediments for grain size and organic carbon - the latter by loss on ignition of the < 2 micron fraction - were also presented. There was debate as to the validity of extrapolation from such estimates to whole sediments. As Dr Irion (Wilhelmshaven) had carried out a variety of analyses of sediments, including trace metal contents, it was agreed that an invitation would be extended to allow him to present the full range of data.

10.3.4. The distribution of macrofauna biomass showed highest values approximately along the 30-40 m contour off the Dutch coast, which could be linked with a frontal system which is known to develop in this vicinity.

10.3.5. There were regional differences in the proportional contribution to total biomass of the major taxonomic groups. For example, molluscs dominated on the Dogger Bank, and echinoderms at most stations to the south. At all sites, polychaetes were dominant in terms of numbers of species.

10.3.6. A series of stations in the NE part of the survey area, at 70-90 m depth, had been sampled both by Van Veen and box corer, allowing inter-comparison of performance. In contrast with the findings of Mr Smaal for the Dutch coast (4.5), the box corer was up to twice as efficient in the sampling of individuals and species. There was no evidence for greater loss of amphipod species using the Van Veen grab.

10.3.7. While these differences did not affect assessment of community structure (the separate data were clustered together into the same "deep muddy sand" group, above), nevertheless there were implications for synoptic mapping of other aspects of data structure in cases where only Van Veen samples had been taken. Further consideration would be given to this potential source of error.

10.4. Epifauna from beam trawls

10.4.1. Work by Dr Duineveld on analysis of the Dutch contribution to the 1986 North Sea survey was presented by Dr Creutzberg. Cluster analysis identified assemblages which were similar in distribution to macrofauna assemblages within the area.

10.4.2. Biomass data showed elevation in the vicinity of a frontal system off the Dutch coast, and at the NE edge of the Dogger Bank.

10.4.3. A gross comparison between data from this and an earlier survey conducted in 1972, revealed that the crustacean Pontophilus spinosus occurred only rarely in 1986. (However, it was again common in a more recent survey conducted in August, 1987). The swimming crab Macropipus marmoreus was absent in 1986, but widespread in 1972. In August, 1987 it was again common, but populations were characterised by small individuals. This might suggest high mortality of adults following the severe winter preceding the 1986 survey.

10.4.4. Dr Heip urged caution in the interpretation of trends from trawl data, given uncertainties in sampling efficiency (see Item 4).

10.5. Protein and pigment analysis of sediments

Analysis of core sub-samples for pigment and protein had been carried out by Dr Soltwedel. No clear spatial trend emerged in the distribution of pigment values, though they were positively correlated with median diameter of sediments. Protein was expressed as mg.r-Globulin equiv./$5cm^3$, and measured both living and dead material. High values were clearly associated with muddy areas. Relationships with benthos distributions had not yet been tested.

11. OTHER NORTH SEA STUDIES

11.1. Macrofauna of the German Bight

11.1.1. Dr Niermann had worked a grid of stations between 1984 and 1987. A trend of increase in biomass and species number in parts of the survey could be attributed to recovery following mortality due to an oxygen depletion event in 1983. Identification of such a trend was permissible only with the use of a closely spaced grid of stations, and thus was a reminder that caution was required in the interpretation of local conditions from widely spaced stations such as in the 1986 North Sea survey.

11.1.2. This work was part of a wider project in the eastern German Bight entitled "Oxygen depletion: sources and effects", initiated by the Biologische Anstalt Helgoland, and due to run until 1989. The project involved study of: phytoplankton (species distribution, biomass, chlorophyll, seston), nutrients (distribution patterns in space and time), production (14-C measurement), microbiology (bacterial numbers, production), oxygen consumption (water-column BOD, benthos) and hydrography (salinity, temperature, oxygen). Effects on the macroinfauna, epifauna and fisheries were being examined.

11.2. Northern North Sea survey

11.2.1. Dr Hall reported that analyses of offshore benthic stations from this DAFS survey was largely complete. Assessment of physico-chemical data had been published, and papers on infauna and epifauna had been submitted. Data from inshore stations were presently being analysed, and would be published shortly.

11.2.2. The WG valued this work, especially as it extended the northern boundary for interpretation of data from the 1986 co-operative survey.

11.3. Epibenthic by-catch from North Sea groundfish surveys

11.3.1. Mrs Fry reviewed the history and work-up of data from these surveys which had been conducted annually since 1978 using Granton and (less frequently) Agassiz trawl, and had involved collaboration between Luton College and MAFF (UK). The data were archived on computer, and contour maps of all species had been produced, along with relevant hydrographic information, examples of which are given at Annex 8. Also archived were the results from analysis of stomach contents of haddock and whiting (see 6th WG report).

11.3.2. The data were available to WG members through contacting Mrs Fry or Dr Harding (MAFF, Lowestoft), who also offered to analyse relevant trawl data from the 1986 North Sea benthos survey along similar lines, to allow intercomparison.

11.4. <u>North Sea beam trawl survey, 1977-1988</u>

Dr Türkay reported on this programme which had involved analysis of over 500 beam trawl samples covering the whole North Sea, except north of Orkney and Shetland Islands, and would be completed by the end of 1988. Dredge samples had also been collected by the Institute of Hydrobiology and Fisheries Research, University of Hamburg. The data base extended from 1977 to 1988, and thus was directly comparable in time with the MAFF/Luton data base.

11.5. <u>Dogger Bank investigations</u>

11.5.1. Further results on comparisons between recent (1985-7) benthos surveys and those of Ursin in the early 1950's were provided by Dr Kröncke (see 6th WG report). Biomass (as AFDW) was some 3-6 times higher now than previously, and there was evidence for increased abundance - and in some cases spatial distribution - of certain opportunistic species, at the expense of slower-growing, longer-lived species. Such observations found parallels with those of other workers in enclosed waters of the Kattegat, where water-column eutrophication had been invoked as a possible cause.

11.5.2. Contaminants in a variety of benthic species had been analysed (see also ICES C.M.1987/E:28). For example, lead levels were up to twice as high in polychaetes of the NE part of the Dogger Bank, compared with the German Bight. Cadmium concentrations were similar at both sites. Parallel work on metals and organic contaminants in sediments and fish showed that higher levels were frequently found in the vicinity of the Dogger Bank.

11.5.3. There were some limitations attached to the comparisons of recent and past benthos data, though the type of grab and time of year were the same. For example, a 1.8 mm mesh sieve had been used previously, compared with a 1 mm mesh sieve. There was no evidence for a change in sediment type, but earlier observations were based on visual assessment only.

11.5.4. Impacts of commercial fishing methods could not be dismissed and Dr Kröncke was presently investigating this aspect. Dr Gordon noted that fishing intensity would have been much lower in the immediate post-war period preceding the earlier survey by Ursin.

11.5.5. Preliminary work on relationships between water column and benthic production in the Dogger Bank area - which might represent a centre for nutrient upwelling from inflowing Atlantic water - were reported by Dr Heyman. Sites representative of depositional areas would be sampled by box-core and underwater camera. Studies of sedimentation in this area would be studied separately in 1988 (the 'Window' project).

11.5.6. Dr Gordon referred to certain parallels existing between the Dogger and Georges Banks, though the latter were characterised by stronger tidal currents.

12. ANY OTHER BUSINESS

12.1. The following is a summary of a discussion which took place during drafting of a recommendations list (Annex 3):

i the Benthos Ecology Working Group recognised that it was an appropriate source of advice on a number of matters relating to pollution impact and its detection. However, a recommendation to embrace the pollution brief in its entirety could - because of its wide scope - limit its ability to deal with those basic scientific issues of concern identified at the time of its inception, notably benthos/fish trophic interactions, benthic production and study methods. There are of course a number of other WGs with a more specific pollution brief;

ii thus the BEWG proposed that it would not offer an initiative on formal approaches to pollution matters in general, but at the same time wished to emphasise its desire to strengthen relationships with other ICES Working Groups considering human impacts on the marine environment. Dr Heip would seek the views of the Biological Oceanography Committee on this point, at the 1988 ICES Statutory Meeting.

13. DATE OF NEXT MEETING

13.1. The Working Group proposes that it meets from 18 to 21 April, 1989 at the Spanish Institute of Oceanography, La Coruna, to consider the results of the inter-sessional work requested (see Annex 2 and 3).

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ANNEX 2

Action List

1. 1986 North Sea benthos survey
   a. Drs Dewarumez, Dörjes, Kingston, Rumohr and Türkay to report on progress in analysis of benthos data;
   b. Dr Irion to be invited to report on physical and chemical analyses of sediments;
   c. Dr Brey to evaluate benthic production in the North Sea, using biomass data from the 1986 survey.

2. Dr Schwinghamer to report on results of a photographic survey of the Canadian Grand Banks, and on the future direction of benthic research in this region.

3. Dr Gordon to report on the role of ecosystem models in evaluation of benthic processes.

4. Dr Lopez-Jamar to present a final report on benthic studies of the Galician continental shelf.

5. Dr Hall to report on studies of benthos/fish interactions off the Scottish coast.

6. Dr Aschan to report on progress of Norwegian studies of benthos/fish interactions.

7. Dr Dörjes to report on effects on macrobenthic species of severe winters (German coast).

8. Dr Dörjes to present results of a study on impact on the benthos of dredged spoil disposal (German coast).

9. Dr Rumohr to report on the impact on benthos of trawling in Kiel Bay.

10. Dr Rachor to provide an overview of effects on the benthos of commercial fishing for sand-eels.

11. Dr Aschan to present further results on sea-bed impacts of scallop dredging (Norwegian coast).

12. Mr Smaal to report on effects of disposal of dredged material on the benthos of the Voordelta (Holland).

13. Dr Rees to report on benthic studies at UK aggregate extraction sites.

14. Dr Niermann to report on benthic studies in the eastern German Bight - including oxygen consumption - in relation to organic enrichment.

15. Dr Heip to review statistical methods appropriate to analysis of benthic monitoring data.

16. Dr Heip to organise the benthos sampling component of a proposed sea-going workshop (see Recommendations).

17. Dr Rumohr to review the utility of imaging methods in benthic

research.

18. Dr Heyman to report on progress of benthic studies on the Dogger Bank (North Sea).

19. Dr Duineveld to further compare the performance of round and square mesh sieves in benthos sampling.

20. Dr Redant to report on mobile epifauna production studies.

ANNEX 3

Recommendations

The Benthos Ecology Working Group recommends that it meets from 18 to 21 April, 1988 at The Spanish Institute of Oceanography, La Coruna, Spain, in order to:

a. prepare the third report on the 1986 North Sea benthos survey;

b. further consider co-operative studies in other areas within the ICES region;

c. examine and report on links between benthos and demersal fish;

d. assess impacts on the marine benthos arising from physical disturbances of the sea bed;

e. evaluate the utility of existing imaging methods for benthic research;

f. explore the usefulness of modelling in understanding the relationship between benthic and pelagic ecosystems;

g. review statistical methods relevant to field monitoring of the benthos;

h. finalise protocols for benthic community sampling in the 1989 sea-going workshop of the ICES Biological Effects Working Group.

ANNEX 4

COMPARISON OF EFFICIENCIES OF SIEVES WITH SQUARE AND ROUND OPENINGS

by

M. van WUYCKHUYSE and G.C.A. DUINEVELD (NIOZ, Texel)

During the 1987 meeting of the Benthos Ecology Working Group in Edinburgh a question was raised about the efficiencies of sieves with round and square holes. Two main types of sieves are commonly used : a classic type made of woven gauze with square openings measuring 1 mm along a side (1 mm2), and a perforated steel plate with round openings measuring 1 mm in crosssection (0.79 mm2). Although in theory the retention on the two types will undoubtedly differ depending on the shape of the particles, it is of interest whether such differences occur while sieving benthic samples. One can ,for instance, imagine that with square openings small bivalves between 1-1.4 mm in length could pass along the diagonal or that living polychaetes take advantage of the slightly larger openings. In connection with the latter possibility of escape, sieving time may be an important factor.

METHODS

Ideally a test of the two sieves should be performed with equally composed samples. Since these are not available, one and the same sample could be used. This should then be preserved prior to sieving since the first sieving could kill part of the organisms. This set up however excludes active passage by crawling organisms. In the present case a series of samples was sieved in order to take the variance into account. This was done at four sites, i.e. two intertidal and two subtidal stations in the western Wadden Sea.

At the subtidal stations the samples were taken with a Reinecks Box sampler (0.06 m2). The samples were resuspended in a plastic container and alternately poured over the sieve with round and square openings. At one station the sediment consisted of fine sand and sieving time was approximately 1 minute. At the other station, with a muddy substrate, sieving time was at least 5 minutes. The residues from the sieves were preserved with a 4 % solution of formalin and stained with rose-bengal.

At the intertidal stations a hand-operated coretube (0.01 m2) was used with a penetration depth of 20 cm. At both stations the sediments consisted of fine sand. For practical reasons the complete samples were immediately after collection preserved with formalin. Active escape in these series is therefore excluded. At the laboratory the samples were alternately sieved over the two sieves and the residues were stained with rose-bengal. Sieving took approximately 1 minute for all intertidal samples. Polychaetes were counted by the presence of heads and the percentage complete worms was assessed.

In order to test the differences between the counts as well as the % complete worms on the two sieve-types the non-parametric MANN-WHITNEY U-test (SIEGEL, 1956) was used. A more powerful alternative is the parametric T-test. Its use requires equal variances of the samples and these may have been changed differentially by sieving as in the most likely case that a percentage of the animals has escaped through the square openings. The variances of the ln-transformed counts would in this case nevertheless be the same (SOKAL & ROHLF, 1981: 60). Hence, the variance-ratio's of the transformed counts were tested (F-test) and in case of no difference, the means of the transformed counts were tested with a T-test.

RESULTS

Table I gives the untransformed counts for each species and the percentage complete annelids in the two series of samples at the different stations as well as the results from the F-test, T-test and Mann-Whitney U-test.

	ROUND OPENINGS						SQUARE OPENINGS						F	T	U
SUBTIDAL-sand:															
Capit	3	3	2	1	22	4	5	1	13	12	24	9	1.3	1.1	26.5
Scolo	27	20	29	11	16	32	35	23	17	28	15	14	1.3	.1	19.0
Macoma	8	9	7	11	10	8	13	12	16	14	7	10	3.1	2.1	29.0
Annel%	79	39	68	75	83	80	51	100	80	69	61	76			29.0
SUBTIDAL-mud:															
Capit		12	14	26	34	63		11	24	17	19	25	4.2	.9	17.0
Annel%		75	64	69	59	60		64	67	39	58	52			19.5
INTERIDAL:															
Capit		14	9	10	62	14		28	13	39	10	9	1.7	.4	13.0
Annel%		50	100	100	68	22		75	71	75	43	100			14.0
INTERTIDAL:															
Capit		6	8	10	4	9		2	9	5	14	5	3.9	.6	14.5
Hydro		11	4	26	14	1		4	11	8	8	1	1.8	.5	16.5
Annel%		100	63	40	80	56		100	44	100	50	100			9.5

Table I. Untransformed counts of species and percentage complete annelids on two sieve-types at the different stations (Capit=capitellids; Scolo=Scoloplos armiger; Macom=Macoma balthica; Hydro=Hydrobia). Latter three columns contain respectively variance ratio's of ln-transformed counts (F), statistic of T-test on transformed means (T) and statistic of MANN-WHITNEY U-test on raw counts (U). Significant values ($P < 0.05$) are marked with an *.

RESULTS

The results summarized in table I show that in the present case no significant differences were found between the counts on the two sieves. The magnitude of the difference due to sieve-type will be dependant on the presence of organisms with critical sizes and will therefore vary with the season. In February when the experiment was carried out, many common species in the Wadden Sea, for instance bivalves and the gastropod Hydrobia, have grown beyond this critical size (R. Dekker pers. comm). The few inividuals possibly lost through the square openings will hardly be detectable taking into account the considerable variance of the sample series.

SIEGEL, S. 1956. Non-parametric statistics for the behavioral sciences. McGraw-Hill, New York. 312 pp.
SOKAL, R.S. & F.J. ROHLF, 1981. Biometry. The principles and practice of statistics in biological research. Freeman, San Francisco. 859 pp.

Draft, not to be cited without prior reference to the author.

ON THE COMPARISON BETWEEN A REINECK BOX CORER AND A VAN VEEN GRAB.

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Introduction.

In quantitative studies of the macrofauna of soft-bottom subtidal areas sample units are taken by removing with a corer or a grab device a given area of sediment surface, usually about 0.1 m^2. One of the most widely used devices is the Van Veen grab. Problems with this grab are that the bite is often asymmetrical and that the depth of penetration varies greatly with the sediment type (Gray 1981). Quite a few specimens might live below this penetration depth and are therefore not sampled. The resulting bias in the estimate is mostly neglected. The Reineck box corer on the contrary not only takes a rectangular sample, but is also said to penetrate to a less variable depth, which is largely determined by the amount of weights attached to it. The use of the box corer has therefore much appeal. Unfortunately the box corer can only be used when wheather conditions are good (less then 5 Beaufort wind speed on open sea).
In the macrobenthos survey in the Dutch Voordelta (Seip & Brand 1987, Smaal et al 1987, van der Meer in prep) the use of only the Van Veen grab on quite a few locations was also unavoidable, in spite of the original plan always to use the box corer. To estimate the comparibility of both instruments 71 sample locations were not only sampled with a Reineck box corer, but also with a Van Veen grab. This comparibility will be discussed in this report.

Materials and Methods.

In april and may 1985 one sample unit was taken with a Reineck box corer (surface area 0.068 m^2, weight 800 kg) and one with a Van Veen grab (surface area 0.184 m^2, weight 80 kg) on each of 71 randomly selected sample locations in the Dutch Voordelta. All specimens were identified to the species level. The penetration depth was determined. Further details are given in Seip & Brand (1987) and Smaal et al. (1987).

The following statistical model was used to evaluate the data:
$y_i = c_1 \cdot y_i'$
$x_i = c_2 \cdot x_i'$
where
y_i = the estimated density (numbers expressed per 0.068 m^2) of a species (or species group) in the Van Veen grab on location i
y_i' = the real density
c_1 = the bias factor of the Van Veen grab
i = location number, from 1 to 71
x as y, but concerning the Reineck box corer.

The expectation of y_i' equals the expectation of x_i' and therefore the expectation of the test statistic $T=\hat{E}(\log(y_i)-\log(x_i))/i$ equals the logarithm of the ratio of the bias factors $\log(c_1/c_2)$. Assuming normality the test statistic T follows a Students t-distribution with zero mean under the null hypothesis that both bias factors c_1 and c_2 are equal. The alternative hypothesis is $c1 < c2$. If the normality assumption was violated Wilcoxons signed rank test was used in stead of the above described t-test for paired comparisons.
To get round the impossibility of taking logarithms of zero densities the number one was added to all densities. This might have biased all estimates slightly. If both grabs on a certain location showed zero densities the location was not taken into account in the analyses. If less than 20 locations remained the species was not considered anyfurther.

Results.

The estimates of T and the results of the statistical tests are given in table 1. Both grabs differ significantly concerning the total number of specimens. The relative underestimation of the Van Veen grab is about 15 percent. This is also true for the number of polychaetes and the number of amphipods, but not for the number of bivalves. At the species level they only differ concerning three species, with a maximum of 40 % for the amphipod Urothoe poseidonis.
Histograms of the penetration depth of the Van Veen grab and of the Reineck box corer are given in figure 1. The average depth of the box corer was 25.6 cm and of the Van Veen only 10.8. The variation was almost equal and while the interquartile distance was 12 cm for the box corer, it was only 8 cm for the Van Veen grab. The relation between the penetration depths of both grabs is given in figure 2. The correlation between the difference of the logs of the total densities and some measure for the penetration depth of the Van Veen grab (log (depth minus minimum depth of the Van Veen grab, which is 3 cm.)) is significant ($r=0.32$, $n=68$, $p<0.01$).
Figure 3, which gives the relation between the log of the total density of both grabs, shows that the bias introduced by the use of different grabs is only of minor magnitude compared to the field sample variance.

Discussion.

For most species no significant differences were found between a Van Veen grab and a Reineck box corer. Compared to the field sample variance the magnitude of the bias also seems to be of minor importance in most cases. However, one should take into account that the bias (sometimes called accuracy or systematic fault) does not, in contrary to the field sample variance, diminish when taking more sample units. So as a matter of fact one should mainly be concerned about bias when taking a large number of sample units!
Further analyses (this report is only a preliminary one) will reveal the importance of the penetration depth in relation to sediment characteristics in determining the magnitude of the bias.

Literature.

Gray, J.S. 1981. The ecology of marine sediments. Cambridge: Cambridge University Press.

van der Meer, J. in prep. Exploring macrobenthos-environment relationships by Multiple Discriminant Analysis.

Seip, P. & R. Brand 1987. Inventarisatie van macrozoobenthos in de Voordelta. NIOZ report 1987-1.

Smaal, A.C., P. Seip & J. van der Meer 1987. Macrozoobenthos in an ebb-tidal delta complex in the south-west of the Netherlands (the Voordelta). ICES North Sea Benthos Working Group, draft paper.

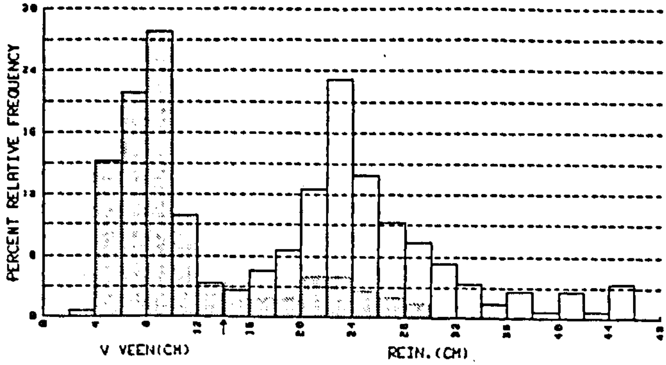
Table 1. The results of the t-test for paired comparisons between the van Veen grab and the Reineck box corer; 10^T is an estimate of c1/c2; df: degrees of freedom, ns: p>0.05, *: p<0.05, **: p<0.01. See text for further explanation.

species	df	10^T	p
All species	70	0.84	*
All polychaetes	67	0.84	*
All amphipods	49	0.71	**
All bivalves	54	1.10	ns
Anaitides groenlandica	20	1.12	ns
Capitella capitella	24	1.93	ns
Magelonis papillicornis	24	0.64	*
Nephthys cirrosi	21	0.71	*
Nephthys hombergii	57	0.89	ns
Scoloplos armiger	52	1.00	ns
Spio filicornis	24	1.00	ns
Spiophanes bombyx	38	1.11	ns
Bathyporeia elegans	27	1.06	ns
Urothoe poseidonis	37	0.58	ns
Ophiura texturata	28	1.01	ns
Macoma balthica	22	0.99	ns
Tellina fabula	25	0.94	ns
Natica alderi	23	1.27	ns

Figure 1. Histograms of the penetration depth of the Van Veen grab and the Reineck box corer. No box corer values on the left side of the arrow.

Figure 2. Penetration depth of the Van Veen grab against the Reineck box corer.

Figure 3. Total density in the Van Veen grab against total density in the Reineck box corer, n=71.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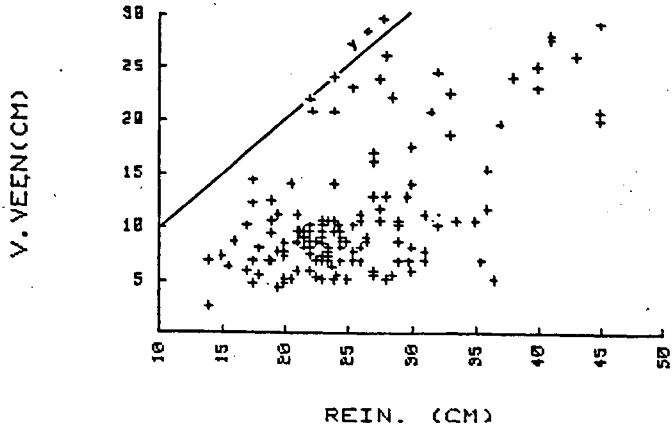
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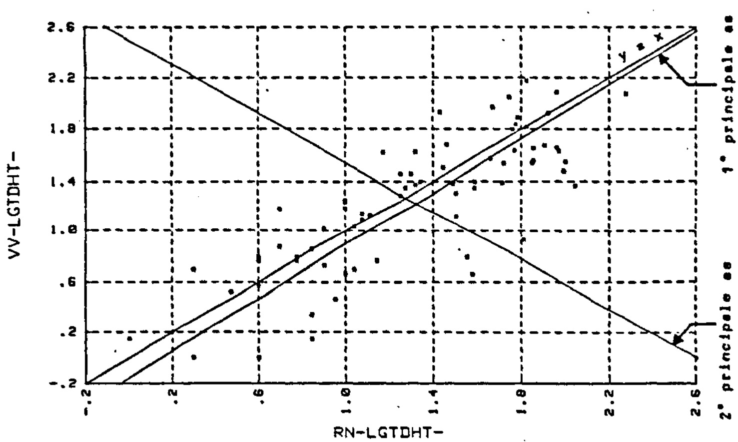
VV-LGTDHT-
RN-LGTDHT-
y = x
1° principale as
2° principale as

ANNEX 6

The effect of Iceland scallop (*Chlamys islandica*) dredging at Jan Mayen and in the Spitsbergen area

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Background

The Iceland Scallop (Chlamys islandica) is a circumpolar arctic species and it is common along the North Norwegian coast, around the Jan Mayen Island and in the Svalbard zone, including the waters around Spitsbergen and the Bear Island.

The Norwegian Iceland Scallop fisheries started in 1984 and increased fast. The production of frozen muscle was:

1985	100 ton
1986	720 ton
1987	4000 ton

In 1986 26 seagoing vessels were dredging for Scallops. In the beginning the fisheries were concentrated South of the Jan Mayen island, but as the resource decreased the fisheries expanded to the Svalbard zone. Here the dredging and processing is more difficult because of worse ice and weather conditions and the high density of fouling organisms covering the shells in this area. In June 1987 the Scallop density at Jan Mayen was reduced to 25% of the density in 1986 and the Scallop field was closed in August the same year. In November 1987, 12 Norwegian processing vessels were fishing, in January and February all vessels were in harbour, because of bad ice conditions and low market prices, and today only 7 processing vessels are working, all in the Svalbard zone.

The fishing procedure is rough. At the Ms Concordia 3 dredges 5 m broad are dredging continuously with a speed of 4-5 knots. 4,000 ton stones, gravel and organisms are taken on board daily and results in about 3 ton produced muscle. In the processing everything with the size > 45 mm and < 70 mm narrow, goes through the process including heating to 80°C.

DESCRIPTION OF THE PROJECT

The field work is done in cooperation with the project "Resource mapping of Chlamys islandica at Jan Mayen and in the Spitsbergen area" lead by Jan Sundet.

The study was conducted from the research vessel F/F Johan Ruud in the summers 1987 and 1988 in an area South of Jan Mayen at 60-120 m depth and at the Northern and Northwestern side of Spitsbergen at 25-80 m depth. Data on the faunal composition was collected through use of dredging, photography and underwater video recording. There are several problems in getting good quantitative faunal data. It seems that video recording of the bottom along depth gradients will give the best results.

Dominating species are, in addition to Chlamys islandica, Astarte elliptica, Strongylocentrotus droebachiensis, Ophiopholis aculeata and Ophiura robusta. At Jan Mayen the sea-cucumber Cucumaria frondosa is common as well as the crustaceans Sabinea septemcarinatus and Spirontocaris spinus. In the Svalbard area, the crustaceans Hyas sp., Sclerocrangon sp., Lebbeus polaris and Balanus balanoides often encrusting the scallops are characteristic. These are results from 100 dredging stations in 1987.

The samples from 1988 have not been sorted or sampled yet, so it is at this stage difficult to give any final results. A fact is though that the dredging has a big influence on the bottom communities in the Scallop fields. Illustrating this is that often more than half of the stones dredged and taken into the processing are clean washed without the normally characteristic red Corallina cover. That means that there are bottoms where over 50% of the bottom substrate has gone through the processing factory of a Scallop vessel, and is thereby more or less sterile. Further studies are required to follow the recolonisation and recovery of these areas.

In the Svalbard area, untouched scallop fields sited within the nature conservation area offer reference data, and in August 1988 they will be studied.

ANNEX 7

Impact of dredging and dredged spoil disposal on the benthic macrofauna, of the Tagus estuary, Lisboa, Portugal: a progress report

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In 1987 the Instituto Nacional de Investigacão das Pescas, Lisboa, with the collaboration of the "Laboratoire d'Océanographie Biologique", UBO, Brest, started to develop a study of the effects of dredging and dredged spoil disposal on benthic communities which play a fundamental role in the energy transfers in a trophic chain.

This study is part of a three year research project worked out with the director of the "Laboratoire d'Océanographie Biologique", Prof. M. Glémarec, and has the support of the Portuguese-French commission for oceanological cooperation. It is being conducted in the Tagus estuary, mainly due to its importance for some fisheries resources, such as the sole, plaice, sea-bass, oysters, cockles and hard-clams. Some of them, such as the sea-bass and the sole, use the estuary as a nursery (COSTA, 1980).

Dredging takes place along three different zones of the harbour every three months, due to ship traffic needs, and the dredged spoil is dumped in three different areas (fig. 1).

The aim of this study is to assess the state of health of the ecosystem by studying the response of the benthic macrofauna to the organic enrichment of the environment (biotic indexes method - HILY's model - GLEMAREC & HILY, 1981), and consequently, to enable INIP to answer some important questions such as:
- Distribution of enrichment and degradation areas of benthic communities in the estuary.
- Choice of dredged spoil disposal areas.

The Tagus estuary is composed of three areas: (i) a euryhaline one, the inner delta with two channels: Cabo Ruivo and Samora; (ii) a transition area between marine and brackish environments - "Mar da Palha", and (iii) the Corridor-Mouth ensemble (fig. 2).

In August 1987 a first campaign was held on board the INIP research vessel "Mestre Costeiro", in order to do the biological characterization of the estuary and the grain size analysis of the sediment. We sampled 76 stations between 5 and 41 m depth with a Van Veen grab (45x45 cm), and 22 stations which are located over the very shallow dumping area (1.5-4 m depth) with a small Van Veen type grab (15x15 cm), manipulated by hand from a pneumatic boat (fig. 2). Three samples were taken per station: one for physico-chemical analysis (grain size, organic carbon and nitrogen and total organic matter) and two for biological parameters (species richness, abundance and biomass). Salinity and temperature at the surface and at depth were also taken at each station.

The collected material was analysed during a 15 day visit to the Brest Lab. under Prof. Glémarec's supervision. This enabled us to identify the main communities of the estuary and also to make a preliminary assessment of the ecosystem state of health.

- The inner delta: The Cabo Ruivo channel, along the northern side shows a relatively rich community dominated by Melinna palmata on a sandy mud bottom. Two "faciès" may be distinguished: one dominated by Lanice conchilega and another one dominated by Diopatra neapolitana. The channel axis which is dredged regularly presents a marked impoverishment in species abundance.

The Samora channel, along the southern side is almost lifeless. Only few specimens were collected in the sampling stations located downstream in the channel: Nephthys hombergii, Melinna palmata, Glycera sp., Nucula sp. and Corbula gibba. This suggests a transition area between the estuarine and the freshwater environment, or a degraded area due to pollution effects.

The dumping area which is very shallow shows an impoverished community composed of Melinna palmata, Sabellaria spinulosa and Corophium sp. In spite of the anthropogenic alterations from which this area suffers we did not find opportunistic species.

- "Mar da Palha": This area, influenced by very strong currents, presents very impoverished communities composed of Melinna palmata, Glycera convoluta, Nephthys hombergii, N. cirrosa, Abra alba and Corbula gibba.

- Corridor and Mouth: The corridor bottom shows patches of mud, sand and sandy mud with communities dominated by Melinna palmata and Barnea candida. The mouth, influenced by strong hydrodynamics, shows a rocky bottom in the middle of the channel which is surrounded by sand and muddy sand. Two main communities were identified: the Nephthys cirrosa - Magelona papillicornis one, near the south side and the community dominated by Venerupis pullastra, Abra alba and Nucula turgida, along the channel axis.

As a preliminary conclusion we may note the relatively good state of health of the estuary, certainly due to the strong currents and to the marine influence which extends very much upstream in the estuary.

Three other campaigns have been accomplished: in December 1987, January and March 1988, though the results have not yet been analysed. Further studies will be carried out in order to attain the mentioned objectives.

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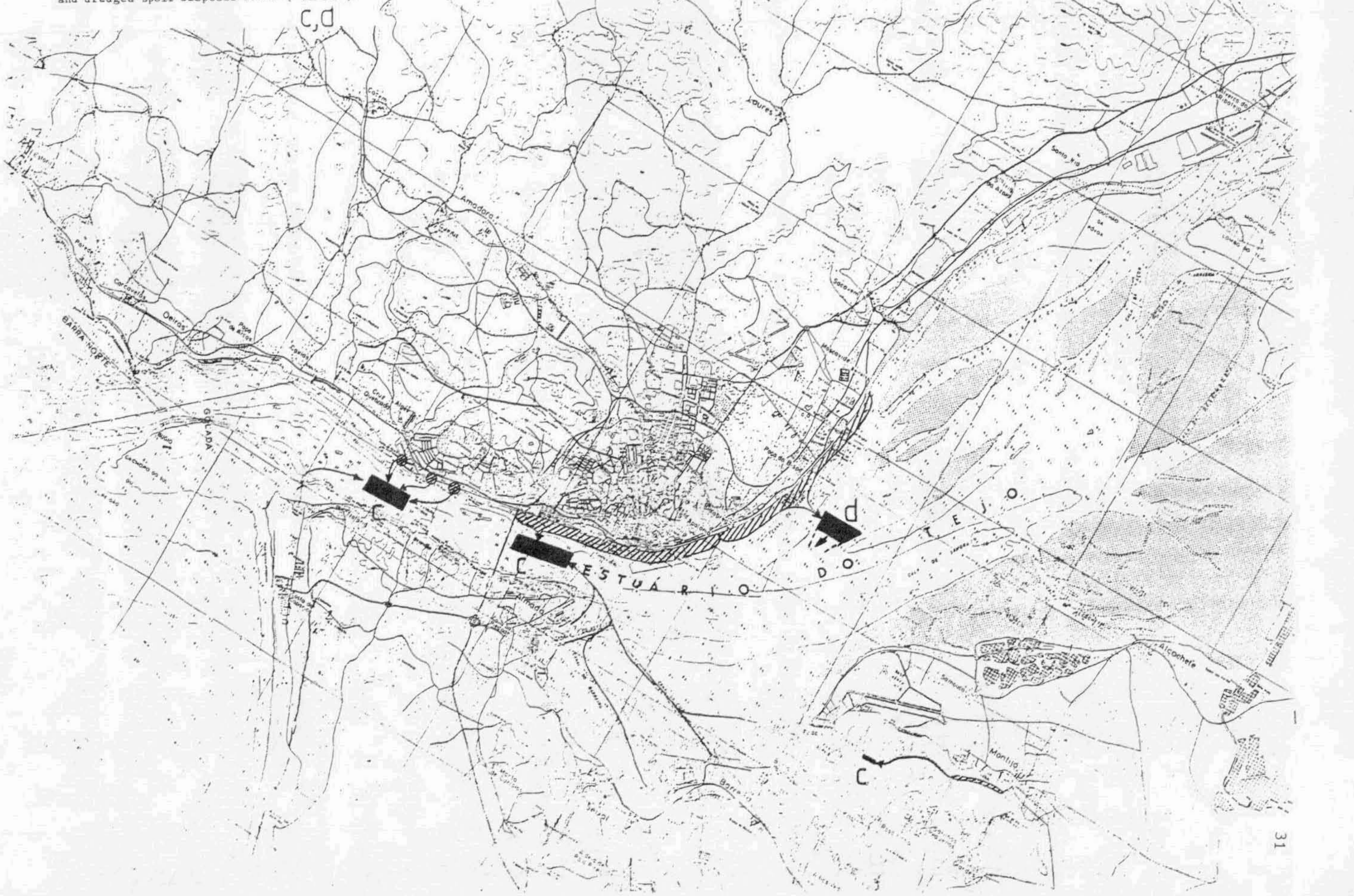
Fig. 1: Dredging ( ) and dredged spoil disposal areas ( )



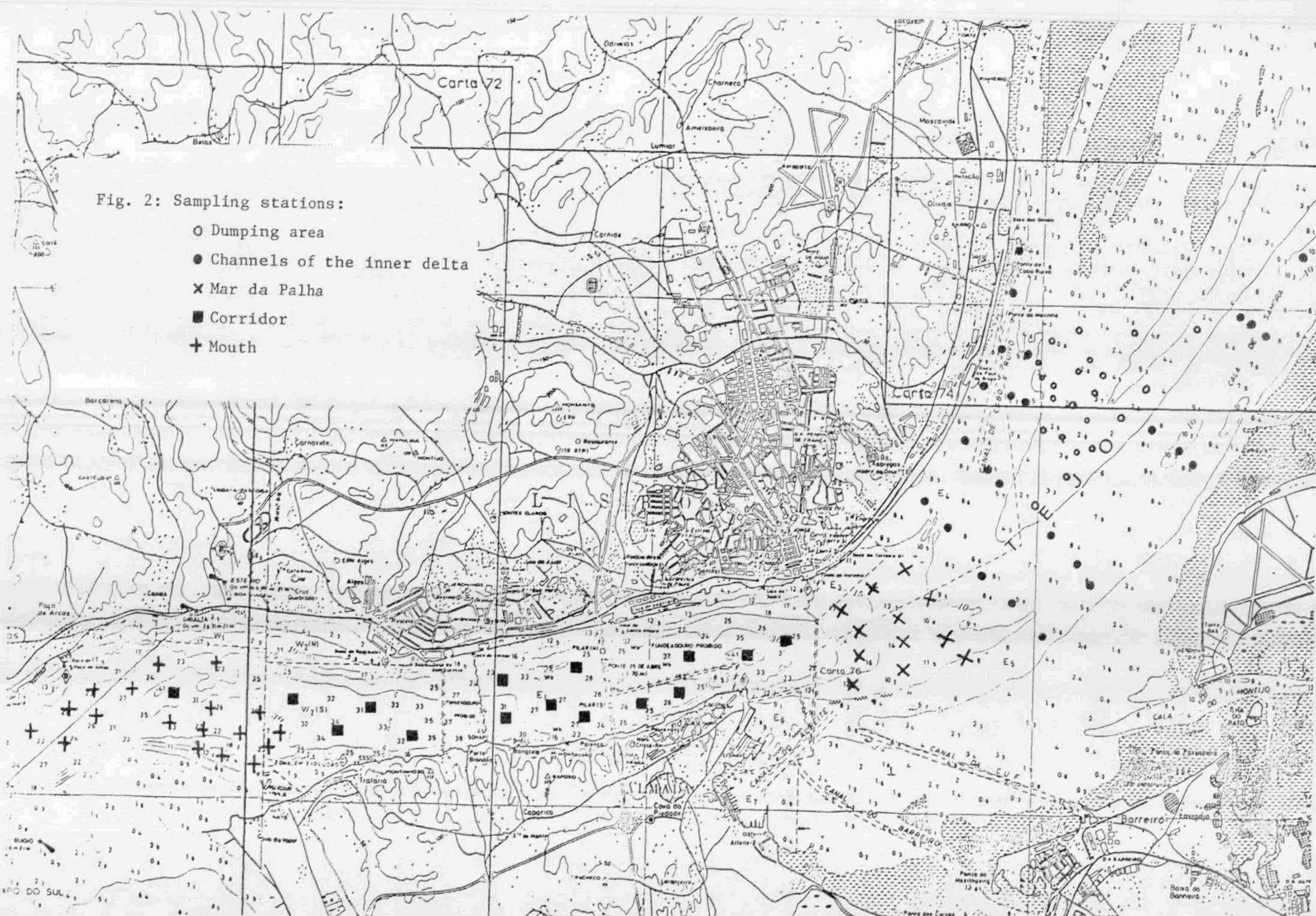
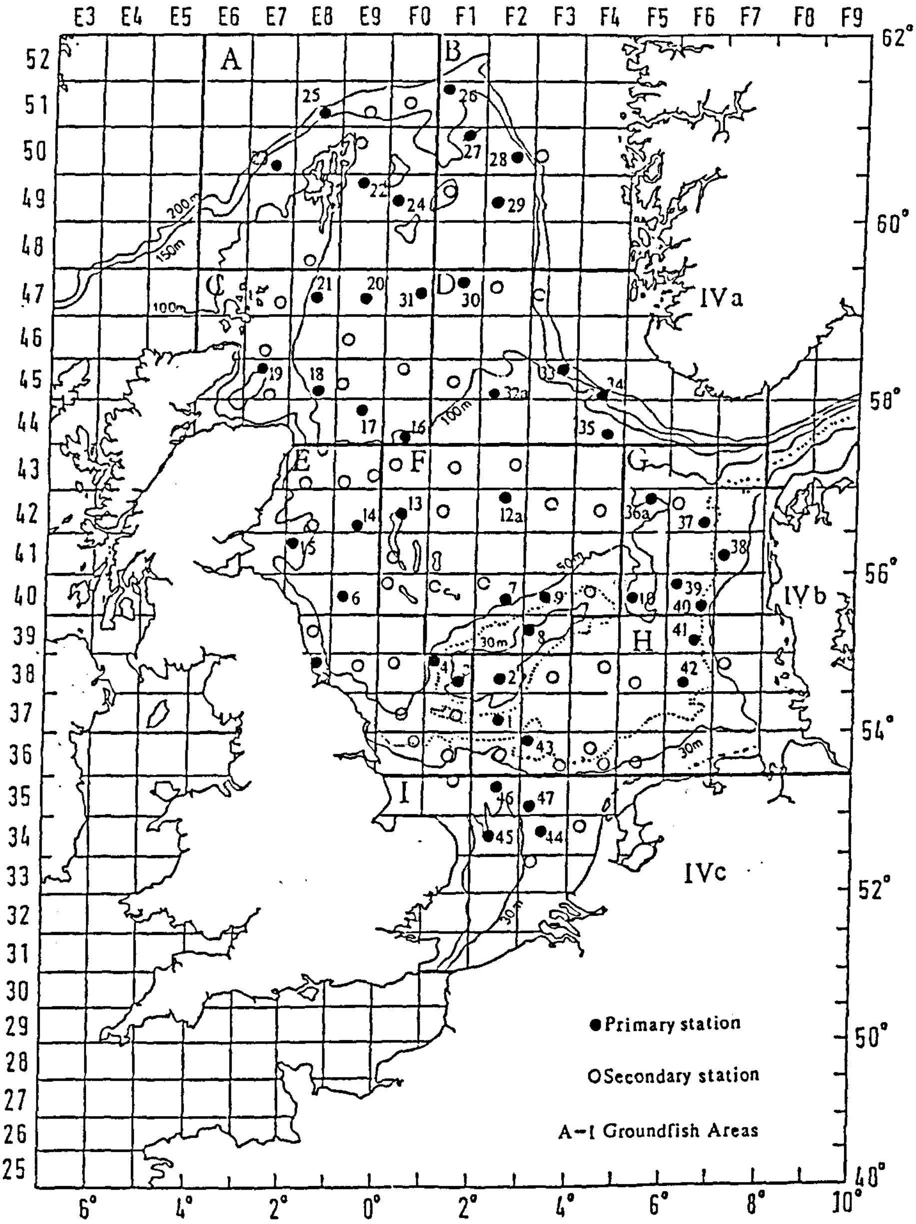
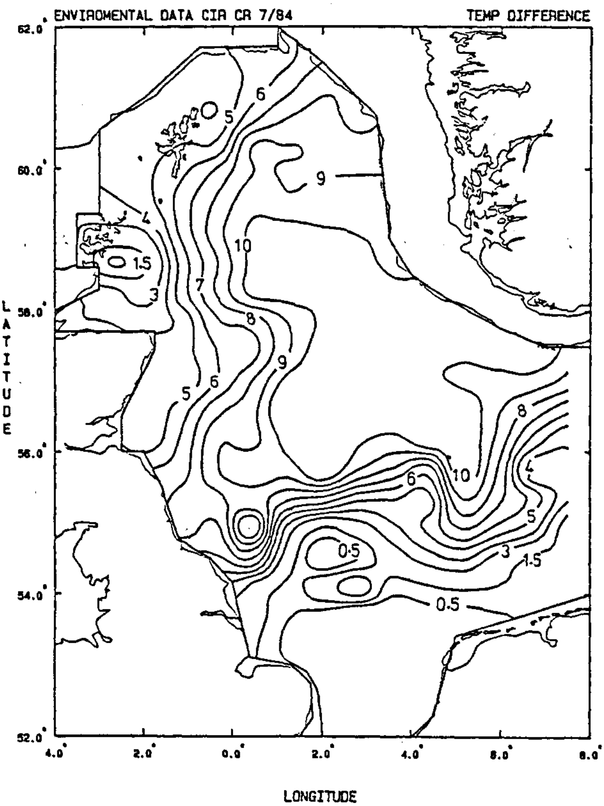


Fig. 2: Sampling stations:

- o Dumping area
- ● Channels of the inner delta
- × Mar da Palha
- ■ Corridor
- + Mouth

ANNEX 8 MAFF groundfish surveys: sampling positions and examples of contour plots





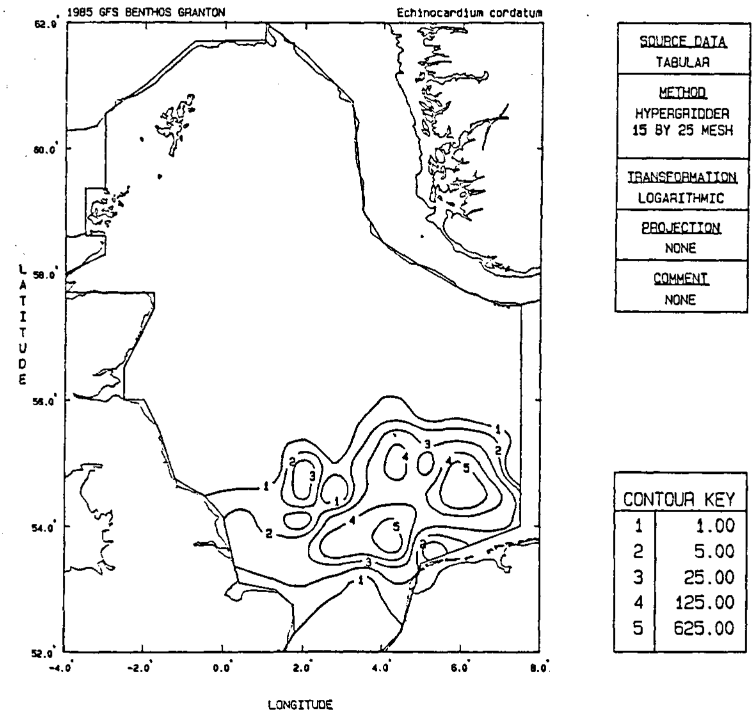
SOURCE DATA
TABULAR

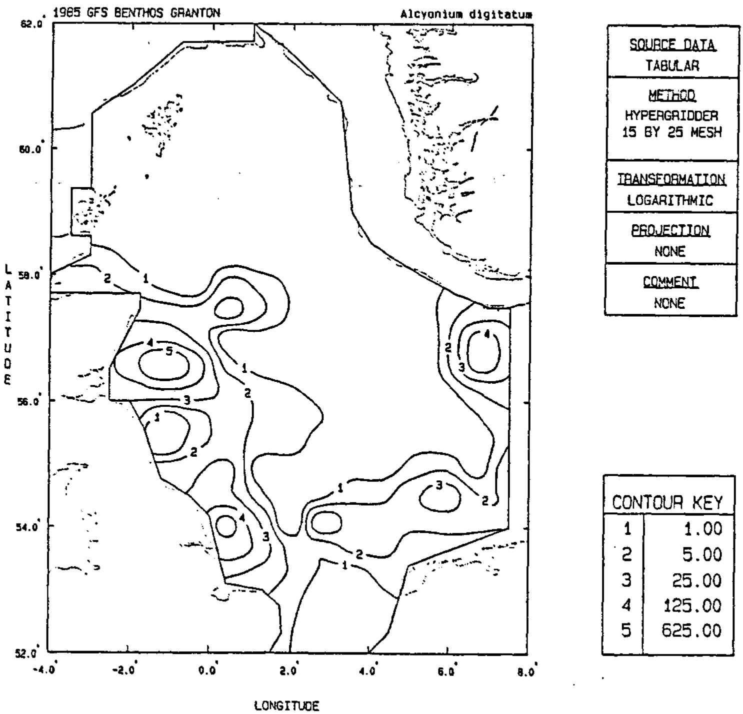
METHOD
HYPERGRIDDER
15 BY 25 MESH

PROJECTION
NONE

COMMENT
NONE

CONTOUR KEY	
1	0.50
2	1.50
3	3.00
4	4.00
5	5.00
6	6.00
7	7.00
8	8.00
9	9.00
10	10.00


1985 GFS BENTHOS GRANTON
Echinocardium cordatum
62.0°
60.0°
58.0°
56.0°
54.0°
52.0°
LATITUDE
-4.0° -2.0° 0.0° 2.0° 4.0° 6.0° 8.0°
LONGITUDE
SOURCE DATA
TABULAR
METHOD
HYPERGRIDDER
15 BY 25 MESH
TRANSFORMATION
LOGARITHMIC
PROJECTION
NONE
COMMENT
NONE
CONTOUR KEY
1 1.00
2 5.00
3 25.00
4 125.00
5 625.00


1985 GFS BENTHOS GRANTON
Alcyonium digitatum
62.0°
60.0°
58.0°
56.0°
54.0°
52.0°
LATITUDE
-4.0°
-2.0°
0.0°
2.0°
4.0°
6.0°
8.0°
LONGITUDE
SOURCE DATA
TABULAR
METHOD
HYPERGRIDDER
15 BY 25 MESH
TRANSFORMATION
LOGARITHMIC
PROJECTION
NONE
COMMENT
NONE
CONTOUR KEY
1 1.00
2 5.00
3 25.00
4 125.00
5 625.00