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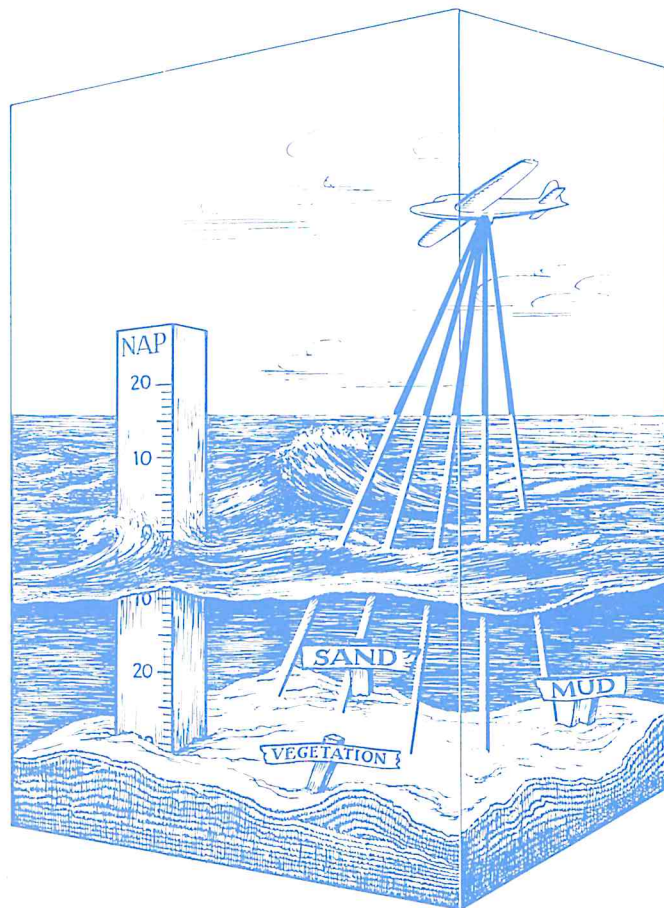
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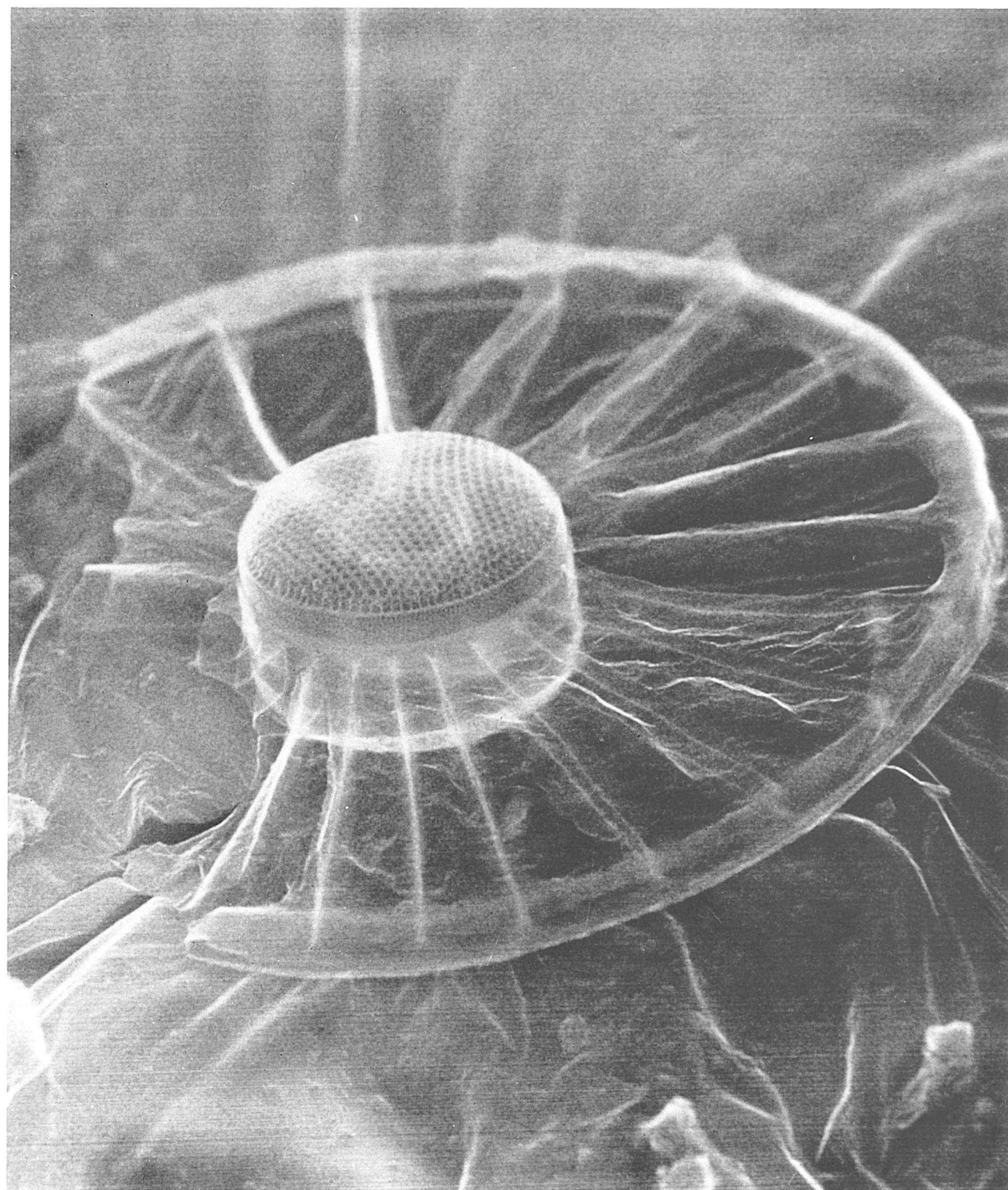
NETHERLANDS INSTITUTE FOR SEA RESEARCH

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1. Scientific activity

1.1. INTRODUCTION

1988 was a year marked by a number of important decisions on the future structure of the organization of the marine research in the Netherlands which is funded by the Ministry of Education and Science.

The first decision is that the Nederlands Instituut voor Onderzoek der Zee, NIOZ, has opted for the Netherlands Scientific Research Organization, NWO, as its future managing organization. The Minister of Education and Science had given the research institutes which he supports, including NIOZ, the choice between NWO, the Royal Netherlands Academy of Arts and Sciences (KNAW) and one of the universities. The institute would have preferred, however, to maintain the original construction with more direct links with the Ministry of Education and Science through the Dutch Zoological Society, NDV, who founded the institute in 1876 and under whose management it has been since then. An argument in favour of NWO is the possibility to create a relatively independent foundation NIOZ. This foundation will become effective in 1989. The English name of the institute will then be change from Netherlands Institute for Sea Research to Netherlands Institute for Oceanic Sciences.

The second important decision is the creation of the Netherlands Foundation of Marine Research, SOZ, also under NWO management, out of the Dutch Council of Oceanic Research (NRZ). SOZ, like the former NRZ, acts in principle as the central organization for marine research in the country, coordinating the research efforts of institutes and university groups interested and active in marine studies, in particular in open ocean research. It played a major role in organizing the Snellius-II Expedition to Indonesian waters, and coordinates for instance the Dutch Antarctic Programme (EPOS) and the Dutch participation in the Ocean Drilling Programme (ODP). NIOZ, as the major oceanographic institute in the Netherlands, has strong bonds with this organization, and the fact that SOZ will now have a structural budget for ocean studies ensures future Dutch participation in ocean research with the research vessels 'Tyro' and 'Tydeman'.

The third important decision is that the Delta Institute for Hydrobiological Research, DIHO, at Yerseke, our sister marine institute in the south of the country, will stay with the KNAW. In many ways this is regrettable, as future scientific integration at the management and financial levels of NIOZ and SOZ with DIHO will become more difficult.

Cooperation of NIOZ with universities involved in marine research has been

strengthened. In addition to the already existing agreement on cooperation with the University of Groningen (Marine Biology), similar agreements have been made or are in preparation with the University of Utrecht (Physical Oceanography, Sedimentology, Marine Geochemistry) and the Free University, Amsterdam (Marine Geology). The agreements involve for instance joint courses at the universities and NIOZ, as well as joint responsibilities for the education and training of Ph.D. students.

The major scientific activities of NIOZ in 1988 concerned research in the Wadden Sea, North Sea, Atlantic Ocean, Black Sea, Mediterranean and Antarctic waters. Research was carried out on board RVs 'Tyro', 'Tydeman', 'Aurelia' and 'Navicula', but in addition NIOZ scientists took part in cruises of the German RVs 'Polarstern', 'Friedrich Heincke' and 'Meteor', the American RV 'Knorr', and the British RVs 'Challenger' and 'Discovery'.

Our long-term series of investigations in the Wadden Sea on primary and secondary productivity and biomass in the pelagic and benthic systems have revealed parallel upward trends over the years which are thought to be related to increased eutrophication of the coastal system of the North Sea during the last decades. Reactions of increased productivity by for example benthic organisms are clearly observed, while there are also indications that a maximum impact level may have been reached: during the summer of 1988, locally oxygen deficiencies caused mortality in a few sensitive benthic species. The specially funded research group on applied ecological scientific research in the North Sea and Wadden Sea (EON, see Annual Report 1987) has completed and published an ecological model of the western Wadden Sea, which for this purpose is subdivided into 12 compartments. This Wadden Sea Ecological Model has been constructed to find and forecast, within certain limits, the impact of a number of stress factors, either persistent or occurring incidentally, on the ecosystem of parts of the Wadden Sea, and is therefore a basic tool for the environmental management of this system.

The North Sea is a main area of investigation for the NIOZ, and research has been carried out with our own vessel 'Aurelia' and on vessels of other institutes of countries bordering the North Sea. As part of an ICES programme, a synoptic mapping of the North Sea benthic fauna has been completed, both for biomass and diversity of species, as a baseline for impact studies in the North Sea, such as those carried out on the effects of drilling mud disposal around platforms.

The BEWON group, until 1988 (as EON) devoted to ecological research and modelling in the Wadden Sea, is now concentrating its efforts on the ecosystems of the North Sea. A combined NIOZ-BEWON cruise has been carried out with RV 'Tyro' to study the impact of vertical mixing on the primary production in the area north of the Dogger Bank, using the experiences of the Frisian Front study as a basis. Storms in summer may open thermocline-layered systems, the reason why this project was called WINDOW. Results of these studies are complementary to those of the British RV 'Challenger' cruises in the North Sea, in which NIOZ contributes the zooplankton studies. NIOZ investigations on pelagic microorganisms have been carried out on the German RV 'Friedrich Heincke'.

Two Atlantic research programmes were carried out with the RV 'Tyro'. The first was the APNAP project together with among others the Free University, Amsterdam, the second a multi-disciplinary project in the coastal waters of Mauritania, carried out together with the Research Institute for Nature Manage-

ment (RIN), the Delta Institute for Hydrobiological Research (DIHO), the State Museum for Natural History, Leiden (RMNH) and the University of Groningen (RUG).

The main objective of the APNAP cruise was to estimate organic C mineralization rates in the sediment as a function of overlying water productivity.

The Mauritania programme concerned ecological and ecotoxicological research in the Mauritanian coastal and estuarine system, concentrating on hydrology, benthic flora and fauna, and behaviour and physiology of overwintering palaeartic bird populations in the area. NIOZ and RMNH carried out the coastal and offshore research on board of the RV TYRO and RIN and DIHO the estuarine aquatic and bird investigations.

In the Antarctic the joint European EPOS (European Polarstern Studies) started with legs 1 and 2, in which 14 NIOZ scientists and technicians participated. EPOS was initiated and organized by the European Science Foundation (ESF) to study the ecology of the Southern Ocean; RV 'Polarstern' was placed at its disposal by the FRG. A total of about 130 scientists from institutes of 11 European and other countries participated in the exercise. So far these multi-disciplinary cruises have produced very interesting results, in particular concerning ice-biology, and the factors limiting primary production in the area investigated, the Weddell-Scotian Confluence.

The chemistry of rare earth elements (REE) in the oxic-anoxic pelagic system of the Black Sea was studied on board the American RV 'Knorr'. NIOZ also participated in two cruises with the German RV 'Meteor', one in the mid-Atlantic for macrofauna sampling in the NEA dump-site for low radioactive material, and one between Greenland and Bear Island. Current meters were deployed between Greenland and Jan Mayen by the Icelandic RV 'Bjarni Saemundsen'.

Within the EROS-2000 (European River Ocean System 2000) programme, NIOZ participation was ensured on board the British RV 'Discovery', during a cruise in the Golfe du Lion, Mediterranean. These studies started already in 1987 with a cruise by RV 'Tyro'.

NIOZ participated intensively in the first EUROMAR (EUREKA/37) Technological Market in Scheveningen (Neth.), jointly organized by the SOZ and the Directorate North Sea of the Rijkswaterstaat. The aim of the market was to bring together manufacturers interested in producing marine equipment for the international market and to obtain EUREKA funding for the development of such products. It has become clear that the technological knowledge available in marine institutes, such as NIOZ and other institutes of its size, is vital to the development of marine equipment, since a thorough firsthand knowledge on the requirements for work at sea is essential. Two instruments developed at NIOZ, a mesocosm and an underwater particle camera, were presented.

In 1988 the Ministry of Education and Science has granted funds for the planning of a new NIOZ research vessel for the North Sea to replace the 33-m-long RV 'Aurelia' in 1990. The plans developed are of a 65-m-long vessel with room for six laboratory containers.

The facilities of NIOZ to host courses and meetings have been used in 1988 for the two regular NIOZ graduate student courses in Oceanology and in Marine Biology, but also for an international Advanced Course in Microbial Ecology. A major meeting attended by ca. 200 participants from 10 countries was jointly organized by NIOZ and the Tidal Waters Division of the Rijkswaterstaat with the aim to present an overview of the present state of knowledge on

the North Sea ecosystem. Such an evaluation was timely in view of the present great concern about the area by the governments of countries bordering the North Sea. Valuable reviews on physical, chemical and biological aspects of the North Sea were presented, as well as a limited number of specialized papers indicating directions for future research. Another meeting was held on the aspects of sea-level rise, jointly organized by NIOZ, RIN and the Ministry of Housing, Physical Planning and Environment. The proceedings of both meetings will be published as special volumes of the Netherlands Journal of Sea Research.

The Netherlands Journal of Sea Research appeared in its four regular issues. One of these was the first in a special series of six issues on the joint Indonesian-Dutch Snellius-II Expedition of 1984/1985, on which a symposium was held in Jakarta, November 1987.

NIOZ has a national task in the pooling of ocean-going equipment, for which it has a contract with the SOZ (Netherlands Foundation of Marine Research). The institute has the responsibility for the construction, maintenance, supply and operation of container laboratories, winches, special equipment on board RV 'Tyro' and 'Tydeman'. Seven technicians are involved in maintenance and operation of this equipment pool.

The progress of NIOZ research in 1988 is presented in chapters dealing with estuarine research (1.2.), research in the North Sea (1.3.), ocean research (1.4.) and special projects (1.5.). The code numbers (*e.g.* H1-04) in the left margin refer to project numbers listed in section 1.7.

J.J. Zijlstra

E.K. Duursma

E. van Abs

1.2. ESTUARINE RESEARCH

1.2.1. Chemical research

1.2.1.1. Carbon dioxide

H1-04

J.W. Rommets, J.M.J. Hoppema

The seasonal cycle of the carbon dioxide system in the sea is studied and in addition to the measurements made earlier complementary data were gathered during three trips in the Marsdiep area. Determinations of alkalinity, TCO_2 and oxygen were performed at an anchor station during a full tidal period and at stations distributed over the area. No difference existed between surface and bottom samples, but locally, for instance at the anchor station Wierbalg, distinct deviations were found from the general alkalinity distribution of the area. A possible cause of the observed phenomenon is a supplementary freshwater source, the North Holland Canal, sluicing water of very high alkalinity.

1.2.1.2. Nitrogen

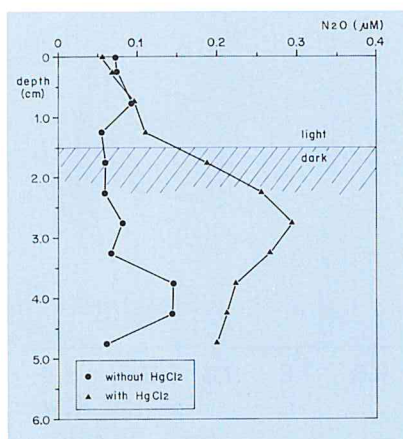
H1-02/H1-03

W. Helder, W.M. Kieskamp

It was demonstrated that mercury(II)chloride (used as inhibitor in the assay of N_2O -profiles in sediments) caused an increase in the N_2O -concentrations by reacting with FeS . This reaction resulted in an increase in dissolved Fe^{2+} , which reduced chemically NO_2^- to N_2O .

Together with Hans de Heij (student of RUG) the research on the inhibitory action of sulphide on the nitrogen cycle was continued. Results of previous experiments indicated that S^{2-} inhibits the denitrification process. Preliminary results of batch denitrification showed that low concentrations of sulphide already inhibit the last step of this process and cause an accumulation of N_2O .

Experiments on the sediment-water exchange of N_2O were started with sediments of the Mokbay, Texel. There is a low flux of N_2O in these sediments.



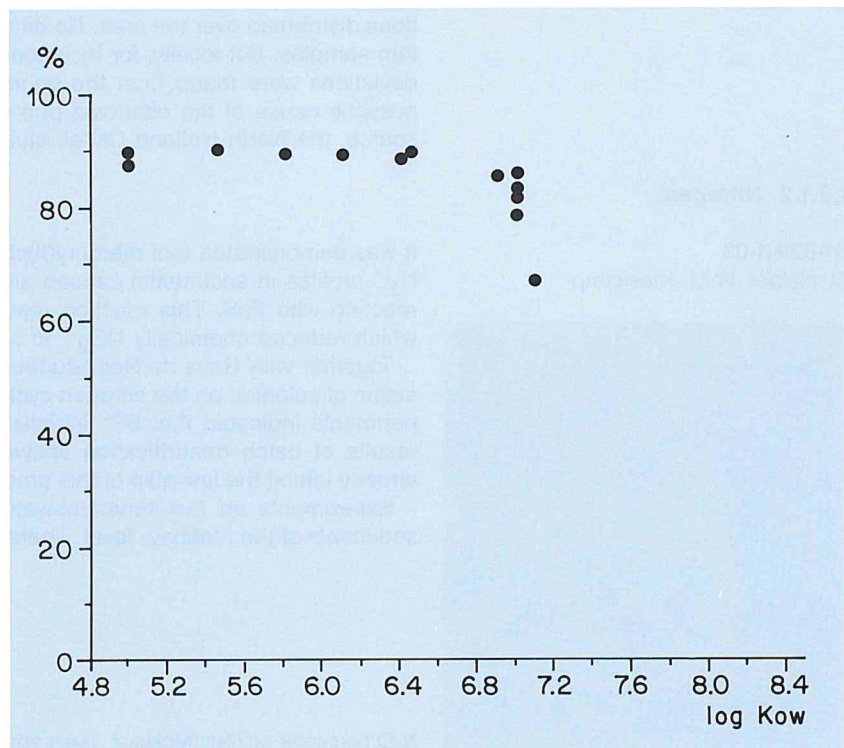
N_2O porewater profiles (Mokbaai, Texel) from cores treated with HgCl_2 and without HgCl_2 .

1.2.1.3. Distribution of metals

H1-07
R.F. Nolting

Measurements of the major elements Si, Al, Fe, Mn, Ti, Ca, Mg and K, and the trace elements Cu, Zn, Cd, Cr and Pb in the suspended matter of the rivers Rhine, Meuse and their estuaries have been worked out. The difference in Ca content in the suspended matter collected in the estuarine zone (Maassluis) and in the freshwater end members Rhine and Oude Maas showed that physical mixing was the major process regulating the suspended matter behaviour in the estuarine zone. Compared to the other areas, trace element concentrations were highest in suspended matter collected near Rotterdam. This could be explained by a selective removal of particles with a low trace element content, before they reach this area. Thus local input in the Rotterdam area is of minor importance. Particles with a high trace element content, however, do not reach the outer estuary but are trapped in the Rotterdam harbour at the early stages of mixing of fresh and marine waters. The influence of the river Meuse on the Rhine-Meuse estuary is minor ($\pm 10\%$). It can be concluded that the Rotterdam harbour acts as a sink for particles enriched in trace metals. Further downstream, physical mixing of resuspended bottom sediments and fluvial suspended matter regulates the suspended material transported seawards.

1.2.1.4.
Extraction efficiency (expressed in %) vs. the hydrophobicity of single PCB congeners in spiked seawater from the NIOZ seawater-supply system. Hydrophobicity is expressed as $\log K_{ow}$ (log octanol-water partition coefficient) and is an experimentally determined value of the distribution of PCB components between octanol and water.



1.2.1.4. Chlorinated hydrocarbons

H1-06
M.Th.J. Hillebrand

The research area of the marine pollution group was extended to marine organic chemistry in a broader sense. This required investments in laboratory facilities and analytical instruments. The laboratory was rebuilt and available space was doubled; two new gas chromatographs were installed. The time-consuming and complex handling of the gas chromatograph output was completely computerized. The existing mass-spectrometer was upgraded with memory and data storage extension. The introduction of liquid-liquid chromatography was started. This powerful separation method offers the opportunity to separate environmental samples into different groups of compounds.

Research on the liquid-liquid extractor was continued. During laboratory experiments the extraction of chlorinated hydrocarbons from filtered and spiked seawater obtained from the NIOZ seawater-supply system showed a fairly good extraction efficiency. Such values could not be reproduced in seawater obtained from the Wadden Sea and North Sea. N-hexaan which was the solvent in use will be replaced by dichloromethane or Freon in an attempt to exclude this matrix effect. These experiments have been carried out in cooperation with the Delta Institute, Yerseke.

1.2.1.5. Sediment-water exchange

H1-05
L. Gerringa

Exchange of trace metals

The effects of aerobic and anaerobic degradation of organic matter in sediments upon the mobility of metals (Cu, Cd, Pb, Ni) have been studied. Under aerobic conditions Cu, Cd and Pb are present in the sediment in a more available form than under anaerobic conditions. The availability of Ni in the sediment does not change with redox potential. The concentration in water under aerobic conditions is governed for each metal by different factors and processes. Cu and Cd are released during aerobic degradation of particulate organic matter; a fixed relationship exists between the production of inorganic N and the release of these metals from the sediment to the water. The concentration of Ni and Cu in the water is influenced by the concentration of dissolved organic carbon. The concentration of Ni is instantly increased upon addition of organic ligands to the water. The Cu concentration changes more gradually upon such an addition. The concentration of Pb stays more or less constant; no relation could be found between degradation processes and the Pb concentrations.

Under anaerobic conditions, no Cd, Cu and Pb could be measured in solution. However, if enough organic ligands are present in solution, Ni is released from the sediment into the solution.

Exchange of organic micropollutants

The flux of some hexachlorocyclohexanes, chlorinated benzenes and PCB's from the water column to the sediment has been studied. Organic pollutants were added to the water column of two microcosms in which the bottom shear stress was maintained at 14 and 55 mN·m⁻². Suspended matter concentrations were 25 and 100 mg·dm⁻³, respectively. After 50 hours the distribution

H1-11
K. Booij

of pollutants in the sediment was determined. The rate of removal from the water column was nearly independent of pollutant hydrophobicity and water flow conditions. Concentration profiles of the pollutants in the sediment phase were also virtually independent of hydrophobicity and water flow conditions. All concentration gradients in the sediment phase extended over 2 cm. The rate of removal from the water column could be described by a first order process. These results indicate that the transport resistance between sediment phase and pore water may be important on the time scales of a few days.

This project is carried out in collaboration with B. Sundby, Maurice Lamontagne Institute, Canada.

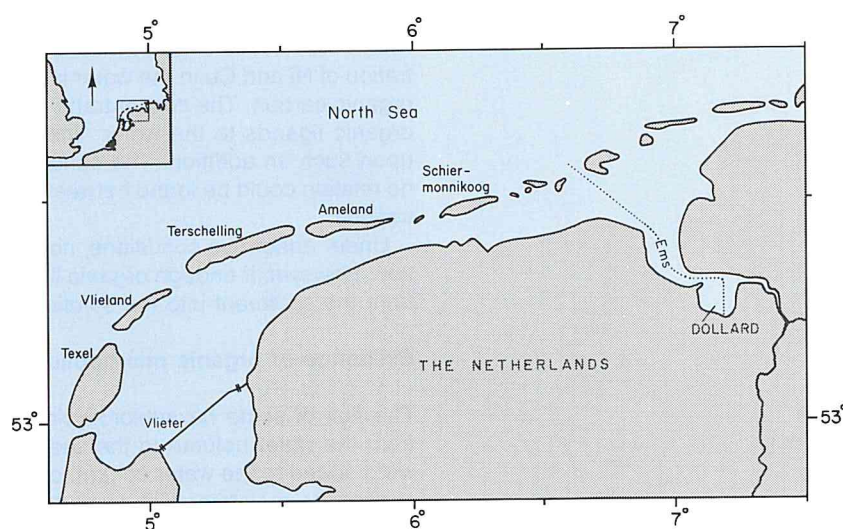
1.2.1.6. Sublethal effects of pollutants

Heavy metals

H1-08

J.M. Everaarts

The uptake of Cd by the mussel *Mytilus edulis* at a high ambient concentration of $50 \mu\text{g}\cdot\text{dm}^{-3}$ and the distribution in different body compartments (kidney, gill, hepatopancreas, mantle, muscle-tissue of the adductor and abductor muscles and the rest of the soft tissues, mainly foot) have been studied in a semi-chronic experiment at two temperatures. Besides this, the rate of Cd depuration from the different organs has been established. The rate of Cd uptake is highest in the kidney and accumulates to a concentration of almost $1000 \mu\text{g}\cdot\text{g}^{-1}$ dry weight after 50 days of exposure at 20°C . The Cd levels in the gill and the midgut gland (hepatopancreas) amount to 425 and $260 \mu\text{g}\cdot\text{g}^{-1}$ dry wt, respectively, after the same exposure time. At the ambient temperature of 15°C , the rate of uptake decreases in the following direction: kidney > hepatopancreas > gill > foot > adductor muscle > mantle. This sequence of rate of uptake changes at a higher ambient temperature (20°C): kidney > gill > hepatopancreas > foot > mantle > muscle-tissue.



Wadden Sea with geographical names mentioned in this report.

The depuration rate is highest during the first 4 days of exposure to control (clean) seawater. After 17 days of exposure to the same quality of seawater as used in the control experiment, the percentage of Cd-loss was highest in the kidney and lowest in the mantle. The depuration of Cd decreased in the sequence: kidney (65.1%) > foot (62.4%) > gill (60.3%) > hepatopancreas (49.2%) > adductor muscle (40.1%) > mantle (14.1%).

The uptake of Cu and Cd in some benthic organisms exposed to low concentration levels (close to ambient levels) has been determined under experimental conditions. In general, all species (the shrimp *Crangon crangon* and the bivalves *Mytilus edulis*, *Macoma balthica* and *Cerastoderma edule*) showed a well-marked difference in the concentration of both metals between control and exposed specimens, especially at the end of the exposure period. The theoretical concentration dosed in the experiments, varying from 0.15 to 0.85 $\mu\text{g}\cdot\text{dm}^{-3}$, is twice as high as the background level in the open ocean for Cd, but lower than its background level for Cu. In all experiments, the concentration of both metals in the tissue did not exceed the limit of concentration for human consumption.



Chlorinated hydrocarbons

H1-10

J.M. Everaarts, J.P. Boon (BEON),
M.Th.J. Hillebrand

Male and female flounders were injected with the technical PCB-mixture Clophen A40. The induction of the Mixed Function Oxygenase (MFO) enzyme system was studied in relation to the uptake of individual CB-congeners. No significant increases in 7-ethoxyresorufin-O-deethylase (7-EROD), 7-penthoxyresorufin-O-depenthylase (7-PROD) or total cytochrome P-450's were found. This was probably because the induction time between injection and sacrifice of the animals was too short and because the variation in enzymatic activities between individuals was too high, standard deviations being close to 100% of the measured values. The experiment will be repeated in 1989 with an adapted sampling scheme. No variations in MFO activities were observed between the two sexes or at different water temperatures (10, 15 and 20°C).

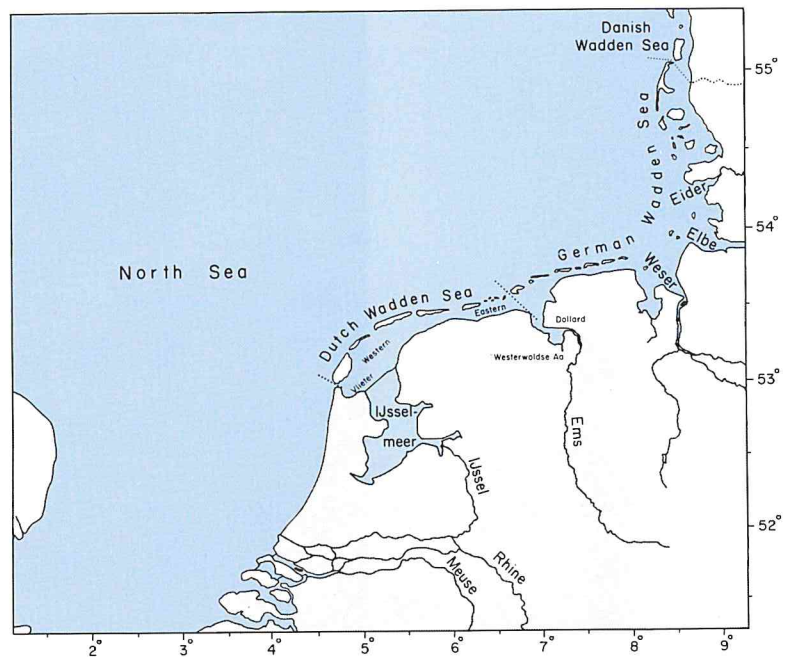
1.2.2. Physical research

Pycnocline-depth motions

H2-03

C. Veth, J.J.M. van Haren,
L.R.M. Maas

Some efforts have been made to improve the digital analysis of analogue echosounder signals by appropriate electronic filtering and digitizing operations. The aim of these efforts is to be able to observe reflections on particles gathered at the pycnocline, and thus to be able to study pycnocline-depth motions. This pioneering study is carried out in the Rotterdam Waterway in order to observe the occurrence of solitary waves.



Wadden Sea and Dutch coastal waters with geographical names mentioned in this report.

H2-05
J.T.F. Zimmerman

Gravitational circulation in estuaries

In collaboration with the Rosenstiel School of Marine and Atmospheric Sciences (Miami, USA) a review was made of the present knowledge on the theory of gravitational circulation in estuaries. Particular attention was given to the dynamics in the so-called 'diffusive limit', for which some new results regarding the salinity intrusion and strength of the circulation cell as a function of estuarine geometry were obtained. It has been shown that for funnel-shaped estuaries, the ratio of the intrusion length scale to the geometric length scale determines the shape of the longitudinal salinity gradient. For a strongly converging estuarine cross-section the characteristic S-shape of the salinity distribution is then recovered.

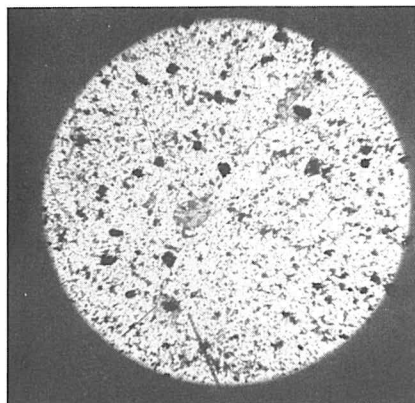
1.2.3. Geological research

H3-11
D. Eisma, T. Schuhmacher

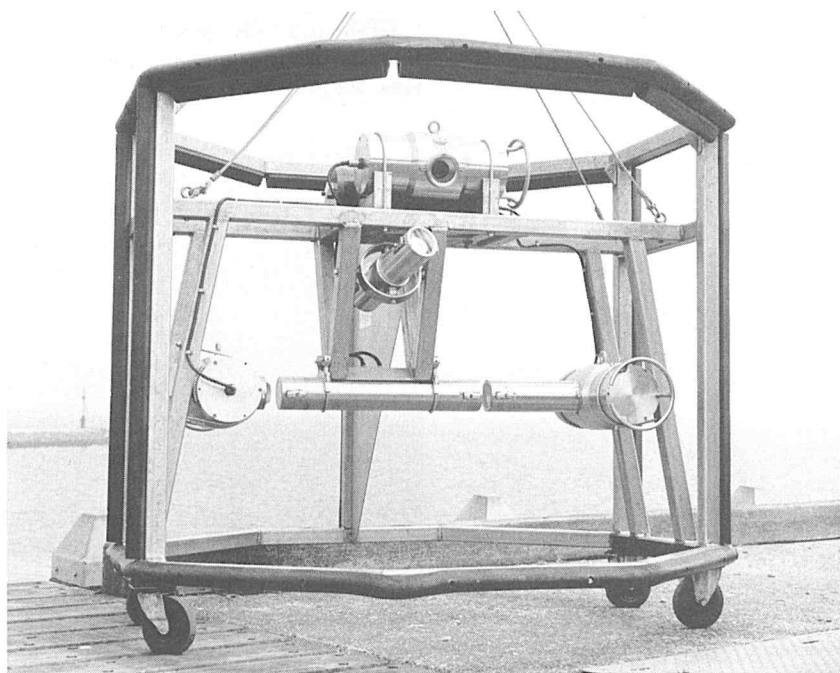
Flocculation and deflocculation of suspended matter

A. Spitzky (Geol./Paläont. Institute University Hamburg) and D. Eisma collected suspended matter and water in the Ems estuary, covering the lower reaches of the river as well, for analysis of dissolved and particulate sugars and fulvic acids. It is thought that these two substances are important in sticking particles together and, therefore, in the flocculation of suspended matter. The *in situ* suspension camera became ready for use and was tried out successfully.

Photograph taken with the *in situ* suspension camera



In situ suspension camera.



Sedimentation in the Wadden Sea

H3-12

D. Eisma, G.W. Berger

Mrs Zang Yong (East China Normal University, Shanghai, P.R. China) studied tidal channel migration in relation to tidal deformation and sediment particle size. Some additional measurements of current velocity and direction and of suspended matter concentrations were carried out in the Dollard in February. The results were discussed in Shanghai in October.

Dating with naturally occurring isotopes

H3-10

Zuo Zhizeng, G.W. Berger, D. Eisma

Zuo Zhizheng (Institute of Geography, Academia Sinica, Nanjing, P.R. China) in December 1987 started with α - and γ -spectrometry in cores from the Oyster Grounds. A second series was collected in May 1988. The analysis of the first series was completed in August. Moreover, α - and γ -spectrometry in cores from the shelf in the East China Sea collected with RV 'Sonne' in 1987 was carried out by Chen Shumin (East China Normal University, Shanghai, P.R. China).

The project ' ^{210}Po in Dutch coastal waters' was continued. After ingrowth of a new generation ^{210}Po , the samples were analysed again. The results indicate that an important source of ^{210}Po is the effluent of phosphate industries in the Rotterdam harbour area. Although this project will be continued, the results obtained so far will be published as a NIOZ Report.

Two projects have been started at the request of and financially supported by the Ministry of Transport and Public Works. The first project is 'Sedimentation rate estimation in the Western Scheldt', the second 'Dating of sediments with ^{210}Po and cesium isotopes in the Wadden Sea'. The first project is finished and will be reported as a NIOZ Report; the second will be finished in 1989.

In cooperation with the University of Nijmegen, dating of cores taken in the estuary of the Sabaki river in Kenya has been started.

^{226}Ra and ^{222}Rn analyses of samples collected during the Snellius-II expedition have been completed and resulted in two papers published in Neth. J. Sea Res. 22 (4).



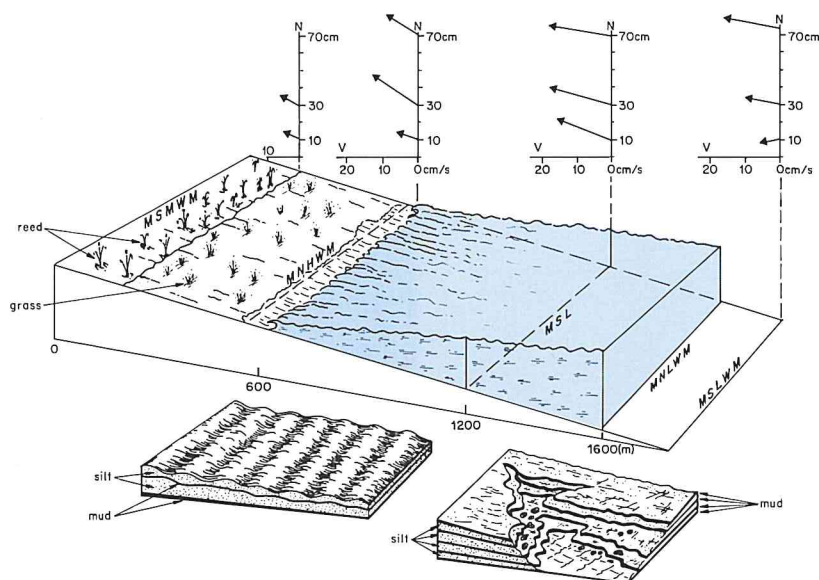
H3-13
D. Eisma

Cooperative research with P.R. China

Prof. Wang Baocan (East China Normal University, Shanghai, P.R. China), who stayed at NIOZ from May to August to study literature on tidal flat sedimentation, and D. Eisma finished three joint papers on north Hangzhou Bay tidal flats, on the comparison between Chinese tidal flats and the Wadden Sea, and on the sedimentary history of the Nanduijiang delta in Hainan. Chen Shumin (East China Normal University, Shanghai) continued the XRD analyses started by Ji Zhong in 1987 on the tidal flat sediments and sediments from the shelf in the East China Sea, and carried out α - and γ -spectrometry in cores from the East China Sea collected in 1987 with RV 'Sonne' as part of a Chinese-West-German cooperative programme.

D. Eisma and B. Kuipers visited Shanghai in September-October to study tidal flat sediments and mangrove sedimentation (Hainan), and D. Eisma participated in a geochemical programme in the mouth of the Chang Jiang, as part of a Chinese-French cooperative programme. Suspended matter and bottom sediment were collected for the analysis of grain size and composition (sorting effects). In November, in cooperation with the Institute for Marine Geology in Qingdao, sedimentation on four tidal flats along the Huang He delta was studied. Sediment cores were collected, profiles were measured and suspended matter samples were collected for total concentration and particle size.

Besides with the East China Normal University in Shanghai, a cooperative programme with the 2nd Institute of Oceanography in Hangzhou was granted for 1988/89. T.C.E. van Weering and G.W. Berger went to Hangzhou in October to study tidal flat sedimentation along south Hangzhou Bay, and after that visited the Huang He delta and the 1st Institute of Oceanography in Qingdao.



General diagram of tidal flats at North Hangzhou Bay. Supratidal flats covered with reeds and grass. Flaserbedding and alternating silt-clay in the intertidal part, and view of erosional puddle with low scarps and clayballs. The arrows indicate velocity and direction of the flood during submergence.

1.2.4. Biological research

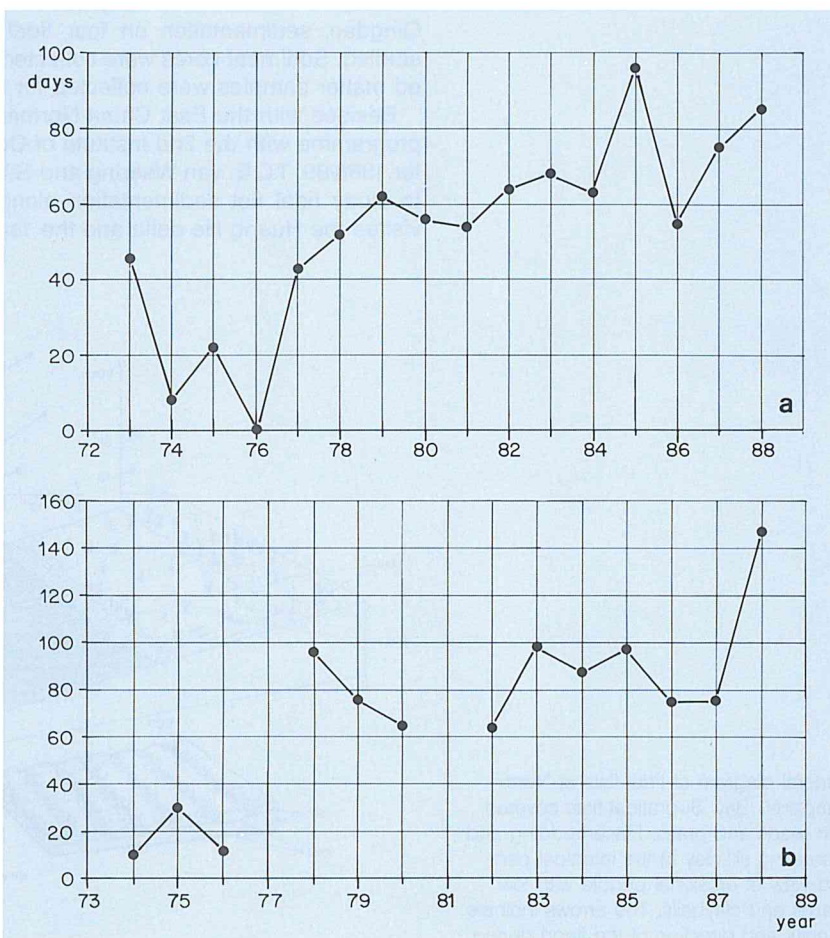
1.2.4.1. Phytoplankton

B3-01

G.C. Cadée

The regular high-water sampling at the NIOZ Marsdiep jetty was continued and phytoplankton primary production data for 1985 and 1986 were worked out. Primary production remained high in these years (resp. 390 and 370 g C·m⁻²·yr⁻¹), which means a doubling since the seventies, but no further increase since 1981/82.

The phytoplankton succession in 1988 was exceptional: diatoms were poorly represented in spring, probably due to the relatively high water temperature, and only an insignificant spring peak developed with a maximum of 4000 cells·cm⁻³ on April 6. The colonial flagellate *Phaeocystis* was already encountered in our samples in February and increased in March before the diatom peak, suggesting the simple succession of diatoms followed by *Phaeocystis* to be more complicated than thought earlier: it is not a taking over



The colonial alga *Phaeocystis* has been increasing regularly in the Marsdiep tidal inlet since the early seventies as indicated by (a) the increase in length of the spring bloom and (b) the increase in total length of the blooms (periods with >1000 cells per cm³). In 1988 *Phaeocystis* bloomed ca 5 months in total.

by *Phaeocystis* after diatoms have depleted Si, but a more or less parallel increase in diatoms and *Phaeocystis* with the latter being able to continue longer. The *Phaeocystis* spring peak lasted for about 3 months (85 days >1000 cells·cm⁻³). The spring peak value (50 000 cells·cm⁻³, April 18) was not exceptional, the highest peak value being up to now 190 000 cells·cm⁻³ observed in 1985. In total *Phaeocystis* occurred this year >5 months in numbers >1000 ·cm⁻³, which was far longer than observed earlier (maximum of 100 days), suggesting a continuing increase in dominance of *Phaeocystis* in Dutch coastal plankton.

1.2.4.2. Activity and dynamics of microorganisms

B1-02
J.H. Vosjan

Microbial research in the Dutch Wadden Sea was carried out during a cruise with RV 'Navicula' from 28 March to 1 April. The respiration activity and biomass of microorganisms were estimated in the western Wadden Sea and in tidal inlets during tidal periods. As part of the BION-project 437.022 B0 (Van Gemerden, Vosjan, Visscher) an inventory of laminated microbial ecosystems in the sediments of the western Wadden Sea (near Vliesloot, Scheurrak and Balgzand) was started. These three locations were surveyed for the presence of anoxygenic phototrophic microorganisms and sulphate reducing bacteria. Though both functional groups of bacteria are considered to be anaerobes, relatively high numbers were found in oxic strata, viz. 10^4 phototrophs and 10^3 sulphate reducers per dm³ determined by the MPN (Most Probable Numbers) technique. This method is known to give an underestimation of 1-2 orders of magnitude. Enrichment culture yielded both purple sulphur and green sulphur bacteria, of which the latter were never found to be abundant in Wadden Sea sediment. The undergraduate student H. de Hey (RUG) measured sulphate-reduction rates in Mok Bay sediment. About 16 to 116 g organic carbon per m² per year was mineralized by these processes, depending on the type of sediment. In the sediment the pools of reduced sulphur compounds were estimated. During the 'Advanced Course in Microbial Ecology', organized by J.H. Vosjan and A.J.B. Zehnder, four groups of students from different European and overseas countries studied microbiological processes and cycles in the Mok Bay during a stormy period in September.

1.2.4.3. Protozoans

B1-06
R.P.M. Bak

Populations of small protozoa (<20 μ m) have been studied in the water column and sediment of the Wadden Sea, North Sea and in the Atlantic Ocean off the coast of Mauritania. Observations on densities of ciliates and bacteria are included whenever feasible.

In the benthos of the Wadden Sea there are clearly two levels of population density: a winter background level (in the 3 mm top layer of the sediment $50\text{-}100\cdot 10^3$ cells cm⁻³) and a summer level (same layer $150\text{-}300\cdot 10^3$ cells cm⁻³). After the winter period, peak densities are reached in March and July, but densities are significantly lower in May. At all localities (Oost Meep, Scheurrak/Omdraai and Balgzand) the general decline to winter background values already manifests itself distinctly in September. Throughout the year, at each site and at all depths sampled at least 50% of the cells are in the 2-5 μ m size class. This is followed in abundance by the 5-10 μ m size class.

When the biomass of small protists is estimated from cell volume and cell concentration, extrapolation shows maximum and minimum values of 8.5 and $1.2 \times 10^{-6} \text{ g C} \cdot \text{cm}^{-3}$, respectively, for the upper sediment layer. About one third of these cells is autotrophic.

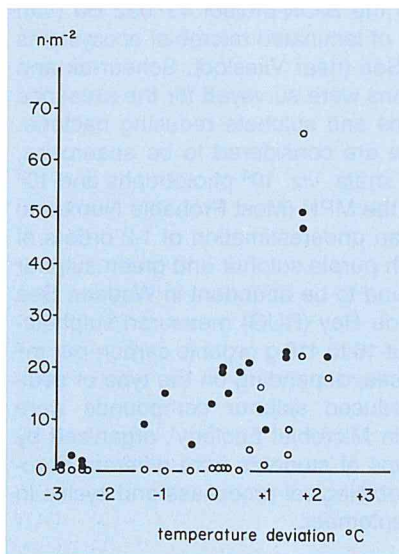
Relations between protozoan densities and parameters such as bacterial density, bacterial production, porosity, bottom respiration, POC (measured in a cooperative programme) *etc.* are not clear. But densities are significantly lower at temperatures below zero.

Small protists, ciliates and bacteria are monitored in natural Marsdiep water.

1.2.4.4. Trends in macrobenthos on tidal flats

B3-02

J.J. Beukema



Several species living on the tidal flats of the Wadden Sea are sensitive to low winter temperatures and show higher numbers in early spring after mild than after cold winters. Examples are shown for two worms *Nephtys hombergii* (●) and *Lanice conchilega* (○). *Lanice* proved to be the most sensitive species; it disappeared completely after colder-than-average winters. *Nephtys* declined to low numbers only after really severe winters.

B3-02b

J.J. Beukema

Production and dynamics

Long-term investigations (started in 1969) on the intertidal benthic macrofauna in the western part of the Wadden Sea have been continued. The usual sampling schedule yielded the twice-annual data on numbers, biomass, recruitment, survival, growth rates and production of several tens of species of molluscs, polychaetes and crustaceans.

The samples taken during 1988, after the exceptionally mild winter of 1987-88, yielded the expected results: — high rates of over-winter survival in the species which are known to be sensitive to low winter temperatures, — early appearance on the tidal flats of the new generations of crabs and shrimps, — low reproductive success of bivalves.

The increasing trends of biomass values which had been observed in about half of the species over the last 10 to 20 years continued. These trends were clear not only in the twice-annual samples taken in the limited Balgzand area (50 km² of tidal flats), but throughout the tidal flats (about 400 km²) of the western half of the Dutch Wadden Sea. In fact, the Balgzand area proved to be highly representative of all of this vast area.

The increasing trends are ascribed to the eutrophication of the Dutch coastal waters. In the western part of the Wadden Sea, the rate of eutrophication appears to have accelerated during the last decade as a consequence of the discharge of fresh water from Lake IJssel into the Wadden Sea, which water has only recently become very rich in nutrients near the sluices. The first signs of problems caused by lack of oxygen became apparent during the summer of 1988, a summer exceptionally poor in sunny weather. Locally on the tidal flats total mortality in a few benthic species was noted.

Part of the available set of data on macrobenthos numbers and biomass at the Balgzand tidal flats (15 stations x 13 years) was used to assess the applicability of a method (the ABC-method: abundance-biomass comparison) proposed by Warwick for detecting pollution effects on marine zoobenthic communities. It was concluded that this method should not be applied to zoobenthic communities living on tidal flats. In particular in areas where small-sized and sometimes very numerous species (such as *Hydrobia ulvae*) live in strongly fluctuating numbers, the method appears useless for assessing the pollution status of a benthic community.

As in foregoing years, part of the macrobenthos research is incorporated in the European Community project COST-647, an international long-term programme to assess and correlate fluctuations in numerical densities of selected species of benthic animals in European coastal areas.

B3-05
R. Dekker

Year-to-year variability in recruitment of bivalves

Long-term investigations by Beukema on intertidal soft bottom benthic invertebrates in the Dutch Wadden Sea have shown a strong year-to-year variation in the recruitment success of these organisms. Cold winters appeared to affect this success positively.

After three cold winters in succession, the winter of 1988 was extremely mild. After such a mild winter, it was expected that a number of common intertidal soft-bottom bivalves, e.g. *Mytilus edulis*, *Cerastoderma edule*, *Macoma balthica* and *Mya arenaria* would show reduced recruitment, and indeed this has been observed. On the other hand, recruits of some common subtidal and North Sea coastal bivalve species (e.g. *Angulus tenuis* and *Spisula subtruncata*) have been observed in relatively high densities.

As in 1987, the observations on recruitment in experimental azoic plots have been continued, as has the experiment on migration of young juvenile bivalves. Preparations were made to assess the impact of epibenthic predators on bivalve year class strength. A preliminary laboratory experiment on biomass and gonad development in adult bivalves under different winter-temperature and feeding conditions has been carried out.

Food limitation and food competition of bivalves

B3-06
P. Kamermans

Results of earlier research indicate that food availability can limit growth rates of bivalve molluscs in the Wadden Sea. The growing season of several bivalves appears to be almost limited to the algal bloom period in spring. The growth rate of some bivalves has increased over the last few years, together with an increase in primary production and the size of algal stocks, as a consequence of the eutrophication of the seawater. Years with a high *Cerastoderma edule* abundance show retarded growth of *Cerastoderma edule* and *Macoma balthica*. Animals living in the centre of *Cerastoderma edule* or *Mytilus edulis* banks grow more slowly than animals on the fringes.

The aim of this project is to investigate whether food scarcity is the cause of growth limitation. Fieldwork was started this year after some preliminary research in 1987. Two intertidal and one subtidal station in the Balgzand area were visited monthly. Stomach contents of bivalves occurring together and food availability in water and sediment were sampled every two to three hours over one tidal cycle. Species composition of algae and other organisms and the chlorophyll *a* and phaeopigment contents of all samples were determined and compared. The first results indicate that there is an overlap in diet for all species (*Mytilus edulis*, *Macoma balthica*, *Cerastoderma edule*, *Mya arenaria* and *Scrobicularia plana*).

During the growing season of the bivalves, experiments were carried out in an outdoor basin to study the influence of density on growth. These experiments gave an indication of a positive influence of the density of *Cerastoderma* on the growth of *Macoma*. Grazing experiments with algae and *Mytilus edulis* showed that the flagellate *Phaeocystis pouchetii* (single cell form) and the diatom *Cylindrotheca closterium* (= *Nitzschia closterium*) were filtered out of the suspension at the same rate.

1.2.4.5. Seabirds

B3-03a

C. Swennen

Weight loss in incubating eiders

Weight loss in incubating eiders was studied with an electric balance under two nests which recored the weight differences automatically. Eider females start egg laying at a weight of about 3 kg. Their weight is about 2.5 kg when they start incubating, and they are about 1.6 kg when their eggs have hatched. It is usually supposed that female eiders store a large amount of reserve fat just before the breeding period and that they fast till they arrive with their young on the foraging grounds in the intertidal zone.

A vast decrease in weight in the first period of incubation was found. Weight loss slowed down later, and no weight loss was found during the last week of the incubation. During the latter period the weight fluctuated strongly, however. It became clear that the birds left their nests regularly for about one hour, first only once per two days, but later every day. The time of the interruption in the incubation was different from what we had expected. Nest-leaving always took place during the night. We collected some indications (faeces with food remains) that the birds do feed during the last week of incubation. A new question now arises: how do the birds find their nests in a closed vegetation on dark nights?

Seasonal changes in the food requirements of Knots

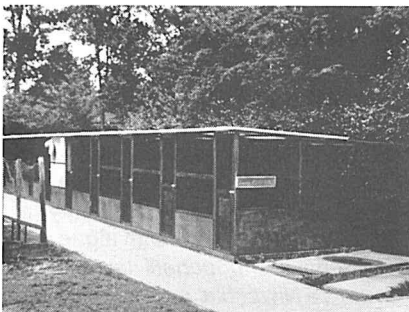
T. Piersma

The large secondary productivity of the intertidal flats in the Wadden Sea is continuously being harvested by various groups of predators. Amongst those, birds consume about a quarter. In most predator-prey interactions, selection for specific prey sizes is the rule. The number of feeding birds varies greatly over the year and peak numbers sometimes coincide with the growth season of macrobenthos. Bird predation might then influence inferred growth and production rates, particularly in species that feed in dense flocks. An evaluation of the role of such species in the dynamics of intertidal ecosystems necessitates detailed information on: 1) habitat selection; 2) food selection processes; 3) seasonal changes in the energy requirements and 4) seasonal changes in the abundance and distribution of the predators.

This project started in April 1988 and focusses on items 1-3. It is carried out at the NIOZ (1, 2) and at the Zoological Laboratory of the University of Groningen (3), under the umbrella of the Centre for Marine Sciences.

Knots *Calidris canutus* were chosen as the study since:

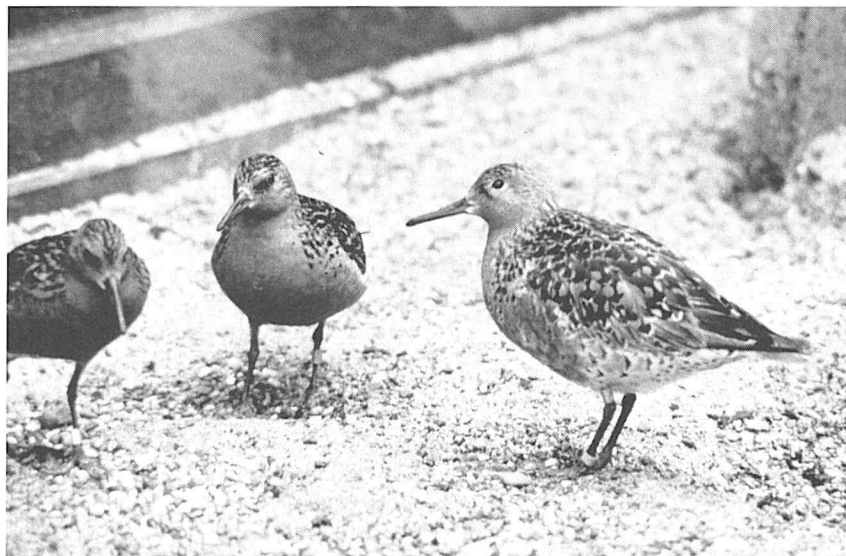
- they feed predominantly on molluscs which are ingested as a whole and can sometimes be identified at a distance,
- they discard the crushed but identifiable prey remains in the faeces (molluscs are also 'good prey for study' since their availability can relatively easily be measured),
- they occur only in particular intertidal areas, suggesting strong habitat selection,
- they can easily be kept in captivity,
- they occur with two subspecies in the Wadden Sea, potentially allowing an interesting comparison. One subspecies breeds in the Canadian Arctic and winters in W Europe, the other breeds in Siberia and stays in the Wadden Sea in spring and in autumn to winter in W Africa. The work consists of three prac-



King Canute's Palace, the series of cages where Knots are maintained in captivity at the University of Groningen.

tical components: 1) continuous studies with caged birds of the two subspecies at the Zoological Laboratory in Haren (see photographs) to determine seasonal changes in food intake in relation to ambient temperature and physiological processes such as deposition of fat reserves and moult, 2) experimental feeding work with the same birds on the artificial (caged) mudflats at NIOZ to study the determinants of prey species, and size selection in relation to prey availability, and 3) the description of prey choice and prey availability in the field.

The summer of 1988 was spent starting the captivity studies in Haren. In August-October fieldwork was carried out on the 10 000-20 000 Knots feeding around the small island of Griend, in the centre of the western Dutch Wadden Sea. In August, the birds fed on *Macoma balthica* only, but they changed to feed on the tiny *Hydrobia ulvae* in the course of September. *Hydrobia* formed the only prey in late October. The dramatic change was a consequence of *Macoma* becoming unavailable in the course of the season: all buried deeper than bill length (3.5 cm). In September shrimps *Crangon crangon* were fed upon as well. In December, four Knots were studied while feeding on the artificial mudflats at NIOZ. They initially preferred to feed on the abundantly available *Corophium volutator* (not a usual prey in the field), changing only partly to the available *Macoma* and *Cerastoderma edule* when the *Corophium* stocks became depleted. Since the birds had fed on soft artificial food pellets in the months before the experiment, they may have been unable to properly digest (crush) the bivalves due to an atrophy of the stomach wall. This experimental difficulty requires further study, but does point out a possible constraint in prey choice in nature.



Three Siberian Knots in summer plumage in close up.

The role of tropical intertidal areas in the life cycle of migratory palaeartic waders

B3-03b
C. Swennen

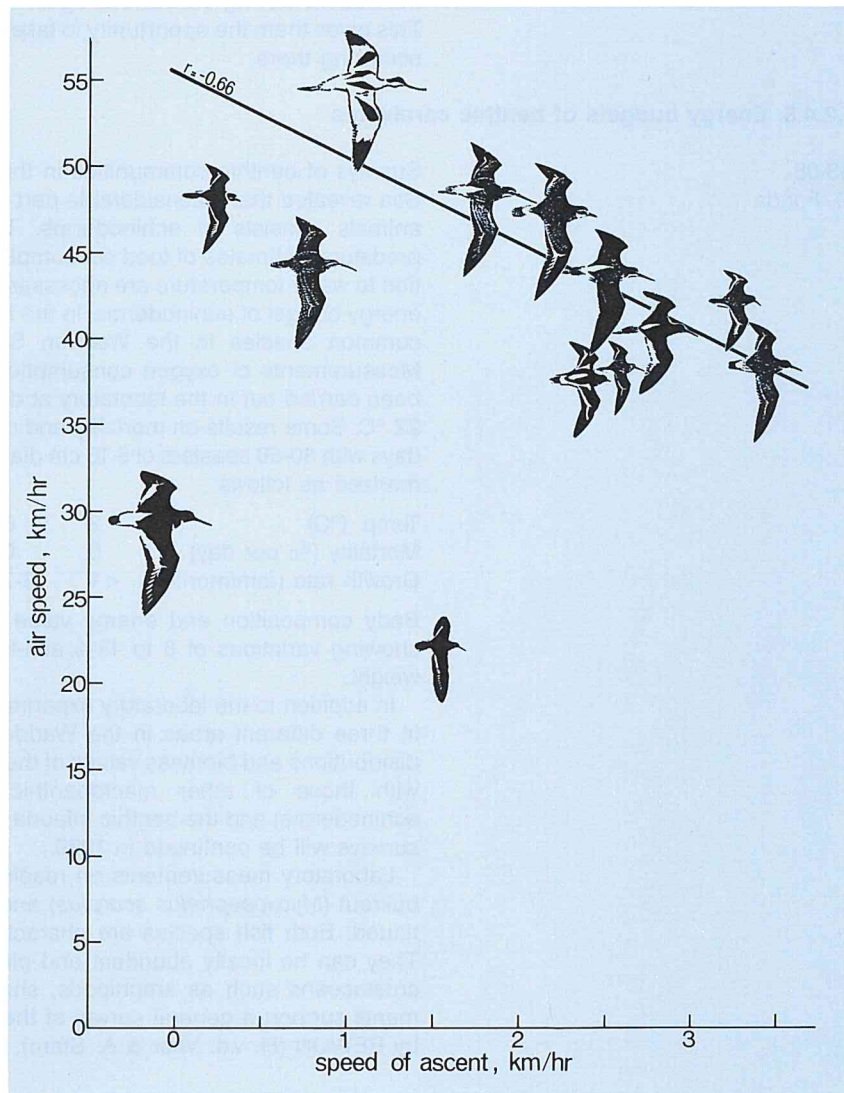
Temperatures were measured in mudflats in southern Thailand. The temperature at the surface showed a large daily fluctuation of between 25.1°C at sunrise and 38.7°C at 13.00 h during low tide. Under the surface the temperature fluctuated less and at a depth of 50 cm it appeared to be stable. In various intertidal flats temperatures of between 28 and 30°C were found at a depth of 50 cm. The high surface temperatures may approach the lethal temperature for some benthic invertebrates. We found that waders stopped foraging and went under cover of mangrove trees during some days. It may well be that also the invertebrates react to the burning sun by moving down into the mud. Direct observations without disturbing the animals have so far been impossible because of the extreme softness of the substrates.

Spring departure of waders from the Banc d'Arguin, Mauritania

T. Piersma, P. Duiven

Ecological research on the Banc d'Arguin in Mauritania, a coastal wetland on the edge of the Sahara which comprises 540 km² of intertidal flats, has indicated that the margins between the local benthic productivity and the food requirements of more than 2 million waders present, are particularly small. This culminates in the question to what extent, and at what speed, waders in spring are able to store the fat and protein reserves required for the long non-stop flights from W Africa to W Europe and to the breeding areas beyond. Preliminary analyses have shown that some species may only be able to reach W Europe on time if they use the favourable tailwinds which are usually found at high altitudes along the Sahara coast. During our research in April-May 1988, which followed earlier work in February-April 1985 and 1986, we tried to capture and mark additional samples of waders to complete the description of patterns of weight-change in spring. To find out whether and how the birds find and use the favourable high altitude winds, we have simultaneously recorded wind speeds and directions at altitudes of up to 10 km, and measured flight trajectories of wader flocks leaving the area. For the wind measurements we used standard helium-filled weather balloons and a theodolite, recording azimuth and elevation every 30 sec. (a 90 m gain in height). For the flight trajectories we employed a new technique: with a specially adapted classic range-finder we recorded distance, azimuth and elevation of the focal flock at 30 sec. intervals. Flocks departing from our fixed observation point could be followed for up to 24 min, up to altitudes of 1.6 km and to a horizontal distance of 6 km.

Our wind data confirm that along the Mauritanian Sahara coast, winds generally become favourable for northward migration at altitudes of 2 km or more. Over all observed wader species ground speeds averaged 24 km/hr. Since the birds were generally facing headwind at the low heights at which they were observed, the average air speed amounted to 41 km/hr. A comparison between species showed that air speed was negatively correlated with the speed of ascent or climb rate. Apparently the trade-off point between gaining height and gaining distance differs between the various species. Oystercatchers and common sandpipers were particularly slow flyers; the first species may not have left the area after all, whereas the latter has a different flight style and may really be a slow flyer. At level flight the average wader was estimated to attain an air speed of 56 km/hr. We were able to follow many flocks to altitudes of



For wader flocks leaving the Banc d'Arguin, horizontal air speed is negatively correlated with speed of ascent. The data points for Oystercatcher (below left) and Common Sandpiper (below right) are far outside the range for the other species and based on rather few data, and are therefore not included in the correlation. The heavy line presents the reduced major axis calculated over the data points for (from left to right) Ringed Plover, Whimbrel, Avocet, Bar-tailed Godwit, Grey Plover, Turnstone, Greenshank, Dunlin, Redshank, Sanderling and Knot. The bird vignettes are to scale and adapted from Hayman, Marchant & Prater (Shorebirds, Croom Helm, 1986).

more than 600 m, and some to heights of 1500 m, but very few flocks showed signs of levelling off within this range in altitudes. This strongly suggests that the waders leaving the Banc d'Arguin in spring climb to heights of at least 2 km. This gives them the opportunity to take advantage of the favourable winds often occurring there.

1.2.4.6. Energy budgets of benthic carnivores

B3-08
M. Fonds

Surveys of benthic communities in the Wadden Sea and the southern North Sea revealed that a considerable part of the benthic biomass of macrobenthic animals consists of echinoderms. To judge their role as consumers or predators, estimates of food consumption, growth and food conversion in relation to water temperature are necessary. Therefore research was started on the energy budget of echinoderms, in the first place with *Asterias rubens*, the most common species in the Wadden Sea and the North Sea coastal area. Measurements of oxygen consumption, food consumption and growth have been carried out in the laboratory at different constant temperatures from 2 to 22 °C. Some results on mortality and maximum growth rate, estimated over 40 days with 30-50 seastars of 5-15 cm diameter fed with live mussels, can be summarized as follows:

Temp. (°C)	2	6	10	14	18	22
Mortality (% per day)	0	0	0	<0.5	1	2
Growth rate (mm/month)	<1	3-7	12-15	6-12	6-9	2-4

Body composition and energy value of the seastars have been estimated, showing variations of 8 to 13% ash-free dry weight and 9 to 16 KJ·g⁻¹ dry weight.

In addition to the laboratory experiments, seastar populations were sampled in three different areas in the Wadden Sea and North Sea. Numbers, size distributions and biomass values of the seastars were estimated and compared with those of other macrobenthic predators (fish, crustaceans, other echinoderms) and the benthic infauna (worms, bivalves). The experiments and surveys will be continued in 1989.

Laboratory measurements on respiration, food consumption and growth of bullrout (*Myoxocephalus scorpius*) and eelpout (*Zoarces viviparus*) were continued. Both fish species are characteristic inhabitants of the Wadden Sea. They can be locally abundant and play a minor role as predators of smaller crustaceans such as amphipods, shrimps and young crabs. The measurements support a general survey of the benthic fish fauna of the Wadden Sea by BEWON (H. v.d. Veer & A. Stam).

1.3. NORTH SEA

1.3.1. Physical oceanography

1.3.1.1. Experimental shelf sea dynamics

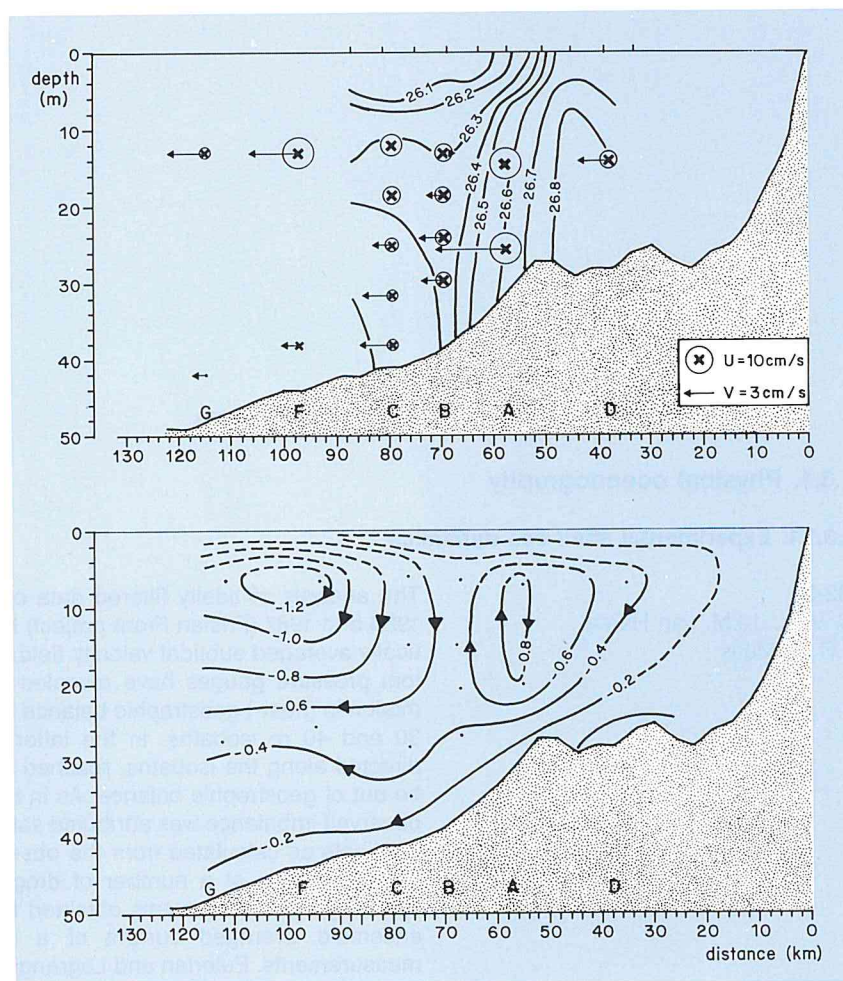
H2-03

C. Veth, J.J.M. van Haren,
L.R.M. Maas

The analysis of tidally filtered data obtained during the field experiments in 1986 and 1987 (Frisian Front project) has started with a description of the vertically averaged subtidal velocity field. Data both from current meters and bottom pressure gauges have revealed predominant along-isobath wind-driven motion in (near-) geostrophic balance throughout the area, except between the 30 and 40 m isobaths. In the latter region the motion, still predominantly directed along the isobaths, reached maximum amplitudes, but was found to be out of geostrophic balance. As in this region fronts were mostly found, the observed imbalance was attributed satisfactorily to (sub-grid) horizontal density gradients as calculated from the observed hydrographic data.

The analysis of a number of drogue experiments has revealed a strong similarity between currents obtained from the centre of mass motion and the ensemble averaged current of a number of Eulerian (moored) current measurements. Eulerian and Lagrangian shear stress terms, however, are very dissimilar. Eulerian shear is predominantly of a kinematic nature, whenever topographic length scales are small compared to the tidal excursion length scale, and is dominated by the same semidiurnal peak that mainly determines the individual current records. Lagrangian shear, however, is a smeared-out version of this. Reduced dispersion rates and clustering of drifters, as observed, are possibly related to the intrinsic non-linear structure of the kinematic equations describing the temporal and spatial evolution of a mass point. Under certain conditions, a functional of the shear matrix terms and water depth is shown to be a conserved Lagrangian quantity. A computation of this term from the drifter data tends to confirm this result.

During the WINDOW project (see 1.3.8.) a series of CTD-sections was made on the north side of the Dogger Bank. The first analysis has shown a wide frontal zone between the fully mixed water over the Bank and the deeper water north of it. This cruise was also used for the testing of acquisition and post-processing software for the CTD-systems.



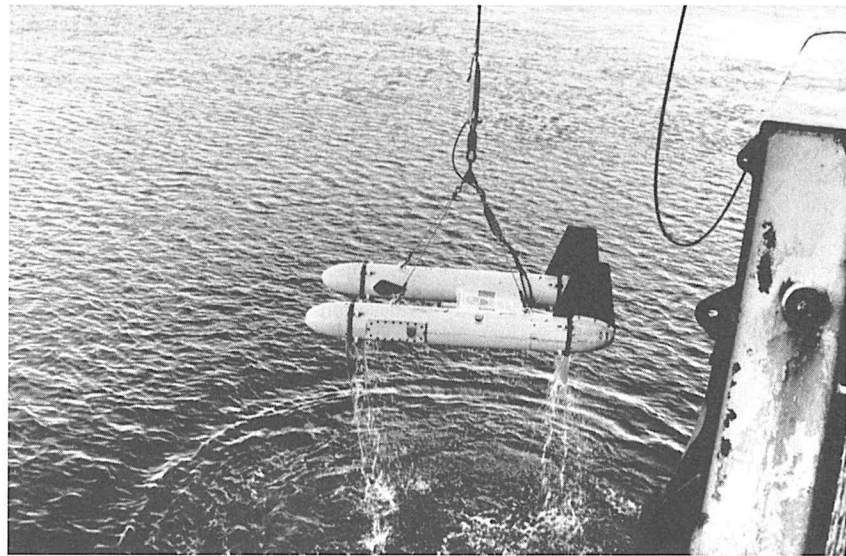
Example of the current pattern during a period of SW winds in a vertical plane perpendicular to the coast as obtained from measurements during the Frisian Front Project. (a) Currents, measured at stations A-G, averaged over 3 days and represented by circles for the along-isobath current component and arrows for the perpendicular-isobath current component. The index for the magnitudes is indicated in the lower right-hand corner; crosses indicate that the along-isobath current is directed with the coast at its right-hand side. Above the figure the magnitudes and directions of the wind stress components are given using the same representation. Fully drawn are lines of constant density excess (in kg/m^3), as interpolated from CTD measurements of which the stations are indicated by tickmarks at the surface. (b) Streamlines as calculated from the current component perpendicular to the isobaths (in $10^{-2} \text{ m}^2 \text{ s}^{-1}$). The streamlines are dashed when the values are interpolated to satisfy the boundary conditions. The currents and circulation pattern generally agree with the values and pattern of a purely wind-driven circulation.

In (b) local enhancement of the wind-driven circulation is observed near stations A and F, which may be associated with the overlying density gradients as shown in (a) (only near A observations), or with the tide-topography interaction (again only A).

1.3.1.2. Small-scale turbulence (and boundary layer studies)

H2-04
C. Veth

The work on small-scale turbulence in the Southern Bight of the North Sea has been finished. This study covered the evolution of turbulence properties during the tidal cycle at different depths in the fully mixed water column and the behaviour close after the turn of the tide. Turbulence measurements with a laser-doppler velocimeter system in a tidally mixed unstratified shelf sea are compared with turbulence properties derived from a model based on the balance equation of turbulent kinetic energy and the eddy viscosity assumption. This comparison shows that reasonable predictions of the vertical structure of the turbulence in a tidally-mixed shelf sea can be made from measurements of water-current speed and wind speed. From the model an estimate of the bottom-drag coefficient c_d is obtained. This estimate is based upon measurements in the outer layer of the water column in contrast to the usual c_d values derived from the roughness-lengths obtained from extrapolations of the logarithmic velocity profiles close to the bottom. In an additional experiment the turbulence is measured in a water column with a growing bottom boundary layer just after the turn of the tide. Using the model derived from the first experiment, the growth speed of the turbulent bottom boundary layer is estimated.



Laser-doppler turbulence meter.

1.3.1.3. Marine optics and remote sensing

H2-01
G. Marees, R.M.J. Dirks

During the WINDOW cruise in the North Sea (see 1.3.8.), and also during a cruise in the Dutch Wadden Sea, spectral irradiance measurements have been carried out. These optical data are correlated, if possible, with *in situ* measurements of concentrations of chlorophyll, suspended matter and yellow substance, and also with irradiance and beam attenuation coefficients. From these correlations algorithms appropriate for the remote sensing of those quantities will be deduced. Several NOAA/AVHRR remote sensing images of the

North Sea between 57°N and 51°N made during the WINDOW cruise are available and will be processed in cooperation with KNMI; it concerns sea surface temperature and water composition images.

NIOZ participated in an international (Euromar) research project on the use of laser remote sensing in coastal waters. The NIOZ contribution concerned several optical measurements during a cruise in Dutch coastal waters.

A model study was finished on the applicability of the airborne remote sensing instrument CAESAR (CAESAR=CCD Airborne Experimental Scanner Applications in Remote Sensing; CCD=Charge Coupled Device) for the remote determination of bottom depth and bottom composition of shallow waters. Depending on water quality and bottom composition, bottom depth and bottom composition algorithms were found to be applicable down to bottom depths of 32 m. The accuracy of these CAESAR algorithms was found to be much better than similar algorithms developed for the LANDSAT satellites.

1.3.2. Chemical oceanography

1.3.2.1. Production and consumption of oxygen

H1-01

S.B. Tijssen, C. Westra

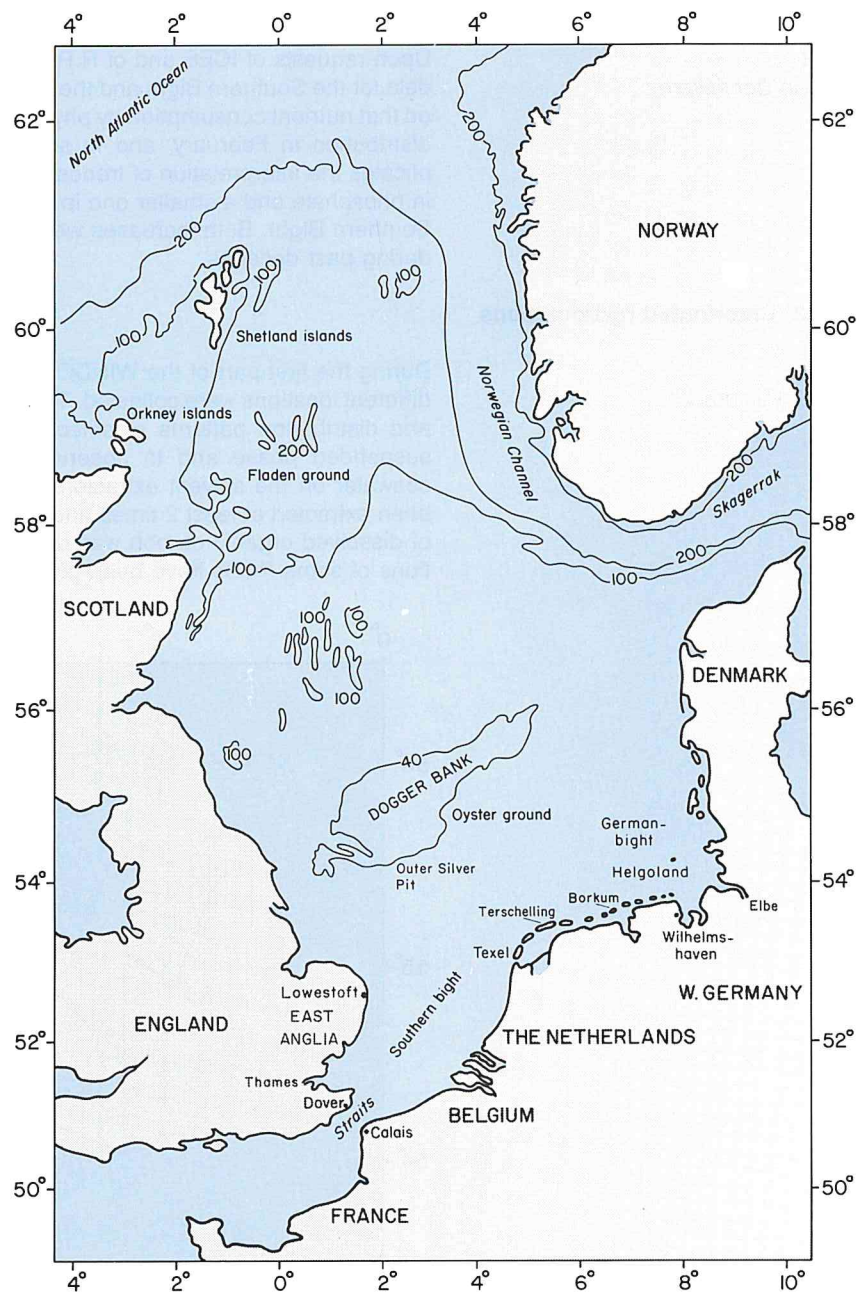
Last year's samples were analysed and data from the Frisian Front area were collected every month. The samples were analysed for oxygen content on board R.V. 'Holland' by RWS assistants. Nutrient samples were kept for analysis at NIOZ. These data will probably give insight into the development of processes over a year. It also serves as a support to the interpretation of data from preceding years.

In August we were invited on a two-week cruise with the German RV 'Friedrich Heincke' of the Biologische Anstalt Helgoland (BAH). Apart from oxygen and nutrient budgets, microbiological (J. Vosjan and W. Gunkel (BAH)) and phytoplankton investigations (E. Hagmeier (BAH)) were made. During the cruise all stations were sampled for salinity, oxygen and nutrients, while temperatures were measured with reversing thermometers and bathythermographs. Successful continuous recordings of temperature, salinity and pH were taken with the Seabird thermosalinograph with water from the deck wash system. High precision oxygen determinations were performed on board with an automated titrator.

In rough weather during the first three days, twelve stations were sampled in a grid between Terschelling and Helgoland up to 70 miles off the coast. As a result of persistently strong winds during preceding weeks, no stratification was found (down to a depth of 40 m!). The water contained very little phytoplankton, and primary production was apparently low.

Next, continuous S, T and pH recordings, showing complex changes, and discrete stations in the Elbe estuary were performed from Otterndorf (S=15) to Helgoland (S=32).

During the remaining 5 days of quiet weather a time series of hydrographic, nutrient, oxygen and (micro)biological measurements was taken near a drogue system released 25 n.m. north of Borkum. Besides vertical measurements, horizontal variation was measured. Diurnal oxygen rhythms were observed. Here too, phytoplankton density was low, and *Mesodinium rubrum*, our main interest, was not found. On our way back to Den Helder, we observed many strongly coloured, high-density, striped patches of *Noctiluca miliaris* on the surface, in which pH was lower than 7.



North Sea with geographical names mentioned in this report.

1.3.2.2. Nutrients

H3-02

A.J. van Bennekom

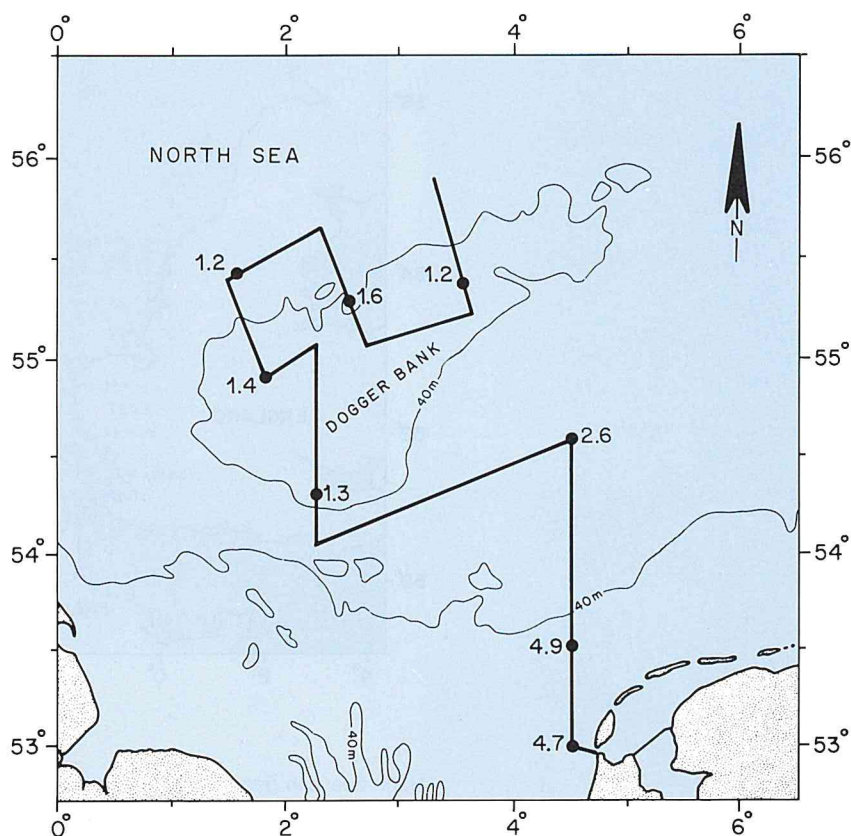
Upon requests of ICES and of R.R. Dickson (MAFF, Lowestoft) winter nutrient data for the Southern Bight and the North Sea were exchanged. It was concluded that nutrient consumption by phytoplankton markedly influences the nutrient distribution in February, and in some years already in January. This complicates the interpretation of trends in nutrient concentrations, but an increase in phosphate and a smaller one in nitrate could be demonstrated in the entire Southern Bight. Both increases were compatible with increases in river loads during past decades.

1.3.2.3. Chlorinated hydrocarbons

H1-06

M.Th.J. Hillebrand

During the first part of the WINDOW cruise (see 1.3.8.) 8 water samples from different locations were collected. The aim was to determine the concentrations and distribution patterns of selected organochlorines in the dissolved and suspended phase and to observe the influence of the organic matrix in seawater on the solvent extractors in use. Therefore all water samples have been extracted at least 2 times and some 3 or 4 times. Also the concentration of dissolved organic carbon was determined in each sample. The concentrations of some PCBs have been plotted against the position of the stations.



During the WINDOW cruise total PCB's were found to be high ($\sim 5 \text{ ng} \cdot \text{dm}^{-3}$) at near-shore stations, low ($\sim 1.5 \text{ ng} \cdot \text{dm}^{-3}$) at stations in the Dogger Bank area and intermediate at a station in between.

1.3.2.4. Metals in sediment and organisms

H1-08/H1-09
J.M. Everaarts

Highest copper concentrations in the silt fraction of the sediment were found in the Southern Bight and west and north of the Dogger Bank. The concentration of zinc and cadmium was found to be highest in the silt fraction from sediment of the Southern Bight and the western part of the Dogger Bank. Particularly the cadmium concentration in sediment from the Southern Bight (off the Dutch coast) showed high values ($10.6 - 31.1 \mu\text{g}\cdot\text{g}^{-1}$ dry weight). Highest lead concentrations were also found in sediments from the Southern Bight. Especially for cadmium and lead, high concentration levels are related to a very low percentage of the silt fraction (grain-size $< 63 \mu\text{m}$) of 0.07 to 0.20.

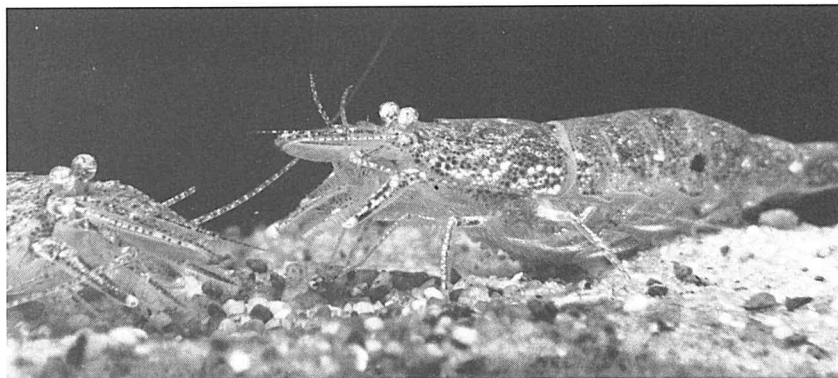
The concentration of copper in the shrimp *Crangon allmanni* (whole body analysis) varied between 24 and $87 \mu\text{g}\cdot\text{g}^{-1}$ dry wt. There is no general trend in the distribution pattern of copper in shrimp sampled from various areas of the North Sea, though specimens obtained from sampling sites north of the Dogger Bank showed somewhat lower concentrations. Copper concentrations in specimens from the central part of the North Sea tended to be higher.

Zinc concentrations varied between 49 and $105 \mu\text{g}\cdot\text{g}^{-1}$ dry wt, and there were no specific areas with significantly higher or lower concentrations, though highest concentrations were measured in specimens from the Dutch coastal zone.

The concentration of cadmium in specimens from different parts of the North Sea varied considerably. Highest concentrations were found in specimens obtained from sampling sites situated north of the Dogger Bank ($4 - 5 \mu\text{g}\cdot\text{g}^{-1}$ dry wt). In specimens from the Dogger Bank and east of the Dogger Bank, the cadmium concentration was even higher ($1.3 - 2.4 \mu\text{g}\cdot\text{g}^{-1}$ dry wt) than in the other areas of the North Sea, such as its central part and the Southern Bight, with concentration levels in *C. allmanni* of $0.6 - 1.2 \mu\text{g}\cdot\text{g}^{-1}$ dry wt.

The concentrations of copper and zinc in the brown shrimp *Crangon crangon* were in the same range as in the shrimp *C. allmanni*. However, the concentration of cadmium in the brown shrimp is considerably lower ($0.27 - 0.55 \mu\text{g}\cdot\text{g}^{-1}$ dry wt) than in the shrimp *C. allmanni*.

There were no differences in the concentrations of both copper and zinc in the common seastar *Asterias rubens* from different areas of the North Sea. Significantly higher cadmium concentrations were found in specimens obtained from sampling sites north of the Dogger Bank ($1.2 - 2.0 \mu\text{g}\cdot\text{g}^{-1}$ dry wt), than in the other areas of the North Sea ($0.4 - 1.2 \mu\text{g}\cdot\text{g}^{-1}$ dry wt).

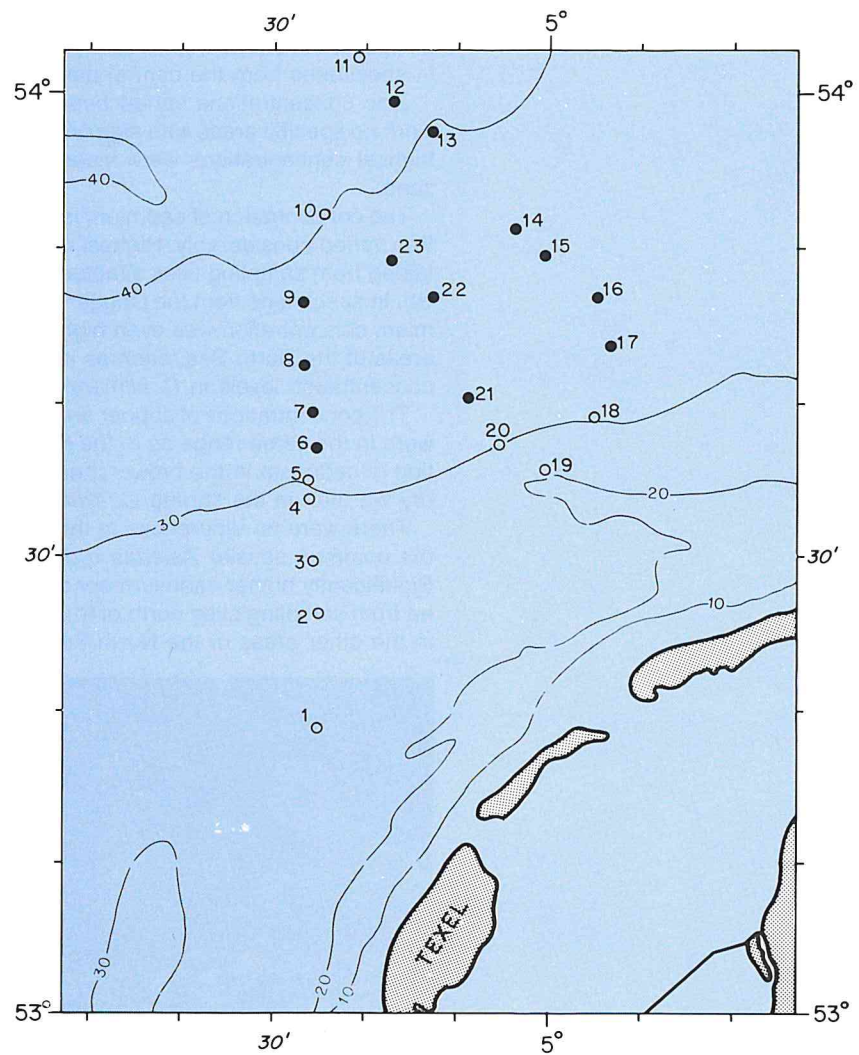


1.3.3. Geological oceanography

H3-01

D. Eisma, T.C.E. van Weering,
Zuo Zhizeng, G.W. Berger

Zuo Zhizeng, Institute of Geography, Academia Sinica, Nanjing, P.R. China, in December 1987 started with α - and γ -spectrometry in cores from the Oyster Ground. The boxcores collected in 1987 were analysed for ^{210}Pb and ^{137}Cs . Many cores showed reworking to different degrees. In the undisturbed cores deposition rates of 30-40 cm/century were measured. A second series of boxcores was collected in May with RV 'Aurelia' in muddy areas off East Anglia, in the Outer Silver Pit and adjacent parts of the Oyster Ground, and in the Elbe Rinne. Additional cores from the northern part of the Elbe Rinne and the Kattegat were obtained from the Geologisch-Paläontologisches Institut Universität Hamburg.



Position of 23 box cores collected in the Oyster Ground area, North Sea. Cores containing silty clay and clay denoted by full symbol; those containing silt and sand with <5% mud by open symbol.

In collaboration with the University of East Anglia at Norwich (B.M. Funnell, D. Brew) and Rijks Geologische Dienst (C. Laban), D. Eisma carried out a shallow seismics and vibro-coring programme off East Anglia between the northern Thames estuary and Lowestoft with R.V. 'Aurelia'. The aim was to study the connection between the deeper layers in the Southern Bight (Pleistocene and Late Tertiary) and the formations known from the East Anglia coast, and to study the continuation of old Holocene (?) valleys off East Anglia. The cores were split, one half going to Norfolk and the other to Texel. Samples of muddy layers have been collected for α - and γ -spectrometry.

A cruise was made with RV 'Aurelia' to the western Skagerrak and the Norwegian Channel south of Bergen, for the collection of box-core samples and data on water chemistry near the bottom. In addition a number of bottom camera stations were made to study the undisturbed sea surface sediments and biota in the Norwegian Channel. This study complements the data collected in 1984 in the eastern and central Skagerrak. The samples will be analysed to determine the sedimentation rates of recent sediments in the Norwegian Channel by means of ^{210}Pb and ^{137}Cs isotopes and to obtain accurate measurements of sediment mixing.

Support has been provided to Sha Li Ping (RU, Utrecht) for his Ph.D. study on the development of ebb tidal deltas along the West Frisian Islands.

1.3.4. Pelagic systems

1.3.4.1. Phytoplankton

B2-01c/B3-01

M.J.W. Veldhuis, F.A.C. Kouwets,
G.C. Cadée

Relatively much time was devoted to the *Chrysochromulina* bloom in Kattegat and Skagerrak this spring. This alga was not encountered in our regular Marsdiep sampling programme. Information on the bloom and on the possibility that it would invade Dutch coastal waters was given to radio, TV and reporters of numerous newspapers. We stressed the regular occurrence of algal blooms in the North Sea, even dating back to before the start of eutrophication. We predicted that this bloom would not invade our waters, because of the residual current from south to north along the coast. However, we could not state that it will never occur here, because so little is known of this alga, which had never bloomed before.

In the first half of the year the analysis of the remaining part of the Frisian Front samples was completed. A data set of chemical and biological parameters collected in the spring of 1985 over a stretch from the North Sea towards the western Wadden Sea was worked out.

During 6 surveys the spring phytoplankton communities were examined at three stations (in the coastal North Sea, the Marsdiep tidal channel and the Wadden Sea). Biomass values, expressed as chlorophyll *a*, protein, extractable carbohydrates and total phytoplankton cell biovolume, increased from the North Sea station towards the Wadden Sea station; a similar pattern was found for the concentration of nutrients. Data on the uptake of methyl ammonium, alkaline phosphate activity (APA) and on pools of extractable dissolved free amino acids indicate that phytoplankton in the Wadden Sea is only weakly limited by nitrogen or by phosphate, if at all. A moderate phosphate depletion was most apparent for the North Sea station. On the other hand, for all three stations it seems most probable that silicate depletion steered the succession from diatoms to the colony-forming flagellate *Phaeocystis*. This phytoplankton

succession on its turn is responsible for the changes in the composition of soluble carbohydrates (acid-soluble versus alkaline-soluble), and in amino acid spectrum.

Concurrently, exploratory experiments with the EPICS flow-cytometer, which was introduced this year, were carried out together with various physiological experiments in the laboratory. The major aim of these studies was to investigate to what extent the flow-cytometer can be used in various lines of research, such as primary production experiments, zooplankton grazing experiments and phytoplankton kinetics studies.

In the study of factors limiting primary production in the Dutch coastal area, the analysis of results of enrichment experiments carried out in 1987 was continued. As F.A.C. Kouwets accepted a function outside the institute, his project was terminated in September.

1.3.4.2. Activity and dynamics of microorganisms

B1-02
J.H. Vosjan

Research in cooperation with W. Gunkel, Helgoland, on the distribution and activity of microorganisms in coastal waters of the Netherlands and Germany was continued.

The results of the cruise with the RV 'Friedrich Heincke' last year were reported at the North Sea Symposium. The conclusions were that biological parameters only to a limited degree follow the general hydrographic patterns in the area studied. High oxygen values were found in regions with high phytoplankton concentrations. Distribution patterns of plankton species were given and microscopic quantification of microplankton showed the same values as biomass determination by the ATP method. The distribution of bacteria determined by the epifluorescence technique was very uniform in contrast to the distribution of saprophytic bacteria determined by the pour plate method. Oil-degrading bacteria were present throughout the area investigated. This year we made a cruise with the RV 'Friedrich Heincke' from 28 July to 12 August in the same area and the Elbe estuary. The aim of this cruise was to study the biological development of blooms during an unstratified summer situation in coastal waters.

1.3.4.3. Zooplankton

B2-02a
H.G. Fransz, M.A. Baars,
B.R. Kuipers, M.J.M. Reichert

Most plankton samples and experimental results obtained during the Frisian Front Project in August 1987 have been analysed with respect to distribution, productivity and grazing. Only the counting of the extensive series of zooplankton net samples awaits completion. In general it can be concluded that the frontal zones in 1986 and 1987 did not add substantially to the local pelagic production. Higher chlorophyll concentrations and differences in pigment composition at the frontal zone seem to be due to aggregation and increased sedimentation. Differences in standing stock of zooplankton and macroplankton between the different water masses were not observed.

1.3.4.4. Pelagic predators

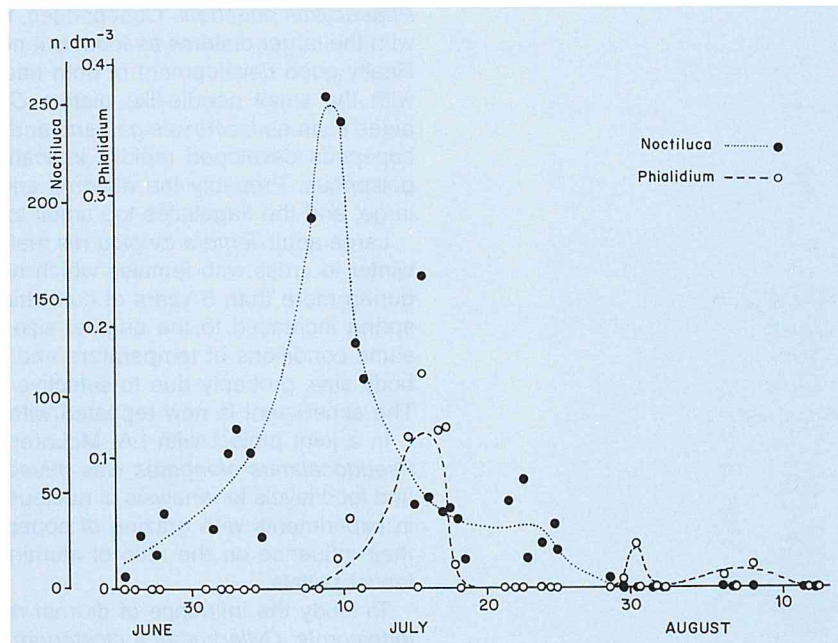
B2-01b/B2-02b
B.R. Kuipers, R. Daan

Several years of research in Dutch coastal waters have shown that the predation exerted by the total group of macroplankton (zooplankton larger than 2 mm) is only of minor significance for population developments of calanoid copepods. This conclusion stands in striking contrast to results obtained in the

comparable German Bight, where coelenterate abundance is some 100 times higher, and where macroplankton is regarded as fully controlling copepod population growth in spring and early summer.

Since the pelagic system along the Dutch coast may have deteriorated somewhat due to the inflow of polluted river water, our macroplankton sampling has been extended to areas further offshore. Extensive macro- and mesozooplankton sampling during the Frisian Front Projects in 1986 and 1987, however, confirm our conclusion on the almost negligible role of invertebrate predators in the control of copepod production. In the Frisian Front area, however, our attention was drawn by dense concentrations of young sprat and herring, which are most likely more important as copepod predators (stomachs were completely filled with adult *Temora longicornis*), but which are very hard to sample quantitatively.

The 1988 WINDOW cruise (see 1.3.8.) offered the opportunity to study the zooplankton-macroplankton relationship in the central North Sea in summer. The analysis of some 300 samples is in progress, but the first impression is again that macroplankton plays hardly any role in the pelagic food-chain in summer. The difference between the German Bight and the rest of the North Sea areas researched will probably be explained when the results of the 'Challenger' surveys are available in 1989-90 (see 1.3.9.). In the coming years the attention will be shifted from invertebrate macroplankton to fish larvae and young fish as zooplankton consumers.



Blooms of 2 planktonic predators in Dutch coastal waters: The hydromedusa *Phialidium hemisphaericum* and the zooflagellate *Noctiluca miliaris* reach peak numbers in early summer. Although both have been found to prey on copepod eggs, their role in copepod population dynamics appeared of minor significance.

1.3.4.5. Plaice larvae

B2-01d

F. Hovenkamp

Results from 1987 showed a large variation in growth of larval plaice which could partly be explained by differences in temperature. To investigate the effect of growth on the immigration and recruitment, daily sampling of immigrating plaice larvae in the Marsdiep was continued during the winter and spring of 1988. In addition, five cruises were undertaken to sample pelagic plaice larvae for comparisons between growth rates of different locations and periods. A start has been made to investigate RNA/DNA ratios of individual larvae which can be used as an index of recent growth. First results seem to indicate substantial differences in individual growth within and between samples. These results are supported by differences in growth indicated by different stage-weight relationships.

1.3.4.6. Experimental investigations on zooplankton

B2-04

W.C.M. Klein Breteler, M.J.M. Reichert

Pelagic calanoid copepods are cultivated continuously in the laboratory for experimental purposes. The species *Temora longicornis* has been bred beyond the 100th generation, which is unique for marine pelagic copepods.

Nauplii hardly ever developed with monoculture of naturally occurring algae, nor with the larger diatoms *Stephanopyxis turris*, *Streptothea thamesis*, *Ditylum brightwellii* and *Thalassiosira eccentrica*, or with the small nanoflagellate *Paraphysomonas* sp. and flagellates and colonies of *Phaeocystis pouchetii*. Copepodites, however, could be raised to some extent with the larger diatoms as food, but not with *Paraphysomonas* or *Phaeocystis*. Really good development of both nauplii and copepodites was only obtained with the small needle-like diatom *Cylindrotheca closterium*. When suitable algae such as *Isochrysis galbana* and *Rhodomonas* sp. were also present, the copepods developed rapidly, indicating that none of these organisms were poisonous. Probably the diatoms and the colonies of *Phaeocystis* were too large, and the flagellates too small to be eaten.

Large adult *Temora longicornis* males were isolated from the sea during the winter to cross with females which had decreased considerably in body size during more than 5 years of cultivation in the laboratory. The size of the offspring increased to the original size of the first generations bred under the same conditions of temperature and food. This indicates genetic changes in body size, probably due to selective forces inherent in the culture schedule. The experiment is now repeated with small males collected in summer.

In a joint project with I.A. McLaren, Dalhousie University, Halifax, Canada *Pseudocalanus elongatus* was raised to maturity at 2 different temperatures and food levels for analysis of nucleus and DNA content. Assistance was given in experiments with grazing of copepods on diatoms and clay-minerals, and their influence on the ratio of aluminium and silica in diatom remains in the faecal pellets.

To study the influence of diurnal rhythms of diatoms on grazing of *Temora longicornis*, *Cylindrotheca closterium* was desynchronized from a 14/10 h L/D cycle to 2/2 h L/D cycle. Parallel grazing experiments with synchronized and desynchronized algae resulted in considerable differences in grazing between day and night in both cultures. Possibly a diurnal grazing rhythm inherent in the copepods is involved. *Cylindrotheca* was considerably reduced in size when growing asynchronously.

1.3.4.7. Modelling

B2-01a
H.G. Fransz

The modelling effort was directed towards quantifying the remineralization of nutrients and the interactions between algae, zooplankton and bacteria. A sub-model for bacteria and remineralization was developed and defined in the modelling language CSSP (Continuous System Simulation Program) during one year's work for an undergraduate thesis. This was added to the SEAWAQ model to simulate plankton dynamics in the Southern Bight. Remarkable results were the indications that competition for nutrients at high organic load can limit algal growth, and can also restrict the flagellate/diatom-ratio increase by eutrophication. The nutrient competition between bacteria and flagellates is most significant in this respect. Zooplankton grazing on algae, bacteria and detritus stabilized the strong and frequent summer fluctuations generated by a flagellate-bacteria regulation cycle.

From February to March the daily fecundity of the copepod *Temora longicornis* from Marsdiep samples was estimated in incubation experiments to study the seasonal cycle in fecundity. In this period daily fecundity increased with temperature, but it was already fairly high at pre-bloom conditions in February. The spring fecundity was high in comparison with the summer fecundity observed at the Frisian Front in 1986 and 1987. With a theoretical model relating fecundity to mortality, generation time and population increase, it was possible to estimate the mortality levels at which different generations remain stable. It was clear that the spring increase of *Temora* is the result of the high fecundity and a low mortality rate below 10% per day. The summer decline from the second new generation is due to a decrease in fecundity, but it also requires an increase in mortality to levels higher than 10% per day.



1.3.5. Benthic systems

1.3.5.1. Synoptic mapping of the benthos

B1-07/B1-11

G.C.A. Duineveld, P.A.W.J. de Wilde

The synoptic mapping of the benthic fauna of the North Sea is an international programme initiated by the Benthic Ecology Working Group of ICES. Analysis of the data from 350 box-core samples collected in 1986 shows that the Dutch sector of the North Sea roughly comprises four types of macrobenthic assemblages. Each assemblage inhabits a geographically distinct part of the investigated area with a characteristic grain-size composition, depth and average tidal-current speed. The assemblages differ in dominant species, species richness, diversity and average biomass. Comparison with previous samples from the area investigated shows that some of the features, such as the dominant species and the average biomass, appear to bear a long-term (~5-year) constancy.

The assemblages found with our analysis correspond to some extent with the '*Tellina*' and '*Amphiura*' communities described earlier in the southern North Sea and the German Bight. For two assemblages no equivalent classic community could be found. These two assemblages are situated in the shallow and turbulent southern part and the deepest northern part of the area investigated. Both have a low average biomass, but species richness is far greater in the deeper assemblage. This suggests that turbulence has a profound influence on the structure of the benthic community.

A preliminary classification analysis of the data from the Dutch sector of the North Sea joined with those from the adjacent eastern area (German Bight and Danish coast) shows that the assemblages distinguished in the Dutch sector have a much wider geographical distribution. This result gives insight into the scale on which the factors that lead to a certain type of benthic fauna operate. By comparing regional variations in a certain assemblage, the effect of local conditions can be assessed.

An attempt will be made to use data obtained during the synoptic mapping programme to study possible effects of commercial beam-trawl fisheries on bottom fauna. Benthic fauna in areas with different fishing intensities will be compared.

1.3.5.2. Benthic fronts

B1-12

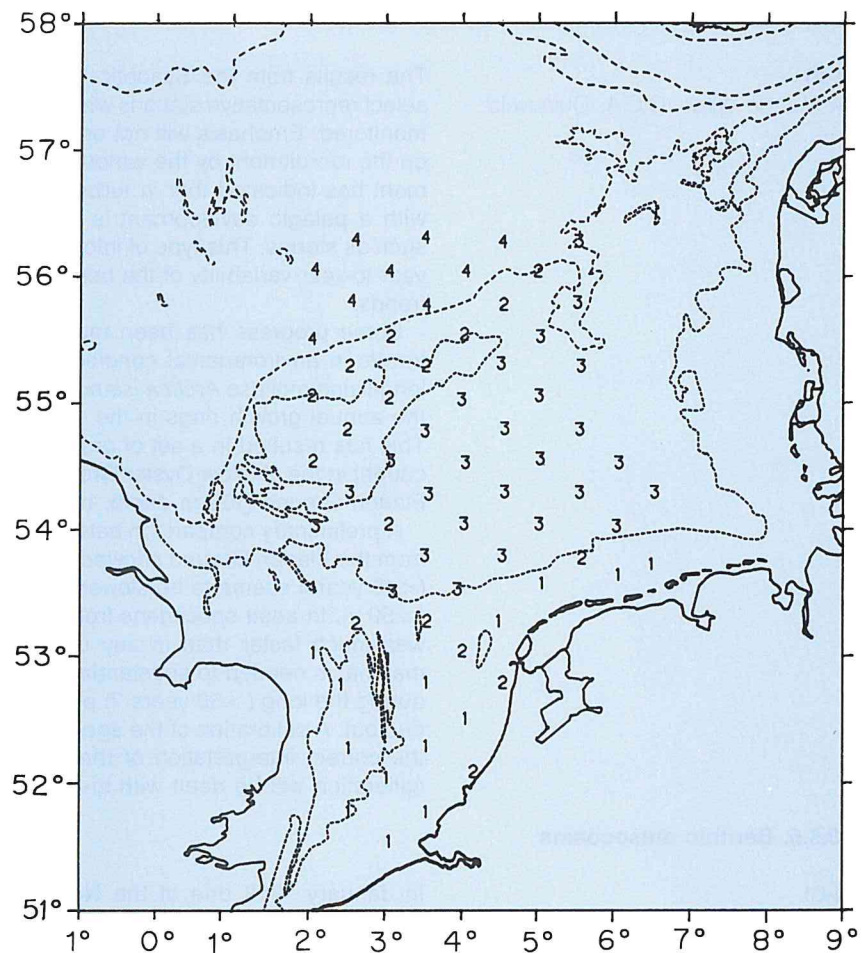
R. Heyman, G.C.A. Duineveld

During the WINDOW cruise (see 1.3.8.) an area NW of the Dogger Bank was investigated in some detail. A distinct zone characterized by an enriched benthic community could not be observed, but there was a clear zoogeographical border separating the subarctic cold-water species and those of more temperate waters.

In September a successful cruise with RV '*Aurelia*' was made to the southwestern part of the Dogger Bank and the Outer Silverpit area. Here, over relatively short distances, a rich benthic fauna with a rapidly changing species composition was observed. The underlying mechanism of the enhanced food supply is still speculative. During the next year benthic studies will be focussed on this particular area.

As a welcome addition, valuable unpublished data of the western Dogger Bank area, collected by the Fisheries Institute at Lowestoft, were placed at our disposal.

Position of four different macrofauna assemblages in the Dutch sector of the North Sea.



1.3.5.3. Growth by regeneration

B1-09
G.C.A. Duineveld, P.A.W.J. de Wilde

A study was made of the regeneration speed of the brittlestar *Amphiura filiformis*. Field studies had shown that the somatic production by the *Amphiura* stock at one of our regular stations consisted mainly of regenerating arms. These arms are cropped by demersal fish. In a laboratory population of *Amphiura*, arms were cut off in various degrees and allowed to regenerate over a period of one month. The experiment was conducted at 4° and 14°C, representing the minimum and maximum temperature at our station. No extra food was given to the animals. Regeneration was high at 14°C but almost negligible at 4°C. The amount of regenerated tissue was moreover dependent on the amount of arm tissue present at the start of regeneration, i.e. the more that was left of the arms the smaller the amount regenerated. Following earlier work on the regeneration of *Macoma* (de Vlas) a general relation was calculated between the amount of regenerated tissue and the condition of the arms, taking into account the sizes of the animals. With this relation an estimate can be made of monthly regeneration in the field by monitoring the average arm condition of the population. Additional experiments are to be carried out to assess the influence of the addition of extra food on regeneration speed.

1.3.5.4. Long-term trends in the benthic fauna

B1-10

P.A.W.J. de Wilde, G.C.A. Duineveld

The results from the Synoptic Mapping (see 1.3.5.1.) offer the opportunity to select representative stations where changes in the macrobenthic fauna can be monitored. Emphasis will not only be put on the resident adult fauna but also on the recruitment by the various dominant species. Previous work on recruitment has indicated that in turbulent areas the year-class strength of species with a pelagic development is determined by unpredictable adverse events such as storms. This type of information is imperative for the explanation of the year-to-year variability of the benthic fauna and the detection of real long-term trends.

Some progress has been made with the retrospective study of long-term trends in environmental conditions as reflected by the growth pattern of the long-living mollusc *Arctica islandica*. Most effort has been spent on elucidating the annual growth rings in the shell by means of the acetate-peel technique. This has resulted in a set of growth data from a limited number of specimens caught in the shallow Oyster Ground (40 m depth, southern North Sea) and the Fladen Ground (100 m depth, northern North Sea).

A preliminary comparison between the first rapid growth phase of specimens from the Fladen Ground showed that the present growth of juvenile specimens (<10 years) seems to be slower than the first growth of now adult specimens (>50 y). In adult specimens from the Oyster Ground, growth in the first years was much faster than in any of the specimens from Fladen Ground. More material is needed to substantiate these conclusions. Analyses of fluctuations during the long (>50 years ?) phase when growth is small are now being carried out. A calibration of the age of the specimens appears to be imperative for the correct interpretation of the variation in the thickness of the rings. This calibration will be dealt with in the near future.

1.3.5.5. Benthic mesocosms

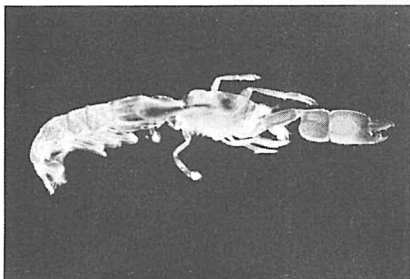
B1-01

P.A.W.J. de Wilde

In January 1988 one of the North Sea mesocosms in the NIOZ aquarium building was stocked with a subtidal benthic community originating from the Frisian Front area in the southern North Sea. Since then the bottom compartment of the system has regularly been monitored by means of non-destructive methods, e.g. photography of the structure of the sediment surface and meiofauna sampling, to follow the development of the community. Over a period of 6 months only minor changes in the texture and the number of burrow openings could be detected. Later, probably as an effect of food shortage, the number of observed holes decreased. A similar trend was found in meiofauna numbers. It was concluded that the adopted method of introduction of the undisturbed bottom sections in the mesocosm and the consecutive maintenance of the ecosystem were adequate to the envisaged goal. In November new bottom sections were collected. In the meantime the twin-mesocosm was lent to the BEWON-group, which used the facility for applied studies dealing with the effects of contaminated drilling mud from offshore installations in the North Sea. Applied mesocosm studies on the effects of contaminated harbour sludges were also carried out in the SEDEX experiments (see 1.5.4.).

Further mesocosm activities include the development and construction of a small modular testing unit, 'boxcosm', for ecotoxicological research. A prototype of the boxcosm was presented during the Euromar-Market held on board RV 'Tyro' in Scheveningen from 6 to 8 September.

A resin cast of the burrow of *Callianassa subterranea*, an abundant benthic crustacean of the Oyster Ground. The burrow is composed of several vertical shafts leading to a more or less horizontal plane of dwelling galleries in which the animal actually lives. Where these tunnels are widened the inhabitant can turn by means of a somersault.



1.3.5.6. Benthic Foraminifera

H3-14
T.C.E. van Weering

A study based on earlier research with B. Corrliss (Duke University, Durham, USA) has been started to relate the distribution of living foraminifera to environmental parameters. Recently, much attention has been paid internationally towards understanding and utilizing the morphological variations observed within many species as indicators of specific environmental conditions. The aim of this study is to recognize persistent correlations between benthic species or assemblages, or morphological variants, and environmental parameters such as salinity, food, temperature *etc.* Possible correlations are tested in the laboratory by culturing benthic foraminifera under specific conditions. Two key areas in the North Sea have been selected for this study, the Frisian Front and the Norwegian Channel.

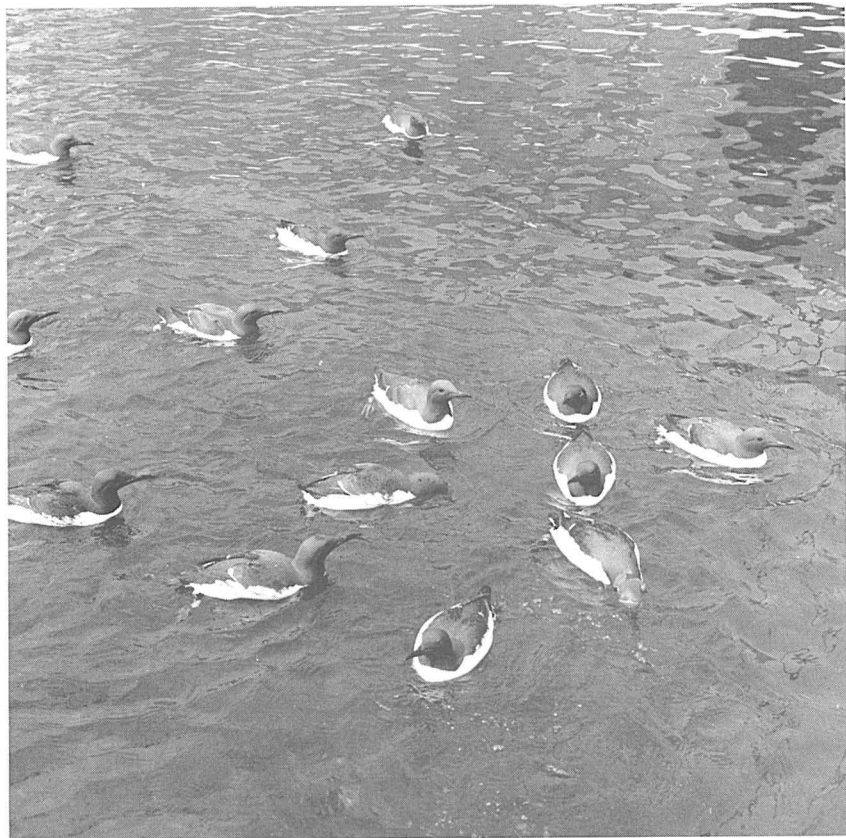
In addition to the parameters mentioned above, attention will also be directed to the study of (variations in) buildup and use of stable oxygen and carbon isotopes in the skeletons.

1.3.6. Pelagic sea-bird distribution

B3-07
M.F. Leopold

The work on distribution patterns of pelagic sea-birds in the North Sea started in 1987 was continued in 1988. Currently, an extensive data base of ship-based counts of sea-birds is being built up. Cetacean-sightings are integrated into this data base. Areas which have been studied most intensively are the Frisian Front, the slopes of the Dogger Bank, the Brown Bank, the coastal zone of the southeastern North Sea and the British east coast. Most of these areas held significant concentrations of sea-birds, most notably of the Guillemot *Uria aalge*. A special effort was made to get an estimate of the numbers of the Little Gull *Larus minutus*, wintering in the eastern North Sea. Almost the whole coastal zone, from the English Channel up to Esbjerg, Denmark, was surveyed. Concentrations of Little Gulls were found at several river mouths.

In January 1988 the bulk-carrier 'Borcea' caused an oil spill off Zeeland. This resulted in the death of an estimated 10 000 to 20 000 sea-birds in the area. Guillemots, Great Crested Grebes *Podiceps cristatus* and Common Scoters *Melanitta nigra* were the most numerous victims. Some 1000 corpses of dead sea-birds were transported to NIOZ to be examined. Biometric measurements were taken and the stomachs of the birds were examined for food remains to obtain information on the diets of the sea-birds in this area.



1.3.7. Function of chemical elements and element turnover in marine organisms

Halogen accumulation in shrimps

B3-04
D.H. Spaargaren

In animals, in contrast to plants, chloride is the most widely dispersed and innocuous anion. Its functions in various physiological processes (e.g. in osmotic pressure regulation, in blood bicarbonate transport, in enzyme activation and in gastric secretion) are well documented. In comparison, the functions of other halogens (fluorine, bromide, iodide), although also commonly absorbed by animals, are relatively obscure. Moreover, the scarce data on non-chloride halogens often only consider the presence and distribution of these elements in an organism; detailed information on their function is virtually lacking.

Fluoride is usually accumulated in the skeletal structures; little or no fluoride accumulation takes place in the soft tissues, with the exception of the skin. Bromine, and possibly also iodine, is more strongly confined to the soft tissues.

In this study the concentrations of non-chloride halogens were measured in *Crangon crangon* at various stages of its ontogenetic development, also considering differences in sex and the responses to environmental conditions (temperature and salinity). The results can be summarized as follows:

—At low temperature the internal fluoride, iodide and bromide concentrations in *Crangon crangon* are strongly increased.

—Fluoride behaves very much like iodide: in response to salinity the concentrations reflect osmotic differences between the animals and their environment.

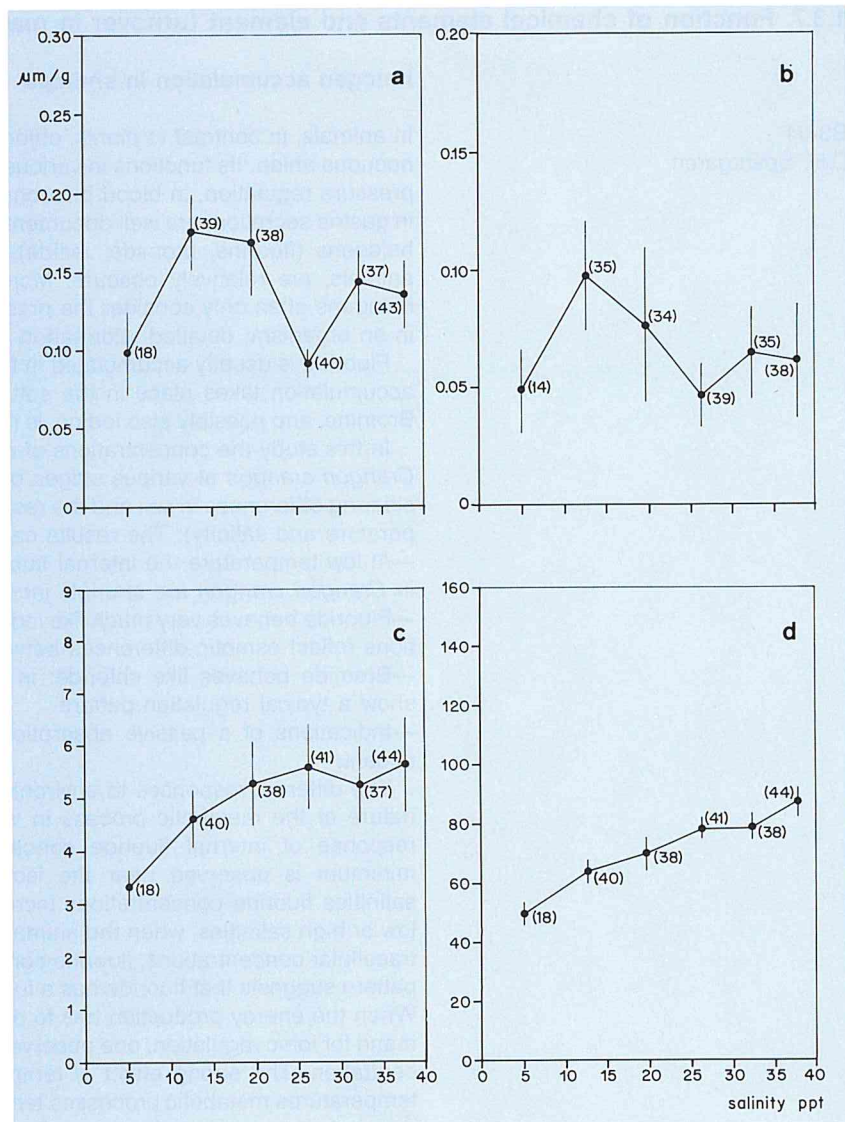
—Bromide behaves like chloride: in response to salinity the concentrations show a typical regulation pattern.

—Indications of a passive absorption to the exoskeleton were found to be absent.

The different responses to environmental conditions may give a clue to the nature of the metabolic process in which the halogens are involved. In the response of internal fluoride concentrations to environmental salinities a minimum is observed near the isosmotic salinity; towards more extreme salinities fluoride concentrations increase. Under extreme conditions, at very low or high salinities, when the animals are no longer able to regulate their extracellular concentrations, fluoride concentrations tend to decrease again. This pattern suggests that fluoride has a function in the release of metabolic energy. When the energy production has to be facilitated, in this case by a higher demand for ionic regulation, one observes an increase in the internal fluoride concentration. The strong effect of temperature also fits in this scheme: at low temperatures metabolic processes tend to slow down. A reduction in the supply of metabolic energy under these circumstances coincides with an increase in the internal fluoride concentration. A possible shortage in the supply of metabolic energy might again be counteracted in this way.

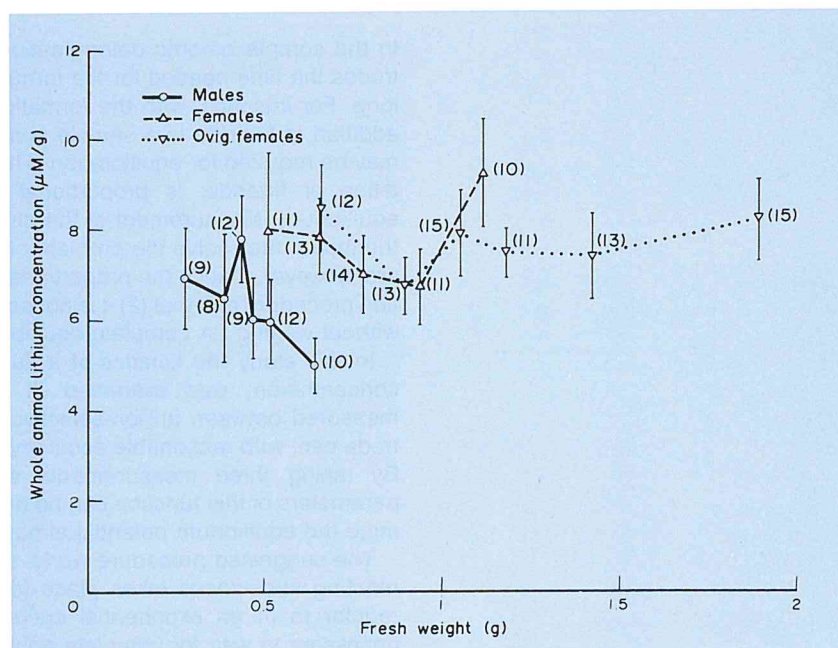
The responses of iodide with respect to size, acclimatization, temperature and salinity appear to be very similar to those of fluoride. These similarities suggest that both elements have more or less the same function and may replace each other. Iodine-containing proteins, mainly in the form of iodinated tyrosine compounds, are very widely distributed in animals. In vertebrates, the plasma level of both inorganic and protein-bound iodine are known to be related to the thyroid hormone production. The thyroxine hormone always acts as a general stimulant of many metabolic processes, a function similar to that deduced above for fluoride.

Whole animal fluoride (a), iodide (b), bromide (c) and total-ion (d) concentrations as a function of the adaptation salinities. Notice the similarities between fluoride and iodide concentrations (top figures), both involved in stimulating oxidation metabolism and between bromide and chloride (bottom figures), both having an osmotic function.

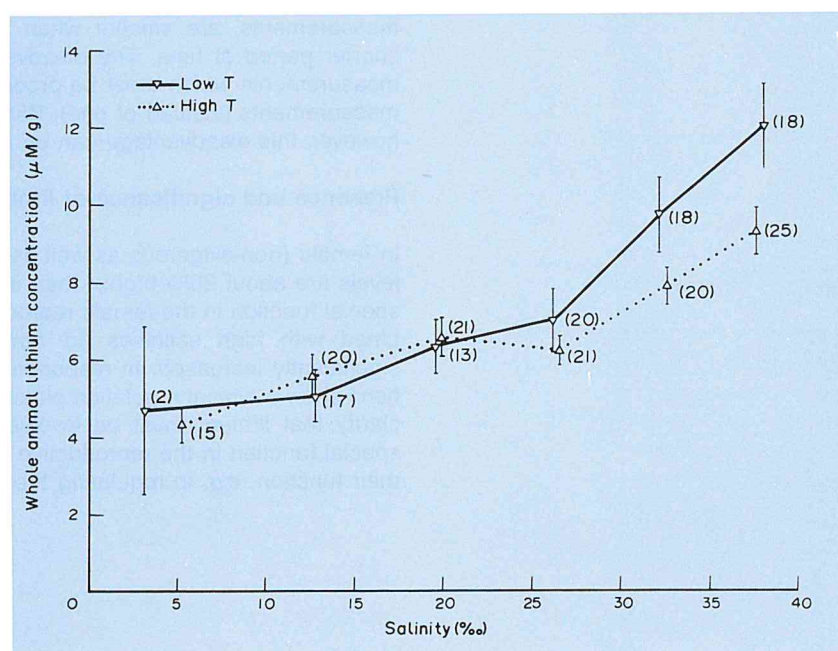


Up till now direct evidence existed that bromide is an essential element. The effect of temperature and the regulation response to environmental salinity clarify that bromide must have a physiological function: the response to salinity is similar to that described previously for chloride; the effect of temperature, very strong in fluoride and iodide, is much weaker, both in bromide and chloride regulation. This suggests that bromide and chloride have similar functions and probably can replace each other.

Whole animal lithium concentration in *Crangon crangon* in relation to size (fresh weight) and sex. Differences in lithium concentration between male and female shrimps suggest that this ion has a function in the reproduction system.



Whole animal lithium concentrations as a function of the adaptation salinities at low (7 - 10°C; drawn line) and high (16 - 20°C; dotted line) temperatures. In response to salinity, lithium concentrations in shrimps show a typical regulation pattern. At high temperatures combined with high salinities, lithium concentrations are reduced. These effects indicate that lithium is also involved in metabolic processes.



Improving the accuracy and speed of ion-selective measurements

In the complexometric determination of ions by means of ion-selective electrodes the time needed for the formation of a particular complex may be fairly long. For instance, with the formation of aluminium-fluoride complexes, after addition of fluoride to a sample containing aluminium, more than 10 minutes may be required for equilibration. The change in potential, shortly after the addition of fluoride, is proportional to the total potential shift attained at equilibrium. Measurement of the change in potential, shortly after addition of the titrant, may solve the problem of long measurement times. Disadvantages are, however, that (1) the proportionality constant must be derived by a calibration procedure and that (2) it is not possible to perform repetitive measurements without waiting for complete equilibration.

In this study the kinetics of a fluoride electrode, following a change in F-concentration, was examined. It appeared that the potential difference measured between an ion-selective electrode and a reference calomel electrode can, with reasonable accuracy, be described by an inverted exponential. By taking three measurements shortly after addition of the titrant the parameters of this function can be deduced. This offers the possibility to determine the equilibrium potential almost immediately after addition of the titrant.

The suggested procedure works satisfactorily when adequate mixing of the reacting substances takes place (otherwise the time course may be too irregular to fit an exponential curve). For the next titrant addition it is not necessary to wait for complete equilibration.

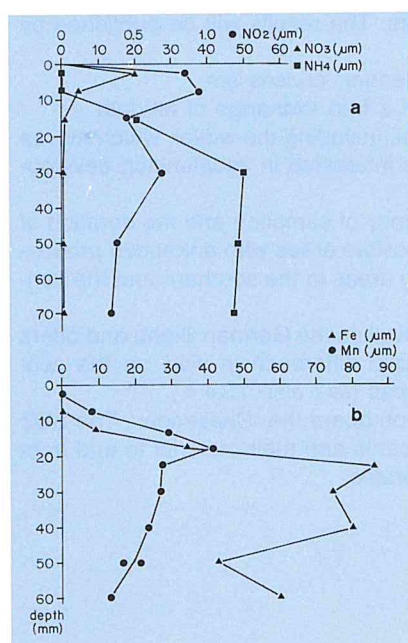
The advantage of the suggested method is the increased speed with which the measurements with ion-selective electrodes can be performed. The increased speed also improves the accuracy of the measurements: instrument drift and temperature changes, which can also interfere with the measurements, are smaller when the measurements are carried out in a shorter period of time. The disadvantage is, however, the larger number of measurements which must be processed. Each determination requires three measurements (instead of one). With automatic data processing procedures, however, this disadvantage can be neglected.

Presence and significance of lithium in *Crangon crangon*

In female (non-ovigerous as well as ovigerous) shrimps whole animal lithium levels are about 20% higher than in males. This suggests that lithium has a special function in the female reproductive system. At low temperatures, combined with high salinities (in winter), internal lithium concentrations are significantly increased. In response to salinity the internal lithium concentrations show a typical regulation pattern. The effects of temperature and salinity clarify that lithium must be involved in metabolic processes: apart from a special function in the reproductive system, lithium may replace other ions in their function, e.g. in regulating the activity of enzymatic processes.

1.3.8. The WINDOW cruise

Interstitial water profiles of nitrogen components and Fe and Mn from a station north of the Dogger Bank, obtained on 7 August 1988 (WINDOW cruise). The data clearly show nitrification in the upper 10 mm (low NH_4^+ , peak in NO_3^-) and denitrification between 10 and 20 mm. The metal profiles indicate the reduction and subsequent dissolution of firstly Mn and secondly Fe below 10 mm.

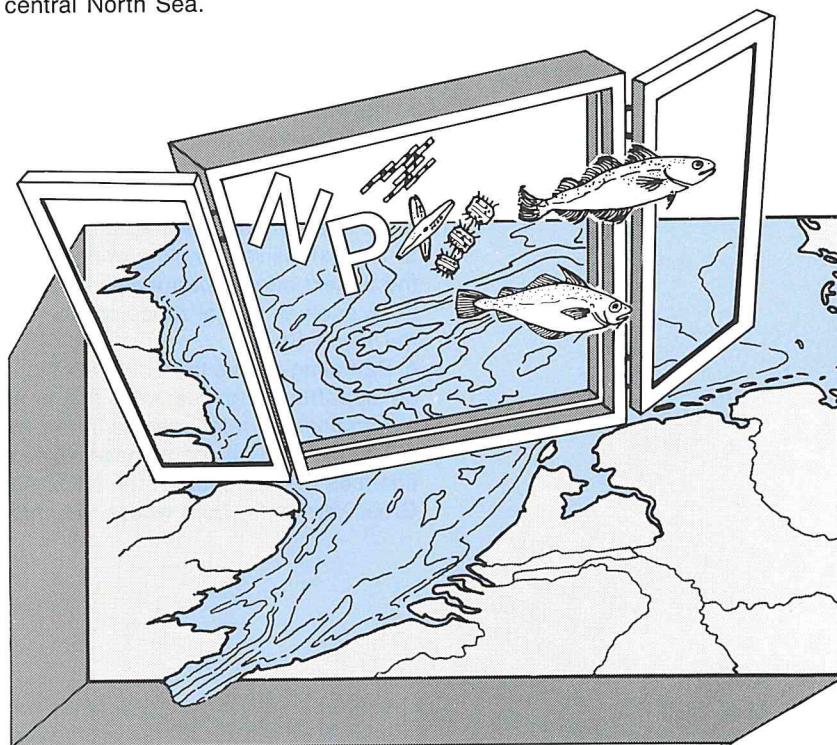


Since J.H. Steele published his well-known North Sea carbon budget in 1974, revised calculations and further research have confirmed the conclusion that insufficient primary production exists compared to food requirements of fish.

The observed mismatches between phytoplankton production and grazing activity of herbivores, benthic community respiration and microbial mineralization all point in the same direction: in the areas investigated up till now there is an unknown channeling of energy into the North Sea's pelagic food-chains leading to fish. Since there can be little doubt about the North Sea's annual fish production estimate, the conclusion must be that in the study of this ecosystem certain crucial sea areas or aspects of the functioning of the ecosystem have been overlooked.

The main reason might be that so far too little attention has been paid to zones with enhanced pelagic productivity, such as mixing fronts and areas of local upwelling. Here, nutrients are transported upwards through the thermocline into the euphotic zone, where they reinforce productivity in the more or less depleted mixed water layer in summer. Situations like these have been described for other sea areas and referred to as 'windows' in the thermocline.

On the northern slope of the Dogger Bank, where high zooplankton and fish biomass occurs in summer, such a 'window' probably exists. Due to tidal mixing or even coastal upwelling against the slope, the summer stratification may be disturbed and nutrient-rich water transported to the surface. A detailed comparison of such a system with areas without upwelling can supply a large amount of fundamental information on the functioning of the ecosystem in the central North Sea.



From July 18 to August 8, a cruise was made with RV 'Tyro' to the area of the Dogger Bank. Simultaneously RV 'Aurelia' carried out a detailed CTD survey. First results are presented in 1.3.1.1., 1.3.4.4., 1.3.5.2. and 1.5.1.1., 1.5.1.2. They indicate that such a 'window' did occur north of the Dogger Bank. A very pronounced algal bloom at the depth of the thermocline was found at the northern slope of the Dogger Bank. This bloom, with chlorophyll *a* values often $> 3 \text{ mg} \cdot \text{m}^{-3}$, covered an area of *ca* 6000 km². Primary production and zooplankton concentrations were enhanced and remarkably high numbers of sea-birds (Guillemots and Fulmars) were observed. CTD profiles indicated mixing of cold (nutrient-rich) water with surface water.

1.3.9. The 'Challenger' surveys 1988-89

B2-01e

M.A. Baars, B.R. Kuipers

Correspondence with the general manager of the British North Sea Project Dr. J. Howarth (Proudman Oceanographic Laboratory, Liverpool) resulted in Dutch cooperation in this large-scale British project. From August 1988 to October 1989, RV 'Challenger' will monthly visit 150 stations distributed over the southern and central North Sea, where mainly physical and chemical data are to be collected. Chlorophyll profiles and primary production measurements are also part of the project of the British scientists. The NIOZ participation consists in the quantitative sampling of zooplankton with 50 micron and 300 micron vertical nets at some 65 selected stations. Zooplankton sampling covers British coastal waters, the central area of the Southern Bight, Dutch coastal waters, the coastal and offshore waters of the German Bight, and the stratified North Sea with emphasis on the surroundings of the Dogger Bank. Sampling and analysis of the enormous amount of material will be carried out by a group of some 8 NIOZ (partly BEWON) zooplankton workers. The results will be published by the covering British organization.

The main reasons for joining the 'Challenger' cruises are:

1. The cooperation occurs on the basis of a free exchange of all data.
2. The sampling covers more than one year, including the winter, which makes the project extremely worthwhile for those interested in zooplankton development in spring and late autumn.
3. The extensive sampling grid, the frequency of sampling and the duration of the project offer opportunities to detect possible areas with enhanced productivity, such as frontal zones or other mixing areas in the southern and the central North Sea.
4. Sampling covers the Southern Bight as well as the German Bight, and offers an opportunity to deal with the problematic difference in view on the zooplankton relationships in the two areas (see also 1.3.4.4.).

The Dutch participants have a free stay on board the 'Challenger'. The SOZ finances the transport of the NIOZ participants and their material to and from Great Yarmouth, from where the ship operates.

1.4. OCEAN RESEARCH

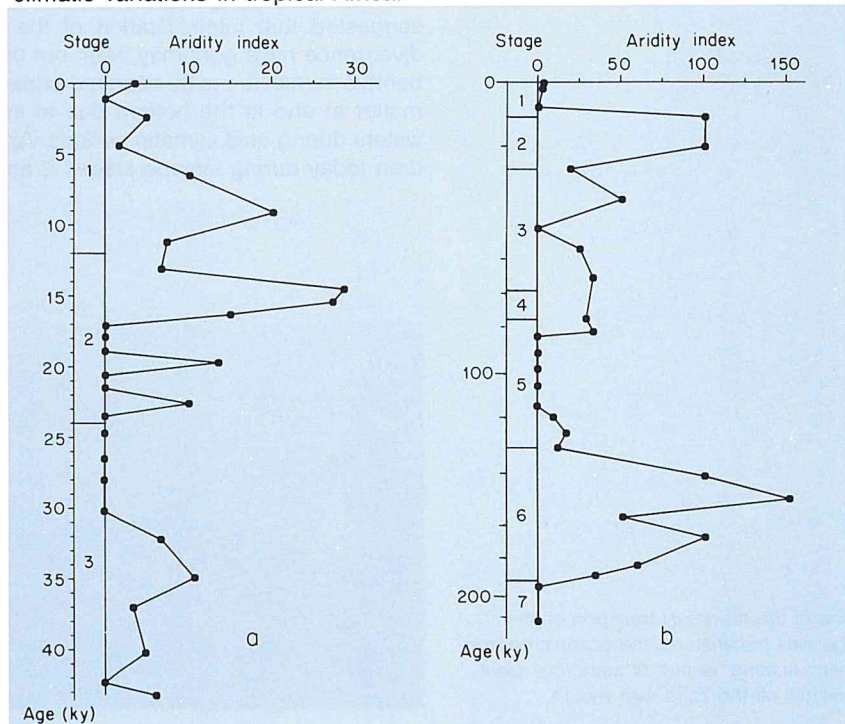
1.4.1. Sedimentology and palaeoceanography of the Angola Basin and Zaire deep-sea fan

H3-03

J.H.F. Jansen

Maps of accumulation rates of freshwater diatoms and phytoliths in the surface sediments of the Zaire fan show that both types of siliceous microfossils have been supplied to the ocean floor by the Zaire river, but that phytoliths also have a southern source, probably the region of the Namibian desert. Therefore, the ratio of phytoliths to freshwater diatoms can be regarded as an aridity index. In two cores, the record of the ratio indicates a humid period about 225 to 190 ka BP, an arid period 190 to 135 ka BP with maxima around 170 and 140 ka BP and a humid excursion 150 ka BP, an increase in humidity 115 ka BP, a less humid period 90 to 30 ka BP, higher humidity between 30 and 17 ka BP with possibly more arid excursions 22.5 and 20 ka BP. The ratio corresponds closely with the known climatic events in the tropics and various other regions in Africa. It can be regarded as a palaeoaridity record which reflects continent-wide climatic variations in tropical Africa.

Aridity index (opal phytoliths vs freshwater diatoms) for equatorial Africa, as recorded in the cores T78-46 (a) and T78-33 (b) from the Zaire deep-sea fan.

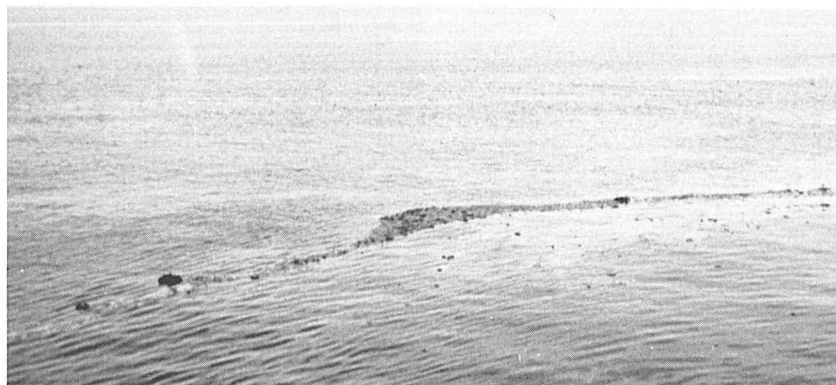


A previous study of the accumulation of ^{10}Be in the sediments of the Zaire fan has indicated that the terrigenous supply of ^{10}Be may be an order of magnitude larger than generally accepted. Motivated by these results, we have measured sediment samples from the Zaire estuary which have not been in contact with seawater. The ^{10}Be concentrations of these samples appeared to be somewhat lower than the maximum value predicted by us, but higher than the values accepted in the literature.

Two Ph.D. theses partly carried out in the context of this project were published in 1988. R.J.W. van Leeuwen, RU Utrecht (Utrecht Micropal. Bull.), has completed his investigations of planktonic and benthic foraminifera of the Angola Basin. He has studied a selection of cores obtained during the NIOZ expeditions of 1978 and 1980, replenished with cores from the collection of Lamont, Woods Hole and Centre Océanologique de Bretagne. A number of biofacies have been discriminated in the planktonic faunas on the sea floor which can be generally described by differences in surface-water temperature and fertility. However, where the thermocline reaches into the photic zone some specific species appear that are linked up with a steep thermal gradient. The deep-sea benthic foraminiferal faunas vary primarily with depth, which is attributed to vertical gradients in bottom-water temperature and in the amount of organic matter arriving at the bottom. Lateral differences may be due to variations in the amount of organic matter at and in the bottom. The results do not support the widely accepted idea that there is a relation between *Nuttalides umboniferus* and Antarctic Bottom Water.

The Late Quaternary planktonic foraminifera indicate that primary production was much higher during cold climatic stages than during warm stages. The influence of the Benguela Current has been strongest during cold phases. It is suggested that intensification of the Benguela Current and the equatorial divergence have generally been out of phase. Climate-related changes in the benthic faunas are to be ascribed primarily to variation in the amount of organic matter at and in the bottom due to increased primary production of surface waters during cold climatic periods. At great depth, bottom waters were colder than today during isotope stages 2 and 4 and in the middle of stage 5.

One of the modes of transport of terrigenous material into the oceanic environment: floating 'island' of mangrove plant material off the Zaire river mouth.

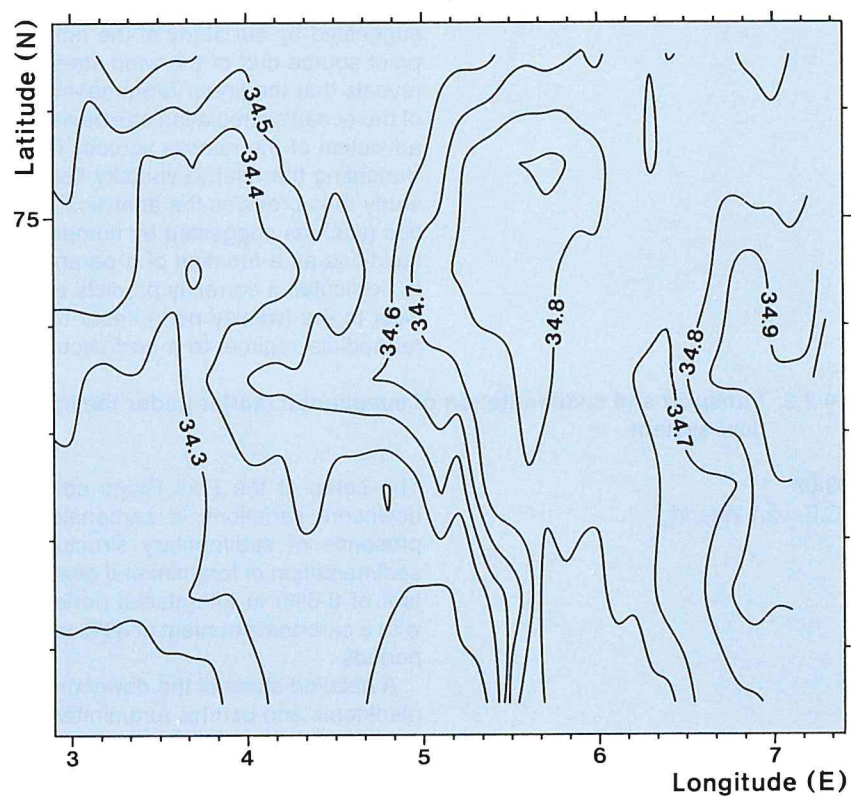


The Ph.D. thesis of G. Moguedet, Université d'Angers, France, is partly based on material collected during a joint expedition to the Congo-Gabon continental shelf in connection with the cruise of 1978. The sediments of this shelf originate mainly from the Zaire River. They are rich in kaolinite, iron and organic matter. North of Cabinda, the deposits are split into two strips situated on the outer and inner zone of the shelf. The minerals are then sorted out: in the calmest waters of the outer zone smectites progressively increase in the muddy deposits, while in the inner zone illite settles most easily. During the Late Weichselian, permanent upwelling caused an enrichment of carbonate and smectites on the outer continental shelf.

Rare Earth Elements

H3-03
T.C.E. van Weering

The study carried out in 1987 has been extended with an additional set of samples. The ratio of Ce/La varies throughout the cores with high ratios in interglacial and low ratios in glacial periods (as observed in 1987). These signals are now thought to be induced by changes in near-sediment surface redox conditions, caused by climate-dependent palaeoceanographic conditions. Results of this study are being prepared for publication (jointly with G. Klaver and K. Beets, VU, Amsterdam).



Horizontal distribution of the sea surface salinity at the Arctic front in the Greenland Sea as observed during the cruise of RV 'Meteor' in November 1988.

1.4.2. North Atlantic Ocean

1.4.2.1. Experimental ocean dynamics

H2-02

H.M. van Aken

In 1988 the physical oceanography department participated in the international Greenland Sea Project. Twelve NIOZ current meters were deployed in September in an array between Greenland and Jan Mayen by the Icelandic RV 'Bjarni Saemundson'. In November H.M. van Aken participated in cruise ME 8/1 of the German RV 'Meteor', in cooperation with the University of Hamburg.

Special emphasis was given to the Arctic Front, southwest of Jan Mayen. A total number of 159 XBTs were launched during a small-scale frontal survey. The data recovery from the XBTs, however, was only 50%. Data processing of the XBT-data and of the sea surface data is well under way. The first results show the presence of strong anisotropic features in the frontal zone with the largest extension in the along-front direction. Participation in this programme will be continued in 1989.

1.4.2.2. Theoretical dynamical oceanography

H2-05

L.R.M. Maas, J.T.F. Zimmerman

The steady state advection-diffusion equation has been solved for the situation of a strained advective flow field and a non-centrally located injection point. Its solution is given in terms of a definite integral, whose asymptotics are transparent. This problem, formulated in the advection-diffusion context, was suggested by our study of the non-linear response of an idealized ocean to a point source curl of the wind stress. This study has now been completed and reveals that the linear Stommel-mode and the, fully non-linear, Fofonoff-mode of the ocean's circulation can be tied together by incorporating the effect of self-advection of the relative vorticity field. This is done in an approximate way by truncating the relative vorticity field's multipole expansion at a low order. This study thus provides the analytical means to understand the symmetry properties (such as suggested by numerical calculations) of the ocean's general circulations as a function of a parameter measuring the degree of non-linearity. In particular, it correctly predicts a turning of the symmetry axis oriented east-west in the (weakly non-) linear regime, over an asymmetrical swirl in the intermediate regime, to a north-south orientation in the fully non-linear regime.

1.4.2.3. Transport and sedimentation of suspended matter under the influence of the Scotland-Greenland Ridge flow system

H3-07

T.C.E. van Weering

The cores of the Feni Ridge collected in 1987 have been studied for their downcore variations in carbonate and organic carbon content and for the presence of sedimentary structures. The cores reflect a cyclic pattern of sedimentation of foraminiferal oozes (60-80% of carbonate, and organic C content of 3-6%) in interglacial periods alternating with terrigenous sediments with a carbonate content of 30% and a content of organic C below 2% in glacial periods.

A detailed study of the downcore presence, distribution and assemblages of planktonic and benthic foraminifera was carried out by S. de Rijk (VU, Amsterdam). These studies confirm that the carbonate stages recognized in the cores may be considered as representing periods similar to oxygen isotope stages.

Diatoms of surface sediments were studied in relation to the present hydrography by C. Brussaard (RU, Groningen) and downcore variations in diatom distributions as a possible tracer of watermass variations and conditions in time by M. van Leeuwe (RU, Groningen). Oxygen isotope results are not yet available because of instrument problems in Gif-sur-Yvette.

Inferred sedimentation rates for the crest of Feni Ridge are $5 \text{ cm} \cdot 1000 \text{ yr}^{-1}$ in stage 5, a mean of $6 \text{ cm} \cdot 1000 \text{ yr}^{-1}$ in stages 2-4 and a rate of $8 \text{ cm} \cdot \text{yr}^{-1}$ in stage 1. Sedimentation on the sediment-wave-dominated southeastern flank of Feni Ridge is slightly lower.

A tentative interpretation of the acoustical profiles of Feni Ridge indicates that Feni Ridge was formed by scour along the southeastern flank of Rockall Plateau, under the influence of a southerly directed bottom current. Subsequently the finer-grained part of the sediment load was deposited as Feni Ridge. Variations of the intensity of near-bottom current transport in the late Quaternary has created a migration of the crest of Feni Ridge towards the SE.

The instrument tripod system for measurements of long-term, *in-situ* time series near the bottom has been further developed. A start has been made with the purchase of components and the development of software. For this purpose a visit has been made to various institutions in the USA, where comparable instrument systems exist or are being constructed (with T. Buisman and R. Groenewegen).

H3-06

D. Eisma, H.M. van Aken

Awaiting the completion of the scanning microprobe system, we have been unable to do any further work on this subject. Analysis is expected to start in 1989.

The CTD-data from FAROR-83 experiment have been processed and reduced to a standard data set in the NIOZ-KL03 format. This data set has been sent to the ICES Service Hydrographique in Copenhagen.

1.4.2.4. Future North Atlantic programmes

Several groups have already started preparations for participation in international projects to be carried out in the next decade. The World Ocean Circulation Experiment (WOCE) aims at obtaining data for the future generation of eddy resolving ocean circulation models, which will be used for climate research. The Joint Global Ocean Fluxes Study (JGOFS) will concentrate on the vertical transport of substance, especially of carbon, in order to explain the carbon dioxide budget of the oceans.

H2-02

H.M. van Aken, L. Otto, C. Veth

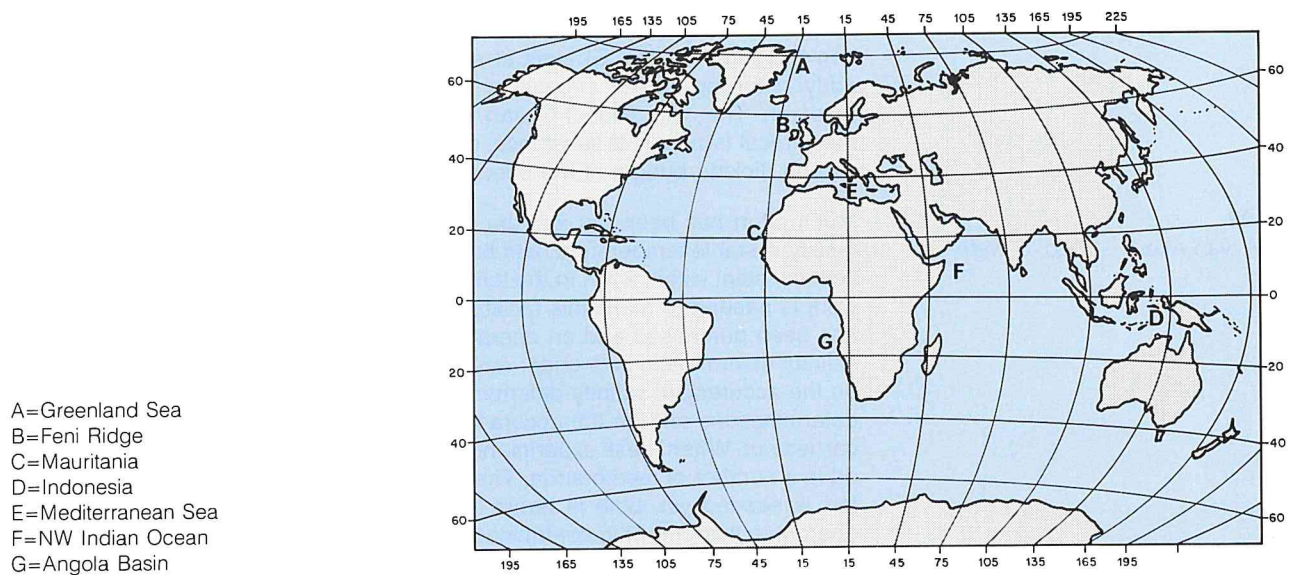
Much effort has been put into the development of a hydrographic calibration facility. A stable temperature bath has been built where the temperature can be kept constant within 2 mK in the temperature range from -2 to 30°C , but more work is needed to make this facility operational. A new Guildline Salinometer has been purchased and an operational procedure to guarantee high quality salinity determinations is under development. A number of small experiments on the accuracy of salinity determinations, on the effect of storage on salinity determinations and on the accuracy of Winkler O_2 determinations have been carried out. When these experiments are finished, the results will be summarized in a number of memoranda. The general impression so far is that much effort is needed yet, both in terms of personnel and financial investments, to guarantee hydrographic determinations of the accuracy required according to WOCE and JGOFS standards.

1.4.3. The Mauritania expedition

Only recently has the importance of the shallow coastal areas of Mauritania known as the Banc d'Arguin been 'discovered'. This area is of worldwide importance as breeding and foraging area for wetland birds, particularly as an overwintering area for palaeartic waders. Research on the Banc d'Arguin has increased considerably and also NIOZ participated herein (see 1.4.2.2.). This rich birdlife must be sustained by high primary and secondary productivity on the Banc. So far it is unknown whether the Banc d'Arguin is a more or less closed ecosystem or subsidized by import of organic matter from the upwelling area off the Mauritanian coast. During the Mauritania expedition research was carried out to answer this question.

From 6 May to 1 June the expedition was carried out in Mauritanian off-shore waters with RV 'Tyro'. The aim was to provide a synoptic picture of the hydrographical conditions of the coastal waters off the Banc d'Arguin and to describe the structure and functioning of the benthic ecosystem between 10 and 200 m depth. A total of 20 NIOZ scientists, assistants and technicians cooperated in the programme, which comprised CTD casts, measurements of primary productivity and organic carbon, collection of zooplankton and juvenile fish, echosounding, box-coring, beam-trawl fishing, bell-jar deployment and incubation experiments, pollution research and observations and counting of sea-birds and mammals.

In spite of the predominantly stormy weather conditions and high seas at this time of the year, a fairly complete set of samples and measuring data could be obtained. Dr. Youri Loktionov, a Russian hydrographer, was assigned by the Mauritanian Government as a counterpart. His scientific contribution and help in solving problems with the local authorities are warmly acknowledged.



Benthic programme

B1-08
P.A.W.J. de Wilde and others

Results from the synoptic survey depicted in a provisional map of the hydrographic conditions show two centres with enhanced upwelling. A tentative impression of the benthic system points to a rich and highly diverse bottom community. A most remarkable observation is the presence of low oxygen saturation values over extensive areas along the coast. More elaborated and synthesized results cannot be expected until the end of 1989.

Pelagic programme

B2-02c
B.R. Kuipers

Macroplankton and zooplankton have been studied simultaneously in the coastal upwelling area along the Mauritanian coast. During the Mauritania cruise extensive sampling has been done at several depths with several types of nets and torpedoes. Samples are presently being analysed, but so far macroplankton has been very rare in the catches. Along the Mauritanian coast, however, a large fishing fleet is currently active, which points again towards a direct connection between zooplankton and fish instead of invertebrate predators.

Sea-birds

B3-07
M.F. Leopold

Pelagic sea-birds were studied from RV 'Tyro'. In the oceanic waters off Mauritania and Senegal both arctic and antarctic sea-birds overwinter. The Senegal upwelling area was already relatively well studied, but Mauritanian waters have only occasionally been visited by ornithologists. In May 1988 a distinct zone was found where Wilson's Storm-Petrels *Oceanites oceanicus*, Sabine Gulls *Larus sabini* and two species of northern hemisphere Skuas *Stercorarius pomarinus* and *S. longicaudus* were numerous. The continuous presence of a fleet of Russian trawlers in the same zone indicates that the waters are very productive.

Uptake, distribution and elimination of metals, pesticides and polychlorinated biphenyls in marine organisms

H1-08/H1-09
J.M. Everaarts

A survey has been carried out to obtain data on the uptake (accumulation) of a number of selected heavy metals (Cu, Zn, Cd and Pb) and chlorinated hydrocarbon compounds (pesticides and PCBs) in benthic macrofauna of the coastal area and deeper upwelling area in the Atlantic Ocean west of Mauritania. Samples have been obtained for whole body analyses of specimens representing a number of different animal groups:

1. Polychaeta (worms)
2. Crustacea: Brachyura (crabs); Penaeidae (shrimps)
3. Mollusca: Bivalvia (*Venus* spp.); Cephalopoda (squids and octopus)
4. Echinodermata: Asteroidea (starfish)
5. Pisces: Teleostei (bottom-dwelling flatfish)

Besides, surface sediment and sediment cores were subsampled from a large box-core taken at a sampling station for the analyses of the above-mentioned contaminants in the different sediment fractions from various depths.

1.4.4. Southern Ocean

1.4.4.1. European Polarstern Study (EPOS)

The history of Antarctic marine research extends over more than one-and-a-half centuries. However, research has not progressed as far as in other areas because of the remoteness and great extent of the region (about 10% of the World Ocean), coupled with severe climatic conditions. While it is accepted that the Southern Ocean is of great importance in a global context, the means to carry out the necessary studies have been available only to a few nations and mostly for short periods, in particular the summers. EPOS is a venture attempting to overcome this problem by pooling manpower resources and bringing together scientists from most West-European countries on the icebreaker RV 'Polarstern' as a convenient platform.

One major objective of EPOS is to investigate the role of sea ice for the pelagic system as well as to study the ice biota themselves (leg 1, 11 October to 20 November). Another is to make a detailed study of the pelagic system in the region of the Weddell/Scotia Seas (leg 2, 22 November to 10 January), while a third objective is to study fish and benthos in the southern Weddell Sea and in the virtually uninvestigated area off eastern Queen Maud Land (leg 3, 12 January to 10 March 1989). There is no doubt that the results will advance our understanding of the Antarctic ecosystem. This is important on a long-time scale when changes in parts of the environment will also cause changes in biological systems.

Experimental ocean dynamics

During the EPOS-project (Leg 2) a number of CTD transects were carried out across the Weddell-Scotia-Confluence between the Antarctic Peninsula and the South Orkneys on the 49°W and 47°W meridians. The transects ran from the Scotia Sea (57°S) into the Weddell pack ice (62°S), so that the marginal ice zone was covered. Contrary to the common thoughts, the surface-mixed-layer appeared to be shallow, probably because of sea ice melting and surface heating. In deeper layers strong horizontal temperature and salinity gradients marked the boundary between the Scotia Sea and the Confluence, but almost every structure in the temperature field was counteracted by a corresponding variation in salinity, such that the density field showed smooth isopycnals ascending to the south. Large 'balloons' of water with Scotia Sea characteristics were found inside the Confluence area, remnants of eddies shed off by the meandering boundary between the Scotia Sea and the Weddell-Scotia-Confluence.

Trace elements

Nolting and de Baar participated in EPOS (leg 2). Sampling was directed towards trace metal distributions in seawater and plankton. Further research in collaboration with A. Buma focused on assessment of the hypothesis of Fe limitation of the Antarctic phytoplankton community, for which Fe enrichment experiments of plankton cultures were executed.

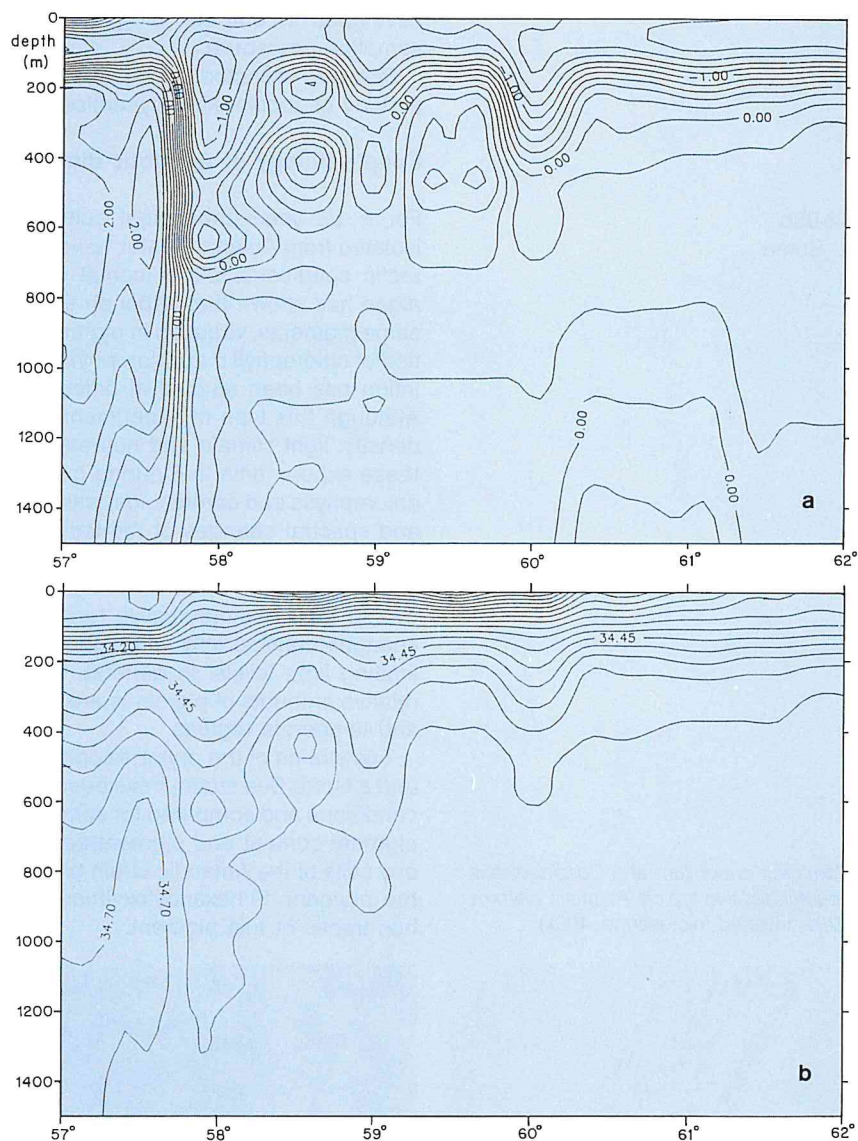
H2-02

C. Veth

H1-14

H.J.W. de Baar, R.F. Nolting

A CTD section perpendicular to the Weddell-Scotia Confluence in the Southern Ocean between the Antarctic Peninsula and the South Orkneys along the 49 west meridian running from 57° to 62° South: a. temperature, b. salinity. The front between the Scotia Sea and the Confluence is clearly visible from the vertical temperature 'wall' between 57°30' and 58° South. The balloon-like structures in the Confluence are remnants of eddies shed off by the meandering front and contain Scotia Sea water.



The pelagic system

B2-05a
H.G. Fransz, A. Buma

Members of the pelagic system group were mainly involved in leg 2 of the EPOS programme, in which keyfactors of plankton succession were studied in the Scotia Sea and the western Weddell Sea. G.W. Kraay cooperated with W.W.C. Gieskes of RUG in leg 1, a preceding cruise in the same area, when the development of algae in the transition zone between the melting ice cover and the water column was studied. For zooplankton sampling under rough conditions a sturdy new opening/closing net was constructed after the design of A. Vaars. The electronics for reading out *in situ* parameters was renewed and

adapted for data transmission by coax cable by M. Laan, while F. Eijgenraam developed a computer programme for control and data handling during the sampling procedure.

Samples collected during all 3 legs of EPOS at the same transect will allow a study of zooplankton dynamics throughout this period.

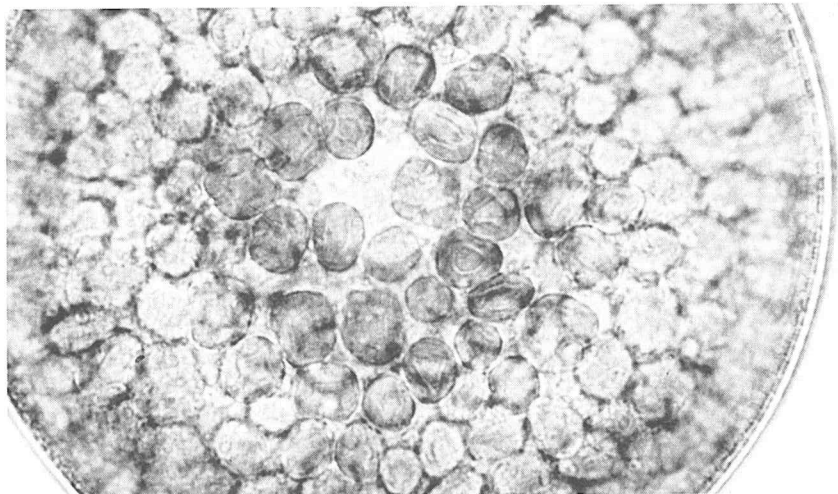
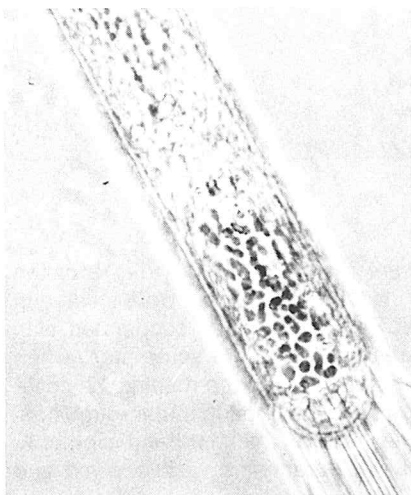
Ecophysiology of Antarctic diatoms

B2-05b
A. Buma

For 1 1/2 years monoalgal cultures of diatoms and a prymnesiophyte, all isolated from Antarctic water, have been kept in the laboratory at simulated Antarctic conditions. Experimental work focused on the pigmentation of these algae has shown that although the species investigated basically contain the same pigments, variation in pigment ratios is substantial. Especially the proportion of chlorophyll *c* to chlorophyll *a* differs markedly between species. Pigmentation has been studied at different phases of growth in batch experiments. Although this type of experiment makes interpretation of data difficult — cell density, light climate and nutrient levels change constantly — it is clear from these experiments that during growth some diatoms alter relative amounts of chlorophylls and carotenoids, with changes of up to 25%. Total energy changes and spectral changes of the light source do not show any effect on pigment ratios in the diatoms investigated, except for the carotenoids diadinoxanthin and diatoxanthin, which show increased concentrations at high light intensities, due to their photoprotective function. Nevertheless pigment content per cell changes considerably with light intensity, exhibiting higher concentrations at limiting light levels. In general, the results show that levels of absolute and relative amounts of pigments are within the range found for diatoms of tropical and temperate regions.

Two strains of the prymnesiophyte *Phaeocystis pouchetii* (an Antarctic strain and a North Sea strain) have been cultivated at identical physical and chemical conditions and compared for some physical properties such as protein content, pigment content and pigment composition. Preliminary results show that colony cells of the Antarctic strain of *P. pouchetii* contain considerable amounts of the pigment 19'hexanoyloxylfucoxanthin, whereas the North Sea strain only has traces of this pigment.

Corethron criophilum and *Coscinodiscus oculis-iridis*, two typical Antarctic diatoms (Zeiss inverted microscope, 400x)



Measuring has now been completed of field samples from a cruise with the RV 'Marion Dufresne' in March-April 1987 in the Scotia Sea. It seems that in this area pigment composition of surface waters can be used as a water-mass tracer in addition to physical and chemical variables.

The silica cycle

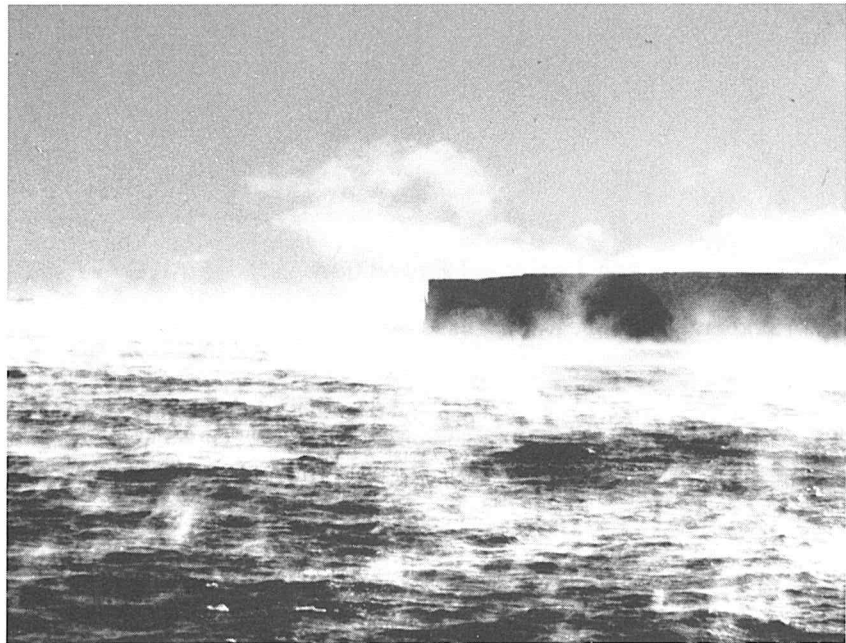
H3-02
A.J. van Bennekom

Growth conditions of some Antarctic diatom species were investigated as a preparation for the experiments carried out on board RV 'Polarstern' during the EPOS leg 2. Most species needed high amounts of silica relative to phosphate and nitrate. The precision of the determinations of Al was improved with a new fluorometer. A cooperation was established with Dr. Lindner (Neth. Inst. for Nuclear and High Energy Physics) to use the radioactive radionuclide ^{32}Si for the first time in oceanic silica kinetics.

Activity and dynamics of microorganisms

B1-02
J.H. Vosjan

For the study of microorganism activity and biomass in Antarctic benthic systems, participation has been planned for EPOS leg 3. The benthic system of this area will be compared with benthos of other Antarctic areas. Results of ATP determinations in the sediment of the regions of the Antarctic Peninsula show a variation of 3.5 to 12.5 mg ATP·m⁻² over a sediment column of 5 cm, *i.e.* about 2 g C m⁻². The highest concentrations of microbial biomass are always found in the upper surface layer of the sediment. Here organic matter settles, and per unit of volume the sediment contains about 5000 times more ATP than the surrounding bottom water.



Seasmoke in the Antarctic. Water in its three phases, ice, liquid and vapour gives this picture of seasmoke a ghostly atmosphere.

1.4.4.2. Small-scale turbulence and boundary layer studies

H2-04

C. Veth

Video tape images of dye releases performed under the sea ice during the Winter-Weddell-Sea-Project WWSP-86 have been processed. The results show dye diffusion in the uppermost layers underneath an ice platelet layer under the fast ice near Drescher Inlet and underneath floating ice in the Weddell Sea. In the uppermost metre of the water, a Richardson type of diffusion has been found and at larger distances a Fickian type of diffusion. Due to the melting of sea ice, the water was weakly stratified in the uppermost metres.

1.4.4.3. Dating with naturally occurring isotopes

H3-10

Zuo Zhizeng, G.W. Berger, D. Eisma

^{226}Ra , ^{210}Po and ^{210}Pb analyses of sediment cores collected during the Antarctica expedition ANT VI-2, October-November 1987, are nearly completed and will be published next year in cooperation with M.M. Rutgers van der Loeff (AWI, Bremerhaven).



1.4.5. Indonesia: the Snellius-II Expedition

1.4.5.1. Experimental ocean dynamics

H2-02

H.M. van Aken

The vertical structure of tracer distributions in the southern Banda Basin has been studied by means of a one-dimensional advective-diffusive model. The theoretical curve fits the data quite well. The vertical diffusion coefficient has been estimated to be $1.3 \cdot 10^{-3} \text{ m}^2/\text{s}$. This relatively high value is probably caused by boundary mixing in the benthic boundary layer along the flanks of the basin. The estimated oxygen consumption ($0.12 \text{ mmol/m}^3 \text{ a}$) is probably for a large part caused by sediment water interaction, while the release of dissolved silica from the sediment at the flanks of the basin can explain the total estimated source term for dissolved silica ($0.17 \text{ mmol/m}^3 \text{ a}$). The ^{14}C profile appears not to be modified by radioactive decay due to the large flushing rate of the southern Banda Basin.

1.4.5.2. Phosphate and silica

H3-02

A.J. van Bennekom

Dissolved silica and phosphate data obtained during the Snellius-II Expedition have been summarized. Almost all phosphate incorporated in phytoplankton is recycled in the upper few hundred metres, while recycling of silica has the largest effects on the dissolved silica distribution around 500 m depth and near the sediment-water interface. This decoupling of the cycles of phosphate and silica, very characteristic of Antarctic waters, is quantitatively of the same importance in Indonesian waters. Below about 1000 m depth diffusion from the sediments is virtually the only source of dissolved silica, as has been deduced qualitatively from Si- Θ graphs and confirmed for the southern Banda Sea from one-dimensional models.

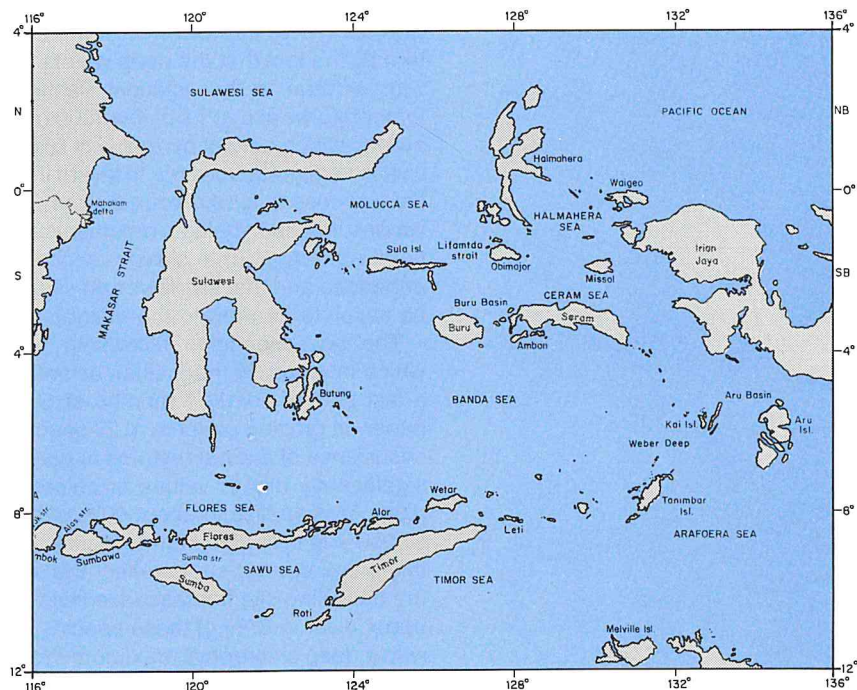
The large flux out of the sediments has been used to calculate transit times of deep water in various basins as well as vertical diffusion coefficients, which are in good agreement with those calculated from radon profiles.

1.4.5.3. Geology and geochemistry of the floor of southern Indonesian deep-sea basins

H3-08

D. Eisma, T.C.E. van Weering,
J.H.F. Jansen

The results obtained on the distribution and composition of suspended matter in Makassar Strait and the Flores Basin have been brought together in two papers, one covering the entire study area, which will be published in the Proc. Snellius-II Symp., Neth. J. Sea Res., and one on the Mahakam river outflow, which will appear in a volume published by Springer. Also results on samples collected with RV 'Sonne' in 1985 have been included. Scanning microprobe analysis in a number of selected suspended matter samples is being continued by A. van Put (University of Antwerp).



Sediment transport and sedimentation in the Indonesian Forearc Basins

H3-08a
T.C.E. van Weering

The study of the seismic structure and sedimentary processes of the Lombok and Savu Basins has been continued, with special emphasis on the seismic stratigraphy of Sumba. Based on multichannel profile interpretations a tentative relationship between the seismic stratigraphy of the Lombok and Savu Basins has been established. To support this interpretation a fieldwork survey has been carried out on Sumba, organized jointly by the department of Earth Sciences, VU, Amsterdam, and NIOZ, as part of the Snellius-II follow-up studies. Two papers on the seismic character of the Lombok and Savu Basins and on the occurrence of acoustic voids in the Savu Basins were accepted for publication in the Proc. Snellius-II Symp., Neth. J. Sea Res., Theme 1.

1.4.5.4. The pelagic system of the permanently stratified ocean

B2-03
M.A. Baars, P.H. Schalk, J.J. Zijlstra

Most papers concerning the pelagic programme in the eastern Banda Sea (theme 3) of the Indonesian-Dutch Snellius-II Expedition have now been completed. Some have appeared in 1988, but the majority will be published in the Neth. J. Sea Res. in 1989 as Proceedings of the Snellius-II Symposium, held in Jakarta in November 1987.

The cooperation between NIOZ and the Institute for Taxonomic Zoology (University of Amsterdam) during theme 3 was crowned by the Ph.D. thesis of P.H. Schalk, based on his participation during the Snellius-II Expedition and financed by a WOTRO-grant (1984-1987). One of the most remarkable parts of this work is the rediscovery of the unusual shallow occurrence of deep-sea medusae and some members of other groups in the Banda Sea, a phenomenon described for the first Snellius Expedition (1929-30) in an earlier, presumably quite overlooked, paper by STIASNY (1935). VAN DER SPOEL & SCHALK (1988) and SCHALK & VAN DER SPOEL (1988) explain this shallow pattern by the fact that the deep waters in the Banda Sea regions are significantly warmer than in the adjacent Pacific and Indian Oceans. The 2-4°C higher temperatures at depths below 1000 m probably result in an increased metabolic activity which cannot be met with a sufficient food supply. The only way to survive is to migrate upwards to layers in, or just below, the photic zone where they have access to food resources, but with even higher temperatures. The observations that bathypelagic organisms sometimes occur outside their narrow temperature range (the classic concept) also imply that dispersal is greatly enhanced and that shallows and sills between deep basins cannot be regarded as absolute barriers to the distribution of this deep plankton.

The post-expedition fellowship programme of the Snellius-II Expedition, which involved 13 Indonesian scientists for theme 3, has come to an end with a last stay of nearly 4 months of O.H. Arinardi, M.Sc., on Texel in 1988. His paper on grazing patterns in 27 species of copepods has been completed. The occurrence of diurnal rhythms in gut fluorescence appears to be frequent, with significantly higher values of chlorophyll pigments in the animals caught at night. This applies to about 60% of the species at all stations. At the upwelling station it is only 22%. Intraspecific differences in gut fluorescence for species inhabiting several strata reflect the vertical heterogeneity between stations; at the upwelling site fluorescence levels are lower in animals caught beneath the upper layer in 67% of these species, whereas at the oligotrophic 1985 stations with a deep chlorophyll maximum this is only 5%. In many species the increase

in gut fluorescence by night is not limited to the upper layer but often extends down to 150-250 m, pointing to rapid sinking of satiated animals. Body carbon weights have been determined to compare the degree of herbivory according to the literature with weight-specific gut fluorescence. The latter is at a maximum at the upwelling station in most species, with highest values not in *Calanoides* but in *Eucalanus* and *Temora* species. At the other stations no clear differences in weight-specific gut fluorescence occurred between categories of feeding behaviour. In the upwelling season the carbon weight of adult females is twice as high as in the other monsoon in *Cosmocalanus*, *Undinula*, *Euchaeta* and *Candacia* species. Estimates of daily ratios, via measurements of the gut clearance rate, are generally low and only at the upwelling stations above 50% of carbon body weight. Estimates on the effect of community grazing vary between 2 and 6% of the standing stock of chlorophyll consumed by mesozooplankton per day.



1.4.6. Mediterranean Sea

1.4.6.1. Transport phenomena near the sediment-water interface

H1-13

K. Booij, W. Helder

An increase in the velocity of the overlying water produces an increase in the oxygen flux between sediment and water. The effect is large for sandy sediments, as has been reported previously. Shipboard incubations of muddy sediments in the Mediterranean show basically the same results. In the laboratory an experiment has been carried out under more controlled conditions. The effect of water flow velocities on the oxygen distribution in a muddy sediment from the Wadden Sea has been studied, as well as the rate at which the oxygen distribution in the sediment changes and the changes in oxygen flux to the sediment. The results show that the oxygen flux to the sediment increases by 30% when the bottom shear stress (τ) increases from 5 to 55 mN m⁻² ($u_* = 0.22$ to 0.75 cm s⁻¹). Suspended solids concentrations increase from 2 to 25 mg dm⁻³, but the oxygen demand of the water column does not increase. The oxygen distribution responds within 1 to 10 minutes to changes in bottom shear stress, but the magnitude of the concentration changes is less than 5%. The oxygen penetration depth increases from 5 mm at $\tau = 5$ mN m⁻² to 6 mm at $\tau = 55$ mN m⁻². This project has been carried out in collaboration with B. Sundby, Maurice Lamontagne Institute, Canada, and G. Gust, University of South Florida at St. Petersburg, United States.

1.4.6.2. Distribution of metals

H1-07

R.F. Nolting

The pore waters and the sediment of the cores collected in the Mediterranean as part of the EROS-2000 programme have been analysed. In the pore waters dissolved Mn, Fe, Zn, Cd, Pb, Ni and Cu have been measured. In the sediment the leachable fraction (0.1 N HCl) of Fe, Mn, Zn, Cd, Pb, Ni, Cu and Ca has been determined. Dissolved manganese profiles show some distinct variations in such a way that they indicate five specific areas. High manganese concentrations in the pore waters are found off the Rhone delta, while very low concentrations ($1 \mu\text{mol}\cdot\text{l}^{-1}$) occur in the deeper southwest part of the area studied (water depth > 500 m). The latter stations also have the highest manganese content in the sediment ($700 \mu\text{g}\cdot\text{g}^{-1}$). Dissolved iron does not show this pattern and is low in most profiles ($< 10 \mu\text{mol}$). Leachable iron is higher (0.5-1.0%) in the cores collected in shallow water and low (0.25%) in those from deeper parts. The calcium content in the sediment is high (17-20%) in the cores from the southeast deep area, which indicates a calcium-carbonate content of almost 50%. Zinc is highest ($50-75 \mu\text{g}\cdot\text{g}^{-1}$) in the cores collected off the Rhone delta, decreasing to $25 \mu\text{g}\cdot\text{g}^{-1}$ in offshore direction. Pore waters show the same pattern. Cu, Pb and Ni concentrations are fairly high in the pore waters and vary from 25 to 200 nmol·l⁻¹ depending on the element; Cd concentrations were ten times lower. The interpretation of all these data will be evaluated according to other parameters, such as nutrients, oxygen and sediment texture. In December 1988 a second cruise in the EROS area was made on board RV 'Discovery'.

1.4.6.3. Transition metals in anoxic basins

H1-15

H.W.J. de Baar, R.F. Nolting,
P. Saager

Anoxic basins serve as a natural laboratory for studying many chemical processes such as also take place during early diagenesis in sediments. The Black Sea is the largest anoxic basin in the world; the anoxic Bannock Basin in the Eastern Mediterranean is furthermore unusual as it contains two distinct hypersaline brines (I and II) derived from dissolution of the well-known evaporites. The study is focusing on the Rare Earth Elements (REE), among which Ce exhibits oxidation and reduction (redox) reactions in seawater. The anoxic basin project is an extension of recently published earlier work which represents the first study ever of REE chemistry in anoxic waters (DE BAAR *et al.*, 1988). On the other hand the more commonly known metals Fe, Mn, Cu, Cd, Ni, Zn and Al are also studied. J. Schijf (RU Utrecht) started this Ph.D. thesis project in the autumn of 1987 at the NWO Laboratory for Isotope Geology, in collaboration with their staff (E.H. Hebeda, among others). Within half a year the extensive high precision Isotope Dilution Mass Spectrometry method has become operational.

Since then the waters from Bannock Basin (RV 'Tyro' expedition in 1987) have been analysed. In general the anoxic brines show concentrations of REE an order of magnitude higher than in overlying oxygenated waters. This is most distinct for Ce; the ensuing Ce anomaly is strongly negative in overlying waters, slightly positive in Brine I and virtually neutral in Brine II. The dissolved Mn levels in the brines are several orders of magnitude higher than in the overlying waters. Dissolved Al shows a striking similarity with silicate in the Mediterranean seawater, while in the brines Al is depleted and silicate enriched.

In July 1988 De Baar participated in a Black Sea expedition (RV 'Knorr') under auspices of the US National Science Foundation. Filtered seawater and suspended particles were collected by ultraclean methods; the sampling scheme was coordinated with that of K.O. Buesseler (WHOI), who will measure Chernobyl derived radioisotopes of the REE. Onboard we also executed mixing experiments between anoxic and oxic waters in collaboration with F.J. Millero (Miami) in order to assess oxidative removal rates of Ce and Mn. Analyses are now in progress at the NWO/IGO laboratory (REE) as well as NIOZ (other metals).

1.4.6.4. Experimental ocean dynamics

H2-02

H.M. van Aken

The CTD-data obtained in the summer of 1987 during the EROS-2000 programme in the Golfe de Lion have been processed, corrected and reduced to a standard data set. This data set contains values of temperature, salinity, potential density excess, oxygen concentration and attenuation coefficients every 5 dbar. The data are formatted in the NIOZ-KL03 data base. A first analysis of the data reveals the presence of a shallow plume, diluted with water from the river Rhone. The water in this river plume is relatively turbid and has a high oxygen content. The plume moves cyclonically over the shelf, the shelf break and the deep water. Over the shelf of the Golfe de Lion, a bottom boundary layer has been encountered with a relatively large turbidity and low oxygen values. The coldest water ($\Theta < 12.6^\circ\text{C}$) in the area has not been observed in the deep Algero-Provencal Basin but in the northwestern part of the shelf. This is probably a relict from the strong cooling over the shelf in the preceding winter. In the deep water of the Algero-Provencal Basin a number of cyclonic and anti-cyclonic eddies have been observed which do not show any signature in the hydrographic properties at the sea surface.

1.4.6.5. Flocculation and deflocculation of suspended matter

H3-11

D. Eisma, T. Schuhmacher

The *in situ* suspension camera became ready for use and was tried out successfully in the Wadden Sea and in the Mediterranean off Villefranche by T. Schuhmacher, H. Boekel and J. van Heerwaarden. It was tested to a simulated depth of 7500 m at Brest (IFREMER). This was made possible by the generous hospitality of IFREMER at Brest and of the CNRS at Villefranche. In December it was used in the EROS programme in the western Mediterranean, on board RV 'Discovery'. Preliminary results show that the new instrument performed quite well.

1.4.7. Trace elements in the oceans

H1-14

H.J.W. de Baar, R.F. Nolting,
P. Saager

Analyses of seawater collected in the northwest Indian Ocean in 1986 (RV 'Charles Darwin') are virtually completed. Within the broad oxygen minimum zone the levels of Mn and Fe are elevated, with a striking similarity to published profiles for the eastern equatorial Pacific Ocean. For Mn a comparison with density yields a distinction of three different Mn maximum features in keeping with known hydrography in the area. Our data are the first for the (NW) Indian Ocean. The vertical profiles for dissolved Cd, Cu, Ni and Zn exhibit the typical oceanic nutrient distribution. The Rare Earth Elements were analysed by our colleagues at Cambridge (C.R. German and H. Elderfield) and show steep Ce maxima in the oxygen minimum zone.

1.4.8. Conversion of clay minerals in the sea

H3-05

S.J. van der Gaast

Basalt glass and its alteration product palagonite from a DSDP core (hole 335) have been analysed for their structures with X-ray powder diffraction. The glass shows a non-clay mineral structure with an average spacing of 12Å. The palagonite shows a smectite-like clay mineral structure with a spacing of 16.2Å at 100% relative humidity and 12.9Å at 0% relative humidity. This structure can be caused by partly blocked layers or by the morphology of the particles. A 20Å peak representing spacings caused by the morphology of the particles and also observed with high resolution electron microscopy analysis shows, however, that the irregular spacings of the smectite are caused by its poorly stacked, irregularly curved layers. This shows that smectite formed from this marine basalt has the same morphology as smectite formed from basalt from Kenya and Tanzania.

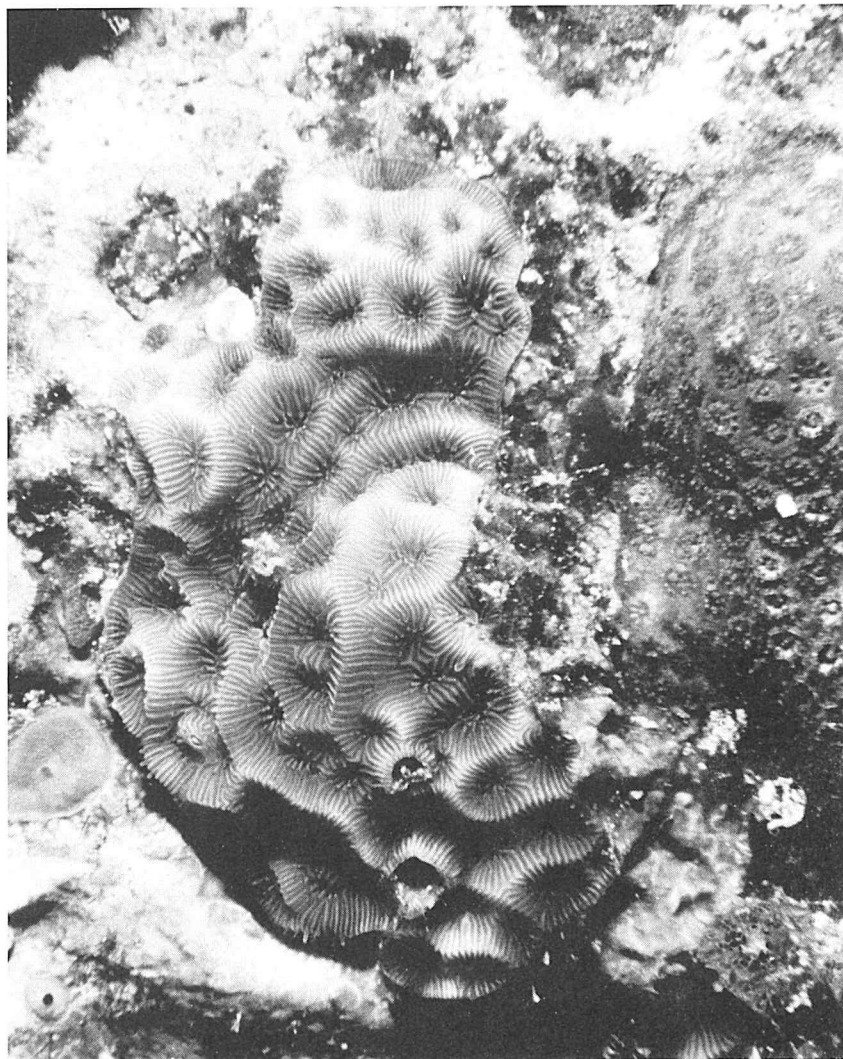
A primitive clay precursor has been found in Precambrian glass from Canada. This glass shows spacings of 14Å and 7-8Å, found both by high resolution electron microscopy and XRD. This mineral, however, shows no sensitivity in expansion of spacing with increasing relative humidity. We conclude that from the glass a primitive clay precursor has been formed. This work is carried out in cooperation with K. Tazaki, W.S. Fyfe and Zhihong Zhou (University of Western Ontario, Canada).

1.4.9. Coral reefs

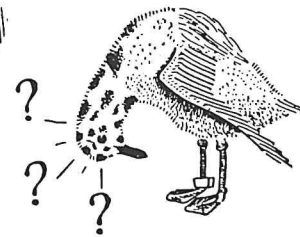
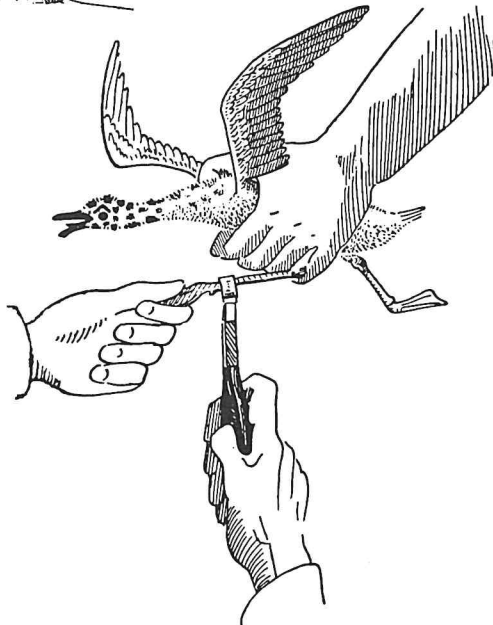
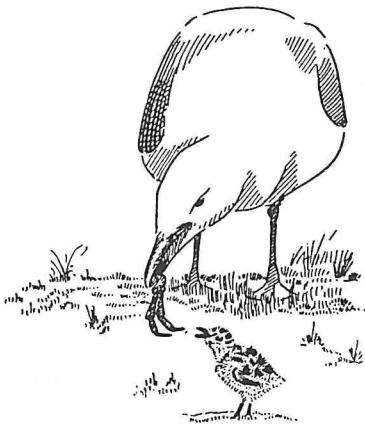
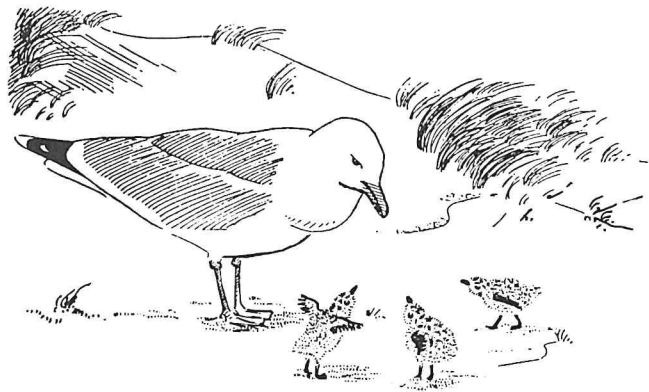
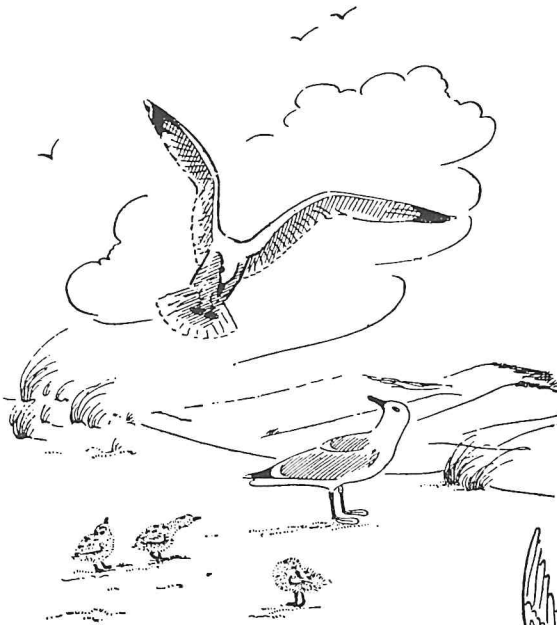
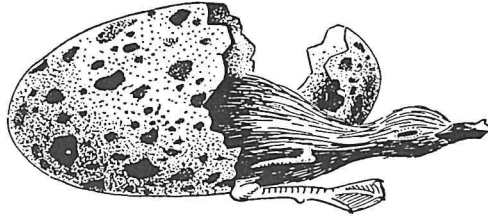
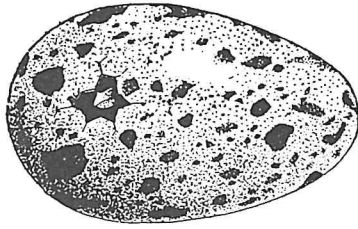
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R.P.M. Bak

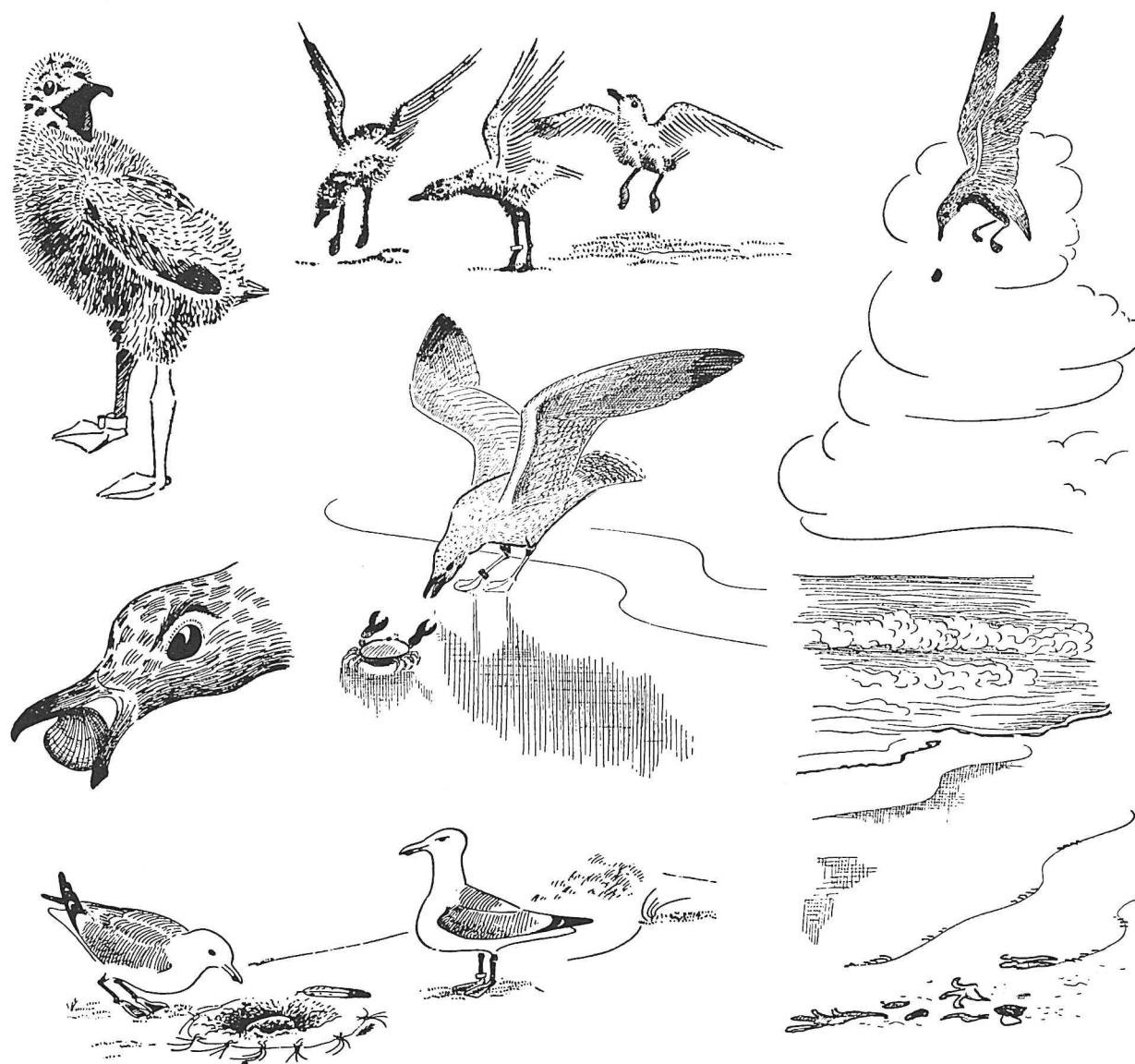
In the destruction of coral reef substrata, bio-erosion is a major process and in this process sea urchins (Echinoidea) are a major component. A comparative study on echinoid bio-erosion in Polynesian lagoonal reef habitats has shown that mainly species of two groups (*Diadema* and *Echinothrix*) are involved. *Diadema setosum* is the most important bio-eroder, processing $\sim 9 \text{ kg CaCO}_3 \text{ m}^{-2} \text{ y}^{-1}$ (ash free dry weight). The figures are very high compared with similar data for e.g. the Netherlands Antilles. Which proportion of the material is primary rock erosion and which the recycling of sediment is being studied.

Studies on settlement strategies of juvenile corals and on life history strategies of large reef sponges are continued.



Interaction between corals. *Agaricia humilis* colony ($\varnothing 35 \text{ mm}$) is partly killed by a *Madracis* colony on the right.





Although Niko Tinbergen († 21 December 1988) had no direct connections with NIOZ, many of us were inspired by his work and still enjoy his stimulating, well-illustrated writing. We have here reproduced a series of his drawings from his book 'Klieuw', written during the war, when he was imprisoned at Vught, as letters to his children. They show the growing up of a Herring gull, one of his famous study objects, from egg to marriage (on Texel).

1.5. SPECIAL PROJECTS

1.5.1. Applied scientific research NIOZ (BEWON)

S-01

The BEWON-project started in January 1988 as part of the larger BEON-project (=Applied Ecological Research North Sea and Wadden Sea), which is a cooperation between 8 Dutch institutes. The work, which now focusses on the North Sea, is a continuation of the EON-project, which ended in December 1987.

The 17-member staff are executing a scientific research programme to solve management questions concerning eutrophication, organic and inorganic micropollutants and effects of fisheries on the benthic ecosystem. Based on the results of the symposium 'Ecology of the North Sea', held on Texel in May 1988, and a compilation of management questions made by the programme-bureau-BEON, a five-year research programme has been developed, which will be executed between 1988 and 1992. The highlights of this year's programme were the presentation of the final report of the EMOWAD-project 'Ecosysteem-model van de westelijke Waddenzee' to the Minister of Transport and Public Works on April 21; the issuing of the special EON-number of the Neth. J. Sea Res. 22(1); the publication of the final documentation of the ecosystem model of the Ems-Dollard estuary in the book 'Tidal Flat Estuaries, Simulation and Analysis of the Ems Estuary' in September; the large-scale participation in the WINDOW research cruise with RV 'Tyro' in July and August (see 1.3.8.); and the publication of the report on the biological effects of drilling muds (NIOZ - Report 1988 - 3).

1.5.1.1. Eutrophication

Nutrient chemistry

S-01a

W. van Raaphorst, H.Th. Kloosterhuis

During the WINDOW and EUZOUT expeditions in the North Sea the nutrient chemistry in the upper 15 cm of the sediments (early diagenesis processes, bottom-water exchange processes), and the chemical hydrography (Dogger Bank area, July-August) were studied. For the benthic processes affecting P and Si, a simple one-dimensional diffusion-reaction model, developed assuming first order kinetics for the fast reversible adsorption reactions (P, Si) and the

slower dissolution processes (Si) in combination with a zero-order mineralization term (P), proved to be in good agreement with the experimental data on the sediment-water exchange of both phosphate and silicate. In this modelling concept the benthic fluxes J ($\text{mmol}\cdot\text{m}^{-2}\cdot\text{day}^{-1}$) are linearly related to the concentrations C_{over} ($\text{mmol}\cdot\text{m}^{-3}$) in the overlying water:

$$J = K_m (C_b - C_{\text{over}})$$

where K_m is the overall mass transfer coefficient ($\text{m}\cdot\text{day}^{-1}$) and C_b a parameter (with the unity $\text{mmol}\cdot\text{m}^{-3}$) characteristic of the interstitial water of the sediment considered. The value of K_m is approximately 0.01-0.05, and 0.001-0.005 $\text{m}\cdot\text{day}^{-1}$ for P and Si, respectively. The corresponding data for C_b are 0.1-1 and 20-250 $\text{mmol}\cdot\text{m}^{-3}$ respectively, the lower values found at the shallow locations over the Dogger Bank, the higher values in the stratified parts of the central North Sea. The C_b estimates for phosphorus are small compared with the pore-water data. This indicates strong adsorption mechanisms in the very upper layer of the sediments. The concentrations C_b found for Si are in agreement with the corresponding concentrations in the interstitial water. The concept for the early diagenesis of nitrogen compounds is more complicated, and not completely elaborated yet.

The chemical hydrography of the Dogger Bank area in the period July-August is characterized by relatively low phosphate and silicate concentrations at the edge of the Dogger Bank (borderline well-mixed/stratified system): $\text{PO}_4 < 0.2 \mu\text{M}$, $\text{Si} < 0.4 \mu\text{M}$, compared to the concentrations over the Dogger Bank (P: 0.2-0.6 μM , Si: 0.5-1.6 μM). For the N-compounds, particularly for NO_3 , less lateral variation was observed. The spatial differences may be reflected in the local primary productivity. An enrichment with nutrients due to the mix up of deeper water from the stratified area with water from the epilimnion at the slope of the Dogger Bank has been demonstrated.

Primary production

S-01b
R. Riegman, J.F.P. Malschaert

In collaboration with the Research Institute for Nature Management (RIN) the influence of the blue mussel *Mytilus edulis* on phytoplankton primary production was studied in mesocosms. The presence of *M. edulis* was found to enhance the productivity of phytoplankton cells, whereas the total biomass of the phytoplankton population decreased dramatically.

As a contribution to the WINDOW expedition field populations of phytoplankton were studied during July and August in the North Sea (Dogger Bank area). Size-dependent primary production, community respiration, chlorophyll *a*, species composition and nutrient uptake kinetics were measured. Bioassays were used to establish the growth-rate limiting factor. These investigations were performed in collaboration with Dr. F. Colijn (Tidal Waters Division, Ministry of Transport and Public Works).

Microbiology

S-01c
F.C. van Duyl, A.J. Kop

The WINDOW and EUZOUT expeditions, the latter in close conjunction with RWS, offered an opportunity to gain insight into the role of pelagic bacteria in the North Sea. Bacterial production was estimated (with the ^3H -thymidine method) in transects from the Dutch coastal zone into the central North Sea

with a dense grid of sampling stations over the Dogger Bank. As expected, the highest bacterial production was found in the eutrophicated coastal waters, where bacterial production was up to 20 times higher than in the central North Sea in July. Vertical gradients in production yielded interesting preliminary results. In stratified waters bacterial production was locally found to be highest just under the thermocline at 20-35 m depth. Such maxima coincided with maxima in fluorescence. These findings point to a close relationship between bacterial production and algal biomass.

Higher trophic levels

S-01d

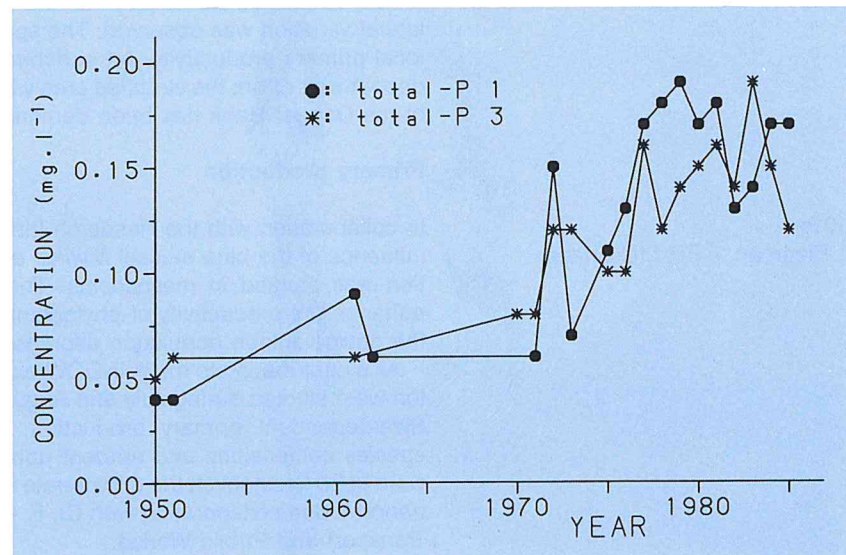
H.W. van der Veer, A. Stam

The research on the relation between eutrophication and higher trophic levels now concentrates on the impact of eutrophication on the amount of food available to the benthic community and epibenthic predators.

Data on the eutrophication of the coastal zone were analysed together with W. van Raaphorst and related with changes in the benthic community, especially the mussel culture in the Wadden Sea. The results suggested food limitation and competition between the various benthic suspension feeders.

An analysis of the growth conditions of one of the most important epibenthic predators in the coastal zone and in particular in the Wadden Sea, the commercially important flatfish plaice *Pleuronectes platessa* L., showed that this species is not food limited during its juvenile stages. The next step will be an analysis of possible effects of eutrophication on the benthic community and adult fish populations in the open North Sea.

Total-P concentrations in the western Wadden Sea during the first (●) and third (*) quarters of the year, showing that eutrophication of this area was highest between 1970 and 1980.



1.5.1.2. Micropollutants

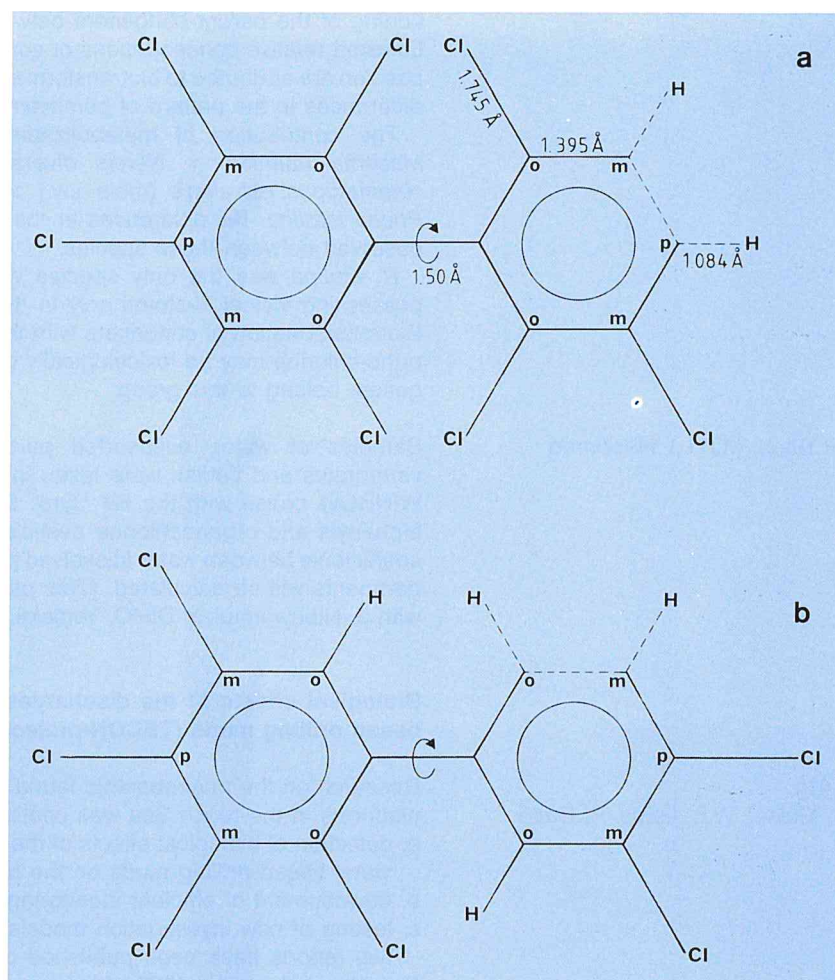
S-01e

P. Saager, H.J.W. de Baar,
R.F. Nolting, J.P. Boon

Trace metals in the North Sea

The main objective is assessment of exchange of dissolved metals between sediment and overlying waters, with emphasis on sandy, low-organic sediments. Special sampling tools were developed for this type of sediment. During the WINDOW campaign (July, August) aboard RV 'Tyro' sediment

samples and interstitial waters were obtained from box cores. From the water column filtered seawater and suspended matter were collected with modified GoFlo samplers and the refitted ultraclean laboratory container. Analyses of Cu, Cd, Pb, Zn as well as Fe and Mn are now virtually completed. The levels of Mn and Fe in pore waters are extremely low. This, combined with results (dissolved oxygen, nutrients) from colleagues (Cramer, Van Raaphorst) for the very same cores, indicates that early diagenesis is at least as active as in hitherto more commonly studied organic-rich, fine-grained sediments. This is a joint project between the BEWON group (Saager, Boon) and Chemical Oceanography (De Baar, Nolting).



Molecular features of PCBs allowing enzymatic biotransformation:

A: Vicinal H-atoms (---) at the meta- (m) and para- (p) positions. Biotransformation occurs regardless of the number of chlorine atoms in the ortho-(o) position.

B: Vicinal H-atoms (---) in the ortho- and meta-positions. Of the species investigated, only the harbour seal appears able to metabolize this type of chlorobiphenyl molecules, and then only in the presence of at most one ortho-chlorine.

Organic

S-01f

J.P. Boon, J.M. Everaarts,
F. Eijgenraam

A quantitative structure-activity relationship has been developed for the influence of biotransformation on the degree of bioaccumulation of PCB-congeners under field conditions. The PCB-patterns of different animal species from the western part of the Dutch Wadden Sea are used to illustrate the model. The PCB-pattern in a particular species is compared with that in the bivalve *Macoma balthica*, where it is assumed that no biotransformation occurs, the PCB-pattern being determined entirely by physical-chemical equilibrium partitioning of the parent congeners between hydrophobic tissues and seawater. Lowered relative concentrations of congeners with vicinal H-atoms in the m,p position are attributed to biotransformation in the assumption that no significant differences in the pattern of persistent congeners existed between species.

The contribution of metabolizable congeners decreased in the order *Macoma balthica* > *Nereis diversicolor* > *Pleuronectes platessa* and *Haematopus ostralegis* (male juv.) > *H. ostralegis* (male (sub-)adult) and *Phoca vitulina*. No differences in the patterns of persistent congeners were observed between these species.

P. vitulina was the only species with a relative concentration of CB-118 possessing vicinal H-atoms only in the o,m position and one ortho-chlorine. Biotransformation of congeners with this configuration and not more than one ortho-chlorine may be toxicologically very important since the most toxic congeners belong to this group.

J.P. Boon, M.TH.J. Hillebrand

Samples of water, suspended particulate matter, sediment, benthic invertebrates and flatfish were taken in the central North Sea area during the WINDOW cruise with the RV 'Tyro'. Concentrations of individual chlorinated biphenyls and organochlorine pesticides will be determined and distribution coefficients between water (dissolved phase) and the other environmental compartments will be calculated. (This part of S-01f is carried out in cooperation with J. Nieuwenhuize, DIHO, Yerseke.)

Biological effects of the discharges of cuttings with oil-based or water-based drilling muds (TECON-project)

S-01g

M. Mulder, W.E. Lewis, R. Daan

Research on the macrobenthic fauna in the vicinity of drilling and production platforms in the North Sea was continued, with the following aims:

- a. detection of biological effects of the discharges of cuttings with oil-based or water-based drilling muds on the benthic fauna;
- b. development of efficient monitoring strategies and
- c. testing of new investigation models.

Two reports have been published on the investigations of 1985 and 1986. Samples collected in 1987 have been sorted and analysed. From the results it became clear that in 1987 again sudden changes in the benthic fauna occurred around one investigated location, confirming the hypothesis of redistribution during storms and consequent secondary effects of discharged oil-based muds on the fauna long after drilling has been terminated.

The experiment of stereo-photography of the sediment-surface to test the applicability of this method for benthic surveying was completed. Although the quality of the stereo-pictures was perfect, a close comparison between fauna present and traces of infauna in the pictures was not possible. This was mainly caused by the lack of tubes and holes belonging to the benthic infauna in the investigated area (fine sandy sediments). The stereo-pictures collected in the sedimentation area (Oyster Ground) showed far more details of the benthic population. Unfortunately comparison of the pictures with simultaneously collected samples was not possible. This location had been sampled during an earlier survey. It is concluded that in areas with sandy sediments this method is not, or less, suitable as an additional monitoring technique for quantitative purposes.

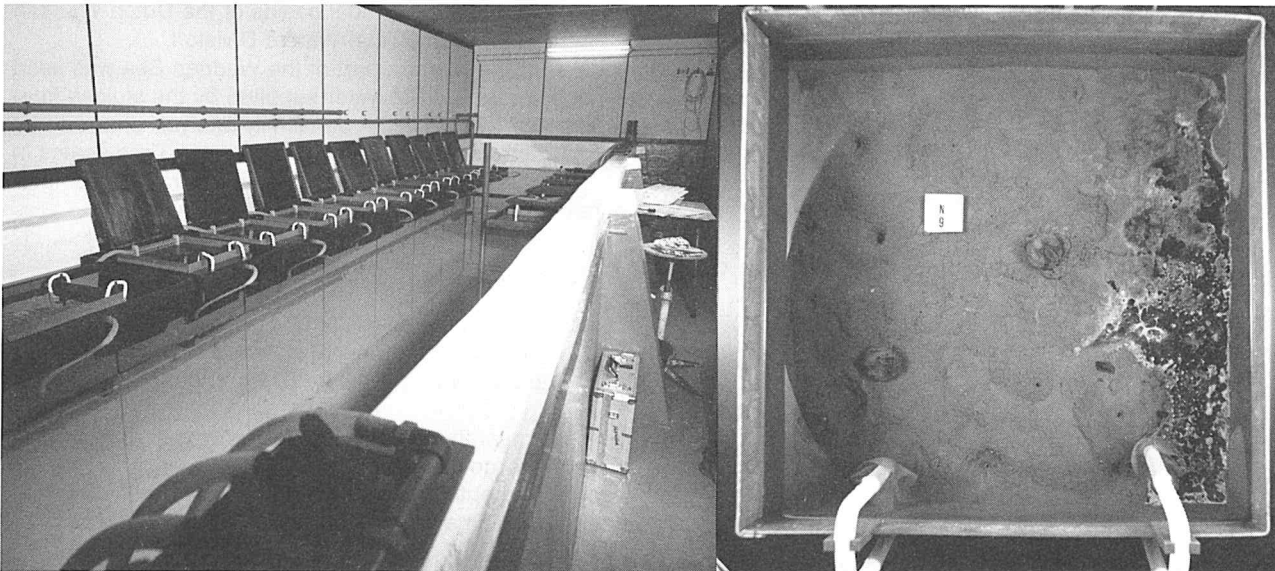
In 1988 three locations were visited during several surveys as a continuation of investigations on long and short-term effects caused by the discharges of cuttings with adhering oil-based muds.

During one of the surveys undisturbed bottom cores were collected around a drilling location in the Oyster Ground and transferred to the laboratory for 'boxcosm' experiments. For this purpose three groups of boxcosms were installed in the laboratory with different grades of oil-pollution. Different experiments were carried out with these intact bottom systems, for instance to study the dose-effect relationship by using test-animals. For these experiments a large number of the echinoderm *Echinocardium cordatum* were collected. This echinoderm proved to be very promising for indoor active biological monitoring.

All investigations were executed in close cooperation with MT-TNO, Den Helder, and RWS, North Sea Directorate.

Left: Subtidal mesocosms ('boxcosms') in an indoor basin at the institute are employed for ecotoxicological research on North Sea bottom ecosystems.

Right: *Echinocardium cordatum* (heart urchins) on top of the sediment in a boxcosm. This bottom core was collected in the vicinity of a drilling location. The black blotches on the right side originate from discharged oil based muds.



1.5.1.3. Modelling

S-01h

J.W. Baretta, P. Ruurdij

In 1988 a number of estuarine projects were finished: - The ecosystem model of the western Wadden Sea was documented in the (Dutch) EMOWAD-I report. - Some aspects of this model were published in Neth. J. Sea Res. 22(1), and still other results are contained in a separate publication, the (English) EMOWAD-II report. - The BOEDE/EON work on the Ems estuary with respect to mathematical modelling was finally published by Springer in their series Ecological Studies, vol. 71.

With the completion of these projects, the emphasis in our work and planning has now shifted to the North Sea. This research should lead to a simulation model of the North Sea which enables the authorities responsible for the various management aspects of the North Sea to calculate the consequences of different management scenarios.

This ambitious goal cannot be reached by our efforts alone within a reasonable time-frame (5 years) and therefore much effort has been spent on organizing collaborative efforts with other laboratories, both in the Netherlands and abroad. If collaborative modelling is to be successful, we need suitable means of information-exchange. These may be provided by existing, or planned, research networks such as EARN. To gain comfortable access to EARN, NIOZ is joining SURFNET. Within the framework of the EC-CREST programme we are trying to involve a number of marine research institutes around the North Sea in a modelling programme. In the meantime, we have started formulating a North Sea ecosystem model, with the emphasis on nutrient-cycling aspects.

POLWAD, time scales of water masses in the Wadden Sea

S-02

M. Philippart, H. Ridderinkhof,
J.T.F. Zimmerman

In cooperation with the University of Utrecht a study has been carried out on time scales of water masses in the different tidal basins of the Dutch Wadden Sea. This project was financed by RWS, Tidal Waters Division.

The EMOWAD box-model for the western part of the Wadden Sea was used to calculate time scales of seawater and of water supplied by the sluices from Lake IJssel to the Marsdiep and Vlie basins. A sensitivity analysis showed that dispersion is the most important transport agency in this area. Time scales in the other tidal basins could be estimated from some characteristic morphological and tidal parameters.

1.5.2. Biological research in relation to the deep-sea dumping of radioactive waste (NAZORG)

S-03

M.S.S. Lavaleye

The NAZORG project, started at the end of 1987, is a continuation of the biological part of the DORA-project, which described the bottom fauna of the NEA-dumpsite in the NE Atlantic Ocean ($\pm 46^\circ\text{N}$, 17°W) in detail. The aim of the project is

- 1) To compare the meio- and macrobenthos of the dumpsite with surrounding areas and especially those downstream.
- 2) To study the foodweb of the benthos of the deep-sea.
- 3) To determine the density and biomass of the megafauna of the site and nearby areas.
- 4) To analyse megafaunal samples of the site and of stations down-stream on radionuclides.

The sampling of the benthos was carried out during a five day expedition in the summer of 1988 with RV 'Tyro'. At 4 stations (± 100 km apart) on a transect from the site towards the north we tried to get samples at a bottom depth of ± 4700 m, with the Scripps box corer, Multiple corer and Agassiz trawl. Due to bad weather and technical problems only a good set of meiofauna samples was obtained. The incomplete set of macrofauna samples could fortunately be supplemented with those obtained during the German expedition in April 1988 with the RV 'Meteor' to the BIOTRANS-area, in which NIOZ participated. So only the megafaunal sampling, except for a successful trawl on a relatively shallow plateau at 4 km depth, was not satisfactory, and the scheduled radionuclide analyses were postponed.

The study of the composition, density and biomass of meio- and macrofauna is now proceeding smoothly and preliminary results are expected in early 1989.

Furthermore, a research project was set up together with the Institut für Hydrobiologie und Fischereiwissenschaften, Hamburg, to study the small-scale distribution of macrobenthos and larger meiobenthos. For this purpose ten Scripps box-cores were taken at more or less the same spot in the BIOTRANS-area (a few hundred km NNE of the dumpsite), during the above-mentioned 'Meteor' cruise. As the cores were cut into horizontal slices, which were sieved separately, the vertical distribution of the fauna in the sediment will also be studied.

1.5.3. Sediment Experiment (SEDEX)

S-04
G.W.N.M. van Moorsel,
P.A.W.J. de Wilde

In 1988, a second sediment experiment was carried out to investigate how harbour-sludge dumping in the North Sea affects tidal-flat ecosystems. The set-up was the same as in 1987. Model dump sites (MODUSes) were connected to model tidal flats (MOTIFs) containing macrofauna. One MODUS was filled with Delfzijl harbour sludge (class 1) and two with Rotterdam sludge (class 2), which was also used in the 1987 experiment. A fourth MODUS was filled with clean sediment (Control). Rotterdam sludge in one MODUS was oxidized to remove part of the nitrogen; the other remained under reduced conditions.

Effects on macrofauna were investigated by NIOZ, other system parameters were measured by TNO, RIN and DGW. Phytoplankton biomass reached very high values ($> 150 \text{ mg Chl. a} \cdot \text{m}^{-3}$) in the Delfzijl harbour sludge and Rotterdam reduced sludge treatment. This was correlated with a change in these MOTIFs in sediment surface structure, quick development of population density in *Corophium*, high growth of *Macoma*, and shell deformation in *Cerastoderma*. In these MOTIFs also the largest reduction in *Arenicola* density occurred, probably as a result of predation by large *Nereis virens*. In general, eutrophication effects masked possible toxic effects of the harbour sludges, like in the 1987 experiment.

A modification of the water supply system resulted in a very successful recruitment of introduced macrobenthic species. 1989 will be the final SEDEX year.

1.5.4. Phaeocystis project (EC)

S-05
W. van Boekel, M.J.W. Veldhuis

During 1988 a set of data was collected from various stations along the Dutch North Sea coast. These data were gathered with support of the North Sea Directorate of the Ministry of Transport and Public Works. Six sampling sites

were selected and samples were taken for the study of phytoplankton, bacteria, chlorophyll *a* and inorganic nutrients. A copy of this data set has been sent to Brussels (headquarters of EC-*Phaeocystis* project). In between, laboratory experiments were carried out to study the repression and inhibition of alkaline phosphate enzyme activity.

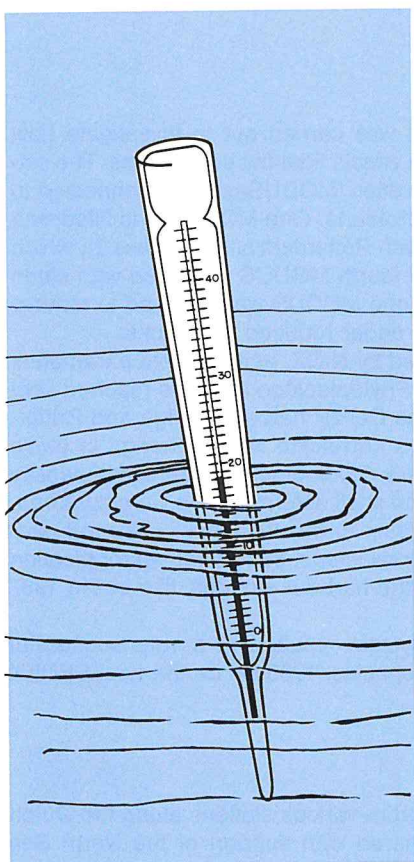
1.5.5. Possible biological effects of long-term changes in temperatures of Dutch coastal waters

S-06

C.G.N. de Vooy

A review (literature study) on the possible biological effects of long-term changes in temperatures of Dutch coastal waters was prepared. It was subsidized by the Ministry of VROM.

The review was intended to serve as a basis for discussion at a workshop on the subject, held at NIOZ from 11 to 15 November. Proceedings of this workshop will be published next year.



1.6. ADDITIONAL RESEARCH

1.6.1. Research at NIOZ by guests

Drs. O.H. Arinardi, M.Sc. (PPPO/LIPI, Jakarta, Indonesia) stayed at NIOZ from 22 January to 13 May to finish his work on the vertical distribution and gut fluorescence of copepods from the Banda Sea, in cooperation with M.A. Baars.

Dr. N. Bano (National Institute of Oceanography, Karachi, Pakistan) performed culture experiments with different strains of *Phaeocystis pouchetii* in collaboration with A.G.J. Buma to study the development and differences in pigment composition. Dr. Bano also worked together with M.Th.J. Hillebrand on the vertical distribution of chlorinated hydrocarbons in sediment.

Chen Shumin (East China Normal University, Shanghai, China) worked on XRD and α - and γ -spectrometry of sediment samples from the continental shelf and coast of China, in cooperation with D. Eisma.

G. Chmura (Louisiana State University, Baton Rouge, USA) worked on pollen in recent deposits of the Dollard, in cooperation with D. Eisma.



Miss Nashreen Bano performing gaschromatographic determination of PCBs.

Ir. R. Edens (TUT, Enschede) worked on the application of intelligence graphs in cooperation with J.G. Baretta-Bekker and E.K. Duursma.

Dr. A. Groenendijk worked on distribution patterns of selected organochlorines in biota, in cooperation with N. Bano and M.Th.J. Hillebrand.

Ji Zhong (East China Normal University, Shanghai, China) worked on XRD analysis of sediment samples from the Chinese coast, in cooperation with D. Eisma.

Li Hong Hai (Regional Marine Environmental Forecasting Observatory of the State Oceanic Administration, Qingdao, China) in September started participation in experimental oceanographic research in cooperation with H. van Haren and H.M. van Aken.

Dr. Lin Rong Gen (University of Bordeaux) carried out research on the automatization of dissolved organic nitrogen determination in cooperation with J.W. Rommets and E.K. Duursma.

P. Krug (Oldenburg University, FRG) spent the month of September at NIOZ working with P. Ruurdij and J.W. Baretta as a continuation of his novel work on mathematical approaches to the problem of model verification/validation, which will be part of his Ph.D. thesis.

Ir. D. Kusnida (Marine Geological Institute, Bandung, Indonesia) continued work on the seismic stratigraphy of the Lombok and Savu fore-arc basins, with emphasis on the (palaeo)position of the island of Sumba, in cooperation with T.C.E. van Weering. For the latter purpose he participated in a field work project on Sumba.

Ma Hongguang (East China Normal University, Shanghai, China) started work on bioturbation in the Wadden Sea in cooperation with G.C. Cadée.

M. Stoessl (Institut für Physik, University of Hamburg, FRG) in October started work on porting the BAHBOE simulation package, developed by P. Ruurdij on the Norsk Data computer in Fortran-77, to the UNIX operating system. The package may later be used, together with the EMOWAD model, to make a model of the Sylt-Rømø area of the Wadden Sea.

Prof. dr. Wang Baocan (East China Normal University, Shanghai, China) stayed from May to September writing 3 papers (with D. Eisma) on comparisons of tidal deposits in China and the Wadden Sea.

Zhang Yong (East China Normal University, Shanghai, China) worked on stability of tidal channels and gullies in the Dollard, in cooperation with D. Eisma.

1.6.2. Participation in national and international programmes

Indonesian-Dutch Snellius-II Expedition: The first issue of The Proceedings of the Symposium of the Indonesian-Dutch Snellius-II expedition was published in December 1988 as part of Neth. J. Sea Res. The remaining issues are to follow in 1989, also as parts of Neth. J. Sea Res.

W.C.M. Klein Breteler cooperated with Prof. Dr. J.A. McLaren, Halifax, Canada, in a joint project on the cultivation of *Pseudocalanus elongatus* at different conditions of food and temperature to analyse DNA and nucleus content.

H.M. van Aken participated in survey ME8/1 of the German RV 'Meteor'. This survey is part of the internationally coordinated Greenland Sea Project.

G. Marees and M.R. Wernand participated in a Euromar project on laser remote sensing techniques. A cruise was carried out in Dutch coastal waters in cooperation with scientists of the University of Oldenburg, the Alfred Wegener Institute and Rijkswaterstaat, Tidal Waters Division.

G. Marees and M.R. Wernand also participated in a national remote sensing programme in cooperation with Rijkswaterstaat and the National Aerospace Laboratory, Amsterdam.

R.F. Nolting took part in an intercalibration of determinations of trace metals in seawater organized by the Commission of the European Community, Brussels.

L. Gerringa, from 18 to 30 April, participated in an international field exercise on trace metal speciation in relation to plankton activity and on intercomparison of several chemical speciation techniques. This workshop was organized by MT-TNO Den Helder.

H.J.W. de Baar participated in an expedition of the U.S. National Science Foundation (RV 'Knorr') to the Black Sea in July.

From 6 May to 1 June the Mauritania I expedition was carried out in Mauritanian offshore waters with RV 'Tyro'. The aim was to provide a synoptic picture of the hydrographical conditions of the coastal water off the Banc d'Arguin and to give a description of the structure and functioning of the benthic ecosystem between the 10 and 200 m depth contour lines. A total of 20 NIOZ scientists, assistants and technicians cooperated in the programme (see 1.4.3.). As a Mauritanian counterpart Dr. Youri Loktionov (USSR) joined the expedition.

The 'Challenger' surveys 1988-89: J.W. Baretta established a contact Dr. J. Howarth, Proudman Oceanographic Laboratory, Liverpool, which resulted in NIOZ participation in this large-scale British North Sea project. B. Kuipers led the discussions and the fieldwork was organized by S.S. Oosterhuis. Some 8 NIOZ (partly BEWON) scientists are to cover the zooplankton surveys, in which M.A. Baars, J. Hegeman, S.S. Oosterhuis and H. Witte have already taken part (see 1.3.9.).

B.R. Kuipers visited China from 8 October to 28 November in an exchange project with the Institute for Estuarine and Coastal Research of the East China Normal University, Shanghai.

D. Eisma participated in a geochemical programme in the mouth of the Chang Jiang, as part of a Chinese-French cooperative programme (see 1.2.3.). He also visited Hainan, China, as part of the cooperation with the East China Normal University, Shanghai, and the Huang He delta as part of the Huang He Delta Project of the Institute of Marine Geology, Qingdao, and the Province of Shandong.

T.C.E. van Weering and G. Berger went to Hangzhou as part of a new cooperation with the 2nd Institute of Oceanography in Hangzhou (see 1.2.3.).

H.J.W. de Baar participated in the first and second meetings (Miami, January, and The Hague, September) of the SCOR Committee for the 1989-1999 Joint Global Ocean Flux Study (JGOFS).

H.G. Fransz, C. Veth and H.J.W. de Baar participated in the JGOFS North Atlantic Pilot Study (1989-1990) planning meeting, held in The Hague in September.

J.H. Vosjan, S.B. Tijssen, C. Westra and E. Pautit took part in a cooperative research programme with the microbiological department of the Biologische Anstalt Helgoland. They made a cruise with the German RV 'Friedrich Heincke' in Dutch and German coastal waters and the Elbe estuary (see 1.3.4.2.).

J.H. Vosjan, in cooperation with Prof. dr. A.J.B. Zehnder (Wageningen), organized the Second (International) Advanced Course in Microbial Ecology held at NIOZ from September 11 to October 8.

J. Kalf and D. Eisma determined base-exchange capacity and carried out SEM analyses of samples collected in the Scheldt river as part of the EC project 'Transfer processes and modelling of plutonium species and gamma emitters in the Scheldt estuary'.

EPOS, European Polarstern Study of the ESF (European Science Foundation) in Antarctic waters on board the RV 'Polarstern'. J.J. Zijlstra, as a member of the 'management group', contributed to the organization of EPOS. G.W. Kraay participated in leg 1 (October-November) to the Weddell Sea. H.J.W. de Baar, A.J. van Bennekom, A. Buma, G.C. Cadée, G.H. Fransz, S.R. Gonzalez, R.F. Nolting, S. Ober, R. Schmidt and C. Veth (assistant chief scientist) participated in leg 2 (November-December-January) to the Weddell-Scotia Confluence area.

Again NIOZ participated in the EC project EROS-2000. W. Helder, W. Keskamp (chemical oceanography), T. Schuhmacher and Z. Zuo (geological department) from 12 to 27 December took part in a cruise with RV 'Discovery' to the Golfe du Lion, Mediterranean Sea (see 1.4.6.).

1.6.3. Visitors from abroad

Dr. A. Alberto, Palanques Instituto Ciencias del Mar, Barcelona, Spain.
 Dr. J.F. Appelbee, Conoca (UK) Ltd, London, UK.
 Dr. A. Bale, Plymouth Marine Laboratory, UK.

Dr. R. Bannister, Shellfish Research Group, Lowestoft, UK.
 Dr. C. Benamou, University of Toulon, France.
 Dr. L.-U. Bergström, Länsstyrelsen Gävleborgs Län, Gävle, Sweden.
 Dr. J.K.B. Bishop, Lamont Doherty Geological Observatory of Columbia University, Palisades, USA.
 Dr. M. Boisson, Centre Scientifique de Monaco.
 Dr. J. Boissonnas, Commission of the European Community, Brussels, Belgium.
 Dr. B.R. Braaten, Norsk Institut Vannforskning (NIVA), Oslo, Norway.
 Dr. D. Brew, University of East Anglia, Norwich, U.K.
 Dr. H.J.B. Brito Queiroga, Universidade de Aveiro, Portugal.
 Dr. N. Das, Utkal University, Bhubaneswar, Orissa, India.
 Dr. A. Davies, Proudman Oceanographic Laboratory, Bidston Observatory, Birkenhead, Merseyside, UK.
 Dr. F. Dehairs, Laboratorium voor Analytische Chemie, Vrije Universiteit Brussel, Belgium.
 Dr. H. Etcheber, Université de Bordeaux, France.
 Dr. D. Evans, British Geological Survey, Edinburgh, UK.
 Dr. D.C. Gordon, Bedford Institute of Oceanography, Dartmouth, Canada.
 Dr. W. Gunkel, Dept. Microbiology, Biologische Anstalt Helgoland, FRG.
 Dr. E. Hagmeier, Biologische Anstalt Helgoland, FRG.
 Dr. J. Hölemann, Geologisch-Paläontologisches Institut, Universität, Hamburg, FRG.
 Dr. G. Irion, Senckenberg Institut, Wilhelmshaven, FRG.
 Prof. Dr. H.W. Jannasch, Woods Hole Oceanographic Institute, Woods Hole, USA.
 Dr. M. Jajawardena, Ministry of Fisheries, Colombo, Sri Lanka.
 Dr. P. van Klaveren, Centre Scientifique de Monaco.
 Dr. A.C. de Kock, Dept. of Oceanography, University of Port Elizabeth, South Africa.
 Dr. A. Künitzer, Alfred-Wegener-Institut, Bremerhaven, FRG.
 Dr. E. Lahdes, Finnish Institute of Marine Research, Helsinki, Finland.
 Dr. C. Louisa, UCNW Bangor, Marine Science Laboratories, Menai Bridge, UK.
 Dr. S.B. MacPhee, Bedford Institute of Oceanography, Dartmouth, Canada.
 Dr. T. Milligan, Bedford Institute of Oceanography, Dartmouth, Canada.
 Dr. J. Mrazek, Ernst-Moritz Arndt Universität, Greifswald, GDR.
 Dr. P. Nounou, IMFREMER, Paris, France.
 Dr. Nauholo, Centre for Oceanological Research and Development, Ambon, Indonesia.
 Dr. U. Niermann, Biologische Anstalt Helgoland, FRG.
 Dr. S. Phillips, Biological Laboratory Northumbrian Waters, Newcastle, UK.
 Dr. L. Reutergardh, Swedish Environmental Protection Board, Solna, Sweden.
 Prof. Dr. Th. Rosswall, International Geosphere Programme, The Royal Swedish Academy of Science, Stockholm, Sweden.
 Dr. B.J. Rothschild, University of Madison, Solomons, USA.
 Dr. B. Scherer, Landesamt für den Nationalpark Schleswig-Holsteinisches Wattenmeer, Tönning, FRG.
 Prof. Dr. B. Schink, Microbiology Dept., University of Tübingen, FRG.
 Dr. M. Schlueter, Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven, FRG.
 Dr. M. Schulz-Baldes, Alfred-Wegener-Institut, Bremerhaven, FRG.
 Dr. Shao Zeng-qiang, State Oceanic Administration, Beijing, China.
 Dr. Shoichi Shimoyama, Dept. of Geology, Kyushu University, Fukuoka, Japan.
 Dr. W.L. Silvert, Bedford Institute of Oceanography, Dartmouth, Canada.
 Dr. A. Spitz, Geologisch-Paläontologisches Institut, Universität Hamburg, FRG.
 Dr. M.S. Stoker, British Geological Survey, Edinburgh, UK.
 Dr. R.P.J. Swannell, Dept. of Biology, University of Essex, Colchester, UK.
 Prof. Dr. S. Tanabe, Dept. Environmental Chemistry, Ehime University, Matsuyama, Japan.
 Dr. P. Tréguer, Université de Bretagne Occidentale, Brest, France.
 Dr. F. Widdel, Dept. of Microbiology, Philipps University, Marburg, FRG.
 Dr. A.P. Woodbridge, Shell Research Ltd, Sittingbourne Research Centre, Sittingbourne, UK.
 Dr. D. Zingmark, Dept. of Biology, University of South Carolina, Columbia, USA.

1.7. LIST OF RESEARCH PROJECTS AND RESEARCH WORKERS

1.7.1. Hydrography (H)

Chemical Oceanography and Marine Pollution department (W. Helder)

- H1-01 Oxygen and nutrient investigations
(S.B. Tijssen, C. Westra, assistant F. Wetsteyn)
- H1-02/03 Nitrogen cycling in the marine environment
(W. Helder, P. Kierskamp, assistant R.T.P. de Vries)
- H1-04 Carbon dioxide research in coastal waters
(J.M.J. Hoppema, assistant J.W. Rommets)
- H1-05 Exchange of trace metals between sediment and water
(L. Gerringa, assistant R.F. Nolting)
- H1-06 Analysis and behaviour of chlorinated hydrocarbons (M.Th.J. Hillebrand)
- H1-07 Distribution of metals (R.F. Nolting)
- H1-08 Sublethal effects of heavy metals on marine organisms
(J.M. Everaarts)
- H1-08/09 Uptake, distribution and elimination of metals, pesticides and polychlorinated biphenyls in marine organisms (J.M. Everaarts)
- H1-10 Sublethal effects of a number of selected chlorinated hydrocarbons on marine organisms (see also S-01f)
(J.M. Everaarts, J.P. Boon (BEWON), assistant M.Th.J. Hillebrand)
- H1-11 Exchange of organic micropollutants between sediment and water
(K. Booij, assistant M.Th.J. Hillebrand)
- H1-12 Early diagenesis processes
(W. Helder, assistants R.T.P. de Vries, R.F. Nolting)
- H1-13 Transport phenomena near the sediment-water interface
(K. Booij, W. Helder)
- H1-14 Trace metals in the oceans
(H.J.W. de Baar, P. Saager, assistant R.F. Nolting)
- H1-15 Rare Earth Elements in anoxic basins
(H.J.W. de Baar, P. Saager, assistant R.F. Nolting)

Physical Oceanography department (C. Veth)

- H2-01 Marine optics and remote sensing
(G. Marees, R.W.J. Dirks, assistant M.R. Wernand)
- H2-02 Experimental ocean dynamics
(H.M. van Aken, L. Otto, C. Veth, assistants M.W. Manuels, S. Ober)

- H2-03 Experimental shelf sea dynamics
(C. Veth, J.J.M. van Haren, L.R.M. Maas, assistants M.W. Manuels, S. Ober)
- H2-04 Small-scale turbulence and boundary layer studies
(C. Veth, assistant S. Ober)
- H2-05 Theoretical dynamical oceanography (J.T.F. Zimmerman, L.R.M. Maas)

Marine Geology and Geochemistry department (D. Eisma)

- H3-01 Sediment transport and sedimentation in the North Sea area
(D. Eisma, T.C.E. van Weering, assistants G.W. Berger, S.J. van der Gaast, J. Kalf, J. van Iperen)
- H3-02 The silica cycle in the sea
(A.J. van Bennekom, assistants G.W. Berger, S.J. van der Gaast, J. van Iperen)
- H3-03 Sedimentology and palaeoceanography of the Angola Basin and Zaire deep-sea fan (J.H.F. Jansen, T.C.E. van Weering, assistants S.J. van der Gaast, J. van Iperen)
- H3-05 Composition and conversion of clay minerals in the sea (S.J. van der Gaast)
- H3-06 Transport and sedimentation of suspended matter under the influence of the Scotland-Greenland Ridge flow system
(D. Eisma, assistants S.J. van der Gaast, J. Kalf, J. van Iperen)
- H3-07 Sediment transport along and across continental margins
(T.C.E. van Weering, assistants G. W. Berger, S.J. van der Gaast, J. Kalf, J. van Iperen)
- H3-08 Geology and geochemistry of the sea floor of southern Indonesian deep-sea basins (T.C.E. van Weering, J.H.F. Jansen, D. Eisma, assistants G.W. Berger, S.J. van der Gaast, J. Kalf, J. van Iperen)
- H3-08a Sediment transport and sedimentation in the Indonesian fore-arc basins (T.C.E. van Weering)
- H3-10 Dating with naturally occurring isotopes (G.W. Berger, Z. Zuo, D. Eisma)
- H3-11 Flocculation and deflocculation of suspended matter
(D. Eisma, T. Schuhmacher, assistant J. Kalf)
- H3-12 Sedimentation in the Wadden Sea (D. Eisma, assistant G.W. Berger)
- H3-13 Cooperative research with People's Republic of China
(D. Eisma, T.C.E. van Weering, G.W. Berger)
- H3-14 Distribution and ecology of living benthic Foraminifera
(T.C.E. van Weering, L. Moodley)

1.7.2. Biology (B)

Benthic systems (P.A.W.J. de Wilde)

- B1-01 Benthic mesocosms (P.A.W.J. de Wilde, assistants E.M. Berghuis, A. Kok, E. Pauptit, G. Nieuwland)
- B1-02 Activity and dynamics of micro-organisms
(J.H. Vosjan, assistants E. Pauptit, G. Nieuwland)
- B1-04 Energy demand and production in dominant benthic faunal elements and community respiration (P.A.W.J. de Wilde, A. Cramer, assistants E.M. Berghuis, A. Kok, E. Pauptit, G. Nieuwland)
- B1-05 Coral reefs (R.P.M. Bak)
- B1-06 Protozoans (R.P.M. Bak, assistant G. Nieuwland)

- B1-07 Synoptic mapping of North Sea benthos
(G.C.A. Duineveld, assistants E.M. Berghuis, G.J. van Noort, E. Pauptit, H.J. Witte)
- B1-08 Structure and function of the ecosystem of coastal Mauritanian waters
(P.A.W.J. de Wilde, G.C.A. Duineveld, R.P.M. Bak, assistants E.M. Berghuis, G. Nieuwland, G.J. van Noort)
- B1-09 Growth and production of dominant macrobenthic species in the North Sea
(G.C.A. Duineveld, P.A.W.J. de Wilde)
- B1-10 Long-term trends in the benthic fauna of the North Sea
(P.A.W.J. de Wilde, G.C.A. Duineveld)
- B1-11 Effects of beam-trawl fisheries on the benthic system of the North Sea
(G.C.A. Duineveld, P.A.W.J. de Wilde, assistants G.J. van Noort, E.M. Berghuis)
- B1-12 Benthic fronts (R. Heyman, G.C.A. Duineveld, assistant G.J. van Noort)

Pelagic systems (H.G. Fransz)

- B2-01 The pelagic system of mixed coastal areas
(H.G. Fransz, B.R. Kuipers, M.J.W. Veldhuis, F.A.C. Kouwets, assistants G.W. Kraay, S.R. Gonzalez)
- B2-02 The pelagic system of areas with a summer stratification
(H.G. Fransz, M.J.W. Veldhuis, M.A. Baars, M.J.M. Reichert, assistants G.W. Kraay, S.R. Gonzalez, S.S. Oosterhuis)
- B2-03 The pelagic system of the permanently stratified ocean
(M.A. Baars, P.H. Schalk, M.J.W. Veldhuis, J.J. Zijlstra, assistants G.W. Kraay, S.S. Oosterhuis, J.I.J. Witte)
- B2-04 Experimental investigations on zooplankton
(W.C.M. Klein Breteler, M.J.M. Reichert, assistant N. Schogt)
- B2-05 The pelagic system of Antarctic seas
(G.H. Fransz, A.G.J. Buma, assistants S.R. Gonzalez, G.W. Kraay)

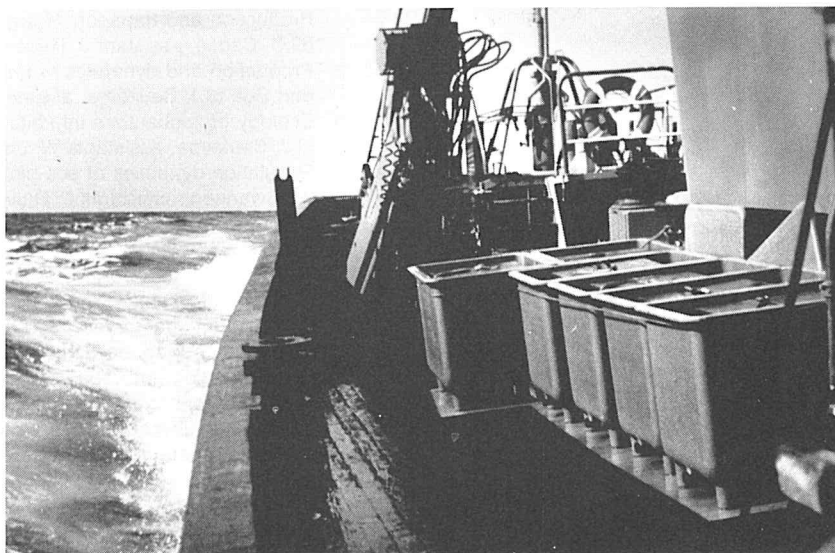
Coastal systems (J.J. Beukema)

- B3-01 Production and transport of organic matter
(G.C. Cadée, assistant J. Hegeman)
- B3-02 a Production and dynamics of macrobenthos on tidal flats in the Dutch Wadden Sea (J.J. Beukema, assistants W. de Bruin, J. Zuidewind)
b Ecology of zoobenthos inhabiting soft bottoms along European coasts
(J.J. Beukema, assistants W. de Bruin, J. Zuidewind)
- B3-03 a Population dynamics of sea-birds in the Wadden Sea
(C. Swennen, assistants P. Duiven, J. Zuidewind)
b The role of tropical intertidal areas in the life cycle of migratory palaeartic waders (C. Swennen, assistants P. Duiven, J. Zuidewind)
- B3-04 Function of chemical elements and element turnover in marine organisms
(D.H. Spaargaren)
- B3-05 Variability in year-to-year recruitment of benthic invertebrates on tidal flats in the Dutch Wadden Sea (R. Dekker)
- B3-06 Food limitation and food competition of bivalve molluscs living on intertidal flats (P. Kamermans)
- B3-07 Pelagic sea-bird distribution in the North Sea (M.F. Leopold)
- B3-08 Energy budgets of benthic carnivores (M. Fonds, assistant P. van der Puy)

1.7.3. Special projects (S)

(H.J. Lindeboom)

- S-01 Applied scientific research NIOZ (BEWON) (M.A. van Arkel, J.W. Baretta, M.J.N. Bergman, A.C. Bol-den Heijer, J.P. Boon, R. Daan, F.C. van Duyl, H.Th. Kloosterhuis, A.J. Kop, W.E. Lewis, H.J. Lindeboom, J.F.P. Malschaert, M. Mulder, W. van Raaphorst, H. Ridderinkhof, R. Riegman, P. Ruardij, P. Saager, A. Stam, H.W. van der Veer)
- S-01 a Eutrophication-nutrient chemistry (W. van Raaphorst, H.Th. Kloosterhuis)
- S-01 b Eutrophication-primary production (R. Riegman, J.F.P. Malschaert)
- S-01 c Eutrophication-microbiology (F.C. van Duyl, A.J. Kop)
- S-01 d Eutrophication-higher trophic levels (H.W. van der Veer, A. Stam)
- S-01 e Micropollutants-trace metals in the North Sea (P. Saager, H.J.W. de Baar, R.F. Nolting, J.P. Boon)
- S-01 f Micropollutants-organic (see also H1-10) (J.P. Boon, J.M. Everaarts, F. Eijgenraam, M.Th.J. Hillebrand)
- S-01 g Micropollutants-Biological effects of the discharges of cuttings with oil-based or water-based drilling muds (TECON-project) (M. Mulder, W.E. Lewis, R. Daan)
- S-01 h Modelling (J.W. Baretta, P. Ruardij)
- S-02 Time scales of water masses in the Wadden Sea (POLWAD) (M. Philippart, H. Ridderinkhof, J.T.F. Zimmerman)
- S-03 Biological research in relation to the deep-sea dumping of radioactive waste (NAZORG) (M.S.S. Lavaleye, assistant S.E. Holtmann)
- S-04 SEDEX (Sediment Experiments) (P.A.W.J. de Wilde, G.W.N.M. van Moorsel, M.J.A. van Wuyckhuyze, M. van der Heijde, Shao Zheng-qiang, assistants E.M. Berghuis, A. Kok (Dienst Getijdewateren RWS, TNO, RIN, NIOZ)).
- S-05 *Phaeocystis* project (EC) (W. van Boekel, M.J.W. Veldhuis)
- S-06 Possible biological effects of long-term changes in temperatures of Dutch coastal waters (J.J. Beukema, C.G.N. de Vooy)



2. Publications, lectures etc.

2.1. PUBLICATIONS

2.1.1. Netherlands Journal of Sea Research and other series issued

In 1988 volume 22 appeared in 4 issues, viz. no. 1 in April with 6 papers, no. 2 in July with 9 papers, no. 3 in October with 12 papers and no. 4 in December with 9 papers. No. 1 is a special issue, with H.J. Lindeboom as co-editor. It contains part of the results of the 'Ecological Research Project North Sea and Wadden Sea' (EON) and reports studies on an ecological model of the western part of the Dutch Wadden Sea. No. 4 is again a special issue, edited by H. Postma with the assistance of J.G. Baretta-Bekker. It is the first part of the Proceedings of the Snellius-II Symposium and reports on the theme: Ventilation of deep-sea basins in eastern Indonesia. Further special issues publishing parts of these Proceedings are planned to appear interspersed with normal issues over the next few volumes.

Out of the 36 papers published in volume 22, 14 are on marine biology, 13 on marine chemistry or geochemistry, 6 on physical oceanography and 3 on marine sedimentology. Among the 36 first authors, 13 were from outside the Netherlands.

In the NIOZ Publication Series only 1 issue was published, viz. the Annual Report 1987 (no. 15).

2.1.2. Publications NIOZ 1988

- 1 AKEN, H.M. VAN. Transport of water masses through the Faroese Channels determined by an inverse method.—Deep-Sea Res. **35**: 595-617.
- 2 AKEN, H.M. VAN & H. VERBEEK. The hydrography and ventilation of Kau Bay in Halmahera.—Proc. Snellius-II Symp. (theme 2) Neth. J. Sea Res. **22**: 403-413.
- 3 AKEN, H.M. VAN, G.C. CADÉE & J.H. VOSJAN (eds). Annual Report NIOZ 1987.—Publ. Ser. NIOZ **15**: 1-138.
- 4 AKEN, H.M. VAN, J. PUNJANAN & S. SAIMIMA. Physical aspects of the flushing of the east Indonesian basins.—Proc. Snellius-II Symp. (theme 2) Neth. J. Sea Res. **22**: 315-339.
- 5 BAAR, H.J.W. DE, C.R. GERMAN, H. ELDERFIELD & P. VAN GAANS. Rare earth element distributions in anoxic waters of the Cariaco Trench.—Geochim. cosmochim. Acta **52**: 1203-1219.
- 6 BAK, R.P.M. & G.D.E. POVEL. Ecological structure and variation in a range of Indonesian fore-reef slope coral communities.—Proc. 6th Int. Coral Reef Symp. **2**: 185-190.
- 7 BARETTA, J.W. & J.F.P. MALSCHAERT. Distribution and abundance of the zooplankton of the Ems estuary (North Sea).—Neth. J. Sea Res. **22**: 69-81.

- 8 BARETTA, J.W. & P. RUARDIJ (eds). Tidal flat estuaries, simulation and analysis of the Ems estuary. Ecological Studies vol 71. Springer, Berlin: 1-348.
- 9 ——. Evaluation of the Ems estuary ecosystem model.—Cont. Shelf Res. 7: 1471-1476.
- 10 BENNEKOM, A.J. VAN. Deep-water transit times in the eastern Indonesian basins, calculated from dissolved silica in deep and interstitial waters.—Proc. Snellius-II Symp. (theme 2) Neth. J. Sea Res. 22: 341-354.
- 11 BENNEKOM, A.J. VAN & M. MUCHTAR. Reactive phosphate in the eastern Indonesian seas.—Proc. Snellius-II Symp. (theme 2) Neth. J. Sea Res. 22: 361-367.
- 12 BENNEKOM, A.J. VAN, G.W. BERGER, S.J. VAN DER GAAST & R.T.P. DE VRIES. Primary productivity and the silica cycle in the Southern Ocean (Atlantic sector).—Palaeogeogr., Palaeoclim., Palaeoecol. 67: 19-30.
- 13 BENNEKOM, A.J. VAN, KASTORO & W.C. PATZERT. Recirculation in the Banda throughflow, traced with dissolved silica.—Proc. Snellius-II Symp. (theme 2) Neth. J. Sea Res. 22: 355-359.
- 14 BERG, M.G. VAN DEN, A.G.A. MERKS & E.K. DUURSMA. Organic complexation and its control of the dissolved concentrations of copper and zinc in the Scheldt estuary.—Estuar. coast. Shelf Sci. 24: 785-797.
- 15 BERGER, G.W. & A.J. VAN BENNEKOM. Radon anomaly as a possible precursor of a submarine earthquake.—Proc. Snellius-II Symp. (theme 2) Neth. J. Sea Res. 22: 369-372.
- 16 BERGER, G.W., A.J. VAN BENNEKOM & H.J. KLOOSTERHUIS. Radon profiles in the Indonesian archipelago.—Proc. Snellius-II Symp. (theme 2) Neth. J. Sea Res. 22: 395-402.
- 17 BERGMAN, M.J.N., H.W. VAN DER VEER & L. KARCZMARSKI. Impact of tail nipping on mortality, growth and reproduction of *Arenicola marina*.—Neth. J. Sea Res. 22: 83-90.
- 18 BERGMAN, M.J.N., H.W. VAN DER VEER & J.J. ZIJLSTRA. Plaice nurseries: effects on recruitment.—J. Fish. Biol. 33 (suppl. A): 201-218.
- 19 BEUKEMA, J.J. An evaluation of the ABC-method (abundance/biomass comparison) as applied to macrozoobenthic communities living on tidal flats in the Dutch Wadden Sea.—Mar. Biol. 99: 425-433.
- 20 BEUKEMA, J.J., J. DÖRJES & K. ESSINK. Latitudinal differences in survival during a severe winter in macrozoobenthic species sensitive to low temperatures.—Senckenbergiana marit. 20: 19-30.
- 21 BOON, J.P. & F. EIJGENRAAM. The possible role of metabolism in determining patterns of PCB congeners in species from the Dutch Wadden Sea.—Mar. Environ. Res. 24: 3-8.
- 22 BRAAT, L.C. & E.K. DUURSMA. Ecologisch economische modellen voor lange termijn waterbeheer. In: A. BIJLSMA. Integraal Waterbeheer, een nieuwe aanpak. NIBI, Utrecht, 156-179.
- 23 BUMA, A. Silicaatopname door Antarctische diatomeeën.—Diatomededelingen 5: 20-23.
- 24 CADÉE, G.C. Organic carbon in the upper 100 m and downward flux in the Banda Sea; monsoonal differences.—Neth. J. Sea Res 22: 109-121.
- 25 ——. The use of size-frequency distribution in paleoecology.—Lethaia 21: 289-290.
- 26 ——. Algenrampen komen vaak voor - ook zonder pers. Wetenschap en Onderwijs, NRC Handelsblad 14-6-88.
- 27 ——. Nieuwe exotische vruchten en zaden van ons strand.—Zeepaard 48: 62-68.
- 28 ——. Bottles crossing the Atlantic Ocean. Letter to the Editor.—Irish Naturalist J. 22: 449.
- 29 ——. Seeds of *Attalea funifera* Mart. and a review of other tropical seeds from the Dutch coast.—Porcupine Newsletter 4: 51-54.
- 30 ——. Levende Hydrobia's in bergeend faeces. Correspondentieblad Ned. Malac. Ver. 343/4: 443-444.
- 31 ——. Organic carbon in the Ems river and estuary.—Mitt. Geol.-Palaeont. Inst. Univ. Hamburg, SCOPE/UNEP Sonderband 64: 359-374.
- 32 CADÉE, G.C. & M.J.W. VELDHUIS. Algenbloei in de Noordzee.—Biovisie 68: 178-179.
- 33 COLIJN, F., W. ADMIRAAL, J.W. BARETTA & P. RUARDIJ. Primary production in a turbid estuary, the Ems Dollard: field and model studies.—Cont. Shelf Res. 7: 1405-1409.
- 34 DAAN, R., S.R. GONZALEZ & W.C.M. KLEIN BRETELER. Cannibalism in omnivorous calanoid copepods.—Mar. Ecol. Progr. Ser. 47: 45-54.

- 35 DICKSON, R.R., D.S. KIRKWOOD, G. TOPPING, A.J. VAN BENNEKOM & W. SCHREURS. A preliminary trend analysis for nitrate in the North Sea west of 3°E.—ICES C.M. 1988/C 4: 14 pp.
- 36 DRAL, A.D.G. A note on aquatic and aerial vision in Odontocetes.—Z. Säugetierk. **53**: 55-56.
- 7 37 DUURSMA, E.K. Oceanologie een domein van dimensies. Rijksuniversiteit Groningen: 1-11.
- 38 DUURSMA, E.K. EUROMAR, a challenge to innovative enterprises. Bordomer Colloquium, Bordeaux, Febr. 1988.
- 39 DUURSMA, E.K., J.J. BEUKEMA, G.C. CADÉE, H.J. LINDEBOOM & P.A.W.J. DE WILDE. Assessment of environmental impact of nutrients. In: P.J. NEWMAN & A.R. AGG. Environmental Protection of the North Sea. WRC Int. Conf. Heinemann Prof. Publish. Ltd. Oxford: 176-188.
- 40 DUURSMA, E.K., A.G.A. MERKS & J. NIEUWENHUIZE. Exchange processes in an estuary as the Westerschelde. Hydrobiology and chemistry of the Schelde and the Westerschelde.—Hydrobiol. Bull. **22**: 7-20.
- 41 DUYL, F.C. VAN & A.J. KOP. Temporal and lateral fluctuations in production and biomass of bacterioplankton in the western Dutch Wadden Sea.—Neth. J. Sea Res. **22**: 51-68.
- 42 EISMA, D. Processes of nearshore accumulation of suspended material.—Mitt. Geol.-Paläont. Inst. Univ. Hamburg SCOPE/UNEP Sonderbd. **64**: 57-69.
- 8 43 ——. Zeespiegelstijging en de Waddenzee.—Waddenbulletin **88**: 175-177.
- 44 ——. An introduction to the geology of continental shelves. In: H. POSTMA & J.J. ZIJLSTRA. Continental Shelves (part 27 of: D.W. GOODALL. Ecosystems of the World). Elsevier Science Publ., Amsterdam: 39-91.
- 9 45 ——. Milieuzorg en de zee. Nederland en de zee.—Marineblad **98**: 22-28.
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2.1.3. Internal reports NIOZ 1988

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2.1.4. Cruise reports NIOZ 1988

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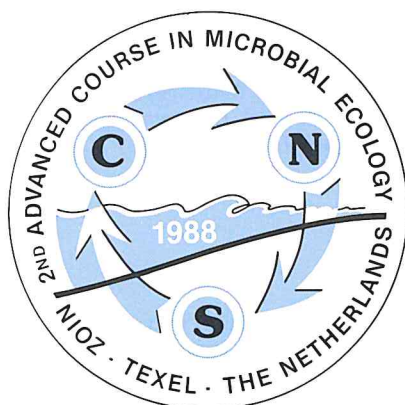
2.2. LECTURES, etc.

2.2.1. Colloquia and lectures at the institute

(titles translated)

22 January	T. Aldenberg (RIVM, Bilthoven): (Causality and indirect effects in ecosystem models) P. Ruardy and J.W. Baretta (NIOZ): (Transport phenomena in ecosystem models)
5 February	'Tools' G. Ganssen and S.R. Troelstra (Free University, Amsterdam): (Micropalaeontology as a 'tool' in palaeoceanography) W.J.M. de Ruijter (University of Utrecht): (The use of mathematical models as a 'tool' in coastal water research)
19 February	Rare Earth Elements H.J.W. de Baar (NIOZ): (Rare Earth Elements in the oceans) K. Beets (NIOZ): (Rare Earth Elements in deep-sea sediments of the Zaire fan)
4 March	Benthic Mapping G.C.A. Duineveld (NIOZ): (The benthic fauna of the Dutch continental shelf) J.M. Everaarts (NIOZ): (Heavy metals and chlorinated hydrocarbons in sediment and some selected benthic invertebrates from the North Sea)
18 March	Ocean Fluxes W. Helder (NIOZ): (Sediment-water exchange—how to measure it?) H.M. van Aken (NIOZ): (Advection and diffusion as transport processes in the deep sea) S.B. Tijssen (NIOZ): (Oxygen fluxes; time scales)
8 April	Flocculation of suspended matter D. Eisma (NIOZ): Introduction A. Bale (IMES, Plymouth, U.K.): Particle size in estuarine waters T. Schuhmacher (NIOZ): Physics of flocculation processes in the sea
15 April	T. Goldschmidt (University of Leiden): (Niche differentiation in planktivorous haplochromine cyclids)
21 April	S. Tanabe (Ehime University, College of Agriculture, Matsuyama, Japan): A differential approach towards PCB's and related compounds with regard to their toxicity, environmental availability and analytical methodology

22 April	Valedictory lecture A. Dral (NIOZ): (Watching and seeing)
29 April	H. Bots (RWS/DGW): Monitoring systems
2 May	Barium in the oceans J. Bishop (Lamont Doherty Geological Observatory, Palisades, USA): Tracking the wild Barite; new clues to the oceanic Ba-cycle F. Dehairs (Free University, Brussels): Biological controls upon the oceanic cycle of Ba
7 October	R. Daan (NIOZ): (Zooplankton: food limitation and predation) H.G. Fransz (NIOZ): (Seasonal fluctuations in the fecundity of <i>Temora longicornis</i> and their effect on the continuity of a population)
14 October	D.M.A. Schaap (RWS): (Comments on MARIS (Marine Information System))
4 November	W. Helder (NIOZ): (The importance of C-mineralization in shallow and deep sea bottoms) M. Stoll (NIOZ): (Bacterial remineralization processes in the North Sea; a simulation study)
7 November	Schoichi Shmimoyama (Kyushu University, Fukuoka, Japan): Effects of low oxygen content on living and dead molluscan assemblages in Hakata Bay
17 November	B.W. Fouke (Department of Earth and Space Sciences, State University New York at Stony Brook, USA): Depositional history and dolomitisation of the Seroe Domi limestones, Netherlands Antilles
18 November	T. Piersma (NIOZ): (Foraging problems in diving seabirds) M. Leopold (NIOZ): (Seabirds as indicators of the activity of marine ecosystems)
25 November	H. de Hey (NIOZ): (The velocities of sulphate reduction in the Mokbaai measured by the $^{35}\text{SO}_4^{2-}$ -Trace technique) P. Kamermans (NIOZ): (Food competition among bivalves)
5 December	George Luther III (Delaware USA): Sulphur-cycling in various marine environments (Delaware Bay, Mediterranean, Black Sea)
16 December	M. Reichert (NIOZ): (The influence of experimental circumstances on the grazing behaviour of copepods) W.K. Klein Breteler (NIOZ): (The influence of food quality on the growth of copepods)
Advanced course in Microbial Ecology	The course was organized by J.H. Vosjan (NIOZ) and Prof. Dr. A.J.B. Zehnder (Agricultural University, Wageningen) and held at NIOZ from September 11 to October 8. The theme of the course was 'Microbial processes in the estuarine environment'. It was conducted at an advanced level, combining theoretical instructions (morning and evening lectures and discussions) and experimental laboratory and field work. The course was attended by 26 graduated scientists from various European and overseas countries. Lectures given during the course: Aamand, J. (Department of General Microbiology, University of Copenhagen, Denmark): Microbial degradation of oil compounds in groundwater. Albrechtsen, H.-J. (Department of General Microbiology, University of Copenhagen, Denmark): Microbiology of groundwater systems. Cappenberg, Dr. Th. (Limnological Institute, Nieuwersluis, The Netherlands): Microbial foodweb.



- Eichler, Dr. B. (Faculty of Biology, University of Konstanz, FRG): Ecology of purple sulphate bacteria.
- Elder, Prof. Dr. E.D. (Department of Biology, Georgia Southwestern College, Americus, USA): Bacteriocidal activity of organic N-halamines.
- Gemerden, Dr. H. van (Department of Microbiology, University of Groningen, The Netherlands): Growth of the purple sulphur bacterium *Thiocapsa* under oxic/anoxic and light/dark regimes.
- Helder, Dr. W. (NIOZ, Texel, The Netherlands): Oxygen profiles worldwide.
- Holliger, C. (Department of Microbiology, Wageningen Agricultural University, The Netherlands): Reductive dehalogenation.
- Jannasch, Prof. Dr. H.W. (Woods Hole Oceanographic Institution, USA): 1. Effects of hydrostatic pressure on microbial growth. 2. Microbial processes at hydrothermal vents.
- Kuenen, Prof. Dr. G.J. (Department of Microbiology and Enzymology, Delft Technical University, The Netherlands): *Thiosprera pantotropha*: N-cycle in one organism.
- Lindeboom, Dr. H.J. (NIOZ, Texel, The Netherlands): (Non)sense of ecosystem modelling.
- Mas-Castella, J. (Department of Genetics and Microbiology, Autonomous Universitiy, Belaterra, Spain): Biopolymers in nature and biotechnology.
- Postma, Prof. Dr. H. (NIOZ, Texel, The Netherlands): Sea-level rise.
- Prins, Prof. Dr. R. (Department of Microbiology, Universitiy of Groningen, The Netherlands): Indigenous fermented foods.
- Rivilla, R. (Centro Investigaciones Biologicas, Madrid, Spain): Seasonal variation of pollution indicators in a wild fowl reserve.
- Rosswall, Prof. Dr. Th. (The Royal Swedish Academy of Science, Stockholm, Sweden): The international geosphere biosphere programme (IGBP).
- Schink, Prof. Dr. B. (Institute for Biology, University of Tübingen, FRG): 1. Energetics and kinetics of methnogenic fatty acid degradation. 2. Fermentation patterns in anoxic ecosystems. 3. Fermentative degradation of aromatic compounds.
- Sweerts, J.P. (Limnological Institute, Nieuwersluis, The Netherlands): Decomposition and bacterial stratification in freshwater and marine sediments.
- Visscher, P. (Department of Microbiology, University of Groningen, The Netherlands): Competition between purple sulphur bacteria and green sulphur bacteria.
- Vosjan, Dr. J.H. (NIOZ, Texel, The Netherlands): Microbial biomass and activity in the oceans.
- Wagner-Dobler, Dr. I. (GBF, Braunschweig-Stockheim, FRG): Fate of GEMs in model ecosystems.
- Widdel, Dr. F. (Department of Microbiology, Philipps University, Marburg, FRG): Sulphate-reducing bacteria (1. Growth, nutrition, systematics; 2. Biochemistry; 3. Ecology).
- Zehnder, Prof. Dr. A.J.B. (Department of Microbiology, Wageningen Agricultural University, The Netherlands): Hallo microbes, where are you?

International Symposium
The ecology of the North Sea

This symposium, held at NIOZ from 15 to 20 May, was organized by the Tidal Waters Division of the Ministry of Transport and Public Works (R.W.P.M. Laane) and NIOZ (H.J. Lindeboom, Mrs J.W. Schröder and P. de Wolf). Chairmen were Ir. P.H.A. Hoogweg (DGW) and Prof. Dr. J.J. Zijlstra (NIOZ). There were just over 200 participants, mainly from North Sea bordering countries. Groups of authors prepared review papers on physical oceanography, nutrients and sediment, bacteria, zooplankton, phytoplankton, pelagic carnivores (non-fish), benthos, fishes, birds, mammals and mathematical methods; besides, 40 contributed papers were presented. Proceedings will be published in Neth. J. Sea Res.

International workshop
'Expected effects of climatic changes on
marine coastal ecosystems'

This workshop was held at NIOZ from 11 to 15 November. The 4 themes discussed by 30 scientists from 8 different countries were: effects of CO₂ increase, effects of UV-B increase, effects of temperature changes and effects of sea-level changes. The workshop was organized by RIN (W.J. Wolff) and NIOZ (J.J. Beukema) and subsidized by the Ministry of VROM (represented by G.P. Hekstra). Recommendations for future research were formulated and proceedings will be published.

2.2.2. Lectures and posters

2.2.2.1. Lectures by NIOZ scientists

(titles translated)

- Aken, H.M.: The flushing of deep basins in East Indonesia, studied with physical and geochemical methods. Spring meeting Nederlandse Oceanografen Club, Amsterdam, 3 May.
- Baar, H.J.W. de: JGOFS Pilot Program: The Double Dutch (1989 & 1990) cruises along the 20°W North Atlantic Transect. Ocean Sciences Meeting AGU/ASLO, New Orleans, USA, 18 January.
- : Nutrient type distributions of Ni, Cu, Zn and Cd in the northwest Indian Ocean. Ocean Sciences Meeting AGU/ASLO, New Orleans, USA, 21 January.
- : Trace metals Ni, Cu and Cd in waters around Iceland. Ocean Sciences Meeting AGU/ASLO, New Orleans, USA, 21 January.
- : The Joint Global Ocean Flux Study. Delta Institute for Hydrobiological Research, Yerseke, 25 February.
- : The Joint Global Ocean Flux Study. Joint Oceanographic Assembly, Acapulco, Mexico, 24 August.
- : The Joint Global Ocean Flux Study. The Netherlands Organization for Scientific Research (NWO), The Hague, 15 September.
- : The Joint Global Ocean Flux Study. KNAW Symposium for the IGBP program, Amsterdam, 22 September.
- Baars, M.A.: (Production, plankton biomass, mineralization and fish stocks in different seasons in the eastern Banda Sea and adjacent part of the Arafura Sea, an area with monsoon-related upwelling). Spring meeting Nederlandse Oceanografen Club, Amsterdam, 3 May.
- Bak, R.P.M.: Reefs and chronic oil pollution. Dept. of Marine Sciences, University of Puerto Rico, Mayaguez, Puerto Rico, 16 March.
- : Physiognomic structural attributes and ecological structure in coral reefs. Dept. of Marine Sciences, University of Puerto Rico, Mayaguez, Puerto Rico, 17 March.
- : Coral Reef Ecology, a lecture series given at the University of Amsterdam, March.
- : Ecological structure in a range of Indonesian fore-reef slope communities. 6th International Coral Reef Symposium, Townsville, Australia, 8 August.
- : (The marine environment and conservation in the Netherlands Antilles). Netherlands Foundation for International Nature Protection, The Hague, 14 October.
- Bennekom, A.J. van: The role of aluminium in the dissolution kinetics of biogenic silica in plankton and sediments. Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven, FRG, 22 June.
- : (The special character of Antarctic seawater). Press conference at the symposium 'Dutch Antarctic Research in an international framework', The Hague, 28 September.
- Berger, G.W.: Determination of sedimentation rates with ²¹⁰Pb isotopes, theory and practice. Second Institute for Oceanography, Hangzhou, China, 3 October.
- : Dating sediments in the Westerschelde by means of ²¹⁰Pb and ¹³⁷Cs isotopes. Second Institute for Oceanography, Hangzhou, China, 16 October.
- : Dating of tidal flat sediments by short-living isotopes. First Institute for Oceanography, Qingdao, China, 19 October.
- : Determination of sedimentation rates using ²¹⁰Pb isotopes. East China Normal University, Shanghai, P.R. China, 3 November.

- Beukema, J.J.: Migration of the bivalve *Macoma balthica* from the Wadden Sea to the North Sea. EBSA, Newcastle, UK, 30 August.
- : Long-term changes in the benthic macrofauna in the western Wadden Sea. 6th International Wadden Sea Symposium, Sylt, FRG, 1 November.
- : Expected effects of temperature changes on tidal-flat macrozoobenthos. Workshop 'Expected effects of climatic changes on marine coastal ecosystems', NIOZ, Texel, 12 November.
- : Expected effects of sea-level rise on tidal-flat zoobenthos. Workshop 'Expected effects of climatic changes on marine coastal ecosystems', NIOZ, Texel, 13 November.
- Boon, J.P.: (A quantitative structure-activity relationship (QSAR) for the influence of biotransformation on the bioaccumulation of PCBs in organisms of various trophic levels (western Wadden Sea)). Symposium 'Structuur, gedrag en effecten van milieuverontreinigende stoffen', University of Amsterdam, 16 June.
- : (Quantitative structure-activity relationships (QSAR) for the influence of biotransformation of polychlorinated biphenyls on the accumulation in organisms of various trophic levels). Lecture at the Institut für Meereskunde, Universität Kiel, 20 October.
- Booij, K.: Transport processes in sediment and across the sediment-water interface. Shell Workshop on experimental determination and modelling of transport across the water-sediment interface and of transformation processes in the sediment, NIOZ, Texel, 22 March.
- Buma, A.G.J.: (Silicate uptake by Antarctic diatoms). Nederlands-Vlaamse Kring van Diatomisten, Amsterdam, 20 October.
- Cadée, G.C.: Biocoenose/thanatocoenose, the fossilization potential of recent marine fauna. Free University (Amsterdam) students' course marine biology, NIOZ, Texel, 19 April.
- : Transport of shells in the Dutch Wadden Sea. Lecture to visiting Chinese scientists from Qingdao University, NIOZ, Texel, 11 May.
- Duursma, E.K.: Oceanology. A course in oceanology, University of Groningen, February.
- : Euromar, perspectives. Bordomer Symposium, Bordeaux, 22 February.
- : Conservative mixing, a fake? Primosten Symposium, Yugoslavia, 3 May.
- : (Oceanology, a domain of dimensions). Inaugural lecture, University of Groningen, 7 June.
- : Euromar. Meerestechniek Symposium, Hamburg, 27 September.
- : Oceans and their developments. Science-week, University of Groningen, 11 October.
- : PCBs in the marine environment. Colloquium Biol. Anst. Helgol., Hamburg, 21 November.
- Eisma, D.: Oceanography, marine sedimentation. Lecture series Sedimentology Department Utrecht University, February.
- : Dispersal of Amazon supplied particulate matter. ASU meeting, Charleston, USA, 1 March.
- : (Flocculation of suspended matter). University of Utrecht, 13 April.
- : *In situ* observation of flocs. Aggregate Methodology Workshop, Bremerhaven, FRG, 2 June.
- : Particulate matter in the North Sea. SCOPE/UNEP meeting, Irkutsk, USSR, 6 September.
- : Late Pleistocene and Holocene history of the North Sea. East China Normal University, Shanghai, P.R. China, 20 September, and Zhongshau University, Guangzhou, P.R. China, 3 October.
- : Dispersal of Zaire supplied suspended matter. East China Normal University, Shanghai, P.R. China, 20 September, and Zhongshau University, Guangzhou, P.R. China, 3 October.
- : Comparison of Chinese tidal flats and the Wadden Sea. Second Institute of Oceanography, Hangzhou, P.R. China, 21 October.
- : Flocculation of suspended matter. Second Institute of Oceanography, Hangzhou, P.R. China, 21 October.

- Eisma, D.: The Rhine and the North Sea. IPRE Conference 'Water Quality - European aspects', Lyon, France, 25 November.
- Everaarts, J.M.: (Marine Ecology). 'Groen Milieubeheer', course Rijkswaterstaat 1988, Rijks Agrarische Scholengemeenschap Boskoop, 8 March.
- : (Heavy metal and chlorinated hydrocarbon pollution in rivers, estuaries and coastal waters of East Java). Nederlandse Oceanografen Club, Free University, Amsterdam, 3 May.
- Fransz, H.G.: Vernal abundance, structure and development of epipelagic copepod populations of the eastern Weddell Sea. Invited lecture Institut für Polarökologie, Kiel, 18 January.
- : Population dynamics and production of North Sea zooplankton. Keynote lecture International Symposium on the Ecology of the North Sea, NIOZ, Texel, 19 May.
- : Egg production and persistence in marine pelagic copepods. 23rd European Marine Biology Symposium, Swansea, UK, 7 September.
- : (Adaptations in Antarctic copepod populations). Symposium 'Netherlands Antarctic Activities', Amsterdam, 29 September.
- Gunkel, W., J.H. Vosjan, S.B. Tijssen, E. Pauptit, K.W. Klings, K. Bruns, K. Poremba & E. Hagemeyer: Distribution and activity of microorganisms in coastal waters of the Netherlands and Germany. International Symposium on the Ecology of the North Sea, NIOZ, Texel, 15-21 May.
- Haren, J.J.M. van: Subtidal currents in relation to fronts in the North Sea: a preliminary investigation. International Symposium on the Ecology of the North Sea, NIOZ, Texel, 15-20 May.
- : Observations on the vertical structure of subtidal currents near a frontal zone in the North Sea. International Conference on Physics of Shallow Estuaries and Bays, Asilomar, Monterey, USA, 30 November.
- Helder, W.: Early diagenesis and oxygen gradients in marine sediments. Shell Workshop on experimental determination and modelling of transport across the water-sediment interface and of transformation processes in the sediment, NIOZ, Texel, 22 March.
- : Early diagenetic processes in marine sediment. University of Bordeaux, France, 7 November.
- : N-cycling in coastal environments. University of Bordeaux, France, 10 November.
- Hovekamp, F.: Within season variation in growth of larval plaice (*Pleuronectes platessa* L.). ICES Symposium on the Early Life History of Fish, Bergen, Norway, 4 October.
- : (On the recruitment of plaice in the North Sea). Meeting of fish biologists on recruitment, Wageningen, 18 October.
- Jansen, J.H.F.: Accumulation rates determined with ^{14}C in sediments from the Lombok Ridge (eastern Indian Ocean) and the Angola Basin (SE Atlantic). 13th International Radiocarbon Conference, Dubrovnik, Yugoslavia, 21 June.
- Kuipers, B.R.: On the function of macroplankton in the North Sea. Keynote lecture International Symposium on the Ecology of the North Sea, NIOZ, Texel, 15-20 May.
- Lindeboom, H.J.: Effects of drilling platforms on the sediment fauna. Shell Workshop on experimental determination and modelling of transport across the water-sediment interface and transformation processes in the sediment, NIOZ, Texel, 22 March.
- : (Ecological model of the western Wadden Sea). EON/BEON dag, Vlaardingen, 21 April.
- : Ecosystem model of the western Wadden Sea: a bridge between science and management. 6th International Wadden Sea Symposium, Sylt, FRG, 3 November.
- : Management of the seas: the North Sea. Congress on Nature Management and Sustainable Development, Groningen, 7 December.
- Maas, L.R.M.: On the verification of the Stommel and Fofonoff mode of the ocean's general circulation using a renormalized Green's function. NATO-ASI course, Les Houches, France, 21 February.
- : (Solitary Poincaré waves). University of Utrecht, 31 March.
- : A comparison of Eulerian and Lagrangian current measurements. JONSMOD meeting, Hamburg, FRG, 26 June.

- Moorsel, G.W.N.M.: (The use of mesocosms to study marine oil pollution). Lecture to students of Professor H.C. van Hall Instituut, Groningen and Nautisch College, Den Helder, at their visit to NIOZ, Texel, 18 April.
- : (Estuarine mesocosm research on effects of harbour-sludge dumping). Professor H.C. van Hall Instituut, Groningen, 21 September.
- : (The use of mesocosms to study marine oil pollution). D.H.V. Apeldoorn, 15 December.
- Nolting, R.F.: Minor and major elements in suspended matter in the Rhine and Meuse rivers and estuaries. International Symposium on the fate and effects of toxic chemicals in large rivers and their estuaries, Quebec, Canada, 12 October.
- Otto, L.: Review of the physical oceanography of the North Sea in relation to ecology. International Symposium on the Ecology of the North Sea, NIOZ, Texel, 15-20 May.
- Raaphorst, W. van: (The estimation of the effect of changes of the phosphorus input from Lake IJssel to the western Wadden Sea, using the EMOWAD ecological model). Tidal Waters Division of RWS, Haren, 2 May.
- : Evaluation of phosphorus fluxes from sediments from eutrophic freshwater Lake Veluwe and from tidal flats of the western Wadden Sea. 2nd International Workshop on phosphorus in sediments, Fiskebäckskill, Sweden, 15 September.
- Reichert, M.J.M.: (Food selection in marine calanoid copepods). Netherlands Zoological Society, Utrecht, 29 April.
- Ridderinkhof, H.: (The use of a WAQUA model in the set-up of an ecosystem model (EMOWAD)). WAQUA 'Informatiedag', Lelystad, 9 June.
- : Residual currents in the western Dutch Wadden Sea. International Conference on Physics of Shallow Estuaries and Bays, Asilomar, Monterey, USA, 1 December.
- : Mixing processes in the western Dutch Wadden Sea. International Congress on Physics of Shallow Estuaries and Bays, Asilomar, Monterey, USA, 2 December.
- Saager, P.M.: Dissolved manganese in the east Mediterranean and its hypersaline anoxic basins. Ocean Sciences Meeting AGU/ASLO, New Orleans, USA, 18 January.
- : Manganese in the Indian Ocean. Ocean Sciences Meeting AGU/ASLO, New Orleans, USA, 21 January.
- Spaargaren, D.H.: Low temperature halogen accumulation in shrimps. SEB Congress, Lancaster, UK, 29 March.
- Veer, H.W. van der: Nursery function of the Dutch Wadden Sea for plaice: results of 20 years of research. Institut für Hydrobiologie und Fischereiwissenschaft, Hamburg, 18 April.
- : Plaice nurseries: effects on recruitment. Conference 'Fish in Estuaries', Southampton, UK, 22 July.
- : Exchange of phosphorus and organic carbon between North Sea and Wadden Sea in the period 1950-1986. EBSA Symposium 'North Sea estuaries interactions', Newcastle, UK, 30 August.
- : Transport of plaice larvae from the coastal zone into the nurseries. ICES Symposium 'The early life history of fish', Bergen, Norway, 4 October.
- : Eutrophication of the Dutch Wadden Sea. 6th International Wadden Sea Symposium, Sylt, FRG, 3 November.
- : Eutrophication and mussel culture in the western Dutch Wadden Sea: impact on the benthic ecosystem, a hypothesis. 6th International Wadden Sea Symposium, Sylt, FRG, 3 November.
- : Regulation of year-class strength in North Sea plaice. Annual Meeting for Marine Ranching Project, Niigata, Japan, 25 November.
- : The ecology of larval plaice and flounder. 10th Annual Meeting for Larval Fish Research, Chiba, Japan, 27 November.
- : Recruitment of North Sea plaice compared with Japanese flounder. Symposium on the biology of Japanese flounder, Nagasaki, Japan, 3 December.
- Veth, C.: (Laser-doppler turbulence measurements in the North Sea and Antarctic waters). Meeting Laser-Doppler users group, NIOZ, Texel, 2 June.

- Vosjan, J.H.: Microbial processes in the sea. Free University (Amsterdam). Course in Marine Biology for Geologists, NIOZ, Texel, 18 April.
- : Microbial activities in tropical (Indonesian) and Antarctic waters. Institute of Oceanology, Polish Academy of Sciences, Sopot, Poland, 17 October.
- : Bioturbation in the Dutch Wadden Sea. Copernicus University, Torun, Poland, 19 October.
- Vosjan, J.H., S.B. Tijssen, G. Nieuwland & F.J. Wetsteyn: Oxygen regime, respiratory activity and biomass of microorganisms in the Fladen Ground area during springtime. International Symposium on the Ecology of the North Sea, NIOZ, Texel, 15-20 May.
- Weering, T.C.E. van: Marine geological research in the Indian Ocean. Lecture at the Ministry of Sciences and Education, The Hague, 16 June.
- : Modern shelf sedimentation processes in the North Sea, with emphasis on the Skagerrak. Second Institute for Oceanography, Hangzhou, China, 3 October.
- : Acoustic signatures of gas bearing shallow sediments. Second Institute for Oceanography, Hangzhou, China, 15 October.
- : Recent sedimentation processes in the North Sea. First Institute for Oceanography, Qingdao, China, 20 October.
- : Fore-arc basin sedimentation in the Lombok and Savu basins. First Institute for Oceanography, Qingdao, China, 20 October.
- : Recent sedimentary processes in the North Sea. East China Normal University, Shanghai, China, 4 November.
- Wilde, P.A.W.J. de: Metabolism of the North Sea. Lecture at the University of Amsterdam, 25 February.
- : Preliminary results of the Mauritania I Expedition. Nouadhibou, Mauritania, 29 May.
- : Basic research in soft-bottom benthic mesocosms, a review. Meeting SCOR WG 85, Hamburg, 7 June.
- : Progress in development of benthic mesocosms. Meeting Euromar W.G. Benthic systems and mesocosms, Heraklion, Crete, Greece, 24 November.
- Wolf, P. de: The price of patchiness. 6th International Wadden Sea Symposium, Sylt, FRG, 1 November.
- Zijlstra, J.J.: Productivity and fisheries potential of the Banda Sea ecosystem. AAAS Annual Meeting, Seminar 'Frontiers of marine ecosystem research', Boston, 12 February.
- : (The influence of the monsoon on the plankton system of the Banda and Arafura Seas). Lecture Science Department KNAW, Amsterdam, 28 March.
- : (Marine ecosystems). Lecture series marine biology, University of Groningen, 6-10 June.
- : The framework of SCAR. Symposium 'Netherlands Antarctic Activities', Amsterdam, 29 September.
- : European Polarstar Study (EPOS). Symposium 'Netherlands Antarctic Activities', Amsterdam 30 September.
- Zimmerman, J.T.F.: (Wind waves). Lecture series, University of Utrecht, January-June.
- : (Long waves and tides). Lecture series, University of Utrecht, September-December.
- : (Physical Oceanography). Lecture series, Int. Inst. Hydr. Civ. Eng., Delft, June.
- : A renormalized Green's function for non-linear circulation on the beta-plane. 13th General Assembly Eur. Geophys. Union, Bologna, Italy, 25 March.
- : Tidal residual circulation. International Conference Tidal Hydrodynamics, Washington, USA, 16 November.
- : Baroclinic residual currents. International Conference Tidal Hydrodynamics, Washington, USA, 17 November.
- : Tidal residual circulation illustrated by a numerical model of the Wadden Sea. International Conference on Physics of Shallow Estuaries and Bays. Asilomar, Monterey, USA, 29 November.

2.2.2.2. Posters

- Booij, K., G. Gust, W. Helder & B. Sundby: Resuspension as a factor that increases the apparent oxygen consumption by sediments in a stirred microcosm. (EOS vol. 68 p. 1699). Ocean Science meeting AGU/ASLO, New Orleans, USA, 18-22 January.
- Buma, A.G.J. & P. Tréguer: Cluster analysis of phytoplankton pigments in Antarctic waters. Symposium 'Netherlands Antarctic Activities', Amsterdam, 29-30 September.
- Franz, G.H.: Adaptations in Antarctic copepod populations. Symposium 'Netherlands Antarctic Activities', Amsterdam, 29-30 September.
- Gieskes, W.W.C. & C. Veth: Secchi Disk visibility record shattered. Symposium 'Netherlands Antarctic Activities', Amsterdam, 29-30 September.
- Gust, G., K. Booij, W. Helder & B. Sundby: On the velocity sensitivity (stirring effect) of polarographic oxygen microelectrodes. (EOS vol. 68 p. 1699). Ocean Science meeting AGU/ASLO, New Orleans, USA, 18-22 January.
- Helder, W., K. Booij & B. Sundby: Responses of O₂-profiles in sandy sediment to changes in overlying water current velocity. (EOS vol. 68 p. 1781). Ocean Science meeting AGU/ASLO, New Orleans, USA, 18-22 January.
- Leopold, M.F.: Concentrations of Guillemots *Uria aalge* at a tidal front near Texel, after the breeding season. 3rd International Conference of the Seabird Group, Cambridge, UK, 12-14 February.
- : Gannets, herring and wind in the Netherlands. 3rd International Conference of the Seabird Group, Cambridge, UK, 12-14 February.
- Veth, C.: Dye diffusion experiments under the sea ice during the Winter-Weddell-Sea-Project (WWSP) 1986. Symposium 'Netherlands Antarctic Activities', Amsterdam, 29-30 September.
- Vosjan, J.H. & E. Pauptit: Respiratory activity in the Western Scheldt. 4th International Workshop on the measurement of microbial activities in the carbon cycle in aquatic ecosystems. Ceske Budejovice, Czechoslovakia, 11-15 July.
- Wilde, P.A.W.J. de: Marine Mesocosms. First Euromar Market, Scheveningen, 6-8 September.
- : NIOZ Boxcosms. First Euromar Market, Scheveningen, 6-8 September.

2.2.3. Advice offered

- On behalf of the environmental authorities of the province of Groningen, a number of model runs were carried out to examine the consequences of brine discharges in the Ems estuary. A report has been published.
- On 29 January a consultation took place between M.A. van Arkel and M. Mulder and the department for environmental planning of Texel. The department was given advice on the use and effects of various drilling muds for an exploration drilling in the Boomkensingdiep in the Wadden Sea.
- As members of the 'Commissie voor de Milieu-effecten Rapportage' (MER), J.P. Boon and H.J. Lindeboom gave advice on a special commission to be set up to deal with the discharge in the sea of oil-containing liquids by mining installations.
- Advice was given by E.K. Duursma to CEC, Brussels, on future policies of CEC with respect to IGBP-global changes.

2.3. SOME ACRONYMS USED IN THIS ANNUAL REPORT

ATP	Adenosine-Tri-Phosphate
AWI	Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, FRG
BAH	Biologische Anstalt Helgoland, Helgoland, FRG
BEON	(Beleidsgericht Ecologisch Onderzoek Noordzee en Waddenzee) Applied Ecological Research North Sea and Wadden Sea
BEWON	(Beleidsgericht Wetenschappelijk Onderzoek NIOZ) Applied Scientific Research NIOZ
BION	(Biologisch Onderzoek Nederland) Biological Research of the Netherlands. (Foundation)
BOEDE	(Biologisch Onderzoek Eems Dollard Estuarium) Biological Research Ems-Dollard Estuary
CREST	Comité de la Recherche Scientifique et Technique (EC)
CTD	Conductivity Temperature Depth (probe)
DGW	(Dienst Getijdewateren RWS) Tidal Waters Division RWS
DIHO	(Delta Instituut Hydrobiologisch Onderzoek) Delta Institute for Hydrobiological Research
DSDP	Deep Sea Drilling Project
EC	European Community
EMOWAD	(Ecologisch Model westelijke Waddenzee) Ecological Model western Wadden Sea
EON	(Ecologisch Onderzoek Noordzee en Waddenzee) Ecological Research North Sea and Wadden Sea
EPOS	European Polarstern Study
EROS-2000	European River Ocean System-2000
ESF	European Science Foundation
ETS	Electron Transport System
IAPSO	International Association for the Physical Sciences of the Ocean
ICES	International Council for the Exploration of the Sea
ICSU	International Council of Scientific Unions
IFREMER	Institut Français de Recherche pour l'Exploration de la Mer
IUCN	International Union for the Conservation of Nature
JGOFS	Joint Global Ocean Fluxes Study
KNAW	(Koninklijke Nederlandse Akademie van Wetenschappen) Royal Netherlands Academy of Arts and Sciences
KNMI	(Koninklijk Nederlands Meteorologisch Instituut) Royal Dutch Meteorological Institute
MAFF	Ministry of Agriculture, Fishery and Food (UK)
MT-TNO	(Afdeling Maatschappelijke Technologie TNO) Division of Technology for Society TNO
NAM	(Nederlandse Aardolie Maatschappij) Dutch Oil Company
NWO	(Nederlandse Organisatie voor Wetenschappelijk Onderzoek) Netherlands Organization for the Advancement of Scientific Research
OPEX	Oil Pollution Experiment
PCB	Polychlorinatedbiphenyls
RCG	(Rijks-commissie voor Geodesie) State commission for Geodesy
REE	Rare Earth Elements
RIN	(Rijks Instituut voor Natuurbeheer) Research Institute for Nature Management

RIVO	(Rijks Instituut voor Visserij Onderzoek) Netherlands Institute for Fishery Research
RWS	(Rijkswaterstaat) Department of the Ministry of Transport and Public Works
SCOPE	Scientific Committee on Problems of the Environment
SCOR	Scientific Committee on Oceanic Research
SEAWAQ	Seawater Quality model
SEDEX	Sediment Experiments
SEM	Scanning Electron Microscope
SOZ	(Stichting Onderzoek der Zee) Netherlands Marine Research Foundation
TECON	(Toegepast Ecologisch Onderzoek Noordzee) Applied Ecological Research North Sea
TNO	(Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek) Netherlands Organization for Applied Scientific Research
UGGI	(Union Geodesique et Geophysique Internationale) International Union of Geodesy and Geophysics
UNEP	United Nations Environmental Programme
VROM	(Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieuhygiëne) Ministry for Housing, Regional Development and the Environment
WOCE	World Ocean Circulation Experiment
WOTRO	(Wetenschappelijk Onderzoek Tropen) Netherlands Foundation for the Advancement of Tropical Research
XRD	X-Ray Diffraction

3. Nederlandse samenvatting van de wetenschappelijke resultaten en andere activiteiten

3.1. SAMENVATTING VAN DE WETENSCHAPPELIJKE RESULTATEN

3.1.1. Inleiding

Evenals in het meer gedetailleerde Engelse verslag van de wetenschappelijke activiteiten tijdens het verslagjaar wordt in deze beknopte Nederlandse samenvatting zoals vanouds de verdeling in onderzoek van estuaria, van de Noordzee en van de open oceaan aangehouden.

Het estuariene onderzoek, dat zo'n 20 jaar geleden de hoofdmoot van het werk omvatte, is nog steeds van grote betekenis o.m. in verband met eutrofiëringsverschijnselen, modellering in het kader van het extern gefinancierde project EMOWAD (zie onder) en studenten- en promotieonderzoek. Het Noordzeewerk, waaraan reeds geruime tijd een groot gedeelte van het onderzoekspotentieel werd besteed, ontving in het verslagjaar een nieuwe impuls door het BEWON-project, gefinancierd door een groep ministeries betrokken bij beleid en beheer van de Noordzee. De integratie van dit project met het oudere Noordzee-onderzoek van het instituut verliep voorspoedig, o.m. tijdens het met de 'Tyro' uitgevoerde WINDOW-project. In het oceaanonderzoek werd deelgenomen aan expedities naar o.m. Antarctische wateren, in het kader van het door de European Science Foundation gecoördineerde EPOS-project, het Mauretanië-project, en het EROS-2000 project, uitgevoerd in de Middellandse Zee en ten dele door de EG gefinancierd. Daarnaast werd nog door enkele personeelsleden deelgenomen aan expedities naar de centrale Atlantische Oceaan (APNAP), naar de Zwarte Zee en het zeegebied tussen Groenland en Jan Mayen.

3.1.2. Estuaria (w.o. de Waddenzee)

In samenwerking met de Rosenstiel School of Marine and Atmospheric Sciences is een overzicht gemaakt van de huidige stand van zaken met betrekking tot de theorieën van dichtheidscirculatie in estuaria, waarbij speciale aandacht besteed is aan de dynamica in de 'diffusieve limiet'.

Bij onderzoek naar variaties in de alkaliniteit van het Waddenzee-water, gericht in verband met het bepalen van de seizoenscyclus van het koolzuursysteem werden sterk afwijkende waarden gevonden nabij Den Helder, vermoedelijk samenhangend met de uitzonderlijk hoge alkaliniteit van spuiwater uit het Noord-hollands Kanaal.

Voortgezet onderzoek naar de N-cyclus in het Waddenzee-sediment bevestigde dat reeds een lage concentratie van sulfide de laatste stap van het denitrificatieproces blokkeert, hetgeen tot een accumulatie van N_2O (een gas bijdragend tot o.m. het broeikaseffect) leidt.

De hoge concentraties van sporen-metalen (Cu, Zn, Cd, Cr, Pb) in het Rotterdamse havenslib lijken niet veroorzaakt door een hoge verontreiniging door plaatselijke bronnen, maar door een selectieve sedimentatie van gesuspendeerd materiaal in rivier en estuarium. Hierbij hoopt zich in het havengebied vooral het fijnere slib op, dat rijk is aan genoemde elementen.

Experimenteel werk aan de uitwisseling tussen sediment en water van enkele metalen (Cu, Cd, Pb, Ni) gaf aan, dat deze sterk afhankelijk is van de aanwezigheid van zuurstof in het sediment, waarbij aërobe condities de uitwisseling van Cu, Cd en Pb sterk bleken te bevorderen. De flux van microverontreinigingen van water naar sediment bleek in experimentele studies vrijwel onafhankelijk te verlopen van de hydrofobiciteit van de verontreinigende stof en de stromingscondities. Dit werd bevestigd door de concentratiegradiënten in het sediment, waarin de toename in concentraties na 50 uur tot een diepte van 2 cm reikten.

De opname en afgifte van Cd in diverse organen van de mossel werd bestudeerd. Hierbij bleek het nierweefsel het snelst op concentratie-verandering van het metaal te reageren en het mantelweefsel het langzaamst. Getracht werd in bot door injectie met PCB de inductie van het MFO (Mixed Function Oxygenase)-enzymstelsel te stimuleren. De eerste resultaten waren echter onbevredigend, door vermoedelijk een te korte incubatietijd en een te grote individuele variatie van de enzymatische activiteit tussen de individuen.

Datering met behulp van natuurlijke isotopen, waarbij gebruik wordt gemaakt van α - en γ -spectrometrie, werd gestart aan kernen verzameld op de Oostergonden in de Noordzee. Bij dateringsonderzoek met behulp van ^{210}Po in Waddenzee-sediment bleek de fosfaatindustrie uit het Rotterdamse havengebied een belangrijke bron voor dit isotoop te zijn.

In samenwerking met Chinese geologen werd vergelijkend onderzoek verricht naar sedimentatieprocessen in getijdegebieden van de Waddenzee en langs de Chinese kust. Door enkele stafleden werden in China o.m. de sedimentsamenstelling op de getijdeplaten en sedimentatieprocessen in mangrovegebieden bestudeerd.

De fytoplanktonproductie in de westelijke Waddenzee, die reeds geruime tijd wordt gevolgd, bleef hoog in 1985-1986, maar is sinds 1981/82 niet meer toegenomen. De fytoplanktonsamenstelling week in 1988 af van het gebruikelijke patroon, door het vrijwel ontbreken van een diatomeeënbloei in het voorjaar. Over het jaar nam de ook in vorige jaren geconstateerde dominantie van *Phaeocystis* verder toe.

In het kader van een BION-project werd het voorkomen van 'Farbstreifensände' in de westelijke Waddenzee geïnventariseerd, waarbij zowel purper als groene zwavelbacteriën werden gevonden. In een studentenonderwerp werd de snelheid van de sulfaatreductie bepaald in sedimenten van de Mokbaai. Hierbij werd soms een grote activiteit (tot $116 \text{ g C m}^{-2} \text{ j}^{-1}$) gevonden.

Benthische protozoën in het Waddenzee-sediment blijken in de zomer ongeveer 3 keer talrijker dan in de winter, met duidelijke zomerpieken in maart en juli. De meeste cellen zijn klein, 2-5 μm . De relatie van de protozoën met bv. bacteriën, organische-stofgehalte, bodemrespiratie enz. is nog verre van duidelijk.

De toename in het macrobenthos van de getijdengebieden van de westelijke Waddenzee, in de laatste 10-20 jaar waargenomen aan de hand van een lange bemonsteringsreeks, zette zich ook in 1988 na een zachte winter voort. De toename wordt in verband gebracht met de eutrofiëring van de Nederlandse kustwateren. Hierbij lijkt in de westelijke Waddenzee een verhoogde afvoer van nutriënten via het IJsselmeer een rol te spelen. Voortgezette eutrofiëring kan tot zuurstofgebrek leiden, waarvoor in de sombere zomer van 1988 aanwijzingen werden gevonden door het lokaal verdwijnen van enkele macrobenthos-soorten die gevoelig zijn voor tijdelijke zuurstofloosheid. Recruitering van de meeste bivalven in het macrobenthos was beneden normaal, zoals gebruikelijk na de zachte winter, hetgeen vermoedelijk samenhangt met een sterke predatie door o.m. garnalen. Ten aanzien van de voedselselectie van volwassen bivalven werd geconstateerd, dat het voedselspectrum van de meeste soorten, ongeacht de bouw van hun siphonen, een sterke overlap vertoont. Dit maakt voedselconcurrentie tussen soorten, waarvoor in het veld aanwijzingen waren gevonden, erg waarschijnlijk.

In samenwerking met de R.U. Groningen werd een onderzoek gestart naar de voedselopname van de op het wad talrijke Kanoetstrandloper, die op *Corophium*, *Macoma* en *Hydrobia* bleek te fourageren. Vogelonderzoek in het Waddengebied van Mauretanië (Banc d'Arguin) richtte zich o.m. op de retour-migratie naar NW-Europa in het voorjaar, waarbij de vogels grote hoogtes opzoeken met een gunstige (ZW) windrichting.

In het kader van de ecosysteemmodellering van de Wadden- en Noordzee werden de groeikarakteristieken van de zeester *Asterias rubens* onder verschillende temperatuurcondities bepaald.

3.1.3. Noordzee

De analyse van getijgefilterde stroommeet- en waterstandsgegevens heeft laten zien dat in het gebied van het Friese Front sprake is van een dominerende windgedreven stroming langs de dieptelijnen die vrijwel in geostrofische balans is met uitzondering van het gebied tussen de 30 en 40 m dieptelijnen. Dit laatste gebied correspondeert met de frontale zone en de inbalans kan bevredigend worden verklaard uit de horizontale dichtheidsgradiënten.

De analyse van een aantal drijverexperimenten hebben een sterke overeenkomst getoond tussen de zwaartepuntsbeweging van de drijver en de gecombineerde bewegingen geregistreerd door de stroommeters. De Eulerse en Lagrangeaanse schuifspanningstermen zijn echter zeer verschillend. Een bevredigende theorie is ontwikkeld om de verschillen te verklaren.

Aan de noordzijde van de Doggersbank zijn een aantal CTD-raaien gemeten in het kader van het WINDOW-projekt.

Het onderzoek naar kleinschalige turbulentie met behulp van laser-Doppler-methoden in de Zuidelijke Bocht van de Noordzee is voltooid. Het bleek mogelijk om een bodemschuifspanningscoëfficiënt te bepalen uit metingen in de waterkolom. Een model voor de beschrijving van kleinschalige turbulentie gedurende de getijcyclus is ontwikkeld.

Gedurende het WINDOW-projekt zijn spectrale irradiantiemetingen verricht en gecorreleerd met in-situ metingen van chlorofyl, zwevend materiaal en yellow substance. Tevens zijn remote-sensing beelden (NOAA/AVHRR) in relatie gebracht met *in-situ* grootheden.

Er is geparticipeerd in een Euromar-project voor het gebruik van laser-remote-sensing in kustwateren.

Een modelstudie naar het gebruik van het remote-sensing instrument CAE-SAR (voor in een vliegtuig) ter bestudering van ondiepe kustwateren is voltooid.

In samenwerking met de Biologische Anstalt Helgoland werd in het gebied benoorden de Waddeneilanden een opname gemaakt van de hydrografische condities, nutriënten, O₂, de pH, respiratieactiviteit en microbiële biomassa. Vanwege het ruwe weer in de zomer van 1988 werd geen stratificatie gevonden. In gebieden met hoge dichtheden van de protozo *Noctiluca* werden pH-waarden gevonden lager dan 7.

Door een combinatie van Engelse en Nederlandse nutriënt-gegevens uit het winterhalfjaar kon worden vastgesteld dat reeds in februari en soms zelfs in januari de nutriëntenconcentraties worden beïnvloed door fytoplankton. Tot nu toe was aangenomen dat de gemiddelde concentraties en de veranderingen in deze maanden alleen samenhangen met de rivierafvoer.

In een studie naar de verspreiding van enkele metalen in sedimenten en garnalen (*Crangon crangon* en *Crangon allmanni*) in de zuidelijke en centrale Noordzee werd een redelijke samenhang gevonden, waarbij voor Cu en Cd de hoogste waarden werden gevonden rond de Doggersbank. De Zn-concentraties waren vooral verhoogd in het Nederlands kustgebied. De concentraties bleken in beide soorten van vergelijkbare hoogte, behalve voor Cd, waar *C. crangon* beduidend lagere concentraties vertoonde. In de zeester *Asterias rubens* bleken in het verspreidings-gebied geen verschillen op te treden van Cu en Zn, maar wel van Cd dat duidelijk verhoogd was in het gebied ten noorden van de Doggersbank.

Uit dateringsonderzoek aan bodemkernen uit de Oestergronden met behulp van ²¹⁰Pb en ¹³⁷Cs werden in vele kernen tekenen van verstoring, bv. door bioturbatie, gevonden. Uit ongestoorde kernen bleek de sedimentatiesnelheid ca. 30-40 cm per eeuw te bedragen. Nieuwe kernen werden verzameld in slibrijke gebieden bij de Engelse kust, de Silver Pit en in de oude Elbe geul. In samenwerking met Engelse onderzoekers en de RGD werd met behulp van ondiepe seismiek en vibro-coring het gebied tussen het oude Theemdsdal en de Engelse kust bestudeerd.

Hoewel *Chrysochromulina*, de alg verantwoordelijk voor de grote voorjaarsbloei langs de Zweedse en Noorse kust, niet in het Nederlandse kustgebied optrad, werd o.m. door vragen uit de media wel aandacht aan *Chrysochromulina* besteed. Uit onderzoek met nieuwe methoden van de fytoplanktonontwikkeling in de Waddenzee in de loop van 1988 werden sterke aanwijzingen gevonden dat stikstofverbindingen en fosfaat nauwelijks limiterend zijn voor de groei van het fytoplankton. Voor nutriëntenlimitering werden wel aanwijzingen gevonden in het kustgebied van de Noordzee. Er werd ervaring opgedaan met het gebruik van de nieuwe flow-cytometer.

Uit een evaluatie van het zoöplanktononderzoek, in 1986 en 1987 uitgevoerd in het gebied van het Friese Front, kon geen verhoogde abundantie of biomassa van het zoöplankton in de frontale zone worden aangetoond, terwijl ook de pelagische productie niet significant hoger lijkt dan in het omgevende water. Hogere chlorofylconcentraties en een afwijkende pigmentsamenstelling in de frontale zone worden dan ook voorlopig toegeschreven aan aggregatie en verhoogde sedimentatie. Ook werden geen aanwijzingen gevonden dat in het

frontgebied een ophoping plaatsvindt van macroplankton met een daarmee samenhangende toename van de betekenis van deze groep evertebraten als predatoren op het mesozooplankton. Wel werden in het frontgebied grote concentraties van jonge Clupeïden aangetroffen, die echter moeilijk kwantificeerbaar zijn. Hun rol als predator op het zoöplankton is derhalve moeilijk aan te geven. Ook in het WINDOW-gebied, ten noorden van de Doggersbank, is het macroplankton te weinig talrijk om een belangrijke rol in de pelagische voedselketen te spelen. Deze conclusies t.a.v. het macroplankton verschillen sterk van de opvatting van Duitse collega's over de rol van het macroplankton in de Duitse Bocht.

Een deel van de groeiverschillen, waargenomen in schollarven in de Zuidelijke Bocht, kan verklaard worden uit temperatuurverschillen. Toch zijn er sterke aanwijzingen, o.m. uit dagringstructuren en RNA/DNA verhouding, dat daarnaast de grote waargenomen variatie in de groei ook samenhangt met voedingsscondities.

Uit experimenten met nauplii en copepodiet-stadia van *Temora*, die diverse monocultures van algen als voedsel kregen aangeboden, bleek dat nauplii in het algemeen niet in staat waren zich op één van de cultures te ontwikkelen, terwijl de copepodieten hierin beter slaagden. Een uitzondering vormde een cultuur met een kleine diatomee *Cylindrotheca closterium*. De kolonievormende *Phaeocystis*, die de laatste 10-20 jaar voortdurend talrijker wordt in het Nederlands kustgebied, bood voor beide levensstadia van *Temora* geen ontwikkelingsmogelijkheden.

In voorgaande jaren werd in experimenteel onderzoek een sterk dag-nacht-ritme geconstateerd in de voedselopname van *Temora longicornis*, dat tenminste ten dele werd toegeschreven aan dagelijkse variaties in de fysiologische toestand van de aangeboden algencultuur. Nieuwe experimenten, waarbij de algencultuur gedesynchroniseerd werd, verschaften aanwijzingen dat het dag-nacht-ritme ook in de copepode zelf zetelt.

Het SEAWAQ-model werd uitgebreid met een model voor bacteriën en mineralisatie, waarbij aanwijzingen werden gevonden dat bij hoge concentratie aan organisch materiaal een concurrentie om nutriënten ontstaat tussen bacteriën en flagellaten, hetgeen leidt tot een beperking in de algengroei. Het grazen van zoöplankton blijkt in dit modelsysteem een stabiliserende invloed te hebben op de flagellaat-bacterie fluctuaties.

Een verdere uitwerking van de bodemfaunamonsters, verzameld tijdens het Synoptic Mapping Project in 1986, toont de aanwezigheid van een viertal macrobenthische gemeenschappen in de Nederlandse sector van de Noordzee. Twee hiervan zijn eerder beschreven, maar die aangetroffen in de Zuidelijke Bocht en het noordelijke deel van de sector zijn nieuw. Beide gemeenschappen worden gekarakteriseerd door een lage biomassa, maar de diversiteit is veel hoger in het diepere, noordelijke gebied, hetgeen een sterke invloed van turbulentie op de structuur van de benthische gemeenschap aangeeft. Het ligt in de bedoeling de invloed van de zware bodemtrawls op de structuur van de gemeenschappen te onderzoeken.

Pogingen om benthische fronten, vergelijkbaar met die op het Friese Front, elders in de Noordzee te lokaliseren, bleven tot nu toe grotendeels zonder resultaat, behoudens aan de zuidwestzijde van de Doggersbank en de Silver Pit. Hier werd, vergelijkbaar met de situatie op het Friese Front, een rijke fauna aangetroffen met over korte afstanden een zich snel wijzigende faunasamenstelling.

In gebieden, waarin *Amphiura filiformis* domineert, komt een groot deel van de benthische productie op rekening van de regeneratie van de vangarmen van deze echinoderm. De armen worden regelmatig "geoogst" door benthische vissoorten. In een experimentele opstelling werd het regeneratiepotentieel van dit dier onder twee temperatuur-omstandigheden vastgesteld.

Er werd een begin gemaakt met het opsporen van lange-termijn-veranderingen in de Noordzee aan de hand van groeiringen van de noordkromp *Arctica islandica*, een bivalve met een potentiële leeftijd van meer dan 100 jaar. Door bestudering van de groeiringen wordt getracht een beeld te krijgen van de groeiomstandigheden over een lange periode van diverse gebieden van de Noordzee, waarbij mogelijk klimatologische en milieu-omstandigheden een rol spelen.

Met de installatie en inrichting van Noordzee-mesocosms werd een begin gemaakt, waarbij samengewerkt wordt met de BEWON-groep in het instituut.

In fysiologisch onderzoek naar opname en verdeling van halogenen in *Cran-gon crangon*, werd geconstateerd, dat bromide eenzelfde fysiologische functie heeft als chloride, terwijl de functies van jodide en fluoride, beide betrokken bij de metabolische activiteit, daarvan afwijken. Voorts bleek het element lithium in vrouwelijke garnalen significant hogere concentraties te hebben dan in mannetjes, waarschijnlijk omdat het op de een of andere wijze betrokken is bij het voortplantingsproces.

In juli-augustus werd een expeditie gehouden naar de noordzijde van de Doggersbank (WINDOW). Hoewel mogelijk de primaire productie en de zoöplanktonconcentratie aan de noordrand van de bank verhoogd zijn, lijkt het gezien de hydrografische profielen onwaarschijnlijk dat dit met opstrooming te maken heeft.

In het verslagjaar werd een samenwerking aangegaan met het Proudman Oceanographic Laboratory, Liverpool, waarbij gedurende 14 maanden zoöplankton-onderzoekers van het instituut mee zullen werken aan het Britse Noordzee-project. Hierdoor zal naar verwachting een uitstekend beeld verkregen worden van verspreiding, abundantie en mogelijke productie van het zoöplankton in de Noordzee. De verkregen gegevens kunnen worden vergeleken met de gelijktijdig genomen waarnemingen van hydrografie, fytoplankton en primaire productie.

3.1.4. Oceaanonderzoek

Door nieuwe bewerkingen van het in 1978 en 1980 verzamelde materiaal van de diepzeedelta van de Zaire rivier, waarmee een reconstructie kon worden verkregen van het paleoklimaat, werden mogelijkheden gevonden perioden van droogte vast te stellen door middel van de verhouding tussen zoetwaterdiatomeeën en fytolieten, waarvan de laatste grotendeels door eolisch transport werden aangevoerd.

Voor het Angola Bekken werd aan de hand van een studie van de verticale verdeling van pelagische foraminiferen in bodemkernen geconstateerd, dat de primaire productie sterk verhoogd was tijdens koude perioden, o.m. door een intensivering van de Benguela Stroom. Ook de benthische foraminiferen vertonen variaties in de profielen, vermoedelijk door een verhoogde aanvoer van organisch materiaal uit de oppervlaktewateren in koude perioden. Bovendien blijkt het bodemwater in deze perioden kouder te zijn geweest dan thans. De

wisselingen in het paleoklimaat gaan ook gepaard met variaties in de Ca/La-verhouding, die laag is tijdens koude perioden, samenhangend met variaties in redox-condities aan het oppervlak van het sediment.

In samenwerking met de universiteit van Hamburg is fysisch-oceanografisch onderzoek verricht in het kader van het Groenlandzee-project met het onderzoekingsvaartuig 'Meteor'. In dit project zijn NIOZ-stroommeters verankerd tussen Groenland en Jan Mayen. XBT-data van raaien dwars op het Arctische front zijn in bewerking.

De mathematische beschrijving van grootschalige oceaancirculatie is voortgezet. Het probleem van de asymmetrie in de circulatie is aangepakt via de advection-diffusie vergelijking en de oplossing toonde een resultaat dat, in tegenstelling tot de lineaire oplossing van Stommel en de volledig niet-lineaire oplossing van Fofonoff, de asymmetrie opleverde.

Geologische studies aan bodemkernen, verzameld in 1987 in het Feni Rug-systeem nabij de Rockall Trog, een gebied dat onder invloed staat van het stroomsysteem van de Schotland-Groenland rug, toonden een afwisseling van foraminiferenslik, afgezet in interglacialen en terrigene sedimenten (glaciale perioden), zoals o.m. bleek uit de koolstof-isotopen samenstelling van de foraminiferen. Acoustisch onderzoek verschaftte aanwijzingen dat de Feni Rug ontstaan is tengevolge van stromingen langs de zuidoostflank van het Rockall Plateau bij een zuidwaarts gerichte stroming.

Uitgebreide voorbereidingen werden getroffen voor deelname aan de grote internationale programma's uit de jaren negentig, met name JGOFS en WOCE. In verband hiermee werd aandacht besteed aan de ontwikkeling van een ijk-systeem van CTD's.

In samenwerking met onderzoekers van o.m. de R.U. Groningen, RIN, Delta Instituut en RMNH werd een veelzijdige expeditie georganiseerd naar het kustgebied van Mauretanië, waarbij zowel vanaf het land in het ondiepe waddensysteem (o.m. RUG, RIN, Delta Instituut) als in het aangrenzende zeegebied (NIOZ, RMNH) werd gewerkt. Dit kustgebied is enerzijds rijk aan vogels, die op hun weg naar het zuiden ook in de wadden en delta fourageren en is, door het nabijgelegen opstromingsgebied van NW-Afrika, eveneens een rijk visgebied. Tijdens de NIOZ-expeditie met de 'Tyro' werd aandacht besteed aan de hydrografie, het benthische en pelagische systeem en aan zeevogels in het gebied zeewaarts van de ondiepe Banc d'Arguin. Ook werd informatie verzameld over het voorkomen, opname en afgifte van zware metalen en PCB's in diverse groepen van organismen. Voor het uitvoeren van het hydrografische werk werd veel steun verkregen van een Russische oceanograaf, die als waarnemer door Mauretanië aan boord was geplaatst.

In de zuidelijke zomer van 1988-1989 werd in Antarctische wateren een in Europees verband georganiseerde expeditie uitgevoerd (European Polarstern Study, EPOS), waaraan een 14-tal personeelsleden van het instituut deelnamen, naast enkele medewerkers van andere Nederlands instellingen (o.m. RUG, RIN). Het initiatief voor de expeditie werd genomen door de European Science Foundation, waarbij het beschikbaar stellen van het moderne poolonderzoekingsvaartuig 'Polarstern' door de Duitse Bondsrepubliek de uitvoering van de plannen zeer bevorderde. In totaal werd in 3 tochten voorzien, waarbij de eerste zich concentreerde op de biologie-chemie van zeeijs, de tweede op het planktonsysteem in het gebied van de Weddell/Scotia Zee, terwijl de derde, uitgevoerd in 1989, zich in hoofdzaak zal richten op studies aan vis en benthos in de zuidelijke Weddell Zee en het slecht onderzochte zeegebied bij Queen

Maud Land. In totaal namen ca. 120 onderzoekers afkomstig uit 12 Europese landen aan het onderzoek deel. Alle tochten verliepen volgens plan, waarbij de Nederlandse bijdrage in de hydrografie (CTD-waarnemingen) opviel.

Gedurende het EPOS-project (leg 2) in het zeegebied rond de Weddell-Scotia confluentie zijn een aantal CTD-raaien gemeten. De oppervlakttemeng-laag bleek vrij dun te zijn door het smelten van het pakij en de instraling. In de diepere lagen waren sterke horizontale gradiënten zichtbaar in temperatuur en zoutgehalte over de grens tussen de Scotia Zee en de confluentie, maar de isopycnen verliepen zeer geleidelijk.

Tijdens voorgaande Antarctische expedities verzameld algenmateriaal werd in het lab met succes gekweekt. Uit experimenten met dit materiaal bleek de pigmentconcentratie tussen de soorten te verschillen, maar binnen een soort ook variabel te zijn, vermoedelijk in afhankelijkheid van de hoeveelheid licht. In parallel-cultures van *Phaeocystis pouchetii* uit Antarctica en de Noordzee werden onder dezelfde condities een groot verschil in de concentratie van één pigment (19'-hexanoyloxyfucoxanthine) gevonden.

Met de publicatie van de meeste resultaten van de Snellius-II expeditie in een zestal afleveringen van het Netherlands Journal of Sea Research werd in 1988 een begin gemaakt. Een aantal andere publicaties ook over werk gedaan in het kader van de Snellius-II expeditie is overigens reeds eerder verschenen.

Voor de uitwerking van het materiaal werd de verticale structuur van 'tracer' verdelingen in de zuidelijke Banda Zee bestudeerd met behulp van een eendimensionaal advection-diffusie model. De geschatte verticale diffusiecoëfficiënt bleek hoog te zijn, hetgeen vermoedelijk samenhangt met grensvlakmenging langs de wanden van het bekken. Voorts werd geconstateerd, dat vrijwel alle organisch gebonden P in de bovenste 200-300 m wordt gemineraliseerd, terwijl dit bij Si tot een diepte van 500 m en in het sediment doorgaat. Deze ontkoppeling van de P- en Si-cycli is vrijwel analoog aan die in het Antarctisch gebied.

Bij de uitwerking van gegevens over de graasactiviteit van copepoden in de Banda Zee, uitgevoerd door een Indonesische stagiaire, werd in vele gevallen een dag-nacht-ritme geconstateerd. Dit ritme werd niet alleen gevonden in dieren die nabij het oppervlak voorkwamen, maar ook in dieper aangetroffen exemplaren, hetgeen een regelmatige verticale migratie gedurende de nachtelijke graasperiode impliceert. In een station met een zeer sterke opstrooming werd bij de meeste soorten geen dag-nacht ritme in graasactiviteit gevonden.

In het kader van het door de EG gesteunde EROS-2000 project werd gewerkt aan sediment-water uitwisseling en aan de verspreiding van zware metalen in de bodem langs de Franse Middellandse Zee kust. De CTD-gegevens verkregen bij de EROS-tocht in 1987 zijn opgewerkt tot een standaard gegevensbestand dat beschikbaar is voor uitwisseling met andere bij EROS-2000 betrokkenen. Deze gegevens tonen aan een troebelheidsmaximum in de Rhone-pluim en een troebelheidslaag met lage zuurstofconcentraties bij de bodem van het continentale plat in de Golfe du Lion.

Zowel in de Middellandse Zee (Bannock Bekken) als in de Zwarte Zee werd een studie gemaakt van het gedrag van zeldzame aarden, met name Ce, in relatie tot anoxische omstandigheden. De nieuw ontwikkelde suspensiecamera werd in de Waddenzee, in de Middellandse Zee en in een proefopstelling van IFREMER getest, waarbij het apparaat goed bleek te functioneren.

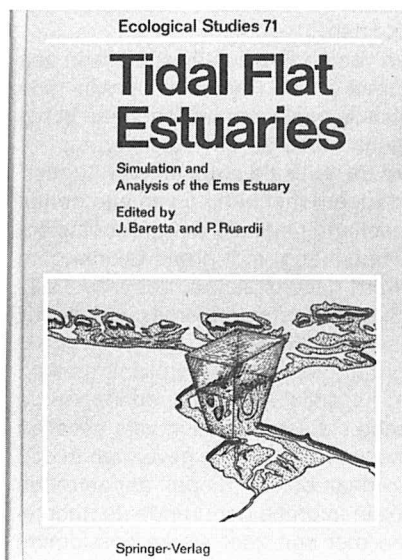
Opnieuw zijn onregelmatig gevormde, slecht kristallijne kleimineralen waargenomen. Verweringsmateriaal van basalt (1,1 miljard jaar oud) uit een DSDP

diepzee kern bleek uit smekiet te bestaan met dezelfde morfologie als gekrulde smekieten van vulkanisch materiaal van hooguit enkele honderden jaren oud uit Kenya en Tanzania. Blijkbaar wordt er via verschillende wegen en uit verschillend materiaal vergelijkbare mineralen gevormd.

In precambrisch glas uit Canada bleek een voorganger van kleimineralen gevormd te zijn. De primitieve kristallietjes bevonden zich nog in het moedermateriaal zodat ze nog geen eigen vorm aangenomen konden hebben.

Op beperkte schaal werd op verzoek van het Centre d'Océanologie de Marseille (CNRS) onderzoek verricht aan enkele koraalriffen in Frans Polynesië. Doel van het onderzoek was de aard en intensiteit van de rif-afbrekende processen te bestuderen. Evenals in het Caraïbisch gebied bleek de afbraak vooral door echinodermen te geschieden, maar de intensiteit bleek zeer hoog in de Polynesische riffen.

3.1.5. Speciale projecten



In het begin van het jaar ging het reeds in het vorige verslag aangekondigde BEWON-project van start als onderdeel Beleidsontwikkelend Ecologisch Onderzoek Noordzee en Waddenzee (BEON), een project waarin 8 instituten samenwerken. De hoofdprijs van het project is het creëren van een basisconcept met bijbehorende gegevens bedoeld om het regeringsbeleid t.a.v. de Noordzee en Waddenzee te adviseren betreffende problemen op het gebied van eutrofiëring, de effecten van organische en anorganische microverontreinigingen en tenslotte het effect van de boomkorvisserij op diverse benthische ecosystemen in de Noordzee. Om deze doelstelling te bevorderen werd in mei een goed bezocht internationaal symposium over de Noordzee georganiseerd door de Dienst Getijdewateren (DGW) en het NIOZ. Voorts werd een vijfjarig werkprogramma opgesteld en geaccepteerd.

In het verslagjaar werd het rapport over het voorgaande in 1987 beëindigde project Ecologisch Model van de westelijke Waddenzee (EMOWAD) aan de Minister van V. en W. aangeboden, terwijl de wetenschappelijke verantwoording van dit project in een speciaal nummer van het Netherlands Journal of Sea Research verscheen. Uit dit voorgaande project verscheen bovendien volgens contract de wetenschappelijke documentatie van het Eems-Dollard-model in boekvorm (Springer Verlag, Ecological Studies, vol. 71) en werd een rapport gepubliceerd over de biologische effecten van boorspoelingen.

In samenwerking met enkele stafleden van het NIOZ en DGW werd een expeditie georganiseerd (WINDOW) naar het gebied rond de Doggersbank, gericht op de bestudering van effecten van eutrofiëring. Hierbij werd aandacht besteed aan o.a. hydrografie, nutriëntenchemie, primaire productie, microbiële processen en het hogere trofische niveau. In het project werden eveneens verontreinigingsaspecten beschouwd, zowel van zware metalen (bodem-water uitwisseling) als van organochloor-verbindingen, o.a. PCB's. Daarnaast werd onderzoek verricht naar opname en verwerking van diverse PCB-componenten door mollusken, polychaeten, vissen, crustaceën en mariene zoogdieren. Het onderzoek aan het biologische effect van boorspoelingen bij boorplatforms werd voortgezet met ten dele nieuwe methoden (o.a. onderwater-fotografie).

Ten aanzien van de modellering van het Noordzee-ecosysteem werd aansluiting gezocht bij bestaande en in ontwikkeling zijnde modellen.

In samenwerking met de R.U. Utrecht werd een project gestart betreffende een studie van de tijdschalen van watermassa's in de verschillende getijdenbekkens van de Waddenzee.

In een vervolg op het DORA-project, gericht op een inventarisatie van bodemfauna en water-sediment uitwisseling in het NEA-dumpgebied in de Golf van Biskaye werd het NAZORG-project gestart, waarin o.m. de bodemfauna op de dumplocaties wordt vergeleken met die in aangrenzende gebieden. In dit verband werd een kort bezoek aan het gebied gebracht, waarbij het onderzoek ernstig gehinderd werd door zeer slecht weer. Een deel van het onderzoek wordt uitgevoerd in samenwerking met het Institut für Hydrobiologie und Fischereiwissenschaften Hamburg.

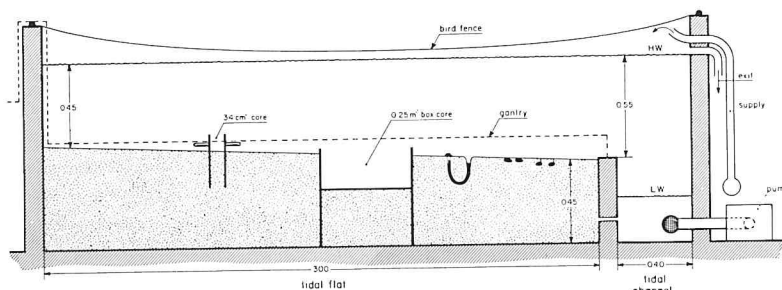
Samen met TNO en RIN werd verder gewerkt aan het Sediment Experiment (SEDEX), waarin in mesosystemen (mesocosms) de effecten van verontreinigd havenslib op de bodemfauna wordt bestudeerd. Hierbij bleek evenals in 1987 in het algemeen het eutrofiëringseffect eventueel aanwezige toxische effecten van het slib te maskeren.

In het kader van een door de EG gesteunde studie van *Phaeocystis*, waarvan een onderdeel gezamenlijk met de RU Groningen wordt uitgevoerd, werd zowel veld- als experimenteel onderzoek aan dit organisme verricht.

Tenslotte werd onder verantwoording van het instituut een literatuuroverzicht gemaakt over mogelijke biologische effecten van een eventuele temperatuursverandering in de Nederlandse kustwateren als gevolg van het broeikaseffect.

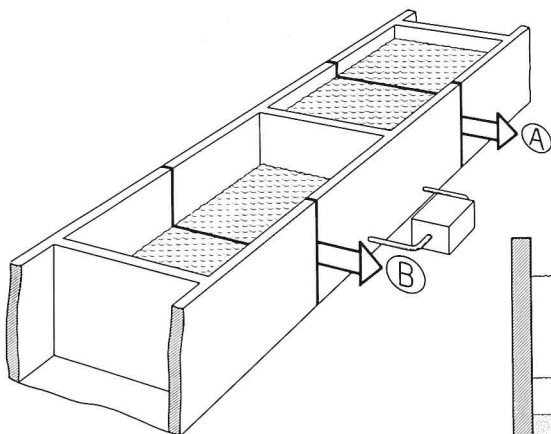
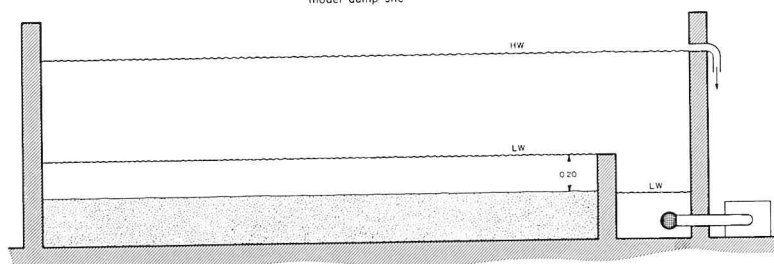
Ⓐ MOTIF

model tidal flat



Ⓑ MODUS

model dump site



3.2. BEZOCHTE CONGRESSEN

EPOS planning meeting leg 2, Alfred-Wegener-Institute für Polar- und Meeresforschung, Bremerhaven, 12-16 januari: H.J.W. de Baar, R.P.M. Bak, A.J. van Bennekom, G.C. Cadée, C. Veth, J.J. Zijlstra.

Ocean Sciences Meeting AGU/ASLO, New Orleans, USA, 18-22 januari: H.J.W. de Baar, P.M. Saager.

ICSU/SCOR committee for JGOFS, eerste vergadering, Miami, USA, 25-28 januari: H.J.W. de Baar.

ICES working group on oceanic hydrography en Nansen working Group, Kopenhagen, Denemarken, 4-5 februari: H.M. van Aken, A.J. van Bennekom.

Taxonomic workshop 'Taxonomy of North Sea benthos', Helgoland, BDR, 8-12 februari: G.C.A. Duineveld.

AAAS Annual Meeting, Seminar: Frontiers of marine ecosystem research, Boston, USA, 11-15 februari: J.J. Zijlstra.

3rd International conference of the Seabird Group, Cambridge, Engeland, 12-14 februari: M. Leopold.

NATO/ASI winter course on modelling of the general circulation and geochemical tracer transport, Les Houches, Frankrijk, 15-26 februari: L.R.M. Maas.

Symposium BORDOMER, Bordeaux, Frankrijk, 21-23 februari: E.K. Duursma.

AGU Chapman Conference on the Amazon, Charleston, USA, 25 februari - 3 maart: D. Eisma.

Annual meeting ICES Marine chemistry working group, Den Haag, 7-11 maart: J.P. Boon.

Euromar W.G. Mesocosms, Oslo, Noorwegen, 9-12 maart: P.A.W.J. de Wilde.

Modellen workshop, NIOZ, Texel, 14-15 maart: J.W. Baretta, F.C. van Duyl, H.J. Lindeboom, W. van Raaphorst, H. Ridderinkhof, P. Ruurdij.

Shell workshop on experimental determination and modelling of transport across the water-sediment interface and of transformation process in the sediment, NIOZ, Texel, 22 maart: M.A. van Arkel, K. Booij, W. Helder, H.J. Lindeboom, M. Mulder, J.H. Vosjan.

13th General Assembly European Geophysical Union, Bologna, Italië, 21-26 maart: J.T.F. Zimmerman.

EPOS planning meeting leg 3, Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven, 23-26 maart: G. Nieuwland, J.H. Vosjan.

Congress Soc. for Experimental Biology, Lancaster, UK, 25 maart - 3 april: D.H. Spaargaren.

1988 International Conference on Drilling Wastes, Calgary, Canada, 5-8 april: M. Mulder.

ICES working group on the biological effects of contaminants, Kopenhagen, Denemarken, 5-8 april: J.P. Boon.

Super critical fluid chromatography, Utrecht, 12 april: M.Th.J. Hillebrand.

CEC modellen workshop, Brussel, 13-14 april: H.J. Lindeboom.

JGOFS North Atlantic Pilot Study Planning Meeting, Plymouth, Engeland, 14-15 april:
G.W. Kraay, M.J.W. Veldhuis.

EUROMAR models, Modena, Italië, 25-29 april: H.J. Lindeboom.

EROS-2000, Villefranche-sur-mer, Frankrijk, 27-30 april: W. Kieskamp.

Symposium 'Chemistry Mediterranean Sea', Primosten, Jugoslavië, 2-9 mei:
E.K. Duursma

ESF (European Science Foundation) Consortium for Ocean Drilling (ECOD): Drilling in the Atlantic, Helsinki, Finland, 5-7 mei: J.H.F. Jansen.

ICES workshop 'The effects of bottom trawling', IJmuiden, 24-26 mei: M.J.N. Bergman, A. Stam.

Euromar board, La Spezia, Italië, 29-31 mei: E.K. Duursma.

ICES werkgroep primaire productie, Kopenhagen, Denemarken, 30 mei - 2 juni:
G.W. Kraay, M.J.M. Veldhuis.

Aggregate Methodology Workshop, Bremerhaven, 1-2 juni: D. Eisma, T. Schuhmacher.

SCOR W.G. 85 Mesocosms, Hamburg, 6-10 juni: P.A.W.J. de Wilde.

Meeting on reference materials for the analysis of seawater, EEG Brussel, 8 juni:
R.F. Nolting.

Die Kliesche (*Limanda limanda* L.) als Umweltfactor, Universität Hamburg, 14-16 juni:
H.W. van der Veer.

Symposium 'Structuur, gedragen effecten van milieuvontreinigende stoffen', Universiteit van Amsterdam, 16 juni: J.P. Boon.

13th International Radiocarbon Conference, Dubrovnik, Joegoslavië, 20-25 juni:
J.H.F. Jansen.

Cold on column injectie technieken, Breda, 22 juni: M.Th.J. Hillebrand.

Congress International Union of Biochemistry, Praag, Tjechoslowakije, 9-16 juli:
D.H. Spaargaren.

4th International Workshop on the measurement of microbial activities in the carbon cycle in aquatic ecosystems, Ceske Dubejovice, Tjechoslowakije, 11-15 juli:
J.H. Vosjan.

Vergadering European Polar Ocean Study (European Science Foundation), Bremerhaven, 13-14 juli: J.J. Zijlstra.

Fish in estuaries. The Fisheries Society of the British Isles, Southampton, UK, 18-22 juli:
H.W. van der Veer.

6th International Coral Reef Symposium, Townsville, Australië, 8-12 augustus:
R.P.M. Bak.

6th International Symposium on photosynthetic prokaryotes, Noordwijkerhout, 8-13 augustus: R. Riegman.

Joint Oceanographic Assembly, Acapulco, Mexico, 23-31 augustus: H.J.W. de Baar, L. Otto.

JONSMOD meeting, Hamburg, 24-26 augustus: L.R.M. Maas, H. Ridderinkhof.

International Congress of Geochemistry and Cosmochemistry, Parijs, 29 augustus - 2 september: S.J. van der Gaast, J.H.F. Jansen.

EBSA, Newcastle, UK, 29 augustus - 2 september: J.J. Beukema, H.W. van der Veer.

SCAR meeting en symposium, Hobart, Australië, 29 augustus - 14 september:
J.J. Zijlstra.

SCOPE/UNEP meeting, Baikal, Sovjetunie, 2-6 september: D. Eisma.

Euromar Market, Scheveningen, 6-8 september: E.K. Duursma, G.J. van Noort, P.A.W.J. de Wilde.

23rd European Marine Biology Symposium, Swansea, UK, 5-9 september: J.J. Beukema, R. Dekker, G.H. Fransz.

IAS 9th European Regional Meeting, Leuven, Belgium, 12-14 september: Z. Zuo.

ICSU/SCOR committee for JGOFS, tweede vergadering, Den Haag, 13-15 september:
H.J.W. de Baar, H.G. Fransz, G.W. Kraay, C. Veth.

2nd International workshop on phosphorus in sediments, Fiskebäckskill, Zweden, 14-16 september: W. van Raaphorst.

JGOFS North Atlantic Pilot Study Plannig Meeting, Den Haag, 16-17 september:
H.J.W. de Baar, H.G. Fransz, J. Hegeman, R.F. Nolting, C. Veth.

KNAW studiedag voor IGBP, Amsterdam, 22 september: H.J.W. de Baar, E.K. Duursma, H.G. Fransz, W. Kieskamp, H. Postma.
 196th ACS National Meeting, American Chemical Society, Division of Environmental Chemistry: Biomarkers of Environmental Contamination, Los Angeles, USA, 25-30 september: J.M. Everaarts.
 Symposium Meerestechniek, Hamburg, 27-29 september: E.K. Duursma.
 Symposium Netherlands Antarctic Activities, KNAW, Amsterdam, 29-30 september: R.P.M. Bak, A.G.J. Buma, H.G. Fransz, G. Nieuwland, R.F. Nolting, J.H. Vosjan, J.J. Zijlstra.
 Duits-Nederlands conferentie Zeespiegelstijging, Groningen, 3-4 oktober: J.J. Beukema.
 The early life history of fish. ICES symposium, Bergen, Noorwegen, 3-5 oktober: F. Hovekamp, H.W. van der Veer, J.J. Zijlstra.
 76th ICES statutory meeting, Bergen, Noorwegen: 5-12 oktober: H.M. van Aken, W. Helder, L. Otto, J.J. Zijlstra.
 International symposium 'Fate and effects of toxic chemicals in large rivers and estuaries, Quebec, Canada, 10-14 October: R.F. Nolting.
 First EURO-WOCE workshop, Straatsburg, Frankrijk, 20-21 oktober: L. Otto.
 Introductory and advanced course in image processing applications. Delft centre for image processing (CBD) en the European association for signal processing (Eurasip), 24-28 oktober: G. Marees, M.R. Wernand.
 EG Workshop 'Eutrophication and algal blooms in North Sea coastal zones, the Baltic and adjacent areas', Brussel, 26-28 oktober: G.C. Cadée, H.J. Lindeboom, H. Ridderinkhof.
 'Monitoring the environment', 6th International Wadden Sea symposium, Sylt, BRD, 31 oktober - 4 november: J.J. Beukema, P. Kamermans, H.J. Lindeboom, H.W. van der Veer.
 Workshop 'Klimaat effecten kustoecosystemen', NIOZ, Texel, 11-15 november: J.J. Beukema, C.G.N. de Vooy.
 International Symposium on tidal hydrodynamics, Washington, USA, 14-19 november: J.T.F. Zimmerman.
 EUROMAR WG Bottom Systems and Mesocosms, Heraklion, Griekenland, 23-26 november: P.A.W.J. de Wilde.
 IPRE Conference 'Water quality — European aspects', Lyon, 25 november: D. Eisma.
 Annual Meeting for Marine Ranching Project, Niigata, Japan, 25 november: H.W. van der Veer.
 10th Annual Meeting for Larval Fish Research, Chiba, Japan, 26-27 november: H.W. van der Veer.
 First WOCE Scientific Conference, Parijs, 28 november - 2 december: L. Otto.
 International symposium on physics of shallow estuaries and bays, Monterey, USA, 28 november - 2 december: J.J.M. van Haren, H. Ridderinkhof, J.T.F. Zimmerman.
 Symposium on the Biology of Japanese Flounder, Nagasaki, Japan, 3 december: H.W. van der Veer.
 AGU/ASLO annual congress, San Francisco, USA, 5-8 december: H. Ridderinkhof.
 Workshop Ecomarge, Perpignan, Frankrijk, 14-15 december: E.K. Duursma.
 Het 'International Symposium on the Ecology of the North Sea', gehouden van 15 tot 21 mei op het NIOZ, werd bijgewoond door de volgende NIOZ'ers: H.M. van Aken, M.A. Baars, G.C. Cadée, E.K. Duursma, F.C. van Duyl, D. Eisma, H.G. Fransz, W.C.M. Klein Breteler, B.R. Kuipers, H.J. Lindeboom, L. Otto, W. van Raaphorst, M. Reichert, H.W. van der Veer, M.J.W. Veldhuis, J.H. Vosjan, P. de Wolf, J.J. Zijlstra.

3.3. BESTUURSFUNCTIES

- E. van Abs
 - lid commissie zeegaand onderzoek Stichting Onderzoek der Zee (SOZ)
 - lid Overlegorgaan Faciliteiten Zeeonderzoek (OFZ)
- M.A. van Arkel
 - lid werkgroep Monitoring rond Mijnbouwinstallaties
- H.M. van Aken
 - lid Arctic Oceans Sciences Board
 - lid Working Group on Oceanic Hydrography ICES
 - lid Hydrographic Committee ICES
 - lid Scientific Steering Group Greenland Sea Project
- H.J.W. de Baar
 - voorzitter Wetenschappelijke Commissie voor Chemische Oceanografie NWO/SOZ
 - voorzitter Werkgroep voor Joint Global Ocean Flux Study NWO/SOZ
 - lid International Committee for Joint Global Ocean Flux Study ICSU/SCOR
 - gastdocent Chemische Oceanografie, Instituut voor Aardwetenschappen, Vrije Universiteit, Amsterdam
 - gastmedewerker NWO laboratorium voor Isotopen Geologie, Amsterdam
- M.A. Baars
 - coördinator BION-discussiegroep zoöplankton-FRIENDS
- R.P.M. Bak
 - lid redactie Snellius II proceedings voor thema 3
 - treasurer International Society for Reef Studies
 - bestuurslid werkgroep Biologisch Aardwetenschappelijk Onderzoek Tropen
 - lid redactieraad Marine Ecology Progress Series
 - lid redactieraad Coral Reefs
 - adviseur wetenschappelijke studiekring Nederlandse Antillen
 - docent (ad-honorem) University of Puerto Rico
 - gastdocent Tropische Marine Oecologie, Universiteit Amsterdam
- A.J. van Bennekom
 - lid werkgroep Antarctica van IUCN-ledencontact
 - plaatsvervangend lid Commissie Antarctica KNAW
 - lid Working Group Oceanic Hydrography ICES
 - lid redactie Circumpolar Journal
- J.J. Beukema
 - coördinator van de sectie "Intertidal soft bottoms" van het EG-project COST-647 (Coastal marine benthos)
 - hoofdredacteur van het Netherlands Journal of Sea Research
- J.P. Boon
 - lid Marine Chemistry Working Group ICES
 - lid Working Group on the Biological Effects of Contaminants ICES
 - lid wetenschappelijke begeleidingscommissie van het project 'Stresspar.MT'
 - lid werkgroep 'regeling lozing oliehoudende mengsels vanaf mijnbouwinstallaties op zee' van de Commissie voor de Milieueffectrapportage

- G.C. Cadée
 - lid commissie voor buitenlandse marien-biologische stations KNAW
 - lid DORA commissie (diepzee opberging radioactief afval)
 - bestuurslid BION werkgemeenschap aquatische oecologie
 - lid redactie NIOZ encyclopedie
 - lid redactie Snellius II proceedings voor thema 3
- G.C.A. Duineveld
 - lid ICES Benthos Ecology Working Group
- E.K. Duursma
 - hoogleraar Algemene Oceanologie, Rijksuniversiteit Groningen
 - voorzitter Nederlandse Raad voor Zeeonderzoek/Stichting Onderzoek der Zee (SOZ)
 - voorzitter SOZ commissie Antarctica
 - voorzitter EUROMAR Board
 - redactielid Oceanologica Acta, Marine Chemistry, Thethys en Journal of Environmental Radioactivity
 - lid redactie NIOZ encyclopedie
- D. Eisma
 - lid working group on marine sediments in relation to pollution ICES
 - lid adviesgroep marien aardwetenschappelijk onderzoek KNAW
 - lid projectgroep slibeigenschappen en coördinatiecommissie slib, Raad van Overleg fysisch oceanografisch onderzoek Noordzee
 - lid commissie geologische wetenschappen, KNAW
 - lid beheerscommissie NWO laboratorium Isotopengeologie
 - lid commissie Afvalgips en Vliegass Gezondheidsraad
 - lid gebruikerscommissie Laser-korrelgrootte bepalingen
 - lid Steering Committee EROS 2000 Program
 - adviserend hoogleraar East China Normal University, Shanghai
 - docent oceanografie Rijksuniversiteit Utrecht
- J.M. Everaarts
 - lid contactgroep ecotoxicologie van de commissie TNO/CNB voor onderzoek inzake nevenwerkingen van bestrijdingsmiddelen
 - lid projectgroep Biologische Toxicologie; BION werkgemeenschap Stofwisselingsfysiologie
 - lid werkgemeenschap mariene monitoring (SOZ)
 - lid redactie Snellius II proceedings voor thema 5
 - lid redactie NIOZ encyclopedie
 - lid Working Group on biological effects of contaminants ICES
- M. Fonds
 - lid Mariculture Committee ICES
- H.G. Fransz
 - lid commissie mariene biologie SOZ
 - lid begeleidingscommissie STW-project voor optische analyse van algen door flowcytometrie
 - lid stuurgroep Joint Global Ocean Flux Study Nederland
 - voorzitter werkgemeenschap Aquatische Oecologie BION
 - lid SCOR/JGOFS werkgroep Modelling
- L. Gerringa
 - lid NNI subcommissie Chemisch Onderzoek in het kader van bodemkwaliteit
 - lid NNI werkgroep Monsterneming in het kader van bodemkwaliteit
- W. Helder
 - lid Working Group Marine Chemistry ICES
 - lid Commissie Chemische Oceanografie SOZ
 - lid Commissie 'Milieuhygienische Aspecten' van de Gezondheidsraad
 - lid Working Group on marine sediments and bottom systems Euromar
 - voorzitter Nederlandse Oceanografen Club
- R.P. Heyman
 - secretaris Stichting ter Bevordering Nederlandse Oceanografie

- J. van Iperen
- bestuurslid Nederlands-Vlaamse Kring van Diatomisten
- redakteur van het verenigingstijdschrift "Diatomedelingen"
- J.H.F. Jansen
- penningmeester Sedimentologische Kring, Koninklijk Nederlands Geologisch Mijnbouwkundig Genootschap
- lid redactie NIOZ encyclopedie
- W.C.M. Klein Breteler
- voorzitter/secretaris BION-discussiegroep Zoöplankton-FRIENDS
- B.R. Kuipers
- lid redactie NIOZ encyclopedie
- H.J. Lindeboom
- lid Commissie voor Milieueffectrapportage
- lid stuurgroep SEDEX
- lid coördinatiegroep ecologie Noordzee en Waddenzee
- Nederlands afgevaardigde CREST Ad-Hoc Working Group on Marine Science and Technology
- Nederlands afgevaardigde EUROMAR Working group on models
- L.R.M. Maas
- lid redactie NIOZ encyclopedie
- G. Marees
- lid werkgroep Optische Remote Sensing Water (ORWA)
- M. Mulder
- lid werkgroep Monitoring rond Mijnbouwinstallaties
- L. Otto
- lid Hydrography Committee ICES
- lid Working group on Shelf Seas Hydrography ICES
- lid European Science Foundation, Committee for WOCE (World Ocean Circulation Experiment)
- lid Bestuur Stichting Onderzoek der Zee (SOZ)
- Voorzitter Commissie voor Oceanografische Informatieuitwisseling SOZ
- lid Commissie voor Fysische Oceanografie SOZ
- lid Programmaraad Werkgemeenschap MFO-NWO
- nominated member SCOR
- lid redactie NIOZ encyclopedie
- W. van Raaphorst
- lid begeleidingscommissie "Kwantitatieve aspecten van uitwisseling en diffusieprocessen van fosforverbindingen over het grensvlak sediment-water in de Loosdrechtse Plassen" (Limnologisch Instituut, Nieuwersluis)
- D.H. Spaargaren
- secretaris commissie voor buitenlandse marien-biologische stations KNAW
- lid Council of Europe Working Group on Chemical Evolution, Early Biological Evolution and Exobiology Marine, Gif/Yvette, Frankrijk
- lid Groupement pour l'Avancement de la Biochimie Marine, Gif/Yvette, Frankrijk
- lid International Association of Geochemistry and Cosmochemistry; working group on natural waters, protection from pollution, Rostov-on-Don, USSR
- C. Swennen
- lid werkgroep bijlage VEG-vogelrichtlijn
- lid Nederlandse sectie International Council of Bird Preservation (ICBP)
- nationaal kontaktpersoon sea duck branch, International Waterfowl Research Bureau (IWRB)
- S.B. Tijssen
- lid Hydrography Committee, ICES
- lid commissie oceanografische informatie-uitwisseling SOZ

- C. Veth
- lid coördinatiegroep WST van de Raad van Overleg voor het fysisch oceanografisch onderzoek van de Noordzee
 - corresponding member of SCOR working group 69 (small-scale oceanic turbulence)
 - lid programmaraad van de werkgemeenschap MFO-NWO
 - lid gebruikersgroep van laser-doppler snelheidsmeettechniek
 - lid Commissie voor Fysische Oceanografie SOZ
- J.H. Vosjan
- lid redactie NIOZ encyclopedie
- T.C.E. van Weering
- lid werkgroep Bodem van de Raad van Overleg voor het Fysisch en Oceanografisch Onderzoek van de Noordzee
 - lid redactiecommissie Snellius II proceedings, voor thema 1
 - gastdocent Mariene Geologische Methodes, Instituut voor Aardwetenschappen, Vrije Universiteit, Amsterdam
 - lid Ad-hoc commissie Nieuwbouw Noordzee vaartuig NIOZ
 - alternate member ODP panel for West Pacific (WESTPAC)
 - secretaris Ned. Oceanografen Club
- P.A.W.J. de Wilde
- lid commissie van beheer Delta Instituut
 - adviseur wetenschappelijke studiering Nederlandse Antillen
 - lid Nederlandse commissie voor internationale natuurbescherming
 - lid stuurgroep/projectgroep SEDEX
 - lid natuurbeschermingsraad, Ministerie voor Landbouw en Visserij
 - lid North Sea Benthos Ecology Working Group, ICES
 - voorzitter Euromar Mesocosm Working Group
 - lid SCOR working group 85, mesocosms
- P. de Wolf
- lid voorlopige commissie voor de milieueffectrapportage
- J.T.F. Zimmerman
- hoogleraar Fysische Oceanografie, Rijksuniversiteit Utrecht
 - lid dagelijks bestuur werkgemeenschap MFO-NWO
 - lid programmaraad werkgemeenschap MFO-NWO
 - lid redactie Netherlands Journal of Sea Research
 - lid redaktieraad Continental Shelf Research
 - IAPSO vertegenwoordiger nationaal UGGI comité
 - lid van de Rijkscommissie voor Geodesie
 - lid van de subcommissie mariene geodesie van de RCG
 - correspondent van Natuur en Techniek
 - lid werkgroep radaraltimetrie TH Delft
 - lid Commissie voor Milieueffectrapportage
 - lid kerngroep 'Vorbereiding Nederlandse Raad voor de Aardwetenschappen', KNAW
- J.J. Zijlstra
- bijzonder hoogleraar Mariene Zoölogie, Rijksuniversiteit Groningen
 - lid bestuur Stichting Onderzoek der Zee
 - voorzitter commissie mariene biologie van de Stichting Onderzoek der Zee
 - lid redactie Snellius-II proceedings, voor thema 3
 - lid commissie antarctisch onderzoek SOZ
 - lid Koninklijke Nederlandse Akademie van Wetenschappen
 - secretaris sectie Biologie, KNAW
 - vice-voorzitter van de Biologische Raad
 - voorzitter bestuur Beijerinck-Popping fonds
 - lid Directeuren Overleg Chemie/Biologie Noordzee
 - lid NWO-adviescommissie gebiedsraad-in-oprichting Biologie
 - lid wetenschappelijke commissie van het Rijksinstituut voor Natuurbeheer (RIN)
 - lid biological oceanography committee ICES
 - voorzitter Publication Committee ICES

J.J. Zijlstra (vervolg)

- lid European Polar Study-group (ESF)
- lid Wissenschaftliche Beirat Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven, B.R.D.
- lid van de Arbeitsgruppe Meeresforschung des Wissenschaftsrates Bundesrepublik Deutschland

3.4. STUDENTENONDERZOEK

Als onderdeel van hun doctoraalstudie of als stagiaire namen de volgende personen deel aan het onderzoek. De nummers verwijzen naar de projecten in sectie 1.7.

E. van Arnhem	Hoge School Alkmaar	BEWON
R. de Boer	RU Groningen	B2-02
M. Borowik	Academy of Agriculture Szczecin, Polen	B3-02/B3-06
L.H. Bravo Rebolledo	LU Wageningen	B2-01
C. Brussaard	RU Groningen	H3-01
A.G. Duiven	LU Wageningen	B3-03a
M. van Egmond	Bakhuys Rozeboom Instituut Beverwijk	B3-06
R. Hawari Djohani	GU Amsterdam	H1-08/09
H. de Hey	RU Groningen	H1-02/03/B1-02
M. van der Heijde	Nautisch College Den Helder	SEDEX
M. Hoeksteen	LU Wageningen	BEWON/H1-09
S. Holtmann	Univ. Braunschweig, BRD	B1-10
A. Jaworski	Academy of Agriculture, Szczecin, Polen	B3-08
L. Karczmariski	Academy of Agriculture, Szczecin, Polen	B3-02/B3-06
C. Klok	GU Amsterdam	H1-08/09
J. Kolk	Bakhuys Rozeboom Instituut Beverwijk	H1-06
M.A. van Leeuwe	RU Groningen	H3-02
C. van Leeuwe	RU Utrecht	H3-12
L. Löhse	Universiteit Oldenburg, BRD	H1-02/03
A. Mutter	TU Delft	BEWON
H.R. Offringa	v.d. Broek Instituut, Amsterdam	B3-07
J.P. Ouweltjes	Hoge School Alkmaar	BEWON
M. Philippart	RU Utrecht	S-01a
W.L. Roozemeyer	GU Amsterdam	B3-04
S. de Rijk	VU Amsterdam	H3-01
I. Schwinder	Univ. Braunschweig, BRD	B1-10
P. Smietana	Academy of Agriculture, Szczecin, Polen	B3-02/B3-06
M.H.C. Stoll	RU Groningen	B2-01
J.C.H. Ursum	v.d. Broek Instituut, Amsterdam	B3-03a
K. de Vries	RU Utrecht	H3-12
W. Warmerdam	Bakhuys Roozeboom Instituut Beverwijk	H1-05
M.J.A. van Wuyckhuyze	RHLS Groningen	SEDEX
D. Zuidema	RU Groningen	BEWON

3.5. CURSUSSEN, VERGADERINGEN EN EXCURSIES

3.5.1. NIOZ cursussen

De cursus 'Inleiding in de Oceanologie' werd gegeven van 8 februari tot 4 maart. Er waren 30 deelnemers, van wie het grootste deel afkomstig was van de RU Groningen. Deze cursus is een onderdeel van het tweede jaars curriculum mariene biologie in Groningen, waarvan het college van 8 tot 12 februari gegeven werd en het praktische gedeelte van 15 tot 26 februari plaats vond op het NIOZ. 55 medewerkers waren min of meer bij deze cursus betrokken. Twee vaardagen werden met de onderzoekschepen 'Navicula' en 'Aurelia' uitgevoerd.

De cursus 'Mariene Oecosystemen' (NIOZ gedeelte) werd gegeven van 13 tot 24 juni. Er namen 20 studenten aan deel, zodat twee betrekkelijk kleine groepen dit jaar onder uitgebreide begeleiding van NIOZ-personeel alle onderdelen konden volgen. De wadbemonsteringen en de Noordzeevaartochten werden zoals gewoonlijk met véél enthousiasme maar toch met goede inzet uitgevoerd. Hoewel er ook voor de andere praktische onderdelen, zoals het meten van primaire productie, respiratie en mineralisatie veel aandacht was, vielen de naderhand binnenkomende verslagen wat tegen. Er zal met de RU Groningen overlegd worden, of deze vrij intensieve cursus van het tijdstip aan het eind van een druk studiejaar naar een periode iets vroeger in het seizoen verschoven kan worden, waardoor de opbrengst wellicht wat optimaler zou kunnen zijn.

3.5.2. Andere cursussen gehouden op het NIOZ

8 en 9 maart	Workshop JGOFS North Atlantic Pilot Study
14-15 maart	Modellen workshop
22 maart	Shell workshop on experimental determination and modelling of transport across the water-sediment interface and of transformation processes in the sediment
19 april	Cursus mariene biologie voor geologen van de Vrije Universiteit, Amsterdam
2 juni	Vergadering Laser-Doppler gebruikersgroep
27 juni	Meeting Laser-Doppler gebruikersgroep

3.5.3. Ontvangen gezelschappen van aanverwante instituten, overheidsdiensten, e.d.

18 januari	Bemanningsleden HMS 'Tydeman'
12 februari	Bewonersgroep Jellinekkliniek, Texel
18 februari	Deelnemers cursus Hydrografie
25 februari	Groep Duitse biologie studenten
27 februari	Alwin Scholengemeenschap, Haarlem
10 maart	Vormingscentrum de Haaf, Bergen, m.m.v. H.J. Lindeboom
10 maart	Groep ambtenaren uit Hannover, m.m.v. H.J. Lindeboom
23 maart	Hogeschool Midden Nederland, Utrecht m.m.v. B. Tijssen
12 april	Deelnemers cursus Mar. Biologie voor geologie studenten
18 april	Prof. H.C. van Hall Instituut, Groningen en Nautisch College, Den Helder, m.m.v. J. Everaarts en G. v. Moorsel
21 april	Polstokschoot, Alkmaar
23 april	Werkgroep Vogelasiel, Middelburg
28 april	RIVM, Lab. voor Anorg. Chemie, Bilthoven
24 mei	SOL, Vakgroep Oriëntatie op de Natuur, Utrecht
24 mei	Secr. Gen. Ocean Marine Conference Indian Ocean. Dr. Jajewardena met vertegenwoordiging NILOS, Utrecht
31 mei	Bad Sachsa Gymnasium, Bad Sachsa, Duitsland
2 juni	Lab. voor Waterbeheer, Amsterdam, m.m.v. R.F. Nolting
10 juni	Personeel Raadhuis, Texel
20 en 21 juni	Delta Instituut, Yerseke
1 juli	Groep Gemeenteartsen, Noord Holland
3 augustus	Esperantistencongres
23 augustus	Lessing Gymnasium, Braunschweig, Duitsland
2 september	Bewonersgroep Jellinekkliniek, Texel
7 september	VSO De Schakel, Alkmaar
22 september	Kottenparkcollege, Enschede
29 september	Afgevaardigden van de ministeries van Economische Zaken en Verkeer en Waterstaat
7 oktober	Europarlementariërs PvdA
11 oktober	Pedagogische Akademie, Sittard
14 oktober	Vaste kamer commissie Waddenzee aangelegenheden
22 oktober	Natuurmuseum, Ameland
12 december	Ministerie van VROM met gasten uit Sri Lanka
15 december	Adviesbureau DHV, Amersfoort, m.m.v. G. van Moorsel

4. Hulpafdelingen

4.1. ALGEMEEN

In september is een hoofd van de technische afdelingen aangesteld. Zoals ook al gemeld in 1987 is de druk op de hulpafdelingen groot. De begeleiding van de oceaanexpedities was zwaar maar succesvol.

De ontwikkeling van nieuwe oceanografische apparatuur is na een poging om dit uit te besteden toch weer zelf ter hand genomen met de ontwikkeling van de ocean bottom landers.

In september is door Marine Structure Consultants M.S.C. in samenwerking met het NIOZ een begin gemaakt met het ontwerp van een nieuw Noordzee-onderzoekvaartuig wat in december resulteerde in een voorlopig ontwerp. Hierbij wordt het NIOZ terzijde gestaan door de afdeling Rijksvaartuigen van het Directoraat Generaal Scheepvaart en Maritieme zaken DGSM.

4.2. TECHNISCHE HULPAFDELINGEN

Onderhouds- en constructieafdeling.—In 1988 werd veel tijd besteed aan de voorbereiding en uitvoering van verschillende vaartochten. Voor de reis naar Mauretanië werd een aluminium werkboot uitgerust met een A-frame, een hulplier, een echolood en een marifoon om op ondiep water onder de kust te kunnen monstern. Voor NAZORG werden de vistuigen van een sluitmechanisme voorzien en bekleed met netwerk. Het fotokamerahuis werd opnieuw geänodiseerd en er werden beugels op het frame gemaakt om de kamera te kunnen bevestigen.

Voor de reis met de 'Polarstern' werden 3 containers klaargemaakt en samen met een hoeveelheid technische apparatuur naar Duitsland verscheept. De r.v.s. Rosette sampler frames werden omgebouwd van 12 flessen naar 24 flessen van 12 liter en van een speciale teflonfluor coating voorzien. Elastiek in de waterscheppers werd vervangen door r.v.s. veren.

Voor de reis met het RV 'Discovery' werd een van de RGD geleende container ingericht en aangepast. Daarna werd deze met eigen transport naar Monaco gebracht.

Na de expedities werd de 'Tyro' uitgerust met een aantal containers, lieren, en bodemonsterapparatuur en een draaiende proefopstelling om voor drie dagen dienst te doen als expositieschip gedurende de 'Euromar'dagen in Scheveningen.

Twee technici hebben een reis gemaakt met de 'Tydeman' voor de VU om de eerder door de 'Tyro' geplaatste sedimentvallen op te halen.

Bij het onderhoud van de NIOZ-schepen werd de dieselmotor van de 'Griend' gereviseerd. De 'Navicula' kreeg zwaardere deuren in de opbouw en machinekamer; daarnaast vond nog een aantal technische veranderingen plaats om het schip onder scheepvaartinspectie te kunnen laten varen.

Voor de NIOZ-haven werd een olieopslagcontainer gebouwd waarin o.a. een vat van kunststof voor de opslag van afgewerkte olie afkomstig van de schepen.

In het gebouw vonden diverse verbouwingen plaats. Er is een afzuigstelsel aangelegd in de nieuwe ruimte voor de gaschromatografie bij Chemische Oceanografie. Voor de BEWON werd in het nieuwe lab een dergelijk stelsel aangelegd voor formalinedampen en een afzuigstelsel voor een verbrandingsoven.

Het afvalwaterbassin werd gestraald en in een speciale coating gezet nadat de lekkende naden die betonrot veroorzaakten waren geïmpregneerd.

Voor de flowcytometer werd een nieuwe ruimte gebouwd en ingericht. Een koelstelsel voor het koelwater van de laser was daarbij nodig. Gekozen werd voor een mobiele koelmachine die in de toekomst met de flowcytometer per container wereldwijd kan opereren.

In de onderstations werden 5 elektrische boilers geplaatst zodat nu 's zomers ook warm water beschikbaar is als de ketels uit zijn.

Instrumentmakerij.—De werkzaamheden aan de suspensiecamera's zijn dit jaar zo goed als beëindigd. De druktest van de RVS316 onderwaterhuizen in de hogedruktank bij IFREMER in Brest verliep de eerste maal niet geheel naar wens. De behuizing van de datalogger implodeerde bij een druk van ± 750 bar. Nu staat er in de instrumentmakerij een mooie platte buis als aandenken. De nieuwe dataloggerbehuizing is van Constructal aluminium gemaakt. Deze aluminiumsoort heeft een veel hogere rekgrens dan RVS316 en kon de 750 bar druktest wel doorstaan. Aan één camerahuis is na een druktest van 750 bar enige blijvende deformatie geconstateerd. Deze huizen zullen in de toekomst moeten worden vervangen door Constructal aluminium huizen.

De vensters die eerst bij de R.U. Utrecht op 750 bar zijn getest begaven het echter na een lange duurttest. De 'O'-ring-groeven vertoonden scheuren. Na verandering van deze groeven hebben de vensters de druktest wel doorstaan. Er wordt nog geëxperimenteerd met de lichthoeveelheid en flitstijd van de één-op-één camera om de foto's bij hoge stroomsnelheid te verbeteren. Momenteel is het camerasysteem gebruiksklaar en heeft al een paar tochten achter de rug.

Na enige jaren van overleg is er door de instrumentmakerij een begin gemaakt met het ontwerpen en bouwen van 3 bodemlanders voor de afdelingen Benthische Systemen, Chemische Oceanografie en Geologie.

Aangezien dit een groot project is met nog vele onzekerheden is besloten om één van de instrumentmakers hiermee te belasten. Momenteel is al het een en ander gerealiseerd zodat er in 1989 enige proeftochten kunnen worden gemaakt.

Verder is er dit jaar weer een groot aantal apparaten gemaakt variërend van vele corerpijpjes tot ingewikkelde filtratieopstellingen, voerautomaten, gloveboxen en incubators. Dit jaar is een digitaal gestuurde freesbank gekocht. Na een programmeer/bedieningscursus is het mogelijk om deze machine alles te kunnen laten frezen en boren. Dit jaar is ook personeelversterking verkregen. Eerst een tijdelijke kracht waarna in november een vaste kracht is aangesteld.

Aquarium-technische afdeling.—Veel werkzaamheden zijn verricht om de Noordzeebakken te verbeteren in de vorm van wateraan- en afvoer. Ook is er een boxcosmsysteem gemaakt welke op de 'Euromar'-markt heeft gestaan. Momenteel draait dit systeem naar volle tevredenheid van de onderzoekers.

Het nieuwe dak op het aquariumgebouw is een hele verbetering, geen lekages meer. De tenten die nodig waren om de proefopstellingen droog te houden werden afgebroken wat een veel netter beeld geeft van de werkvloer.

Electronica.—Naast de gebruikelijke assistentie bij de 'Tyro'- en 'Tydeman'-tochten is in 1988 een groot beslag op de afdeling gelegd door de tochten met de 'Polarstern'. In goede samenwerking met Fysische Oceanografie en de werkplaatsen is een volwassen en professioneel CTD-systeem tot stand gekomen, wat op de 'Polarstern' veel lof oogstte. Eveneens voor de 'Polarstern'-tocht is een speciale antarctische planktontorpedo gebouwd, waarvoor F. Eijgenraam de programmatuur leverde.

Door de grotere bezetting op de afdeling kon een groot deel van de achterstand van de afgelopen jaren worden ingelopen. Een belangrijke nieuwe ontwikkeling is de intrede van computerbestuurde zelfstandige meetapparatuur. De 'in situ' suspensie-camera' is het eerste produkt wat van een dergelijke computer voorzien is. Een aanvang is gemaakt met het ontwikkelen van 'Ocean Bottom Landers', zelfstandig op de oceaanbodem opererende apparatuur welke korte (1 dag) of langere (1 jaar) tijd ingezet kan worden. Een oriëntatiereis naar de VS was hierbij een grote duw in de goede richting.

Elektrotechnische werkplaats.—Door de ingebruikname van de automatische klimaatbeheersingsinstallatie is een ruime besparing bereikt op het gas- en elektriciteitsverbruik. In 1988 is 110.000 m³ gas minder verstoekt waarvan ongeveer de helft veroorzaakt is door het zachte weer.

In februari heeft de windgenerator i.v.m. een storing $\pm 2\frac{1}{2}$ week stilgestaan. Totaal werd door de windgenerator 196.000 kWh geleverd.

Op de 'Tyro' zijn nieuwe voedingskasten geplaatst, tevens zijn de besturingen van de kranen en de lieren aangepast.

Expeditie.—De DAF vrachtwagen werd vervangen door een nieuwe DAF. Tevens werd door de onderhouds- en constructieafdeling een oude aanhangwagen volledig gereviseerd welke nu achter de nieuwe vrachtwagen gekoppeld kan worden. Hiermee kunnen gelijktijdig 2 containers worden vervoerd.

Haven en vaartuigen.—De 'Aurelia' heeft 167 vaardagen gemaakt en 201 opstappers vervoerd. Het schip is in Engeland (Lowestoft) en Noorwegen (Bergen) geweest. Er zijn 2 sets handmobilofoons aangeschaft.

De Navicula heeft 159 vaardagen gemaakt met 443 opstappers aan boord. Het schip is onder Scheepvaartinspectie gebracht. Hierbij zijn in overleg met de onderhouds- en constructieafdeling enige noodzakelijke aanpassingen gerealiseerd.

De 'Griend' heeft 104 vaardagen gemaakt. In de winterperiode zijn de motor en koppeling gereviseerd door de onderhoudsafdeling.

De vlet heeft met de fuikenvisserij goede resultaten geboekt. De schroef en as zijn in de winterperiode vervangen door de onderhoudsafdeling.

De haven is gebaggerd. Het brugpontoon is naar het dok geweest voor onderhoud. De oude olieopslagtank is vervangen door een nieuwe p.v.c.tank en in een container geplaatst.

4.3. ADMINISTRATIEVE HULPAFDELINGEN

Algemeen.—In het eerste kwartaal van 1988 is, na overleg met de OR, het formatievoorstel met bijbehorende functiebeschrijvingen ingediend bij het ministerie. De vaststelling van de formatie door het ministerie beperkte zich echter uitsluitend tot de functiewaarderingen. Over deze aangelegenheid zal, mede in verband met de overgang van het instituut naar NWO, met het ministerie nader overleg worden gevoerd.

Bibliotheek.—In 1988 werden 2 atlassen en 98 boeken aangeschaft. Met ingang van 1988 heeft de bibliotheek abonnementen op de volgende tijdschriften:

Clay minerals 1988 vol. 23(1)-
Geobyte 1988 vol. 3(1)-
Marine Science Bulletin 1988 vol. 1(1)-
Scanning Microscopy 1987 vol. 1(1)-
Uitbreiding door ruil met Netherlands Journal of Sea Research:
Bulletin Marine Geological Institute Indonesia 1985 1(1)-
China Nieuwsbrief AMPEK 1988 nr. 1-
Berichte über die Fahrten Hamburger Forschungsschiffe Valdivia 1985-
China Information 1988 vol 2(3)-
Mitteilungen Deutsche Gesellschaft für Meeresforschung Hamburg 1984(3)-
Sula 1986 vol. 2(1)-
Journal Fisheries China 1988 vol. 2(1)-
Radiological Protection Research. Annual Report 1988-
Global Change Report 1988(4)-
MAP Technical Report Series UNEP/FAO 1987(10)-
Environmental Radioactivity in Denmark 1988-
Harwell UK Atomic Energy Authority AERE R 9997-
Acta Oceanologica Sinica 1987 vol. 6(1)-
Memoirs Faculty of Science Serie D-Geol. Kyushu University Japan 1983 vol. 25(1)-

Redactie.—Zie 2.1.1.

Reprografische afdeling.—In dit jaar is veel teken- en reprografisch werk verricht voor het in de maand mei georganiseerde Noordzee-symposium. Tevens werd veel voorbereidend werk uitgevoerd voor de Snellius-publicaties. De werkzaamheden ten behoeve van de Noordzeefilm, die in het vorige jaar door de extra belasting van de afdeling stagneerden, werden weer opgepakt.

Administratie.—De in 1987 aangeschafte computer werd in de loop van dit jaar geïntegreerd in het financiële beheerssysteem van de afdeling.

Vanwege het vertrek van Chris Lanser werd de werktijd van Irene Wernand uitgebreid en werden twee nieuwe part-time medewerkers aangesteld.

Huishoudelijke dienst/Logeergebouw 'In den Potvis'.—Met ingang van 1 januari is Henk Spigt aangesteld in de functie van hoofd kantine. Hij volgde mevr. Weijdt op die eind 1987 met pensioen ging. In de persoon van Mildred Jourdan werd een opvolgster voor Henk Spigt gevonden.

Logeergebouw: In 1988 werd een groter beroep gedaan op de faciliteiten van het logeergebouw. De bezettingsgraad van de huisjes herstelde zich ten opzichte van 1987 (60%) en kwam op 73.3%. De éénpersoonskamers werden zelfs volledig benut (95% in 1987). Het aantal overnachtingen wegens overbezetting nam toe met ruim 40% (1594). Het aantal losse overnachtingen was 1776. Weliswaar was dit aantal in 1987 hoger maar dit werd veroorzaakt door de groep Indonesische gastonderzoekers.

De beheerderswoning werd verbouwd en er werd een nieuwe vaatwasmachine aangeschaft.

Biologisch studiemateriaal.—Opvallend was dat er in 1988, in tegenstelling tot andere jaren, meer vraag was naar een grotere verscheidenheid van zeeorganismen. Deze verzoeken waren vooral afkomstig van onderwijsinstellingen en de afwerking hiervan vergde veel tijd.

De verkoop van gefixeerd materiaal nam ten opzichte van 1987 iets af. Daarentegen nam de verkoop van levende dieren en van zeewater toe.

Er bestaat behoefte aan automatisering van het administratieve bestand.

4.4. REKENCENTRUM

Het jaar 1988 heeft voornamelijk in het teken gestaan van de vraag: op welke wijze kan het rekencentrum op efficiënte en gecoördineerde wijze richting geven aan de ons overwoekerende en onverzadigbare PC-markt?

Vanuit het oogpunt van een rekencentrum dient te allen tijde met het aspect van compatibiliteit rekening gehouden te worden, terwijl de PC-gebruiker een veel meer egocentrische benadering heeft.

De vraag naar meer rekencapaciteit en gegevensopslag op de mini-computer en de in de toekomst te realiseren automatisering aan boord van het nieuwe onderzoekvaartuig heeft eind 1988 geleid tot de beslissing een snellere mini-computer aan te schaffen en het eventueel realiseren van een netwerk voor PC's te onderzoeken. Deze combinatie van mini-computer met PC-netwerk wordt in eerste instantie ook realiseerbaar geacht voor automatisering aan boord van het nieuwe onderzoekvaartuig. De benodigde software (programmatuur) om het geheel te laten functioneren zal, zoals meestal bij automatiseringsprojecten, de grootste problemen opleveren.

5. Sociaal jaarverslag

5.1. ALGEMEEN

De ontwikkelingen met betrekking tot de koepelorganisatie hebben uiteindelijk geleid tot een keuze voor de Nederlandse Organisatie voor Wetenschappelijk Onderzoek (N.W.O.). Deze voorkeur is aan de minister kenbaar gemaakt. Het NIOZ zal als zelfstandig werkgever in een gebiedsraad Biologie, Oceaan en Aardwetenschappen onder N.W.O. worden gebracht. Er zal een werkgroep worden opgericht die de overgang naar N.W.O. zal begeleiden. Een aantal zaken, zoals statuten, arbeidsvoorwaarden, aanvraag B-3 status, inrichting begroting en meerjarenplanning, zal nader uitgewerkt en geformaliseerd dienen te worden.

5.2. BEHEER

Het beheer van het instituut berust tot aan het moment van overgang naar N.W.O. bij der Nederlandse Dierkundige Vereniging. Het NIOZ beheerde, evenals in voorgaande jaren, de zogenaamde 'instrumentenpool' van het Nederlands Consortium voor Zeeonderzoek en verzorgde de wetenschappelijk-technische uitrusting van de oceaanschepen 'Tyro' en 'Tydeman'.

Bestuur (per 1-12-1988)

Commissaris:	Prof. Dr. W. Scharloo
Commissie van toezicht:	Prof. Dr. W. Scharloo Dr. W.F. Jansen (penningmeester NDV) Prof. Dr. J. Lever Prof. Dr. W.G. Mook Prof. Dr. Ir. J.A. Battjes
Financiële commissie:	Prof. Dr. W. Scharloo Dr. W.F. Jansen Prof. Dr. J. Lever Prof. Dr. W.G. Mook Prof. Dr. Ir. J.A. Battjes P. Buys (Ministerie van O en W)

Wetenschappelijke commissie

Prof. Dr. Ir. J.A. Battjes	Faculteit der Civiele Techniek, Technische Universiteit Delft.
Prof. Dr. N. Daan	Rijksinstituut voor Visserij- onderzoek, IJmuiden
Dr. C.H.R. Heip	Delta Instituut voor Hydrobiologisch Onderzoek, Yerseke
Prof. Dr. C. van den Hoek	Vakgroep Mariene Biologie, Rijksuniversiteit Groningen
Dr. J. van der Land	Rijksmuseum van Natuurlijke Historie, Leiden
Prof. Dr. J. Lever	Biologisch Laboratorium Vrije Universiteit, Amsterdam
Mw. Drs. W. de Ligny	Shell Int. Petr. Mij., Den Haag
Dr. G.M. Lokhorst (secretaris)	Rijksherbarium, Rijks- universiteit Leiden
Dr. W.G. Mook (voorzitter)	Centrum voor Isotopen Onder- zoek, Rijksuniversiteit Groningen
Prof. Dr. R.A. Prins	Rijksinstituut voor Natuurbeheer, Leersum
Prof. Dr. W.P.M. de Ruyter	Vakgroep Meteorologie en Fysische Oceanografie, Rijks- universiteit Utrecht
Dr. W. Salomons	Instituut voor Bodem- vruchtbaarheid, Haren (Gr)
Prof. Dr. W. Scharloo	Vakgroep Populatie- en Evolutiebiologie, Rijksuniversiteit Utrecht
Prof. Drs. P.A. Schenck	Afd. Scheikundige Technologie, Technische Universiteit Delft
Prof. Dr. C. Schuurmans	Koninklijk Nederlands Meteorologisch Instituut, de Bilt
Dr. W.J. Wolff	Rijksinstituut voor Natuurbeheer, Leersum

5.3. WERKOVERLEG

Evenals in 1987 werd met de ondernemingsraad o.a. overleg gevoerd over de uiteindelijke koepelkeuze. Als gevolg van een aantal mutaties binnen de O.R. werd voorgesteld om de besprekingen over de arbeidsvoorwaarden met de 'oude' delegatie van de O.R. te voeren. Het overleg met hoofden van dienst vond op de gebruikelijke wijze plaats.

5.4. PERSONEELSBELEID

Bevorderingen

In 1988 werden onderstaande personen bevorderd:

R.P.M. Bak	benthische systemen
H.J. Boekel	instr. & aquar. techn. afd.
S.J. v.d. Gaast	geologie
T. Kuip	instr. & aquar. techn. afd.
R. Lakeman	instr. & aquar. techn. afd.
H.J. Lindeboom	BEWON
C.J. Mozes	haven & vaartuigendienst
G. Nieuwland	benthische systemen
J.H. Vosjan	benthische systemen
J.T.F. Zimmerman	fysische oceanografie

Voor een gratificatie kwamen in aanmerking de heren S.J.M. Gieles (werktuigbouwkundige afdeling) en W.P. Jongejan (haven & vaartuigendienst).

Mutaties

In dienst:

J.J. Blom	NCZ technicus	werktuigbouw	01-01
M. Otten	med. huish. dienst	huish. dienst	01-01
M.J.W. Veldhuis	wet. onderzoeker	pel. syst.	01-01
R. Riegman	wet. onderzoeker	BEWON	01-02
J.P. Boon	wet. onderzoeker	BEWON	15-02
L. Moodley (32u)	promotie-ass.	geologie	15-04
M. Spel (19u)	adm. med.	administratie	01-08
C. Bakker	hfd. techn. dienst	techn. dienst	01-09
M.T. Jourdan	med. huish. dienst	huish. dienst	01-09
J.M.M. Zoetelief (8u)	recept./telefoniste	receptie	01-09
A. Keijser (19u)	adm. med.	administratie	01-10
E. Okkels	analiste	geologie	01-10
E. Keijzer	instrumentmaker	instr. & aquarium	01-11
M.J.M. Reichert (32u)	promotie-ass.	pel. syst.	01-12
G.C. Weijdt-Eelman	hfd. kantine	huish. dienst	01-01 (pens.)
R.W.J. Dirks	promotie-ass.	fys. ocean.	01-05
A.D.G. Dral	wet. onderzoeker	kustsyst.	01-05 (vut)
M. Otten	med. huish. dienst	huish. dienst	17-06
F.A.C. Kouwets	promotie-ass.	pel. syst.	01-09
E.C. Lanser	adm. med.	administratie	01-09
T. Verveer	hfd. techn. dienst	techn. dienst	01-09 (vut)
S.B. Tijssen	sen. wet. ond.	chem. ocean & zeeverontr.	01-12 (vut)

Uit dienst:

5.5. PERSONEELSLIJST (per 31-12-1988)

Direktie:	Secretaresse:	Assistentie:
Alg. dir. Prof. Dr. J.J. Zijlstra	J.W. Schröder-ter Avest	J.I.J. Witte
Wet. dir. Prof. Dr. E.K. Duursma	J. Hart-Stam	J.W. Rommets
Techn.- Adm. dir. Ing. E. van Abs		

Onderzoekafdelingen

afd. chemische oceanografie en
onderzoek zeeverontreiniging

onderzoeker:
Dr. W. Helder
Dr. Ir. H.J.W. de Baar
Drs. K. Booij
Dr. J.M. Everaarts
Drs. L. Gerringa
Drs. J.M.J. Hoppema
Drs. W. Kieskamp
Drs. C. Westra

Assistentie:
K. Bakker
M.Th.J. Hillebrand
S. Jansen
R.F. Nolting
R.T.P. de Vries
F.J. Wetsteyn

afd. fysische oceanografie

Drs. C. Veth
Dr. H.M. van Aken
Dr. L.R.M. Maas
L. Otto (via KNMI)
Prof. Dr. J.T.F. Zimmerman

M.W. Manuels
S. Ober
M.R. Wernand

afd. mariene geologie en geochemie

Dr. D. Eisma
Drs. A.J. van Bennekom
Dr. J.H.F. Jansen
L. Moodley
Ir. T. Schuhmacher
Dr. Tj.C.E. van Weering
Z. Zuo

G.W. Berger
S.J. van der Gaast
J. van Iperen
J. Kalf
E. Okkels
J. Schilling

afd. benthische systemen

Dr. P.A.W.J. de Wilde
Dr. R.P.M. Bak
Drs. A. Cramer
Drs. G.C. Duineveld
Drs. R. Heyman
Dr. J.H. Vosjan

E.M. Berghuis
A. Kok
G. Nieuwland
G. van Noort
E. Pauptit

afd. pelagische systemen

Dr. Ir. H.G. Fransz
Dr. M.A. Baars
Drs. F. Hovenkamp
Dr. W.C.M. Klein Breteler
Dr. B.R. Kuipers
Drs. M. Reichert
Dr. M.J.W. Veldhuis

S.R. Gonzalez
G.W. Kraay
S.S. Oosterhuis
N. Schogt
H.J. Witte

afd. kustsystemen

Dr. J.J. Beukema
Dr. G.C. Cadée
Drs. R. Dekker
Dr. M. Fonds
Drs. P. Kamermans
Drs. M. Leopold
Drs. T. Piersma (via RUG)
Dr. D.H. Spaargaren
C. Swennen

W. de Bruin
P. Duiven
J. Hegeman
P. van der Puyt
J. Zuidewind

Rekencentrum

R. Dapper
F. Eijgenraam

44

Hulpafdelingen

Hoofd administratieve hulpafdelingen tevens personeelschef: P.C. Vooy's

redactie	Dr. J.J. Beukema	B. Bak-Gade J.P. Mulder-Starreveld	
bibliotheek	J. v.d. Wal-Doornekamp	M. Bruining-du Porto	
administratie	G. Goslinga	D.J. Bruin	I. Wernand-Godée A. Keijzer M. Spel
reprografie	H. Hobbelink	R.P.D. Aggenbach N. Krijgsman	R. Nichols B. Verschuur
telefoon/receptie	M. Zonnenberg	J.M.M. Zoetelief	
biologisch studiemateriaal (Den Helder)	J.M. Nieuwenhuizen		
huishoudelijke dienst en logeergebouw 'de Potvis'	G.H. Steenhuizen H. Spigt	T. Steenhuizen-Borkulo M.T. Jourdan	
hoofd technische dienst	C. Bakker		
werktuigbouwkunde	T. Buisman	S. Gieles S.D. Groot	H.H. de Porto F.J. Parlevliet
houtbewerking	L. Heerschap	R.M. Daalder	
electrothechniek	F.J. Schilling		
magazijn	A. Ran	S.W. de Porto	J. Visser
instrumenmakerij/aquariumtechnische afdeling	H.J. Boekel	J. van Heerwaarden E. Keijzer T. Kuip	R. Lakeman A. Vaars
elektronica	Ing. R.L. Groenewegen	Ing. H. Franken G.M. Manshanden	Ing. R. Schmidt
haven en vaartuigen	C. van Zwieten C. Wisse C. Gerssen E. Adriaans W.P. Jongejan	R.J.R. Anthonijsz A.A. Balk A. Boon J.C. Groot W.J.M. Koomen	C.J. Mozes J. Pieterse R. Rebel A.J. Souwer J.C. Tuntelder

5.6. TIJDELIJKE PERSONELE ONDERSTEUNING

K.M.J. Bakker	analist	chem. ocean. & zeeverontr.	01-06 tot 31-12
Drs. R. Daan	wet. ond.	pel. syst.	01-01 tot 29-2
H. Ellermeijer	instr. maker	instrumentmakerij	01-08 tot 31-12
A.J.M. Gieles	analist	geologie	16-03 tot 13-05 en 01-09 tot 31-10
S.M. Jansen	analist	chem. ocean. & zeeverontr.	01-07 tot 31-12
Drs. M. Phillipart	wet. ond.	alg. dienst	01-10 tot 30-11
J. de Ridder	technicus	werktuigbouw	01-02 tot 31-7
Dr. C.G.N. de Vooy's	wet. ond.	alg. dienst	01-10 tot 30-11

Onderzoekers met een NWO-beurs:	Drs. J.J.M. van Haren wet. ond.	fysische ocean.	01-01 tot 31-12
werken met behoud van uitkering:	A. de Graaf	01-01 tot 31-12	via G.M.D. Alkmaar
	S.H. Haskemi Saleh	07-10 tot 31-12	via gemeente Texel

Het NIOZ verleent zijn medewerking aan de uitvoering van speciale projecten, bijv. ter onderbouwing of uitvoering van het beleid van andere ministeries dan het Ministerie van Onderwijs en Wetenschappen en van het bedrijfsleven. Het stelt hiervoor ruimte en wetenschappelijke kennis ter beschikking. Het personeel voor deze projecten wordt op kosten van de opdrachtgever speciaal voor de duur van het project ingehuurd. Het NIOZ personeel dat de eigenlijke taak van het instituut —fundamenteel onderzoek— uitvoert, is hierbij slechts in een adviserende rol betrokken.

In principe worden slechts projecten aangenomen die samenhangen met of nauw aansluiten bij de taak van het instituut. De looptijd van de projecten kan sterk variëren, van enkele maanden tot vele jaren. Er waren de volgende speciale projecten (zie ook onder 1.5. en 1.7.3.):

Projecten:

BEWON

Dr. H.J. Lindeboom	
Drs. M.A. van Arkel	
Drs. J.W. Baretta	
Ir. M.J.N. Bergman (8 u)	
A.C. Bol-den Heijer (21,25 u)	
Dr. J.P. Boon	vanaf 15-02
Dr. F.C. van Duyl	
Drs. C.V. Fischer	15-11 tot 31-12
A. Kikkert	01-01 tot 29-02
Ing. H.Th. Kloosterhuis	
J.F.P. Malschaert	
M. Mulder	
Dr. Ir. W. van Raaphorst	
Drs. H. Ridderinkhof	
Dr. R. Riegman	vanaf 01-02
Drs. P. Ruardij	
Dr. Ir. H.W. van der Veer (30,4 u)	

gedetacheerd door TNO

A.J. Kop
A. Stam
Dr. P. de Wolf

N.C.Z.-Antarctisch Onderzoek

Drs. A. Buma	01-01 tot 31-12
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Remote sensing-R.W.S.

Dr. G. Marees	01-01 tot 31-12
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NAZORG

Drs. M.S.S. Lavaleye	01-01 tot 31-12
E. Okkels	15-06 tot 01-10
S.E. Holtmann	15-09 tot 31-12

M. v.d. Heide	21-03 tot 01-06	HLO Den Helder	benth. syst.
M. Hup	01-05 tot 31-12	v.d. Broek Inst.	kustsyst.
R. v.d. Neut	01-02 tot 01-07	BRI Beverwijk	pel. syst.
E. v. Arnhem	01-09 tot 31-12	HLO Alkmaar	chem. ocean.
E. Blaauw	15-08 tot 31-12	NTC Den Helder	energietechn.
B. v. Heerwaarden	15-08 tot 31-12	NTC Den Helder	electronica
J. v. Heerwaarden	15-08 tot 25-11	NTC Den Helder	werktuigbouw
J. Koning	22-08 tot 31-12	MTS Alkmaar	energietechn.
M. Lamers	01-09 tot 31-12	HLO Alkmaar	geologie
C. Oderkerk	28-11 tot 31-12	NTC Den Helder	werktuigbouw
J. Ouweltjes	01-09 tot 31-12	HLO Alkmaar	BEWON
M. v. Egmond	13-09 tot 31-12	MLO Alkmaar	kustsyst.

5.7. DEELTIJD

Onderstaande personeelsleden vervulden in 1988 een part-time dienstverband.

M. Bruining-du Porto	33.25 uur	bibliotheek-assistente
W.C.M. Klein Breteler	32 uur	bioloog
E.C. Lanser	26.6 uur	administratie-assistente (tot 01-09)
J. van der Wal-Doornekamp	33.25 uur	bibliothecaresse
I. Wernand-Godée	30 uur	adm. med./telefoniste (tot 01-07)
J.T.F. Zimmerman	26.6 uur	fysicus
M. Zonnenberg	35.15 uur	telefoniste
T. Steenhuizen-Borkulo	19 uur	huishoudelijke dienst
J.P. Mulder-Starreveld	19 uur	redactie
B. Bak-Gade	19 uur	redactie
J.W. Schröder-ter Avest	32 uur	directie-secr.
R. Dekker	32 uur	AIO
L. Gerringa	32 uur	AIO
F.A.C. Kouwets	32 uur	AIO (tot 01-09)
F. Hovenkamp	32 uur	AIO
W.M. Kieskamp	32 uur	AIO
J.M.J. Hoppema	32 uur	AIO
A. Cramer	32 uur	AIO
R. Heyman	32 uur	AIO
C. Westra	32 uur	AIO
P. Kieskamp	32 uur	AIO
P. Kamermans	32 uur	AIO
T. Schuhmacher	32 uur	AIO
M. Leopold	32 uur	AIO
Z. Zuo	32 uur	AIO
A. Keijser	19 uur	adm. med. (vanaf 01-10)
M. Spel	19 uur	adm med. (vanaf 01-08)
J.M.M. Zoetelief	8 uur	telefoniste/recept. (vanaf 01-09)
L. Moodley	32 uur	AIO (vanaf 15-04)
M.J.M. Reichert	32 uur	promotie-ass.
J. v. Iperen	8 uur	analiste (vanaf 12-05)
G.M. Manshanden	32 uur	electronics (vanaf 01-04)

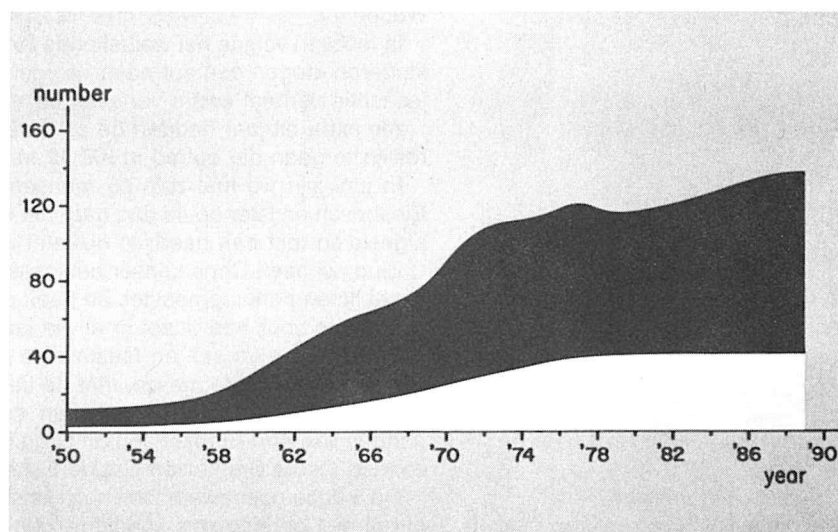
M. v.d. Heide	21-03 tot 01-06	HLO Den Helder	benth. syst.
M. Hup	01-05 tot 31-12	v.d. Broek Inst.	kustsyst.
R. v.d. Neut	01-02 tot 01-07	BRI Beverwijk	pel. syst.
E. v. Arnhem	01-09 tot 31-12	HLO Alkmaar	chem. ocean.
E. Blaauw	15-08 tot 31-12	NTC Den Helder	energietechn.
B. v. Heerwaarden	15-08 tot 31-12	NTC Den Helder	electronica
J. v. Heerwaarden	15-08 tot 25-11	NTC Den Helder	werktuigbouw
J. Koning	22-08 tot 31-12	MTS Alkmaar	energietechn.
M. Lamers	01-09 tot 31-12	HLO Alkmaar	geologie
C. Oderkerk	28-11 tot 31-12	NTC Den Helder	werktuigbouw
J. Ouweltjes	01-09 tot 31-12	HLO Alkmaar	BEWON
M. v. Egmond	13-09 tot 31-12	MLO Alkmaar	kustsyst.

5.7. DEELTIJD

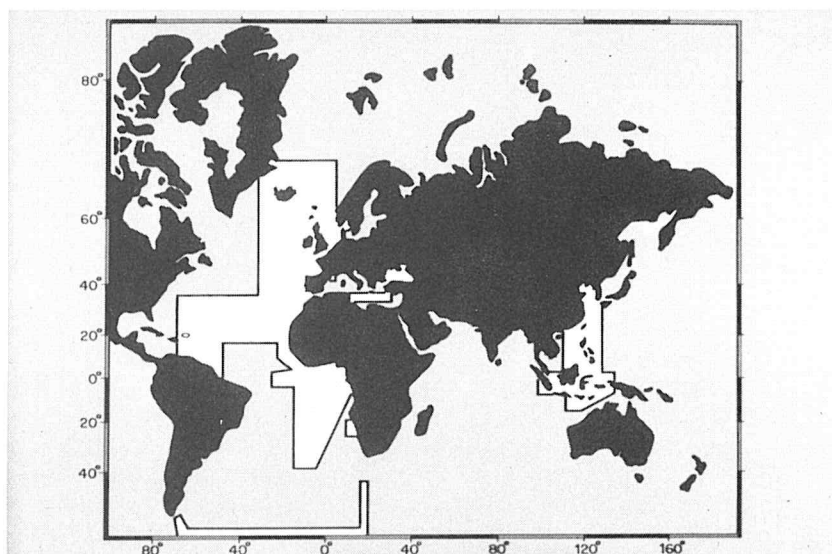
Onderstaande personeelsleden vervulden in 1988 een part-time dienstverband.

M. Bruining-du Porto	33.25 uur	bibliotheek-assistente
W.C.M. Klein Breteler	32 uur	bioloog
E.C. Lanser	26.6 uur	administratie-assistente (tot 01-09)
J. van der Wal-Doornekamp	33.25 uur	bibliotheecaresse
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J.T.F. Zimmerman	26.6 uur	fysicus
M. Zonnenberg	35.15 uur	telefoniste
T. Steenhuizen-Borkulo	19 uur	huishoudelijke dienst
J.P. Mulder-Starreveld	19 uur	redactie
B. Bak-Gade	19 uur	redactie
J.W. Schröder-ter Avest	32 uur	directie-secr.
R. Dekker	32 uur	AIO
L. Gerringa	32 uur	AIO
F.A.C. Kouwets	32 uur	AIO (tot 01-09)
F. Hovenkamp	32 uur	AIO
W.M. Kieskamp	32 uur	AIO
J.M.J. Hoppema	32 uur	AIO
A. Cramer	32 uur	AIO
R. Heyman	32 uur	AIO
C. Westra	32 uur	AIO
P. Kieskamp	32 uur	AIO
P. Kamermans	32 uur	AIO
T. Schuhmacher	32 uur	AIO
M. Leopold	32 uur	AIO
Z. Zuo	32 uur	AIO
A. Keijser	19 uur	adm. med. (vanaf 01-10)
M. Spel	19 uur	adm med. (vanaf 01-08)
J.M.M. Zoetelief	8 uur	telefoniste/recept. (vanaf 01-09)
L. Moodley	32 uur	AIO (vanaf 15-04)
M.J.M. Reichert	32 uur	promotie-ass.
J. v. Iperen	8 uur	analiste (vanaf 12-05)
G.M. Manshanden	32 uur	electronics (vanaf 01-04)

Personeelssterkte uitgezet tegen de tijd.
Grijs: wetenschappelijk personeel;
zwart: niet-wetenschappelijk personeel.



Vroegere en huidige werkgebieden van
het NIOZ.



5.8. VERSLAG VAN DE PERSONEELSVERENIGING

De activiteiten begonnen in januari met een optreden van Tim Jones die en 'try out' verzorgde van zijn nieuwste show met de prachtige titel 'Super Booper Woppela'.

In februari volgde het welbekende kinderfeest met frieten en frikandellen. De kinderen kregen een optreden voorgeschoteld van Fred Velle die een sprookjesachtig verhaal kwam vertellen en uitbeelden.

Als extra dit jaar hadden de p.v. leden de gelegenheid om naar Hans Dorrestijn te gaan die optrad in Klif 12 te Den Hoorn.

In juni zijn we met zo'n 65 mensen een dagje uit geweest, eerst naar de Biesbosch en later op de dag naar het Omniversum in Den Haag. De dag werd afgesloten met een heerlijke rijsttafel in een Indisch restaurant.

Eind juli heeft Chris Lanser het instituut verlaten; de p.v. zal haar missen als actief lid en penningmeester. Ze heeft dan ook bij haar afscheid een leuk kado ontvangen voor haar inzet in al die jaren.

De jaarlijkse toneel- en feestavond werd dit jaar in oktober georganiseerd. Het toneelstuk van Ionesco, met de titel 'Jacques of de onderwerping', liet een vrolijke koppeling tussen een man en een vrouw zien. De muziek was in handen van Adri Broekeband uit Groningen en in de kleine kantine speelde en zongen Oscar Bremer en Saskia Eelman, allebei afkomstig van Texel.

Op 5 december kwam toch nog geheel onverwacht Sinterklaas op bezoek en of dat niet genoeg was kondigde zich na een half uur nog een tweede aan.

Verder werd er subsidie verleend aan de volleybal- en de voetbalclub en werden er diverse malen fruitmanden e.d. aan zieke p.v. leden gestuurd.

