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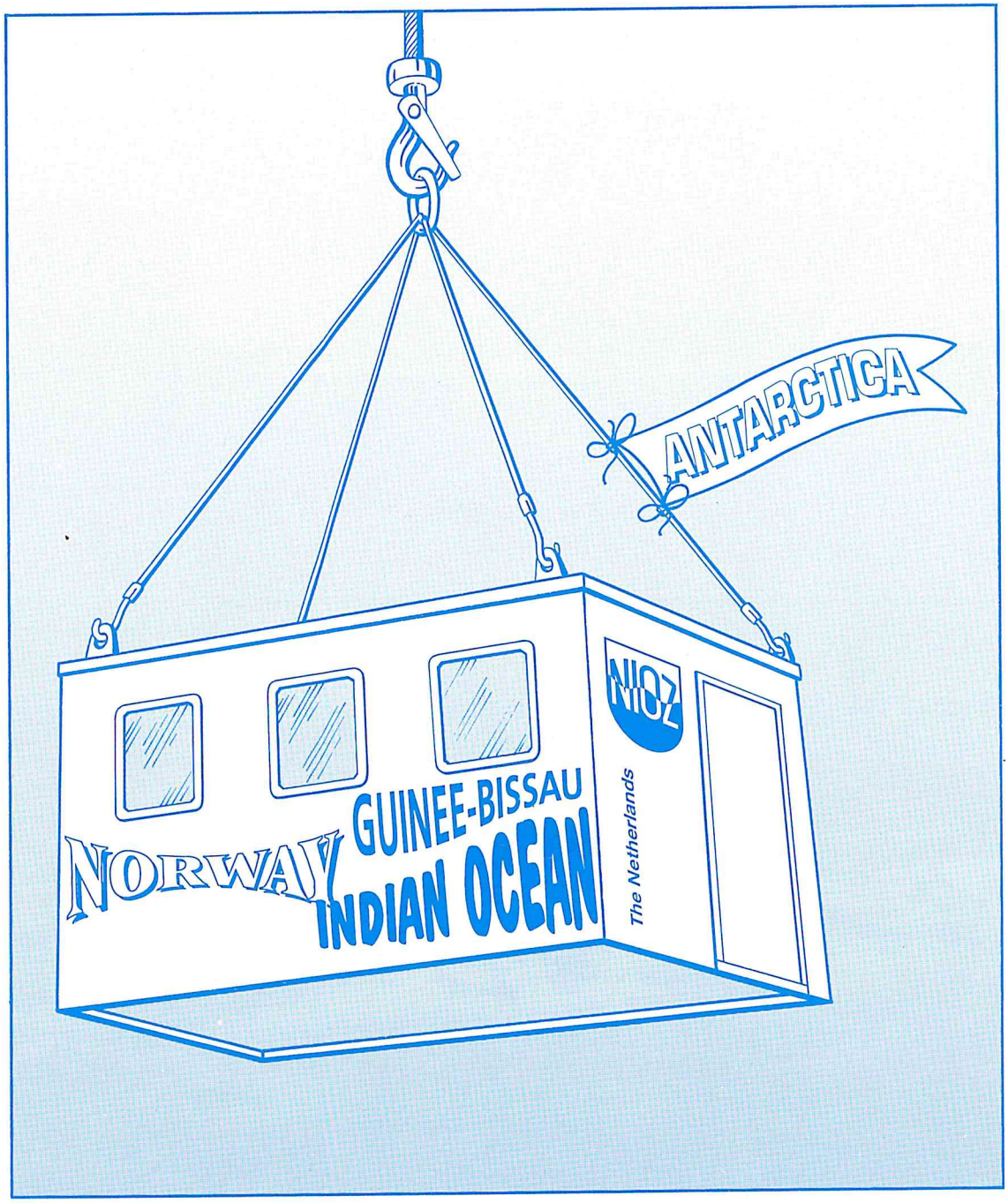


NETHERLANDS INSTITUTE FOR SEA RESEARCH (NIOZ)


PELAGIA

CONTENTS

INTRODUCTION

During 1992 three main issues occupied the attention of many NIOZ employees, or determined the future course of developments within NIOZ, *viz.* the Netherlands Indian Ocean Programme, the start of new research programmes within the European Community and within the Netherlands, and matters concerning a restructuring of the national marine research organization.

The start of the 11-month Indian Ocean Programme of the Marine Research Foundation (SOZ) took place on 4 May in the presence of the President of the Netherlands Organization for Scientific Research (NWO), Dr. J. Borgman, and the Kenyan Ambassador to the Netherlands, S. Mageto. Of the NIOZ employees, 31 scientists and analytical staff and 16 technicians participate, spending periods of 4 to 6 weeks in the NW Indian Ocean. Especially for several members of the technical staff, the NIOP results in prolonged absence from the Institute.

So far the scientific efforts have largely been very successful, despite technical complications encountered because of the state of repair of RV 'Tyro'.

After time-consuming preparations two large, new research programmes became operational. One is the NWO/NOP programme on Global Change (Verstoring van Aardsystemen). NIOZ is taking part in 4 themes, *viz.* ocean circulation (theme 2), coastal and shelf fluxes (theme 4), past global changes (theme 8) and ocean (carbon) flux studies (theme 9). These themes are related to the international WCRP and IGBP core projects WOCE, LOICZ, PAGES and JGOFS, respectively. This programme involves a total number of 7 postgraduate positions and 2 postdocs.

The other large programme concerns projects within MAST II, a continuation of the MAST I programme of the European Community. Collaborating with colleagues from foreign institutes, NIOZ scientists received approval for 4 projects, which will start in 1993.

Discussions, also on ministerial level, are in progress concerning the future of BEON (Policy-Linked Ecological Research of the North Sea), and of the BEWON Department of NIOZ. Present plans are directed at a project-based financial scheme, replacing the structural support to NIOZ that resulted from the previous 5-year BEON agreement.

The situation is a source of much concern. There is some doubt whether in the long term NIOZ will be able to continue providing the necessary fundamental knowledge about the North Sea and Wadden Sea to policy makers, if financing is on an *ad-hoc* basis.

Plans for a restructuring of the 50-strong technical staff were completed and become operational as of January 1993. The grouping in various service departments is now more closely related to the respective tasks, instead of the technical disciplines. A formal description and evaluation of all positions within NIOZ will be completed in 1993.

NWO took the initiative for streamlining the national organization of marine research, specifically by reconsidering the tasks of NIOZ and SOZ in the execution of sea-going research and the position of marine research within a new NWO structure under BOA (Board for Biology, Oceanography and Earth Sciences).

A group of 15 NIOZ scientists and analysts took part in the Southern Ocean expedition on board the RV 'Polarstern'. The very successful cooperation with the Alfred Wegener Institut für Polar- und Meeresforschung is to become formalized in 1993. The formal cooperation will also include the Plymouth Marine Laboratory. Together our three institutes will serve as a basis for a European network of multidisciplinary marine institutes.

The Integrated North Sea Programme, launched in 1990, was continued in 1992, primarily supported by the BEWON Department of NIOZ, in cooperation with other North Sea bordering countries.

A decision of major importance was the re-allocation of the Organic Geochemistry group of the Delft Technical University, founded by Prof. Schenck and presently headed by Dr. De Leeuw, to NIOZ. The group will be structurally included in the Institute as the Department of Marine Biogeochemistry. A further stimulus to this new scientific activity is the approval of a Pioneer grant to Dr. Sinninghe Damsté, member of the group.

In 1992 eight OIO's (PhD students) successfully defended their PhD dissertations, and five reached the end of their research programmes.

The Science Committee of NIOZ held two regular meetings, reviewing the Departments of BEWON and of Chemical Oceanography. The sincere interest in the ongoing scientific activities and the valuable advice of the committee members are very much appreciated.

The NIOZ-owned RV 'Pelagia' concluded a successful year with 240 days taken up by expeditions primarily to the North Sea, but also to the Bay of Biscay and to Greenland, the latter for the RGD (Dutch Geological Survey). The combination of ship's crew and technical crew tasks on board continued to be a successful concept.

A drawback for the national marine research and education certainly was the failure to set up a Research School for Marine Research, which was attempted together with three university institutes. NIOZ will now less formally support three different proposed Research Schools, which more or less include the various disciplines within marine research. NIOZ has agreed with the various proposed Research Schools to organize a general course on introductory oceanography at NIOZ, while on the other hand the NIOZ students can take part in the more specialized university courses.

With the approval of the above-mentioned EC and NWO research programmes, the number of PhD students has grown to a total of 45.

NIOZ received financial support from NWO for extensive cooperation with Russian colleagues. One such contact is with the Marine Biological Institute in Murmansk, another is with the Marine Geology Faculty of the University of Moscow, together with the Free University Amsterdam (VUA) and the Marine Research Foundation (SOZ). Mutual visits to determine the exact contents of the cooperation have already resulted in joint cruises in the Barentz Sea and Black Sea.

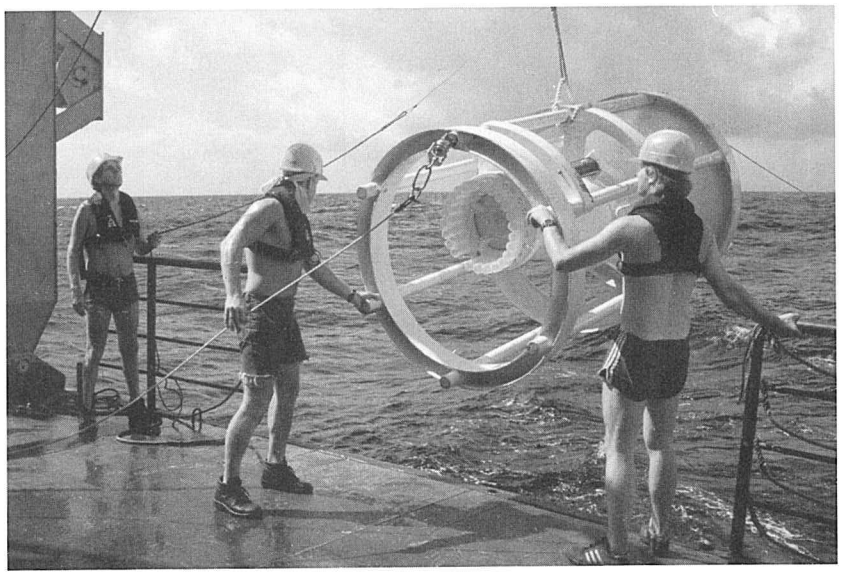
After its long period of preparation, Prof. E.K. Duursma in August presented the first copy of the Encyclopedia of Marine Sciences, which was written and edited by NIOZ employees. Being the first compilation in this field, it received wide attention and appreciation.

The Science Programme of NIOZ is gradually being structured into scientifically and/or regionally determined research themes. The long-range plan 1994-97 contains the first initiative in that direction. Important examples are the various Global Change programmes and coastal and shelf-sea programmes related to the North and Wadden Sea regions.

In conclusion, NIOZ constitutes a healthy scientific environment. In 1992 relatively much time was invested in new projects and developments which will bear fruit in the years to come. This will not least be thanks to the skill and motivation of the technical and analytical staff.

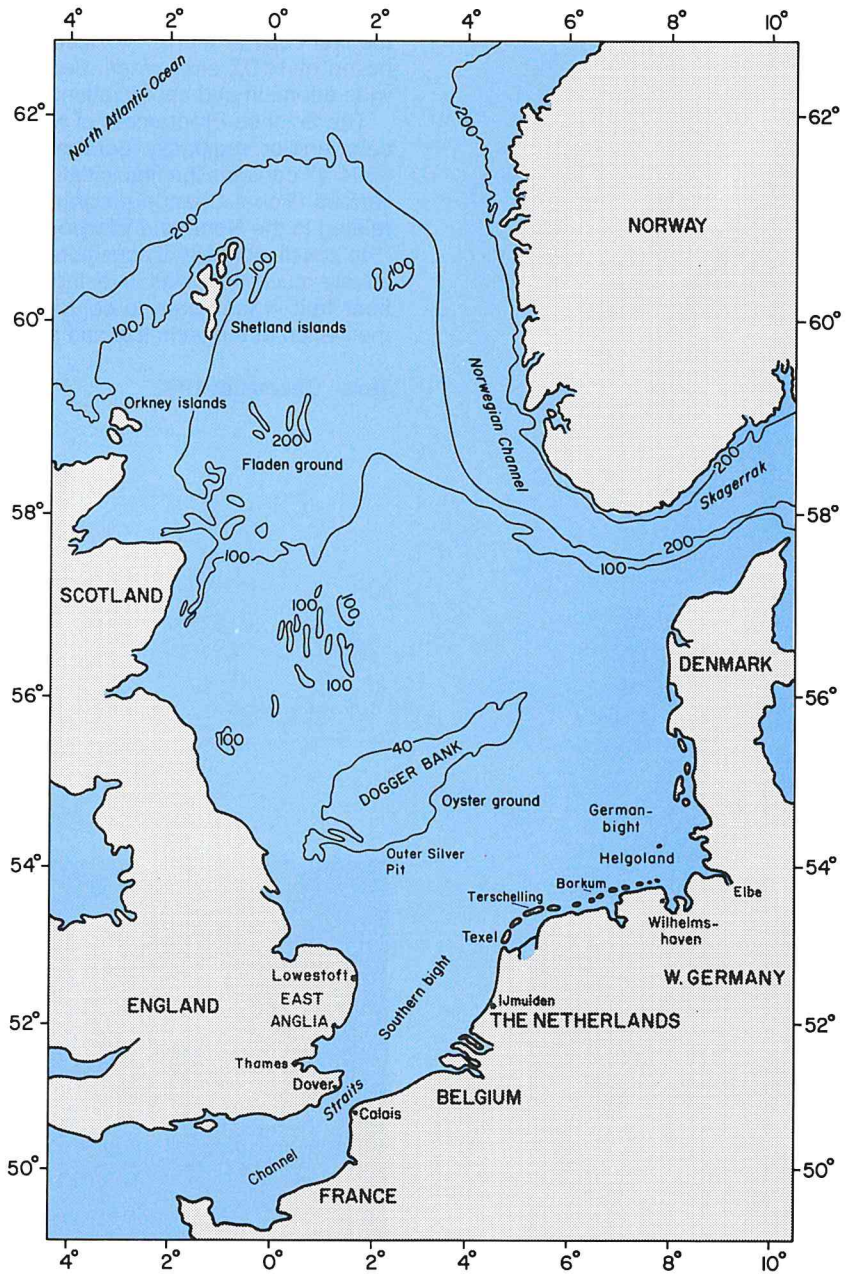
Texel, December 1992

W.G. Mook



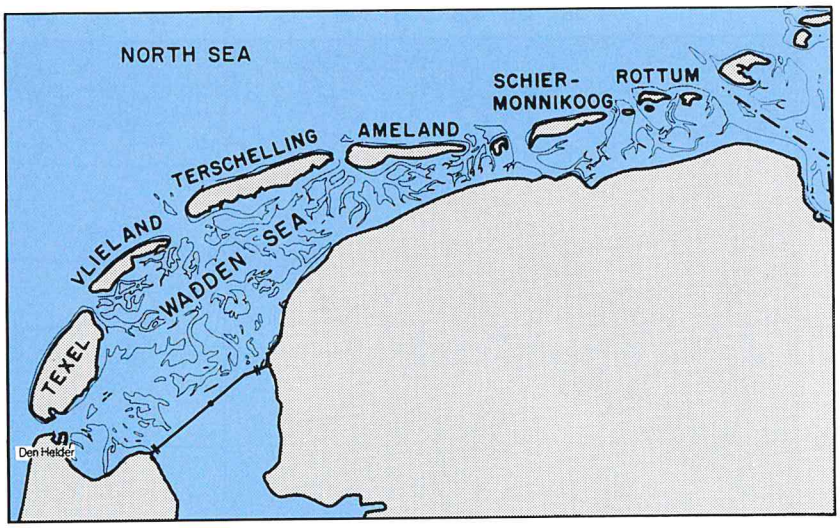
Launching a sediment trap from RV 'Tyro'. Photo: J. Nieuwenhuis)

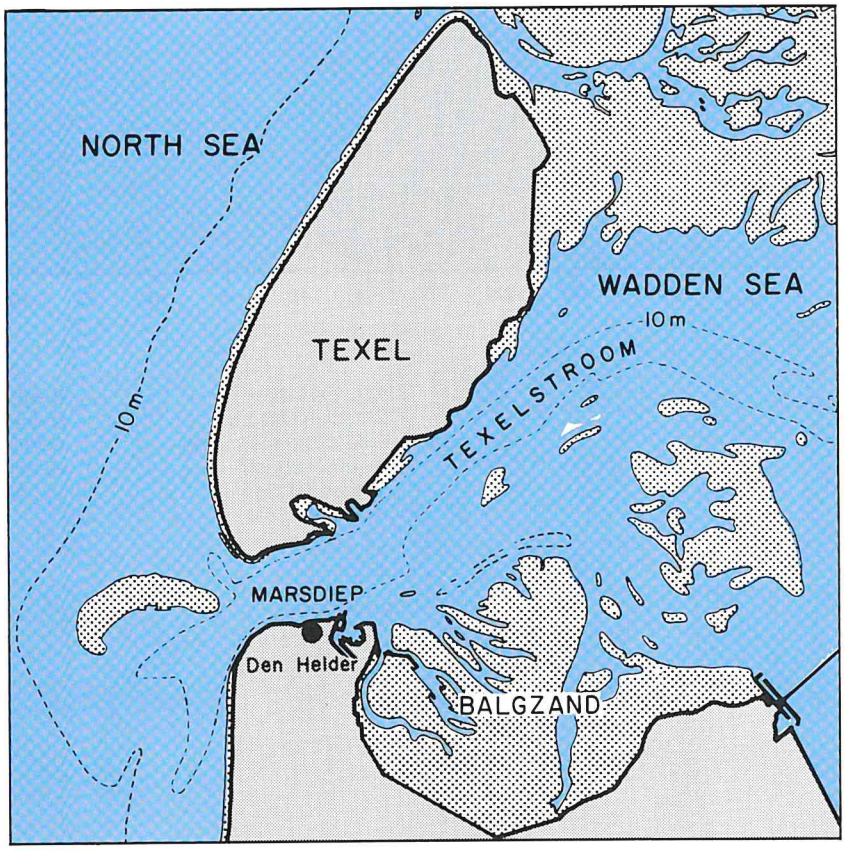
MAPS



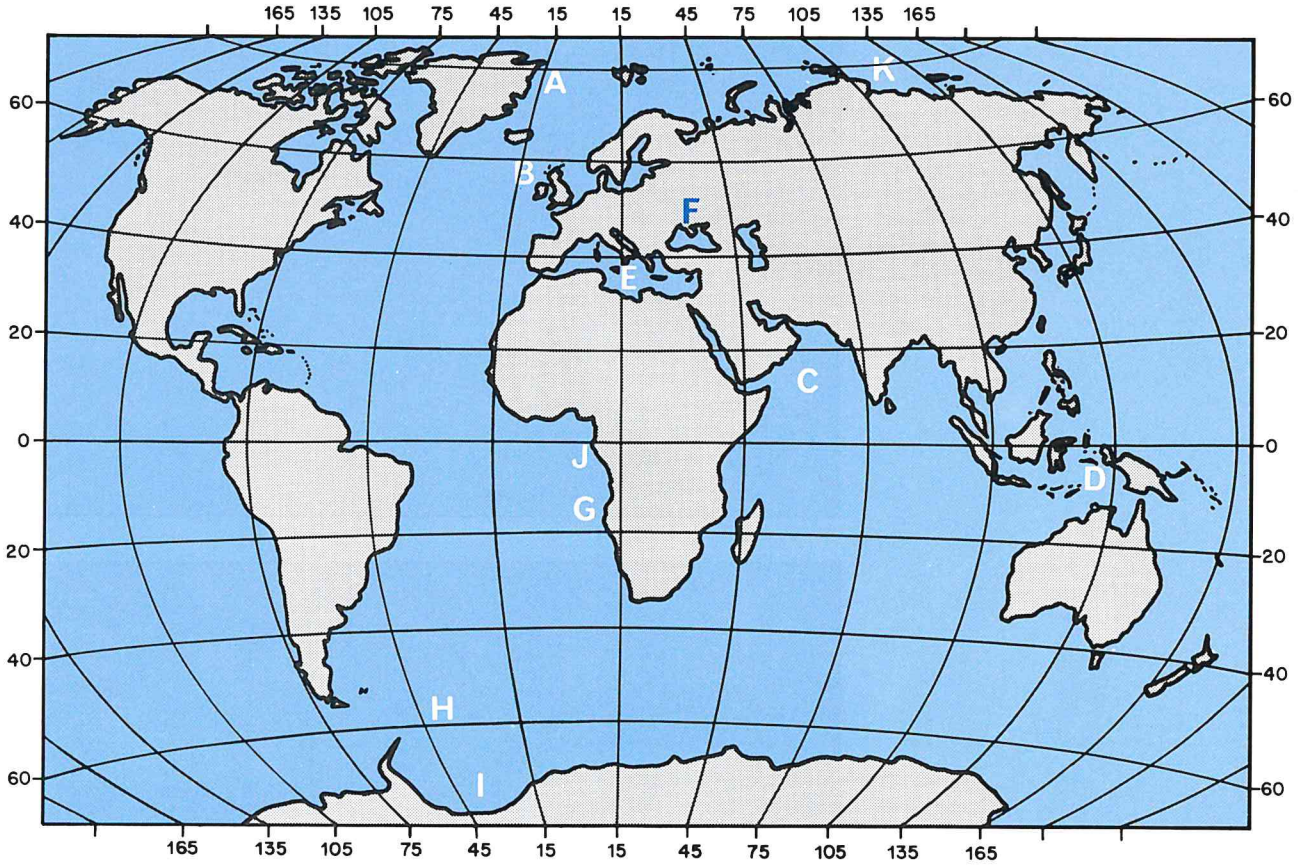
1=Brown Ridge
2=Breeveertien
3=Frisian Front

North Sea with geographical names mentioned in this report





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



A=Greenland
B=NE Atlantic Ocean
C=Indian Ocean
D=Indonesia
E=Mediterranean Sea
F=Black Sea
G=Angola Basin
H=Scotia Sea
I=Weddell Sea
J=Zaire Estuary
K=Laptev Sea

1.1. MULTIDISCIPLINARY PROGRAMMES

Netherlands Indian Ocean Programme 1992-1993

M.A. Baars, Tj.C.E. van Weering

After the International Symposium on the Snellius-II Expedition (Jakarta, November 1987), plans crystallized in the Dutch oceanographic community to execute a similarly large and diverse programme in the northwest Indian Ocean. Proposals were submitted in 1989, and in April 1990 the Indian Ocean Committee was installed by SOZ, with representatives of five main projects. Coupling the budgets of 2 years enabled SOZ to plan a series of 13 cruises (including outward and homeward parts) by RV 'Tyro' from May 1992 up to and including March 1993.

The projects A, B and C are related to the seasonal wind and current reversal in the NW Indian Ocean, and are cruises planned in both monsoons. Project A concerns the coastal ecosystems of Kenya and is coordinated by the Centre of Estuarine and Coastal Ecology (Yerseke). NIOZ performed benthic studies during these cruises (see H1-06b and B1-04-3). The projects B (Monsoons and pelagic systems) and C (Tracing a seasonal upwelling) are coordinated by NIOZ, in cooperation with the Institute of Taxonomic Zoology (University of Amsterdam) and the Geomarine Centre (Free University Amsterdam), respectively. B and C execute 5 cruises in total with studies of the upwelling regions near Somalia and Yemen, including research during transit in the Red Sea and the Gulf of Aden. Project B focuses on hydrography of the upper layer and on plankton and micronekton studies (see H1-04, H2-13, B3-04-4), whereas Project C centres on geology, vertical transport, benthic processes and deep water hydrography (see H1-04, H3-23). In early June 1992, at the onset of the seasonal upwelling by the SW monsoon, sediment traps and a bottom lander were deployed in the upwelling area between Ras Hafun and Socotra; these will be retrieved in February 1993, when cruises near Somalia/Yemen during the NE monsoon conclude the expedition.

In the intermonsoonal period, the two remaining projects have been executed. Project D (Geological Study of the Arabian Sea) was coordinated by the University of Utrecht and concerned legs near Pakistan and Oman. Project E (Biology of oceanic reefs) was located at the Seychelles and coordinated by the National Museum for Natural History (Leiden). Some NIOZ participation occurred in both D and E (see H1-04 and B1-05). For all NIOP projects NIOZ coordinated most of the technical preparations and NIOZ/SOZ technicians were responsible for all major sampling operations onboard RV 'Tyro'.

As the international programmes JGOFS, WOCE and GLOBEC will operate in the Indian Ocean from 1994 onwards, the Netherlands Indian Ocean Programme 1992/1993 attracts much attention. Several JGOFS teams from outside The Netherlands participate in 'Monsoons and pelagic systems' and the cruises of Project B were adopted by the JGOFS Indian Ocean Planning Group. The third meeting of this group was held on board RV 'Tyro' en route from Gibraltar to Port Said during its outward voyage in May 1992.

RV 'Tyro' anchored in Port Said at the entrance to the Suez Canal. (Photo: T. de Bruin)

Joint Global Ocean Flux Study

H.J.W. de Baar

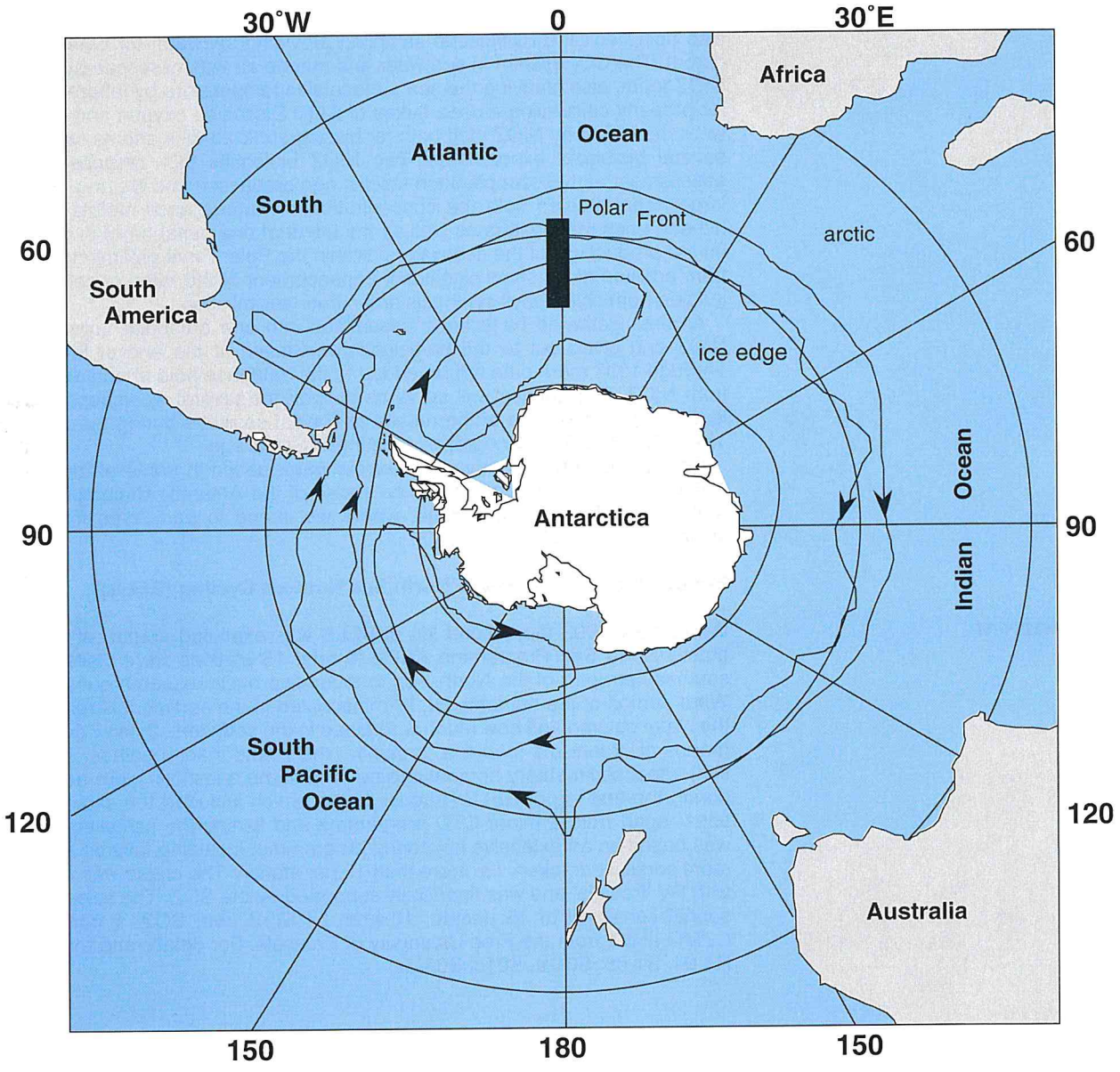
From its 1987 initiation, NIOZ has contributed to this core project of the International Geosphere Biosphere Program. Results of the 1989-1990 Tyro cruises in the Northeast Atlantic Ocean have been published from 1990 onwards with more manuscripts and PhD theses being produced.

This year the Antarctic Ocean JGOFS programme started with cruises of RV 'Polarstern' (Germany) as well as RV 'James Clarke Ross' and RV 'Discovery' (both from Britain) to be followed by French expeditions aboard RV 'Marion Dufresne' scheduled from 1993 onwards. After several years of planning and preparation RV 'Polarstern' left the port of Punta Arenas (Chile) on 29 September 1992 with a party of 51 scientists from six European countries as well as 44 officers and crew. From NIOZ fourteen scientists participated and provided some pivotal investigations and activities.

The overall objective was to quantify the spring plankton bloom with respect to the budget of carbon dioxide. Special attention was paid to productivity along the receding ice-edge and in frontal systems. The Antarctic continent being ice-covered, it is this marine plankton photosynthesis which supports the whole Antarctic ecosystem. Most of what is known thus far about the biology and chemistry of the Antarctic Ocean relies on observations in nearshore waters, *i.e.* around the Antarctic Peninsula and in the Weddell and Ross Seas. However, these relatively minor regions are probably not representative of the large, eastward flowing, Antarctic Circumpolar Current, (ACC) bounded north-

wards by the Subantarctic Front. Within the Antarctic Circumpolar Current there is a jet-stream, the Polar Front, where the eastward transport is faster, and somehow the plankton is more abundant. The open water is bounded at the south by the ice edge.

Area of research (black rectangle) of the JGOFS Southern Ocean expedition on board RV 'Polarstern'.



The focus of the two-month expedition was six weeks of repeated north-south transects of 600 nautical miles each at the 6°W meridian. In this period (spring) in the Antarctic, the sea-ice is retreating. Satellite observations show a lacey-patterned ice-edge with eddy structures, their shapes apparently driven by the underlying sharp front between the ACC and the Weddell Sea gyre. The research programme consisted of the 20 recommended JGOFS core topics, along with 5 additional Southern Ocean JGOFS topics (ice cover, -physics, -biology, silica cycle, iron/plankton interactions) as well as several other topics. Within this context NIOZ physicists studied the light and mixing regimes and also operated all CTD/Rosette sampling providing seawater for other investigators. The CO_2 system in seawater and marine air was assessed by another NIOZ team, also studying the sea surface skin temperature by infrared sensor for properly calculating air/sea fluxes of CO_2. Dissolved oxygen and nutrients were measured by NIOZ staff both for hydrographic studies and as support for several biological experiments. Two NIOZ biologists took responsibility for assessment of mesozooplankton stocks, egg production and grazing. Finally a larger team studied both the concentration of various trace metals in these hitherto uncharted waters as well as the effect of one metal (iron) in particular on the productivity of the ecosystem. Within the Polar Front preliminary results from addition of Fe show significant enhancement of the rates of cell division judging from chlorophyll synthesis and nitrate assimilation.

All data gathered have been assembled into one database organized by NIOZ and given out to the participating institutes at the end of the cruise. Through 1993 more data will be added to the database held at and distributed from NIOZ. This dataset will serve as support for several workshops in 1993 leading to presentation of the results at special sessions during the February 1994 AGU/ASLO Oceanography Meeting in San Diego.

Planning is now well advanced for our participation in some of the French JGOFS cruises in the Indian Ocean sector of the Antarctic Circumpolar Current, the ANTARES programme, where we intend to participate from 1994 onwards.

Benthic Links and Sinks in North Sea Nutrient Cycling (BELS)

W. van Raaphorst

In February 1992 the second leg of BELS was executed as part of the Integrated North Sea Programme (INP). In total 15 stations were visited in the southeastern part of the North Sea to study two basic research questions: **1:** What portion of the nutrients (N, P) mineralized in the sediment is released to the water column and how much is retained in the sediment, **2:** How do benthic groups of organisms (bacteria, protozoa, meio- and macrobenthos, demersal fish) affect sedimentary nutrient cycling. The same questions were addressed during the first leg of BELS (August 1991), which included the same 15 stations. Apart from a minor CTD programme and fishing the sampling scheme was based on an extensive boxcoring programme. Including failures 290 sediment cores were taken, *i.e.* more than 19 per station. The cruise was executed with RV 'Pelagia' and was financially supported by the SOZ. The scientific personnel consisted of 15 people, 10 from NIOZ, 3 from SOZ, 1 from NIOO-CEMO and 1 from the Free University of Brussels. For details and results see H1-04, B1-06, S01-a, S01c, S02-d.

1.2. CHEMICAL OCEANOGRAPHY AND MARINE POLLUTION (H1)

INTRODUCTION

The Chemical Oceanography and Marine Pollution Department continued work along three main themes of research:

- biogeochemistry of carbon, nitrogen and sulphur in estuarine, coastal, and deep sea systems (H1-02/03, H1-04, H1-17)
- behaviour of organic contaminants and metals in the water column and in sediment (H1-06, H1-09, H1-14, H1-15)
- the effects of organic contaminants and metals on organisms (H1- 07, H1-08, H1-12).

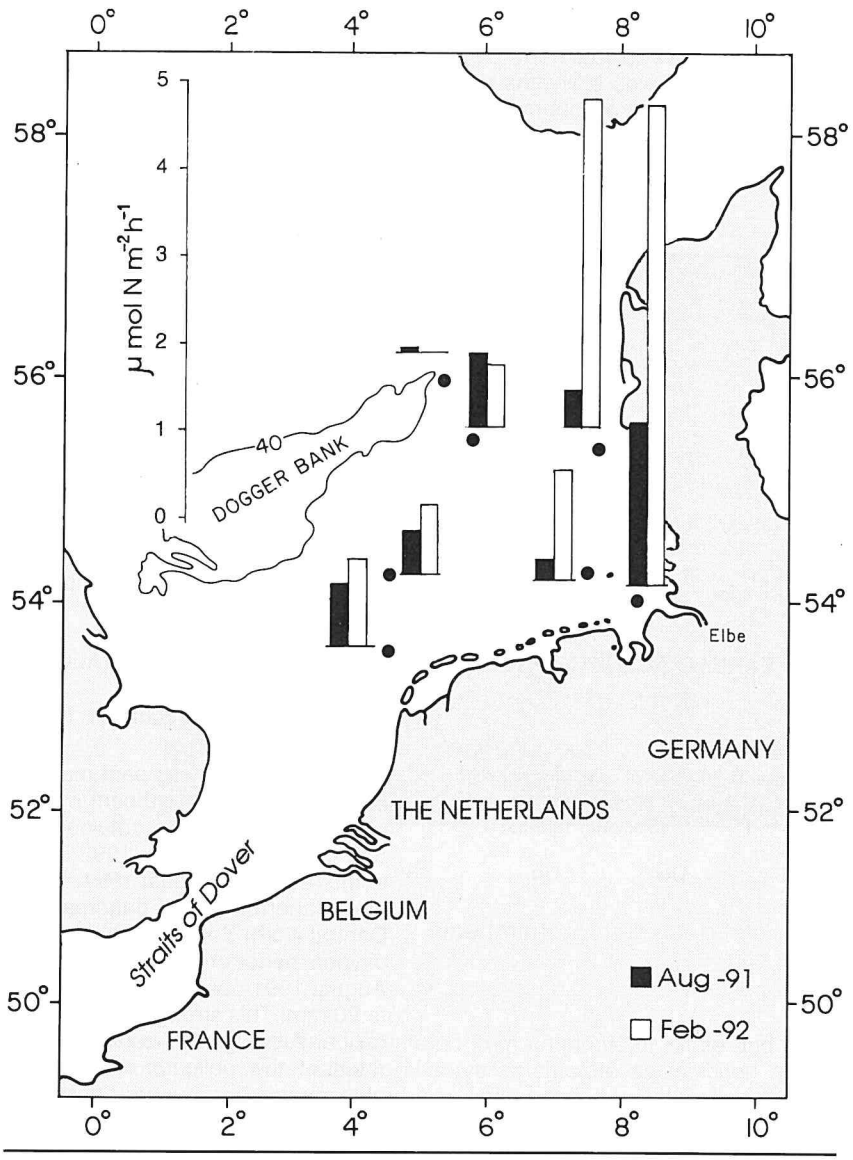
Although these themes are consistent over the years, the research areas and the experimental approaches are of a dynamic character.

In 1992 the Department participated in the BELS cruises in the North Sea, various cruises of the NIOP, and in the Southern Ocean JGOFS programme. Related to these programmes the nutrient analysts spent considerable time at sea and analysed an impressive amount of samples (H1-01).

Thanks to external funding (NOP) it became possible to study the exchange between sea surface and atmosphere of the greenhouse gases CO_2, CH_4, and N_2O. Some results are presented in H1-04, and H1-17.

The recent installation of a Stable Isotope Mass Spectrometer will make it possible in the near future to apply natural abundance of C, N, O isotopes in NIOZ research projects, and the application of ^{15}N and ^{13}C compounds as tracers is of primary importance in H1-02/03 and H1-04.

(Photo: G. Nieuwland)



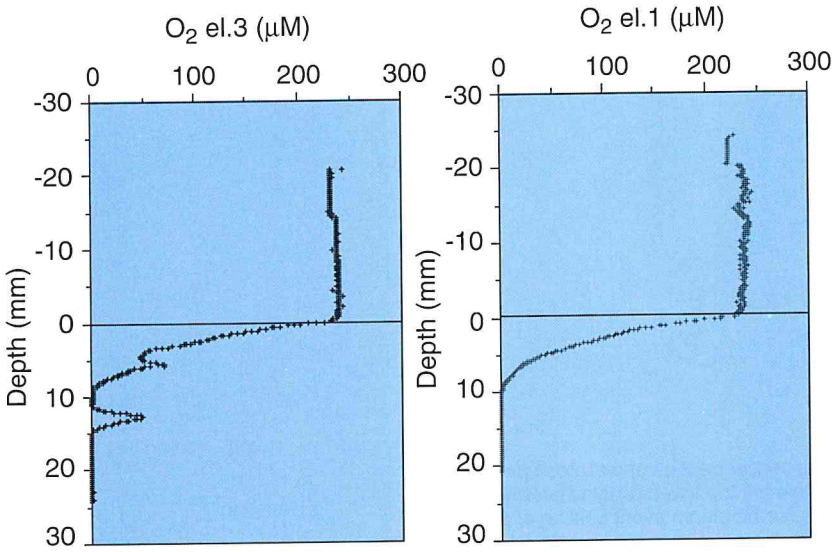
H1-04
Denitrification rates (in μmol $N \cdot m^{-2} \cdot h^{-1}$) in August 1991 and February 1992 during the Benthic Links and Sinks (BELS) cruises.

In the period 9-24 March a cruise with the Italian RV 'Ravello' was executed by a team of 20 Italian and Dutch participants. At 8 stations in the area the following measurements were made:

- CTD profiling and water sampling with on board analyses of nutrients.
- Deployment of the benthic chamber lander for benthic community respiration and *in situ* sediment-water exchanges.
- Deployment of the oxygen profiling lander (TROL).
- Boxcoring for squeezing of porewater for the analyses of nutrients and total CO_2 and for the analyses of organic C, -N and biogenic Si (opal).
- Qualitative and quantitative assessment of sediment fauna.

By application of these techniques it became possible to compare sediment-water fluxes calculated from pore-water profiles by application of Fick's laws of diffusion, with those measured *in situ*. From this comparison the effect of infauna on sediment-water exchange rates can be estimated.

Preliminary results indicate that sediment-water fluxes are highest at the shallow stations in the vicinity of the delta of the river Po and diminish regularly in a southern direction with maximum water depth of 250 m. The same trend can be found in the penetration depth of oxygen in the sediment with values of 2-3 mm in the Po delta to 15 mm at the southern stations. The effect of infauna on the distribution of oxygen in the sediment is illustrated.



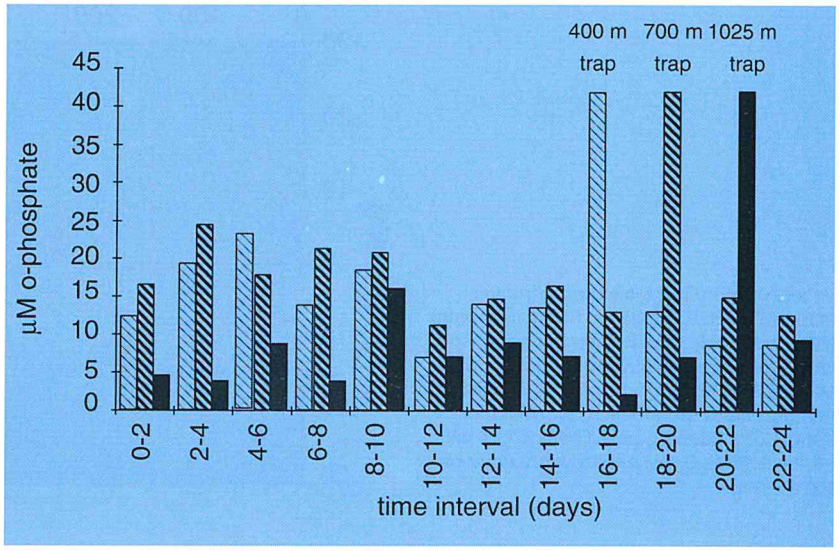
In situ oxygen micro-electrode profiles, made with TROL, at station 3. The left panel gives the profile of electrode 3 in which the presence of animal burrows at depths of about 6 and 12 mm in the sediment can be recognized. In the profile made with electrode 1 (right panel), at a distance of 4 cm from electrode 3, such burrow phenomena are absent.

Downward fluxes of particulate carbon

G.J.A. Brummer, W. Helder, R. Kloosterhuis, K. Bakker

Research focused on two sets of samples from deep-moored sediment traps taken within the JGOFS North Atlantic programme at 47°N/20°W. One of these forms part of a larger experiment together with the UK and USA, to look at mesoscale spatial variation in particle fluxes. The combined results show great similarity from early autumn to late spring, including the marked maximum originating from the spring bloom, which arrived almost simultaneously in May-June at all three sites. During summer, however, maxima of a similar magnitude, *viz.* about 50 $mg \cdot m^{-2} \cdot d^{-1}$, were recorded in mid July (NL) and mid August (UK). Such maxima were not recorded at the other sites. Particle fluxes showed a consistent composition despite such temporal and spatial variability. Organic carbon to carbonate carbon ratios generally amounted to *ca.* 0.7:1 at reference depth, which appears typical of open-ocean environments in the low and high latitudes. Research was carried out jointly with the GeoMarine Centre Amsterdam (GMCA); a joint manuscript with UK colleagues is being prepared which combines the results of the UK and the Netherlands with those of the USA.

Another set of samples from the same site, previously occupied by a year-round array of traps by the USA, is currently being analysed for particle-specific carbon fluxes at a high resolution. Most fortunately, the Dutch traps recorded a short but pronounced flux maximum which originated from a bloom of the coccolithophorid *Syracosphaera pulchra*, a calcareous alga previously unknown as a 'bloom species'. Preliminary results show that specific faecal pellets carry most of the flux of up to 10^9 skeletal plates·m^{-2}· d^1, in contrast to the larger shells of other groups such as pelagic foraminifera and gastropods which settle individually. Dissolved phosphate concentrations in the collecting cups reflect the organic carbon fluxes associated with the carbonate carbon, and show that the bloom export event settles towards the ocean floor at a velocity of about 150 m·d^{-1}. Research is carried out jointly with M. Knappertsbusch (GMCA/ETH-Zürich) among others.



Peak concentrations of dissolved phosphate mark the two-day delay in arrival time of the same bloom event settling at about 150 m·d^{-1} to sediment traps moored at 400, 700 and 1025 m depth below the ocean surface (JGOFS' 47°N, 20°W superstation)

Tracing a seasonal upwelling (NIOP leg C1)

W. Helder, R.F. Nolting, T. Tahey, G.J.A. Brummer, R. Kloosterhuis

The aim of our participation in the NIOP was to study early diagenetic processes triggered by input of organic carbon to the sediment surface. From the porewater profiles of oxygen, nitrate, Mn^{2+}, Fe^{2+}, and ammonia the relative importance of aerobic organic matter degradation (oxygen profiles), denitrification (nitrate profiles), Mn- and Fe-oxide reduction (Mn^{2+} and Fe^{2+} profiles), as well as of sulphate reduction (NH_4^+ profiles), can be quantified and used to estimate the total carbon mineralization rates. In the NIOZ laboratory sediment slices will be analysed for organic C and -N, and together with data on sedimentation rates, the burial of organic C will be quantified.

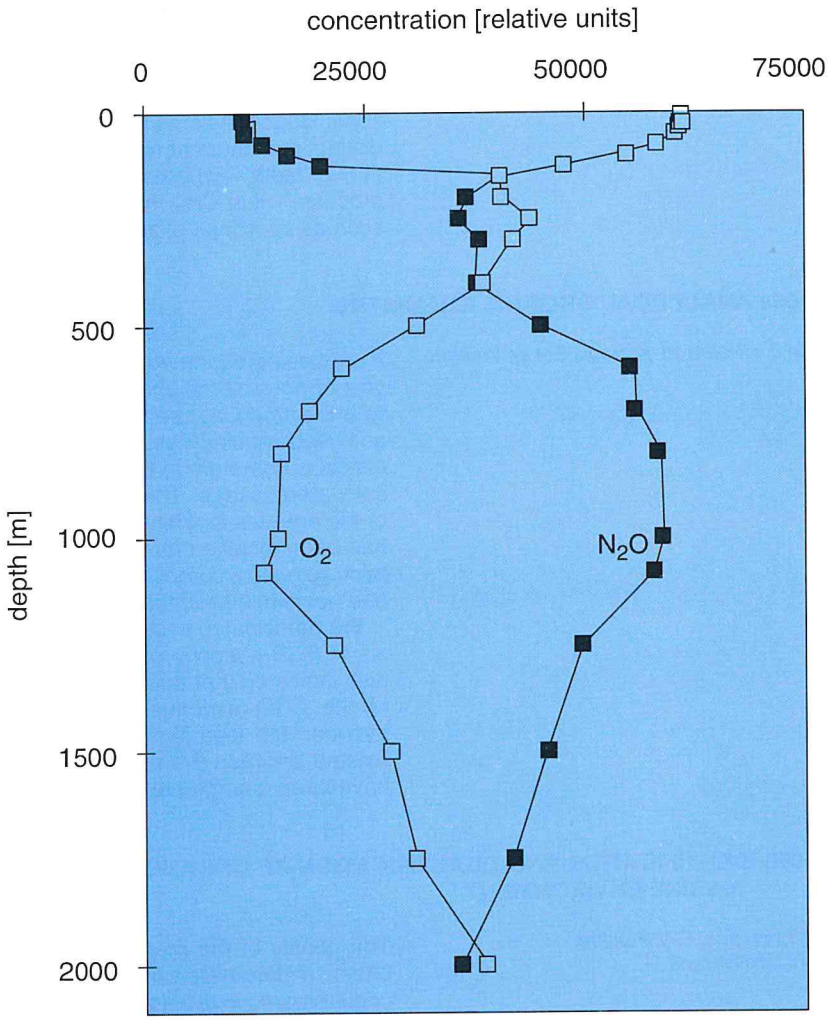
During leg C1 boxcores were collected at two transects (each 5 stations) perpendicular to the Yemen coast and at 3 deep stations(4000-5200 m) outside the coastal upwelling areas. Apart from porewater chemistry and shipboard determination of oxygen profiles in sub-cores, these last measurements were also made (at 5 stations) *in situ* by deployment of the TROL. Due to technical problems valid results from these deployments were gained only at three stations.

Preliminary results indicate that porewater chemistry in the Yemen area is strongly governed by the low oxygen concentration in overlying bottom waters (<25 μM at depth of 30-900 m), which causes oxygen penetration in the sediment to be restricted to 3-5 mm and oxic and sub-oxic mineralization processes to start already above the sediment-water interface.

Water-atmosphere fluxes of N_2O in marine systems

H.P.J. de Wilde, W. Helder

Nitrous oxide (N_2O) is an atmospheric trace gas that contributes to both global warming and ozone depletion. Since the present N_2O concentration of 310 ppb is increasing at about 0.25% a year, a better understanding of aquatic and terrestrial N_2O sources is important. This NOP project focuses on the biochemical production and consumption of N_2O in the marine environment, as well as on the extent of N_2O air-sea exchange. Recently, similar research has started on methane (CH_4), which is another important greenhouse gas.



Vertical profiles of dissolved N_2O and O_2, Indian Ocean, Cruise B1, Station 214, 3°48.1 N 48°48.7 E, 18-07-1992, 11:00 LT.

At present field work is concentrated on the Indian Ocean in the framework of the Netherlands Indian Ocean Programme. During cruises, N_2O and CH_4 concentrations of both surface waters and the atmosphere are measured continuously. This makes it possible to identify areas of sources and sinks of these greenhouse gases. At stations N_2O and CH_4 depth profiles are registered by means of analysis of discrete samples from various depths. This provides information about production and consumption in the water column in relationship with other registered parameters such as oxygen and nutrient concentrations.

Measurements were made during a cruise in the Somalian upwelling area (in August, 1992) and during two cruises in the Arabian Sea (October and November 1992). Although all surface water measurements still have to be corrected for temperature, first results indicate considerable supersaturation of both N_2O and CH_4 at several locations, resulting in a net sea-air flux of these greenhouse gases. The extent of these fluxes, which is strongly dependent on wind speed, will be assessed with the Liss-Merlivat wind speed relationship. At most of the stations in the Indian Ocean, the concentration of N_2O in the water column was strongly negatively correlated with the O_2 concentration, resulting in N_2O concentrations of up to 800% supersaturation in the oxygen minimum zone. Concentrations of CH_4 in the water column in the Arabian Sea showed a distinct maximum at about 100 m depth. Since the water column was still oxic at this depth —whereas the microbial production of CH_4 is a strictly anaerobic process— this CH_4 may have been produced in anoxic micro-environments, such as intestines of zooplankton.

H1-06a ANALYTICAL ORGANIC CHEMISTRY

M.Th.J. Hillebrand, K. Booij, E. van Weerlee

A continuing effort has been made to improve the analytical quality of the analysis of polychlorobiphenyls (PCBs) with Gas Chromatography in combination with Electron Capture Detection (GC-ECD). Certified reference materials were analysed regularly as a control over the entire analytical procedure. Various critical parameters in the analysis could be monitored with a newly developed software package. The use of internal standards has decreased the variability of the analysis to a few percent. A second, slightly more polar, capillary column has been installed for verifying the identification of the congeners.The use of hydrogen as a carrier gas has increased the lifetime of the capillary columns, and has diminished the contamination of the inlet liners.

We participated in step 3a of the ICES intercalibration exercise on the analysis of PCB congeners. The results of this exercise were promising, but have also indicated that additional improvements are necessary. A detailed analysis of the ECD-response to PCBs has indicated that a linear relation exists between the logarithms of injected amount and response. No linear relation existed between the untransformed variables. Existing calibration procedures have been changed to account for this observation.

H1-06b IDENTIFICATION AND QUANTIFICATION OF ORGANIC MICROCONTAMINANTS AND THEIR FATE IN THE MARINE ENVIRONMENT

J.M. Everaarts, C.V. Fischer, M.Th.J. Hillebrand

The quality of the marine environment assessed by measuring physical and chemical parameters in water and sediment gives information about the fate of contaminants in the aquatic system. However, the results of such studies can-

not be directly extrapolated to the biota, which therefore should be investigated separately. Here, two possible main research approaches are usually followed:

(1) Measurement of concentration levels of contaminants in biota and (2) measurement of toxicological and biochemical responses to enhanced concentrations of contaminants as a measure of the impairment of biological processes in organisms (see H1-07).

In the framework of the study of the coastal ecosystems of Kenya (Project A of the Netherlands Indian Ocean Programme 1992/1993) surveys were made along four transects perpendicular to the Kenyan coast in order to distinguish the pathways of contaminants in the coastal zone and along the continental slope into the deep sea. This study was part of the research project on the effects of the monsoon regime on coastal marine systems, in particular the changing effects of two contrasting weather patterns through their impact on land run-off and river flow and the reversal of the currents. One research cruise was carried out during the southeast monsoon (18 June-9 July) and the second cruise during the northeast monsoon (18 November-7 December).

Until now, the few pollution studies have been concentrated in the vicinity of Mombasa harbour and nearby creeks. To obtain information on the distribution of contaminants in the sediments and the uptake (accumulation) of heavy metals (Cu, Zn, Cd and Pb) and chlorinated hydrocarbons such as PCBs and pesticides (DDT-family, dieldrin and HCHs) sediment samples were taken and benthic organisms were collected. Processing of the samples was partly done on board RV 'Tyro', and analysis has to be carried out at NIOZ.

Analyses of PCB congeners in the pyloric caeca of seastars (*Asterias rubens*), collected during two cruises made in the framework of the Integrated North Sea Programme (1991 and 1992) indicate highest concentrations in specimens from nearby coastal areas in the Southern Bight. Lowest concentrations of selected toxic CB congeners were found in specimens from the central North Sea.

Killer Whales off the coast of Denmark. (Photo: L. Lohse)

H1-07 BIOLOGICAL MARKERS OF ENVIRONMENTAL CONTAMINATION

J.M. Everaarts, S.A.W. Jansen

To quantify exposure to chemical agents in the environment and its potential impact on biota one has to monitor biological end-points (biomarkers) in feral animals and plants as indicators of exposure and effects of environmental contaminants. A biomarker will be defined as a change in a biological system that can be related to an exposure to, or effect of, an environmental chemical or group of chemicals. Biological systems can range from molecular through biochemical, cellular and physiological responses to behavioural changes and even as far as species composition. In our studies the main focus is the range from molecular to physiological. Biomarkers can demonstrate that environmental chemicals have entered an organism, reached sites of toxic action and are exerting an effect on the organism. The organisms function as integrators of exposure, accounting for abiotic and physiological factors that modulate the dose of the toxicant taken up from the environment. These biological markers can be used to quantify exposure to harmful agents and to detect the response to environmental insults. Furthermore, they may function as 'early warning signals' for the assessment of environmental contamination and be included in monitoring programmes.

Physiological responses to anthropogenic and naturally occurring contaminants involved in the present research are the haematological status and hepatic (liver) somatic index, induction of detoxifying systems (see S-02b) and genetic damage, such as DNA adduction and strand breaks. Haematological parameters (haematocrit, haemoglobin concentration and mean corpuscular haemoglobin concentration) and the hepatic somatic index (as a general health parameter) were measured. Samples obtained during two cruises of the Integrated North Sea Programme (1991 and 1992) were analysed. From preliminary data on the DNA integrity (DNA strand breaks) in seastars (*Asterias rubens*) it can be concluded that there is some increase in DNA strand breaks (lower integrity) in specimens from coastal areas in the Southern Bight. However, so far no correlation has been found with the concentration of certain CB congeners with a dioxin type toxicity, such as the non-ortho CBs 77, 126 and 169 and the mono-ortho CBs 105 and 118.

H1-08 HEAVY METALS IN THE MARINE ENVIRONMENT

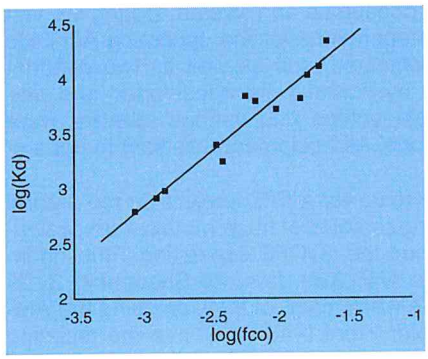
J.M. Everaarts, C.V. Fischer

Heavy metal concentrations were established in the fine fraction (grain size <63 μm) of surface sediments from the southern part of the North Sea. High concentrations of copper (25 to 240 $\mu g \cdot g^{-1}$ dry weight, DW), zinc (400-4000 $\mu g \cdot g^{-1}$ DW), cadmium 3 to 30 $\mu g \cdot g^{-1}$ DW) and lead (75-630 $\mu g \cdot g^{-1}$ DW) were measured in the Southern Bight. In the fine fraction of surface-sediment samples from the area north of the Dogger Bank and from the western part of the Dogger Bank proper, enhanced concentrations of heavy metals were found. The concentrations of heavy metals in the fine fraction of the surface sediment from a sedimentation basin, the Oyster Grounds, were relatively low. Metal concentrations in the fraction <63 μm were highly correlated with the grain-size distribution: a high concentration, in particular of zinc and cadmium, was related to a low percentage of the fine sediment fraction.

H1-09 EXCHANGE OF ORGANIC CONTAMINANTS BETWEEN SEDIMENT AND WATER

K. Booij

The mass fraction of organic carbon in sediments is commonly considered to be the factor that governs the sorption of hydrophobic contaminants between



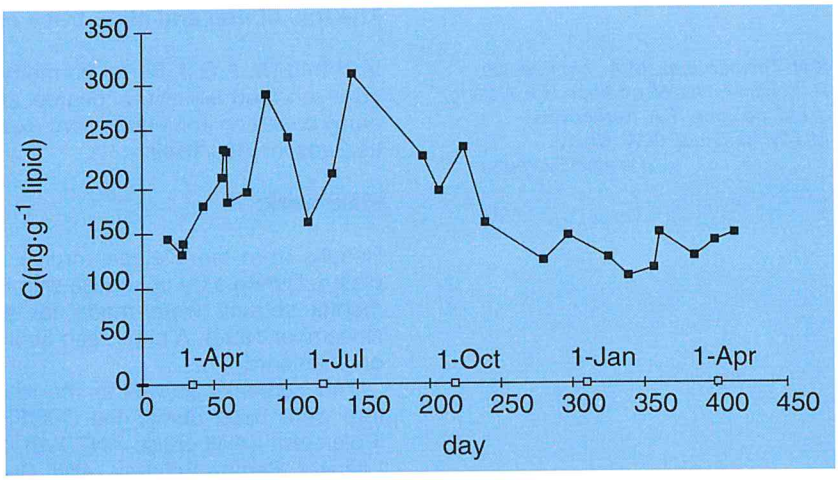
sediment and water. Thus, partition coefficients between sediments and water are linearly proportional to the mass fraction of organic carbon. Several investigators have shown that differences in the chemical composition of the organic carbon result in an additional variation of an order of magnitude. In order to study the validity of the organic carbon concept for North Sea sediments, the partition coefficients of 2,2',5,5' tetrachlorobiphenyl were determined for several sediments from the German Bight, the Skagerrak and the Norwegian Channel. The results show that the organic carbon concept is valid for these sediments (H1-09). A maximum deviation of 40% indicates that the concept should be applied with caution, and only explains the order of magnitude variation.

Relation between the partition coefficient of 2,2',5,5' tertrachlorobiphenyl and the mass fraction of organic carbon.

H1-14 DYNAMICS OF CONTAMINATION

K. Booij

In 1991 a biweekly sampling of sediments and vertebrates on a tidal flat near the island of Texel was started to study the extent of variation of PCB levels in these compartments throughout the year. This year the sampling was continued to cover a time period of 13 months. The analysis of PCB levels in *Arenicola marina,* expressed on a basis of total (polar and non-polar) lipids, was completed. Levels of 2,2',3,4,4',5' hexachlorobiphenyl (CB138) have been established. PCB levels differed by a factor of 2-3. The interpretation of these differences is only possible after the other compartments have been analysed.



Concentration of 2,2',3,4,4',5' hexachlorobiphenyl (CB138) in *Arenicola marina* expressed on a basis of total lipids.

H1-15 TRACE METALS IN THE OCEANS

The Southern Ocean

B. Löscher, J.T.M. de Jong, R.F. Nolting, H.J.W. de Baar

The final manuscript based on the 1988/1989 EPOS expedition is now being completed by Nolting and De Baar. Within the Weddell Sea, the Scotia Sea, and the intermediate Confluence zone distinct biogeochemical provinces were

found in the surface waters (<300 m depth) both for the metals Ni, Cu, Zn and Cd and for the related nutrients nitrate, phosphate and silicate. During the first half of the year much effort went into preparations for the upcoming Antarctic expedition. Two clean air laboratory container vans as well as two different special winches with metal-free kevlar hydrowire were constructed and prepared. In addition, hundreds of sample bottles and various labware were cleaned by rigorous yet laborious methods. All equipment was sent to ports of call of RV 'Polarstern'.

In August Bettina Löscher joined our team for a PhD project on the natural processes responsible for the scavenging removal of trace metals from seawater. Löscher, De Jong and De Baar joined the JGOFS expedition 'Frühling im Eis' aboard RV 'Polarstern' (AWI cruise ANT X/6), from 29 September to 29 November. Several north-south sections were made at 6°W, crossing the Antarctic Circumpolar Current from the Polar Front (~48-50°S) into the receding ice edge. So far, no data exist on distributions of trace metals, including the rare earths (REE) in the Antarctic Circumpolar Current. Samples were collected with ultraclean techniques for a study of horizontal and vertical distribution of trace elements in the Southern Atlantic Ocean. The study is focusing on Fe, Co, Cu, Ni, Zn, Pb, Cd, Ag, Mn and the REE. Both the dissolved and the particulate phases were sampled and will be analysed in the home laboratory at NIOZ. In addition smaller projects were executed for studies of sea ice and icebergs. The results on field abundances of metals will also contribute towards elucidating the hypothesis of iron limitation of phytoplankton productivity in the Southern Ocean (see below). Upon successful analysis the results from hundreds of samples collected are intended to constitute the core of the thesis of Löscher.

The role of iron and other trace elements in oceanic ecosystems

K.R. Timmermans, M.A. van Leeuwe, R. Scharek, H.J.W. de Baar, R.F. Nolting, J.T.M. de Jong, F.A. Kerkhoven; M.J.W. Veldhuis, G.W. Kraay
(Pelagic Systems)

In March Dr. A.G.J. Buma (formerly at NIOZ, now at the University of Groningen) received her Ph.D. degree at the University of Groningen for a thesis partly based on iron enrichment experiments executed in the Weddell and Scotia Seas in 1988/1989.

Field work:

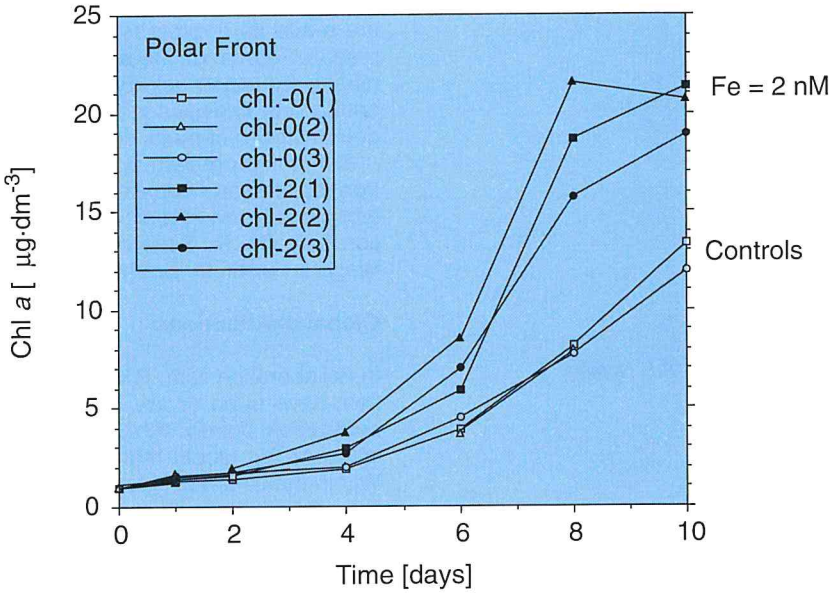
Results from the 'Pelagia' cruise in November-December 1991 were completed. During a try-out cruise with RV 'Pelagia', several adjustments in experimental set-ups were made for the 'Polarstern' ANTX/6 cruise (October-November 1992). A new clean cool container was built for culture experiments on shipboard.

This container as well as the refurbished clean analytical container laboratory were used during the JGOFS expedition 'Frühling im Eis' aboard RV 'Polarstern' (AWI cruise ANT X/6), 29 September to 29 November. Maria van Leeuwe, Renate Scharek (AWI, Bremerhaven) together with Jeroen de Jong, Hein de Baar, and several other shipboard scientists, studied the role of iron (Fe) and some other metals in Antarctic plankton productivity.

Production in Antarctic waters appears considerably lower than expected in such nutrient-rich waters. Low iron concentrations may be one of the limiting factors in these regions. As concentrations of other trace metals (Mn, Co, Zn) are also very low additional enrichment experiments were also performed. Seawater collected with ultraclean methods was incubated in precleaned, seawater conditioned 20 dm^3 polycarbonate vessels kept at 0-1°C receiving light-

intensities between 90 and 120 µE· s^{-1}. Following the development of the algal community subsamples for species composition, chlorophyll and nutrients (NO_2, NO_3, Si, PO_4, NH_4) were taken regularly. At the start and the end of the experiments larger subsamples were taken from the 20 dm^3 bottles. These samples were used to perform shipboard isotopic uptake experiments for ^{14}C, ^{15}N and ^{55}Fe, as well as microzooplankton grazing assessments. Furthermore subsamples were taken for assessment in the home laboratories (NIOZ and AWI) of Fe levels, species composition and other parameters (*e.g.* POC/PON, pigments, lipids, bacterial abundance and growth rate, DOC, DMSP, diatom frustules).

Preliminary results show that the biomass in the water to be incubated was generally very low. Therefore, the incubation times were set for a relatively long period, in order to obtain measurable responses. Biomass would increase in all bottles; an enhancement in the bottles with Fe addition was observed, though not always very distinct because of the low chlorophyll levels. Respective decreases in nutrients (nitrate, phosphate, silicate) could be measured, but due to the very low biomass accumulation rates in many experiments, were close to detection limits. However, additional data, to be obtained from species composition and the other parameters, will give more information necessary to interpret the results of these experiments.



The increase of chlorophyll *a* over time in three control mesocosms (open symbols) and three mesocosms (filled symbols) with addition of 2 nM Fe each. Excellent reproducibility of the 3 replicates allows the conclusion that trace amounts of Fe significantly enhance the synthesis of Chl *a*.

A clear response to Fe addition is apparent in one experiment, where water from the generally more productive Polar Front was incubated. The higher starting biomass (1 µg chl. *a*· dm^3) resulted in a sharp increase in chlorophyll *a* in the bottles with Fe addition, compared to a more moderate growth in the control bottles. Significantly higher rates of uptake of nitrate, phosphate and silicate were also found. Additional grazing experiments support the contention that for these Polar Front waters the addition of some iron (2 nM) yields both a higher algal growth coefficient and a higher grazing coefficient. In summary

iron addition yields higher biological activity in the microcosms. According to these results Fe and other trace metals seem to stimulate growth rate, hence biomass in the Atlantic part of the Southern Ocean. However, higher concentrations of these metals would not necessarily overcome the strong ambient controls set by physical conditions and grazing pressure.

Experimental work:

Work with Antarctic phytoplankton species was largely discontinued due to very poor growth. A shift was made to phytoplankton species from temperate regions for experimental work. The research focuses on three topics:

1) Phytoplankton growth in relation to iron availability. The growth is estimated on cell counts and nutrient dynamics. Iron availability is calculated using a speciation model (EASEQL). Differences in oceanic *versus* neritic species are considered.

2) Nitrogen metabolism in relation to availability of iron. It is hypothesized that new production, through uptake of nitrate, can only take place when iron is available for the formation of nitrate reductase. In the absence of iron only ammonium should be used for growth (*i.e.* regenerated production). In batch cultures nitrate and ammonium uptake of several species is studied in relation to presence of iron. The nutrient uptake (indirect, loss in the medium) and nitrate reductase activity are determined. Preparations for use of ^{15}N analyses are made as a direct tool for nitrate/ammonium uptake studies. This type of research demands the development of several new methods: protocols for the nitrate reductase activity determinations, mass spectrometry (^{15}N) analyses, ammonium analyses in the nM range, and ultra clean filtration techniques for determination of metal content in phytoplankton cells are being developed.

3) Plankton growth and grazing experiments in which copepod grazing on iron repleted and depleted phytoplankton is studied. Here we studied both Antarctic and North Atlantic species. The experiments are performed in collaboration with Dr. R. Scharek, visiting post-doctoral investigator from the Alfred Wegener Institute, Bremerhaven, Germany.

Global distributions

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

In collaboration with. P.M. Saager (Free University, Amsterdam) various datasets have been or are being (JGOFS North Atlantic Ocean) worked out for publication. Jointly with J. van der Meer (NIOZ statistics group) we prepared a study of the global relation between Cd and phosphate, currently in press. Within the context of his thesis Saager is using these datasets towards modelling global distributions, in collaboration with prof. Goudriaan (Wageningen) and De Baar (the latter serving as one of three thesis advisers).

Scientific Programme on Arctic and Siberian Aquatorium (SPASIBA)

R.F. Nolting, W. Helder

All sediment samples collected during the SPASIBA expedition, (Lena river and adjacent Laptev Sea) were analysed for trace and major elements, such as copper, cadmium, lead, calcium, aluminium. For most elements the mobile as well as the residual fractions were determined. So far, iron, manganese and zinc have also been determined in the interstitial waters.

Generally, most elements show little variation in their vertical distribution in the sediments of the Laptev Sea. Only in areas with strong redox activities, do manganese and iron show concentration gradients. Thus the sediment shows

a rather homogeneous pattern, with no signs of a recent increase in trace metal concentrations, as was found for example for lead and zinc in NW Mediterranean sediments.

Sediments supplied by the Lena river and deposited in the Laptev Sea are very low in calcium carbonate content (below 1%). The organic carbon content is, however, rather high (1-3%), and this creates anoxic conditions in the sediments, resulting in strong concentration gradients of manganese and iron in porewaters and sediments, especially at stations in the vicinity of the Lena delta. Rather high manganese concentrations (2500-5500 $\mu g \cdot g^{-1}$), in comparison with those found in the Lena river and the rest of the Laptev Sea, are found in some sediments far away from the river mouth, in a shallow area surrounded by small islands.

The lateral distribution of most trace elements shows a pattern of increasing concentrations with increasing distance from the river mouth. This is perhaps due to a particle size effect, by which smaller particles with a higher metal content are deposited further away from the river mouth. The same mechanism is probably responsible for the relatively low trace metal contents in some sandy sediments close to the river mouth.

In conclusion, it seems that trace metal concentrations in sediments from the Lena River and Laptev Sea are rather low, taking into account the low carbonate content. Especially the low cadmium concentrations (<100 $ng \cdot g^{-1}$) are similar to general background values.

River inputs to the Mediterranean Sea (EROS-2000)

R.F. Nolting, W. Helder

Results obtained in this research were further analysed. First, all element data determined in the sediments were normalized against aluminium. This confirms the earlier conclusions about the existence of five subareas in the NW Mediterranean. The vertical distribution of element/Al ratios in sediments of the Gulf of Lions is rather constant with the exception of lead and zinc. This in contrast with the lateral distribution which shows that there are three groups of trace metals with different behaviour. Cadmium, lead and zinc belong to the first group, with lowest ratios in the deeper part (> 2000 m) of the Gulf and near the Ebro mouth. Near the Rhône mouth consistently higher ratios were found. A second group consists of copper and nickel. They also have the lowest ratios near the Ebro, but the highest ratio is found in the deepest part of the Gulf, with the ratio of the Rhône area in between. Chromium belongs to the third group, with low ratios near the Ebro.

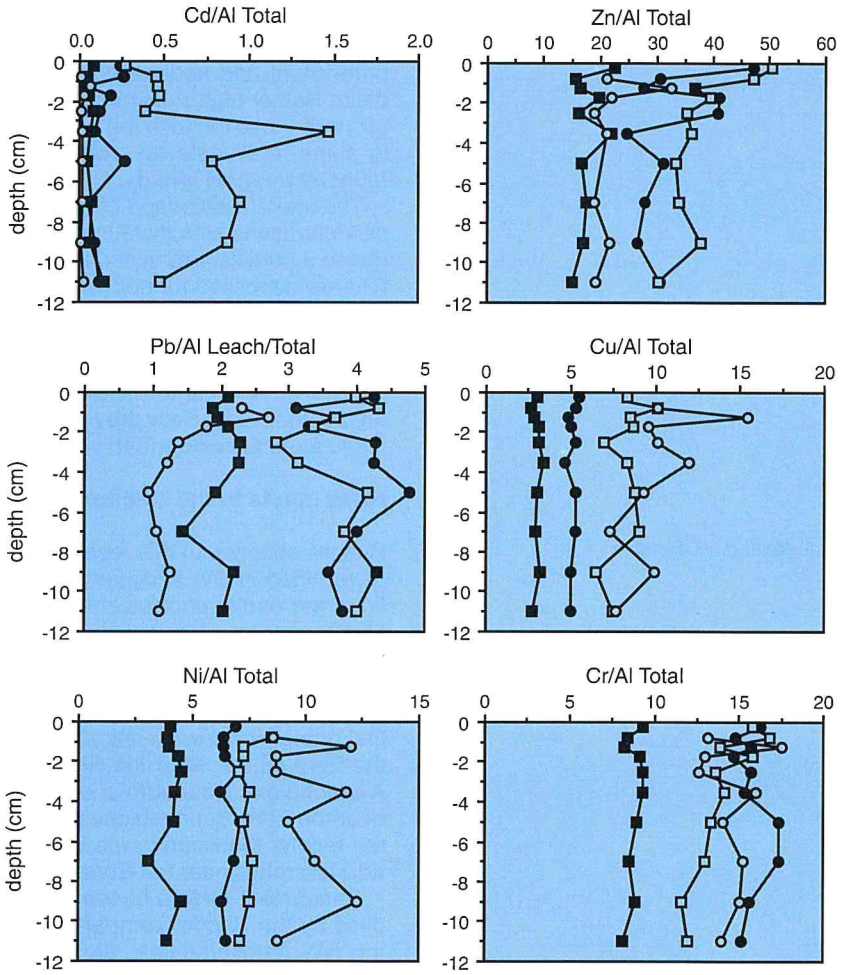
Enrichment factors based on total metal concentrations in sediments supplied by the Rhône, compared to concentrations found in the deepest part of the NW Mediterranean, are 1.8 for zinc, 4 for lead, 0.9 for copper, 0.7 for nickel, 0.9 for chromium and 22-40 for cadmium. For the Ebro these factors are 1 for zinc, 1.7 for lead, 0.3 for copper, 0.4 for nickel, 0.6 for chromium and 3 for cadmium.

The calculated ratio Kd(aerobic)/Kd(suboxic) in these sediments gives information about the mobility of metals. This shows that for example zinc is more mobile in the oxic zone, than in the suboxic zone. The reverse is found for iron and manganese. This indicates that zinc is highly associated with organic material, and becomes mobile during mineralization.

Budget calculations for deposited trace metals in the whole W Mediterranean were made. These results will be published in an EROS project book.

Sediment cores collected during all EROS cruises were shared with D. Cossa (IFREMER, Nantes, France), who determined mercury, R. Chester

(University of Liverpool, UK), for sequential extraction of metals and J.M. Martin (Montrouge, France) for arsenic and selenium determinations. DOC and DIC in the interstitial waters were determined by G. Cauwet (University Perpignan, France)



Depth profiles of element/Al ratios·10^{-4} in sediments of four stations in the W. Mediterranean Sea.

Metal distribution in sediments of Banc d'Arguin (Mauritania)

R.F. Nolting, J.M. Everaarts

Sediment cores were collected along two transects of the continental slope of the Banc d'Arguin (Mauritania), and analysed for trace and major elements. Sediments collected at the shallower parts (25-900 m) of the Banc and the continental slope are a factor of 2-3 richer in calcium carbonate, than those in the deeper parts (>1000 m). This implies that for comparison of element concentrations at different stations, a correction on a calciumcarbonate-free basis has to be made. Based on this correction, most major elements show no large variations in their lateral and vertical distribution. However, there is some evi-

dence of a recent increase in lead, zinc and copper concentrations in the top centimetre of the sediments of the deep stations, where sedimentation rates and bioturbation are expected to be low. Despite this recent increase in concentration, the overall trace metal concentrations are rather low and comparable to natural background values. Cadmium is an exception with at the stations closest to Cap Blanc a significantly higher concentration than the rest of the area, *viz.* ~1.36 $\mu g \cdot g^{-1}$ *versus* 0.16 $\mu g \cdot g^{-1}$.

In contrast to the shallow stations where sediments are oxic, the deep stations clearly show transitions from oxic to anoxic situations, indicated by manganese and iron reduction.

Netherlands Indian Ocean Programme (NIOP)

R.F. Nolting, W. Helder

During the C1 leg of the NIOP cruise 13 boxcore samples were collected. Near the coast of Yemen sediment samples were collected at 10 stations, on two transects perpendicular to the coast, covering water depths of 74 to 2215 m. Three stations were visited near the Equator at around 5000 m water depth. Sediment cores were processed directly on board, including squeezing of the interstitial water from the sediments at *in situ* temperature. Trace and major elements in the sediments and interstitial water will be determined later at NIOZ.

H1-16 RARE EARTHS AND OTHER METALS IN ANOXIC BASINS

H.J.W. de Baar

This project has largely been concluded with Dr. Johan Schijf receiving his PhD degree in May from the University of Utrecht, and now working at Woods Hole. With two papers already published and one in press, three other chapters of the thesis are being prepared for publication.

H1-17 MASS BALANCE OF CARBON IN PELAGIC SURFACE WATERS

CO_2-system in the northeast Atlantic Ocean (JGOFS North Atlantic project)

M.H.C. Stoll, H.J.W. de Baar, J. Rommets, W.G. Mook

The datasets obtained during 1989 and 1990 JGOFS cruises and 1990 and 1991 WOCE cruises, all aboard RV 'Tyro', are currently being interpreted and worked out within the context of the PhD thesis of Stoll.

CO_2-exchange between the ocean and the atmosphere in temperate South Atlantic waters

D.C.E. Bakker, H.J.W. de Baar, W.G. Mook, A.A.J. Majoor

The partial pressure of CO_2 in the atmosphere has increased by 3% each year since 1958. This corresponds to about half of the CO_2-release by the use of fossil fuel. The oceans presumably serve as a net sink for about 40% of the fossil fuel CO_2. Records of atmospheric CO_2 and $^{13}C/^{12}C$ isotopic ratio and studies in the southwest Pacific Ocean suggest a CO_2 sink at about 40 S latitude. Virtually no observations exist of the partial pressure of CO_2 in Atlantic or Indian Ocean waters at 30 to 60°S latitude. The objective of this thesis research of Bakker is to quantify more accurately the locality, seasonality and magnitude of this sink with emphasis on the South Atlantic Ocean. For this purpose Bakker participates in a series of cruises with RV 'Polarstern', each time the ship sails to and from the Antarctic. The first measurements were made when RV 'Polarstern' crossed the Atlantic in November/December 1991. Here

we collaborated with the CO_2 research team of the Institut für Meeresforschung (Dr. B. Schneider and associates, Kiel). The exchange of CO_2 between the oceans and the atmosphere was monitored by measuring the difference in partial pressure between surface water and marine air. In 1992 this dataset was further processed. Also preparations were made for the next crossing, from late January to end of February 1993, from Ushuaia to Bremerhaven, where Majoor (see also below) intends to execute additional underway measurements of TotalCO_2 in surface waters.

CO_2-system in the Antarctic Circumpolar Current (JGOFS Southern Ocean)

J.W. Rommets, M.H.C. Stoll, H.J.W. de Baar, D.C.E. Bakker

During the JGOFS expedition 'Frühling im Eis' aboard RV 'Polarstern' (AWI cruise ANT X/6) several North-South sections were made at 6°W, crossing the Antarctic Circumpolar Current from the Polar Front (~48-50°S) into the receding ice edge. Alkalinity, TotalCO_2 and partial pressure of CO_2 (pCO_2) were determined on discrete samples from various depths; (pCO_2) also on continuously sampled surface water and marine air. The difference in pCO_2 between surface water and marine air was used to estimate the exchange of CO_2 between the oceans and the atmosphere. The skin temperature of the surface ocean, which may differ as much as 0.5°C from the bulk temperature was determined to obtain algorithms for proper calculation of the CO_2-flux. Combination of parameters of the CO_2-system with physical and biological properties yielded information on *in situ* processes. Notably the underway datasets for pCO_2 are being combined with data for temperature and chlorophyll *a* abundance (Dr. Bathmann, AWI) as to obtain general relationships for these surface properties in the Southern Ocean. Throughout the expedition Rommets and Stoll also served towards organizing and collating the overall integrated dataset produced by all 51 participants (see also section 1.1.1.).

CO_2-system in the Antarctic Ocean

A.A.J. Majoor, J.M.J. Hoppema, H.J.W. de Baar, W.G. Mook

Dr. Hoppema joined the Alfred Wegener Institut as of April 1992. In the preceding months at NIOZ we designed and constructed the equipment to be used in two Weddell Sea expeditions, one in winter (May-June 1992), the other in summer (December 1992-January 1993). Throughout both cruises data were obtained on the Alkalinity, TotalCO_2 and pCO_2 in these waters, elucidating the CO_2 signal of this source of oceanic deep water masses. This project is designed and supported jointly with the Alfred Wegener Institut (AWI, Dr. E. Fahrbach) at Bremerhaven. Both institutes envision continuation of this joint research in coming years.

In mid-December Majoor joined our team for a PhD project. Partly for his training he will first join one crossing of 'Polarstern' through the temperate South Atlantic Ocean (see above). The main thrust of the thesis will be based on truly Antarctic expeditions, where his participation in cruises aboard either RV 'Polarstern' or RV 'Marion Dufresne' is foreseen. His project is part of the JGOFS theme (VvA-9) of the NWO Global Change programme.

CO_2-system in Norwegian fjords

M.H.C. Stoll, D.C.E. Bakker, H.J.W. de Baar

Bakker and Stoll participated in the *Emiliania huxleyi* study in April and May on board RV 'Pelagia' in a fjord near Bergen, Norway. Total CO_2, partial pressure of CO_2 (pCO_2) and oxygen content were determined on discrete samples from

various depths, as well as pCO_2 of continuously sampled surface water and marine air. This yielded information on the CO_2-system, on CO_2-fluxes between the ocean and the atmosphere and on physico-chemical characteristics of the fjords during the melting of the snow, preceding a bloom of the algae.

Enhanced storage of carbon dioxide in the deep ocean

H.J.W. de Baar

The immense prospect of rising levels of atmospheric carbon dioxide has led to many ingenious but very few, if any, feasible schemes for storage of CO_2 derived from fossil fuel. The option of deep ocean storage continues to attract policy makers and energy agencies. Upon request the feasibility of such scheme has been reviewed again, with emphasis on the fate of such deposed CO_2 in the ocean basins. Briefly the energy efficiency of deep ocean storage is not attractive; the CO_2 would be stored only temporarily, unless dissolution of calcium carbonate deposits ($CaCO_3$) is greatly enhanced and thus acts as a buffer. The rate of such $CaCO_3$ dissolution as function of CO_2 dumping is not known, yet deserves further investigation. The findings were presented at an international CO_2 storage conference held in March in Amsterdam, where representatives from industry, government and science were present.

Dissolved Organic Matter

C.J. Wiebinga, H.J.W. de Baar, J. Hegeman (Coastal Systems)

The modest preliminary dataset for comparison of three methods for determination of Dissolved Organic Carbon has been published in a special issue of Marine Chemistry, also reporting on the 1991 Seattle DOC intercalibration workshop where Hegeman participated.

The special NWO programme Global Change dedicated one theme to JGOFS (VvA-9) where a subgroup of three graduate students has been appointed to investigate dissolved organic matter in the oceans. C. Wiebinga started in mid-December and will study the abundance and microbial turnover rates of Dissolved Organic Carbon. As an undergraduate student he already worked on this project during two cruises (May and July) of the Netherlands Indian Ocean Programme. Also a literature study as required for his graduation was dedicated to this topic. The remainder of the year was spent preparing for another cruise in the Indian Ocean, taking place in January 1993, where both Wiebinga and Hegeman will participate. Parallel we have seen appointments of J. van Heemst at Delft University of Technology, and M. le Clercq at the Centre for Isotope Research of the University of Groningen. Van Heemst together with Prof. De Leeuw will investigate the organic geochemical composition of dissolved organic matter. Le Clercq together with Van der Plicht and Meier will assess the isotopic signature ($^{13}C/^{12}C$, $^{14}C/^{12}C$) of the same material. The overall team of three graduate students and several senior staff are currently setting up a coordinated research programme, where it is noted that the Delft team will as of early 1993 become part of NIOZ.

Ocean carbon cycle

T. Lukk, H.J.W. de Baar

Upon initiative of Prof. Goudriaan (Wageningen) and Dr. Westbroek (Leiden) an effort towards modelling the ocean carbon cycle was started by guest investigator Dr. Tomas Lukk from Estonia. The first period of the year Dr. Lukk spent at Wageningen, the second half he worked within our group at NIOZ. The ensuing model has been run sucessfully.

1.3. PHYSICAL OCEANOGRAPHY (H2)

INTRODUCTION

The theoretical research in the department of Physical Oceanography in 1992 mainly concerned the study of non-linear phenomena in the ocean. This implies predictable deterministic phenomena as well as deterministic but chaotic systems. Also some mathematical-physical modelling of the micro-environment of algae was carried out.

The processing of the data collected during the 1990 and 1991 cruises of the DUTCH-WARP programme has been completed. The analysis of these data continued in 1992. The complete data set consists of hydrographic, infrared-remote sensing, current meter, and surface drifter data. Besides these data, historical data from surface drifters and GEOSAT satellite altimetry have become available for analysis. Four surveys of WOCE XBT section AX5 in the north Atlantic were performed in cooperation with the Royal Netherlands Navy.

Together with a visiting scientist (G. Budeus) a large data set on the Arctic Front in the Greenland Sea has been completed. In cooperation with several German institutes these data are being analysed.

The participation in the Integrated North Sea project consisted of the maintenance of a mooring with a full suite of self-recording instruments and additional hydrographic observations over the Oyster Grounds. The data set obtained in this programme will be used to model the development and decay of the stratification and the interaction of the stratification with biological processes.

The Antarctic research has been continued by participation in the JGOFS Southern Ocean Programme on board RV 'Polarstern'. Based on earlier Antarctic cruises, models for the interaction between stratification and biological processes in the melting season have been developed.

By cooperation between the theoretical and experimental groups within the Department, a new programme has been initiated on shelf edge processes in the Bay of Biscay. A first research cruise to that area has been carried out, and at the end of the year a second PhD student was appointed for the study of shelf edge processes.

Experience in the dpfield of marine optics was made operational by our participation in the Anglo-French FLUX MANCHE project. Also a new national project to study particulate matter in the North Sea by optical methods was supported. A PhD student has been appointed for this project, with scientific guidance from the University of Southampton. Thermal remote sensing was used for the study of meso-scale features in the North Atlantic as well as the Somali Current.

H2-01 NON-LINEAR DYNAMICS OF OCEAN CIRCULATION

J.T.F. Zimmerman, L.R.M. Maas, R. v.d. Toorn

A strategy has been formulated for a study of the dynamics of eddies on a beta plane. We will try to combine the skills of Hamiltonian fluid mechanics and variational principles generated by it with the method of re-normalization. In order to gain insight into Hamiltonian fluid dynamics, it has been placed in the context of calculus on manifolds. This has yielded a clear view on current variational principles in fluid dynamics and has added to our understanding of the connection between the Lagrangean and the Eulerian description of fluid motion.

The formerly obtained method of analysing non-linear ocean circulation models by means of a perturbation expansion in a small inverse Ekman-number was continued in order to arrive at 'almost free' fully inertial circulations. These can be formulated exactly in terms of the perturbation series. For the first time it seems that in this way an 'almost free' inertial circulation can be obtained analytically that obeys the principal integral constraints of these kinds of motion and that seems to approach a linear relationship of the absolute vorticity and the stream function. (Co-scientist: W.T.M. Verkleij, KNMI, de Bilt.)

H2-02 NON-LINEAR TIDAL DYNAMICS

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

a) Non-linear Helmholtz-resonator

A Helmholtz-resonator, in the oceanographical context, consists of an inland sea, or bay, which is connected to a larger sea or ocean, by a relatively narrow channel. In addition to the (slightly changed) eigenmodes of an entirely enclosed bay, the pumping, or Helmholtz-mode can be excited. This mode, driven by a mass-flux through the channel, consists of the water in the basin going up and down in unison. When the sides of this largely enclosed bay are sloping the restoring force has become non-linear. This is obvious: with a constant mass-flux, it will take more time to raise the water level by the same amount when the water level is initially high, than when it is low, because then the area occupied is smaller. This non-linearity has a number of interesting implications. First, it provides a natural mechanism by which a system may detune itself. Second, it may give rise to multiple steady states and associated shocks (sudden in- or decreases in water level). There are indications that some of the smaller Wadden basins are behaving as a non-linear Helmholtz-resonator at (and near) the tidal frequency (*e.g.* the Schiermonnikoog-Lauwers-oog basin).

b) Internal tides and solitons

The equations that are to describe internal solitons have been submitted to a critical evaluation. Some of them rest on the assumption that waves travel in one direction only; this turns out to be pernicious as soon as (earth) rotation is significant (which may well be the case for internal solitons in the ocean). Hence we preferred to omit the assumption of unidirectional travelling, and thus found a rotation-modified Boussinesq equation, which is presently being investigated by numerical methods.

Quasi non-linear tide-topography interactions have been studied in order to clarify the mechanism by which solitons are generated. Numerical analysis allowed us to study the generation of internal waves near the sill. The non-

hydrostatic case proved to be intricate, though the evolution of strong depressions was convincingly brought to light. Whether such a depression leads to solitons or not is still to be investigated.

H2-03 NON-LINEAR TIDAL DYNAMICS: CHAOTIC STIRRING

H. Ridderinkhof, J.T.F. Zimmerman, P. Beerens

Particle trajectories in a 2D fluid can be chaotic even if the flow is laminar. This so-called 'Lagrangean Chaos' or 'chaotic advection' may also be present in tidal areas such as the Wadden Sea. To investigate the presence of Lagrangean Chaos a numerical model of a tidal inlet has been made. The model consists of two dipoles working one at a time, simulating the ebb and the flood flow, resulting in a quadrupolar residual velocity field, which is typical of tidal inlets. By plotting the position of a particle after each tidal period a Poincaré map is constructed. This map looks like a stroboscopic picture of the particle trajectory. It has some interesting mathematical properties and is easier to study than the original system. Two parameters tune the stability of the system: the vortex strength tunes the non-linearity and the tidal period tunes the time dependence. The map has chaotic areas near the vortices, which grow linearly with the parameters. For physical values of the parameters the chaotic region covers almost the whole inlet. One of the properties of chaotic systems is that nearby trajectories diverge exponentially. This leads to strong mixing in the chaotic areas. Particle release model experiments were done to quantify the mixing. The diffusion coefficients calculated from the spatial distributions are in the order of 100 $m^2 \cdot sec^{-1}$, which shows that chaotic advection is an important - probably the dominant- mixing process in the Wadden Sea.

H2-05 EXPERIMENTAL OCEAN RESEARCH IN THE NORTH ATLANTIC

DUTCH-WARP

H.M. van Aken, C. de Boer, T. de Bruin, J.C. de Munck, L. Otto, R.X. de Koster, R. Manuels, S. Ober; M. Stoll (Dept. of Chemical Oceanography)

The data processing of the hydrographic data from the DUTCH-WARP cruises of 1990 and 1991 has been completed. The data from the 1990 AR7E WOCE Hydrographic Programme (WHP) section have passed the Data Quality Expert referee system and in their final form they have been sent to the WHP Special Analysis Centre (WHP-SAC) in Hamburg.

The analysis of the hydrographic data from the Iceland Basin is carried out in order to get a qualitative indication of the transport at deep and intermediate levels in the Iceland Basin. By defining characteristic water types in an objective way in order to establish mixing ratios, an attempt is made to study the mixing process quantitatively. For this last purpose an analytical mixing model is used, which, at present, only uses potential temperature and salinity data, but which will be extended to other tracers. The results have so far been puzzling. A new variational principle of inverse modelling of the geostrophic circulation has been developed. While traditionally the mean square of the reference velocity is minimized, the new model aims at minimizing the total enstrophy of the circulation. A student from Delft Technical University (A.E. Bollweg) performed an analysis of the required accuracy of the hydrographic parameters for the geostrophic calculations. The accuracy, as obtained during the 1990 and 1991 cruises, appears to meet the requirements.

The processing of the current-meter data and drifter data of the 1990 and 1991 cruises has been finished and compilations of these data have been pub-

lished. The deep flow over the lower southern Icelandic slope veers due to along-slope density gradients and seems to be influenced strongly by the bottom topography. A slight reversal of the bottom slope at 61° N, 20° W results in a reversal of the bottom current with overflow water flowing south-eastwards instead of westwards. Along the western slope of the Hatton Bank water flows in N-E directions at all levels. The ARGOS drifters deployed during the DUTCH-WARP cruise of 1991 could be followed during the first months of 1992. The last drifter finished transmission one year after deployment, on 16 April 1992, northeast of the Faroes. Preliminary study of the results shows a complex drift pattern with several eddies. Estimates of dispersion characteristics in summer and winter were made.

XBT repeat sections

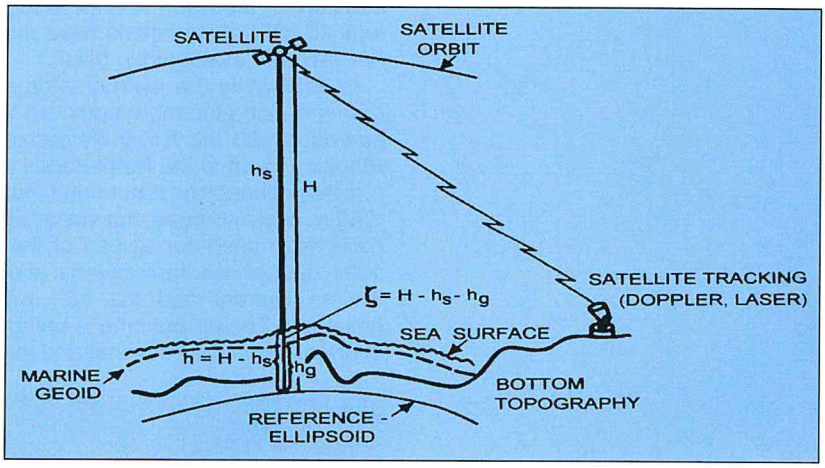
The crossing by RV 'Pelagia' to Greenland because of a programme of the Netherlands Geological Survey (RGD) offered the possibility to obtain additional XBT (Expendable Bathythermograph) measurements of the thermal structure of the North Atlantic along this transect. At distances of 30 n.miles in total 43 XBT observations were made between 7 and 16 July. The data have not yet been evaluated in detail.

In addition to the hydrographic activities in the Iceland Basin an XBT programme along the more southern WOCE AX5 section has been started in cooperation with the Royal Netherlands Navy. The frigates that sail across the Atlantic Ocean to the Netherlands Antilles and back carry out high-density (30 n.miles) observations four times per year. The observations are made with T-7 (750 m depth) probes, but since autumn 1991 also T-5 (1800 m depth) probes have been used during part of the programme. A preliminary analysis of the 1991 data shows that several features such as the presence of eddies, the Azores Current and the 18° water-mass in the Sargasso Sea can be observed. The programme is being continued, so in future these data will give information on the seasonal and inter-annual variations along the track.

RV 'Pelagia' looks very small against the steep rocky coast of Greenland. (Photo: C. Laban)

Satellite altimetry

Since both radar altimetry from satellites and ARGOS drifters give information about the surface oceanic currents, a comparison of the two types of data sets can give insight into the precision of the data sets and into the relevance of data processing techniques used to transform the raw data into oceanic currents. Therefore a study of the surface circulation of the north eastern Atlantic by means of surface drifters and altimetry has been initiated. In order to transform radar altimetry data into an oceanic current field it is necessary to have a better model of the earth geoid than the best ones currently available. However, without geoid we can derive the variability of the current, *i.e.* the difference between two currents in one place at different times. This variability can be compared with the variability of the drifter data, derived from the 'cross over points' of the drifter trajectories. In this study pre-processed GEOSAT altimeter data from the Department of Geodesy of the Technical University at Delft are used and the drifter data have been obtained from NOAA.



The geometry of an altimetry satellite measuring its height above the sea surface.

H2-06 GREENLAND SEA PROJECT

H.M. van Aken, G. Budeus

During the six-month stay of G. Budeus (AWI, Bremerhaven) at NIOZ research has been carried out on the Arctic Front in the Greenland Sea. A number of XBT surveys from different years and seasons have been processed as well as additional CTD-sections and a number of ARGOS surface drifters. These data display intensive eddy fields where the eddies are nearly stationary. The eddies may form a mechanism for cross-frontal transport of salt, heat and fresh water, competing with intrusive processes. The small scale of the eddies (25-50 km) and their frontal jets (5 km) easily lead to a highly aliassed estimate of the transport in the Norwegian Atlantic Current if this estimate is based on discrete ADCP stations on a 20-km grid coinciding with a high resolution CTD-survey. This research is carried out in cooperation with Hamburg University and AWI, Bremerhaven.

H2-07 JGOFS/SOUTHERN OCEAN, PHYSICAL PART AND MODELLING

C. Veth, S. Ober, M.R. Manuels, R.X. de Koster

The southern Atlantic Ocean is characterized by a zonally structured series of water masses separated by frontal regions. During the JGOFS/Southern Ocean project on board RV 'Polarstern', a hydrographical section between 47°S and 60°S along the 6°W meridian has been investigated repeatedly in several stages of development following the spring retreat of the seasonal sea-ice cover. The section under investigation covered the most northern part of the Weddell gyre, the frontal zone between the Antarctic Circumpolar Current (ACC) and the Weddell gyre, the southern ACC, and the Polar front. In the measurement period the sea-ice retreated several degrees, but this was mainly sea-ice north of the ACC-Weddell front which seemed to be transported north of this front by eddies. Satellite pictures clearly showed the interaction between the sea-ice edge and the frontal structures in cases where they were close to each other.

The frontal zones are detectable from the surface to the bottom. Instabilities in the frontal structures are not in phase at all depths, which means that interleaving of water masses from the different sides of the front is found at stations near the front. A consequence of this is that layers containing relatively high concentrations of phytoplankton are regularly found underneath layers with low concentrations. Density differences prevent the deeper layers from reaching the euphotic zone to a sufficient extent and these algae will stop taking part in the primary production. The algae in these layers will be likely candidates for the sedimentation, and enrichment of the silicate in this zone.

The hydrographic data will be used to validate a one-dimensional mixed-layer model developed during the EPOS-project. The presence of frontal zones will be a major complication. From the measured CTD-profiles it is clear that multi-dimensional processes and advection cannot be ignored. Chemical and biological tracers will be applied to get an idea about the water motions near the fronts.

H2-08 EPOS, PHYSICAL PART AND MODELLING

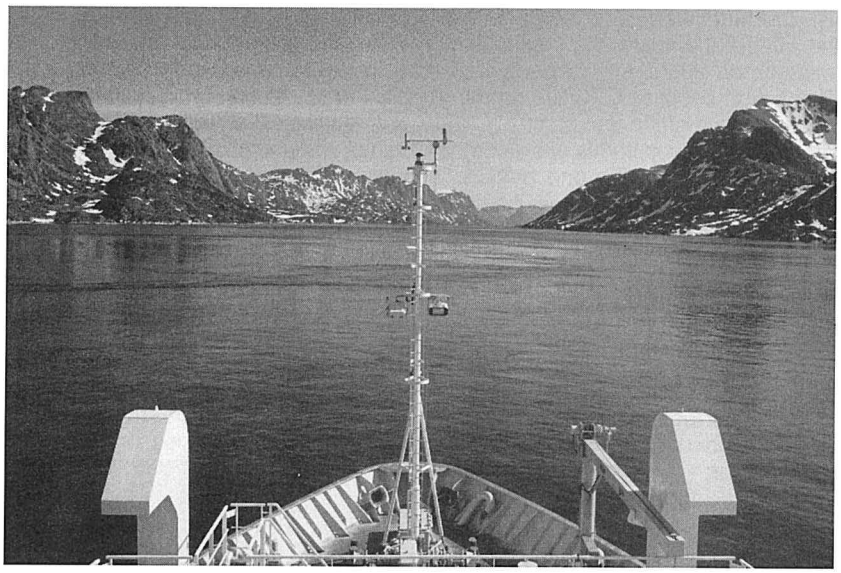
C. Veth, S. Ober

In cooperation with C. Lancelot (Université Libre Bruxelles) a study has been made of the physical factors controlling the phytoplankton bloom in the Weddell Sea during spring sea-ice retreat. The study was based on the data collected during the EPOS-cruise leg-2. It was shown that the combined effect of melting and heating on the stability of the water column is roughly a constant for different ice concentrations; in the literature the importance of the melt water lens is often exaggerated. A study of the relationship between ice coverage and sea-water temperature indicates that it is possible to use seawater temperature as a clock. This makes it possible to combine data from different stations for process studies in the wind-mixed layer. Data to confirm this will be collected during JGOFS/Southern Ocean (H2-07).

H2-10 INTEGRATED NORTH SEA PROJECT (INP), PHYSICAL PART

J.J.M. van Haren, C.Veth, H. Ridderinkhof, R. Manuels

In continuation of the project in 1991, a multi-disciplinary mooring has been deployed at a single site in the Oyster Grounds (54°25' N, 4°02' E) between February and October. The mooring consisted of a number (3-6) of current meters, 2 thermistor strings, a fluorometer and 2 mussel cages and was serv-



RV 'Pelagia' at the entrance of the Søndre Strømfjord, Greenland.
(Photo: T. de Bruin)

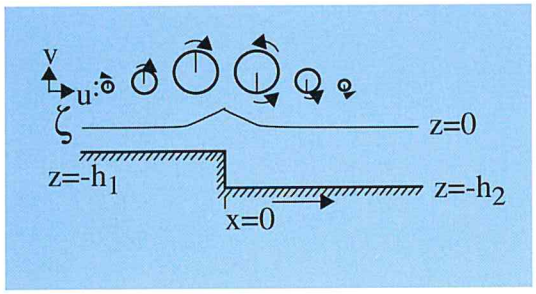
H2-14 SHELF EDGE PROCESSES

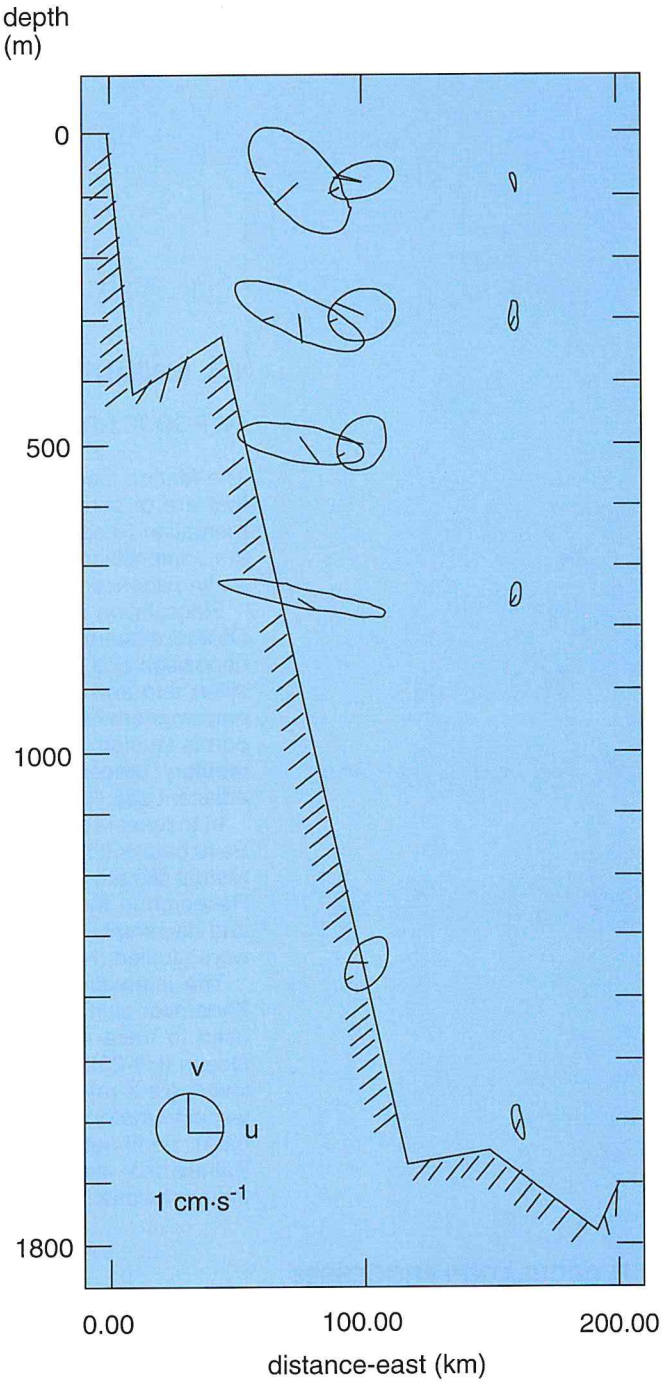
H.M. van Aken, L.R.M. Maas, J.T.F. Zimmerman, F.-P. Lam, Th. Gerkema, S. Ober

A student from Utrecht University (F.-P. Lam) investigated the barotropic and baroclinic tides, as observed between Greenland and Jan Mayen during the Greenland Sea Project (see also H2-06). The diurnal barotropic tides, especially the K1 sub-inertial tide, appear to have a cross-shelf structure which can be described by a double Kelvin wave. The semi-diurnal baroclinic tides have a time varying amplitude due to variations in the background stratification and low-frequency currents. The first internal mode is dominant for the semi-diurnal internal tides. The observed bottom-ward intensification of the diurnal tides needs an explanation in terms of topographic Rossby waves in a stratified ocean. This research on shelf edge bound tidal phenomena is continued as a PhD study

A field experiment in the Bay of Biscay was carried out in June on board RV 'Pelagia'; CTD observations were carried out along two sections normal to the continental shelf slope. In this same area, at three drifting stations, simultaneous CTD yoyos, echo-sounder and ADCP observations were obtained. These observations contain information on the low-frequency and tidal (and super-tidal) frequency ranges, respectively. The first data set contains some evidence of a northward flowing geostrophic current along the shelf edge as well as of the presence of Mediterranean Water. The second set shows some clear features of the (well-known) non-linear tide in that area (many high-frequency, possibly solitary waves, and first and second mode motions). Students from Utrecht University and Delft Technical University participated in the cruise.

In collaboration with the Centre for Earth and Ocean Research, Victoria, Canada, research is carried out to reveal the combined effects of boundary mixing and the earth rotation when a geostrophic current flows along a sloping bottom in a stratified environment. The last two factors themselves, *viz.* a sloping bottom and stratification, are believed to be able to generate a cross-slope circulation and associated enhanced mixing. The effects of the earth rotation turn this into an even more complex system. Co-worker is C.J.R. Garrett, CEOR, UVIC, Victoria, Canada.





Horizontal current vector with diurnal (tidal; K1) frequency as a result of harmonic analysis of the observed time series (left). The 12 current meters were situated between Greenland and the isle Jan Mayen at 71°N. The ellipses (and velocity amplitudes) are much larger at the edge of the continental shelf. At the same time it can be seen that the orientation of the rotation is different: clockwise near the shelf edge, anti-clockwise off the shelf. These two observations suggest the existence of a so-called 'double Kelvin wave'. A sketch of the corresponding theoretical (and barotropic) velocity vector is given in the right hand figure. The double Kelvin wave propagates along the shelf edge, with the shallow water at the right hand side. To explain the downward amplification of the velocity amplitude, the density structure will be implemented in the theoretical model.

1.4. MARINE GEOLOGY AND GEOCHEMISTRY (H3)

INTRODUCTION

The Marine Geology and Geochemistry Department is studying several topics that are of prime interest in marine sediments: sediment transport and sedimentation (erosion) processes (both for suspended matter and for sand), and the composition of sediments and suspended matter in relation to origin and early-diagenetic changes.

Flocculation of suspended matter is studied under H3-01, *viz.* in the Ems-Dollard estuary and the Elbe river mouth in relation to the tides, followed by deposition and erosion on tidal flats along the Chinese coast (H3-02.2), deposition rate and resuspension in the southern North Sea (H3-02.3) and in the northwestern Mediterranean (EROS-2000 Programme; H3-02.4). Sand transport is studied off the Dutch coast (H3-06), Late-Quaternary and Recent sedimentary processes in the Skagerrak-Norwegian Channel (H3-07) and the adjacent sea areas of the Faroe-Shetland Channel (H3-08).

In Indonesia seismic and sedimentary studies were made in the Lombok and Savu basins (H3-10). In the Angola Basin palaeoceanography in relation to terrestrial climate is studied in a series of piston cores collected in 1989 (H3-13). Research in the Lena river mouth and the Laptev Sea was related to supply and dispersal of fine-grained sediment (H3-21). In the Black Sea mud diapirs were studied (H3-22).

The interaction of biogenic opal, silica and aluminium was studied in the Zaire river plume and in the laboratory (H3-15), while silica and nutrients were used to trace water masses in the Antarctic (H3-15) and in the NW Indian Ocean (H3-23). Ferrihydrate in recent sediments and soils is being studied by low-angle X-ray diffraction (H3-17) and radionuclides were studied (with α- and γ-spectrometry) in the Scheldt, the North Sea and Dutch coastal waters (H3-02.3). Semi-automatic microprobe analysis became operable and samples of Sahara dust were analysed (H3-20) related to the study of bottom sediments in the northwestern Mediterranean (H3-02.4).

H3-01 FLOCCULATION PROCESSES

D. Eisma, S. Chen, J. Kalf, A. Li

The data collected in the Dollard in January 1991 were analysed and the suspended matter photo-negatives were analysed (by image analysis) for particle size. During the tidal cycle a clear relation was found between floc size and

particle concentration. Concentrations of fine particles were particularly large after slack tide, which indicates that resuspension of fine material occurs when the tidal current velocity increases. This is followed by flocculation in the water. These results suggest that in a tidal area such as the Dollard, particle concentration determines floc size rather than current velocity (turbulence). This will be checked with data from earlier measurements in the Dollard and the Elbe estuary.

In January a first cruise was made to study flocculation of suspended matter in the North Sea. With the *in situ* suspension camera and image analysis system floc size was measured and additional analyses were made of suspended matter concentration, Coulter counter size, organic matter content and organic matter composition. As image-analysis of the *in situ* camera negatives and the organic analyses are time-consuming, the final results are not yet available. Stable carbon isotope analyses as well as the suspended matter concentrations indicated considerable resuspension of fine-grained material during or just prior to the cruise. This cruise was the first of four cruises studying flocculation during four different seasons in the North Sea.

In situ measurement of suspended matter particle size in the northern Mediterranean (Gulf of Lions), carried out in December 1988, has caused problems during image-analysis because of low particle concentrations and a high frequency of scratches on some of the negatives. Counting by eye was necessary because the image-analysis system does not distinguish between real particles and the artificial 'particles' produced by the scratches, which, however, can easily be distinguished by eye. We obtained good results by counting as many particles as possible and by counting the particles in the scratched negatives by eye.

A calibration was carried out with undamaged negatives between directly counted particles and those counted by the image analysis system. The results show, as expected, much higher suspended-particle sizes than found with Coulter counter. The total particle surface area and particle volume are not much influenced by the percentage of fine particles (<50 μm), although they occur in relatively large numbers. The total particle volume is strongly influenced by the number of large particles (also when there are few). The particle-size distributions (based on particle volume) are generally log-normal. This suggests that the flocculation process is a random process, depending on the particles available.

H3-02.2 DEPOSITION AND EROSION IN THE TIDAL FLATS ALONG THE CHINESE COAST

D. Eisma, J. Kalf

In spring the *in situ* suspension camera was shipped to Shanghai to be used in flocculation studies, but because of delays during transport it arrived too late in Shanghai for fieldwork and was shipped back to NIOZ. With the collaborating institutes in Shanghai, Hangzhou and Nanjing it was agreed to postpone this research until 1994.

Tj.C.E. van Weering, G.W.Berger

Mr. Xia Xia Ming and Mrs. Xie Qinchun (Second Institute of Oceanography, Hangzhou) ended their study visit to NIOZ on May 2. During their stay the samples of Wenzhou Bay and the Oujiang estuary collected during 1991 were studied. Initial results indicate that the Holocene development of the tidal flats is reflected in three stages (0-4000 BP, 4000-8000 BP and 8000-10000 BP). The distribution of surface sediments reflects the input of coarse sediments derived from the Oujiang and of fine sediment by a southerly directed coastal

current, with the Chiangjiang river as the main source. Based on ^{210}Pb measurements three different accumulation areas with high (~3 cm·y^{-1}), medium (~1.5 cm· y^{-1}) and low (0.5 cm·y^{-1}) accumulation rates could be recognized.This relates to the morphological facies distribution of the tidal flats forming the southern Oujiang estuary. Here a high tidal flat with mixed sand/mud facies, a sandy middle tidal flat and a muddy lower tidal flat can be discriminated.

This programme forms part of the Chinese-NIOZ cooperative programme (through the China commission of the KNAW).

H3-02.3 THE ^{210}Pb and ^{210}Po SYSTEM IN THE SOUTHERN NORTH SEA

D. Eisma, J. Beks, Z. Zuo

The results obtained by Z. Zuo in the southern North Sea were presented as a thesis (which was defended on 8 September). The distribution of ^{210}Pb and ^{137}Cs in the southern North Sea indicates strong sediment mixing. Mixing rates are higher in the Outer Silver Pit area than in the German Bight. Deep penetration of ^{137}Cs may be linked to migration in the sediment or to size-selective mixing. Subsurface maxima are thought to be related to biogenic mixing, which is the dominant mixing process in the southern North Sea. The residence times of ^{210}Po and ^{210}Pb in the water are in the order of 66 to 80 days.

Removal by sinking particles is strongly enhanced by resuspension and redeposition. River input is unimportant. The low concentration of dissolved ^{210}Pb in the southern North Sea is due to the low atmospheric input, the high concentrations of suspended matter and the high sediment resuspension rates. A mass balance for ^{210}Pb and ^{210}Po was made on the basis of a scavenging model.

This programme was extended to the entire North Sea, possibly including in the future also the eastern part of the Channel. During the cruise in January, samples of suspended matter for particulate and dissolved ^{210}Pb, ^{210}Po and ^{137}Cs were collected over the entire North Sea. The vertical and horizontal fluxes of ^{210}Pb and ^{210}Po in the North Sea will be studied as well as their nearshore concentration. It is the first part of a programme to be carried out seasonally in 1992 and 1993.

H3-02.4 SEDIMENTATION RATES IN THE NORTHWEST MEDITERRANEAN (EROS-2000)

D. Eisma

Additional sedimentation rates were determined (using ^{210}Pb) in cores collected in November 1991 (with RV 'Tyro') in the Gulf of Lions and the adjacent deep sea as well as off the Ebro river mouth. These were used in combination with data on trace metal concentrations in the sediment for estimating trace metal fluxes to the bottom.

H3-06 FORMATION OF EBB-TIDAL DELTAS AND CHANNELS IN AND NEAR COASTAL INLETS OF THE WADDEN SEA

Tj.C.E. van Weering, D. Eisma

Comparison between sample results of the Ameland tidal inlet collected in 1987 and those of 1990 shows the extremely short time scale of sediment (re)distribution in the outer ebb tidal delta. Storm wave activity in shallow water is considered the main responsible agent. This study formed part of a MSc thesis by Theo Arp (VU Amsterdam).

H3-07 LATE QUATERNARY AND RECENT SEDIMENTS AND SEDIMENTARY PROCESSES IN THE SKAGERRAK, THE NORWEGIAN CHANNEL AND THE ADJACENT CONTINENTAL SLOPE

Tj.C.E. van Weering, L. Moodley, E. Okkels

During 1992 Leon Moodley finished his PhD on experimental ecology of benthic foraminifera in soft sediments and its (palaeo)environmental significance. He showed that in areas with relatively high organic carbon input more living foraminifera are found, also deeper below the sediment surface. The downcore distribution of foraminifera seems to be determined by biological interactions, allowing passive and active downward migration. These field studies were supported by laboratory experiments, which showed that oxygen enrichment through burrows creates favourable conditions for foraminifera deeper down in the sediment where oxygen depletion normally occurs.

Another important factor is the meiofaunal activity at and in the sediment. It has been shown that the interrelated effect of food availability and biological interaction increases the usefulness of benthic foraminifera as palaeo-evironmental indicators for depositional conditions of for instance Skagerrak sediments.

Boxcore samples collected during the 1991 cruise with RV 'Pelagia' to the northern Norwegian Channel were studied for their foraminiferal content, including both dead and live (stained) assemblages, by Katalin Baldi (Tempus grant from Budapest University). Results show that there is a positive correlation between the planktonic/benthic foraminiferal ratio and salinity, the planktonic foraminifera being contained in the inflow of Atlantic water at the western margin of the Norwegian Channel. The distribution of the live assemblages seems to coincide with bottom water mass properties. The standing crop of the foraminifera in the >125 μm fraction corresponds with the distribution of organic matter in the surface sediments.

H3-08 SEDIMENTATION AND SUSPENDED MATTER TRANSPORT IN THE FAROE-SHETLAND CHANNEL

Tj.C.E. van Weering

Interpretation was started of seismic profiles taken east of the Faroer in cooperation with the Danish Geological Survey. Midway on the continental slope they show drift deposits caused by NDSW transport parallel to the slope. Large-scale slump structures occur at the base of the continental slope; these are probably of Recent age.

In cooperation with Drs Duplessy and Labeyrie (CNRS/CEA, Gif sur Yvette, France), we continued our study of core NA 87-22. AMS age determinations will allow high resolution stratigraphy and a study of the changes in water masses during the postglacial.

H3-10 SEISMIC STRUCTURE AND SEDIMENTARY DEVELOPMENT OF THE LOMBOK AND SAVU FORE-ARC BASINS, INDONESIA

Tj.C.E. van Weering, A.J. van Bennekom, W.J. van der Werff, J. van Iperen, J.H.F. Jansen

On the basis of both single channel and multichannel (industrial) seismic profiles the forearc basin structure was further outlined. A possible structural relationship between Sumba and Northern Timor was established. We also found evidence of a 'lost' volcanic arc of Miocene age south of Sumba, thought to be responsible for the large amount of volcanic detritus in the Savu Basin and on Sumba.

In February 1992, during a one-month field campaign on Sumba, a set of samples was collected which is being used to establish a vertical profile of

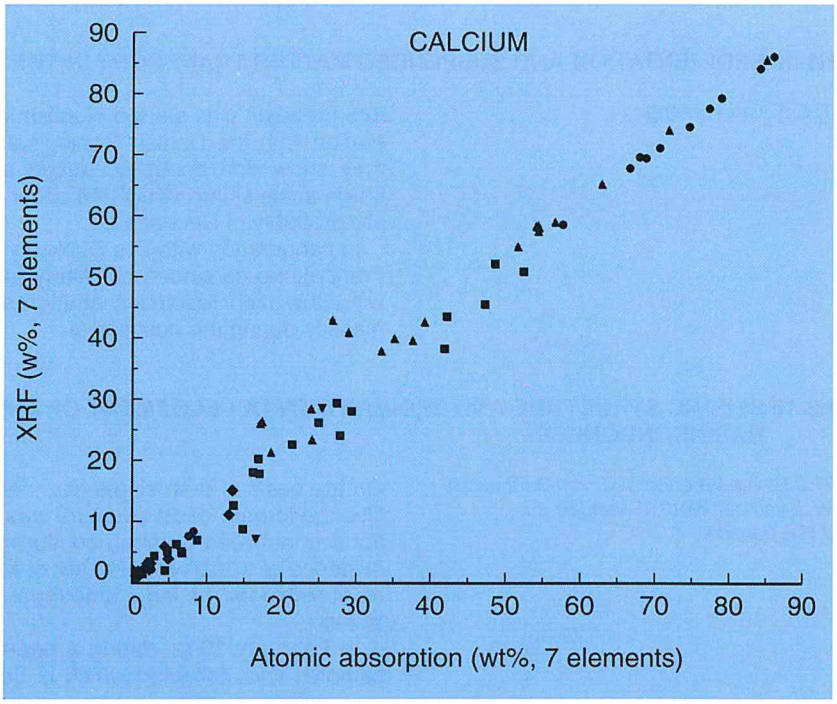
physical parameters of the rock section which presumably also fills the Savu basin and part of the Lombok basin. These parameters will subsequently be used for seismic modelling.

Diatoms in surface sediments collected during the Snellius II expedition were studied to assess their relationship with water masses in the region. Pacific Ocean and Indian Ocean assemblages were defined, allowing calculation of a PO/IO ratio which can be used in downcore studies of variations of water masses through time. Three significant diatom assemblages were distinguished by factor analysis, related to warm, saline oceanic surface water (1), to low salinity inflow in Makassar Strait (2) and to main seasonal upwelling areas in the Arafura Sea and south of Java (3). Shelf influence is shown in high abundances of allochthonous species. Downcore studies of their presence will yield information on effects of sea-level changes. Preliminary results of piston-core G6-4 show lower PO/IO ratios in interglacials, indicating less Pacific water throughflow.

H3-13 PALAEOCEANOGRAPHY OF THE ANGOLA BASIN AND TERRESTRIAL CLIMATE

J.H.F. Jansen, E. Ufkes, J.M. van Iperen

Several piston cores taken during the expedition to the Angola Basin in late 1989 were selected for AMS ^{14}C dating, micropalaeontological studies, and measurements of stable isotopes by R. Schneider (Geowissenschaften, Universität Bremen). The first results confirm the provisional stratigraphy based on XRF measurements of calcium with the CORTEX corescanner.



XRF measurements of calcium compared with atomic absorption measurements of the same element. The values are in relative concentrations of 7 elements.

The CORTEX corescanner

The measurements have shown that the Ca fluorescence represents the $CaCO_3$ concentration, so that we may use the carbonate stratigraphy known for the Atlantic Ocean. This stratigraphy parallels the deep-sea $\delta^{18}O$ curve. The XRF data have been verified with atomic absorption (AAS) analyses. The results are very promising: we believe that it will become possible to obtain semi-quantitative data for at least the most important chemical elements. Because the first version of CORTEX is limited to measurements of the elements with an atomic number of 20 (Ca) and higher, a second version of the CORTEX has been constructed. It is equipped with a specially developed KEVEX detector which can also detect elements with atomic numbers <20 such as Si (14) and Al (13).

Planktic foraminifera

During the expedition to the Angola Basin planktic foraminifera were collected from the surface water. The counts were subjected to cluster analysis, which gave better results than the principal component analysis applied previously. The cluster analysis yielded 5 clusters which are mainly determined by temperature and productivity of the surface waters. The clusters 1, 2 and 3 reflect the impact of the Zaire River, the Benguela Current and the open ocean, respectively. At the Angola Benguela Front (16°S), the clusters 4 and 5 are related to the South Equatorial Counter Current and the outer edge of the Benguela Current.

Downcore studies of piston core T8940 from Walvis Ridge show a mixed fauna of coexisting 'polar' and '(sub)tropical' species in interglacial intervals. Generally, polar assemblages are thought to represent cool surface water in particular. 'Polar species' have also been recorded in the plankton samples, where they indicate increased productivity rather than low temperatures. Therefore, the mixtures probably point to high interglacial productivity.

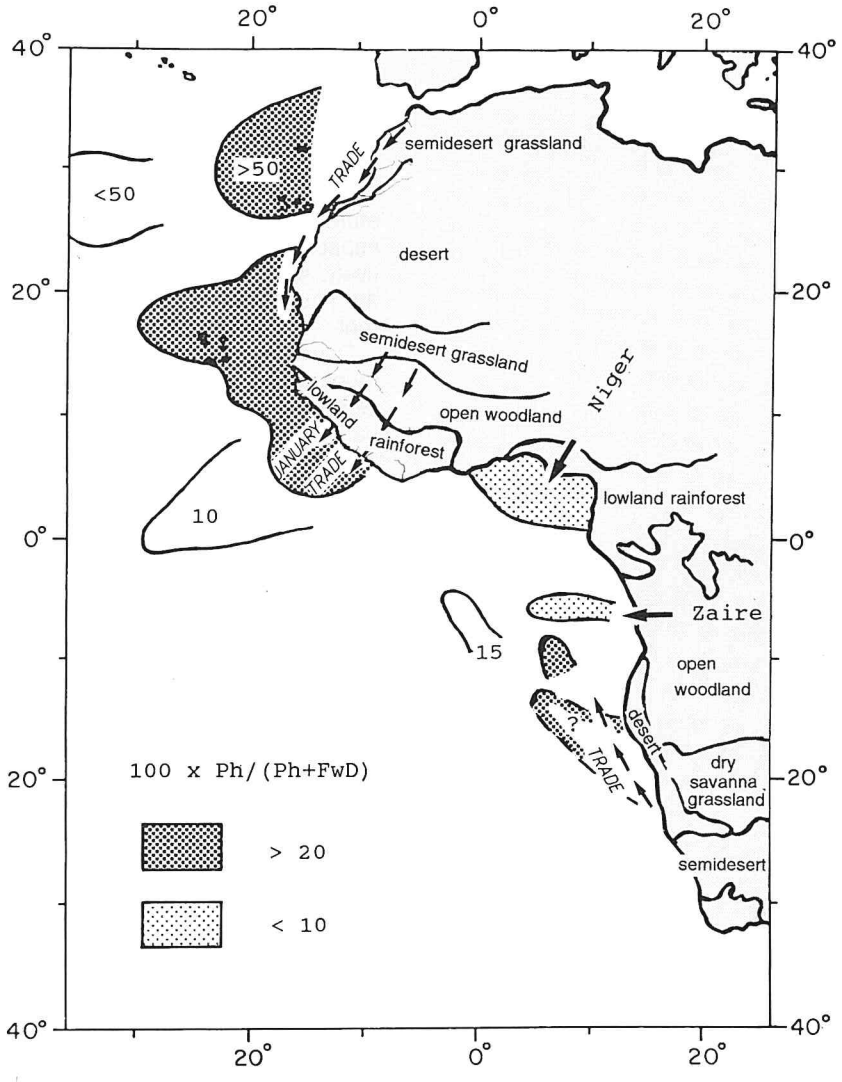
Freshwater diatoms and opal phytoliths

Two types of siliceous microfossils in marine sediments are of terrigenous origin: freshwater diatoms (FD) and opal phytoliths (Ph). Phytoliths are siliceous clasts from leaves of vascular plants, mainly grasses. In the central Atlantic off northwest Africa, opal phytoliths and FDs are predominantly supplied by wind transport. Previous work on sediments of the Zaire deep-sea fan has, however, demonstrated that a fluvial contribution cannot be ignored. The PhFD ratio, Ph/(Ph+FD), has been introduced as a proxy of the contribution of wind *versus* fluvial supply and as a proxy of palaeoaridity on land. We have tested the significance of this proxy for the eastern Central and South Atlantic in co-operation with E.M. Pokras and L.H. Burckle (Lamont Doherty Geological Observatory, USA) and B.Stabell (Geological Institute, University of Oslo).

From the distribution in surface sediments of the eastern Atlantic it appears that regions of dominant fluvial and eolian supply can be distinguished on the basis of the PhFD ratios: for fluvial transport PhFD <10, for eolian transport PhFD >20. This is true for the zone within about 800 km from land. More offshore, the PhFD ratio decreases due to selective eolian transport of small diatom fragments. Time series of cores from south of the lowlands rain-forest belt in NW Africa appear to match the continental climate data for the last 150 000 years. Consequently, high PhFD ratios represent aridity in the rain forest in NW

Africa south of the Sahara. West of the Sahara, however, high PhFD ratios were created in the most humid periods. Here, the diatoms originate from deflation of dry lakes and coastal sebkhas in the Sahara, while the phytoliths are produced by the Sahelian grassland.

We conclude that the PhFD ratio is a proxy of aridity on land. High PhFD values represent aridity, except if the source area of the diatoms is a desert. In this case the lowest PhFD ratios reflect the severest aridity.



PhFD ratios for surface sediments in regions of large influx of freshwater diatoms (FD) and opal phytoliths (Ph) in the eastern central and southern Atlantic. West of the Sahara, around 25°N, the ratios are low due to enlarged eolian influx of freshwater diatoms originating from dry lakes and coastal sebkhas.

H3-15 THE GEOCHEMICAL CYCLES OF SI AND AL

A.J. van Bennekom

Al/Si ratios in diatoms sampled with nets from surface waters in the Angola Basin and in surface sediments from the Angola Basin and the Southern Ocean were determined with the wavelength-dispersive microprobe technique available at the Technical-Physical Service for Agriculture (TFDL) at Wageningen University. The low Al/Si ratios in plankton samples (Al/Si 0.0007 to .007) cannot be determined with the energy-dispersive technique available at NIOZ.

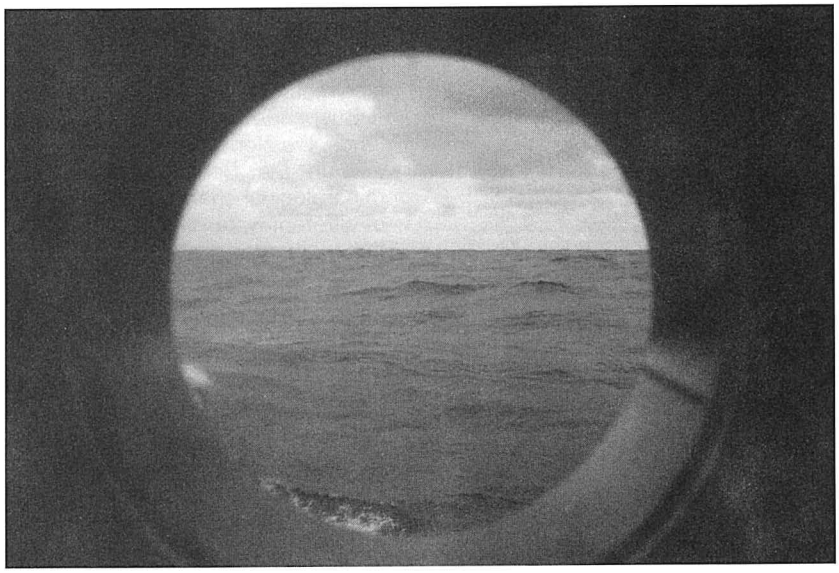
Calibration was carried out with samples of pure diatoms, in which Al was also determined with flameless Atomic Absorption Spectroscopy. The average Al/Si ratio was the same with both methods but the microprobe results showed a large variation, both in frustules of the same species and between species.

Diatoms from the edge of the Zaire river plume had a slightly lower Al/Si ratio than those from the open South Atlantic, in spite of the fact that Al/Si in water was higher in plume waters. Apparently more factors play a role in the uptake of Al than the Al/Si ratio in water.

In diatoms from the Zaire deep sea fan the high Al/Si ratios (.14 to .16) are the same at .5 and at 10 cm depth, whereas in the Southern Ocean there is an increase of Al/Si with depth. It can be concluded that the 'armouring' of biogenic silica with Al, which greatly reduces the dissolution rate, mainly takes place in the surface sediments. In a coastal environment like the Zaire deep sea fan, where many Al-releasing minerals are present this is a quick process, whereas the armouring proceeds more slowly in the open Southern Ocean.

Nutrients in the North Sea and rivers

In the framework of a workshop organized by the Tidal Waters Division of Rijkswaterstaat 'early' data on nutrients were compiled. Since about 1980 there has been a decrease in the spring and summer concentrations of silicic acid in the lower branches of the river Rhine, while the winter concentrations remained the same. Probably this is due to inhibition of diatom growth before 1980 when the river was more 'polluted'.



(Photo: T. de Bruin)

H3-17 THE ROLE OF CRYPTO-CRYSTALLINE MINERALS IN SEDIMENTS

S.J. van der Gaast

Differential X-ray powder Diffraction (DXRD) studies of North Sea sediment samples, which are visibly free from Si frustules of diatoms *etc.*, has shown that about 0.8% Si, as amorphous SiO_2 (opal), can be dissolved with 0.05N Na_2CO_3. This low amount of opal can be released from submicroscopic fragments of diatom frustules *etc.* and from the outside of quartz particles, having an amorphous phase. Si can also be present on and in precipitated Fe-(hydr)oxides in the sediment. DXRD indicates that these phases are probably the poorly crystallized ferrihydrite and akaganeite. This work has been carried out in cooperation with M. Gehlen (Free University Brussels) and A. Khan (Atomic Energy Centre, Dacca, Bangladesh) under supervision of W. van Raaphorst (BEWON S-01a).

For proper X-ray analysis of clays and clay minerals it is recommended to measure at defined relative humidity conditions. At NIOZ this technique has already been employed for 15 years. An apparatus to generate these humidities has been developed at NIOZ and is now commercially available from Philips Analytical, X-ray division.

With the new low-angle XRD apparatus, measurements on mixed-layer clay minerals have been carried out to detect their particle stacking. With the total reflection of the X-ray beam at the specimen surface it is possible quickly to measure the degree of obliquity of stacking of particles. The interparticle diffraction effect, showing its presence as a broad reflection at low angles, can also be measured. It is new that these two effects can be measured accurately and so quickly on an XRD apparatus. Moreover, the preferred orientation of the particles in the specimen can also be measured and agrees well with values found with a differently equipped XRD apparatus. This work has been carried out in cooperation with H. Lindgreen from the Geological Survey of Denmark and P. Hansen from the University of Copenhagen.

H3-20 SEMI-AUTOMATIC MICROPROBE ANALYSIS

J.P. Beks, J.W.M. de Graaff, D. Eisma

The mineralogy of silt size particles was measured by semi-automatic microprobe analysis, developed at NIOZ in 1991. By this method, the composition of single particles on a filter is compared with a set of 20 standard minerals.

Suspended matter samples from the sea between Iceland and the Shetlands, the North Sea and the Scheldt estuary were analysed. The mineral content in the Scheldt estuary shows a transition from fluvial to marine mineralogical characteristics. Preliminary results indicate that characterization of different watermasses can be made by the ratio of illite to montmorillonite in the suspended matter.

H3-21 SUSPENDED MATTER AND BOTTOM SEDIMENT IN THE LENA RIVER MOUTH AND THE LAPTEV SEA

D. Eisma, J. Kalf

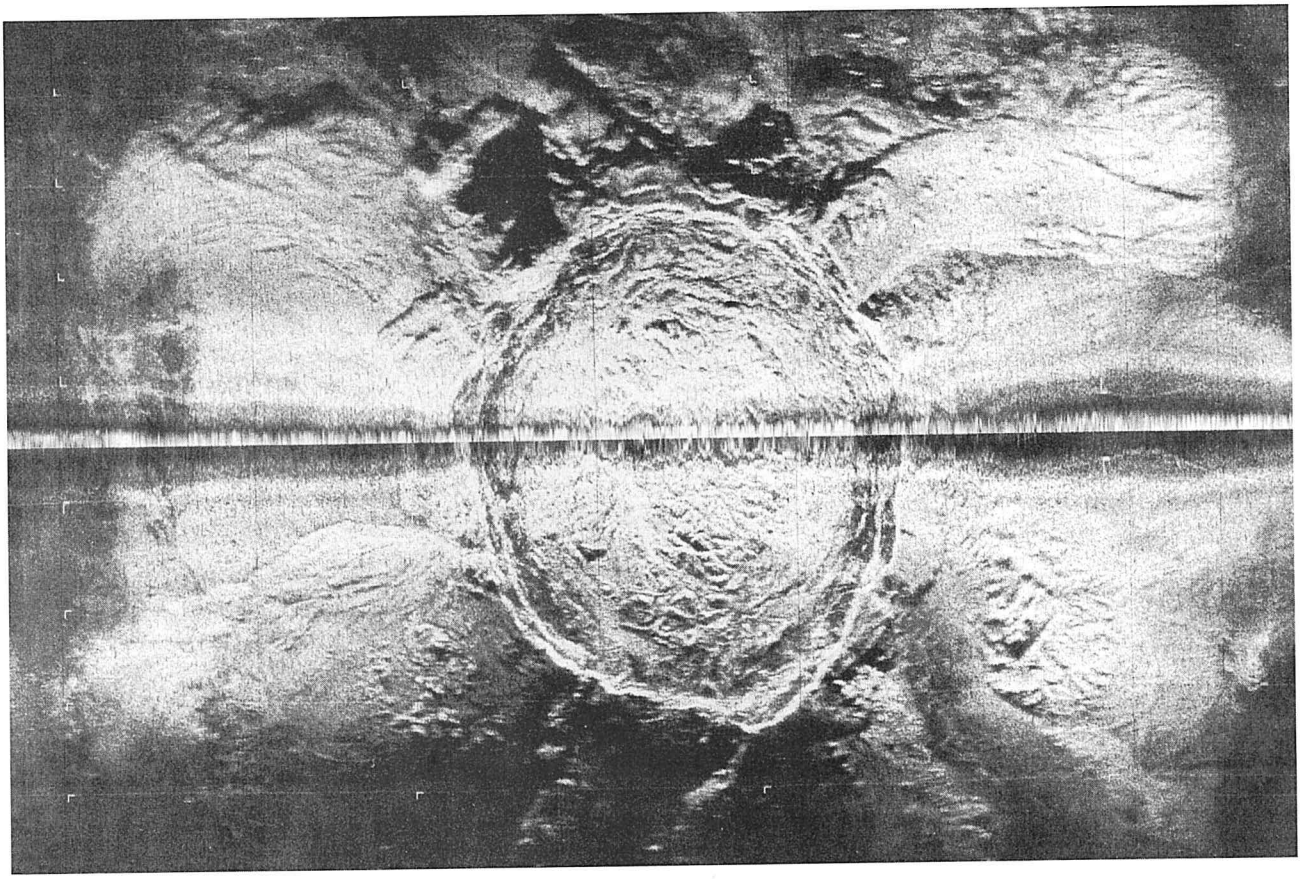
Analyses of the samples from the Lena river mouth and the Laptev Sea were not yet finished by October 1992. The results so far obtained on sedimentation rates (with ^{210}Pb) are difficult to interpret. Older sediment is present on top of younger sediment, which may reflect a natural displacement of sediment because of mass movements along a slope or under the influence of ice, but may also have originated during sampling. More analyses will be done to clarify this.

H3-22 BLACK SEA MUD DIAPIRISM

Tj.C.E. van Weering

The boxcores collected during the 1991 cruise in the Black Sea are being studied for their surface and downcore ^{210}Pb and ^{137}Cs distribution. The Rare Earth Element distribution across the sapropel/normal marine sediments transition is being studied, but sample analysis has not yet been finished.

The mud volcanoes in the Black Sea south east of the Crimean peninsula generally have a mushroom-shaped or crater-like cone that rises 40-120 m out of the surrounding sea floor. Their diameter at the sea bottom ranges from 900 to 2700 m. However, asymmetrical shapes with depressional sinks and rims along the margin also occur. The distribution and seismic character of the mud volcanoes show that they must be related to overpressure induced by gas pressure released from below.



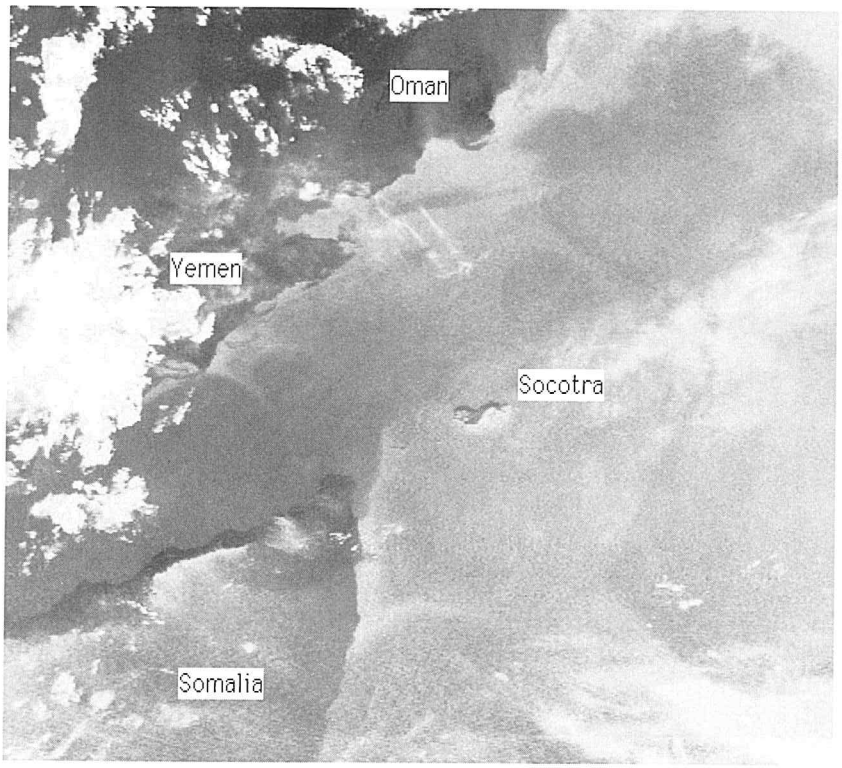
Surface structure of a mud volcano in the Black Sea, registered by a deep-towed side scan sonar, made in Russia by Yuzmorgeologia in 1991; local water depth is 2200 m; the diameter of the mud volcano is about 100 m. The photograph clearly shows the various mud flows over the rim of the crater. The mud contains fragments of sediment and clay breccia, associated with (mainly biogenic and a small quantity of thermogenic methane) gas released from below.

H3-23 WATER MASSES IN THE NW INDIAN OCEAN; NETHERLANDS INDIAN OCEAN PROGRAM (NIOP)

A.J. van Bennekom, M.A. Baars
(Pelagic Systems)

An overview of the hydrography of the NW Indian Ocean was prepared as a guidance for NIOP participants to the extensive literature on this region. The origin of the different water masses present in the region between Socotra and Somalia has been investigated using oxygen and nutrients as tracers together with temperature and salinity. In deeper layers silicic acid appears to be a useful tracer, together with temperature, salinity and oxygen, to distinguish between the various water masses. A preliminary conclusion is that during July and August in a section between Cap Guardafui and Socotra the presence of water masses from the Somali Basin is more pronounced than direct influence of water masses from the Gulf of Aden and the Arabian Sea.

As part of the project 'Application of remote sensing techniques during NIOP' (H2-13), the upwelling off Somalia was regularly observed by means of infrared images received on board from NOAA satellites. The results compare well with sea surface temperatures. Detection of turbid areas in the sea from reflected visible radiation was nearly impossible because of dust, haze and the altitude of the sun.



Infrared radiation received on board RV 'Tyro' from the NOAA 12 polar orbiting satellite on August 23, about 7.20 Local Time. Light-grey areas show relatively cold surface waters.

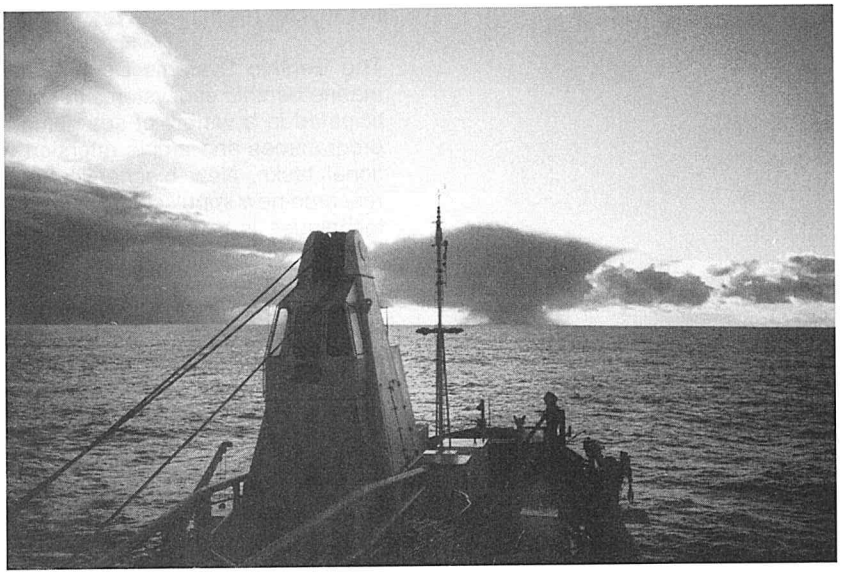
Indian Ocean Expedition; Legs C0 and C1

Tj.C.E. van Weering, G.J. Brummer

During the outward voyage (Leg C0) of RV 'Tyro' a small-scale acoustic study of the intended deployment sites for sediment lander and sediment traps of programmes C1 and C2 was done off the coast of Somalia. Subsequently lander and traps were deployed at depths of 1535 m and 4035 m in the Somali Basin.

During cruise C1 transects perpendicular to the Yemen and western Oman coastal upwelling areas were acoustically surveyed, followed by water column sampling with multi(plankton) nets and plankton pumping and by CTD with oxygen sensor and transmissometer. Sediment properties and composition, and porewater chemistry and oxygen content were measured in boxcore samples and by benthic lander operations. Off the Somali coast a hydrographic transect to study the inflow of Red Sea Water in the Somali Basin was made.

During these transects 19 stations were occupied.



(Photo: T. de Bruin)

1.5. BENTHIC SYSTEMS (B1)

INTRODUCTION

The Benthic Systems Department studies the structure and functioning of marine benthic ecosystems in shelf seas and the deep sea. This year we participated in a variety of sea-going expeditions and laboratory and mesocosm programmes and ample attention was paid to teaching-related and organizational tasks. New biochemical techniques were introduced to give benthic research new impulses. Especially the composition of phytopigments by HPLC techniques is thought to provide detailed insight into the quality and fate of sedimented organic matter; RNA/DNA ratios are used as a measure of growth in macrobenthic organisms (B1-09). The Benthic Lander System (BOLAS) has been further improved (B1-04) by installing a device for *in situ* preservation of benthic micro-organisms. Unfortunately the installed micro-oxygen-probes did not reach the intended high standards. The first results of the newly developed sedimentation recorder (B1-15) were promising.

Results of our participation in the EROS-2000 cruise (B1-04) were elaborated. In March Benthic Systems participated in a joint Dutch-Italian cruise in the Adriatic Sea (B1-04-2). In the period June-December the Department participated in four cruises of the Indian Ocean expedition, *viz.* 2x Kenya (B1-04-3), 1x Arabian Sea (B1-04-4) and 1x Seychelles B1-05). Coral reef studies were carried out in the Caribbean islands of Curaçao and Bonaire, and in northern Colombia (B1-05). From November 1992 to February 1993, on board RV 'Polarstern', the Southern Ocean was visited to measure the activity of micro-organisms and the effect of UV-b radiation on marine life (B1-02). Similar studies were also performed in the Wadden Sea and in laboratory set-ups (B1-02).

Heterotrophic nanoflagellates are important links in the 'microbial loop', both in pelagic and in benthic systems. Trophic relationships between nanoflagellates and bacteria were studied in the Wadden Sea and the North Sea, in the coastal zone of Curaçao and in the Indian Ocean (B1-06).

The Lagoon of Venice suffers from blooms of thallous and filamentous macro-algae. The effects of such blooms on the benthic system were studied in Venice itself (B1-14) and in a mimicked version in the outdoor mesocosms in Texel (B1-01). Interest in bioturbation and bio-irrigation was shown in teaching activities in a Comett Course in Ravenna, Italy (B1-03).

Research on long-term trends in the growth of the bivalve *Arctica islandica* was continued (B1-10-2/3). The damage of *Arctica* shells was used in a study

to estimate the impact of beamtrawling on benthic communities in the North Sea (B1-10-3). Much time and efforts were devoted to the benthos-monitoring programme in the North Sea in particular, covering the Dutch economic sector (B1-10-1) and the coastal area north of the Frisian Islands (B1-10-2).

As preparation to a new project (B1-15: Carbon sinks in the North Sea), a new type of sedimentation recorder was developed and tested.

B1-01 BENTHIC MESOCOSMS

P.A.W.J. de Wilde, R.P.M. Bak, G.C.A. Duineveld, H. de Hey

Originally this project was started to develop a tool for studying benthic fauna and benthic processes; as such it has been highly successful, and mesocosms are now used in other projects (see B1-14, S-01c).

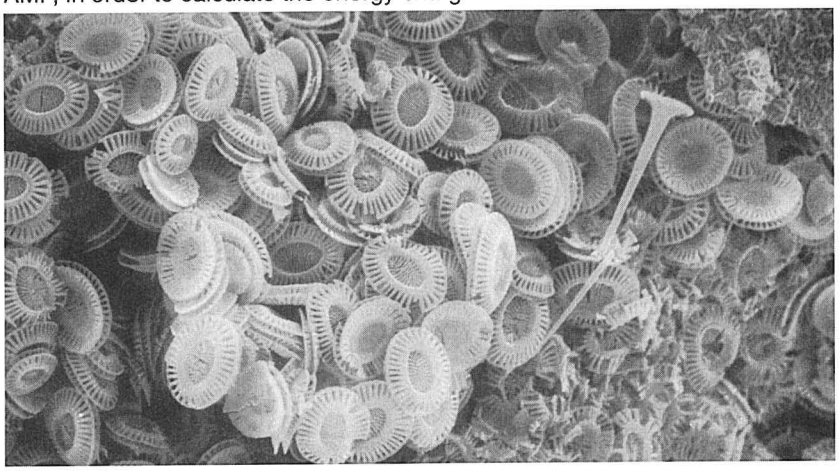
The North Sea mesocosms have been renovated and upgraded (with financing by IAS, 1992) especially as to their temperature control and automation of their functions.

B1-02 MICROBIAL BIOMASS AND ACTIVITY IN MARINE ECOSYSTEMS

J.H. Vosjan, E. Pauptit, G. van Noort

Distribution of microbial biomass and activity was studied in selected marine ecosystems in various climatic regions. Related to possible climate change, this year special attention was paid to the effect of UV-b.

During a short cruise with RV 'Navicula' in the western Wadden Sea, microbial biomass, bacterial numbers, respiration activity and the underwater light climate were estimated. The bacterial growth rates under natural conditions with and without grazing have been studied; bacterial growth rates proved to be about 0.3-0.4 d^{-1}. The UV-b penetration in the turbid Wadden Sea water is very small (less than 1 m); hence the organisms in the Wadden Sea water receive only a small dosis of UV-b. However, on the tidal flats the UV-b reaches micro-organisms of the surface layer at low tide. In laboratory experiments with natural water and with an artificial tidal sediment the UV-irradiated samples of water and sediment contained less ATP than the controls. In experiments with pure cultures of *Emiliania huxleyi* the UV-irradiated cultures also contained less ATP. Some preliminary experiments were executed to measure ADP and AMP, in order to calculate the energy charge.



Cluster of coccoliths of *Emiliania huxleyi* collected in a sediment trap deployed in the North Sea in the summer of 1991 (x3900). (Photo : P. v.d. Wal)

North Sea observations from a previous cooperation with the Biologische Anstalt Helgoland have been worked out and published.

Earlier research in the Zaire estuary and plume has been completed with bacterial countings. High biomass and high bacterial numbers were found in the wedge of salt water under the 'jet stream' of low salinity river water. The bacterial biomass mineralizes the input of organic material and causes low oxygen concentrations and high nutrient concentrations. Unpublished data of another tropical region, the Banda Sea (Snellius Expedition), have been elaborated and laid down in a manuscript.

Much time and effort were spent to prepare an expedition to Antarctica. In December 1992/January 1993 participation took place in the Summer Weddell Sea Gyre Study (ANT/7) of the Alfred Wegener Institute on board RV 'Polarstern'.

B1-04 COMMUNITY METABOLISM AND BENTHIC BOUNDARY PROCESSES OF SHELF SEAS AND THE DEEP SEA

B1-04-1 EROS

G.C.A. Duineveld, T.M. Tahey, E.M. Berghuis

During the EROS-2000 cruise with RV 'Tyro' in the Gulf of Lions, November 1991, sediment fluxes of oxygen and nutrients were measured in shipboard-incubated cores taken at 8 stations between 60 and 2700 m depth. To this end, a 30 cm ø perspex bell-jar was inserted in a large boxcore sample (50 cm ø), which was subsequently installed in a thermostated incubator. The reduction of the oxygen level underneath the bell-jar was registered with electrodes, whereas fluxes of nutrients (N, P, Si) were determined by means of discrete samples taken at intervals during the incubation. In conjunction with the incubation measurements, sediment samples were collected for the analysis of infauna, sediment grain size and sediment pigment content. As a possible clue to the interpretation of the pigments in the sediment surface, pigment samples from the bottom and surface water were collected at each station.

Sediment respiration showed a steep (non-linear) decrease with increasing depth. Highest respiration values were measured at the stations closest to the mouth of the rivers Rhone and Ebro. Lowest activity was found at the two 2700-m-deep stations, with the nearshore one (<20 nm off the coast) having an only slightly higher activity than the station 80 nm offshore. Sediment respiration showed a strong linear relation with macrofauna density and somewhat less so with macrofauna biomass. Preliminary results of the HPLC analysis of phytopigments in the sediment-surface reveal a progressive reduction in total pigment content with depth. At the stations below 500 m there were virtually no phytopigments detectable in the top 1 cm layer. These results suggest that there is little export of organic material from the shallow shelf to the adjacent deep sea.

B1-04-2 BENTHIC RESEARCH IN THE ADRIATIC SEA

P.A.W.J. de Wilde, T.M. Tahey, E.M. Berghuis, A. Kok

Funded by EC/STEP and the National Science Foundation of Italy, a joint Dutch-Italian research project was carried out in the northern Adriatic Sea, March 9-23 (see also project H1-04). Participants from the Marine Geological Institute in Bologna, the Department of Chemistry of the University of Bologna, the Department of Marine Botany of the University of Firenze and from the

NIOZ Departments Marine Chemistry and Benthic Systems cooperated in the project '*In-situ* measurements of oxygen profiles in marine sediments and of sediment/water fluxes of solutes'.

The experimental sites were selected in the coastal area of the Adriatic along a transect from the outflow of the river Po in the North to the city of Pescara in the south. The depth range of the stations was between 25 and 45 m, with a single deep station (250 m) off Pescara. Boxcore samples revealed the presence of rich and diverse bottom communities in terms of species richness, animal numbers and biomass values. Locally dense populations of *Amphiura filiformis, Corbula gibba* and callianassids occurred. Apparent negative effects of eutrophication and/or contamination, such as the presence of gelatinous macro-aggregates of algae at the bottom or in areas suffering from anoxia, were not observed during this trip.

The shipboard incubation experiments, and *in situ* lander deployments showed a decline in total sediment oxygen uptake along the transect from the Po delta southward. In the northern part of the transect oxygen consumption amounted to about 1000 μmol $O_2 \cdot m^{-2} \cdot h^{-1}$; values in the deep station of Pescara were an order of magnitude lower.

B1-04-3 KENYA

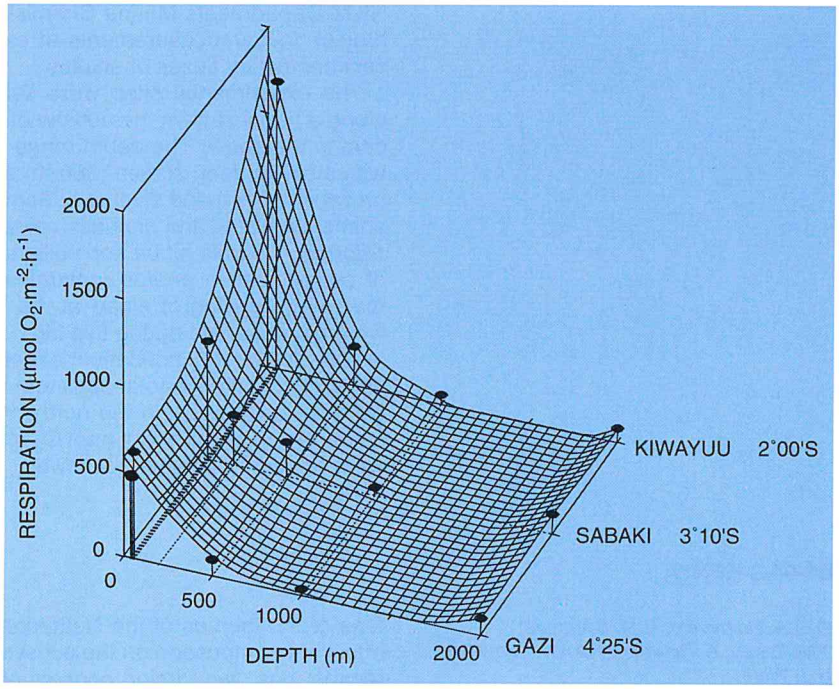
G.C.A. Duineveld, E.M. Berghuis, T.M. Tahey, A. Rowden, P.A.W.J. de Wilde, H.J. Witte

One of the themes of the Netherlands Indian Ocean Project is a study of the effect of the monsoon on the ecosystem of the shelf off Kenya. The monsoonal regime has two major consequences for the coastal ecosystem. Firstly, because of different amounts of rainfall due to the contrasting weather patterns in the two seasons, there is a change in the river discharge onto the shelf. Secondly, the alteration of the wind direction causes a reversal of the flow along the Kenyan coast. As a result of this, the coastal water has a different source and composition during the two monsoons. These effects are likely to cause seasonal changes in surface productivity and deposition of organic material on the seabed. Measurements of the benthic respiratory activity and fluxes of nutrients in the two monsoon periods will provide insight into the seasonal changes of the benthic food input.

The first of two cruises was held in June-July 1992. Measurements were conducted along four transects perpendicular to the coast. Each transect consisted of four stations at depths ranging from 60 to 2000 m. Benthic fluxes of oxygen and nutrients were determined by means of shipboard-incubations in combination with *in situ* measurements (benthic lander, bell-jars). At selected stations, sedimentation was measured with traps mounted on the benthic lander. At first sight, striking differences in sedimentation rates were observed. At all stations, cores were collected for later laboratory analysis of the fauna, and the content of pigments, organic carbon and nitrogen in the sediment. The benthic lander was deployed 5 times. Working conditions in the area proved to be quite harsh because of irregular, steep bottoms and strong surface currents.

The benthic respiration measurements showed a steep decline with increasing depth along all transects. Respiratory activity, however, increased in a south to north direction at most depths. This pattern corresponds with the preliminary results from measurements on the primary productivity (NIOO-CEMO, Yerseke).

In November-December the second cruise was executed.



Benthic community respiration *versus* depth of water along three north-south orientated transects off the Kenyan coast, measured by means of deck-incubations, June 1992.

B1-04-4 SOMALIA

T.M. Tahey, A. Kok, R.P.M. Bak, G. Nieuwland

The Northern Indian Ocean is characterized by a reversal monsoonal regime, *i.e.* from May to September wind direction is southwest, and from November to April northeast. As a result of the changing winds, the ocean surface currents also change. Upwelling occurs off the coasts of Yemen and Somalia during the southwest monsoon. During the northeast monsoon coastal upwelling in these regions is absent. The cold, nutrient-rich upwelling water causes an increase of primary production in the photic zone. However, it is unknown to what extent the enhanced primary production affects the benthos, in other words: are there seasonal changes in benthic life and activity?

Our contribution to the Netherlands Indian Ocean Project, focuses on this theme. The C1-cruise, held in August and September, coincided with the end of the southwest monsoon period of upwelling.

Six stations on two transects in the coastal waters off Yemen were sampled, with depths ranging from 70 to 2250 m. Further south in the waters near Somalia, stormy weather and rough seas made work in the upwelling area impossible. Therefore, a 5200-m station in the Somalia Basin was added. Activity parameters such as oxygen consumption and nutrient fluxes of the bottom were measured by incubation methods, and benthic fauna was collected to determine species abundance and biomass. *In situ* measurements were carried out with the benthic lander and deck incubations of intact boxcores, for comparison.

The first results showed very low oxygen concentrations in the bottom waters of the Yemen transects. Especially the shallow coastal stations were

almost anoxic (concentrations down to 14 $\mu mol \cdot dm^{-3}$). This probably led to a rapid contamination with atmospheric air when Winkler samples were taken, or boxcores were processed on deck for incubation. The oxygen consumption measurements must therefore be regarded as rather inaccurate. Considerable nitrate fluxes from the overlying water into the sediment suggest the importance of nitrate as electron acceptor in the mineralization of organic carbon when oxygen is depleted. Silicate fluxes from the bottom into the overlying water up to 200 $\mu mol \cdot m^{-2} \cdot h^{-1}$ were measured.

The benthic lander was deployed 5 times. Apart from the last deployment, at the 5200-m station, the results were generally satisfying, considering the present state-of-the-art. The 5200-m station failed, due to the extreme pressure conditions. The benthic lander is still in a developmental phase, and improvements such as new oxygen electrodes are needed.

A newly developed instrument to measure velocity and direction of near-bottom currents mounted on the lander frame was tested several times. A new device was used on the sediment corers of the lander allowing *in situ* fixation of benthic flagellates. Characteristics of bacterial and flagellate communities along the transects are studied comparing *in situ* and shipboard fixation.

B1-05 CORAL REEFS

R.P.M. Bak, G. Nieuwland, E. Meesters, M.L.J. van Veghel, U. Frank

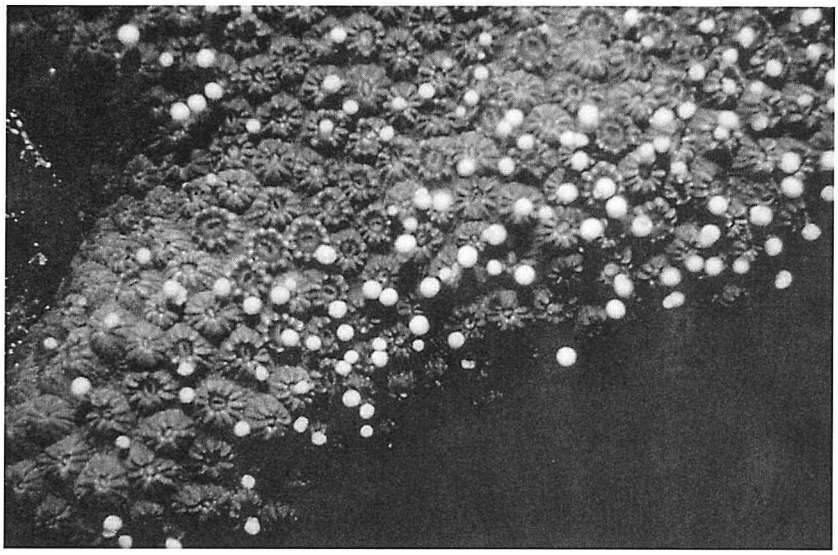
Stony corals (scleractinians) are the building elements of coral reefs in terms of physical structure and reef community. Their ecological strategies, in response to environmental parameters and environmental changes, are investigated in joint research with tropical research institutions (Carmabi Ecological Institute, Curaçao; Israel Oceanographic & Limnological Research; Invemar, Colombia; LIPI/UNAS, Hasanuddin University, Indonesia). The lines of investigation are: key processes, key organisms, long-term change.

Studies on the regeneration efficiency of coral species along the coast of Curaçao showed the variation between species in impact of environmental variables such as temperature and sedimentation on regeneration of tissue lesions. Temperature adaptation resulted in relatively high regeneration rates of stressed colonies. A series of field experiments showed the impact of damage, resulting in a lesion, to depend on the surface/periphery relation of the wound. Although the concentration of chlorophyll differs significantly over the surface of coral colonies in relation with incident light (sun/shade organisms), regeneration efficiency is independent of position on the colony surface. To investigate the possible relation between regeneration capacity and chemical pollution, the concentrations of PCBs and heavy metals were identified in various benthic reef species at a range of localities.

A strong force in the organization of benthic reef communities is competition for space and a number of mechanisms have evolved to aggressively interact with encroaching neighbouring organisms. The differentiation in interspecific aggression between three coral species and three morphological types of the dominant reef builder *Montastrea annularis was* studied to assess ecological differences between the morphs. Field experiments as well as surveys demonstrated significant differences. Biochemical aspects of such interactions, including the chemical base of a memory component in repeated aggressive encounters, are being studied in coral larvae and fully grown corals in the Red Sea.

The main thrust in the study of the *Montastrea* morphotypes was on reproduction strategies, characteristics of gonads and spawning behaviour. Charac-

teristics such as mean gonad weight·polyp^{-1} differ significantly but all morphs display the same spawning patterns. Spawning occurs synchronously in mass events 6, 7 and 8 days after full moon in September/October. Attempts will be made to set up cross fertilization experiments. The distribution of the morphs along the coast, investigated at 11 sites, has been surveyed in relation to abiotic variables.



Mass spawning of *Monastrea annularis*.
(Photo: R.P.M. Bak)

Photographing permanent quadrats along the reefs of Curaçao and Bonaire (depths 10-40 m) was continued. Preliminary analysis suggests considerable changes in coral cover over the last 20 years. Macro algae cover over the reef slope has increased.

To assess possible impact of eutrophication on the reef system we started to record densities of bacteria and nanoflagellates along the coast of Curaçao throughout the year. A potential link between eutrophication, expressed as increase in densities of microbial organisms, and the reef benthos was studied in a series of explorative field experiments. The first results indicate that some coral species as well as sponges ingest significant numbers of bacteria. Intake rates between species vary from zero to 20 and 100 x 10^3 cells·cm^{-2} surface·hour^{-1}, which suggests that changes in pelagic microbial characteristics influence the composition of the community of benthic reef organisms.

As part of the Netherlands Indian Ocean Programme (see 1.1.1.) part E (Biology of Oceanic Reefs), a team was formed to study community dynamics in seaward reef slopes with emphasis on the role of interaction in space monopolization.

B1-06 PROTOZOANS

R.P.M. Bak, B.J.M. Hondeveld, G. Nieuwland

Heterotrophic nanoflagellates are voracious predators on bacteria in marine pelagic systems. A significant part of the energy produced by primary producers is channelled through this microbial loop, which figures as an alternative to the classic trophic structure of such systems. Our data on densities of hetero-

trophic nanoflagellates in marine sediments support the hypothesis that a similar stage is set for these organisms in the benthos. We studied fluctuations of densities in the field and investigated the trophic relationship between nanoflagellates and bacteria (growth/grazing) in field and laboratory experiments.

To complete our summer data set for densities in North Sea bottoms, identical stations were surveyed in winter 91/92. Highest numbers of flagellates were observed in the upper 3 mm of the bottom, ranging from 30 to $120 \times 10^3 \cdot cm^{-3}$, with densities decreasing with depth in the sediment. Particularly at sandy coastal stations, densities were 2-8 times lower than in summer. On the contrary, in most silty sediments the densities were comparable to summer values or, at 2 out of 15 stations, even 2-5 times higher than in summer.

The trophic relationship between heterotrophic nanoflagellates and bacteria in North Sea sediments, *viz.* grazing by the flagellates on their bacterial prey, has been studied using Fluorescently Labelled Bacteria (FLB) as tracers. Mean grazing rates ranged from 11 to 44 bacteria per flagellate per hour. We found no differences between summer and winter grazing rates. Multiplication of flagellate densities by average grazing rates results in estimates for the total consumption by nanoflagellates. When a comparison is made between consumption by nanoflagellates and bacterial production, using summer values for densities and bacterial production, between 0.4 and 28% of the production is consumed by the nanoflagellates. At 15 stations more than 15% of the bacterial production was consumed, whereas at the other stations bacterivory by nanoflagellates was less.

During summer the percentage of the nanoflagellate community actually ingesting FLB varied between 0 and 17. Again sandy shallow bottoms appeared to differ from silty ones: most FLB-ingesting flagellates were observed in sandy sediment. Flagellates in sandy sediments were larger than in silty sediments. Consequently, we hypothesize that a high proportion of non-grazing flagellates in a community could be caused by the relatively large size of our experimental bacteria (FLB). FLB were on overage 1.5 times the size of *in situ* bacteria. This hypothesis was tested in water (same grazing rates) using FLB comparable in size to *in situ* bacteria. It appears that bacterial size is not the decisive factor. Our new hypothesis is whether discrimination against FLB is based on a preference by surface-associated nanoflagellates for attached bacteria over suspended cells.

B1-09 GROWTH AND PRODUCTION OF MACROBENTHOS

RNA/DNA

I. Jenness, A. Kok, G.C.A. Duineveld

Determining growth rates of macrofauna by measuring growth increments is usually a time-consuming and imprecise process. Moreover, it does not allow assessment of instantaneous growth rates which are useful for spatial and temporal growth comparisons in relation to other environmental variables. In the last decades RNA/DNA ratio has been used as an indicator of instantaneous growth, especially in juvenile fish. This ratio can be determined fluorometrically after staining one or both types of nucleic acid with a fluorescent dye. Another method, developed by S. Oosterhuis (NIOZ), uses HPLC for the separation of RNA and DNA. In a pilot study, both methods were applied to tissues of the bivalves *Spisula* sp. and *Arctica islandica* as well as to known mixtures of commercially obtained RNA/DNA. The fluorometric method used consisted of differentially staining DNA with BIS (bisbenziimidazole) and total nucleic

acid with EB (ethidium bromide). Although EB was found to underestimate total nucleic acid content of known mixtures, notably in the higher ranges of concentrations, more reliable results were achieved after improvement of the method. The simultaneous application of the fluorometry and HPLC (in collaboration with S. Oosterhuis) to different tissues of starved and optimally fed *Arctica* yielded very similar results. Consistently high ratios were found for tissues from fed animals and considerably lower values for the tissues from starved animals. On the basis of these encouraging results, more experiments will be carried out in order to establish a relation between the RNA/DNA ratio and the somatic growth. Especially the use of HPLC will be further explored as this requires less manipulation of the samples and allows a direct assessment of the nucleic acid concentrations.

B1-10 LONG-TERM TRENDS IN BENTHIC FAUNA OF THE NORTH SEA

B1-10-1 BIOMONITORING NORTH SEA

G.C.A. Duineveld

In 1991, a 3-year monitoring programme of the macrofauna was started in the Dutch Sector of the North Sea. This programme, commissioned by the Tidal Waters Division of RWS, aims at obtaining insight into the year-to-year fluctuations in the composition and the standing stock of the macrobenthic communities. In contrast with the Dutch Wadden Sea, no long-term observations on macrofauna exist for the offshore part of the Dutch Sector in spite of the assumption that the North Sea benthic fauna is subject to considerable disturbances (beamtrawl fisheries, eutrophication). For this project, 25 stations were selected where every year five boxcore samples will be collected. The stations were selected in such a way that they would together cover the major abiotic gradients and benthic communities in the southern North Sea. The data from the first survey (spring 1991) show that the stations were indeed representative of the principal macrobenthic assemblages distinguished by earlier studies (ICES North Sea Benthos Survey; MILZON-Benthos I & II). This result justifies the continuation of the monitoring programme on the basis of the selected stations.

B1-10-2 MILZON-BENTHOS II project

S. Holtmann

In spring 1991, the MILZON-BENTHOS II (=MILieuZONering / Environmental Zonation) project was carried out under commission of the North Sea Directorate (RWS) as a continuation of the MILZON-BENTHOS I project. The aim of MILZON is to map in great detail the spatial distribution of zoobenthos in the Dutch Sector of the North Sea. The ensuing data serve as a basis for management decisions concerning areas of special interest or value. The study area of 1991 comprised the Vlieland Ground/Terschelling Bank and the Oyster Grounds. The area was divided in 18 homogeneous plots according to known bathymetric and sediment gradients. Each plot had a minimum of 4 random sampling locations where one boxcore sample for infauna was collected together with cores for grain-size analysis, POC and chlorophyll *a* determinations. The number of locations visited in the whole area was 85.

On the basis of the distributions of mud, chlorophyll *a* and POC, an enriched, and relatively muddy zone could be distinguished between the 30 and 40 m isobaths, which coincided with the position of the Frisian Front area. This zone

was not apparent in the distribution of macrobenthic biomass or density. The four station groups that were discriminated on the basis of species density could be associated with the mud content of the sediment. The stations in the muddy Frisian Front zone, however, did not emerge as a separate cluster in the classification analysis. They were instead part of a larger group covering the southern and central Oyster Grounds. The same result was obtained when stations were classified on the basis of species biomass. With the combined data sets of the MILZON-BENTHOS projects I & II, a detailed map has been produced of the benthic assemblages along the Dutch coast and the adjacent Oyster Grounds.

B1-10-3 GROWTH VARIATIONS IN THE BIVALVE *ARCTICA ISLANDICA*

R. Witbaard

During the 1983 REFLEX expedition benthic samples were taken at a great number of localities in de Fladen Grounds (northern North Sea). These localities were found to be clustered in two areas about 70 km apart. In 1991 these two areas were visited again to see if growth variations similar to those found in shells sampled in 1983 could still be observed after 8 years. If so this would validate the method and give further evidence of annual growth line formation. The similarity in growth variations indeed was high (Gleichlaufigkeit up to 80%), both within the 1983 and 1991 samples and between them.

This opened the possibility to apply dendrochronological methods to describe growth fluctuations over the past 25 years. This chronology compares expected growth with observed growth, resulting in a growth index. Such indices can be used to calculate a population chronology which shows those variations which are common among the samples used. The results obtained in this way showed that growth in the 70s was below expectation while it was above expectation during the 80s. The next step to be taken is to see if any relation exists with abiotic or biotic factors. Furthermore 1972 appeared to be a year in which growth was extremely slow. Almost all shells studied showed this pointer year. It is striking that a sample from the Faroer also showed reduced growth over a couple of years, of which 1972 is the most extreme. This suggests that growth is at least partly controlled by very large-scale processes. To explain the observed growth differences, laboratory experiments are undertaken which focus on the effect of temperature and food quantity on shell growth.

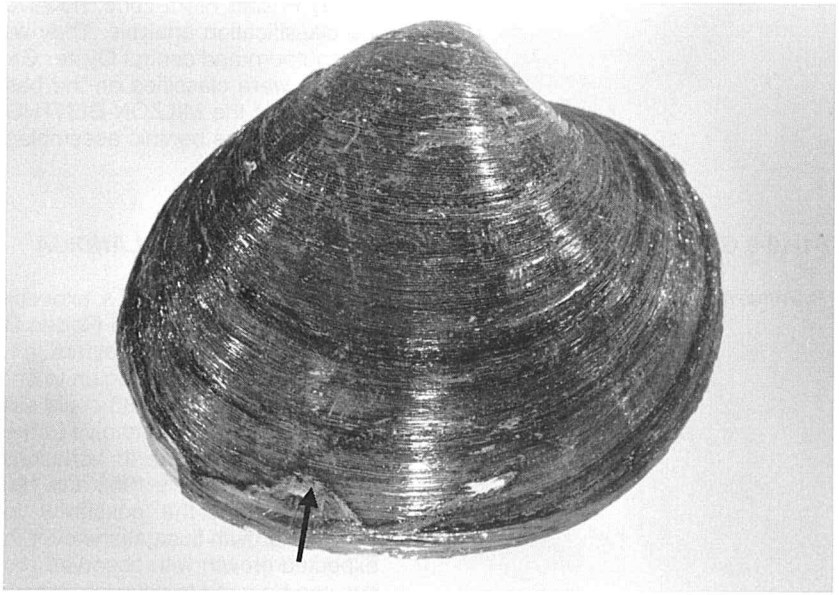
B1-10-4 EFFECTS OF FISHERY ON *ARCTICA ISLANDICA*

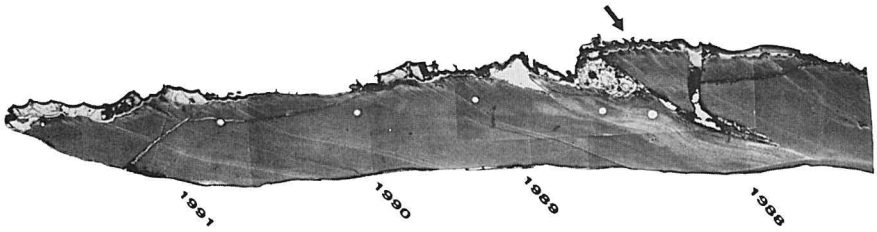
R. Klein, R. Witbaard

To investigate a possible relation between the intensity of beamtrawl fishery and damaged *Arctica islandica* shells, an inventory has been made on the extent, nature and position of the most recent shell damages.

About 1700 empty shells and fragments from *ca.*150 different locations in the North Sea were collected for this purpose. In the southern North Sea the ratio damaged/undamaged shells is 1.6; in the northern North Sea this ratio is only *ca.* 0.5. This confirmes the supposed effect of beamtrawl fishery on shell damage because this type of fishing is generally confined to the more southern areas. Further confirmation that such damage is due to beamtrawl fishery is provided by similar damage patterns on living shells caught commercially with RV 'Tridens', though here the number of damaged shells was 4 times higher than the number of undamaged ones. Most of the damages, especially the

larger ones, were found on the postventral side *i.e.* the part of the shell that points upward in the sediment. In addition a study has started to date repaired injuries by means of annual growth checks.





Top figure
Left valve of *A. islandica* with arrow pointing at recovered injury.
(Photo: B. Aggenbach)

Bottom figure
The shell is embedded in epoxy resin and a section is made just along the damage; by means of acetate peel techniques and light microscopy it is possible to photograph the section and date the damage.

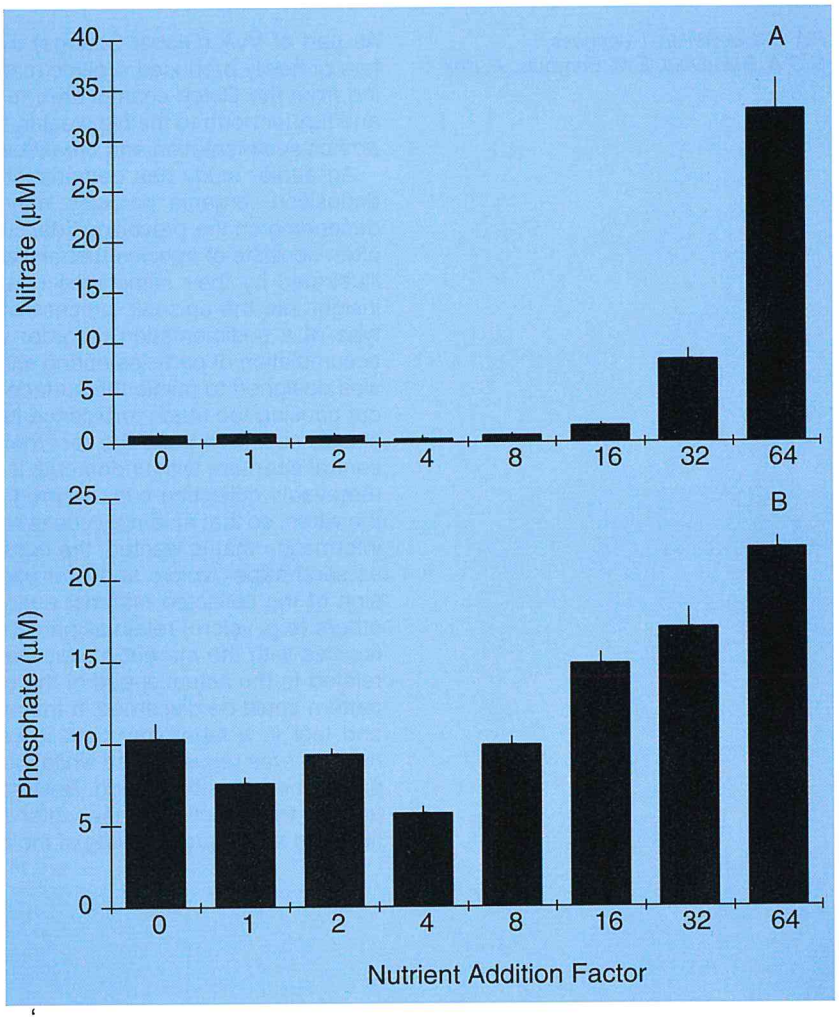
B1-14 BENTHIC EUTROPHICATION STUDIES-BEST

H. de Heij, P.A.W.J. de Wilde, W. Helder

The project Benthic Eutrophication STudies (BEST), a co-operative research project in which TNO/Den Helder, IBN/Texel, the University of Venice and NIOZ participate, is an investigation of the responses of coastal benthic communities to eutrophication in the Wadden Sea and the northern Adriatic Sea, in particular the Venice Lagoon. In the second year of this project eight outdoor mesocosms (21 m^2), MOVEL's (MOdel VEnetian Lagoon), were used to study the response of an intertidal ecosystem to different nutrient loadings. Four trips were made to the Venice Lagoon for *in situ* measurements, in April, May, July and September. Field measurements of oxygen demand, nutrient concentrations and fluxes in the benthic boundary layer were carried out at 3 selected stations, showing increasing degrees of eutrophication.

In each of the eight MOVEL's different amounts of nutrients (nitrate and phosphate) were added daily. The nutrients were added with a factor 0, 1, 2, 4, 8, 16, 32 or 64 times 10 mmol N (as nitrate) and 1.25 mmol P (as phosphate) per mesocosm per day.

In the mesocosms, measurements were conducted by TNO (phytoplankton, zooplankton, macroalgae, chlorophyll in water and sediment and organic content of the sediment); IBN (macrofaunal densities and species composition, irradiation, temperature and salinity) and by NIOZ (community respiration and oxygen production, nutrient dynamics of water and sediment, and alkalinity). The experiments lasted from the beginning of April till the end of September. Most parameters were measured every five weeks, but some (phytoplankton, zooplankton and nutrient concentrations in the water) were measured weekly.



Nutrients in MOVELs. With additions of up to a factor 8 for nitrate and phosphate all nutrients were used and were thus limiting. At higher additions nutrients were left over and light might be limiting due to self-shading.

Oxygen uptake and production, nutrient fluxes and alkalinity fluxes were measured in plexiglass bell-jars equipped with a stirring device and an oxygen electrode. Nutrient and alkalinity samples were taken every twenty minutes from the bell-jar with 50 cm^3 syringes. Alkalinity samples were conserved with mercury chloride and stored cool until analysis in the lab. Bell-jar incubations

were conducted for one hour in the dark and one hour in the light, each preceded by an equilibration time of about 30 min. Darkening was achieved by covering the bell-jar with a black PVC-cover.

Nutrient concentrations in the sediment were measured by slicing sediment cores and collecting the pore water by centrifuging. Analysed was ammonium, phosphate, nitrate, nitrite and occasionally urea.

B1-15 THE NORTH SEA AS A CARBON SINK

P.A.W.J. de Wilde, I. Jenness, G.C.A. Duineveld, E.M. Berghuis, A. Kok

As part of VvA (Global Change) this project studies the transport routes and fate of newly produced organic matter in the North Sea along a transect ranging from the Dutch coastal area to the Oyster Grounds, the Elbe 'Urstromtal' and further north to the Norwegian trench. Special attention will be given to the *ad hoc* sedimentation and breakdown of phytodetritus.

An earlier study has demonstrated that in turbulent areas without any net deposition, organic particles may temporarily accumulate on the seabed depending on the prevailing tidal currents. The benthic fauna in these habitats often consists of species that are able to efficiently exploit this food source as illustrated by their sometimes unexpectedly high growth rates. To get more insight into the episodic process of accumulation and resuspension, a prototype of a sedimentation recorder was built which measures the intermittent accumulation of particles during short intervals over a tidal cycle. The recorder was designed to mimic the surface of the seabed as closely as possible without causing too much turbulence itself. These objectives exclude the use of a classic sediment trap. The recorder consists essentially of a flat disc having a central aperture, with underneath it a rotating wheel holding a series of shallow removable collecting cups. A programmable timer signals the motor to rotate the wheel so that an empty cup is shifted under the aperture. Depending on the information that is wanted, the cups can be covered with different linings such as sand paper, velcro and filter paper. Some of these linings allow resuspension of the collected material during the period of exposure of the cup while others (*e.g.* velcro) retain all particles trapped in the cups. Due to technical difficulties with the current meter, the first results from a field test could not be related to the actual speed of the bottom current. Nevertheless, a clear cyclic pattern could be discerned in the amounts of chlorophyll *a* collected. In a second test in a laboratory tank it was observed that part of the accumulated material was resuspended while the cup turned away from the aperture; a filter paper lining was then used. Resuspension only occurred when the cup turned against the direction of the water flow. Further improvements to resolve this flaw and subsequent testing of the recorder are envisaged for the near future.

1.6. PELAGIC SYSTEMS (B2)

INTRODUCTION

The Department of Pelagic Systems investigates the role of plankton in the productivity of the sea, and the cycle of organic matter in the foodweb. This comprises a quantitative description of biomass, consumption, production and species composition at different trophic levels, in relation to physical and chemical conditions, in the North Sea (project B2-03), the Indian Ocean (B2-08) and polar seas (B2-11). Properties of key species are studied to understand their functioning in nutrient uptake kinetics, growth and reproduction, prey selection and energy-balance under different experimental conditions. Special attention is directed to the phytoplankters *Phaeocystis* sp. (B2–01), *Emiliania huxleyi* (B2-13) and zooplanktonic ciliates (B2-01/03) and copepods (B2-10). The interactions of species and trophic levels, and ultimately the functioning of complete ecosystems, can be related to environmental conditions in multi-species experiments or mesocosms (B2-03) and mathematical models (B2-01, B2-13). One pelagic mesocosm system was realized and the construction of another 3 was initiated. For the modelling, and also the processing of plankton data, it was necessary to convert computer programs running on the NORD to be used on the SUN/PC configuration of the new computer network.

In cooperation with a number of British and Dutch institutes and universities, and the NIOZ Departments of Physical Oceanography and Marine Geology, a remote sensing project was prepared to study the composition of particulate matter in the North Sea by optical measurements. Algorithms will be developed in the next few years from data collected by synoptical cruises with Dutch ships and aerial surveys by British aircraft.

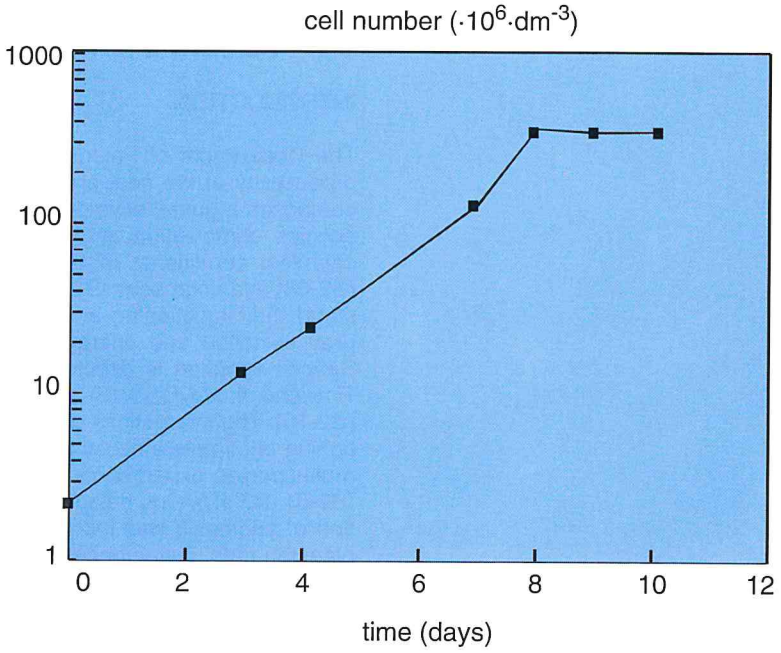
B2-01 EUTROPHICATION AND PHYTOPLANKTON IN DUTCH COASTAL WATERS

W. van Boekel (RUG)

In 1992 the ecophysiological research of the colony-forming alga *Phaeocystis* concentrated on the composition and properties of the colony mucus and on the role of this alga in the production of DMSP and DMS.

The composition and properties of *Phaeocystis* colony mucus are still largely obscure. In a laboratory study some components of the mucus were identified with the use of a specific staining technique and the role of Ca^{2+} and other cations as binding agents was investigated. Also, the effect of Ca^{2+} concentration

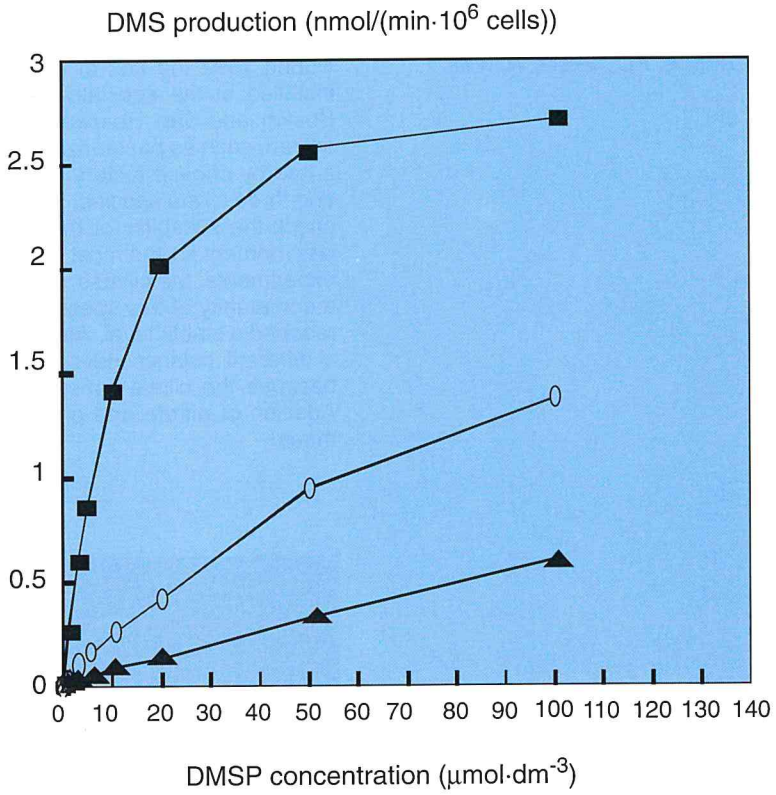
on colony formation in batch cultures was studied. Colonies of *Phaeocystis* sp. were stained with alcian blue at two different pH values. This revealed that the colony mucus contained both carboxylated and sulphated polymers. Incubation of colonies in media lacking one or more cations showed that calcium and magnesium ions were essential for the gelling of colony mucus, whereas potassium ions had no influence. The percentage of colony cells formed by *Phaeocystis* in batch cultures was reduced in media with calcium concentrations below 2.5 mmol·dm^{-3}. No colonies were formed in media with calcium concentrations below 1.5 mmol·dm^{-3}. Growth rate was not dependent on calcium concentration. The results suggest that under natural conditions *Phaeocystis* colony firmness and morphology may depend on the composition of mucus polymers.



Phaeocystis cell numbers during growth in batch culture used for determining the effect of DMSP concentration and of growth phase on the DMS production rate.

In the marine environment, production of dimethylsulphide (DMS) from dissolved dimethylsulfoniopropionate ($DMSP_d$) - an algal osmolyte - is thought to occur mainly through bacterial activity. In cooperation with Jacqueline Stefels (University of Groningen) the possibility that phytoplankton itself converts $DMSP_d$ into DMS was investigated, using axenic batch cultures of *Phaeocystis* sp. at different growth stages. $DMSP_d$ added to the medium was converted enzymatically to DMS by *Phaeocystis*. A culture in the exponential growth phase displayed Michaelis-Menten type kinetics for $DMSP_d$ conversion, yielding an apparent K_m value of 11.7 ± 3.1 µM $DMSP_d$ and a V_{max} value of 3.05 ± 0.48 nmol DMS (min 10^6 cells)$^{-1}$. DMS production rates declined during the transition from exponential to stationary phase. This decrease was not caused by accumulation of inhibiting substances in the medium or the undersaturation of the enzyme. Intracellular DMSP concentrations in *Phaeocystis* batch cul-

tures increased from 71 mM in exponential phase cells to approx. 150 mM in stationary phase cells. DMS and $DMSP_d$ concentrations in the culture remained very low during the exponential growth phase. DMS production started in early stationary phase. In a senescent culture $DMSP_d$ appeared when cell number started to decline. DMSP production in this culture continued even when cell number declined. In completely lysed batch cultures approx. 25% of the particulate DMSP produced in the culture was left as $DMSP_d$. The results indicate that *Phaeocystis* may contribute significantly to DMS production from $DMSP_d$ during blooms in the field.



Relation between dissolved DMSP concentration in the medium and DMS production rate of day 3, 7, and 10 during growth of *Phaeocystis* in the batch culture shown in previous figure.

F.C. Hansen, M.U.A. Reckermann

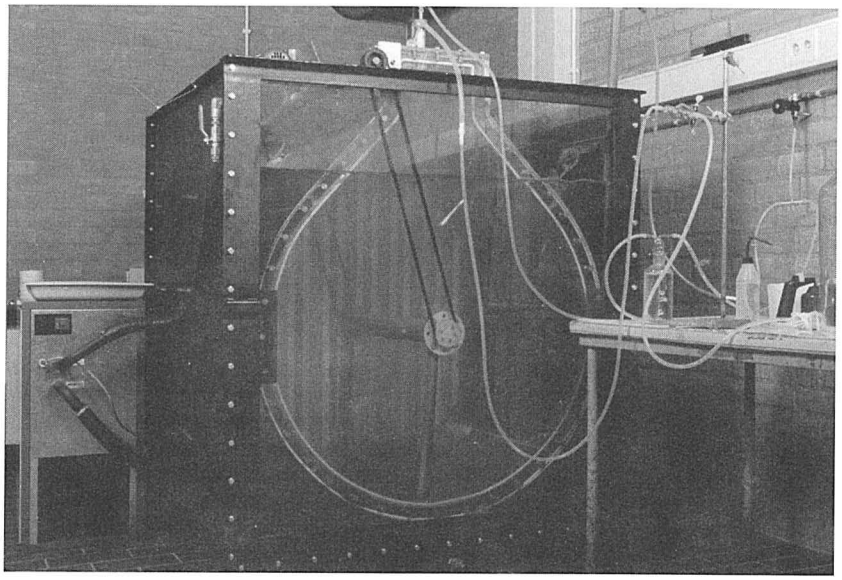
The EC project 'Dynamics of *Phaeocystis* blooms in nutrient-enriched coastal zones of the North Sea', a 4-year study on the trophic interactions between zooplankton and *Phaeocystis,* was completed. On the basis of the results of a joint investigation of the Marsdiep 1990 spring bloom, we tested whether selective grazing by copepods may enhance rather than depress *Phaeocystis* blooms. Laboratory grazing experiments including three trophic levels: a copepod (*Temora longicornis*), a protozoan (*Oxyrrhis marina, Strombidium elegans, Strombidinopsis acuminatum*) and *Phaeocystis* cf. *globosa* single cells,

showed that copepods strongly preferred protozoans. In the experiments with the heterotrophic dinoflagellate *Oxyrrhis* as well as with the ciliate *Strombidinopsis*, which both fed on *Phaeocystis*, the presence of *Temora* reduced the overall grazing pressure on *Phaeocystis* and led to enhanced *Phaeocystis* growth rates. Herbivorous microzooplankton can have an important function in the foodweb, coupling *Phaeocystis* primary production with higher trophic levels. The grazing studies were finished with F.C. Hansen taking his PhD at the University of Kiel on 4 November.

B2-03 PRODUCTION AND CARBON BUDGETS IN THE NORTH SEA IN RELATION TO HYDROGRAPHICAL STRUCTURE

B.R. Kuipers, F.C. Hansen, H. Witte

During 1992 the first of a series of pelagic mesocosms was completed and installed in the specially prepared dark laboratory F (by NIOZ technicians Boekel and Van Heerwaarden). After a few additional problems had been solved, such as pasteurizing the necessary 850 litres of seawater by heating in a nearby cheese factory and preparing sufficiently large batches of one algal and three ciliate species, test runs started in September. Their main aim was to check the suitability of the mesocosm jar and its slowly rotating water as an environment for the most fragile organisms involved in planned pelagic system experiments: the ciliates. After initial inoculation with the alga *Isochrysis* spec., a community of this species with bacteria, small flagellates and some diatoms reached a stable level. After introduction of the ciliate *Ancistrumina* (prel. det.)., a different balance developed with a higher level of *Isochrysis*, presumably because the ciliate consumed the competing small flagellates and bacteria. Addition of nitrate and phosphate led to an increase in algal and ciliate biomass.



The mesocosm system.
(Photo: B. Aggenbach)

B2-08 MONSOONS AND PELAGIC SYSTEMS

M.A. Baars, M.J.W. Veldhuis, G.W. Kraay, S.S. Oosterhuis, J.IJ. Witte, M.U.A. Reckermann, C.J. Wiebinga

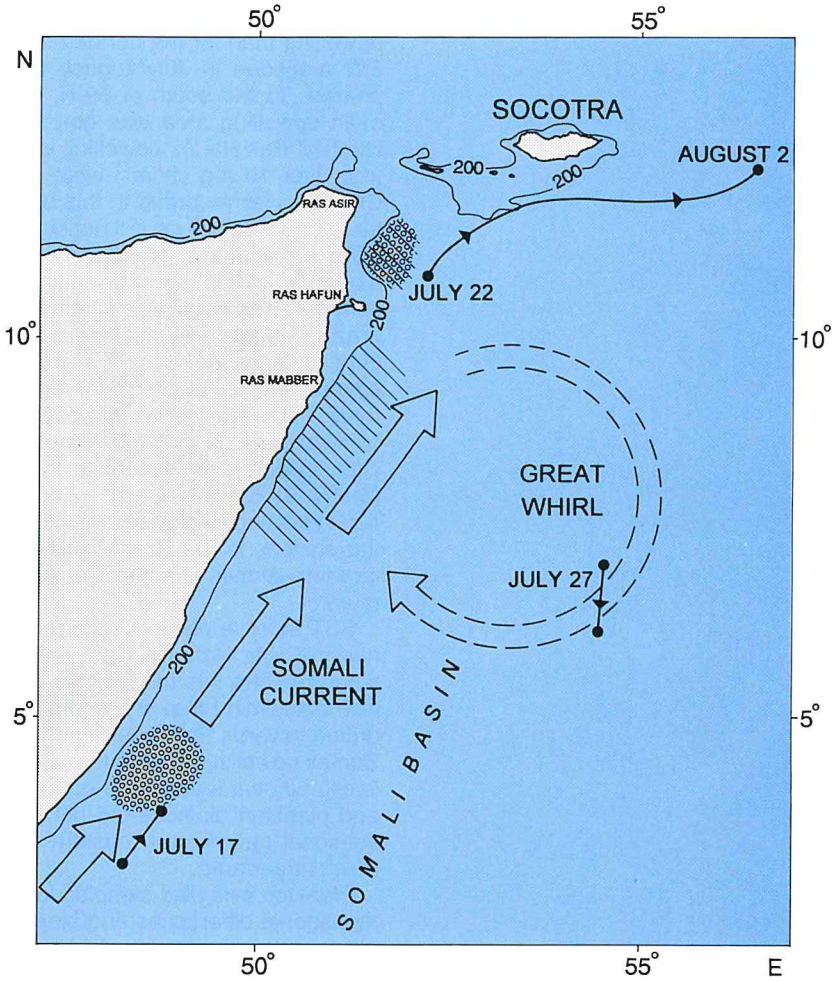
As part of the Netherlands Indian Ocean Programme 1992/1993 (see 1.1.1.) the upwelling off Somalia was studied during two cruises by RV Tyro in the Somali Current, the Gulf of Aden and the Red Sea. In early June, at the onset of the SW monsoon, the hydrography between Cape Guardafui and Ras Hafun was mapped by XBT launches and continuous recording of temperature, salinity, oxygen and fluorescence of the upper water layer. Along 11°N, isotherms sloped up towards the coast and sea surface temperature (SST) dropped from 29°C at 53°30'E to 25°C west of 52°E. There, increased nutrient and chlorophyll concentrations were found in the upper layer and subadults and adults were caught of *Calanoides carinatus,* the copepod species typical of upwelling. Though molting to the adult stage occurred, no eggs have yet been produced in shipboard incubations.

A second, larger upwelling area was encountered during sailing into the Somali Current southwards, around 4°N, 49°E. Moderately high nutrient concentrations and a large zooplankton abundance pointed to a later stage of upwelling than for the northern area. Six weeks later, during the height of the SW monsoon in July/August, the southern centre of upwelling had disappeared. To the south of 60°N, surface temperatures were above 26°C. The main upwelling area was now between 8 and 10°N, with SST below 18°C. North of Ras Hafun, upwelling was still continuing, and phytoplankton patches with over 10 mg chl·m^{-3} were found. A high primary production of 300 mg $Cm^{-3}·d^{-1}$ was recorded in this bloom but the photic zone was very limited, so the production per m^2 did not surpass 2 g $C·d^{-1}$. Bacterial production, with subsurface maxima at 15-40 m depth, was relatively low, compared with values measured in this region in early June. Preliminary data on phytoplankton mortality rate, as determined from dilution experiments, pointed to a substantial grazing pressure by microzooplankton, in the order of 20-60% per day. Numbers of *C. carinatus* were highest in waters of 18-19°C, both for nauplii and copepodids. Incubations for egg production and molting showed moderate rates. In the warmer waters downstream of the coastal upwelling, zooplankton biomass was on average highest, and was dominated by other copepod species. Upper layer waters in the southward-flowing part of the Great Whirl (5-9°N, 55°E) were not yet nutrient-depleted and contained subadult *C. carinatus*, indicating clockwise circulation of part of the population of this copepod. At the stations in the Great Whirl the profiles of bacterial production showed a larger maximum at a depth of 70-80 m, besides the common subsurface maximum.

SST satellite pictures received onboard suggested that the upwelling water north of Ras Hafun did not enter the Great Whirl but spread west and east along Socotra into the Arabian Sea. Tracking of an ARGOS buoy —equipped with a sediment trap at a depth of 150 m— confirmed this picture, as the buoy drifted towards ENE over a period of 10 days. A preliminary impression of the Somali upwelling system is that by the strong wind and current the enrichment is diluted over a vast area of the NW Indian Ocean. Mean primary productivity and plankton biomass did not seem to be higher than for the much weaker seasonal upwelling in eastern Indonesia, but the effects are spread over a much larger area.

Plankton was also sampled in the Gulf of Aden and in the Red Sea to study monsoonal differences and biogeographical patterns. At the end of May, both areas were oligotrophic, and no blooms were found in or near Strait Bab-el-Mandeb, with surface inflow of Gulf water and bottom outflow of Red Sea

water. In August, however, a three-layer current structure had developed in the Strait, with Gulf of Aden thermocline water flowing to the Red Sea, and outflowing Red Sea water near both the sea surface and the bottom. A large phytoplankton bloom was encountered south of the Strait, presumably due to mixing of the upper water masses. The CZCS archives indicate that blooms near Bab-el-Mandeb are very common almost throughout the year and the area will therefore be revisited in the NE monsoon, during a third cruise in February 1993. During the cruises in 1992, most of the JGOFS core measurements were performed, but many types of samples were stored for processing after the return of RV Tyro to Texel in spring 1993. For phytoplankton characterization, flow-cytometry was applied directly on fresh samples, and here results are given for some oligotrophic stations during the outward voyage through the Red Sea.



Scheme of the Somali Current upwelling centres observed at the beginning of June (circles) and in the second half of July 1992 (hatched areas). The lines show tracks of 24 hour drogue experiments (July 17 and 27) and of the 10 day drift of an ARGOS buoy (July 22-August 2).

The vertical distribution of picoplankton (cyanobacteria and prochlorophytes) in the southern Red Sea was investigated in relation with their chlorophyll and phycoerythrin fluorescence signatures, applying flow-cytometry. At the three stations examined, two strains of cyanobacteria always occurred together, with maximal numbers of up to 80000·cm^{-3}. Although cyanobacteria proportionally dominated towards the surface, they were usually outnumbered by the prochlorophytes, with highest counts (maximum of 275000·cm^{-3}) just a little deeper than the peak of cyanobacteria.

With depth the ratio, in cell numbers, of the two cyanobacteria strains increased up to twentyfold. The strain possessing the lowest phycoerythrin-fluorescence (indicative of a low nitrogen demand) dominated the nutrient-depleted surface waters. This clone also had the lowest chlorophyll content. In contrast, the other clone showed a more pronounced increase in the cellular chlorophyll and phycoerythrin fluorescence signals; maximal values of these signals were observed at a growth irradiance of 1% of the surface (I_d 1%). This strain seemed to have a preference for deeper nutrient-rich water, with reduced light levels. A high content of the highly nitrogen-demanding pigment phycoerythrin can be maintained, as sufficient nitrogen is available.

Although the prochlorophytes dominated the entire euphotic zone, the greatest abundance of the *Prochlorococcus* sp. was at the deep chlorophyll maximum, below the cyanobacteria. This phytoplankter seemed to be even more adapted to reduced light levels since saturation in cellular chlorophyll fluorescence was not found below a growth irradiance of 0.01% of the surface irradiance.

These results seem to prove that not only the cellular content but also the ability to increase pigment concentration with a reduction in light intensity highly determines the vertical distribution among the various types of picoplankton as well as intra-specific variation, as in the case of cyanobacteria.

B2-10 POPULATION DYNAMICS AND BIO-ENERGETICS IN EXPERIMENTAL PELAGIC ECOSYSTEMS

W.C.M. Klein Breteler, N. Schogt

The experimental research on zooplankton aims at the significance of environmental variables for the ecophysiology of marine zooplankton under controlled conditions in the laboratory. To this end *Temora longicornis* and *Acartia clausi* were cultured in the laboratory for many generations.

Experiments with *Acartia clausi* were prolonged to determine the exact rate of development through the successive stages. The results are presently being worked out together with the results obtained in last year's experiment under 16 different conditions of temperature and food. Comparison of the two data sets will allow an evaluation of different methods of calculation to determine the rate of development.

Temora longicornis was cultured for various experimental purposes. It is used to represent the upper trophic level in mesocosm experiments (B2-03). It is used to determine the role of iron transferred to higher trophic levels (H1-15, and R. Scharek, AWI, Bremerhaven). At regular intervals, *T. longicornis* has been supplied to L. van Duren (Univ. Groningen) for behavioural studies on copepods. Together with *Acartia clausi* this species was also used to prepare Electron Microscope slides to study the ultrastructure of copepod spermatozoa (B. Hosfeld, Univ. Oldenburg).

The possibility was studied for automatic quantification of autotrophic and heterotrophic microorganisms through microscopic Image Analysis. Such a system is required to adequately analyse samples with different organisms

mixed with detritus, like in the mesocoms (B2-03). Following advice from abroad, all possible effort will be made to establish a true-colour Image Analysis system at the Institute.

B2-11 ZOOPLANKTON LIFE CYCLE IN ANTARCTIC SEAS

H.G. Fransz, S.R. Gonzalez

During the EPOS cruise in 1988/89 in the Southern Ocean, size fractions of living zooplankton were incubated at ambient temperature and food conditions for 3 days, to study rates of development by comparing stage distributions before and after incubation. The samples were partly sorted this year, but no shifts in stage distributions of the predominant copepod species could be observed. Presumably longer incubation times are required for this method at the prevailing low growth rate.

Apparently the estimation of growth rate and production of Antarctic copepods requires information about their seasonal development over the whole year. This would also clarify the adaptation of copepod populations to the changing conditions in food supply. To widen our seasonal information, Dr. S.B. Schiel of AWI, Bremerhaven, took 9 samples with our 50 μ m net for us in the Weddell Sea during the autumn cruise with RV 'Polarstern', in April-May. From 19 August to 15 September, Fransz visited the Department of Antarctic Biology of the Polish Academy of Science in Warsaw and the Department of Biological Oceanology of the Gdansk University in Gdynia and Hel to analyse a year series of samples from Admiralty Bay in South Georgia (Warsaw) and winter samples from Croker Passage (Gdansk). Preliminary results indicate that eggs and nauplii of the predominant copepod *Oithona similis* disappear in August-September, but subadult copepodids (C4-C5) and adult females remain present in the upper 500 m throughout winter. This confirms the hypothesis that many individuals require two seasons to complete their life cycle; growth rates can thus be very low. Analysis of the seasonal shifts in stage composition must prove the dominance of a two-year cycle. *Oithona* did not resume its egg production before or during the spring diatom bloom, but during the following period with small flagellates and heterotrophs. As everywhere else, also in polar waters it seems to be linked to the regenerative phase of pelagic systems typical for oligotrophic conditions. The predominance of this species in polar waters poses the question whether in the study of food chains and continuity in polar systems the diatom-based food webs are not studied too one-sidedly. Taxonomically related *Oncaea* species spawned in the middle of winter at depths greater than 500 m, indicating the variety of life strategies and niche differentiation in the 'simplest' of all marine pelagic systems.

B2-13 LIFE-CYCLE, PRODUCTION AND CALCIFICATION OF THE COCCOLITHOPHORE *EMILIANIA HUXLEYI*

P. van de Wal, J.D.L. van Bleijswijk Tierens Verhagen, R. Kempers, M.J.W. Veldhuis, G.W. Kraay, M. Stoll, D. Bakker. G.J. Brummer, P. Westbroek (RUL)

The research activities this year were focused on field experiments which were conducted in a Norwegian fjord system from 21 April to 29 May. In total nearly 40 scientists from Norway, Germany, Monaco, USA, Sweden, United Kingdom and the Netherlands carried out experiments in enclosures situated near the biological station Espegrend (near Bergen) or joint cruises on board RV 'Pelagia' or 'Håkon Mosby'.

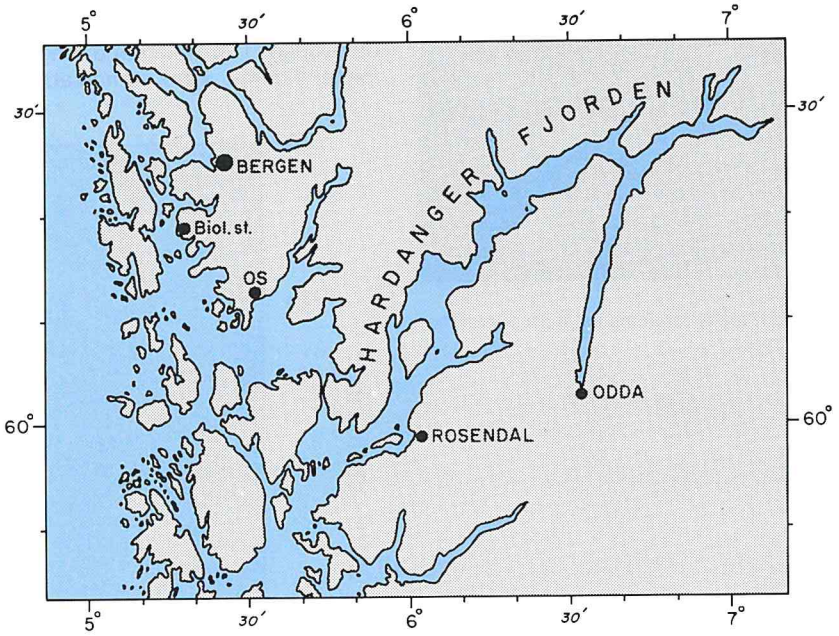
The Dutch part of the sea-going programme was situated in Björnafjorden. During the cruise a set of physico-chemical parameters was measured from 21 April to 9 May. Although the weather conditions prevented the coccolithophorid

Emiliania huxleyi from blooming, an indication of the environmental conditions favouring bloom formation could be obtained.

Due to influence of the freshwater discharge of the surrounding area, vertical profiles showed a structure typical of fjords. Salinity of the surface water never exceeded 32‰. Nutrient concentrations, and in particular nitrate, were low at the surface but gradually increased with depth. Typical values were < 1 µM at the surface, increasing to 11 µM at a depth of 50 m.

Measurements of the various inorganic carbon pools showed surface values for total inorganic carbon (tCO_2, *ca.* 2000 µM), which were at least 10% lower than those obtained at greater depths. A noteworthy observation was that the partial pressure of inorganic carbon (pCO_2aq) indicated an undersaturation in the surface water as compared with air, implying a further reduction of this pool of CO_2. Especially under low pCO_2aq, growth of coccolithophorids would be favoured, because this type of alga may also use bicarbonate as inorganic carbon source instead of free CO_2aq.

The phytoplankton biomass remained low over the whole period, probably due to the low nitrogen levels (1 to nearly 3 µg $\cdot dm^{-3}$). Nevertheless, a change in the phytoplankton composition was observed towards the dominance of *E. huxleyi*.



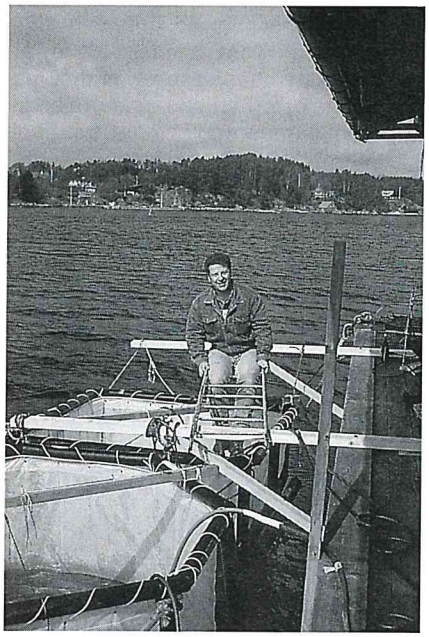
Location of study area and position of sampling stations (station 5 was the major sampling station).

The euphotic zone was shallow, *ca.* 45 m, due to the high amount of debris in the water. Daily organic and production values ranged from 10 to 50 $mM \cdot m^{-2} \cdot d^{-1}$ for the organic fraction and <1 to 5 $mM \cdot m^{-2} \cdot d^{-1}$ for carbonate, respectively. With time the calcification increased slightly to 10% of the total production. A massive blooming of the phytoplankton would not occur until the northeasterly wind mixed the upper water column, thereby increasing the nutrient level at the surface.

The RV 'Håkon Mosby' continued to survey the fjords after the Pelagia had left. They observed a more moderate bloom of *E. huxleyi* (up to $6*10^6$

cells ·dm^{-3}) in the Samnagerfjord, an arm of the Björnafjord, south of Bergen. Populations of this alga were tightly coupled with the brackish water layer, since they were found at the border of the nutrient-depleted upper water layer and nutri-en-rich, high-salinity, intermediate water zone.

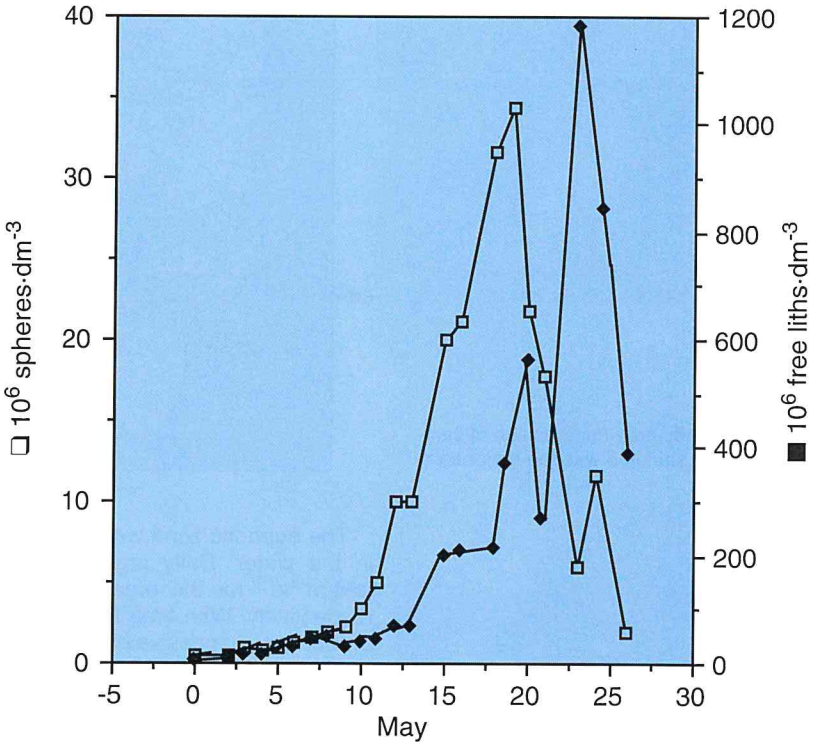
Enclosure experiments



Scientist ready for sampling from one of the enclosures.

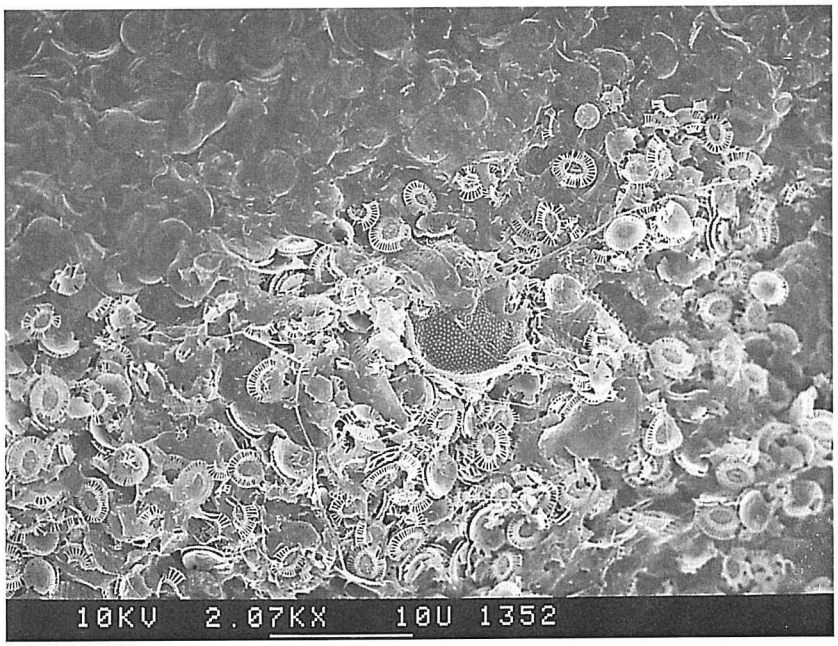
The objective of the large mesocosm project carried at Espegrend field station from 22 April to 29 May was to study phytoplankton bloom development in seawater enclosures with various nutrient conditions, with special emphasis on the study of the causes and effects of the waxing and waning of blooms of the coccolithophore *Emiliania huxleyi*. In total eight enclosures were prepared, each of which consisted of a floating frame to which a 4-m-long and 2-m-wide polyethylene bag was attached. They were connected to a raft 200 m from the shore in an embayment of Raunefjorden and filled with unfiltrated natural seawater. This water was continuously renewed with water from outside at a flow rate of 10% of the bag volume per day. At the start of the experiment two series of three enclosures were fertilized with nitrate and phosphate in an N/P ratio of 16/0.2, 16/1 and 16/5, respectively. In the course of the experiment 10% of the supply of nutrients at the start were added daily.

In the enclosures with N/P ratios of 16/0.2 and 16/1 blooms of *E. huxleyi* developed. The timing and magnitude of the various developmental stages of these blooms were remarkably similar: After 11 May, $CaCO_3$ production



Numbers of coccospheres and free coccoliths in enclosure 6 during the experiment.

increased rapidly for 5 days, then remained constant or increased further until 20 May. Thereafter the production rapidly declined. After the peak productivity cell numbers decreased dramatically. The final stage of the bloom was characterized by the release of large numbers of free coccoliths, which were eventually also steadily removed from the system. Copepod grazing appeared to be an important mechanism for the removal of both coccospheres and free coccoliths, judged by the abundance of faecal pellets almost exclusively consisting of the skeletal remains of *E. huxleyi.* Most probably these blooms were triggered by the steady increase in temperature and irradiance during the experiment; nutrient limitation is thought to have caused the sharp decrease in growth. It is interesting to note that this sequence of rapid rise and fall in cell numbers and the shedding of coccoliths in the final stages of the bloom is also characteristic of blooms of *E. huxleyi* occurring in the open ocean.



Copepod faecal pellet stuffed with coccoliths of *E. huxleyi* (x1800).

1.7. COASTAL SYSTEMS (B3)

INTRODUCTION

The Coastal Systems Department studies the structure and functioning of coastal soft-sediment ecosystems, in particular in the Dutch Wadden Sea. The emphasis is on quantification of the food chain and production processes. All trophic levels are included: primary production (B3-01), secondary production (B3-02) and dynamics of primary consumers (B3-03 and B3-04), and secondary consumers (B3-05, B3-06, B3-07, B3-08, B3-09). Other projects deal with the physiology of marine organisms (B3-10) and palaeobiology (B3-11). Most effort is devoted to the study of dynamics and interactions of the following groups: phytoplankton (B3-01), macrobenthic invertebrates (B3-02, B3-03, B3-04, and B3-07), flatfish (B3-05, B3-06), and birds (B3-08, B3-09).

B3-01 PRODUCTION AND TRANSPORT OF ORGANIC MATTER

G.C. Cadée, J. Hegeman

Phytoplankton development in the Marsdiep in 1992 was markedly different from the last few years, which always showed an overwhelming presence of *Phaeocystis*. After the spring diatom peak only a weak *Phaeocystis* bloom developed, with peak values below 40000 cells per cm^3. In late April and the larger part of May very low numbers of *Phaeocystis* occurred, whereas in foregoing years this was the main period for the *Phaeocystis* bloom, with *e.g.* a peak value of 125000 cells per cm^3 in 1991. At the end of May there was a short revival of *Phaeocystis* but still the maximum cell numbers were relatively low (*ca.* 70000 per cm^3). Although the diatom spring peak in 1992 was lower than in 1991, diatoms were slightly more abundant in late March and early April during the dip in *Phaeocystis* than in 1991. Like in 1991 a small diatom autumn peak occurred in August. As diatoms are the best food for most herbivores, these data indicate good feeding conditions in the Wadden Sea in 1992. Chlorophyll *a*, primary production and nutrient data have to be worked out to give a more complete picture of the phytoplankton development in 1992. This might enable us to understand the aberrant seasonal pattern in 1992.

B3-02 SECONDARY PRODUCTION AND DYNAMICS OF TIDAL-FLAT MACROZOOBENTHOS

J.J. Beukema, W. de Bruin, J. Zuidewind

The long-term investigations (started in 1969) of the intertidal benthic macrofauna in the western part of the Wadden Sea have been continued. A data set

of more than 20 years is now available. This year again a part of it was worked out. Special attention was given to the dynamics of juvenile shrimp during their stay on the tidal flats. High numbers of post-larval shrimp start to settle there in April (after a mild winter) or May (after a cold winter). Maximal numbers are reached in June and July, respectively. Intensive settlement generally continues till early autumn. During their stay on the tidal flats, the juvenile shrimp grow rapidly. Within about one month they reach a length of more than 2 cm. At this size they start to leave the tidal flats (which are situated at levels around mean-tide level) to join the stock of larger shrimps living in permanently submerged areas. Tidal flats thus serve as a transit nursery for shrimp, where several successive cohorts grow up during one summer.

Year-to-year differences in juvenile-shrimp abundance on the tidal flats of Balgzand were strong, with generally high numbers and biomass values after mild winters and low values after cold winters. These differences are thought to explain most of the generally highly successful recruitment of the bivalve *Macoma balthica* after cold winters. Laboratory experiments indicate a decisive influence of the presence of juvenile shrimp on the survival of *Macoma* spat. Shrimp densities on the tidal flats are generally sufficiently high to remove most of the small *Macoma* spat. Only the highest flats (well above mean-tide level) are drained for too long periods each day to form a suitable habitat for shrimp and only these limited areas are a refuge to *Macoma* spat, even in summers with high shrimp abundance. Summer densities of spat show little year-to-year variation at the highest parts of the tidal flats. Contrastingly, at all lower tidal flats (more than 90% of the entire tidal-flat area of the Wadden Sea), *Macoma* recruitment succeeds only in the summers with low shrimp abundance. Such successful years are rare and usually start with a severe winter. Adult populations of low tidal flats (and of subtidal areas) generally originate from spat grown up on high tidal flats and migrated in winter in an offshore direction.

Crawling track of *Ophiura*.
(Photo: G.C. Cadée)

B3-03 WINTER TEMPERATURES AND REPRODUCTIVE SUCCESS IN BIVALVES LIVING ON TIDAL FLATS IN WESTERN EUROPE

P.J.C. Honkoop, D. Kwast

This newly started project is subsidized by the NOP 'Mondiale Luchtverontreiniging en Klimaatverandering' (a national research programme on causes and effects of climatic change).

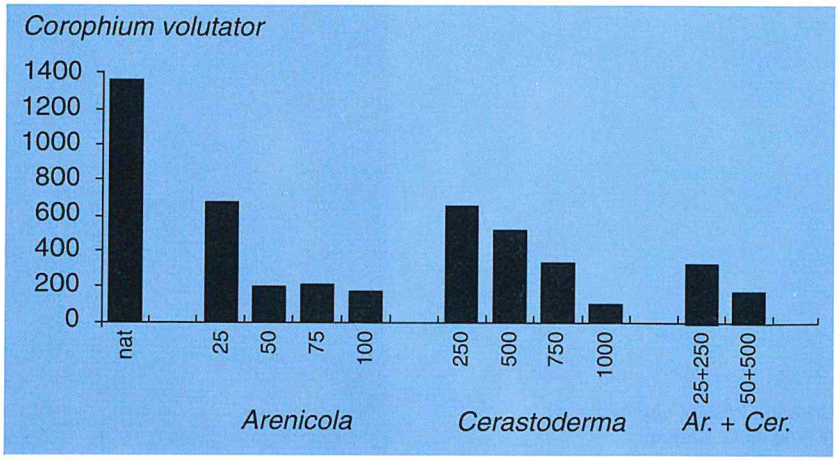
Reproductive success of bivalves on tidal flats is generally high after cold and low after mild winters. Two processes are supposed to contribute to this difference: -1. higher predation pressure on young bottom stages of bivalves by shrimps and shore crabs in summers after mild than after cold winters (see B3-02), and -2. lower reproductive output of bivalves after mild than after cold winters, as a consequence of greater weight loss during mild than during cold winters. The latter hypothesis is studied by large-scale experiments with basins kept at temperatures higher and lower than field values during winter. Reproductive output of various bivalve species (*Mytilus*, *Cerastoderma*, *Mya*, *Macoma*) kept over winter in these basins is estimated by measuring such parameters as egg numbers, egg sizes, hatching success, *etc.* First results indicate production of smaller eggs at higher late-winter temperatures.

B3-04 INTERACTIONS BETWEEN MACROZOOBENTHOS SPECIES ON TIDAL FLATS

E.C. Flach, W. de Bruin, C. Baltus

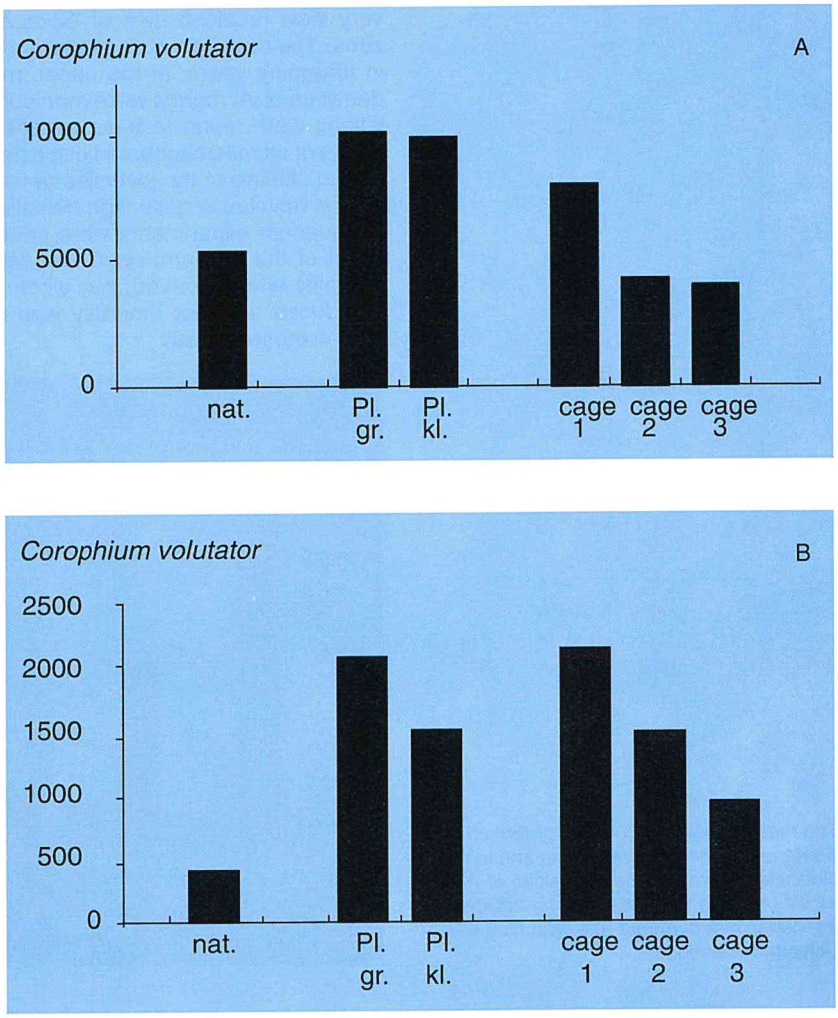
This year the study of the effects of different densities of lugworms (*Arenicola marina)* and cockles (*Cerastoderma edule)* on the macrozoobenthic community was continued in three different places:

1) From 23 March to 20 June at Kristineberg Marine Biological Station, Sweden, where in co-operation with R. Rosenberg and L. Pihl (University of Gothenburg) experiments were carried out in shallow bays in the Gullmarsfjord. In these bays live the same species as in the Wadden Sea, but under different physical conditions. We concentrated on the effects of lugworms and cockles on the amphipod *Corophium volutator.* In Gullmarsvik (a bay with very low natural densities of lugworms and cockles) four different densities of these species were placed in 1-m^2 plots in March and the numbers of *C. volutator* were counted in June. A strongly negative effect of both lugworms and cockles was found, which is the same as was found in foregoing yearsat Balgzand in the Wadden Sea. In Finnsbovik (a bay with a high density of lugworms) the lug-



The mean density (n·m^{-2}) of *Corophium volutator* in the natural situation (nat.) and in the plots with the different (initial) densities (n·m^{-2}) of *Arenicola marina* and *Cerastoderma edule* in Gullmarsvik.

worms were killed in two places (by placing small plastic mats on the sediment for two weeks). In both places the numbers of *C. volutator* became much higher in these plots without lugworms than in the surrounding area. In the deeper place (high predation pressure) the numbers were about four times as high, whereas at the shallowest place (with a low predation pressure) the numbers were only about two times as high as in the natural situation. Cage experiments to exclude predators in the natural situation showed no effect at the shallow place, but had a positive effect on the numbers of *C. volutator* in the deeper part.



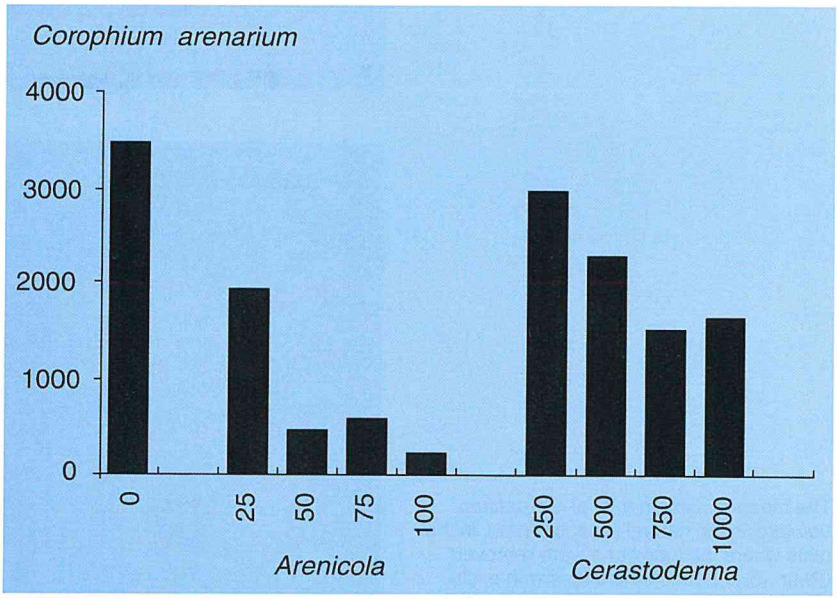
The mean density ($n \cdot m^{-2}$) of *Corophium volutator* in the natural situation (nat.), in the plots where the lugworms were removed (Pl.gr., Pl.kl.) and in the cages with exclusion of predators in the shallow part of Finnsbovik (a) and in the deeper part (b).

2) On a tidal flat near the island of Schiermonnikoog the effect of lugworms and cockles on another species of *Corophium* living in the Wadden Sea, *C. arenarium,* was studied. This was done both by manipulating the numbers of lugworms and cockles in otherwise undisturbed small plots of 1 m^2 and in a

depopulated square of 10 x 10 m in which small plots were recolonized with different densities of cockles and lugworms and some plots remained 'empty'. In the azoic plot quite high densities of *C. arenarium* (3500·m^{-2}) were found in the empty plots in July and a strongly negative effect of both cockles and lugworms was found. In the natural situation the numbers of *C. arenarium* were quite low (~400·m^{-2}); the addition of cockles and lugworms had no significant effect, but in the plots where the lugworms were removed very high densities of *C. arenarium* were found (~ 4000·m^{-2}).

3) The monthly sampling of a transect from the upper, muddy zone to a lower sandy part at Balgzand was continued. After last year's total extinction, a very slow recolonization of *Corophium volutator* was observed in the upper zone. The densities of *C. arenarium* in the lower parts were about the same as in foregoing years. In the upper, middle and lower parts of the transect, the densities of *A. marina* were manipulated in small plots of 2 m^2. These manipulations were found to have no effect on the densities of the already settled adults of all macrozoobenthic species counted, but negative effects were found on the settling of the juveniles of most species. Especially the removal of lugworms resulted in quite high densities of almost all species found.

Aquarium experiments were carried out to see to what extent the negative effect of the lugworm on *C. volutator* is due to mortality. No direct effect on mortality was observed, but when predators (small *Carcinus maenas)* were introduced a higher mortality was often found in the aquaria with lugworms than in those without.



The mean density (n·m^{-2}) of *Corophium arenarium* in the empty (0) plots and in the plots with different (initial) densities of *Arenicola marina* and *Cerastoderma edule* in the depopulated square at a tidal flat near Schiermonnikoog.

B3-05a RECRUITMENT MECHANISMS IN FLATFISH POPULATIONS

H.W. van der Veer, E. Adriaans, L. Bolle, P.A. Walker, J.IJ. Witte

Main topic of the project is a study of the factors determining the year-class strength and ultimate recruitment in flatfish species.

An analysis of the recruitment data in North Sea plaice indicates that temperature may be a key factor in the determination of the stock size of this species. The main processes operate during the egg and larval stages. Besides affecting egg production, temperature has a strong influence on mortality especially during egg and larval stages.

Settlement and ecology of 0-group dab *Limanda limanda* has been studied in the southern North Sea. Previous research has indicated that dab settlement occurs at about 10 m depth. Extensive surveys in the North Sea suggest, however, that main areas for settlement are situated at about 20 m depth. Despite this open-sea settlement, dab is more abundant than plaice, although plaice grows up in sheltered nursery areas such as the estuarine Wadden Sea. Special attention will be paid to a comparison between growth and mortality estimates in dab and plaice.

At the First International Symposium on Flatfish Ecology, Texel 1990, it was concluded that recruitment mechanisms in flatfish might vary with latitude. For that reason research was initiated with J.M. Miller (North Carolina State University, Raleigh, USA) in a subtropical system in Puerto Rico and in a tropical estuary Archipélago dos Bijagós in Guinea-Bissau. Preliminary results from Guinea-Bissau suggest a growth rate of juvenile flatfish of more than 1 $mm \cdot d^{-1}$ and an instantaneous mortality rate of 0.04$\cdot d^{-1}$. This mortality rate is in the same order as those observed in plaice and flounder in the temperate Wadden Sea area.

The Dutch research vessel 'Knud-W', in the Archipélago dos Bijagós during the 1992-1993 Guinea-Bissau expedition. (Photo: H.W. v.d. Veer)

B3-05b LONG-TERM CHANGES IN FISH STOCKS IN THE COASTAL ZONE

H.W. van der Veer, J.IJ. Witte, J. van der Meer

A statistical analysis has been carried out for all species caught to permit a selection of those species that can be used to study long-term changes in their abundance. This analysis required the development of special techniques. A preliminary analysis of the species richness over the period 1960 -1992 did not show a clear trend. Total number of species remained more or less the same. There was only a slight increase in the number of crustacean species.

B3-06 FISH-BENTHOS INTERACTIONS

H.W. van der Veer, J.IJ. Witte

Central theme has been the 'maximum growth/optimal food condition' hypothesis, which predicts a maximum growth of 0-group plaice only depending on prevailing water temperatures. Growth of 0-group plaice was studied in relation to food abundance and prey species composition at a number of stations on the tidal flats and in the sublittoral of the Wadden Sea. The results falsified the maximum-growth hypothesis. Growth was related with food abundance. Differences in growth rate could be explained by shifts in feeding activities *i.e.* handling and searching time. However, growth was not density-dependent. Consequently, in all areas studied the carrying capacity for plaice was not reached even at the highest densities encountered.

B3-07 ENERGY BUDGET OF BENTHIC CARNIVORES

M. Fonds, P. van der Puyl

Work on the ecology of *Asterias rubens* was continued. Populations of starfish in the Wadden Sea and in the southern North Sea (Texel to Dogger) were regularly sampled to estimate their growth rates. Laboratory measurements were carried out on oxygen consumption and feeding of starfish at constant temperatures of 5, 10, 15, 20°C.

Measurements were started on the metabolism of young rays (*Raja radiata*) at various temperatures (5, 10, 15°C).

B3-08a DYNAMICS AND FEEDING OF SEABIRDS IN THE WADDEN SEA AND TROPICAL TIDAL-FLAT AREAS

C. Swennen, P. Duiven

Due to fishery restrictions and recruitment, the stocks of cockles and mussels have partly recovered after the over-exploitation in previous years. In contrast to the last few years, dead or dying Eiders are now rare in the Dutch part of the Wadden Sea. Birds with a hyper-infection of *Polymorphus botulus*, so common in periods of food scarcity, are not seen now.

The breeding population of Eiders on the island of Vlieland was smaller than a few years ago. Egg laying was about 10 days later than normal, but only very few nests were deserted and hatching success was about 95%.

A rearing experiment conducted with incubator-hatched ducklings shows that sufficient food animals for small ducklings were present at only a few sites on the intertidal flats in the nursery area off Vlieland. In such a situation the females need good landmarks to find back the good feeding sites for the ducklings during the following low tides. However, the destruction of the wild mussel beds by fishermen has changed the nursery area from a structured habitat into a wet sand desert without any landmarks that can be seen by a walking duck from a distance. This probably caused the great discrepancy between the low mortality among ducklings of the experiment and the extremely high mortality among the wild ones, both groups feeding on the tidal flats off Vlieland.

During a survey of feeding sites of coastal birds along the west coast of Thailand (Adaman Sea) by the Asian Wetland Bureau and the Prince of Songkla University (7-29 February), several mud flats and small islands were visited, some with considerable numbers of waders, terns and herons.

In collaboration with the East China Normal University (Shanghai), the ecology of wintering Oystercatchers was studied along the East China Sea (4-23 November). The East Asian race of the Oystercatcher (*Haematopus ostrale-*

gus osculans) is becoming rare and may be on the verge of extinction. This in contrast to the West European subspecies (*H. o. ostralegus)* whose numbers have continually been increasing over the last century. The most obvious morphological difference between the two subspecies is the length of the bill. Therefore the emphasis of the study was put on the feeding ecology. The first results indicate that the birds in Asia are much more dependent on crustaceans and worms in their food than on bivalve molluscs, which form their main food type in Europe.

B3-08b ANNUAL ENERGETICS OF KNOTS

Final countdown of waders during starvation in winter

I. Tulp, T. Piersma

The vagaries in food availability and weather expose waders wintering in the temperate zone to the risk of starvation. The northerly winterers show peaks in bodily nutrient reserve levels when the putative risks are highest in midwinter. The correlations between winter severity and nutrient reserve levels within and among species have invariably been interpreted as indicating adaptively longer 'survival spans upon complete starvation'. We have examined this interpretation by looking at the interaction between final-nutrient status and thermostatic costs in both sedentary and actively migrating Knots and Dunlins. Since these species die at lower body masses under warm weather conditions than in the severe cold, the 'survival spans' of the average winterers at different latitudes are more similar than expected at first sight. This suggests that the winter nutrient levels are indicative of a relatively constant risk of death, wherever the bird eventually dies.

Contrasts in available prey species for waders in the Sivash (Ukraine)

Y. Verkuil

In April and May a study was carried out on the spring migration of waders through the Sivash area, a stopover site along the poorly studied Mediterranean Flyway (Sea of Azov). The feeding behaviour of three wader species (Dunlin *Calidris alpina*, Curlew sandpiper *Calidris ferruginea* and Broad-billed sandpiper *Limicola falcinellus*) was studied in detail.

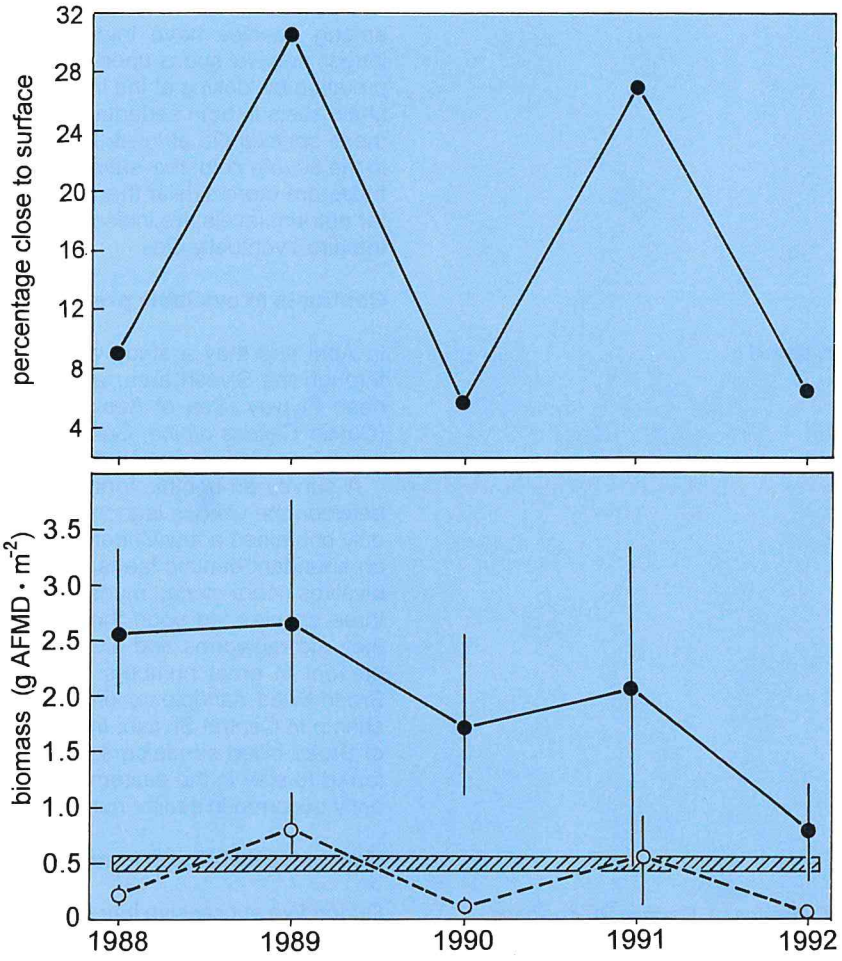
A survey on benthic food resources for the birds showed large differences between the various lagoons in the area. In general lagoons in the central part only contained a few Chironomid larvae, while lagoons in the eastern part had an abundant benthic fauna with rich stocks of ragworms (*Nereis diversicolor*), bivalves (*Abra ovata*), mudsnails and Chironomid larvae. In Central Sivash the three species fed upon the brine shrimp (*Artemia*), while in the eastern part they ate ragworms and bivalves. While Curlew sandpipers and Dunlins were present in great numbers both in the central and eastern part, only a few Broad-billed sandpipers (in total no more than 250) were foraging on brine shrimp in Central Sivash. In the lagoons in East Sivash up to 2000 specimens of Broad-billed sandpipers were seen. Broad-billed sandpipers evidently preferred to stay in the eastern part, while Curlew sandpipers and Dunlins apparently occurred in similar numbers in the two parts.

Occurrence of Knots in relation to food abundance

T. Piersma, A. Dekinga, A. Koolhaas

During five successive late-summer/autumn seasons (1988-1992) the distribution and diet of Knots occurring on the intertidal flats around Griend in the western Dutch Wadden Sea were documented, and simultaneously their ben-

thic food supply was mapped. Two or more 'waves' of Knots (up to 40000 birds) usually visited the area in late July-October, the first always representing the Afro-Siberian subspecies, the later ones the Euro-Canadian. Their diet consisted of *Macoma balthica* if available in sufficient numbers, *Hydrobia ulvae* if *Macoma* was not available, and *Cerastoderma edule* only when neither *Macoma* nor *Hydrobia* occurred abundantly enough. Over the years the abundance and availability of all three food types decreased, leading to poverty, and a complete absence of Knots in 1992. We are inclined to believe that this scarcity has much to do with the disappearance of local mussel (*Mytilus edulis*) banks, and the repeated reworking of sediment by industrial cockle fisheries.

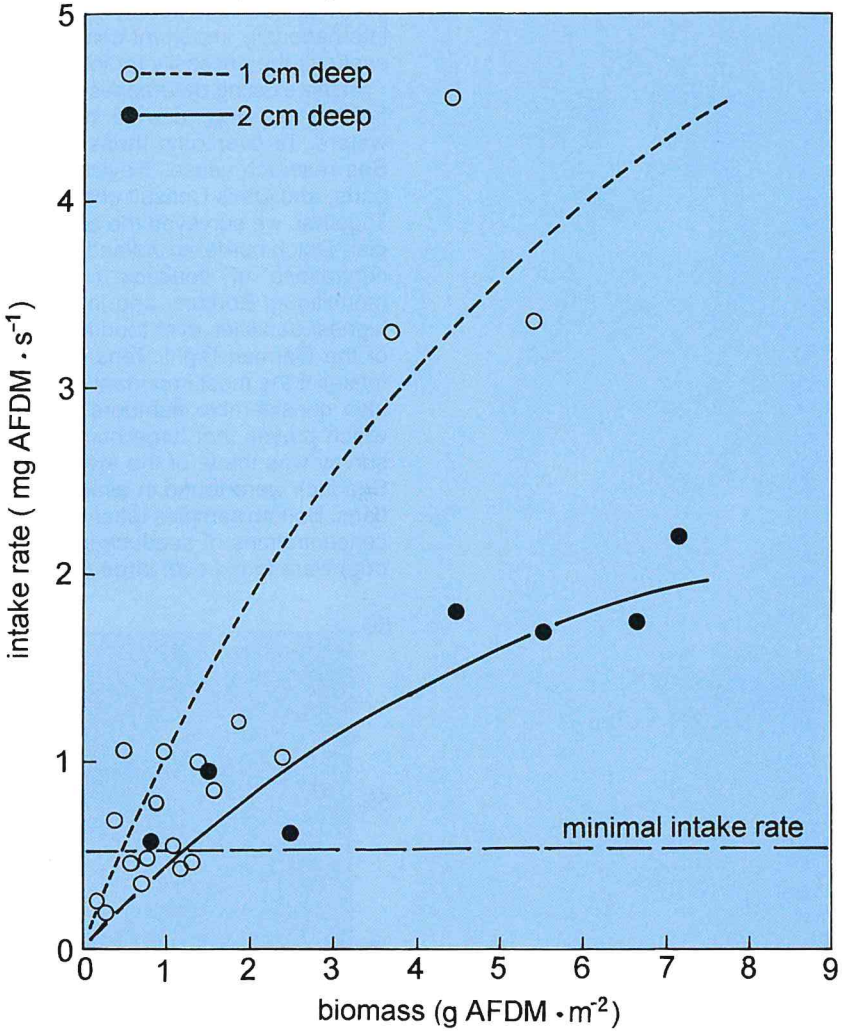


Historical changes in the availability of *Macoma balthica* ingestible by Knots (size 3-18 mm) on the mudflats around Griend in the western Wadden Sea in August. The upper panel shows the yearly percentages of *Macoma* of which the upper edge is shallower than 2.5 cm in the sediment (based on depth measurements of 2100 individual *Macoma*). The lower panel shows the yearly biomass densities of ingestible *Macoma* (closed dots) and the biomass densities of harvestable *Macoma* (ingestible and available within 2.5 cm; open circles). The vertical bars indicate the range in values for the five regions around Griend. The horizontal bar approximates the minimum densitites required by Knots in autumn and winter. This figure is based on more than 3000 sieved cores.

B3-08c PREDATION BY BIRDS AND EPIBENTHOS ON THE MACROZOOBENTHOS OF TIDAL FLATS IN THE WADDEN SEA

P. de Goeij, T. Piersma, J. van Gils

This newly started project studies, in an integrated way, predation pressure exerted on tidal-flat benthos by both warm-blooded birds and cold-blooded epibenthic animals (fishes, crabs, shrimps). One of the main questions is: do these two groups of predators compete for the same food supply, or do they facilitate each other's predatory effort?



Intake rates of Knots feeding on different biomass densities of two depth classes of 14 mm long *Macoma balthica*. The experiments were carried out on small artificial mudflats in the laboratory and registerd on video-tape. Each dot is based on 10-15 ingested prey and 5 different individual birds. The functional response curves are based on the model of Zwarts & Blomert with adjusted empirical values for probe-frequency and -depth and handling time. The horizontal line gives the minimum intake rate required by free-living Knots feeding 12 h at a cost level of 4 W.

First experiments were performed on intake rates of Knots in relation to food abundance. By offering trained Knots set densities and depth distributions of molluscs in small mudflats in the laboratory, we tried to measure the empirical 'functional response curves' (describing the relationship between prey density, prey depth and intake rate) for different prey types, in order to describe the availability thresholds of *Macoma, Hydrobia* and *Cerastoderma*. The feeding

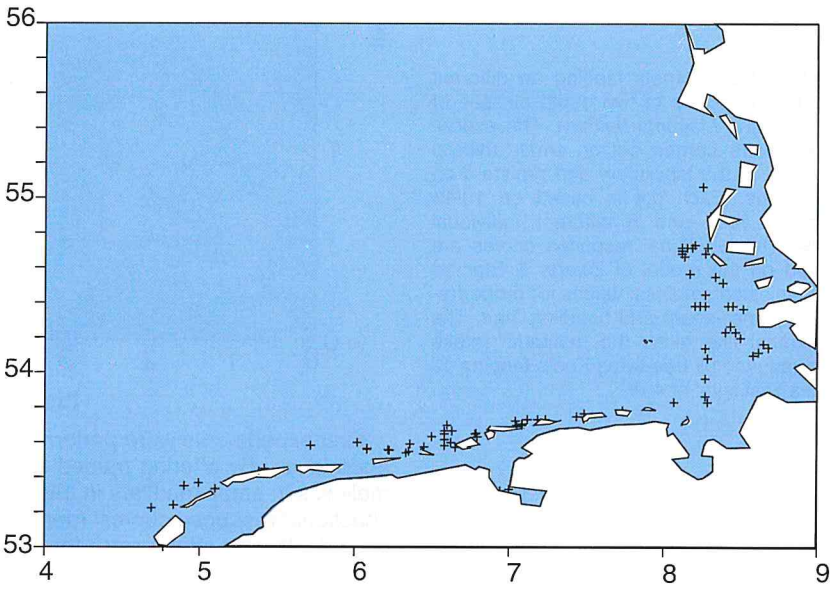
trials are registered by video and the recordings analysed in detail afterwards. Simultaneously a theoretic model is built in which all the relevant feeding parameters are incorporated.

B3-09 SEABIRDS AND CETACEANS

M.F. Leopold, C.J. Camphuysen

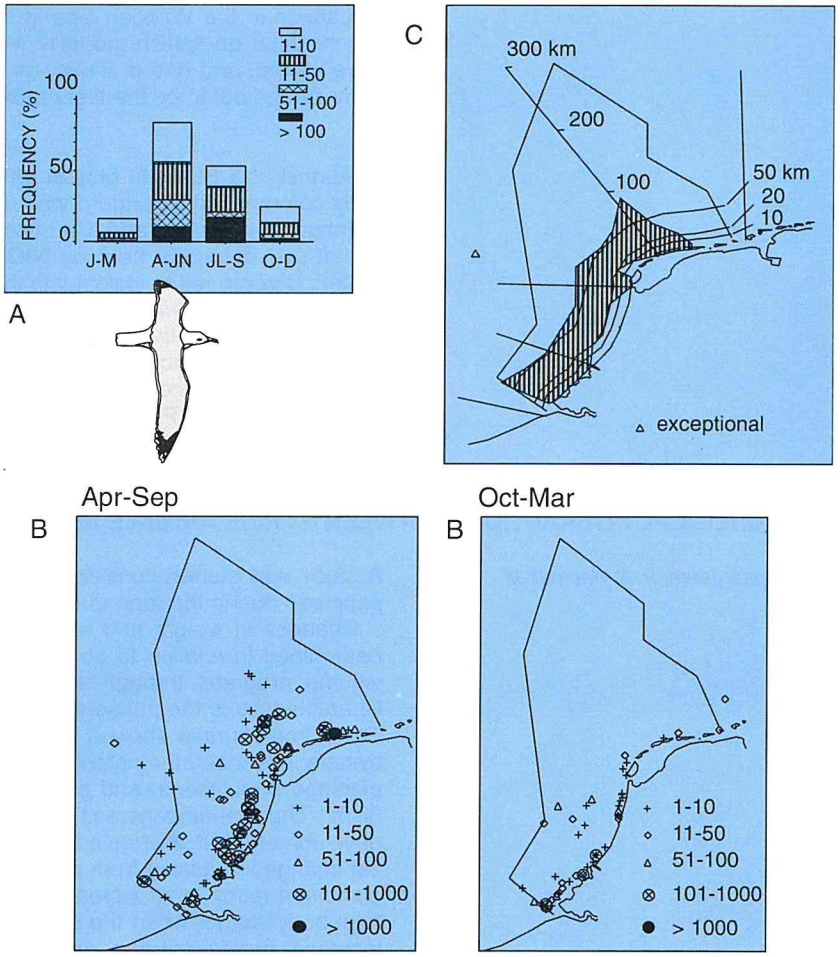
Seabird and cetacean work in the North Sea continued as an EC-financed project, in which NIOZ and Ornis Consult, Copenhagen, are partners. The aim of this project is to survey the coastal zone of the southeastern North Sea, for internationally important concentrations of seaduck and harbour porpoises, to evaluate the necessity for international protective measures in this area.

In the existing data-bases, the waters in the German Bight have been insufficiently covered, due to navigational problems in these shallow, inshore waters. To overcome these problems, NIOZ offered to provide the Wadden Sea research vessel 'Navicula', with a draft of less than 1 m for the inshore parts, and Ornis Consult chartered another ship for the deeper, offshore parts. Together, we surveyed the area in midwinter (January/February), from the Belgian-Dutch border to Jutland, from the 20 m depth line to the shore. Large concentrations of seaduck (>10000) were found off Terschelling, Schiermonnikoog, Borkum, and in Denmark. Divers were more dispersed, with the highest densities ever found in the North Sea in the German and Danish parts of the German Bight. Tens of thousands of divers winter in this area, which makes it the most important wintering ground for this group. During this survey also considerable numbers of harbour seals were found in the North Sea, which proves that large numbers leave the Wadden Sea in winter. In May a survey was made of the area between Texel and the German-Danish border. Seaduck were found in similar numbers as in winter in much the same locations. Bottom samples taken in winter and in May revealed that (as in 1991) the concentrations of seaduck in the Dutch part (Terschelling and Schiermonnikoog) were found over large *Spisula subtruncata* banks.



Sightings of harbour seal *Phoca vitulina* in January 1992 in the south-eastern North Sea.

In February an oil spill hit the seabirds over the Brown Ridge, off IJmuiden. The southwesterly wind transported around 400 killed Guillemots to Texel, where we collected a sample for stomach analysis. Food remains found in the stomachs allowed a description of the diet of these birds in this area of the North Sea, which is known as one of the most important wintering sites on the Dutch continental shelf. The diet consisted mainly of sandeel, herring, sprat, poor cod, whiting and some miscellaneous fish, among which some flatfish indicating that Guillemots may also use fisheries discards as food.



The Lesser Black-backed Gull *Larus fuscus* as scavenger behind commercial trawlers in the southern North Sea, 1987-1992. (A) Frequency of occurrence, (B) distribution of sightings, (C) area where the species was found dominating (>50% of associated seabirds)

In September the waters off the British east coast were visited during the herring surveys of the Netherlands Institute for Fishery Investigations (RIVO). One of the most striking results was the relative scarcity of cetaceans in this part of the North Sea, where in previous years much higher numbers were always found. In November we participated in the RIVO International Bottom Trawl Survey in the southern North Sea, and in December we joined the herring larvae survey in the English Channel for seabird counts in this area.

Around 10 volunteer birdwatchers assisted in the seabirds counts at sea.

Some time was spent in data-transfer to the international seabird-at-sea database in Aberdeen, which now holds the data of all major groups working around the North Sea. Data storage and processing were discussed, and the resulting atlas of vulnerable concentrations of seabirds in the North Sea was presented at the end of the year.

In the Wadden Sea a pilot study was started to investigate the diet of the Cormorant. To date, no marine work has been done on this species, which was always considered to be a freshwater bird, but which now numbers several thousands in the Wadden Sea in summer. Food consumption and impact of this predator on flatfish mortality will be evaluated. Several Cormorant roosts were visited, and one of these, on an artificial island of the Dutch Gas Company, turned out to be the first marine breeding colony in the Netherlands.

In August, the BEWON project on beamtrawl fisheries and scavenging seabirds commenced. Literature was reviewed to collate information on breeding distribution, numbers, and diet of scavenging seabirds. An analysis of the seabird-at-sea database held by NIOZ and by the Dutch Seabird group/Tidal Waters Division led to insight into the relative abundance of Fulmars *Fulmarus glacialis*, Gannet *Sula bassana,* and (common) *Larus* gulls as scavengers in the Dutch sector of the North Sea. A project proposal was prepared for a North Sea wide study of scavenging seabirds on board fisheries research vessels in February 1993, in cooperation with Glasgow University, Joint Nature Conservation Committee (Peterborough/Aberdeen), Vogelwarte Helgoland (Wilhelmshaven), Hamburg University, and Ornis Consult (Copenhagen).

B3-10 CHEMICAL INTERACTIONS BETWEEN MARINE ANIMALS AND THEIR ENVIRONMENT

D. H. Spaargaren, P. A. Haefner Jr

A study was started considering the interactions between ovary and hepatopancreas during the reproductive cycle of *Crangon crangon* (L.).

Changes in weight and water content of hepatopancreas and ovary were determined in relation to body weight and ovarian development. Weight and volume progress through cycles of progressive and retrogressive growth. Characteristic is the phase shift between the development of the two organs. Their time-courses show a clear resemblance with a classic Volterra-Lotka system, described for instance for the development of phytoplankton and zooplankton populations, and probably caused by the same underlying mechanism. The hepatopancreas nearly doubles in size during early oogonial development, but decreases during vitellogenesis. The ovary shows the largest change in passing from previtellogenesis to secondary vitellogenesis. The combined result is an increase to a combined volume occupying 9.5% of the total body weight when the ovary is fully vitellogenic. Despite the large mass increase during ovarian development the water content of both organs decreases, from >70% in immature ovaries to about 46% in vitellogenic ovaries, to a slighter extent in the hepatopancreas (from 73% to 67%).

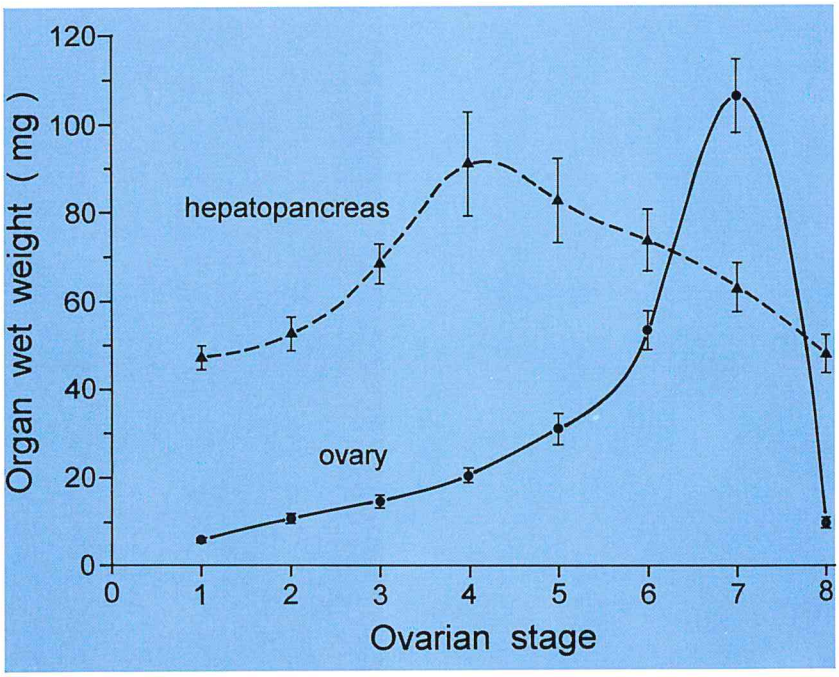
The results contributed to our understanding of interorgan relationships during reproductive development in Crustacea.

Total protein, lipid and carbohydrate (TCHO) content were determined in blood, ovary and hepatopancreas of the brown shrimp, *Crangon crangon,* in relation to the stage of ovarian development. In the combined organs the quantities all show a regular increase relative to ovary stage, most strongly for pro-

tein, to a lesser extent for respectively lipid and TCHO; after oviposition all quantities drop to more or less their original values.

The gradual changes in the total organic contents are not in a similar way reflected in the quantities as present in the various organs. The increase in protein content is mainly due to protein accumulation in the ovary. Blood and hepatopancreas protein only increase to a limited extent and start to decrease already at stage 6 (Meredith classification). The increase in total lipid content is mainly due to lipid accumulation in the hepatopancreas. At ovarian stage 6 the lipid content of the hepatopancreas drops, associated with an increase in blood and ovary lipid content. Changes in TCHO content are also mainly due to TCHO accumulation in the hepatopancreas (only during stages 3 to 5 inclusive). Blood TCHO is increased as soon as hepatopancreas TCHO decreases. The ovary never accumulates large quantities of TCHO.

The changes in organic contents are associated with changes in the volume of the various organs. It appears that also the concentrations of the various compounds in the various organs are highly variable relative to the stage of ovarian development. The significance of the different patterns can be discussed in terms of biochemical conversion and transport processes during the reproductive cycle and compared to chemical organ interactions in other species.



Changes in hepatopancreas (dashed line) and ovary (solid line) weights of *Crangon crangon* according to ovarian stage. N=180. Means and standard error bars plotted for each stage.

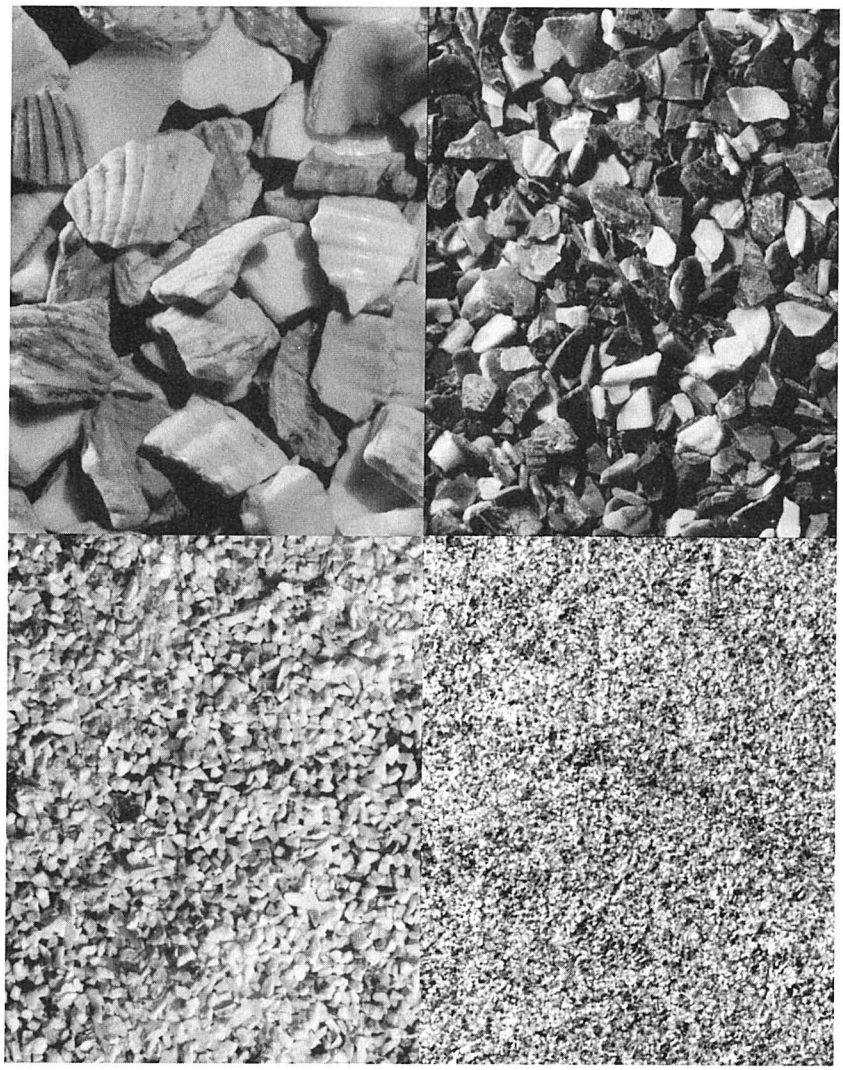
B3-11 PALAEOBIOLOGY

G.C. Cadée

A high percentage of shell fragments in fossil sediments is often considered to be an indicator of deposition in a turbulent environment. However, predators also produce shell fragments. 75% by weight of the carbonate fraction of sur-

face Wadden Sea sediments is found to consist of fragmented shells, 30% of fragments >8 mm and 45% in the 2-8 mm fraction. In a long-term project we try to estimate the role of various predators in shell fragmentation in the Wadden Sea.

Eider ducks are well-known predators on bivalves in the Wadden Sea; they crush shells internally. Sieve analysis of their faeces indicated a size range of fragments from <0.1 mm to 8 mm. 65% by weight is in the 2-8 mm fraction. By their annual consumption we can estimate that 1/3 to 1/2 of the fragments in the 2-8 mm fraction of Wadden Sea sediments are due to Eider predation. The remaining fragments are probably due to other predators. Work is in progress to quantify their role.

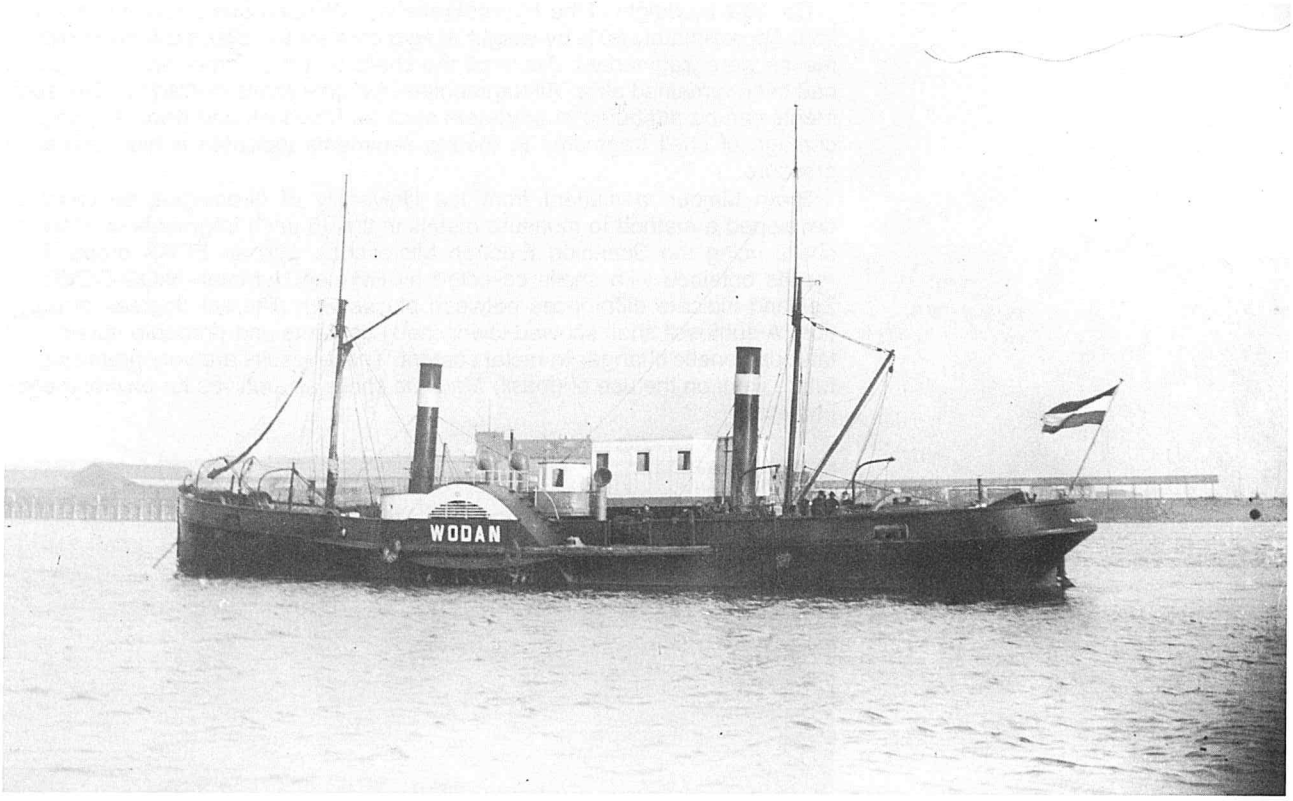


A set of 4 pictures showing different size classes of shell fragments from Eider faeces.

Ca. 40% by weight of the *Hydrobia* shells in Wadden Sea sediments are broken. Approximately 80% by weight of *Hydrobia* shells collected from Shelduck faeces were fragmented. Amongst the shells that had remained intact, some had even remained alive. All fragmented *Hydrobia* shells in Wadden Sea sediments can be attributed to predators such as Shelduck and Knot. A high percentage of shell fragments in marine sediments indicates a high predation pressure.

Bram Majoor, a student from the University of Groningen, successfully developed a method to measure metals in tiny (6 μm^2) fragments of *Macoma* shells using the Scanning Electron Microscope with an EDAX probe. First results obtained with shells collected by Herman Hummel (NIOO-CEMO) in Zeeland indicate differences between places with different degrees of pollution. A subfossil shell showed lower metal contents and probable absence of later diagenetic changes in metal content. These results are very promising for future work on the use of (fossil) *Macoma* shells as archives for environmental changes.

Pellet of herring-gull with broken and undamaged cockle-shells.
(Photo: G.C. Cadée)



Negentig jaar geleden (1902) werd door de Nederlandse Dierkundige Vereniging de radersleepboot 'Wodan' (boven) van eigenaar L. Smit en Co te Rotterdam gehuurd. Dit schip was voor 70 dagen in gebruik voor het doen van marien-biologisch onderzoek in de Noordzee. Tot in de eerste wereldoorlog is het regelmatig gebruikt voor dit doel.

Ninety years ago (1902) the 'Nederlandse Dierkundige Vereniging' (Dutch Zoological Society) rented the paddle steamer 'Wodan' (top) from her owner L. Smit & Co in Rotterdam. The ship was then used for 70 days to carry out marine biological research in the North Sea. Up till World War I she was regularly used for this purpose.

Zestig jaar geleden (1932) kwam de Nederlandse Dierkundige Vereniging tot het besluit een eigen schip te laten bouwen, een kotter van 13x3,80x1,75 m.

Deze bouw werd mogelijk via subsidies van enkele rijksinstellingen en het ministerie. Op voorstel van de oud directeur van het Zoölogisch Station de heer H.C. Redeke kreeg deze kotter de naam 'Max Weber' (rechts boven) naar de man die zoveel voor de NDV en de Nederlandse zoölogie heeft gedaan.

Op 21 december 1932 werd het schip in dienst gesteld. Het schip werd voornamelijk gebruikt voor het onderzoek op de Waddenzee (rechts onder).

De 'Max' is op 4 mei 1963 vervangen door het nieuw gebouwde NIOZ schip de 'Ephyra' (1963-1980).

Sixty years ago (1932) the 'Nederlandse Dierkundige Vereniging' decided to have a ship of their own, a 13x3.80x1.75 m cutter. This was made possible by subsidies from government institutions and the Ministry. At the suggestion of the former director of the Zoological Station Dr. H.C. Redeke this cutter was named 'Max Weber' (right top) after the man who had done so much for the 'Nederlandse Dierkundige Vereniging' and for zoology in the Netherlands.

On 21 December 1932 the ship came into service. She was mainly used in Wadden Sea research (right bottom). On 4 May 1963 the 'Max' was replaced by the new NIOZ research vessel 'Ephyra' (1963-1980).

(Photo: Dik Kreger, 1948)

1.8. SPECIAL PROJECTS (S)

APPLIED SCIENTIFIC RESEARCH NIOZ (BEWON)

BEWON executes a scientific research programme to improve the scientific basis for the management of the North Sea and the Wadden Sea. Special attention is given to politically sensitive problem areas: eutrophication, micropollutants and fisheries. Short- and long-term changes in the ecosystem, as well as in the abundance of different species, are major research topics. BEWON is part of BEON (= Policy Linked Ecological Research North Sea and Wadden Sea), a cooperation between nine Dutch institutes including NIOZ. The research is financed by various Dutch ministries and receives additional funding from EC, NOP and industry. Most programmes are carried out by a multidisciplinary team in close cooperation with other Dutch and foreign institutes.

This year's programme focused on the direct effects of fisheries on the benthic ecosystem, long-term changes in the abundance of vertebrates and invertebrates in the North Sea, the role of different types of sediments in nutrient carbon cycles, the biology of the small food web, ecological modelling of the North Sea and Wadden Sea and the effects of pollutants on higher trophic levels.

BEWON was co-organizer of the Integrated North Sea Programme (INP); following the cruises in 1991 two major INP cruises were carried out in 1992. These focused on studies on the effects of micropollutants and the role of sediments as link or sink in nutrient cycles.

The group gave advice concerning the establishment of protected areas in the North Sea, scientific research to be carried out in such areas, the drafting of the Quality Status Report of the North Sea, eutrophication - algal blooms - and higher trophic levels, effects of drilling platforms on the ecosystem, the effects of beamtrawl fisheries, and the ecology of the coastal zone.

S-01 EUTROPHICATION

S-01a NUTRIENT CHEMISTRY

W. van Raaphorst, C.P. Slomp, J.F.P. Malschaert

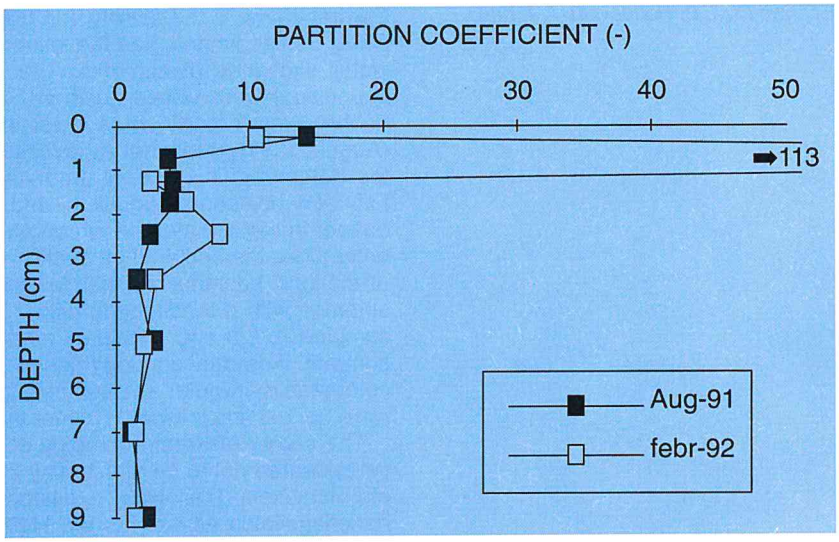
All activities concentrated on sediment-water interactions of nutrients (N, P, Si) and their early diagenetical processes in North Sea sediments. Results from mesocosm experiments with sandy sediments showed that sediment-water

release rates of phosphate and ammonium sharply increase for 2 to 6 days after a single addition of dead *Phaeocystis* material to the sediments. At the same time the nitrification rate decreases and nitrate starts being consumed by the sediment to fuel increased denitrification. This reponse mimics coastal areas with ample nitrate in the water column. In the open sea where nitrate concentrations in the overlying water are low, denitrification probably decreases after addition of organic matter due to nitrate limitation. This hypothesis was supported by field measurements during the BELS cruises (August 1991 and February 1992, in close cooperation with L. Lohse, H1-04).

Pools of inorganic ammonium were measured in sediments of 15 stations of the North Sea. Both in winter and in summer approximately 55% of the total pool of ammonium was adsorbed to the sediment particles, 30% was fixed in microbial cells and only 15% was dissolved in the pore water of the 0-1 cm sediment layer. Adsorption seems to be related to the organic matter content of the sediments.

Benthic release rates of phosphate were much higher in summer than in winter. Apart from the inner German Bight where exchange rates were exceptionally high, typical North Sea benthic fluxes were 50 to 200 $\mu mol \cdot m^{-2} \cdot d^{-1}$ in August and -50 to 50 $\mu mol \cdot m^{-2} \cdot d^{-1}$ in February. Phosphate sorption experiments indicated that the phosphate concentration in the pore waters of oxic surficial sediment layers of the North Sea is efficiently buffered at concentrations between 0.5 and 2 µM.

In cooperation with M. Gehlen from the Free University of Brussels, Laboratoire d'Océanographie, the silica cycle of North Sea sediments was studied, with particular emphasis on processes taking place within time scales that determine main ecological processes (days to months). A method was developed to determine 'reactive' solid silica in sandy sediments with low opal contents (<2%) and adsorption of silica to sediment particles was quantified. Further geochemical characterization of sedimentary silica was performed together with S.J. van der Gaast (H3-17).



In sediments, an equilibrium exists between ammonium dissolved in the pore water and adsorbed to the sediment particles (clays, organic matter). Both fractions are easily exchangeable and may become available to the water column or benthic organisms. The *in situ* equilibrium is expressed by the dimensionless partition coefficient, which is the ratio between total amounts of dissolved and adsorbed ammonium. The figure shows data from a sandy station in the North Sea (near Esbjerg) obtained during BELS cruises in August 1991 and February 1992. Particularly in the upper cm the partition coefficient can be very high, indicating that in this layer the largest portion of the total pool of exchangeable ammonium is adsorbed.

S-01b PHYTOPLANKTON

R. Riegman, A.A.M. Noordeloos, C. Brussaard, W. Stolte, T. McCollin

The impact of microzooplankton grazing on phytoplankton dynamics in the Marsdiep was studied during the seasons. Especially during the establishment of the spring bloom, there were significant phytoplankton losses due to grazing. In some samples more than 75% of the daily primary production was consumed by microzooplankton. After the spring bloom successive *Phaeocystis* and *Noctiluca* blooms were observed. The blooming of *Nocticula* was not related to the dominance of *Phaeocystis*. An attempt was made to correlate *Phaeocystis* blooms with the dynamics of zooplankton. *Phaeocystis* bloomed three times in the Marsdiep area. These blooms probably ended by nutrient-depletion induced autolysis, since the highest values for autolyses were observed during the terminal phases. These autolysis peaks were always followed by a blooming of tintinnids. No specific *Phaeocystis* predator could be identified among micro- or meso-plankton on the basis of population dynamics.

A new method to estimate the grazing of mesozooplankton on microzooplankton was developed. This study is still in progress.

An experimental study was performed to investigate the impact of nitrate *versus* ammonium on phytoplankton species composition. Nitrate was found to stimulate the dominance of larger algal species. Larger algae were able to accumulate nitrate faster than smaller species. Additionally, their storage capacity seems to be higher. These observations imply that especially in areas where nitrate is an important nitrogen source the blooming of larger algal species is favoured. In contrast with nitrate, no selective advantage of cell size was observed with respect to ammonium uptake. The sedimentation rate of mixed algal cultures was higher when nitrate instead of ammonium was the nitrogen source.

S-01c MICROBIAL ECOLOGY

Benthic small food web in North Sea sediments

F.C. van Duyl, B. Hondeveld, A.J. Kop

Central theme is the activity and trophic relationships in the small food web in North Sea sediments and the influence the small food exerts on the sediment-water exchange of nutrients. The stations sampled in August 1991 (BELS expedition) were visited again in February 1992. Heterotrophic bacterial production was 3 to 10 times lower in winter (February 1992) than in summer (August 1991). Seasonal variations in temperature had no significant effect on the heterotrophic bacterial production in sediment surface layers. A relation between bacterial production and temperature could be established only deeper in the sediment (6 cm depth). The supply of available carbon probably determines the bacterial production rates in the upper cm's of the sediment. At all stations, bacterial biomass in winter is in the same order of magnitude as in summer, with a tendency to higher biomasses in winter in the deepest layer sampled (6-6.3 cm). Bacterial mortality is apparently lower in winter than in summer. Individual grazing rates of benthic bacterivorous nanoflagellates were comparable in winter and summer, but the densities of benthic nanoflagellates were up to 8 times lower in winter than in summer.

The sediment-water exchange of dissolved inorganic nitrogen (DIN) in winter appeared not to be affected by the treatment with cycloheximide, a eucaryotic inhibitor. This was expected, because of the lower densities of nanoflagellates as well as the higher ambient inorganic nitrogen concentra-

tions in winter. In summer addition of cycloheximide to intact sediment cores reduced the DIN efflux in 3 out of 10 stations, possibly by inhibiting mineralization by nanoflagellates. It was hypothesized that in the absence of grazing bacterial biomass may increase, forming a temporal sink of N. It was demonstrated that in sandy sediments poor in organic matter (Dogger Bank region), increase in bacterial biomass (N=nitrogen) may be balanced by an equal decrease in sediment-water efflux of inorganic N.

Benthic mesocosms

R. Osinga, W.E. Lewis, F.C. van Duyl

The experiments carried out were a follow-up of the boxcosm experiments conducted in 1990. The main objective was to get more insight into the underlying processes determining the response after a single dosage of organic matter. A eutrophication gradient is simulated by supplying increasing quantities of organic matter (*Phaeocystis* material) to the boxcosms. Oxygen consumption, sulphate reduction and bacterial production rates are measured, as well as oxygen profiles (in cooperation with NIOO-CEMO) and organic carbon profiles in the sediment. Changes in bacterial numbers and biomass are being monitored. The sea urchin *Echinocardium cordatum* is used to study the impact of bioturbation on these processes.

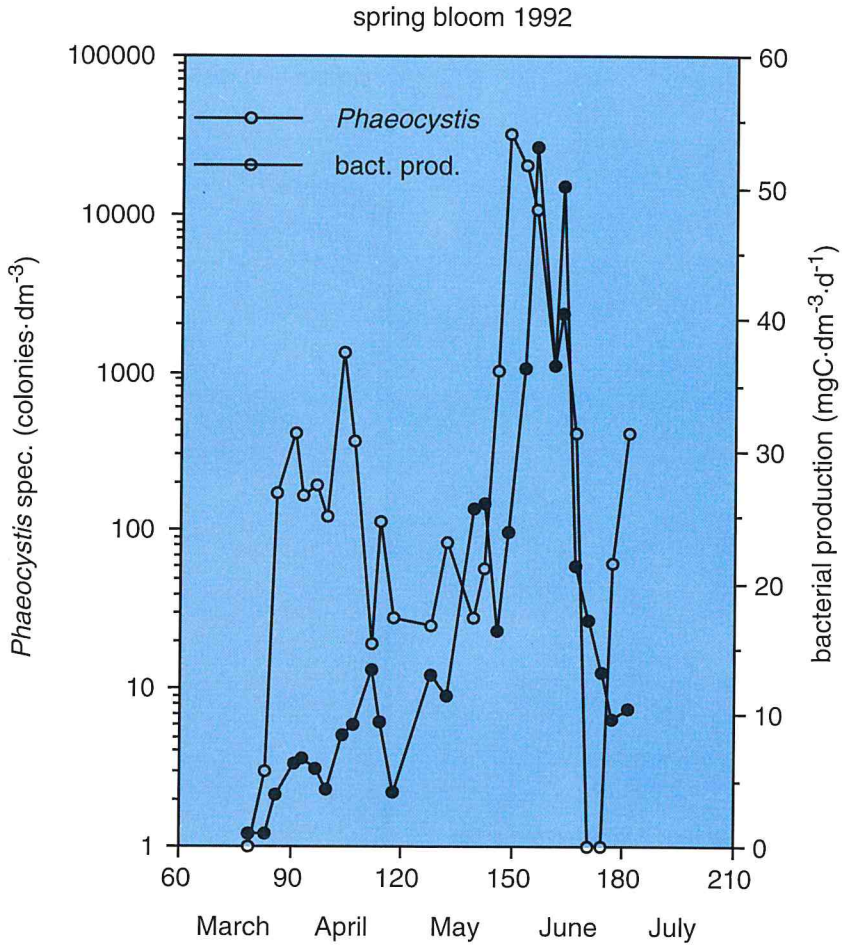
The North Sea boxcosm experimental set-up. Oxygen consumption measurements are taken on the rear right-hand side. (Photo: F.C. van Duyl)

Preliminary results in boxcosms without *E. cordatum* show two consecutive peaks in oxygen consumption rates in response to a single organic matter supply. After these peaks, a rather constant level is maintained, which is only slightly higher than the consumption in starved sediments. Peak levels increased with increasing organic matter load. In boxcosms with *E. cordatum*, biodegradation is expected to proceed faster, due to a better distribution of organic matter into the sediment caused by macrofaunal activity.

Spring blooms in coastal waters

F.C. van Duyl, A.J. Kop

The spring bloom of *Phaeocystis* was monitored with respect to number of algal colonies, bacterial production, acrylate, dimethylsulfoniopropionate (DMSP) and dimethylsulfide (DMS), in cooperation with TNO. In the Marsdiep *Phaeocystis* did not bloom until the end of May, whereas in the North Sea the first blooms were already noticed at the end of March (see also B3-01). Bacterial production followed the oscillations in colony abundance of *Phaeocystis* with a time lag of approximately 10 days. Comparable results were obtained in



The development of the spring bloom with respect to number of *Phaeocystis* colonies and bacterial production, measured from the NIOZ-pier during high tide.

the spring bloom in 1991. Increase in *Phaeocystis* coincided with increase in the acrylate and DMS concentration in ambient water suggesting a coupling between *Phaeocystis*, acrylate and DMS. The rapid decline of DMS in the ambient water after a drop in *Phaeocystis* colony abundance coincided with an increase in bacterial production. A considerable part of DMS may be consumed by bacteria.

S-01e MODELLING

ERSEM (European Regional Seas Ecosystem Model)

P. Ruardij, A. van de Berg

The ERSEM-model, a joint project of 7 European institutes and subsidized by the EC MAST I programme, has reached its final stage. The goal of this project is to construct, calibrate and validate an ecosystem model of the North Sea. In this model the North Sea is divided into 10 areas, roughly corresponding with the ICES boxes. The 5 deeper areas consist of a surface box with a depth of 30 m and a bottom box. The other areas consist of only one box. The pelagic processes defined in the model are calculated for all boxes. The benhtic processes have been calculated only for the boxes that adjoin the sediment.

This year each partner has produced new submodels according to the task description. The result, covering nearly all important processes, is the first version of the ERSEM-mode, which was distributed to the partners in May 1992. From September to December the final version was calibrated and validated.

NIOZ has a twofold task: 1. The maintenance of the existing simulation software (SESAME package) and development of extensions and replacements of the existing software. 2. The delivery of the benthic nutrient model with proper nutrient dynamics (N,P,Si). This model includes the following processes: nitrification, denitrification, dissolution of silicate, adsorption of ammonium and phosphate, vertical transport and exchange of nutrients between the water column and the sediment.

Model results show that sedimentation of material is the most important key factor for the state of the benthos, especially during spring and summer when low ammonium and nitrate concentrations are present in the water column. Too high an input of organic material to the benthos leads to low oxygen levels in the sediment. At such low oxygen levels the nitrification and denitrification rates will be too low. However, a low sedimentation, and thus low input of organic nitrogen, will also lead to low nitrification and denitrification rates.

A new proposal for the continuation of the ERSEM-project after 1992 has been submitted to the EC (MAST II) by 6 of the 7 partners already involved in ERSEM I. Last June this proposal was approved by the EC. The objective of the proposal is thoroughly to test, analyse and further develop the first generation of the ERSEM-model. Further development of the model will concentrate on modelling of biological and chemical processes that determine long-term trends in structure and function of the North Sea ecosystem: the storage, immobilization and permanent removal processes for carbon and nutrients. The applicability of the model to smaller regions will be developed by testing the model in the marginal areas of the North Sea (*e.g.* Dutch coastal zone and German Bight).

FYFY

A biological model of the succession of algae has been developed. The model describes the blooms of several algal species in a qualitative and quantitative

manner. This biological model has been incorporated in a physical water transport model (FYFY) which can describe the spread and occurrence of the algal blooms in the southern North Sea and the Dutch coastal zone. The water transport is calculated on a daily basis and incorporates wind forcing of the transport. In this way the influence of the weather conditions on the algal blooms can be assessed. These weather conditions might for instance be responsible for the variability in blooms between years which is found in the North Sea ecosystem. The first simulations of the model are in good agreement with the start and biomass of the blooms which are found from the coastal zone towards the open sea. In addition, the model shows that the dominance of large algae in the coastal area might be explained by zooplankton grazing. It seems that the ratio of nitrogen to phosphate in the system is a selecting factor for the species composition in the southern North Sea. The research will be continued by making a comparison in time and space of the algal composition between different years with different weather conditions. The effects of reduction of nutrient concentrations in the rivers will also be examined.

S-01g ECOWASP (WADDEN SEA ECOSYSTEM MODEL)

W. van Raaphorst, J.P.C. Smit, P. Ruardij

Together with IBN, the ECOWASP model (based on the older EMOWAD) was further developed, putting most emphasis on sedimentary processes and benthic-pelagic coupling. The larger part of this work was performed within the EC-MAST project WASP (Wadden Sea Project), a cooperation between German, Danish and Dutch institutes concerning physical, geomorphological and ecosystem modelling in the Wadden Sea. ECOWASP (and WASP) will be finished in the first quarter of 1993. See also S-01e (North Sea ERSEM project).

S-02 MICROPOLLUTANTS

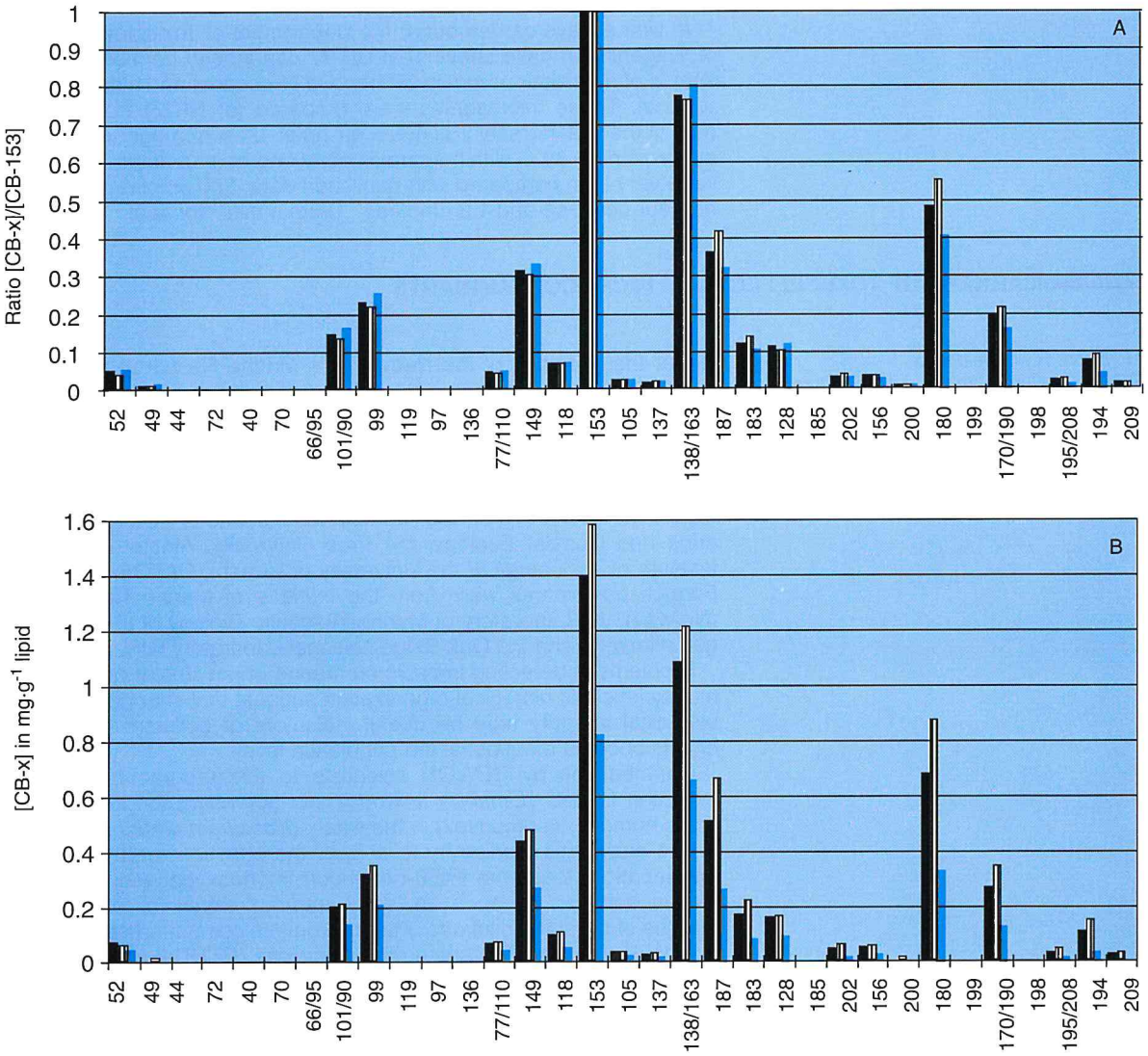
S-02a ANALYSIS AND ENVIRONMENTAL FATE OF PCBs AND PAHs

J.P. Boon, I. Oostingh, M.Th.J. Hillebrand

A comparison of the patterns of individual chlorobiphenyl congeners in experimentally kept female harbour seals (*Phoca vitulina*) with that of their diet led to the conclusion that certain CB-congeners could be metabolized by enzymes of the cytochrome P450-dependent mono-oxygenase system (P450-system). Structural requirements are the presence of vicinal H-atoms in either the meta- and para-position, or the ortho- and meta-positions, but then only when not more than 1-ortho-Cl is present. Unfortunately it was impossible to compare the CB-pattern in blood with that of other organs. A comparison of different organs of cetaceans shows very similar CB-patterns between different organs from the same specimens, but regrettably blood was not sampled. The yet unpublished data from 3 harbour seals, 1 ringed seal, and a harbour porpoise (*Phocoena phocoena*) show that the CB-patterns in blood, liver (the most important organ for biotransformation), and blubber (the main storage organ for lipophilic contaminants) of the same specimen, are very similar indeed in these small marine mammals. Even the lipid-based concentrations of CB do not differ by more than a factor of 5 between these organs within each animal, which is striking in view of the large difference in lipid content of the organs: blood 0.1-0.3% of wet weight, liver 3-7%, and blubber about 100%. This means that in small marine mammals, blood appears to act as the central

transport medium maintaining a dynamic equilibrium between the different organs and tissues. Thus, a relatively small blood sample of 15-100 cm^3 may give important information on the CB-contamination status of the entire animal. This could make it possible to monitor populations of marine mammals that can easily be sampled on shore.

The use of a new type of capillary gaschromatographic column (CPSil19) allows the unambiguous quantification of the three most important mono-ortho Cl substituted congeners with a dioxin-type toxicity ('dioxin-type' CBs -105, -118 and -156).



A) Patterns of chlorobiphenyl congeners, expressed as the ratio of each congener to CB-153, in blood (black), liver (hatched) and blubber (blue). B) Concentrations in $\mu g \cdot g^{-1}$ extractable lipid, of chlorobiphenyl congeners of the same animal.

The second part of this project was carried out in close cooperation with the Department of Toxicology of the Agricultural University of Wageningen (drs. T. Murk and dr. A. Brouwer). Metabolites of another dioxin-type CB congener (CB77) have been shown to cause a completely different mechanism of toxicity than the parent compound: they interfere with the regulation of plasma levels of thyroxin (TT4) and retinol (vitamin A), by binding to the carrier protein of TT4, transthyretin (TTR). This also reduces the complex formation between TTR and the retinol-binding protein (RBP), to which retinol is bound during transport in the blood. This type of toxicity also appears relevant in harbour seals from the Dutch Wadden Sea.

In vitro assays carried out at the Department of Toxicology of the University of Wageningen have shown that CB-77 can indeed be metabolized by microsomes of a harbour porpoise (*Phocoena phocoena*) and a harbour seal (*Phoca vitulina*). These microsomes were prepared (at NIOZ) from specimens that died at the seal nursery 'Ecomare' on Texel. Liver homogenates were prepared and frozen at -80°C within approximately one hour of death. The EROD values were very high compared with published data: 350 pmol·mg^{-1} protein·min^{-1} for harbour porpoise and 1.3 nmol·mg^{-1} protein·min^{-1} for seal.

S-02b BIOMARKERS OF TOXIC EFFECTS OF MICROCONTAMINANTS

J.P. Boon, H.M. Sleiderink, C.C. ten Hallers-Tjabbes, J.M. Everaarts, I. Oostingh, M.Th.J. Hillebrand

Under the auspices of the Netherlands Marine Research Foundation (SOZ), two cruises in the Integrated North Sea Programme, theme microcontaminants (INP-MICON), were designed for 1991 and 1992. The first was executed in August-September 1991, the second in May-June 1992. Both cruises were sailed with RV 'Pelagia'.

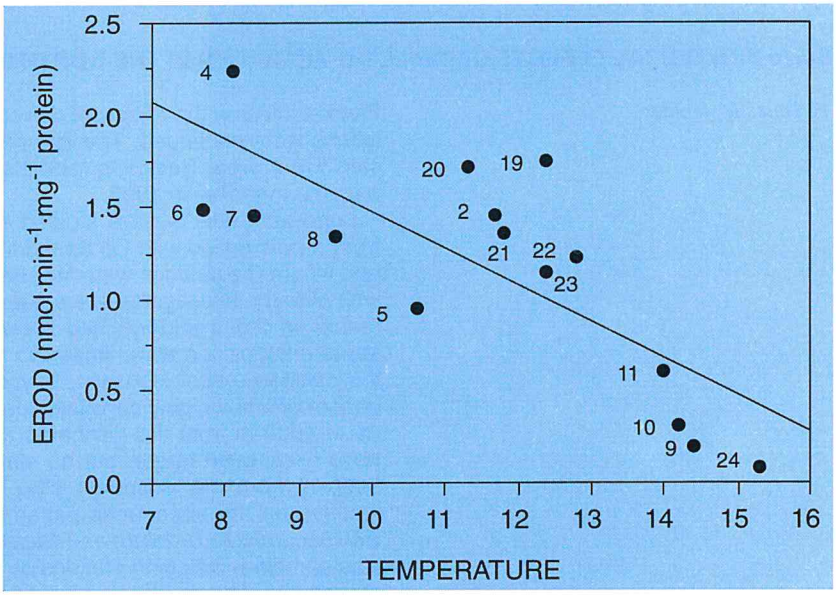
The Dutch participants were from NIOZ, the Tidal Waters Division of Rijkswaterstaat (DGW-RWS), the Netherlands Institute of Ecology, Centre for Estuarine and Coastal Ecology, the Free University, Amsterdam, the Research Institute of Toxicology of the University of Utrecht, CATO-marine Ecosystems. Foreign participants were from the Institute of Marine Research in Bergen (Norway), the Laboratory of Marine Molecular Biology of the University of Bergen (Norway) and the Oak Ridge National Laboratory (USA).

Problems in detecting impacts on marine organisms at population and community levels of biological organization suggest that changes at lower levels of biological integrity may be useful indicators of pollutant effects well before effects become manifest at the population level.

Contributions by BEWON scientists to this programme include enzyme induction in dab (*Limanda limanda*) and screening for the occurrence of a penis homologue (imposex) in the whelk (*Buccinum undatum*).

The enzymatic studies try to answer the question whether the induction of the hepatic cytochrome P450-dependent monooxygenase (MO) enzyme system in dab can be such an 'early warning' signal for exposure to certain classes of organic pollutants. Planar aromatic compounds such as chlorinated biphenyls (PCBs), chlorinated dibenzodioxins (PCDDs) and chlorinated dibenzofurans (PCDFs) are able to induce the cytochrome P4501A (CYP1A) subfamily of cytochrome P450 enzymes in fish. Measurement of the activity of the hepatic cytochrome P450 enzyme system in dab is currently considered for inclusion in in the Joint Monitoring Programme of the Oslo and Paris Commission (OSPARCOM) and the North Sea Task Force (NSTF) of the International Council for the Exploration of the Sea (ICES).

During both INP-MICON cruises the highest EROD-activities occurred at the stations with the lowest temperatures of bottom water: *i.e.* in the stratified areas. In contrast to the first INP-MICON cruise, a continuous range of water temperatures occurred during the second cruise. A significant negative correlation between the EROD-activities and the temperature is observed, but it is interesting to note that all stations below the line are offshore stations expected to show low contamination levels, while those at or above the line are coastal stations where higher levels of contaminants may be observed. Laboratory experiments will have to prove the cause-effect relationship between water temperature and EROD activity



Correlation plot between temperature of bottom water and 7-ethoxyresorufin-o-deethylase (EROD) activity in adult 15-20 cm male dab during the second INP-MICON cruise.

Several hundred female whelks (*Buccinum undatum*) were screened for imposex. The trend of the first cruise was confirmed: total absence of whelks at the coastal stations, a high incidence of penis homologues at the offshore stations in the Southern Bight, and a low incidence at the stations near the Dogger Bank.

The only station where imposex occurred (station 6) is situated in an area with three times as many ship movements as the Dogger Bank. The stations with the highest frequencies of imposex are located in the area of the Deep Water Shipping Route (stations 8, 20 and 21). The present station 22 was located very close to station 12 of the INP-MICON/1 cruise, where all 6 female specimens investigated showed penis homologues. Despite intensive trawling for five hours throughout the area that was also visited in 1991, only 2 male whelks were caught this time.

In dogwhelks (*Nucella lapillus*), organotin compounds are the cause of this sexual aberration. The fact that whelks are by now absent in the area of the very busy coastal Traffic Separation System and show a high incidence of penis homologues in the area of the less busy Deep Water Shipping Lane makes organotin-based anti-fouling paints a primary suspect for the anomalies observed. Laboratory experiments to establish a cause-effect relationship will be executed with whelks that were taken ashore from the cruise. The present

results on imposex-like anomalies in whelks are the first reported on snails living in the open sea.

Chemoreception is by far the most important sensory system in *Buccinum undatum*. Chemical stimuli are implemented in a wide range of orientation and behavioural responses. Chemoreception responses in whelks were tested in the presence of contaminated and clean sediments. One type of dredge spoil interfered with chemoreception acuity and appeared to hamper food odour recognition.

The whelks caught in 1991 reproduced successfully and their offspring is still alive.

S-02c BIOLOGICAL EFFECTS OF DRILLING ACTIVITIES IN THE NORTH SEA (TECON)

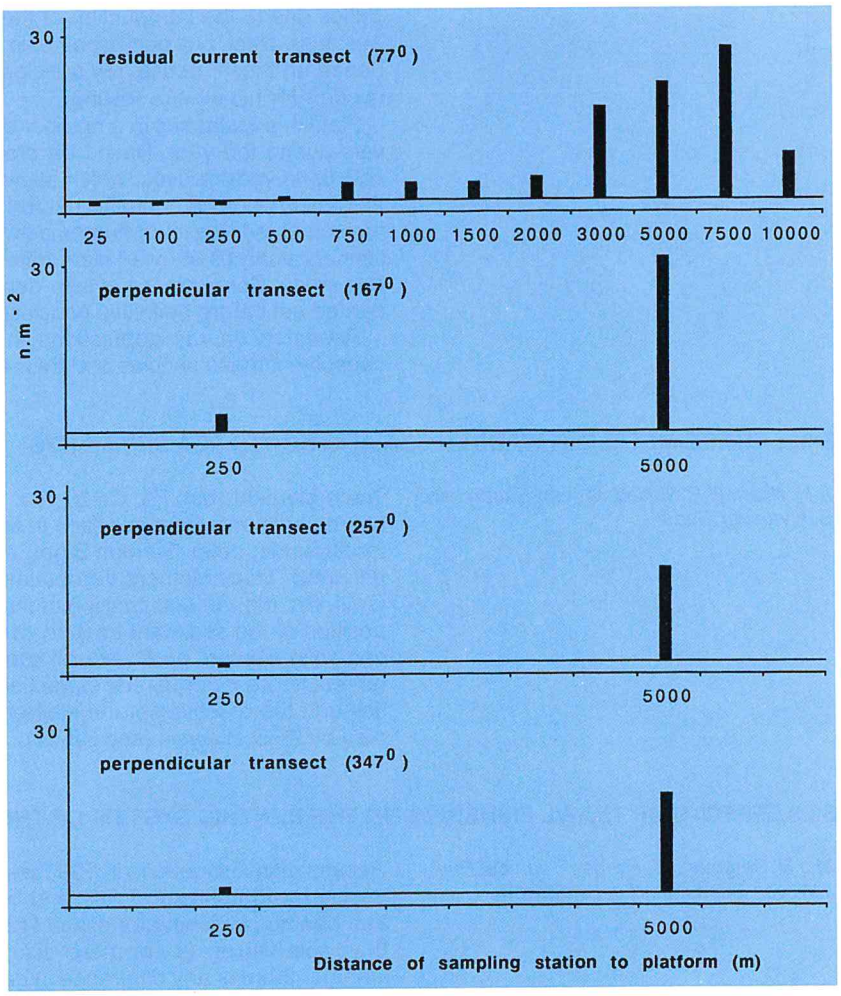
R. Daan, M. Mulder

Field studies on the effects of drill cuttings discharged at offshore mining installations were continued. The drill sites investigated were all situated in the Frisian Front area. Sampling took place in the autumn of 1991, but the results became available in 1992.

Long-term effects were studied at a location where OBM cuttings (cuttings from a hole drilled with Oil Based Muds) had been discharged 3 years before, and where the cuttings were 'washed' before dumping took place. The location was already investigated twice before (6 and 18 months after discharge). The results of these surveys had shown that major effects on the macrobenthic fauna composition were limited to an area within a radius of 100-250 m from the discharge site. However, beyond 250 m the absence (or reduced abundance) of a few highly sensitive species was indicative of environmental stress up to 1000 m from the discharge site. The area of environmental stress may have been even larger, but no stations were sampled between 1000 m and 5000 m from the discharge site. The long-term effect study (survey 1991) focused on the abundance patterns of 2 of such very sensitive species, *viz. Echinocardium cordatum* and *Montacuta ferruginosa*. A dense grid of stations was sampled, including stations at 1500 m, 2000 m and 3000 m from the discharge site. The spatial abundance patterns of both species showed clear density gradients, with reduced frequency of occurrence up to 2000 m from the discharge site compared to the stations at 3000 m and farther away. It is argued, however, that this is most probably a long-term consequence of an initial effect (*i.e.* extermination of these species in the initially contaminated area) and should not be considered a permanent effect of contamination. Apparently there has not been a substantial spatfall in the area after the drilling was terminated, which prevented recovery of the populations. Only within 250 m were the oil concentrations in the sediment possibly still too high to allow successful settlement of new generations.

Field surveys were also carried out around 2 drill sites where only WBM cuttings (cuttings from a hole drilled with Water Based Muds) were discharged. The discharges had been terminated 2 months before the surveys took place. The results of one of these surveys are now available. They show no significant biological effects, not even at 25 m from the discharge site. The only slight indication of organic pollution is the presence of a few specimens of the opportunistic species *Capitella capitata* within 75 m from the discharge site.

The studies were carried out in close cooperation with MT-TNO Den Helder. The OBM effect study was performed under contract with RWS (North Sea Directorate) and the WBM studies were performed by order of MOBIL and NAM, but also financed by other companies.



Spatial abundance pattern of *Echinocardium cordatum* (specimens >1 cm) sampled along 4 transects around a drilling site in the Frisian Front area where OBM cuttings had been discharged.

S-02d EFFECTS OF ANTHROPOGENIC ACTIVITIES ON HIGHER TROPHIC LEVELS

H.W. van der Veer, L. Bolle, C.G.N. de Vooys, P.A. Walker, J.IJ. Witte

This is a study of the impact of human activities on the population dynamics on the higher trophic levels in the North Sea. Analyses of long-term changes in the occurrence of species in the Dutch part of the North Sea over the last decades have led to hypotheses which are tested on selected key species.

A Principal Component Analysis of the long-term changes in rare fish species resulted in two general patterns. The first was attributed to the impact of fishery in the North Sea. These findings were tested for a number of epibenthic predators in the North Sea. An analysis of the patterns in these species resulted in similar main patterns. The first pattern showed an increase of records in the fifties, followed by a general decrease, only interrupted in the

sixties due to the introduction of the beam-trawl fisheries. The second pattern was less clear but our hypothesis is that it reflects the effects of pollution. Based on these results, ray species and flatfish species were selected as key species for hypothesis testing.

Flatfish populations in a number of areas were sampled at regular time intervals during the year. Based on otolith analysis the various populations were split up in year-classes, which allowed the estimation of mortality rates. Under the assumption of a similar natural mortality, differences found must indicate the combined impact of human activities such as pollution and fisheries. A preliminary analysis showed clear differences in mortality rates between the various areas. Comparisons of size-dependent mortality between species must be carried out before definitive conclusions can be drawn.

Research on ray populations in the North Sea focuses on reproduction capacity of these species and their sensitivity to micropollutants.

S-02e TRACE METALS IN WADDEN SEA AND NORTH SEA SEDIMENTS

A.H. Khan, R.F. Nolting, W. van Raaphorst, S.J. van der Gaast

Trace element (Mn, Fe, Cr, Ni, Cu, Zn, Cd and Pb) geochemistry was studied at the sediment-water interface in the southern North Sea (Frisian Front, Oyster Grounds, outer German Bight) and the western Dutch Wadden Sea (subtidal area). Trace element distribution was related to the major element (organic C, Si, Ca, Mg, Al) composition of the bulk sediments and the clay mineral composition of the sediment fraction <10 µm. The data include pore water profiles and solid element profiles (total contents, HCl exchangeable fractions) as well as results from sequential extractions to assess the geochemical characteristics and the reactivity of the elements. Sequential extractions were accompanied by XRD analysis (see H3-17).

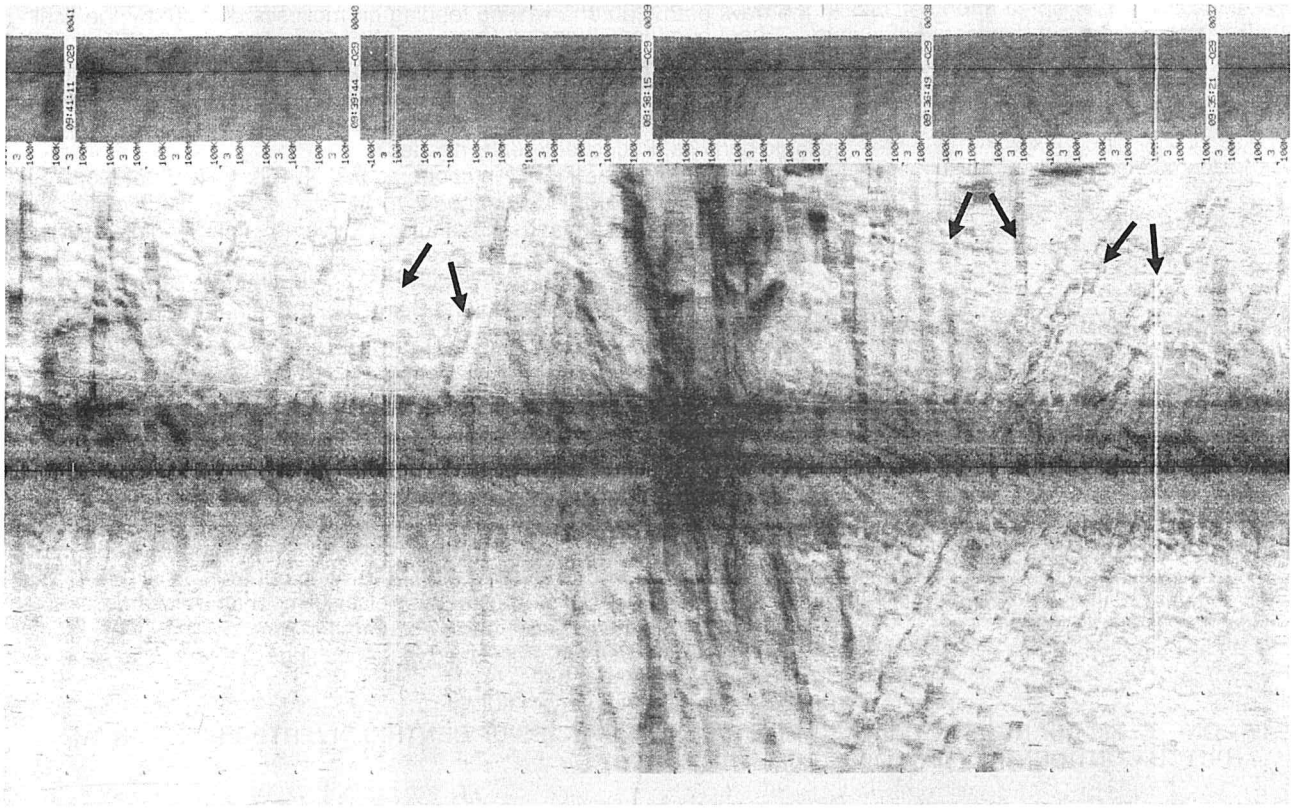
S-03 EFFECTS OF TRAWL FISHERIES ON THE BENTHIC SYSTEM OF THE NORTH SEA

M.J.N. Bergman, M. Fonds, P. van der Puyl, J.W. van Santbrink, H.J. Lindeboom

Results of investigations in 1991 were summarized. The studies on catch composition and survival of fish and benthos incommercial beamtrawls indicate that beamtrawl fishing for plaice (13 cm mesh size) catches less bottom fauna than sole fishing (8 cm mesh size) per m^2 trawled. However, it is uncertain whether there is any difference in damage to bottom species that pass through the meshes of the trawl. Survival chances of starfish (*Asterias*) in both commercial beamtrawls are high (>90%), the survival of most crustaceans and molluscs is lower (40-60%), while some species (*Cancer, Arctica*) show very low survival rates (10-15%).

In the sampling area sole fisheries produce at least 5 kg dead discard fish and 1 kg dead benthos per kg marketable sole (*Solea solea).* A study is needed of the impact that these large amounts of dead discards have on both the populations of organisms killed by trawling and on potential predators.

Long-term effects of beamtrawling were studied by comparing the benthic fauna in trawled and adjacent non-trawled areas. A detailed study of the long-term effects on the benthic system was planned in and around Borkum Riff, one of the few suitable locations in the southern North Sea. Side-scan sonar recordings of the area inside Borkum Riff showed that 70% of the transect was covered with marks of 12-m beamtrawlers. Attemps to discover other non-trawled areas inside Borkum Riff were unsuccessful. It is unlikely that other potential reference areas exist in the southern North Sea.



Tracks ↙ ↘ of commercial 12 m-beam-trawlers on Borkum Riff. (Side-scan sonar recording RV 'Mitra'.)

Studying long-term effects of beamtrawling seems possible only if trawling is completely banned in a large area. The development of the benthos and fish should be studied for at least 10 to 20 years in such a closed area and in a comparable trawled area.

In 1992 investigations were carried out on the catch composition and the survival of benthic invertebrates and fish in 12-m beamtrawls (RV 'Tridens'), 4-m beamtrawls (RV 'Isis') and 8-m beamtrawls for shrimp fishing (RV 'Isis'). Comparison of catch composition in commercial trawls with the numbers of animals collected in a narrow-meshed net covering the cod end of the trawl net indicates that at least 60% of the invertebrates and fish passed through the 8-cm meshes of the nets. Small animals such as shrimps, small mollusc species (*Donax, Spisula*) and small fish (*e.g.* solenette) all passed through the meshes. The survival rate of animals passing through the 8-cm meshes was estimated to be at least 70-85%; starfish showed a very high survival rate of about 95-99%. Some species were clearly damaged by the 10 ground chains of the net, showing a high mortality even in very short hauls of about 3 min: *Corystes* 39%, *Liocarcinus* 48%, *Cancer* 40%, *Arctica* 87% and *Acanthocardium* 44%.

Repeated trawling over the same line provided information on the proportion of catchable benthic fauna actually caught in the nets. The numbers of larger invertebrates gradually decreased on the fished line, but the numbers of fish remained stable or increased and there was evidence that fish were attracted

1.9. BIOMETRICS AND STATISTICS

J. van der Meer

The work of a consultant on the use of mathematical models and other statistical techniques to scientists from a range of disciplines is by its nature of a great variety. This diversity has several reasons. Firstly, all statistical models require assumptions. Only a thorough mutual understanding of both the statistical models and the scientific context of the data can reduce the risk of the inclusion of implicit assumptions that are unlikely and not verifiable. This means that at least the researcher has to study a little statistics and the statistician has to study some biology, chemistry, physics and geology. Secondly, at a marine research laboratory the research methods differ considerably, from unplanned field surveys in which messy multivariate data are gathered to properly designed multi-factorial experiments, and everything in between and beyond.

Within this melange of activities it is necessary to focus on a few topics, in order to contribute more than reference to sometimes less appropriate handbook methods. This year special attention was paid to the ornithological research at the institute.

Firstly, to make possible the analysis of an experiment by C. Swennen in which he examines the preference of guillemots, *Uria aalge*, for different size classes of sprats, *Sprattus sprattus*, a general framework of statistical models for the analysis of such a dichotomous preference experiment has been developed. This framework not only linked all the different approaches followed so far by students of animal behaviour, but also placed other models, originating in econometry, in the same framework.

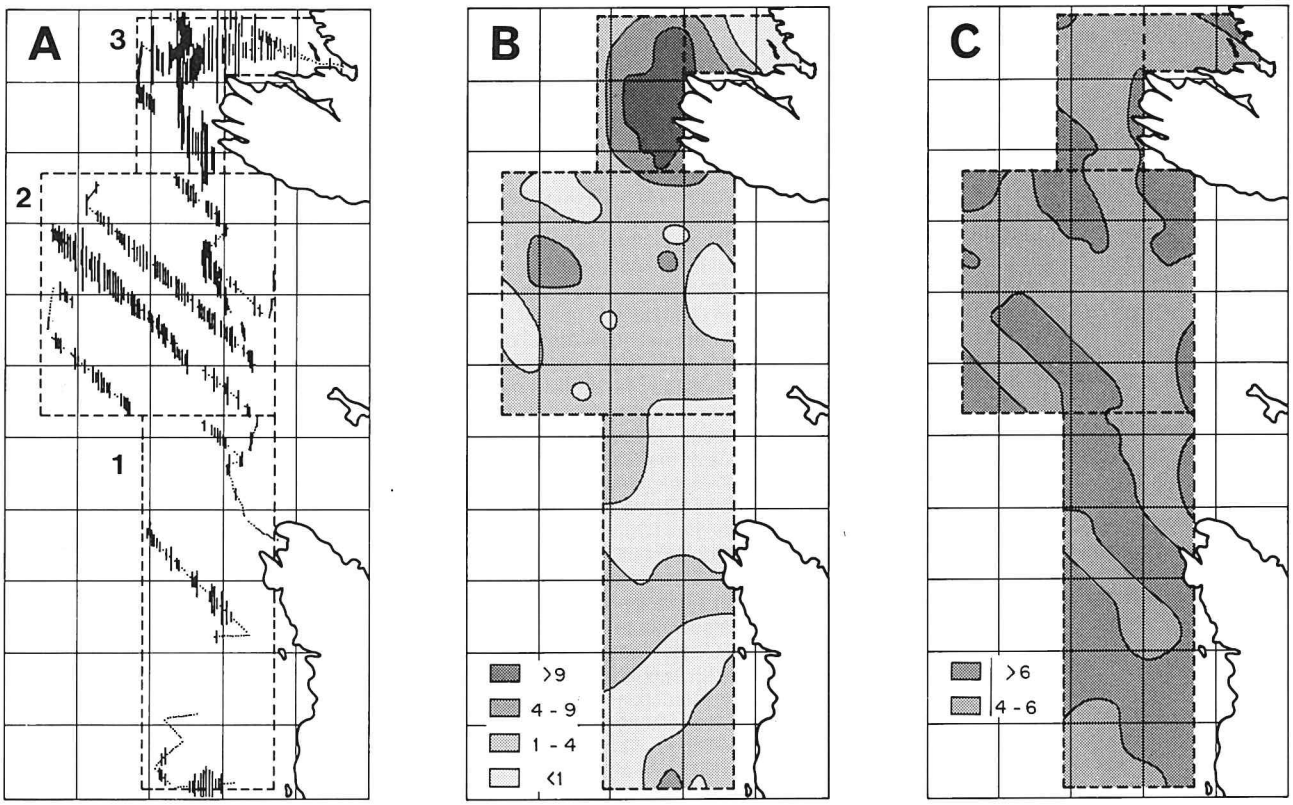
Secondly, haphazardly sampled data on egg size of Eiders, *Somateria mollissima,* were analysed for consistent differences among individual females, differences among years, age, and the size of the clutch and sequence of the egg within the clutch. From quite a few females, clutches from several years were available. For this reason and because clutches had not been sampled randomly a fixed factor analysis of variance model was applied, with the factor female included. Inclusion of the factors female, age and year in the model forced the use of a single arbitrary constraint on the parameters. Otherwise, it was not possible to disentangle the effects of age and year. However, arguments in favour of the constraint chosen were given.

Thirdly, the use of geostatistical methods, like ordinary kriging, for the assessment of seabird abundance was examined. These methods take into account the spatial auto-correlation of the data. Since seabird data are usually non-randomly sampled these methods offer a useful alternative to the classical

sampling theory. Data on the densities of Storm Petrels, *Hydrobatus pelagicus,* gathered by M. Leopold were analysed. It appeared that more than half a million of these birds were present on the continental shelf between Ireland and Spain. This figure is even higher than former estimates of the total world breeding population.

In close cooperation with T. Piersma much work has been done on the development and testing of statistical models that enable prediction of nutrient stores in birds.

Finally, time-series of 20 years of monthly wader counts in the Dutch Delta area have been are analysed.



Densities of Storm Petrels, *Hydrobatus pelagicus*, on the continental shelf between Ireland (upper right) and western France (lower right). Each grid square is 10x100 km. A. observed densities at each 10-min transect segment (1.2 km^2). The length of each bar is proportional to the square root of the density. B. Contour map of the kriging predictions of the density. C. Contour map of the standard error of the predictions.

- M.J.N. Bergman, M. Fonds, H.J. Lindeboom and J. van Santbrink participated in the IMPACT project, an EC funded project on the effect of fisheries.
- P. Ruardij and E. Embsen participated in the EC-MAST project for ERSEM, for which NIOZ is the leading institute.
- W. van Raaphorst coordinated the ecosystem modelling in the EC-MAST project WASP, in which German, Danish and Dutch institutes cooperate. P. Ruardij and J.P.C. Smit participated in this programme.
- W. Helder and R.F. Nolting participated in the EC-MAST programme EROS-2000, which is carried out in the northwestern Mediterranean.
- W. Helder and M.H.A. Dekker participated in the EC-MAST programme on fluorescent xenobiotic substances. This programme is coordinated by RWS/DGW.
- W. Helder coordinated the EC-STEP programme on the distribution of oxygen in sediments and on sediment-water fluxes of solutes in the northern Adriatic Sea. In this programme scientific departments of NIOZ and of the Institute for Marine Geo-logy in Bologna, Italy, cooperate. T. Tahey and P.A.W.J. de Wilde also participated in this programme.
- H. de Hey participated in the EC programme BEST (Benthic Eutrophication Studies) in Texel and Venice Lagoon, Italy.
- R.F. Nolting participated in the EC programme of the Bureau of Certification of Reference Material in Brussels for the certification of trace metals in seawater and estuarine reference material.
- R.P.M. Bak cooperated with Glasgow University to develop an EC strategy for coral reef management and research in developing countries.
- Tj.C.E. van Weering participated in the ESF Network programme on Mediterranean Marine Geosciences.
- M.J.N. Bergman participated in studies on the effects of fisheries in the Irish Sea and on the Grand Banks, organized by MAFF, UK and BIO, Canada, respectively.
- T. Piersma cooperated with Dr. Ramenofsky of the University of Washington to study the production of stress hormones in staging waders in the Wadden Sea, and with Dr. Blem of the Virginia Commonwealth University to study seasonal changes of the fatty acid composition in migrant waders. He also cooperated with the Canadian Wildlife Service and the Atmospheric Environment Service in Canada in the analysis of patterns and recent changes of the climatological conditions which affect long-distance migrants upon arrival in Canada.
- M. Leopold participated in the international ORNIS project on the surveying of marine mammals and seabirds in the German Bight. He also participated in the North Sea Task Force programme to produce a seabird-vulnerability atlas for the North Sea.
- J.H.F. Jansen participated in the international programme PAGES (Past Global Changes) of the IGBP.
- R.F. Nolting participated in SPASIBA, a coordinated Russian-French-Dutch biogeochemical programme, carried out in the Lena delta and the adjacent Laptev Sea.
- J.H. Vosjan and T. van Balen participated in the ANT/7 cruise of RV 'Polarstern' in the Weddell Sea.
- H.J. Lindeboom, F.C. van Duyl and R. Osinga participated in the national NWO/NOP project on DMS.
- H.P.J. de Wilde and D.C.E. Bakker participated in the national NWO/NOP programme on air-sea exchanges of CO_2, N_2O and CH_4.
- D. Eisma, P.A.W.J. de Wilde, W. Helder, W. van Raaphorst, and Tj.C.E. van Weering participated in the national NWO/NOP global change programme on fluxes of organic matter, minerals and nutrients from the Southern Bight towards the Norwegian Sea.
- M. Leopold participated in a national programme on the consequences of an area in the North Sea closed to fisheries for food provisioning of seabirds, their reproductive output and their numbers.
- H. Ridderinkhof participated in a GLOBEC programme (funded by NSERC-Canada and NSF-USA) on analysing the circulation in the Gulf of Maine.
- D.H. Spaargaren participated in a research programme on porphyrin and oxyhaem degradation at the Jinhua Biochemical Institute (Zehjang, PR China) from 7 November to 12 December.

1.10.3. Visitors from abroad

- J.W. Baretta, WKI, Hørsholm, Denmark.
- J.G. Baretta-Becker, WKI, Hørsholm, Denmark.
- Dr. R. Berghahn, University of Hamburg, Germany.
- J. Blackford, PML, Plymouth,UK.
- Dr. S. Boxal, Univ. of Southampton, UK.
- Dr. H. Boyd, Canadian Wildlife Service, Ottawa, Canada.
- N. Broekhuizen, University of Strathclyde, Scotland, UK.
- Dr. A.D. Bryant, University of Aberdeen, Scotland, UK.
- Dr. F. Carlotti, Station Zoologique, Villefranche-sur-Mer, France.
- Dr. G. Castro, WHSRN/Wetlands for the Americas, Manomet, USA.
- Dr. A. Cruzado, CEAB, Blanes, Spain.
- R. van Dam, University of California, San Diego, USA.
- Dr. N.C. Davidson, Nature Conservancy Council, Peterborough, UK.
- Prof. Dr. J.M. Dean, University of South Carolina, Columbia, USA.
- Prof. Dr. W. Ebenhöh, University Oldenburg, Germany.
- Dr. G. Gayer, GKSS Forschungszentrum Geesthacht, Germany.
- Dr. M. Gehlen, Université Libre, Brussels, Belgium.
- Dr. P. Giordani, Instituto di Geologia Marina, Bologna, Italy.
- H.E. Gonzalez, AWI, Bremerhaven, Germany.
- Dr. D. Gordon, Bedford Institute of Oceanography, Canada.
- Dr. B. Gurney, University of Strathclyde, UK.
- Dr. R.I.G. Morrison, Canadian Wildlife Service, Ottawa, Canada.
- Dr. S. Hall, MLA, Aberdeen, Scotland, UK.
- Dr. M. Heath, MLA, Aberdeen, Scotland, UK.
- B. Hosfeld, Univ. Oldenburg, Germany.
- C. Kohlmeier, University of Oldenburg, Germany.
- Dr. M. Lastra, Facultade de Bioloxia, Santiago de Compostela, Spain.
- H. Lenhart, Ifm, Hamburg, Germany.
- Dr. Å. Lindström, University of Lund, Sweden.
- Dr. R. Luttick, University of North Carolina, USA.
- Dr. M.L. Machain, Universidad Nacional Autonoma de Mexico, Mexico.
- Prof. Dr. J.M. Miller, North Carolina State University, Raleigh, USA.
- Prof. Dr. F. Millero, Rosenstiel School of Marine and Atmospheric Sci., Miami, USA.
- Dr. D. Mills, MAFF, UK.
- L. Mintrop, Inst. Meereskunde, Kiel, Germany.
- Dr. A. Noor, Hasanuddin University, Ujung Pandang, Indonesia.
- Dr. M.-R. Plante-Cuny, Centre d'Océanologie de Marseille, France.
- Dr. P. Prokosch, WWF-Arctic Programme, Oslo, Norway.
- Dr. G. Radach, IfM, Hamburg, Germany.Ph. Radford, PML, Plymouth, UK.
- Dr. B. Rinkevich, Israel Oceanographic and Limnological Research, Haifa, Israel.
- Prof. Dr. W. Rosenthal, GKSS Forschungszentrum Geesthacht, Germany.
- Dr. T. Rowell, Bedford Institute of Oceanography, Canada.
- P.T. Santos, University of Porto, Porto, Portugal.
- Prof. Dr. F.R. Schram, Natural History Museum of Los Angeles, USA.
- Prof. Dr. Sen Gupta, Louisiana State University, Baton Rouge, USA.
- Dr. B. Schneider, Inst. Meereskunde, Kiel, Germany.
- Dr. R. Schneider, Fachbereich Geowissenschaften, Universität Bremen, Germany.
- Prof. Dr. L.G. Underhill, University of Cape Town, South Africa.
- R. Varela, CEAB, Blanes, Spain.
- Dr. R. Wanninkhof, NOOA, Miami, USA.
- Dr. E.M.S. Woodward, Plymouth Marine Laboratory, Plymouth, UK.
- Dr. M. Zdanowski, University of Warsaw, Poland.
- Zheng Lianfu, Second Institute for Marine Research, Hangzhou, China.
- Zheng Shilong, Second Institute for Marine Research, Hangzhou, China.

2.1. PUBLICATIONS

2.1.1. Netherlands Journal of Sea Research and other series issued

In 1992, the last issue of vol. 28 and volumes 29 and 30 of the Netherlands Journal of Sea Research appeared. Further, two issues were published of the NIOZ Publication Series, *viz.* no 19: the Annual Report 1991 and no 20: the Proceedings of the 7th International Wadden Sea Symposium. The latter was edited by N. Dankers, C.J. Smit & M. Scholl (all of the DLO-Institute for Forestry and Nature Research). Under the title 'Present and future conservation of the Wadden Sea' it contains some 20 papers on management, 10 on (mostly biological) research and 20 short notes (posters).

The Netherlands Journal of Sea Research completed the Proceedings of the First International Symposium on Flatfish Ecology with part II (vol. 29, no 1-3), containing 23 papers on various aspects of flatfish biology plus 4 summary reports of workshops. It was edited by R. Berghahn, A.D. Rijnsdorp & H.W. van der Veer with the assistance of J.G. Baretta-Bekker.

Two regular issues of the Netherlands Journal of Sea Research (edited by the permanent editors) appeared in 1992, *viz.* vol. 28 no 4 with 7 papers and vol. 29 no 4 with 11 papers. Of these 18 papers, 9 were on marine biology, 5 on marine chemistry and 4 on physical oceanography.

Finally, as vol. 30 the Proceedings of the 26th European Marine Biology Symposium were published. This volume was edited by C.H.R. Heip & P.H. Nienhuis (both of the Centre for Estuarine and Coastal Ecology of the Netherlands Institute of Ecology), with the assistance of P. Pollen-Lindeboom. It contains 28 papers on the theme 'Biological effects of disturbances in estuarine and coastal environments'.

2.1.2. Publications NIOZ 1992

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2 AKEN, H.M. VAN, G.C. CADÉE & P. DE WOLF. Annual Report 1991 NIOZ.—NIOZ Publ. Ser. **19:** 1-157.

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5 BAAR, H.J.W. DE, C. BRUSSAARD, J. HEGEMAN, J. SCHIJF & M.H.C STOLL. Sea trials of three different methods for non-volatile dissolved organic carbon in seawater during the JGOFS North Atlantic pilot study.—Mar. Chem. **41:** 145-152.
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7 BAKKER, J.F. Biogeochemical processes in marine sediments with emphasis on the nitrogen cycle and oxygen dynamics. Ph.D. Thesis Free University, Amsterdam: 1-99.
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11 BERGMAN, M.J.N. Long-term effects of beamtrawl fishing on the benthic ecosystem in the North Sea. In: Effects of beamtrawl fishery on the bottom fauna in the North Sea: III - the 1991 studies.—BEON-report **16:** 25-27.
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15 BEUKEMA, J.J. Expected changes in the Wadden Sea benthos in a warmer world: lessons from periods with mild winters.—Neth. J. Sea Res. **30:** 73-79.
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2.1.3. Internal reports NIOZ 1992

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DUINEVELD, G.C.A. The macrobenthic fauna in the Dutch sector of the North Sea in 1991. Monitoring macrofauna NCP. NIOZ-Report 1992-6.

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DAAN, R., M. MULDER & W.E. LEWIS. Long-term effects of discharges of washed and unwashed OBM drill cuttings on the Dutch Continental Shelf. NIOZ Report 1992-9.

KHAN, A.H., R.F. NOLTING, S.J. VAN DER GAAST & W. VAN RAAPHORST. Trace element geochemistry at the sediment-water interface in the North Sea and the western Wadden Sea. NIOZ Report 1992-10.

2.1.4. Cruise reports 1992

AKEN, H.M. VAN. DUTCH-WARP 91, RV Tyro cruise 91/1, Part 1, WOCE Hydrographic Programme, section AR7E.

BAARS, M.A. Topics and operational plans of the 1992/1993 cruises by RV 'Tyro' for the project 'Monsoons and pelagic systems'.

BAARS, M.A. & G. GANSSEN. Shipboard report of the outward voyage by RV 'Tyro'; Port Said - Mombasa, May 21 - June 12 1992; Project B 'Monsoons and pelagic systems', project C 'Tracing a seasonal upwelling'.

BAARS, M.A. & P.H. SCHALK. Shipboard Report of the SW monsoon cruise by RV 'Tyro'; Mombasa - Djibouti, July 11 - August 8 1992; 'Monsoons and pelagic systems'.

BOON, J.P. INP-MICON programme 1991-1992. Report of cruise 2: 18 May - 6 June 1992.

HAREN, J.J.M. VAN. INP-mooring 1992 cruises RV 'Pelagia' and RV 'Holland'.

HELDER, W. and shipboard party. Shipboard report RV 'Tyro'. Gulf of Lions, EROS-2000 project, 19 Nov. - Dec. 1991.

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RAAPHORST, W. VAN. Report of cruise BELS/INP, RV 'Pelagia', leg 2: February 10 - February 27, 1992.

VELDHUIS, M.J.W. & P. VAN DER WAL. Coccolithophorids project Norway, MS PELAGIA, 21 april - 11 mei 1992.

2.1.5. Data reports 1992

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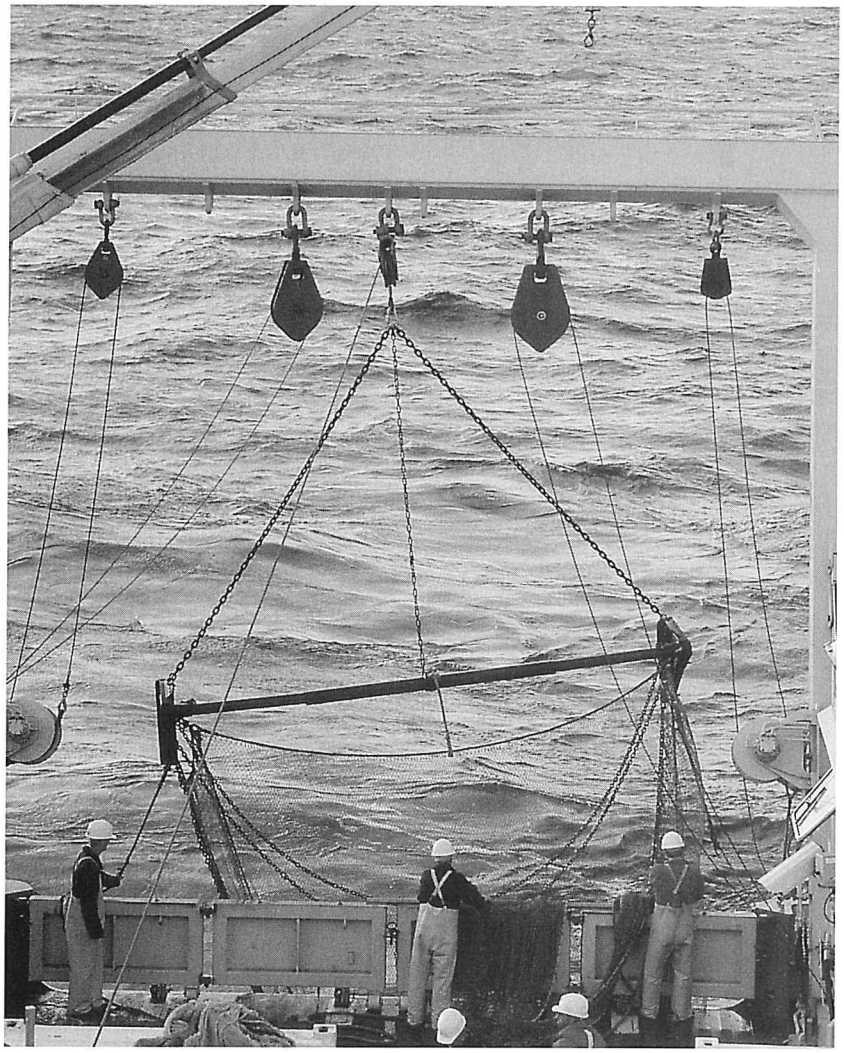
OTTO, L., H.M. VAN AKEN & R.X. DE KOSTER. Use of drifters in the 'DUTCH-WARP' programme, 1990 and 1991. Programme description and preliminary results. NIOZ Data Report 1992-2.

BRUIN, T. DE, R.X. DE KOSTER, S. OBER & L. OTTO. Netherlands XBT programme along the WOCE AX-5 section. NIOZ Data Report 1992-3.

EISMA, D. *In situ* suspended matter particle size Gulf of Lions, December 1988. NIOZ Data Report 1992-4.

DALEN, M. VAN & R.F. NOLTING. Spoor- en hoofdelementen in sediment en poriënwater van het Lena-estuarium en de Laptevzee. NIOZ Data Report 1992-5.



(Photo: G. Nieuwland)

2.2. LECTURES ETC.

2.2.1. Colloquia at the Institute

(titles translated)

17 January	S.I. Voropayev and Ya.D. Afanasyev (Institute of Oceanology, Moscow): Mushroom-like currents in the ocean and in the laboratory.
23 January	M. van Veghel (Carmabi, Curaçao): (Size and shape of colonies of the dominant Caribbean coral reef builder related to ecological processes and environmental variables.)
14 February	(beam trawl fisheries) A. Rijnsdorp (RIVO, IJmuiden): (Regional distribution of beam trawl fisheries in the southern North Sea.) N. Daan (RIVO, IJmuiden): (Damage to benthos because of beam trawl fisheries.)
25 February	G.G. Sutyrin (P.P. Shirshov Institute of Oceanography, Moscow): Intense vortex motion on the beta-plane.
27 February	J. de Leeuw (Technical University, Delft): (Palaeo-climate reconstruction using specific molecules of *Emiliania huxleyi*: relations with Milankovich-cycles.)
28 February	H.M. van Aken (NIOZ): (Inverse models: how to retrieve information from data?) H. de Baar (NIOZ): (An expedition to the anoxic waters of the Black Sea.)
13 March	(heavy metals in freshwater organisms) B. van Hattum (Institute for Environmental studies, Amsterdam): (Bio-accumulation of heavy metals in fresh-water invertebrates.) K. Timmermans (NIOZ): (Heavy metals in larval Chironomidae.)
10 April	(Netherlands Indian Ocean Programme 1992-1993) M. Baars (NIOZ): (General design of the NIOP and seasonal variations in the pelagic near Somalia, in the Gulf of Aden and the Red Sea.) Tj.C.E. van Weering (NIOZ): (Sedimentation in the NW Indian Ocean in relation to climate change.)
13 April	R. Wanninkhof (U.S. Dept. of Commerce, NOAA, Atlantic Oceanographic and Meteorological Laboratory, Miami): On the relationship between gas-exchange and wind speed.

15 May	W. Salomons (Institute for Soil Fertility, Haren): (The 'Chemical time-bomb'.)
22 May	Third seminar 'Ocean and Climate'. H. de Baar (NIOZ): (Exchange of CO_2 between ocean and atmosphere.)
22 May	J. Molemaker (Institute for Marine and Atmospheric Research, Utrecht): (The influence of sea-ice on watermass formation.) A.J. van Bennekom (NIOZ): (Changes in composition and/or transit time of Norwegian Sea bottom water.) L. Otto (NIOZ): (What do we learn from ARGOS buoys about the transport on the NE Atlantic Ocean?)
26 May	F. Millero (Rosenstiel School of Marine and Atmospheric Sciences, Miami): The adsorption of metals to solids in seawater.
27 May	(The occurrence of species: statistical approach) J. van der Meer (NIOZ): (Exploring species-environmental relationship by Multivariate Linear Methods.) M.F. Leopold (NIOZ): (What exactly is the number of storm petrels?) J. Williams (Joint Nature Conservation Committee, Aberdeen): Large European Seabirds-at-sea Data-base.
12 June	Tj.C.E. van Weering (NIOZ): (Gas from the sea bottom.) L. Otto (NIOZ): (Driftbottles.)
30 October	M. Veldhuis (NIOZ): (Global *Emiliania* Modelling (GEM) initiative. Introduction.) J. van Bleijswijk (NIOZ): *(Emiliania huxleyi* from light to darkness.) P. van der Wal (NIOZ): (The development of *Emiliania huxleyi* blooms at open sea and in microcosms.)
5 November	S.T. Goldstein (Dept. of Geology, Univ of Georgia, USA): Ecology, taphonomy and palaeo ecology of salt marsh foraminifera of the Georgia coast.
6 November	J. Terwindt (RUU), H. de Vriend (WL, de Voorst): (The Netherlands Centre for Coastal Research: Organization and planning.)
13 November	C. Laban (RGD): (GIMEX Marine '92. Greenland expedition Dutch Geological Survey, RV 'Pelagia'.)
20 November	C. Slomp, L. Lohse (NIOZ): (Eutrophication in the North Sea: the destiny of nutrients (N, P) in sediments.)
11 December	H. Ridderinkhof (NIOZ): (Analysis of currents near shallow banks in the Gulf of Maine using a finite element model.)
18 December	J. Sinninghe Damsté (Groep Organische Geochemie, TUD): Natural sulphurization of organic matter in sediments: a key to reconstruction of palaeo-environments.

2.2.2. Lectures and posters

2.2.2.1. Lectures by NIOZ scientists

(titles translated)

BAAR, H.J.W. DE. (Chemical oceanography.) Lecture series. Free University, Amsterdam, 16-18 January.

BAAR, H.J.W. DE. Overview of Netherlands JGOFS activities. French-Netherlands workshop on cooperation in the field of climatology. Scheveningen, the Netherlands, 30 January.

BAAR, H.J.W. DE. (Introductory oceanography.) Lecture series, Department of Marine Biology, University of Groningen, 10-14 February.

BAAR, H.J.W. DE. Options for enhancing the storage of carbon dioxide in the oceans. First International Conference on Carbon Dioxide Removal, Amsterdam, 5 March.

BAAR, H.J.W. DE. Advanced course chemical oceanography for graduate students. NIOZ, Texel, 30 March-1 April.

BAAR, H.J.W. DE. (Pollutant metals; greenhouse gases). Lecture series in course Marine Environment, University of Groningen, 20-21 May.

BAAR, H.J.W. DE. Carbon balance in the oceanic mixed layer and air/sea exchange. Workshop National Research Programme (NOP) Climate Change, Bergen, the Netherlands, 10 September.

BAAR, H.J.W. DE. Dissolved organic matter in seawater. Workshop National Research Programme (NOP) Climate Change, Bergen, the Netherlands, 10 September.

BAARS, M.A. On seasonal upwelling in the NW Indian Ocean. Mombasa, Kenya, 13 June.

BAARS, M.A. The Frisian Front: a biologically enriched transition zone in the southern North Sea. Workshop Frontal, Marseille, 20-22 October.

BAK, R.P.M. (Tropical marine biology). Lecture series, University of Amsterdam, January.

BAK, R.P.M. (Marine biology). Lecture series, University of Groningen, June.

BAK, R.P.M. Echinoids and their impact on coral reef carbonate budgets in past, present and future. 7th Int. Coral Reef Symp., Guam, 22-26 June.

BAKKER, D.C.E. Uptake of CO_2 by the ocean. Meeting Working Group Environmental Models, IMW-TNO, Delft, 9 April.

BAKKER, D.C.E. CO_2-exchange between the ocean and the atmosphere. Lecture for the international peer review committee of the NOP/NWO programme, Apeldoorn, the Netherlands, 18 August.

BAKKER, D.C.E. CO_2 exchange between the ocean and the atmosphere. NOP/NWO workshop Water, Bergen aan Zee, the Netherlands, 10 September.

BEERENS, P. Chaotic mixing in tidal areas. Overleggroep Coherente Strukturen, IMAU, University of Utrecht, 16 April.

BEERENS, P. Chaotic mixing in tidal areas like the Wadden Sea. Overleggroep Waterstanden, DGW, Rijkswaterstaat The Hague, 23 September.

BENNEKOM, A.J. VAN. Inputs of silicic acid into the open ocean. NATO Workshop, Brest, France, 14 December.

BENNEKOM, A.J. VAN. Contrast between biogenic silica production in Scotia Sea and Weddell/Scotia Confluence. NATO Workshop, Brest, France, 15 December.

BERG, A. VAN DEN. (A new model: interactions between wind-driven transport and succession algae.) Symposium 5 years BEWON, Rijkswaterstaat, The Hague, 28 October.

BERGMAN, M.J.N. (BEON-studies on the effects of fisheries: 1989-1993.) Meeting with the Dutch fisheries organizations, NIOZ, Texel, 19 February.

BERGMAN, M.J.N. (Effects of beamtrawling on the benthic system.) Meeting with students of Univ. of Utrecht and Univ. Groningen, NIOZ, Texel, 28 February.

BERGMAN, M.J.N. BEON-studies on beamtrawl effects: 1989-1993. ICES Study Group on Ecosystem Effects of Fishing Activities, Copenhagen, 10 April.

BERGMAN, M.J.N. Experimental studies on the environmental impacts of beamtrawling in the North Sea. Bedford Institute of Oceanography, Canada, 16 September.

BERGMAN, M.J.N. Experimental studies on the effects of beamtrawls in the North Sea. Institute of Social Studies and NILOS, NIOZ, Texel, 7 October.

BERGMAN, M.J.N. (Protected areas; a prerequisite for research into the effects of fisheries.) 5 years BEWON.Rijkswaterstaat, The Hague, 28 October.

BEUKEMA, J.J. Factors affecting recruitment success in mussels and cockles in the Wadden Sea. Workshop Spatfall and Recruitment of Mussels and Cockles. Yerseke, The Netherlands, 16-17 March.

BEUKEMA, J.J. (Winter temperatures and reproductive success of bivalves in the Wadden Sea.) Workshop Gevolgen Klimaatveranderingen, Bilthoven, The Netherlands, 7-8 April.

BEUKEMA, J.J. Are the successive mass migrations of juveniles of *Macoma balthica* in the Wadden Sea adaptive? International Symposium The Challenge to Marine Biology in a Changing World, Helgoland, Germany, 13-18 September.

BEUKEMA, J.J. Biological effects of dredging sediments for coastal sand supply. German-Dutch meeting on sea-level changes, Aurich, Germany, 5-6 November.

BOON, J. (Micropollutants: research and policy.) Symposium 5 years BEWON, Rijkswaterstaat, The Hague, 28 October.

BOSSCHER, H. & E.H. MEESTERS. Depth-related changes in the growth rate of *Montastrea annularis*. 7th Int. Coral Reef Symp., Guam, 22-26 June.

DAAN, R. On the environmental effects of discharges of OBM drill cuttings in the North Sea. NAM Drilling Contractors Safety Meeting, NAM, Assen, the Netherlands, 6 October.

DAAN, R. Research on the environmental effects of drilling activities in the North Sea. Institute of Social Studies and NILOS, NIOZ, Texel, 7 October.

DAAN, R. (Monitoring of mining installations.) Symposium 5 years BEWON, Rijkswaterstaat, The Hague, 28 October.

DUYL, F.C. VAN. Benthic bacterial production and nutrient sediment-water exchange in sandy North Sea sediments. Sixth International Symposium on Microbial Ecology, Barcelona, Spain, 10 September.

DUYL, F.C. VAN. (Mesocosms, a prerequisite to understand the benthic ecosystem.) Symposium 5 Years BEWON, Rijkswaterstaat, The Hague, 28 October.

EISMA, D. (Marine Sedimentology.) Lecture series University of Utrecht, February-March.

EISMA, D. (Sediment transport and deposition in the Wadden Sea.) Marine Biology Course NIOZ, 17 February.

EISMA, D. Flocculation of suspended matter. Seminar 90th Anniversary Nanjing University, Centre Geo Marine Sciences Nanjing, China, 19 May.

EISMA, D. *In situ* suspended matter particle size in the Gulf of Lions. EROS-2000 Meeting Plymouth, UK, 29 September.

EISMA, D. Bottom cores on the continental slope and rise of the Gulf of Lions. EROS-2000 Meeting Plymouth, UK, 29 September.

EISMA, D. (X-ray imaging of fine-grained sediment. Nederlandse Bodemkundige Vereniging, Wageningen, the Netherlands, 19 November.

EPPING, E. Hydrogensulphide and trisulphide inhibition on nitrous oxide consumption in sediment slurries and mixed populations of denitrifying microorganisms. Verweydagen, NIOZ, Texel, 2-4 March.

EPPING, E. Nitrogen and sulphur coupling in marine sediments. N-study group meeting, NIOZ, Texel, 15 June.

EPPING, E. A comparison between a microbial mat and an intertidal flat sediment system, with respect to oxygen, nitrogen, and sulphur compounds. Roscoff, France, 20 September.

EVERAARTS, J.M. Physiological aspects of flatfish toxicology. Flatfish Toxicology Symposium, Tidal Waters Division, Groningen, 30 January.

EVERAARTS, J.M. Biological markers as indicators of marine pollution. Use of biomarkers in assessing health and environmental impact of chemical pollution. NATO Advanced Research Workshop, Luso, Portugal, 1-5 June.

EVERAARTS, J.M. (Biomarkers in environmental toxicology.) BION Working Group Toxicology, Utrecht, 1 October.

EVERAARTS, J.M. (Biological responses in fish: DNA integrity, haematological parameters and liver somatic index.) Colloquium series Centre for Estuarine and Marine Ecology, Netherlands Institute of Ecological Research, Yerseke, the Netherlands, 15 October.

EVERAARTS, J.M. (Microcontaminants in sediments and organisms from marine systems of various latitudes.) Colloquium series Tidal Waters Division (DGW-RWS), Groningen, 5 November.

FLACH, E.C. The influence of *Arenicola marina* and *Cerastoderma edule* on the numbers of *Corophium volutator* in shallow-water bays in the Gullmarsfjord compared to the situation in the Dutch part of the Wadden Sea. Symposium of Swedish marine biologists, Tjärnö Marine Biological Laboratory, Sweden, 7-8 August.

FRANSZ, H.G. The role of plankton in the ecosystem of Antarctica. Internationale Week van de Rotterdamse Studenten- en jongerenvereniging voor Internationale Betrekkingen, Erasmus Universiteit, Rotterdam, 26 October.

FRANSZ, H.G. Distribution, structure and biomass of copepod populations around the Svalbard Archipelago in the summer of 1991. Workshop on hydrographic and planktologic studies during EPOS II, Trieste, Italy, 14-16 December.

GAAST, S.J. VAN DER. (Low-angle XRD, an interesting but difficult field.) Ned. Ver. Kristallografie, Delft, 13 November.

HANSEN, F.C. Trophic interactions between zooplankton and *Phaeocystis*. International Symposium The Challenge to Marine Biology in a Changing World, Helgoland, Germany, 13-18 September.

HAREN, J.M. VAN. (Measurements of the 3D structure of currents round the Frisian Front.) Rijkswaterstaat, Lezingendag Overleggroep Waterstanden en Getijden, The Hague, 23 September.

HAREN, J.J.M. VAN. Several lectures at the Current Meter Workshop. UNESCO, Doha, Qatar, 1-7 November.

HELDER, W. Sediment-water exchange processes and recycling of organic carbon. OMEX workshop, Brussels, 30 January.

HELDER, W. Invited lecture. *In situ* oxygen measurements in deep sea sediments. EUREKA/EUROMAR-BIMS meeting Benthic Chambers: State of the art and new approaches. Milan, Italy, 5 March.

HELDER, W. Invited lecture. Response of coastal sediments to organic matter input. EC-Comett course for graduate students, Ravenna, Italy, 8 September.

HELDER, W. Benthic respiration and early diagenesis. Results from the TYRO-91 cruise. 4th EROS-2000 workshop, Plymouth, UK., 29 September.

HONDEVELD, B.J.M. (Bacterivory by heterotrophic nanoflagellates in North Sea sediments.) Werkgroep Protozoölogie, IBN-DLO, Haren, the Netherlands, 20 May.

JANSEN, J.H.F. (Ocean sediments as an archive of land climate.) Institute of Earth Sciences, University of Utrecht, 22 January.

JANSEN, J.H.F. (Palaeoceanography, why and how?) University of Utrecht, Institute of Earth Sciences, 3 March.

JANSEN, J.H.F. (Accumulation rates, indispensable messengers in palaeoceanography. Modelling and observation in the Earth Sciences.) 1e Nederlands Aardwetenschappelijk Congres, Veldhoven, 9 April.

JANSEN, J.H.F. (Deep-sea sediments as an archive of marine and terrestrial climate.) Institute of Earth Sciences, Free University, Amsterdam, 11 December.

JANSEN, J.H.F. (Solar and orbital forcing and response of climate, an inventory of research in the Netherlands and suggestions for future investigations.) Symposium Netherlands Contribution to the Programme Past Global Changes (PAGES), KNAW, Amsterdam, 15 December.

KAMERMANS, P. & T. PIERSMA. Life history of *Macoma*. IBN-DLO/IWRB workshop Strategic Decisions of Individuals, Texel, 10 April.

LEOPOLD, M.F. Seabirds and seabird research in the North Sea. Annual Zoology Lecture Day, Vogelwarte Helgoland, Germany, 26 March.

LEOPOLD, M.F. (Riches of the Frisian Front.) Thematic day on the Frisian Front, with Greenpeace, Dutch Gas Company, Departments of Transport & Public Works, Agriculture, Nature & Fisheries, Economic Affairs and Dutch Seabird Group. Alkmaar, the Netherlands, 16 May.

LEOPOLD, M.F., C. CAMPHUYSEN & M.L. TASKER. Conservation of seabirds in coastal and offshore waters. ICBP-Conference, Aachen, Germany.

LEOPOLD, M.F. (Some questions concerning Scoters.) Noord-Hollandse Vogeldag, Texel, 3 October.

LINDEBOOM, H.J. (Policy-directed research; the future jobs market?) Verwey-dagen, NIOZ, Texel, 3 March.

LINDEBOOM, H.J. (Production and degradation of Uric acid in an Adelie penguin rookery.) Utrecht, 25-26 March.

LINDEBOOM, H.J. (Eutrophication.) The Hague, 19 June.

LINDEBOOM, H.J. Protected areas, an absolute need for future marine research. International Symposium The Challenge to Marine Biology in a Changing World, Helgoland, Germany, 13-18 September.

LINDEBOOM, H.J. The importance of international marine environmental monitoring programmes. Seawatch seminar, Delft, 25 September.

LINDEBOOM, H.J. (Research and policy, a poorly understood challenge.) Symposium 5 years BEWON, Rijkswaterstaat, The Hague, 28 October.

LOHSE, L. North Sea nutrient cycling: Benthic denitrification-nitrification coupling. Second EMINar, European Interdisciplinary Marine Network, NIOZ, Texel, 3-5 June.

MAAS, L.R.M. Nonlinear and free-surface effects on the spin-down of axisymmetric laboratory vortices. Dept. of Aerospace and Mech. Eng., University of Arizona, USA, 23 January.

MAAS, L.R.M. On a nonlinear tidal Helmholtz resonator. CEOR, University of Victoria, BC, Canada, 20 July.

MAAS, L.R.M., G.J.F. VAN HEIJST & C.W.M. WILLIAMS. The spin-up of a fluid in a rectangular container with a sloping bottom. AGU 1992 Ocean Sciences Meeting, New Orleans, 28 January.

MEER, J. VAN DER. Estimation of abundance and mapping of spatial patterns of seabirds. Seabirds at Sea Meeting, NIOZ, Texel, 27 May.

MEER, J. VAN DER. (Sampling variance and the design of a biological monitoring programme.) Symposium Biologische Monitoring Nederlandse Vereniging Aquatische Ecologie, DGW/RIZA, Amsterdam, 18 November.

MEESTERS, E.H. (Aspects of coral regeneration). Verwey-dagen, NIOZ, Texel, 2-4 March.

MEESTERS, E.H. Effects of sedimentation, lesion morphology and lesion position on coral tissue regenetation. 7th Int. Coral Reef Symp., Guam, 22-26 June.

MEESTERS, E.H. (Coral regeneration: intra-colony patch dynamics). ITZ, University of Amsterdam, 20 February.

MULDER, M. (Research on the biological effects of discharges of drill cuttings near drilling sites.) Lecture to staff of Staatstoezicht op de Mijnen (EZ), NIOZ, Texel, 11 June.

NOLTING, R.F. Diagenesis and the vertical distribution of metals in sediments of the Gulf of Lions. 4th EROS-2000 workshop on research in the northwest Mediterranean Sea. Plymouth, UK, 30 September.

NOLTING, R.F. Trace and major elements in sediment and porewater of the Lena estuary and Laptev Sea. SPASIBA workgroup. Paris, 7-10 December.

OTTO, L. First results of ARGOS drifter experiments during the Netherlands 'DUTCH-WARP' programme, 1990 and 1991. WOCE/TOGA Surface Velocity Programme Planning Committee, Bermuda, 6-9 April.

OTTO, L. Determination of the current field and the diffusivity in the NE Atlantic Ocean with ARGOS drifters in the framework of WOCE. Workshop theme A of the NWO/NOP programme on changes of earth systems, Bergen, the Netherlands,10-11 September.

PIERSMA, T. (Thermostatic costs of Knots.) Guest lecture, Univ. of Groningen, 13 April.

PIERSMA, T. How economic trade-offs and constraints shape the seasonal movements of a long-distance migrant, the Red Knot. 4th International Behavioral Ecology Congress, Princeton University, USA, 20 August.

PIERSMA, T. Shorebird energetics and migration. Seminar Manomet Bird Observatory, Mass., USA, 24 August.

PIERSMA, T. (Overwintering.) VPRO-televisie programma Noorderlicht, 27 September.

PIERSMA, T. Are red breast honest signals of migratory quality in Bar-tailed Godwits? 9th International Waterfowl Ecology Symposium, Hajdúszoboszló, Hungary, 7 September.

PIERSMA, T. Physiological implications of long-distance migration. Seminar Zoölogisches Institut, University of Zürich, Switzerland, 26 November.

RAAPHORST, W. VAN. (Eutrophication of the North Sea: Nutrient dynamics.) University of Groningen, 19 May.

RAAPHORST, W. VAN. (Eutrophication, the wrongly estimated role of the sediments.) Symposium 5 years BEWON, Rijkswaterstaat, The Hague, 28 October.

RAAPHORST, W. VAN & L. LOHSE. (North Sea nutrient cycling: Benthic nitrification-denitrification coupling.) Nederlandse Vereniging voor Aquatische Ecologie, Amsterdam, 2 October.

RIDDERINKHOF, H. Chaotic stirring in a tidal system. Dalhousie University, Halifax, Canada, 16 January.

RIDDERINKHOF, H. Chaos in the Wadden Sea. Memorial University, St. Johns, Canada, 27 February.

RIDDERINKHOF, H. Chaotic stirring in a tidal system. Woods Hole Oceanographic Institution, Woods Hole, USA, 7 April.

RIDDERINKHOF, H. Lagrangean circulation on Georges Bank from a finite element model. CMOS 26th Annual Congress, Quebec, Canada, 10 June.

RIDDERINKHOF, H. Chaotic stirring in a tidal system. Université de Quebec à Rimouski, Rimouski, Canada, 2 October.

RIDDERINKHOF, H. Lagrangean characterization of circulation over submarine banks with application to the Gulf of Maine. Bedford Institute of Oceanography, Dartmouth, Canada, 9 October.

RIEGMAN, R. (Eutrophication studies at NIOZ.) Applied Biology course, University of Amsterdam, January.

RIEGMAN, R. (Experimental research on the role of ecophysiological factors with respect to the blooming of *Phaeocystis*.) Scientific meeting of the Dutch Society of Aquatic Ecology, April.

RIEGMAN, R. (Phytoplankton in the North Sea.) Applied Biology course, University of Amsterdam, April.

RIEGMAN, R. (The impact of eutrophication on phytoplankton in the North Sea). Environmental Biology, University of Groningen, May.

RIEGMAN, R. (The impact of eutrophication on the planktonic foodweb structure.) Marine biology course, NIOZ, June.

RIEGMAN, R. (Eutrophication and the foodweb.) Symposium 5 years BEWON, Rijkswaterstaat, The Hague, 28 October.

RUARDIJ, P. (North Sea models- the European dimension.) Symposium 5 years BEWON, Rijkswaterstaat, The Hague, 28 October.

SLEIDERINK, H.M. (Levels of EROD-activity and PCB-concentration in dab (*Limanda limanda*) from the southern North Sea.) Platvis toxicologiedag, Haren, the Netherlands, 31 January.

SLEIDERINK, H.M. (Levels of EROD-activity and PCB-concentration in dab (*Limanda limanda*) from the southern North Sea.) Verwey-dagen, NIOZ, Texel, 2-4 March.

SLOMP, C.P. (Phosphorus dynamics in North Sea sediments). Verwey-dagen, NIOZ, Texel, 2-4 March.

SPAARGAREN, D.H. Synthesis of biliverdin and bilirubin from natural ferroporphyrine compounds using enzymatic, alkaline and acid transformation procedures. Dept. of Biochemistry, Jinhua Normal University, PR China, 27 November.

SWENNEN, C. (The birds of the Wadden Sea.) Ecomare, Texel, 23 January.

SWENNEN, C. Temperature as an ecological factor in tropical coastal areas. Prince of Songkla University, Thailand, 22 October.

TOORN, R. VAN DER. Foundation of the beta plane model. Overleggroep Coherente Strukturen, IMAU, University of Utrecht, 16 April.

TULP, I. & T. PIERSMA. Final countdown of waders during starvation in relation to size, reserve and cost levels. Wader Study Group Annual Conference and Symposium, Hajdúszoboszló, Hungary, 5 September.

VEER, H.W. VAN DER. (Effects of eutrophication and micropollutants on fish populations in the North Sea.) Symposium 5 years BEWON, Rijkswaterstaat, The Hague, 28 October.

VEGHEL, M.L.J. VAN. (Reproduction characteristics of *Montastrea annularis* morphotypes. Mass spawning of a major Caribbean coral.) Verwey-dagen, NIOZ, Texel, 2-4 March.

VEGHEL, M.L.J. VAN. Reproduction in *Montastrea annularis* morphotypes. 7th Int. Coral Reef Symp., Guam, 22-26 June.

VEGHEL, M.L.J. VAN. (Life history and genetical aspects of *Montastrea annularis* and morphotypes.) ITZ, University of Amsterdam, 23 January.

VERKUIL, Y. Stopover ecology of Broad-billed Sandpipers in the Sivash area, Ukraine: a problem of supply and demand. Wader Study Group Annual Conference and Symposium, Hajdúszoboszló, Hungary, 5 September.

VERKUIL, Y. & T. PIERSMA. (Migration strategies of waders in spring: problems and solutions.) Noord-Hollandse Vogeldag, Texel, 3 October.

VOSJAN, J.H. Lecture series International Postgraduate Training Course on Fundamental and Applied Marine Ecology of the Free University Brussels, Belgium, 20-24 January and 16-20 November.

VOSJAN, J.H. Marine Bacteriology. Lecture series, Interuniversitaire Derde Cyclus, IZWO, Oostend, Belgium, 20-24 January and 16-20 November.

VOSJAN, J.H. Penetration of PAR, UV-a and UV-b radiation in Antarctic coastal water. Antarctica Symposium, Utrecht, 25 March

VOSJAN, J.H. (Antarctic research.) Lecture to Van Hall Instituut, NIOZ, Texel, 22 April.

WEERING, Tj.C.E. VAN. (Research vessels and marine research; marine geological research at NIOZ.) Lecture Students' Union Geoflex, VU Amsterdam, 29 October.

WEERING, Tj.C.E. VAN & M. IVANOV. Mud volcanoes in the Black Sea. 33rd Meeting of CIESM, Trieste, Italy, 12-17 October.

WEERING, Tj.C.E. VAN & W. VAN DER WERFF. Seismic structure and sedimentology of sediment drifts in the Norwegian Sea and in the NE Atlantic Ocean. Workshop Sediment Waves and Sediment Drifts, International Paleoceanographic Congress, Kiel, Germany, 19-25 September.

WEERING, Tj.C.E. VAN, M. IVANOV & R. KRUGIJAKOVA. Mud volcanoes in the Black Sea, 2nd Meeting Gas in Marine Sediments, Hirtshals, Denmark, 25-28 August.

WERNAND, M. (Introduction to optical RS; relevant properties and instrumentation.) Course Remote Sensing, Enschede, the Netherlands, 7 January.

WERNAND, M. (Application of optical RS in marine scientific research.) Course Remote Sensing, Enschede, the Netherlands, 7 January.

WERNAND, M. Application of optical RS on suspended matter in the eastern Channel. The Hague, 6 October.

WIERSMA, P. & T. PIERSMA. Seasonal changes in the food intake of Great Crested Grebes. 9th International Waterfowl Ecology Symposium, Hajdúszoboszló, Hungary, 7 September.

WILDE, H. DE. Sea-air fluxes and distribution in the water column of the greenhouse gases N_2O and CH_4. Verwey-dagen, NIOZ, Texel, March 2-4.

WILDE, H. DE. Biochemical exchange of methane. Meeting Working Group Environmental Models, IMW-TNO, Delft, 9 April.

WILDE, H. DE. Water-atmosphere exchange of N_2O in marine systems. NOP Workshop Theme B, Amersfoort, the Netherlands, 7-8 May.

WILDE, P.A.W.J. DE. Energetics in benthic systems. Symp. Animal Energetics in the Constraints of the Marine Environment. University of Groningen,19-20 February.

WILDE, P.A.W.J. DE. The ecosystem of the North Sea. Symp. The Other North Sea, Amsterdam, 21 February.

WILDE, P.A.W.J. DE. Fifteen years of bell-jar experiments in the Netherlands: The NIOZ Bottom Lander System, BOLAS. Int. Conf. Benthic Chamber Technology. CISE, Milan, Italy, 5-6 March.

WILDE, P.A.W.J. DE. (Relation between the microbial loop and small and large food webs.) Symp. on plant-animal relations in a tritrophic context. Ned. Dierk. Ver. Amsterdam, 19 March.

WILDE, P.A.W.J. DE. Effects of bioturbation on the benthic system. Comett Course, Ravenna, Italy, 8-11 September.

WILDE, P.A.W.J. DE. Structure and functioning of benthic ecosystems in Kenya. Application course Dutch-Kenyan cooperation, Mombasa, Kenya, 7-8 December.

ZIMMERMAN, J.T.F. (Dynamical oceanography.) Lecture series Univ. Utrecht, January-June.

ZIMMERMAN, J.T.F. (Long waves and tides.) Lecture Series Univ. Utrecht, Sept.-Dec.

ZIMMERMAN, J.T.F. (Physical oceanography.) Lecture Series Int. Inst. Hydraul. Envir. Eng., Delft, June.

ZIMMERMAN, J.T.F. (Chaotic mixing in geophysical currents.) KNAW Symposium Nietlineaire en inverse problemen in de aardwetenschappen, Amsterdam, 2 October.

ZIMMERMAN, J.T.F. Principles of chaotic stirring in tidal flow. Symp. Physics of Estuaries and Shallow Seas, Perth, Australia, 3 December.

2.2.2.2. Posters

BENNEKOM, A.J. VAN, A.J.J. SANDEE & M. LIPSKI. Why is silicate high in Antarctic surface water? Not because of glacial weathering. Arctowski Symposium, Utrecht, 25 March.

BLEIJSWIJK, J.D.L. VAN & R. KEMPERS. Mass changes in calcium carbonate during phytoplankton development in seawater enclosures. Third GEM Workshop, 13-17 September.

BRUIN, T. DE, L. OTTO & M.R. WERNAND. NIOZ applications of Remote Sensing. Space-4 conference, Delft, 24-27 May.

BURY, S.J. & P. VAN DER WAL. Nitrogen cycling dynamics and C:N uptake ratios during a coccolithophorid bloom in enclosures of the Korsfjorden, Norway. Third GEM Workshop, 13-17 septEmber.

CADÉE, G.C. & F.K. MCKINNEY. A Pliocene coral-bryozoan association from the North Sea Basin. 9th Intern. Bryozoology Conference, Swansea, UK.

FLACH, E. Density-regulation in the lugworm *Arenicola marina* L. Verwey-bijeenkomst, NIOZ, Texel, 2-4 March.

GIORDANI, P., W. HELDER, T. TAHEY & P.A.W.J. DE WILDE. Benthic respiration in the Adriatic Sea and its effect on nutrient exchanges at the sediment-water interface. CIESM meeting, Trieste, Italy, 12-17 October.

GONZALEZ, H. & P. VAN DER WAL. Mesozooplankton and fecal pellet abundances during the development of a bloom of *Emiliania huxleyi* as observed in a seawater enclosure of Korsfjorden, Norway. Third GEM Workshop, 13-17 September.

GRAAFF, J.W.M. DE. Electron microprobe applications in marine studies. Second EMINar, Texel, 3-5 June.

HONDEVELD, B.J.M. Bacterivory by heterotrophic nanoflagellates in North Sea sediments. Verwey-dagen, NIOZ, Texel 2-4 March, and Second EMINar, NIOZ, Texel, 3-5 June.

IPEREN, J. VAN. Diatom indicator assemblages for palaeoceanography in the Indonesian Archipelago. 12th Int. Diatom Symp., Renesse, the Netherlands, 30 August-5 September.

JANSEN, J.H.F., S.J. VAN DER GAAST, B. KOSTER & A. VAARS. CORTEX, an XRF scanner for chemical analyses of sediment cores. (Modelling and observation in the Earth Sciences). 1e Nederlands Aardwetenschappelijk Congres, Veldhoven, 9-10 April.

JANSEN, J.H.F., J.M. VAN IPEREN, E.M. POKRAS, L.H. BURCKLE & B. STABELL. Freshwater diatoms and phytoliths as signals of continental aridity. Fourth International Conference on Paleoceanography, ICP IV, Kiel, Germany, 21-25 September.

JANSEN, J.H.F., S.J. VAN DER GAAST, B. KOSTER & A. VAARS. CORTEX, an XRF scanner for chemical analyses of sediment cores. Fourth International Conference on Paleoceanography, ICP IV, Kiel, Germany, 21-25 September.

KÜHNEL, R.A. & S.J. VAN DER GAAST. Humidity controlled diffractometry and its applications. 41st Annual Denver X-ray Conference, 3-7 August.

LEOPOLD, M.F., O. HÜPPOP, B. GRUNSKY & A. MAUL. How large an area of sea do the Helgoland seabirds use for foraging during the breeding season? Helgoland, 13-18 September.

LOHSE, L., W. VAN RAAPHORST & W. HELDER. North Sea nutrient cycling: Benthic nitrification-denitrification coupling. Symposium the challenge to marine biology in a changing world, Helgoland, 13-18 September.

LUKK, T. Modelling the long-term ocean carbon cycle. Third GEM Workshop, 13-17 September.

MALSCHAERT, J.F.P. & W. VAN RAAPHORST. North Sea nutrient cycling: Benthic pools of ammonium. Symposium the challenge to marine biology in a changing world, Helgoland, 13-18 September.

MEESTERS, E.H. Aspects of coral regeneration. Verwey-dagen, NIOZ, Texel, 2-4 March.

PIERSMA, T., R. DRENT & P. WIERSMA. Thermostatic costs of Knots wintering at different latitudes. Symposium Energetics in the marine environment, University of Groningen, 19-21 February.

SLOMP, C.P. & W. VAN RAAPHORST. North Sea nutrient cycling: Sediment-water exchange of phosphorus. Symposium the challenge to marine biology in a changing world. Helgoland, 13-18 September.

TAHEY, T.M. Oxygen porewater profiles and community respiration of marine sediments by means of *in situ* techniques. Verwey-dagen, NIOZ, Texel, 2-4 March.

VEGHEL, M.L.J. VAN. Reproductive characteristics of *Montastrea annularis* morphotypes. Mass spawning of a major Caribbean coral. Verwey-dagen, NIOZ, Texel, 2-4 March.

WAL, P. VAN DER & P. WESTBROEK. Production rates of particulate organic carbon and $CaCO_3$ in blooms of *Emiliania huxleyi* as observed in seawater enclosures at Espegrend field station, Norway. Third GEM Workshop, 13-17 September.

WEERING, Tj.C.E. VAN. Heinrich layers and high resolution stratigraphy in the eastern North Atlantic Ocean. Kiel ICP IV, 19-25 September.

WITTE, H., J.CH. NEJSTGAARD & P. VAN DER WAL. Microzooplankton and copepod grazing rates during the waxing stages of a phytoplankton bloom in a sea water enclosure at Espegrend field station, Norway. Third GEM Workshop, 13-17 September.

2.2.3. Advice offered

R.P.M. Bak advised the Bonaire Marine Park (Netherlands Antilles) on the establishment of coral reef permanent quadrats.

M.J.N. Bergman advised the 'Interdepartementale Planologische Werkcommissie' on the ecological effects of the discharge of WBM cuttings in the coastal zone of the Frisian Islands.

J.P. Boon gave advice as a member of the committee 'Increased Risk of food-chain poisoning of lung-breathing top-predators' (Doorvergiftiging) of the National Health Council (Gezondheidsraad).

M. Fonds gave advice to M. Kaiser of MAFF, Conwy Laboratory, on the construction of an epibenthic dredge.

W.C.M. Klein Breteler gave advice to C.C. Notox, Den Bosch, on copepod cultivation and to Zeemuseum Scheveningen, on cultivation of algae.

B.R. Kuipers, H.W. van der Veer, M.J. Rietveld and H.J. Lindeboom advised Dutch shrimp fisheries on the effects of fisheries on the shrimp stock.

M.F. Leopold had continuous contacts with the Mininstry of Agriculture, Nature and Fisheries, on the proclamation of an area of sea to be closed for fisheries, and the impact of such a measure on seabirds. He also advised the same Ministry on the effects on seaduck of a developing fishery for shellfish (*Spisula*) in the coastal zone of the North Sea.

M.F. Leopold gave advice on World Wide Fund for Nature (WWF) project 'Hazards to North Sea Seabirds'.

C. Swennen advised the 'Natuurbeschermingsraad' concerning shellfish fisheries in the Wadden Sea, and RWS North Sea Directorate concerning the dangers that the use of surface-tension-reducing substances pose to seabirds.

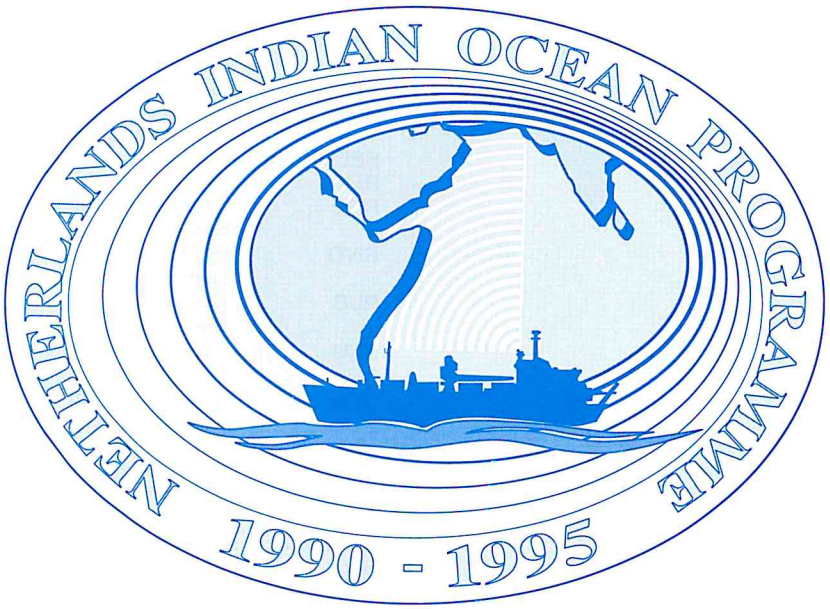
2.3. ACRONYMS USED IN THIS ANNUAL REPORT

ADCP	Acoustic Doppler Current Profile
AFDW	Ash-Free Dry Weight
AMS	Accelerator Mass Spectrometry
ASGASEX	Air Sea Gas Exchange Experiment
ATP	Adenosine-Tri-Phosphate
AVHRR	Advanced Very High Resolution Radiometer
AWI	Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany
BAH	Biologische Anstalt Helgoland, Helgoland, Germany
BCRS	(Beleids Commissie Remote Sensing) Netherlands Remote Sensing Board
BELS	Benthic Links and Sinks in North Sea Nutrient Cycling
BEON	(Beleidsgericht Ecologisch Onderzoek Noordzee en Waddenzee) Applied Ecological Research North Sea and Wadden Sea
BEST	Benthic Eutrophication Studies
BEWON	(Beleidsgericht Wetenschappelijk Onderzoek NIOZ) Applied Scientific Research NIOZ
BIOLMON	Biological Monitoring
BION	(Biologisch Onderzoek Nederland) Biological Research of the Netherlands
BOA	(Biologie, Oceanografie en Aardwetenschappen) Foundation for Biological, Oceanographic and Earth Sciences
BOEDE	(Biologisch Onderzoek Eems Dollard Estuarium) Biological Research Ems-Dollard Estuary
CARMABI	Caribbean Marine Biological Institute
CB	Chlorobiphenyl
CEAB	Centre d'Etudis Avancals de Blanes
CMCA	GeoMarine Centre Amsterdam
CORSAIR	Coastal Optical Remote Sensing Airborne Radiometer
CREST	Comité de la Recherche Scientifique et Technique (EC)
CTD	Conductivity Temperature Depth (probe)
CZCS	Coastal Zone Colour Scanner
DGS	Denmark's Geological Survey
DGSP	Differential Global Positioning System
DGW	(Dienst Getijdewateren RWS) Tidal Waters Division RWS
DIN	Dissolved Inorganic Nitrogen
DMS	DiMethylSulphide
DMSP	Dimethyl Sulphonic Proprionate
DNZ-RWS	Directorate North Sea, Ministry of Transport and Public Works
DSDP	Deep Sea Drilling Project
DUTCH-WARP	Deep and Upper Transport, Circulation and Hydrography, WOCE Atlantic

	Research Programme
EC	European Community
ECN	(Energieonderzoek Centrum Nederland) Energy Research Centre Netherlands
EPOS	European Polarstern Study
EROD	Ethoxy Resorafin-o-de ethylase
EROS-2000	European River Ocean System-2000
ERSEM	European Regional Seas Ecosystem Model
ESF	European Science Foundation
ETS	Electron Transport System
FLB	Fluorescence Labelled Bacteria
FRIENDS	Food consumption/Faeces production, Respiration/Reproduction, Ingestion, Excretion/Egg production, Nutrition, Digestion/Development, Selectivity/Simulation studygroup
FYFY	Fysics-fytoplankton model
GKSS	GKSS Forschungszentrum Geesthacht
HMO	Hepatic Monooxygenase System
HREE	Heavy Rare Earth Elements
HRTEM	High Resolution Transmission Electron Microscope
IAPSO	International Association for the Physical Sciences of the Ocean
IBN	Instituut voor Bos en Natuuronderzoek, formerly RIN
ICES	International Council for the Exploration of the Sea
ICSU	International Council of Scientific Unions
IFM	Institut für Meeresforschung
IFREMER	Institut Français de Recherche pour l'Exploration de la Mer
IGBP	International Geosphere Biosphere Program (under ICSU)
INP	Integrated North Sea Programme
INQUA	International Quaternary Association
IUCN	Internation Union for the Conservation of Nature
INVEMAR	Instituto de Investigaciones Marinas de Punta de Betin (Colombia)
IPO	International Planning Office WOCE
IRI	Interuniversitair Reactor Institute, Delft
JGOFS	Joint Global Ocean Flux Study
KAFEE	Kontaktgroep Algen Fysiologie en Ecologie
KNAW	(Koninklijke Nederlandse Akademie van Wetenschappen) Royal Netherlands Academy of Arts and Sciences
KNMI	(Koninklijk Nederlands Meteorologisch Instituut) Royal Dutch Meteorological Institute
LDGO	Lamont Doherty Geological Survey
LOICZ	Land Ocean Interaction in the Coastal zone
LREE	Light Rare Earth Elements
MAFF	Ministry of Agriculture, Fishery and Food (UK)
MAST	MArine Science and Technology programme
MFO	Project group Meteorology Physical Oceanography
MGI	Marine Geological Institute, Bandung
MILZON	Inventariserend Macrobenthos Onderzoek in de Milieu Zonering op het Nederlands Continentaal Plat (Dir. Noordzee, RWS)
MREE	Medium Rare Earth Elements
MT-TNO	(Afdeling Maatschappelijke Technologie TNO) Division of Technology for Society TNO
NAM	(Nederlandse Aardolie Maatschappij) Dutch Oil Company
NASA	National Aeronautics and Space Administration USA
NERC	Natural Environment Research Council (UK)
NIOP	Netherlands Indian Ocean Programme
NIOO-CEMO	(Nederlands Instituut voor Oecologisch Onderzoek-Centrum voor Estuariene en Mariene Oecologie) Netherlands Institute of Ecology-Centre for Estuarine and Coastal Ecology

NOAA	National Oceanographic & Atmospheric Administration
NOGEPA	(Nederlandse Olie en Gas Exploratie en Productie Associatie) Dutch Association for the Exploration and Production of Oil and Gas Association
NOP	(Nationaal Onderzoeksprogramma voor luchtverontreiniging en klimaatverandering) National Research Programme on Atmosperic Pollution and Climate Change
NRSP	National Remote Sensing Programme
NSTF	North Sea Task Force
NWO	(Nederlandse Organisatie voor Wetenschappelijk Onderzoek) Netherlands Organization for the Advancement of Scientific Research
OCEAN	Ocean Colour European Archiving Network
OIO	(Onderzoeker in opleiding) Ph.D. student
PACT	Committee on the Application of Physical and Chemical Techniques in Archaeology
PAGES	Past Global Changes
PCB	Polychlorinated biphenyls
POM	Particulate Organic Matter
RCG	(Rijks-commissie voor Geodesie) State commission for Geodesy
REE	Rare Earth Elements
RENA	project Reguleerbare vormen van Natuurlijke Achtergrondstraling
RGD	(Rijks Geologische Dienst) National Geological Service
RIVO	(Rijks Instituut voor Visserij Onderzoek) Netherlands Institute for Fishery Investigations
RUG	(Rijksuniversiteit Groningen) State University of Groningen
RUU	(Rijksuniversiteit Utrecht) State University of Utrecht
RWS	(Rijkswaterstaat) Department of the Ministry of Transport and Public Works
SEA	Sea use management studies, Education and Advice
SEAWIFS	Sea Viewing Wide-Field of View Sensor
SCOPE	Scientific Committee on Problems of the Environment
SCOR	Scientific Committee on Oceanic Research
SEAWAQ	Seawater Quality model
SEM	Scanning Electron Microscope
SPASIBA	Scientific Programme on Arctic and Siberian Aquatorium
SOZ	(Stichting Onderzoek der Zee) Netherlands Marine Research Foundation
STEP	Science and Technology for Environmental Protection
TECON	(Toegepast Ecologisch Onderzoek Noordzee) Applied Ecological Research North Sea
TNO	(Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek) Netherlands Organization for Applied Scientific Research
TROL	Temperature Resistivity Oxygen Lander
UGGI	(Union Geodesique et Geophysique Internationale) International Union of Geodesy and Geophysics
UNEP	United Nations Environmental Programme
UO	University of Oldenburg (Germany)
VROM	(Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieuhygiëne) Ministry for Housing, Regional Development and the Environment
VVA	(Verstoring van Aardsystemen) Netherlands Research Programme on changes of earth systems

WASP	Wadden Sea Project
WCRP	World Climate Research Programme
WHOI	Woods Hole Oceanographic Institute
WHP	WOCE Hydrographic Programme
WOCE	World Ocean Circulation Experiment
WOTRO	(Wetenschappelijk Onderzoek Tropen) Netherlands Foundation for the Advancement of Tropical Research
WQI	Water Quality Institute
XBT	Expendable Bathythermograph
XRD	X-Ray Diffraction
ZUNOWAK	(Hydrografisch model van Rijkswaterstaat) Hydrographical Model of the Ministry of Transport and Public Works



Logo designed for NIOP.

3. Nederlandse samenvatting van de wetenschappelijke resultaten en andere activiteiten

3.1. SAMENVATTING VAN DE WETENSCHAPPELIJKE RESULTATEN

3.1.1. Inleiding

Voor deze samenvatting zijn de resultaten niet per project maar per onderzoeksgebied (Estuaria, Noordzee, Oceaan en Speciale Projecten) samengevat.

3.1.2. Estuaria (w.o. de Waddenzee)

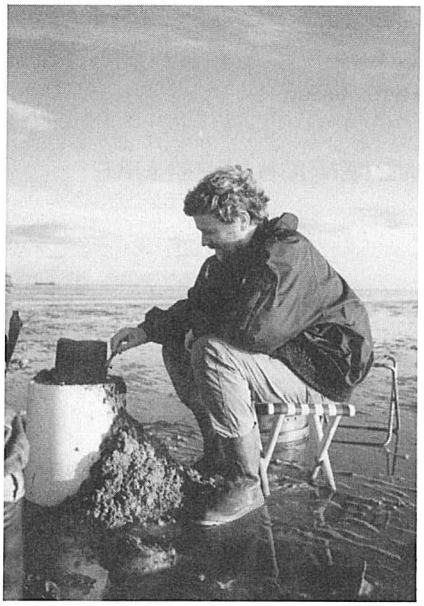
De fytoplanktonontwikkeling in het Marsdiep was in 1992 duidelijk anders dan in vorige jaren: *Phaeocystis* vertoonde niet de brede 2 à 3 maanden durende voorjaarspiek, maar twee vrij kleine piekjes met een dal eind April-begin Mei waar anders juist de hoogste aantallen *Phaeocystis* aangetroffen worden. Diatomeeën waren wat algemener dan andere jaren. Aangezien diatomeeën het beste voedsel zijn voor de meeste herbivoren was 1992 een goed jaar voor de tweede stap in de voedselketen.

Calcium en magnesium in het water bleken essentieel voor de vorming van het slijmomhulsel van de kolonievormende alg *Phaeocystis*. Met behulp van bacterievrije cultures kon aangetoond worden dat *Phaeocystis* zelf dimethylsulfide (DMS) kan produceren. Produktie van DMS is laag gedurende de exponentiële groeifase, maar hoog in de stationaire fase. *Phaeocystis* zal een belangrijke bijdrage leveren aan de DMS produktie in ons kustwater. Een groot deel daarvan komt niet vrij in de atmosfeer, maar wordt door bacteriën geconsumeerd. Laboratoriumexperimenten met drie trofische niveaus: *Phaeocystis*, *Phaeocystis*-etende protozoa (*Oxyrrhis*, *Strombidium, Strombidinopsis*) en de copepode *Temora* leerden dat *Temora* de graasdruk op *Phaeocystis* vermindert door zijn voorkeur voor protozoa. *Temora* kan dus invloed hebben op de piekhoogte van *Phaeocystis*-bloeien.

Post-larvale garnalen vestigen zich eerder op de wadplaten na een zachte winter (nl. al in April) dan na een strenge winter (Mei). Na zachte winters zijn ook de aantallen garnalen groter. Predatie van deze garnalen op juveniele stadia van andere bodemorganismen is daardoor groter na zachte dan na strenge winters. Hiermee kan verklaard worden dat recrutering van tweekleppigen als *Macoma* na strenge winters het grootst is. Na een zachte winter blijken de hoogste wadplaten door hun onbereikbaarheid voor garnalen echter een refugium te vormen voor jonge *Macoma*. Adulte *Macoma*-populaties op lagere

wadplaten komen dan ook meestal tot stand door wintermigratie van juveniele *Macoma* opgegroeid op deze hoge wadplaten.

Gedurende een zachte winter verliest een tweekleppige meer van zijn gewicht. Om na te gaan of dit ook invloed heeft op reproduktie werden een aantal tweekleppigen 's winters gehouden bij verschillende temperaturen. Een eerste resultaat is dat bij hogere wintertemperatuur kleinere eieren geproduceerd worden.



Koos van Zomeren aan het 'werk'.
(Foto: Jan van Gils)

Met toestemming van de auteur overgenomen uit NRC-Handelsblad, 13 & 14 augustus 1992. Ze verschijnen in 1993 in 'Zomer', Arbeiderspers, Amsterdam.

13 AUGUSTUS 1992

Vandaag of morgen

Monsters

Kanoeten zijn dol op nonnetjes, vooral die uit de eerste jaarklasse, van 5 tot 15 mm.
We gaan langs een vast traject het wad op en nemen monsters van de bodem. Deze worden gezeefd. De nonnetjes die zo te voorschijn komen, geven je een beeld van hun verspreiding.
Maar niet alle verspreide nonnen zijn ook werkelijk te verkrijgen. Een kanoet komt met zijn snavel niet dieper dan een centimeter of drie.
Nu worden bodemmonsters, 15 cm hoog, 15 cm in doorsnee, op een omgekeerde emmer gezet en aangesneden met een keukenmes, dunne plakjes, van boven naar beneden. Stuit je op een non, dan meet je hoe diep ze zit. Zo krijg je een beeld van haar beschikbaarheid.
Je zit in een kring in de leegte van het wad. Je snijdt modder en raakt bezield door de geest van de kanoet. Daardoor een gevoel van onzaligheid als tussen twee nonnetjes te veel tijd verstrijkt.
Kanoeten doen in wezen hetzelfde. Ze monsteren het wad. Ze kijken of het de moeite loont ergens te gaan eten, of het niet meer kost dan oplevert; het abc van hun economie. Ze werken efficiënter dan wij. Ze hebben het voordeel dat ze met zovelen zijn. En dat bij hoogwater hun laarzen niet vollopen.
Er waren bijna geen nonnetjes en die er waren, waren niet beschikbaar. In geen jaren hadden kanoeten op Griend zo weinig te zoeken gehad.

Koos van Zomeren

14 AUGUSTUS 1992

Vandaag of morgen

Goed werk

Inderdaad, ik heb een paar dagen van mijn leven besteed aan het snijden van modder en opsporen van tweekleppige schelpdieren die nonnetjes worden genoemd en ik moet zeggen: het heeft wel wat, het idee dat je je zoiets in de gegeven maatschappelijke context kunt veroorloven, dat je op zo'n manier de kost kunt verdienen. En het was nog lekker weer ook.
We zaten op klapstoeltjes, de zon schitterend aan de hemel, het wad warm aan onze voeten. "Theunis", zei Yaa in haar mooie, diepe Engels, "waarom doen we dit eigenlijk?
"Om meer te weten te komen over vogeltrek", zei Theunis.
"En als we dat weten?"
"Dan weten we meer over het leven."
"En als we dat weten?"
"Dan gaan we dood", zei ik, maar Yaa zat niet om grapjes verlegen. Ze wordt steeds op haar huid gezeten door mensen die vragen wat het nut is van haar werk, wat het bijdraagt aan de economie van Ghana, wat het helpt tegen de honger in Afrika.
"Die mensen ken ik", zei ik, "die heb je hier ook." Ze zien dat je dingen doet waar je goed in bent, of erger nog: waar je plezier in hebt, en dan komen ze zeuren waarom je niet wat anders doet, iets belangrijkers, iets wat zij als het verbeteren van de wereld beschouwen. Ze weten niet half hoe dom ze zijn. Als ik de wereld wou verbeteren, zou ik om te beginnen voorstellen dat soort mensen op te ruimen.

Koos van Zomeren

Wadpier en kokkel beïnvloeden de aanwezigheid van andere wadorganismen als *Corophium*. Bij veldexperimenten op het wad bij Schiermonnikoog, werden de aantallen *Corophium arenarium* tien maal zo hoog als in de normale situatie als het proefvlak eerst levenloos gemaakt was, maar ook als alleen alle wadpieren verwijderd waren. Vergelijkbare negatieve effecten van kokkel en wadpier op *Corophium* werden gevonden in de Gullmarsfjord. Verwijdering van wadpieren uit een proefvlak op het Balgzand bleek tot veel hogere broedval te leiden van bijna alle macrofaunasoorten vergeleken met plekken met wadpieren. Daarentegen werden geen effecten gezien op reeds aanwezige adulte macrofauna.

Mede als gevolg van beperkingen voor de schelpdiervisserij in de Waddenzee is er een gedeeltelijk herstel opgetreden in de hoeveelheden mossels en kokkels na de over-exploitatie in voorgaande jaren. Als onmiddellijk resultaat leidde dit tot minder sterfte onder eidereenden en een aanmerkelijk groter broedsucces op Vlieland alhoewel de broedpopulatie nog niet op het niveau is van enkele jaren geleden. Jonge eiders bleken echter grote moeite te hebben de weinige plekken met geschikt voedsel te vinden op het wad. Dit hangt mogelijk samen met het ontbreken van goede landmerken op het wad nu de wilde mosselbanken door vissers vernield zijn.

Rond het eiland Griend komen normaliter tussen juli en oktober grote aantallen kanoetstrandlopers voor, maximaal tot 40000. Zij eten bij voorkeur jonge *Macoma,* maar gaan over op wadslakjes (*Hydrobia*) als er te weinig *Macoma* is en op kleine kokkels als zowel *Macoma* als *Hydrobia* ontbreken. In de periode van 1988 tot 1992 nam dit voedsel regelmatig af, en in 1992 was er zo weinig dat de kanoeten zelfs weg bleven uit dit gebied. Hoogstwaarschijnlijk hangt voedselschaarste samen met de te grote activiteit van mossel- en kokkelvissers in de afgelopen jaren. Onderzoek is begonnen naar een mogelijke concurrentie tussen vogels en koudbloedige predatoren (vis, krab, garnaal) die dezelfde prooidieren eten.

In het Sivash gebied (Zee van Azov) werd onderzocht welk voedsel enkele wadvogels eten, tijdens hun korte verblijf hier in het voorjaar op weg naar het broedgebied in het hoge noorden.

Terwijl de Westeuropese ondersoort van de scholekster gestadig in aantal toeneemt, verkeert de Oostaziatische ondersoort op het randje van uitsterven. Onderzoek op Aziatische wadden wees uit dat deze scholekster hier meer kreeftachtigen en wormen eet en een iets kortere snavel heeft dan de onze die voornamelijk schelpdieren eet.

Groei van jonge schol in de Waddenzee blijkt niet alleen afhankelijk van de temperaturen maar ook van de hoeveelheid aanwezig voedsel. Groei bleek niet dichtheidsafhankelijk, waaruit blijkt dat er geen voedseltekort is zelfs bij de hoogste dichtheden schol die werden aangetroffen.

PCB gehaltes in de wadpier variëren een factor 2 à 3 gedurende het jaar.

Menging van water in de Waddenzee geschiedt waarschijnlijk voornamelijk door chaotische advectie. Dit is de uitkomst van een modelstudie. Kleinere bekkens in de Waddenzee zoals het Schiermonnikoog-Lauwersoog bekken, gedragen zich waarschijnlijk als een niet-lineaire Helmholtz-resonator.
In getijdegebieden als de Dollard wordt de grootte van de in het water zwe-

De ontwikkeling en precisering van de analyse van PCB's in water, slib en biota is een voortgaand proces, waarbij ook in de verslagperiode weer vorderingen werden gemaakt.

Analyse van PCB's in zeesterren toonde aan dat de hoogste concentraties voorkomen in dieren verzameld in kustzones van de Zuidelijke Bocht van de Noordzee, terwijl de laagste concentraties worden gevonden in de centrale Noordzee. Voorlopige data uit het onderzoek naar het voorkomen van DNA-breuken bij zeesterren tonen dat er een toename van het aantal breuken is in zeesterren in de kustwateren van de Zuidelijke Bocht. Tot dusver is er echter geen correlatie gevonden tussen het aantal DNA-breuken en de concentratie PCB-congeners met een dioxine-achtige giftigheid.

De concentratie zware metalen (koper, zink, cadmium en lood) in de fijne fractie (<63 μm) van het oppervlakkige sediment in de Zuidelijke Bocht is hoog. Verhoogde concentraties werden ook gevonden ten noorden van de Doggerbank, en in het westelijk deel van de Doggerbank zelf. Daarentegen zijn de concentraties in dezelfde sedimentfracties in een typisch sedimentatiegebied (de Oestergronden) relatief laag.

Heterotrofe nanoflagellaten zijn een belangrijke schakel in het microbiële voedselweb, zowel in pelagische als in benthische systemen. De trofische relaties tussen deze flagellaten en bacteriën werden ook in de Noordee onderzocht; aanvullend op de zomerwaarnemingen werden gegevens verzameld in de winter van 91/92. De hoogste aantallen, in de bovenste 3 mm van de bodem, varieerden van 30 tot 120 $\times 10^3 \cdot cm^{-3}$; de dichtheden namen af dieper in het sediment. Op stations nabij de kust, met een zanderige bodem, waren de dichtheden 2 tot 8 keer lager dan in de zomer. Daarentegen waren de dichtheden op slibrijke bodems ongeveer even hoog, en op enkele stations zelfs een factor 2 tot 5 keer hoger dan in de zomer.

De opname van bacteriën door flagellaten werd gemeten met behulp van met fluorescerende stof gemerkte bacteriën; deze opname varieerde van 11 tot 44 bacteriën per flagellaat per uur. Er waren geen verschillen tussen zomer en winter. Berekeningen toonden aan dat in de zomer 0,4 tot 28% van de bacteriële produktie wordt gegeten door flagellaten.

De bepaling van groeisnelheden van macrofauna door het meten van lengteverschillen is gewoonlijk een tijdverslindende bezigheid; bovendien wordt zo een gemiddelde groei over een bepaalde periode gemeten en is een momentane groeimeting niet mogelijk. Momentane groei kan gemeten worden aan de hand van de RNA/DNA ratio. Tot nu toe werd daarbij gebruik gemaakt van fluorometrie. Een nieuw ontwikkelde scheiding van RNA en DNA door middel van HPLC geeft vergelijkbare resultaten en is aantrekkelijk aangezien de te onderzoeken monsters minder handelingen ondergaan, terwijl een directe bepaling van de nucleïnezuurconcentraties mogelijk is.

De analyse van de bodemfauna in het Nederlandse deel van het continentale plat werd voortgezet. De studie van de groeivariaties van *Arctica islandica* (noordkromp) met methoden uit de dendrochronologie tonen aan dat de groei in de zeventiger jaren kleiner was dan gemiddeld, terwijl de groei in de tachtiger jaren juist groter was dan gemiddeld. Bovendien bleek 1972 een jaar te zijn met een zeer geringe groei, in die mate dat dit jaar in vrijwel alle schelpen is terug te vinden, niet alleen in de Fladen Gronden, maar ook in een monster van de Faroer. Dat wijst er op dat de verschillen in groei beïnvloed worden door zeer grootschalige processen.

De eerste van een serie pelagische mesocosm-systemen werd in gebruik genomen, en oriënterende proeven over de bruikbaarheid van het mengmechanisme uitgevoerd met een community van de alg *Isochrysis*, bacteriën, en een aantal flagellaten en enkele diatomeeën; er ontstond een stabiel evenwicht.

Ten behoeve van de studie van de coccolithophoor *Emiliania* werd een grootschalig onderzoek (40 deelnemers uit Noorwegen, Duitsland, Monaco, USA, Zweden, Verenigd Koninkrijk en Nederland) uitgevoerd in een Noors fjordensysteem, met twee schepen (w.o. de 'Pelagia'), 1 veldstation en een groot mesocosm-project.

De inventarisatie ten behoeve van de zeevogels-op-zee database werd voortgezet als een EG-project, een samenwerking tussen NIOZ en het Deense Ornis Consult, waarbij de 'Navicula' (1 m diepgang) de kustwateren bevaart, en een Deens schip het diepere water van de zuidoostelijke Noordzee, van de Belgisch-Nederlandse grens tot aan Jutland. Grote concentraties zeeëenden (>10 000) werden gevonden voor Terschelling, Schiermonnikoog, Borkum en Jutland, in januari, februari. Duikers waren meer verspreid, met de grootste concentraties voor de Duits-Deense kust; ook van deze soorten overwinteren tienduizenden in de Duitse Bocht. Bovendien werden aanzienlijke aantallen gewone zeehonden in de Noordzee aangetroffen, wat er op wijst dat aanzienlijke aantallen de Waddenzee in de winter verlaten.

3.1.4. Oceaanonderzoek

In 1992 is op het NIOZ oceaanonderzoek uitgevoerd in het kader van verscheidene grote nationale en internationale projecten. Verschillende afdelingen namen deel aan het JGOFS Southern Ocean programma aan boord van het Duitse onderzoekschip 'Polarstern'. De 'Tyro' van de SOZ werd ingezet in het kader van het Nederlandse Indische Oceaanprogramma (NIOP). Vanuit het NIOZ werd door verschillende onderzoekafdelingen in het NIOP geparticipeerd, terwijl de technische en logistieke ondersteuning voor een belangrijk deel door de NIOZ hulpafdelingen werd verzorgd. In samenwerking met Italiaanse onderzoekers werd een programma uitgevoerd in de Adriatische Zee, terwijl verschillende Russische estuaria en kustzeeën werden onderzocht in samenwerking met Russische onderzoekers. Onderzoek in het kader van de internationale programma's WOCE, JGOFS, EPOS en EROS-2000 werd ook in 1992 voortgezet.

Aan het Nederlandse Indische Oceaanprogramma werd deelgenomen door de afdelingen Chemische Oceanografie, Mariene Geologie, Benthische Systemen en Pelagische Systemen met een kleine bijdrage van de afdeling Fysische Oceanografie.

Chemisch onderzoek aan verschillende componenten in de bovenste lagen van het sediment in de NW Indische Oceaan is uitgevoerd om de totale mineralisatie van organische koolstofverbindingen in het sediment vast te stellen. De partiële spanningen van N_2O en CH_4 in de oppervlaktewateren van de Indische Oceaan en in de atmosfeer zijn bepaald. De voorlopige uitwerking van deze meetresultaten duidt op een netto transport van deze broeikasgassen van de oceaan naar de atmosfeer.

(Foto: J. Nieuwenhuis)

De concentraties van organische micro-verontreinigingen en spore-elementen werden bepaald in de kustwateren van Kenia en in het sediment bij Mombassa, terwijl ook sedimentmonsters uit de ondiepe wateren bij Jemen en uit de diepe equatoriale Indische Oceaan werden geanalyseerd op gehaltes van spore-elementen.

In het gebied van de Somalië-stroom werd de toepasbaarheid van Remote Sensing als ondersteuning van oceaanexpedities getest. Een goede overeenkomst met de scheepswaarnemingen werd vastgesteld. In het Somalië-bekken zijn experimenten uitgevoerd met de geologische benthische lander en zijn sedimentvallen verankerd.

De moessons bij Kenia veroorzaken seizoensvariaties in de primaire produktie en dus in de depositie van organisch materiaal op de zeebodem. Om dit te bestuderen zijn benthische experimenten uitgevoerd voor de kust van Kenia. De benthische lander is een aantal malen uitgezet om *in situ* de benthische respiratie te meten. Ook werden laboratoriumincubaties met sedimentmonsters uitgevoerd. De respiratie blijkt sterk af te nemen met toenemende waterdiepte.

Ook bij de kust van Jemen veroorzaken de moessons seizoensvariaties in de primaire produktie. Deze hangen hier samen met moessongebonden opstroming. Op een sectie in de kustwateren van Jemen is het effect van deze variaties op het benthos bestudeerd. Hierbij werd gebruik gemaakt van laboratoriumincubaties zowel als van *in situ* metingen met een benthische lander. In het bijzonder dicht bij de kust was het bodemwater bijna anoxisch. De fluxen van nitraat en silicaat bleken aanzienlijk te zijn.

Het pelagische systeem van de moessongebonden opstromingsgebieden in de Somalië-stroom, de Golf van Aden en de Rode Zee is bestudeerd met een veelheid aan methoden, waarbij de meeste JGOFS-kernmetingen werden uitgevoerd. In de actieve opstroming bij Somalië was de primaire produktie per m^3 hoog in de fotische zone, maar door de hoge troebelheid van het water kwam de produktie per m^2 niet boven de 2 g $C \cdot d^{-1}$. De bacteriële produktie

bleek relatief laag en de begrazingsdruk door zoöplankton was hoog. In mei werd bij Straat Bab-el Mandeb geen planktonbloei waargenomen, terwijl deze in augustus wel gevonden werd. Dit was vermoedelijk gekoppeld aan de door de moesson veranderde circulatie in de Straat die sterke menging mogelijk maakte. Veel monsters zijn geconserveeerd voor verdere analyse. De doorstroom-cytometer werd gebruikt voor de karakterisering van fytoplankton in verse monsters.

Het NIOZ gaf een substantiële bijdrage (15 opstappers) aan het JGOFS-programma in de Zuidelijke Oceaan dat uitgevoerd werd door het Duitse ijsbrekende onderzoekschip 'Polarstern'. Twee speciale schone containers werden op het NIOZ geprepareerd voor dit onderzoek. De CTD-waarnemingen en het nemen van watermonsters met aan de CTD verbonden waterscheppers werd door NIOZ-medewerkers uitgevoerd. Het NIOZ verzorgde de data-base voor deze expeditie.

Ten behoeve van het onderzoek naar metalen en zeldzame aarden zijn monsters genomen die in 1993 op het NIOZ zullen worden geanalyseerd. Het effect van opgelost ijzer op de primaire produktie in Antarctische wateren werd bestudeerd met behulp van laboratoriumincubaties. Door het zeer lage gehalte aan plankton konden echter geen definitieve conclusies worden getrokken. Dit was wel mogelijk voor watermonsters genomen bij het noordelijker gelegen polaire front. Daar bleek toevoeging van opgelost ijzer de primaire produktie significant te verhogen.

Tijdens de tocht van de 'Polarstern' werd continu een aantal parameters gemeten die het CO_2-systeem in het oppervlaktewater beschrijven. Ook de partiële CO_2-spanning in de atmosfeer werd bepaald. Met deze gegevens zal de uitwisseling van CO_2 tussen de atmosfeer en de oceaan berekend worden. Combinatie van deze gegevens met de door andere onderzoekers continu geregistreerde biologische parameters zal informatie opleveren over biologische en chemische processen in de zee.

Meer dan 200 profielen van temperatuur en saliniteit, gemeten met een CTD-instrument, zijn geregistreerd tijdens de JGOFS-tocht van de 'Polarstern'. Deze gegevens zijn ter beschikking van alle deelnemende onderzoekers en zullen op de afdeling Fysische Oceanografie gebruikt worden bij de ontwikkeling van menglaagmodellen ten behoeve van de modellering van het Antarctische ecosysteem.

Het NIOZ werkt samen met Italiaanse onderzoekers in een door de EG gesubsidieerd onderzoek aan het sediment van de noordelijke Adriatische Zee. In maart werd in dit kader deelgenomen aan een tocht met het Italiaanse schip 'Ravello'. Hierbij werden twee verschillende, op het NIOZ ontwikkelde, autonome landers ingezet. Fluxen uit het sediment, gemeten met de landers werden vergeleken met fluxen bepaald uit laboratoriumexperimenten aan sedimentmonsters. De uitwisseling tussen sediment en water bleek het hoogst in de nabijheid van de ondiepe Po-delta en het laagst in het meer zuidelijke diepe water, waar zuurstof veel dieper het sediment in dringt. De bodemfauna bleek rijk, zowel in termen van biomassa en aantallen dieren als in aantallen soorten.

Monsters uit verschillende sedimentvallen, verkregen tijdens het internationale Noord-Atlantische JGOFS-programma, werden geanalyseerd. Hieruit bleek dat organische deeltjes, afkomstig uit de voorjaarsbloei, op verschillende geografische posities gelijk arriveerden in de vallen. In de zomer vonden bloeien

van gelijke grootte als de voorjaarsbloei plaats. Deze hadden echter een veel kleinere geografische omvang en werden slechts in een enkele positie waargenomen.

Sedimentmonsters verkregen tijdens het EROS-2000 programma in de NW Middellandse Zee zijn verder geanalyseerd op hun gehalte aan metalen. Door normalisatie ten opzichte van het aluminiumgehalte konden verschillen in verspreidingsmechanismen worden aangetoond voor verschillende gebieden en verschillende groepen metalen. Het zuurstofgehalte in het sediment bleek van belang voor de mobiliteit van metalen in het sediment.

Met behulp van de verticale verdeling van loodisotopen in het sediment is de sedimentatiesnelheid bepaald. Door combinatie met de metaalconcentraties in het sediment kon de flux van metalen naar het sediment worden vastgesteld.

In het EROS-2000 programma is ook onderzoek gedaan naar de sediment-water uitwisseling van zuurstof en voedingszouten, in samenhang met de macrofauna. De fluxen bleken het grootst in de nabijheid van de mondingen van de Rhône en Ebro en het kleinst in de diepe Middellandse Zee. Hierbij werd een sterke lineaire relatie gevonden tussen de dichtheid van macrofauna in het sediment en de fluxen. Bij waterdiepten van meer dan 500 m werden geen fytopigmenten in het sediment waargenomen. Geconcludeerd werd dat er nauwelijks export van organisch materiaal bestaat van het ondiepe continentale plat naar de diepe bekkens.

Ook sedimentmonsters verkregen in de wateren van Mauretanië zijn geanalyseerd op gehaltes aan metalen en spore-elementen. Na correctie voor het sterk variërende gehalte aan calciumcarbonaat bleek dat de verspreiding van de verschillende elementen in het sediment weinig verticale en laterale verschillen vertoont. Alleen voor lood, zink en koper kon een recente toename van de concentraties in de bovenste centimeter van het sediment worden aangetoond.

In samenwerking met Russische onderzoekers is het sediment in de Laptev Zee en het Lena-estuarium onderzocht. De verticale verdeling van de meeste elementen in het sediment van de Laptev Zee vertoont weinig variatie, met uitzondering van ijzer en cadmium. Bij de laatste twee elementen spelen redoxreacties t.g.v. het hoge gehalte aan organisch koolstof en de daaraan verbonden anoxische condities in het sediment een belangrijke rol. De sedimentatiesnelheid in de Laptev Zee, bepaald m.b.v. loodisotopen is moeilijk te interpreteren. Ouder sediment blijkt voor te komen bovenop jonge sedimenten. Vermoedelijk is verplaatsing van sediment t.g.v. stromingen en zeeijs hier debet aan.

Gedurende de oversteek van de 'Polarstern' van Europa naar Antarctica werd de uitwisseling van CO_2 in de Zuid-Atlantische Oceaan bestudeerd door continue registratie van de partiële druk van CO_2 in de atmosfeer en in het oppervlaktewater. Het hierbij verkregen gegevensbestand wordt verder bewerkt. In 1993 zal dit experiment worden herhaald. Instrumentatie om alkaliniteit, totaal CO_2 en partiële CO_2-spanning in het zeewater te meten is ontwikkeld en gebouwd op het NIOZ. Deze apparatuur is op verschillende tochten van het Duitse Alfred Wegener Institut (AWI) gebruikt in een samenwerkingsprogramma tussen NIOZ en AWI.

De haalbaarheid van de opslag van door industriële activiteiten geproduceerd CO_2 in de oceaan is bestudeerd. Dit blijkt geen geschikte oplossing voor

het CO_2-probleem. De opslag is slechts tijdelijk vanwege interactie met het oplossen van $CaCO_2$ in het sediment.

Theoretisch fysisch onderzoek werd uitgevoerd naar de dynamica van oceaanwervels in een β-vlak. Door de Hamiltonse beschrijving van de vloeistofmechanica te combineren met een renormalisatiemethode werd duidelijk inzicht verkregen in het gebruik van variationele methoden in de vloeistofmechanica.

Niet-lineaire modellen van de ocaancirculatie werden geanalyseerd m.b.v. een storingsreeks. Hiermee werd een 'bijna-vrije' traagheidscirculatie verkregen die aan de voornaamste integraalbeperkingen voldoet.

In samenwerking met de Université Libre in Brussel is het effect bestudeerd van fysische processen in de menglaag op de planktonbloei in de Weddellzee. Het effect van het zoete water dat vrijkomt bij het afsmelten van zeeijs blijkt minder belangrijk dan tot nu toe is verondersteld.

De resultaten van incubatie-experimenten uitgevoerd tijdens het EPOS-programma in de Weddellzee tonen geen veranderingen in de copepodestadia. Dit hangt waarschijnlijk samen met een erg lage groeisnelheid en een tweejarige levenscyclus van de copepoden. Analyse van gegevens uit verschillende seizoenen zijn nodig om een dergelijke tweejarige cyclus aan te tonen. Er blijken grote variaties te zijn in levensstrategie en differentiatie tussen verschillende maar verwante copepodesoorten.

Een aanvang is gemaakt met een studie van de fysische processen bij de rand van het continentale plat. Het enkeldaagse barotrope getij in de Groenlandzee kon goed worden beschreven als een dubbele Kelvingolf. Bij dubbeldaagse inwendige getijden is de eerste interne modus dominant. In het kader van dit programma is een eerste tocht uitgevoerd in de Golf van Biskaye. Hierbij werd een kleinschalige hydrografische opname uitgevoerd en werden waarnemingen uitgevoerd aan hoogfrequente interne solitonen.

De hydrografische gegevens, verkregen tijdens het DUTCH-WARP-programma in 1990 en 1991, zijn volledig verwerkt en overgedragen aan het WOCE-data-centrum. De menging van de verschillende watertypen in het IJsland-bekken is bestudeerd m.b.v. een kwantitatieve watermassa-analyse en met een analytisch mengmodel. Om de transporten van de verschillend watertypen te bepalen is een invers model ontwikkeld waarbij de totale enstrofie van de circulatie wordt geminimaliseerd. De gegevens van de stroommeterverankeringen uit het IJsland-bekken wijzen op en cyclonale circulatie op alle niveaus. De ARGOS-drijvers uit het IJsland-bekken tonen, naast de cyclonale circulatie, een complex patroon van oceaanwervels.

In het kader van het hydrografische programma van WOCE zijn XBT-opnames uitgevoerd op secties in de Atlantische Oceaan. In samenwerking met de Koninklijke Marine zijn 4 XBT-secties uitgevoerd tussen het Kanaal en de Caraïbische Zee.

Een begin is gemaakt met de analyse van satelliet-altimetriegegevens van de Noord-Atlantische Oceaan. Een relatie wordt gezocht tussen de variatie van het zeeniveau en variaties in de circulatie, bepaald met ARGOS-drijvers.

In samenwerking met het AWI is een gegevensbestand opgezet met betrekking tot het Arctische front in de Groenlandzee. Op dit front komen bijna-stationaire oceaanwervels voor die een belangrijke rol spelen bij de uitwisseling over dit front.

Seismische profielen uit de omgeving van de Faroer zijn onderzocht in samenwerking met Deense onderzoekers. Op de continentale helling van de Faroer werden sedimentafzettingen aangetroffen, veroorzaakt door de circulatie van diep water uit de Noorse Zee.

De analyse van seismische profielen uit Indonesische wateren heeft een structurele relatie aangetoond tussen Sumba en Noord Timor. Op Sumba is veldwerk verricht waarbij gegevens zijn verzameld t.b.v. de seismische modellen.

Sedimentmonsters verzameld tijdens de Snellius-II-expeditie zijn verder geanalyseerd. Met behulp van factoranalyse van diatomeeëngroepen konden verschillende hydrografische regimes worden onderscheiden. Hiermee worden de variaties van het transport van water uit de Stille Oceaan, samenhangend met ijstijden en interglacialen, bestudeerd.

De op het NIOZ ontwikkelde Röntgen-sedimentkernscanner is gemodificeerd. Met het nieuwe instrument kan nu ook de aanwezigheid van elementen met lage atoomgetallen worden aangetoond.

Planktonische foraminiferen uit het Angola-bekken werden met clusteranalyse gerelateerd aan verschillende hydrografische situaties. Door de aanwezigheid van deze foraminiferen in sedimentkernen te bestuderen konden glaciale cycli van de hydrografische omstandigheden in het gebied van de Walvisrug worden gereconstrueerd.

De verhouding tussen zoetwaterdiatomeeën en fytolieten in sedimentkernen uit het Angola-bekken blijkt goed bruikbaar voor de bestudering van het klimaat in Afrika. De hieruit verkregen 'PhFD-ratio' is een goede schatter voor de droogte op het continent. Tijdreeksen hiervan, verkregen uit sedimentkernen uit het Angola-bekken, komen goed overeen met bestaande reconstructies van het klimaat over de laatste 150 000 jaar.

De verhoudingen tussen silicium en aluminium in diatomeeën in het oppervlaktewater en in het sediment van de Zaïre-sedimentpluim in het Angola-bekken werden vergeleken met het sediment uit de Zuidelijke Oceaan. In het Angola-bekken blijkt voldoende aluminium aanwezig te zijn om het oplossen van silicium sterk te beperken. In de Zuidelijke Oceaan is dit niet het geval, waardoor daar relatief meer silicium uit het sediment oplost.

De beïnvloeding van de ecologische strategie van tropische steenkoralen door veranderende milieufactoren is bestudeerd in samenwerking met onderzoekers uit Curaçao, Israël, Colombia en Indonesië. De regeneratie na beschadigingen van het koraal en veranderingen van milieuvariabelen blijkt te variëren tussen de verschillende soorten, en is niet afhankelijk van de positie op het rif. Door het herhaald fotograferen van het koraal in permanente kwadraten bij Curaçao en Bonaire konden aanzienlijke variaties over de laatste 20 jaar worden vastgesteld. Een studie naar mogelijke effecten van eutrofiëring op het koraalrifsysteem bij Curaçao suggereert dat veranderingen in de karakteristieken van pelagische bacteriën de samenstelling van de benthische riforganismen beïnvloeden. De interactie en agressie tussen verschillende koraalsoorten is bestudeerd in de Rode Zee. Hierbij is ook aandacht besteed aan biochemische aspecten van dergelijke interacties.

3.1.5. Speciale Projecten

De BEWON-groep is een onderdeel van het Beleidsonderbouwend Ecologisch Onderzoek Noordzee (BEON), waarin 9 instituten samenwerken. BEWON

besteedt speciale aandacht aan politiek gevoelige onderwerpen als eutrofiëring, verontreinigende stoffen en visserijeffecten in Noordzee en Waddenzee.

In het kader van het Integraal Noordzee Programma (INP) werden twee tochten uitgevoerd waarin de rol van het sediment in de nutriëntencycli en de effecten van verontreinigende stoffen centraal stonden. Van de in de bovenste cm van het sediment aanwezige ammonium blijkt 55% het hele jaar geadsorbeerd aan het sediment, 30% is aanwezig in microorganismen en slechts 15% komt opgelost voor. De fosfaat-flux uit het sediment is 's zomers hoger dan 's winters. Bacteriële produktie bleek 's winters 3 tot 10 maal lager dan 's zomers, maar de biomassa van bacteriën vertoont vrijwel geen seizoensvariatie. Dit wijst op een relatief lage sterfte van bacteriën in de winter, samenhangend met een tot 8 maal zo lage dichtheid aan bacterivore benthische nanoflagellaten.

Het toxicologisch onderzoek richtte zich vooral op biochemische en fysiologische effecten die als vroegtijdig waarschuwingssignaal kunnen dienen voor aantastingen van het ecosysteem. Nadruk lag hierbij op activiteitsmetingen van het monooxygenase-enzymsysteem bij de schar en het voorkomen van 'imposex' bij de wulk. Dit laatste is het voorkomen van een penis-homoloog bij vrouwelijke slakken waardoor voortplanting waarschijnlijk onmogelijk wordt en de soort dus gedoemd is te verdwijnen. Imposex werd voor het eerst ook gevonden in open zee en vooral aangetroffen in de diepwater scheepsroute. Dit wijst er op dat imposex ook bij de wulk veroorzaakt kan zijn door anti-fouling verven.

Tijdens de voorjaarsbloei van *Phaeocystis* in het Marsdiep blijkt bacteriële produktie de variatie in aantallen *Phaeocystis*-kolonies te volgen met een piek 10 dagen na de *Phaeocystis*-piek. Toename in *Phaeocystis* had ook een toename in acrylaat en DMS in het water tot gevolg. DMS wordt in de atmosfeer geoxideerd tot sulfaat en draagt bij aan de lage pH van regenwater. Echter, een deel van dit door *Phaeocystis* geproduceerde DMS wordt door bacteriën geconsumeerd, en komt dus niet vrij in de atmosfeer. De rol van microzooplankton blijkt belangrijker dan tot nog toe verondersteld; tijdens de voorjaarsbloei van fytoplankton consumeert microzooplankton in het Marsdiep tot 75% van de primaire produktie. Toch lijkt het einde van een *Phaeocystis*-bloei eerder samen te hangen met nutriëntbeperking die tot autolyse van *Phaeocystis* leidt. Pieken in autolyse werden gevolgd door een 'bloei' van tintinniden, maar er werd geen specifieke predator op *Phaeocystis* gevonden.

Een model is ontwikkeld voor de fytoplanktonsuccessie in de Noordzee. Ook weerinvloeden, mogelijk bepalend voor jaar op jaar verschillen, worden in dit model betrokken. Het model verklaart dominantie van grote algensoorten in de kustzone door zooplanktonbegrazing. De N/P verhouding bepaalt waarschijnlijk de soortsamenstelling.

In mesocosms werd eutrofiëring nagebootst door toevoeging van dood *Phaeocystis* materiaal. Afbraak hiervan gaat sneller in aanwezigheid van de zeeklit (*Echinocardium cordatum)* die door omwoeling van het sediment dit organisch materiaal beter verspreidt.

Het ecosysteem model voor de Noordzee ERSEM, een gezamenlijk project van 7 Europese instituten, komt in zijn eerste eindfase. De Noordzee is voor dit model verdeeld in 10 stukken, praktisch samenvallend met de ICES gebieden. In dit model blijkt sedimentatie van organisch materiaal in voorjaar en zomer een sleutelfactor voor het benthos. Te hoge aanvoer zal leiden tot lage zuur-

stofgehaltes en lage nitrificatie en denitrificatie, maar een lage aanvoer van organisch materiaal (en dus ook N) zal ook leiden tot lage nitrificatie en denitrificatie.

Bij zeezoogdieren werd gevonden dat de onderlinge verhouding van chloorbifenyl(CB)-verbindingen in de verschillende organen grote overeenkomst vertoont. Hieruit blijkt dat bloed het centrale transportmedium is en dat een klein bloedmonster voldoende is om CB-contaminatie in zeezoogdieren te meten. Metabolieten van een dioxine achtige CB-verbinding CB77 blijken op een totaal andere manier toxisch te zijn dan CB77 zelf.

Binnen een straal van 250 m konden na drie jaar nog duidelijke effecten van lozingen van oliehoudende boorspoeling op de macrofauna aangetoond worden. Gevoelige soorten als de zeeëgel *Echinocardium cordatum* en de tweekleppige *Montacuta ferruginosa* bleken zelfs binnen een straal van 1 km nog niet voor te komen, in relatief lage aantallen tussen 1 en 2 km en pas op 3 km afstand was geen effect meer meetbaar. De afwezigheid kan verband houden met ontbreken van vestiging van juvenile exemplaren; het is niet noodzakelijkerwijs een permanente verstoring. Waterhoudende boorspoeling lijkt veel milieuvriendelijker. Lozing hiervan blijkt zelfs op 25 m van de lozingsplaats geen significant effect te hebben op de macrofauna.

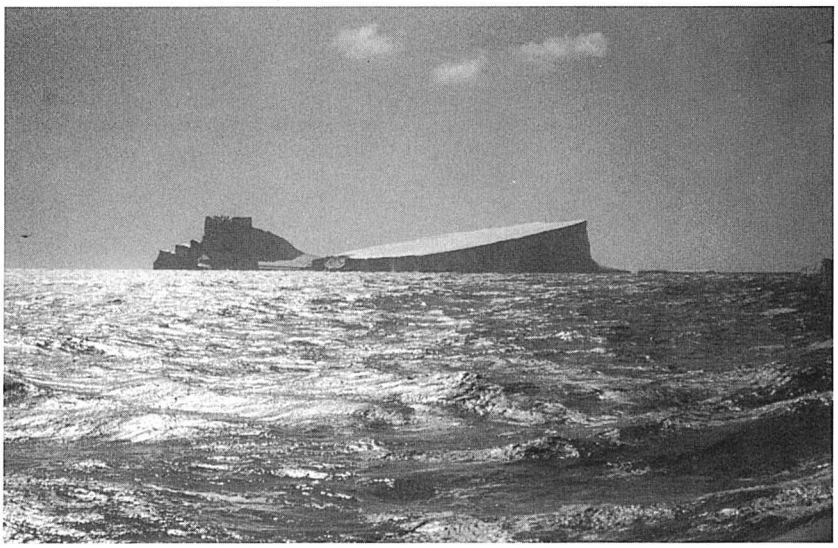
Trawlvisserij heeft duidelijk een negatief effect op bodemorganismen. De overlevingskansen van organismen die na vangst weer overboord gezet worden varieert van 10-15% bij de noordkromp (*Arctica*) en Noordzeekrab (*Cancer*), 40-60% bij de overige kreeftachtigen en mollusken tot 90% bij de zeester (*Asterias).* Per kg geviste marktwaardige tong worden 6 kg andere organismen gedood. Herhaald vissen op dezelfde plek had tot gevolg dat de dichtheid van evertebraten geleidelijk afnam, terwijl de visvangst niet terug liep. Kennelijk wordt vis aangetrokken door de beschadigde bodemfauna. Het is niet gelukt gebieden in de Noordzee te vinden die niet bevist worden. Hierdoor is het onmogelijk lange-termijnonderzoek te doen naar visserijeffecten op de bodemfauna, totdat gebieden voor visserij gesloten worden. Analyse van sinds 1930 tot nu door commerciële vissers aangevoerde evertebraten toont een achteruitgang van zeekreeften (*Nephrops* en *Homarus*) en zeeëgels (*Psammechinus* en *Spatangus*) als gevolg van visserij.

Monitoring van het macrozoobenthos van de Waddenzee werd voortgezet. De milde winter heeft geleid tot het overleven van soorten gevoelig voor lage wintertemperaturen en in het algemeen slechts geringe recrutering van tweekleppigen. Slechts plaatselijk was enige broedval van kokkel en mossel.

3.2. BEZOCHTE CONGRESSEN

Minisymposium: Microbes in the marine environment. Biol. Centrum, RU Groningen, 14-16 januari: R.P.M. Bak, F.C. van Duyl, B. Hondeveld, R. Osinga, C.P. Slomp, T.M. Tahey.
Impact of calcifying phytoplankton on the carbon system of the ocean, Universiteit Bergen, Noorwegen, 15 januari: M.J.W. Veldhuis.
American Geophysical Union, 1992 Conference on Ocean Sciences, New Orleans, 27-31 januari: L.R.M. Maas.
Ocean Margin Experiment (OMEX) workshop, Brussel, 29-30 januari: W. Helder.
Symposium 'Platvis Toxicologie', Groningen, 30 januari: J.P. Boon, J.M. Everaarts, H.M. Sleiderink.
Demi-annual ERSEM-workshop, januari, Texel: P. Ruardij.
Visserij-dagen, Bakkeveen, 7-8 februari: M.J.N. Bergman.
Lyell meeting Sediments and Organisms, Londen, 13 februari: G.C. Cadée.
Minisymposium: Animal energetics in the constraints of the marine environment. Biol. Centrum, RU Groningen, 19-21 februari: G.H. Fransz, P. de Goeij, R. Osinga, T. Piersma, I. Tulp, Y. Verkuil, P. Wiersma, P.A.W.J. de Wilde, R. Witbaard.
Symposium 'The other North Sea', Amsterdam, 21 februari: M.J.N. Bergman, P.A.W.J. de Wilde, R. Witbaard.
Sedimentary sequences and cyclic orbital forcing, Institute of Earth Sciences, Utrecht, 22-23 februari: J.H.F. Jansen.
ICES Shelf Seas Working Group, Kopenhagen, 26-28 februari: A.J. van Bennekom.
Verwey dagen, NIOZ, Texel 2-4 maart: R.P.M. Bak, J.J. Beukema, F.C. van Duyl, E.C. Flach, G.H. Fransz, B. Hondeveld, H.J. Lindeboom, L. Lohse, E.H. Meesters, R. Osinga, W. van Raaphorst, H.M. Sleiderink, C.P. Slomp, M.L.J. van Veghel.
Intergovernmental WOCE Panel, IOC, Parijs, 3-4 maart: L. Otto.
Symposium Niet-lineare systemen, NWO Den Haag, 4 maart: R. van der Toorn, P. Beerens.
First International Conference on carbon dioxide removal, Amsterdam, 4-6 maart: H.J.W. de Baar, D.C.E. Bakker.
Int. Workshop on Benthic Lander Technology, Milano, 5-6 maart: W. Helder, P.A.W.J. de Wilde.
IOC Technical Committee on Ocean Processes and Climate, Parijs, 5-6 maart: L. Otto.
Jaarvergadering van de ICES Marine Chemistry Working Group (MCWG), Tenerife, 9-14 maart: J.P. Boon.
Workshop Spatfall and Recruitment of Mussels and Cockles, RIVO, Yerseke, 16-17 maart: J.J. Beukema, C.G.N. de Vooys.
Antarctica Symposium, Utrecht, 25-26 maart: G. Nieuwland, J.H. Vosjan.
EPOS workshop, Cambridge, UK, 27-31 maart: R.P.M. Bak, J.H. Vosjan.
Workshop 'Hazards to North Sea seabirds', Glasgow University, 27 maart: M.F. Leopold, C.J. Camphuysen.
Seabird Group Conference 'European Seabirds', Glasgow, 27-29 maart: M.F. Leopold, C.J. Camphuysen.

Dutch Seabird Group/World Wildlife Fund/Seabird Group UK/University of Glasgow: workshop European Beached Bird Surveys, Glasgow University, 30 maart: M.F. Leopold, C.J. Camphuysen.
ICES working group on the statistical aspects of trend monitoring, Halifax, Canada, 31 maart-3 april: J. van der Meer.
WOCE/TOGA Surface Velocity Programme planning committee, Bermuda, 6-8 april: L. Otto.
Background levels of nutrients and metals in the North Sea and adjacent waters, Den Haag, 6-10 april: A.J. van Bennekom.
AOSB, 11th meeting, St. Johns, Canada, 7-10 april: H.M. van Aken.
ICES/IOC meeting Harmful Algal Blooms, Vigo, Spanje, 7-10 april: G.C. Cadée.
ICES Study Group on Ecosystem Effects of Fishing Activities, Kopenhagen, 7-14 april: M.J.N. Bergman.
Workshop Gevolgen van Klimaatsveranderingen, NOP, Bilthoven, 7-8 april: J.J. Beukema, P.J.C. Honkoop.
Meeting of the OCEAN (Ocean Colour European Archiving Network) Project Application Demonstration Programme, JRC CEC, Ispra, Italië, 7-8 april: M. Wernand.
IBN-DLO/IWRB Workshop 'Strategic decisions of individuals', Texel, 9-10 april: T. Piersma, P. Kamermans, P. de Goeij, I. Tulp.
Modelleren en waarnemen in de Aardwetenschappen, 1e Nederlands Aardwetenschappelijk Congres, Veldhoven, 9-10 april: J.H.F. Jansen, E. Ufkes.
International symposium on the measurement of primary prodcution from the molecular to the global scale, ICES-CIEM CNRS-IFREMER, La Rochelle, Frankrijk, 21-24 april: G.W. Kraay.
ICES-WGOH meeting, Thorshavn, Far-Oer, 22-24 april: H.M. van Aken.
NATO Advanced Research Workshop 'Towards a model of ocean biogeochemical processes', Chateau de Bonas, Frankrijk, 3-9 mei: H.G. Fransz.
ICES benthos ecology working group, Bergen Noorwegen: 3-8 mei: G.C.A. Duineveld, R. Witbaard.
NSTF modelling workshop, Den Haag, 6-7 mei: A. van den Berg.
WOCE 10th meeting WHP-PC, Woods Hole, USA, 6-8 mei: H.M. van Aken.
Third meeting JGOFS Indian Ocean Planning Group, Gibraltar-Port Said (RV 'Tyro'), 10-19 mei: M.A. Baars.
Demi-annual ERSEM-workshop, Aberdeen ,13 mei-5 juni: P. Ruardij.
INP workshop, Rijswijk, 14-15 mei: H.J. Lindeboom.
NCF Supercomputerdag, Jaarbeurs Utrecht, 15 mei: P. Beerens.
Meeting, ANT/7, Antarctic expedition, Bremerhaven, 21 mei: J.H. Vosjan.



(Foto: M.H.C. Stoll)

North Sea Task Force meetings on the international North Sea seabirds-at-sea database: 29 maart en 26-27 mei: M.F. Leopold, C.J. Camphuysen, J. van der Meer.
Seminar 90th Anniversary Nanjing University Centre of Geo Marine Sciences, China, mei: D. Eisma.
NATO Advanced Research Workshop 'Use of Biomarkers in Assessing Health and Environmental Impact of Chemical Pollution', Luso, Portugal, 1-5 juni: J.M. Everaarts.
EMINar, European Interdisciplinary Marine Network, NIOZ, Texel, 3-5 juni: L. Lohse, J. de Graaff, C.P. Slomp.
CMOS, Quebec, Canada, 8-12 juni: H. Ridderinkhof.
XXII SCAR, San Carlos de Bariloche, Argentinië, 8-13 juni: C. Veth.
BEON-beleidsdag, Den Haag, 19 juni: W. van Raaphorst, R. Riegman, P. Ruardij, H.J. Lindeboom.
Seventh Int. Coral Reef Symp., Guam, 21-26 juni: R.P.M. Bak, E.H. Meesters, M.L.J van Veghel.
IMPACT (EG-visserij projekt) vergadering, IJmuiden, 29-30 juni: H.J. Lindeboom.
9th International Bryozoology Conference, Swansea, Wales, UK, 25 juli-1 augustus: G.C. Cadée.
4th International Behavioral Ecology Congress, Princeton University, USA, 17-22 augustus: T. Piersma.
2nd Meeting on Gas in Marine Sediments, Hirtshals, Denemarken, 25-28 augustus: Tj.C.E. van Weering.
12th International Diatom Symposium, Renesse, 30 augustus-5 sepember: G.C. Cadée, J. van Iperen.
Wader Study Group Annual Conference and Symposium, Hajdúszoboszló, Hongarije, 5-6 september: T. Piersma, I. Tulp, P. de Goeij, Y. Verkuil, P. Wiersma.
9th International Waterfowl Ecology Symposium, Hajdúszoboszló, Hongarije, 6-11 september: T. Piersma, I. Tulp, P. de Goeij, Y. Verkuil, P. Wiersma.
ISME-6 International Symposium on Microbial Ecology, Barcelona, Spanje, 6-11 september: F.C. van Duyl
EC-Comett Course, Ravenna, 8-11 september: W. Helder, P.A.W.J. de Wilde.
Workshop on Theme Water of national research programme (NOP) on Air Pollution and Climate Change, Bergen, Ndl., 10 september: H.J.W. de Baar, D.C.E. Bakker, A.A.J. Majoor, C.J. Wiebinga.
Third GEM Workshop (Global *Emiliania* Modelling Initiative), Chateau de Blagnac, Cabara, Frankrijk, 13-17 september: P. van der Wal, J. D.L. van Bleijswijk, T. Lukk, R. Kempers, M.J.W. Veldhuis.
Symposium The challenge to Marine Biology in a Changing World, BAH, Helgoland, 13-18 september: J.J. Beukema, G.C. Cadée, M.F. Leopold, L. Lohse, C.J. Camphuysen, J.H. Vosjan, H.J. Lindeboom, J.F.P. Malschaert, C.P. Slomp, F.C. Hansen.
Fourth International Conference on Paleoceanography, ICP IV, Kiel, Germany, 21-25 september: J.H.F. Jansen, Tj.C.E. van Weering, E. Ufkes, J. Beks.
ICES 80th Statutory Meeting, Warnemünde, Duitsland, 23-29 september, H.M. van Aken, J.M, Everaarts, P.A. Walker.
Seawatch seminar, 25 september, Delft:. H.J. Lindeboom.
EROS-2000 Meeting, Plymouth, UK, 27 september-2 oktober: D. Eisma, W. Helder, R.F. Nolting.
Symposium Niet-lineaire en inverse problemen, Raad voor de Aardwetenschappen KNAW, Amsterdam, 2 oktober: J.H.F. Jansen, P. Beerens, H. van Haren, R. van der Toorn, J.T. F. Zimmerman, J. de Munck.
Themadag koppeling van nutriëntencycli in het aquatisch milieu, Nederlandse Vereniging voor Aquatische Ecologie, Amsterdam, 2 oktober: L. Lohse, J.F.P. Malschaert, W. van Raaphorst, C.P. Slomp, J.H. Vosjan.
The Fluorescent Probes for Marine Flow Cytometry, Bigelow Laboratory for Ocean Sciences, USA, 11-15 oktober: M.J.W. Veldhuis.
33e Congres de la Commission Internationale pour l'Eploration Scientifique de la Mer Méditerranée (CIESM), Trieste, Italië, 12-17 oktober: W. Helder, Tj.C.E. van Weering.
ERSEM-calibration workshop, Plymouth, 19-23 oktober: P. Ruardij.
Workshop 'Processes and budgets in geostrophic fronts ('Frontal', France JGOFS), Marseille-Luminy, 20-22 oktober: M.A. Baars.

WOCE 11th meeting WHP-PC, Hamburg, 26-28 oktober: H.M. van Aken.
Vijf Jaar BEWON, Wetenschappelijk Onderzoek ter Onderbouwing van het Beleid, Rijkswaterstaat, Den Haag, 27-28 oktober: H.J. Lindeboom, W. van Raaphorst, R. Riegman, F.C. van Duyl, H.W. van der Veer, J.P. Boon, R. Daan, P. Ruardij, A. van den Berg, M.J.N. Bergman.
Royal Society Meeting 'Understanding the North Sea Ecosystem', Londen, 4-5 november: M.A. Baars, S.S. Oosterhuis.
German-Dutch meeting on sea-level changes, Aurich, Duitsland, 5-6 november: J.J. Beukema.
Oceanisch picoplankton en flow-cytometrie, Coulter Company (NL), 17 november: M.J.W. Veldhuis.
Symposium 'Man and the Barents Sea Ecosystem', Arctic Centre RUG, Groningen, 19-20 november: H.G. Fransz, W.G. Mook.
Symposium Zeespiegel-fluctuaties in heden en verleden, meten en mechanismen. Raad voor de Aardwetenschappen KNAW, Amsterdam, 20 november: R.P.M. Bak, G.C. Cadée, J.H.F. Jansen, W.G. Mook.
Ocean Margin Experiment (OMEX) workshop, Brussel, 26-29 november: W. Helder.
AGU Fall Meeting, San Francisco, USA, 6-11 december: D. Eisma.
Symposium on the Physics of Estuaries and Coastal Seas, Perth, Australië, 6-12 december: J.T.F. Zimmerman.
SPASIBA workshop on research in the Lena delta and Laptev Sea, Parijs, 7-10 december: R.F. Nolting.
Demi-annual workshop, Oldenburg, 7-12 december: P. Ruardij, E. Embsen.
WASP Workshop, Westerland, Sylt, 9-11 december: W. van Raaphorst, J.P.C. Smit.
ESF workshop on the hydrographic and planktologic studies during EPOS II, Trieste, Italië, 14-16 december: H.G. Fransz.
Global Marine Silica Budget, NATO Workshop, Brest, 14-17 december: A.J. van Bennekom.
Symposium Netherlands contribution to the programme Past Global Changes, INQUA/PAGES commissie KNAW, Amsterdam, 15 december: J.H.F. Jansen, W.G. Mook.
DGW Workshop Nutriëntgehaltes in de Noordzee, Rijswijk, 17 december: W. van Raaphorst.
ESF Workshop on Mediterranean Geosciences, Ankara, 18-21 december: Tj.C.E. van Weering.

3.3. HOOGLERAREN NIOZ

H.J.W. de Baar
Universiteit: Rijksuniversiteit Groningen
Leeropdracht: Algemene Oceanologie
Soort aanstelling: deeltijdhoogleraar
Benoemingsdatum: 1/5/1992
Promovendi:

naam	dienstverband
M.H.C. Stoll	NWO/CO2
D.C.E. Bakker	Global Change NOP
A.A.J. Majoor	Global Change VvA-9
J. Schijf	RUU
M.A. van Leeuwe	NIOZ
B.M. Löscher	AWON
J.D.H. van Heemst	Global Change VvA-9
M. le Clercq	Global Change VvA-9
P.M. Saager	VUA
E.T. Buitenhuis	Global Change VvA-9

R.P.M. Bak
Universiteit: Universiteit van Amsterdam
Leeropdracht: Tropische Mariene Biologie
Soort aanstelling: bijzonder hoogleraar in deeltijd
Benoemingsdatum: 1/9/1989
Promovendi:

naam	dienstverband
L. Aerts	WOTRO
H. Boscher	VUA*)
R. van Dam	Universiteit California, San Diego
U. Frank	Israel Oceanogr. & Limnol. Instituut
G. Geertjes	WOTRO
B.J.M. Hondeveld	NIOZ
E.H. Meesters	WOTRO
M. Starink	Limnologisch Instituut (NIOO)
M.L.J. van Veghel	WOTRO

D. Eisma
Universiteit: Rijksuniversiteit Utrecht
Leeropdracht: Mariene Sedimentologie
Soort aanstelling: deeltijdhoogleraar
Benoemingsdatum: 1/1/1991

Promovendi:	naam	dienstverband
	J. Baas	RUU
	J. Beks	NIOZ
	W. ten Brinke	RWS/DGW Middelburg
	S. Chen	NIOZ (ECNU, Shanghai, China)
	W. van Leussen	RWS/DGW Den Haag
	H. Moechtar	RUU (MGI, Bandung, Indonesië)
	A. Oost	RUU
	T. Schuhmacher	Hydronamics, Dordrecht
	O. Szthano	RUU
	A. van der Spek	RGD, Haarlem
	N.H. Verbeek	RUU
	G.J. Weltje	RUU
	H. Zijlstra	RUU

W.G. Mook

Universiteit:	Rijksuniversiteit Groningen
Leeropdracht:	Isotopen-Fysica
Soort aanstelling:	hoogleraar (in deeltijd per 1/4/1990)
Benoemingsdatum:	1/1/1980
Universiteit:	Vrije Universiteit van Amsterdam
Leeropdracht:	Isotopen in de Exogene Aardwetenschappen
Soort aanstelling:	deeltijdhoogleraar
Benoemingsdatum:	1/5/1986

Promovendi:	naam	dienstverband
	M.H.C. Stoll	NIOZ
	H.P.J. de Wilde	NIOZ
	M.R. Kilian	RUG/UvA
	M. le Clercq	RUG
	P. Römkens	RUG/IB

P.A.W.J. de Wilde

Universiteit:	Rijksuniversiteit Groningen
Leeropdracht:	Mariene Zoölogie
Soort aanstelling:	bijzonder hoogleraar in deeltijd
Benoemingsdatum:	1/1/1991

Promovendi:	naam	dienstverband
	E. Flach	NIOZ
	P.J.C. Honkoop	NOP
	L. Lohse	NIOZ
	T. Taheij	EEG/STEP
	R. Witbaard	NIOZ
	Vacature VvA	NOP
	Vacature OMEX	EG/MAST

J.T.F. Zimmerman

Universiteit:	Rijksuniversiteit Utrecht Instituut voor Atmosferisch en Marien Onderzoek
Leeropdracht:	Fysische Oceanografie
Soort aanstelling:	deeltijdhoogleraar
Benoemingsdatum:	1/10/1981

Promovendi:	naam	dienstverband
	P. Beerens	NIOZ/MFO
	T. Gerkema	NIOZ/MFO
	F.P. Lam	NIOZ
	E. Neven	geen dienstverband
	R. van der Toorn	NIOZ/MFO

*) copromotor

3.4. EXTERNE FUNCTIES

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 SOZ gebruikersgroep CTD-systemen
- lid SOZ Gebruikers-Advies-Groep Verankerde Meetsystemen
- lid SOZ ad-hoc-commisiie invoering DARIS
- lid WOCE Hydrographic Programme Planning Committee
- WOCE Hydrographic Programme Data Quality Evaluator

H.J.W. de Baar
- hoogleraar Algemene Oceanografie, Rijksuniversiteit Groningen
- voorzitter Wetenschappelijke Commissie voor Chemische Oceanografie NWO/SOZ
- voorzitter werkgroep voor Joint Global Ocean Flux Study NWO/SOZ
- docent Chemische Oceanografie, Instituut voor Aardwetenschappen, Vrije Universiteit, Amsterdam
- afgevaardigde internationale IGBP/SCOR/JGOFS vergadering
- lid NWO Platform Verstoring van Aardsystemen
- lid MAB/SCOPE/IGBP Commissie (KNAW)
- lid JGOFS Southern Ocean Working Group
- associate editor Marine Chemistry
- convenor symposium Ocean Carbon Cycle, European Union of Geosciences, 1993

M.A. Baars
- coordinator BION-discussiegroep zoöplankton-FRIENDS
- lid Indische Oceaan Commissie (SOZ)
- lid JGOFS Indian Ocean Planning Group

R.P.M. Bak
- bijzonder hoogleraar Tropische Mariene Biologie, Universiteit van Amsterdam
- External Examiner, Dept. Biology, The University, Newcastle, Engeland
- member International Association of Biological Oceanographers (IABO) Coral Reef Committee
- bestuurslid werkgroep Biologisch Aardwetenschappelijk Onderzoek Tropen
- lid redactieraad Marine Ecology Progress Series
- bestuurslid natuurwetenschappelijke studiekring voor het Caraïbisch gebied
- lid JGBP subcommissie LOICZ

A.J. van Bennekom
- vervangend lid Antarctica-commissie SOZ
- lid redactie Circumpolar Journal

M.J.N. Bergman
- lid Study Group on Ecosystem Effects of Fishing Activities ICES

J.J. Beukema
- hoofdredacteur van het Netherlands Journal of Sea Research
- lid bestuur werkgemeenschap Populatiebiologie BION

J.P. Boon
- lid wetenschappelijke commissie voor Chemische Oceanografie NWO/SOZ
- 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
- lid Editorial Board The Science of the Total Environment

K. Booij
- lid begeleidingscommissie onderzoek Mobiliteit microverontreinigingen Universiteit Utrecht

G.C. Cadée
- lid commissie voor buitenlandse marien-biologische stations KNAW
- advisor Neth. J. aq. Ecol.
- associate editor Ichnos
- lid advisory council International Bryozoology Association
- lid redactie Netherlands Journal of Sea Research
- bestuurslid Nederlands Vlaamse Kring van Diatomisten
- lid werkgroep Antarctica IUCN

C.J. Camphuysen
- bestuurslid Nederlandse Ornithologische Unie (NOU)
- voorzitter Nederlands Zeevogelgroep (NZG)
- redactie Sula

R. Daan
- lid werkgroep Monitoring rond Mijnbouwinstallaties

G.C.A. Duineveld
- lid ICES Benthos Ecology Working Group

F.C. van Duyl
- lid protozoën werkgroep
- lid IPCC subgroup
- lid BAOT themagroep
- lid NVAE

D. Eisma
- hoogleraar Mariene Sedimentologie, Rijksuniversiteit Utrecht
- lid wetenschapscommissie Laboratorium voor Sedimentologie en Milieuonderzoek in Meren en Kustwateren, Nanjing, China
- lid working group on marine sediments in relation to pollution ICES
- lid projektgroep slibeigenschappen en coördinatiecommissie slib, Raad van Overleg fysisch oceanografisch onderzoek Noordzee
- lid Steering Committee EROS-2000 Program
- adviserend hoogleraar East China Normal University, Shanghai
- lid Commissie Mariene Aardwetenschappen SOZ
- lid Aquatic and Atmospheric Physical Sciences Research Grants and Training Awards Committee (AAPS RG & TA) NERC

J.M. Everaarts
- lid kontaktgroep ecotoxicologie van de commissie TNO/CNB voor onderzoek inzake nevenwerkingen van bestrijdingsmiddelen
- lid BION werkgemeenschap Biologische Toxicologie
- lid Working Group on biological effects of contaminants ICES
- lid Marine Environmental Quality Committee ICES
- lid Editorial Board of the Bulletin of Environmental Contamination and Toxicology: Aquatic Toxicology - Metals

M. Fonds
- lid Mariculture Committee ICES

H.G. Fransz
- lid commissie mariene biologie SOZ
- lid stuurgroep Joint Global Ocean Flux Study Nederland
- voorzitter werkgemeenschap Aquatische Oecologie BION
- lid commissie Nederlands Arctisch Onderzoeks Programma
- lid GLOBEC werkgroep voor numerieke modellering (NMWG)

S.J. van der Gaast
- editorial board van Applied Clay Science

P. de Goeij
- general secretary van de international Wader Study Group

W. Helder
- lid Commissie Chemische Oceanografie SOZ
- voorzitter Nederlandse Oceanografen Club
- lid Working Group on Marine Chemistry (ICES)
- voorzitter gebruikers adviesgroep auto-analysers (SOZ)
- lid International JGOFS Task Team on Benthic Processes
- lid Advisory Board Netherlands Journal of Sea Research
- lid Ned. SCOR commissie
- lid Sectorcommissie Paleo- en Endogene Processen AWON
- lid Marine Chemistry Committee CIESM

J.H.F. Jansen
- lid Nederlandse Ocean Drilling Project (ODP) Werkgroep

W.C.M. Klein Breteler
- voorzitter/secretaris BION-discussiegroep Zoöplankton-FRIENDS
- vertegenwoordiger GLOBEC voor Nederland

A.J. Kop
- lid van de Nederlandse Vereniging voor Stralingshygiëne

G.W. Kraay
- lid flow-cytometer werkgroep

M. Leopold
- bestuurslid Nederlandse Zeevogelgroep

H.J. Lindeboom
- lid Commissie voor Milieueffectrapportage
- lid stuurgroep SEDEX
- lid coördinatiegroep ecologie Noordzee en Waddenzee
- lid commissie mariene biologie SOZ
- gecommitteerde Hogeschool 'Noorderhaaks' studierichting milieu
- lid MER-werkgroep nieuwbouw Aldel-Delfzijl
- lid MER-werkgroep gaspijpleiding door de Waddenzee
- lid redactie NSTF 'sub-regional assessments'
- voorzitter BEON werkgroep effecten van visserij op vogels en zeezoogdieren
- lid ICES study group on Ecosystem Effects of Fishing Activities

J. van der Meer
- lid Working Group on the statistical aspects of trend monitoring (ICES)

W.G. Mook
- hoogleraar Isotopen-Fysica, Rijksuniversiteit Groningen
- hoogleraar Toepassingen van Isotopen in de Exogene Aardwetenschappen, Vrije Universiteit, Amsterdam
- lid Koninklijke Nederlandse Academie van Wetenschappen
- lid Academia Europaea
- lid Sectie Aardwetenschappen (KNAW)
- lid Academie Raad voor de Aardwetenschappen (KNAW)
- lid klimaatcommissie/nationale WCRP-commissie (KNAW)
- lid INQUA-commissie/nationale PAGES-commissie (KNAW)
- lid IGBP/MAB/SCOPE commissie (KNAW)
- voorzitter/nominated member SCOR Nederland (KNAW)
- lid bestuur Stichting Onderzoek der Zee (NWO)
- lid commissie Watersysteem Verkenningen
- lid Raad van Overleg van het fysische oceanografisch onderzoek van de Noordzee
- voorzitter Curatorium van het Centrum voor Isotopen Geologisch Onderzoek, Vrije Universiteit Amsterdam

- lid PACT-commissie Raad van Europa
- lid Scientific Steering Committee IGBP core project PAGES
- Associate Editor Radiocarbon

M. Mulder
- lid werkgroep Monitoring rond Mijnbouwinstallaties

J.C. de Munck
- lid radarhoogtemeterteam

R.F. Nolting
- lid EC commission on the certification of sea- and estuarine water for trace metals
- lid gebruikersgroep CTD-systemen van SOZ

S. Ober
- voorzitter SOZ Gebruikers-Advies-Groep CTD-systemen

L. Otto
- lid Hydrography Committee ICES
- lid European Science Foundation Committee for WOCE
- lid Commissie voor Fysische Oceanografie SOZ
- lid Programmaraad NWO Werkgemeenschap MFO
- lid IOC Technical committee on ocean processes and climate
- lid Nederlandse SCOR Commissie
- voorzitter Nederlandse WOCE werkgroep
- voorzitter IOC/WMO Intergovernmental WOCE Panel
- co-ordinator Subthema 'Water' NOP
- lid Comité scientifique d'Oceanologica Acta

T. Piersma
- vice-chairman of the international Wader Study Group
- lid Grebe Specialist Group of the International Waterfowl and Wetland Research Bureau and the International Council for Bird Preservation (ICBP, Cambridge)
- lid British trust for Ornithology - Estuaries Unit Consultative Committee, Thetford, England
- lid Adviesraad voor het Ringwerk, Nederlandse Ringcentrale, Instituut voor Oecologisch Onderzoek, Heteren

W. van Raaphorst
- lid begeleidingscommissie Vastlegging van fosfaat in sedimenten (DBW/RIZA, Lelystad)
- lid organisatie 3rd International Workshop on Phosphorus in Sediments, 1991 en lid redactie workshop proceedings
- lid begeleidingscommissie Denitrificatie-onderzoek in de Randmeren (DBW/RIZA, Lelystad)
- lid bestuur Nederlandse Vereniging voor Aquatische Ecologie

R. Riegman
- secretaris BION WGM Aquatische Oecologie

M.J. Rietveld
- lid Directeuren Overleg Beleidsgericht Ecologisch Onderzoek Noordzee/Waddenzee (BEON)

D.H. Spaargaren
- secretaris commissie voor buitenlandse marien-biologische stations KNAW
- lid Council of European Working Group on Chemical Evolution, Early Biological Evolution and Exobiology, Strassbourg
- lid Groupement pour l'Avancement de la Biochemie Marine, Gif sur Yvette, Frankrijk
- lid Society for Experimental Biology, London

C. Swennen
- lid Stork specialist Group, ICBP
- lid jury Heimans & Thysse prijs
- lid Nederlandse sektie International Council of Bird Preservation (ICBP)

H.W. van der Veer
- lid Organizing Committee Second International Symposium on Flatfish Ecology, Texel 1993
- lid Organizing Committee 6th International Conference of Coelenterate Biology, Noord wijk, 1993

- lid Working Group on Larval Fish Ecology ICES
- lid redactie Hydrobiological Bulletin
- adjunct associate professor Zoology Department, North Carolina State University, Raleigh U.S.A.
- adjunct associate professor of Marine Science, University of South Carolina, Columbia U.S.A.

M.J.W. Veldhuis
- lid stuurgroep Joint Global Ocean Flux Study Nederland
- lid Flow Cytometrie Werkgroep Nederland
- Voortrekker Verstoring van Aardsystemen project no. 9: Koolstofbalans in de oceanische menglaag lucht-zee uitwisseling VvA 9
- projectleider NOP project *Emiliania huxleyi* (NIOZ)

C. Veth
- lid Raad van Overleg voor het fysisch oceanografisch onderzoek van de Noordzee
- lid programmaraad van de werkgemeenschap MFO-NWO
- lid gebruikersgroep van laser-doppler snelheidsmeettechniek
- lid Commissie voor Fysische Oceanografie SOZ
- lid overleggroep waterstanden en getijden van de Raad van Overleg voor het fysisch oceanografisch onderzoek van de Noordzee
- lid EPOS management group van de ESF
- lid European Science Foundation's WOCE Committee's group of experts on calibrations
- lid Southern Ocean Planning Group for JGOFS
- voorzitter gebruikersgroep CTD-systemen SOZ
- lid Commissie Antarctisch Onderzoek

J.H. Vosjan
- lector Mariene Bacteriologie, Vrije Universiteit Brussel, België
- werkgroepleider Bion werkgemeenschap Algemene Microbiologie
- lid commissie 'Risico's UV straling' van de Gezondheidsraad
- lid organisatie komitee: Interuniversitaire derde cyclus Mariene Ecologie, Instituut voor Zeewetenschappelijk Onderzoek, Oostende, België

T.C.E. van Weering
- lid beheersgroep OPI van SOZ
- lid Indische Oceaan Commissie van SOZ voor planning programma 1991/1992
- gastdocent tweede fase onderwijs Mariene Aardwetenschappen, Vrije Universiteit, Amsterdam
- lid Commissie Mariene Aardwetenschappen SOZ

M.R. Wernand
- lid ORWA (Optische Remote Sensing Water)
- lid Optics task Team JGOFS
- member of the scientific panel on the evaluation of proposals for the NASA NRA Sea Wifs Programme

P.A.W.J. de Wilde
- bijzonder hoogleraar Mariene Zoölogie, Rijksuniversiteit Groningen
- lid Programma Commissie Open Universiteit, Heerlen
- lid Nederlandse commissie voor internationale natuurbescherming
- lid stuurgroep SEDEX/EUTEX
- lid Benthos Ecology Working Group, ICES
- lid Biological Oceanography Committee, ICES
- lid bestuur onderzoekschool Functionele Oecologie

J.T.F. Zimmerman
- hoogleraar Fysische Oceanografie, Rijksuniversiteit Utrecht
- lid redactie Netherlands Journal of Sea Research
- lid redaktieraad Continental Shelf Research
- IAPSO vertegenwoordiger nationaal UGGI comité (ARA-KNAW)
- lid van de subcommissie mariene geodesie van de RCG
- lid Commissie voor Milieueffectrapportage
- lid Nederlandse Commissie van Geodesie (ARA-KNAW)
- lid themacommissie 'Kustonderzoek' van BOA-NWO
- lid van de New York Academy of Sciences

3.5. STUDENTENONDERZOEK

Balen, A.L.H. van	Agrar. Hogeschool Larenstein	B1-02
Baltus, C.	VU Amsterdam	B3-04
Berg, J. van den	Hogeschool Amsterdam	B3-09
Berg, C. van den	Bakhuis Roozeboom Inst., Beverwijk	H1-14
Bolweg, A.-E.	TU Delft	H2-05
Boots, G.	Bakhuis Roozeboom Inst., Beverwijk	B3-08b
Borsje, F.	Van Hall Inst., Groningen	B3-08c
Bruinzeel, L.	RU Groningen	B3-08b
Cleary, D.	VU Amsterdam	B1-05
Dalen, M. van	Hogeschool Alkmaar	H1-15
Das, J. den	Hogeschool Alkmaar	H1-15
Dekinga, A.	RU Groningen	B3-08b
Eleveld, A.	Bakhuis Roozeboom Inst., Beverwijk	B3-08b
Flameling, I.	RU Groningen	B1-05
Gast, G.J.	Univ. Amsterdam	B1-05, BEWON
Gils, J. van	RU Groningen	B3-08b
Haas, W. de	RU Utrecht	H3-02
Hamer, R.R.A.J.	Hogeschool Enschede	S-01a
Harding, R.	Bakhuis Roozeboom Inst., Beverwijk	B3-08b
Jansen, S.A.W.	Hogeschool IJsselland, Deventer	H1-07
Karels, A.	LU Wageningen	B3-05a
Keizer, A. de	Van Hall Inst., Groningen	H1-14
Koolhaas, A.	RU Groningen	B3-08b
Kwast, D.	Bakhuis Roozeboom Inst., Beverwijk	H1-09
Lam, F.-P.	RU Utrecht	H2-14
Langeberg, V.	Univ. Amsterdam	B1-05
Langendijk, P.	RU Groningen	H1-02
Leeuwen, A. van	RU Groningen	S-02c
Majoor, A.A.J.	RU Groningen	H1-16
Mars, A.E.	RU Groningen	H1-02
McCollin, T.	Polytechnics, Hatfield, U.K.	BEWON
Mets, A.	Bakhuis Roozeboom Inst., Beverwijk	B1-06
Mom, B.	RU Groningen	B3-05a
Mosch, T.	Noorderhaaks College Den Helder	BEWON
Noordeloos, M.	Univ. Amsterdam	B1-05
Pauchli, W.	RU Utrecht	B1-05
Ramkema, A.	Hogeschool Alkmaar	H1-15
Schie, A. van	RU Groningen	B3-02

Scholtens, E.	RU Groningen	H1-08, B1-05
Simon, C.	Van Hall Inst., Groningen	BEWON
Staal, M.J.	RU Groningen	H1-02
Steenbergen, H. van	RU Leiden	S-01d
Supit, S.	RU Utrecht	H3
Surkum, J. van	TU Enschede	S-01e
Verkuil, Y.	RU Utrecht	B3-08b
Visser, S.	Bakhuis Roozeboom Inst., Beverwijk	B3-08b
Vrauwdeunt, I.C.	Reynevelt College, Delft	H1-07
Vries, K. de	RU Groningen	S-01a,c,e
Vriezen, C.	Int. Agrar. Hogeschool Larenstein	S-01c
Weber, T.	RU Groningen/Univ. of Oxford	B3-08b
Werges, J.	Hogeschool Midden Nederland	S-01a
Wesseling, J.	LU Wageningen	B1-05
Wiebinga, C.J.	Univ. Amsterdam	B2-08
Wopereis, K.J.	Int. Agrar. Hogeschool Larenstein	S-01c
Worst, D.	VU Amsterdam	B1-05
Zillen, P.	Hogeschool Alkmaar	H1-06b

3.6. CURSUSSEN, VERGADERINGEN EN EXCURSIES

3.6.1. NIOZ cursussen

De cursus Inleiding in de Oceanologie werd gegeven van 10 februari tot 6 maart. Er waren 32 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 10 tot 14 februari gegeven werd en het praktisch gedeelte van 17 tot 28 februari plaats vond op het NIOZ. 55 medewerkers waren min of meer bij deze cursus betrokken. Zes vaardagen werden met het onderzoekschip Navicula uitgevoerd.

Van 15 tot en met 26 juni volgden ruim 30 studenten het praktisch gedeelte van de NIOZ cursus Mariene Oecosystemen 1992. Door afwezigheid van vele leden van de biologische werkgroepen en hun apparatuur i.v.m. meerdere oceaanexpedities moest van het gebruikelijke cursusprogramma worden afgezien. Inplaats daarvan werd in het NIOZ aquariumgebouw onder het motto 'vele handen maken het werk licht' een groot mesocosm planktonbloei-experiment uitgevoerd waarbij alle cursisten afwisselend een veelheid aan tellingen en metingen verrichtten. Centraal stonden de ontwikkelingen in de algen- en heterotrofen-community bij overschakelen van de oligotrofe naar eutrofe situatie. Gedurende de bloei werd b.v. continu microzooplankton grazing gemeten met de verdunningsmethode en werden verschillende aspecten van sedimentatie bestudeerd. Ter afwisseling werden met ploegen cursisten vaartochten gehouden met de Navicula om m.b.v kwantitatieve bemonsteringsmethoden te demonstreren hoe het natuurlijke oecosysteem er na afloop van de voorjaarsbloeien uitziet. De ongebruikelijke opzet van de cursus —die grotendeels gebaseerd was op eigen verantwoordelijkheid der studenten en vooral het inschakelen van allen in een echt en zeer intensief stuk onderzoek— ontmoette bij de deelnemers zoveel enthousiasme dat we besloten hebben in 1993 een zelfde opzet te volgen.

3.6.2. Andere cursussen gehouden op het NIOZ

2- 4 maart	Verwey-dagen 1992; landelijke AIO-bijeenkomst mariene biologie
11-18 april	cursus geologen VU
1- 7 juni	EMINAR-workshop
8- 9 oktober	Ned. Ver. v. Theoretische Biologie
24-27 november	BEON-workshop

3.6.3. Ontvangen gezelschappen van instituten, opleidingen, overheidsinstellingen, e.d.

24 januari	deelnemers Internationale Cursus Visserijdeskundigen - Wageningen
5 februari	studenten werktuigbouwkunde HTS
10 februari	studenten Middelbare Agrarische School
2 maart	studenten Universiteit van Braunschweig
5 maart	Biologen Vereniging Amsterdam
1 april	dierenartsen Kop van Noord-Holland
3 april	studenten HEAO - Den Helder
15 april	studenten Marnix College - Alkmaar
21 april	studenten Van Hall Instituut - Groningen
13 mei	studenten Laboratoriumschool - Oss
20 mei	medewerkers Nederlands Kanker Instituut
11 juni	medewerkers Staatstoezicht op de Mijnen
16 juni	studenten Lerarenopleiding - Utrecht
24 juni	leerkrachten Jozefschool - Den Burg
30 juni	leraren Zeevaartschool - Den Helder + bezoeker uit Egypte
7 juli	leraren Alcwaard College - Alkmaar
21 september	leden Vereniging van Plattelandsvrouwen + bezoek uit Tsjechoslowakije
23 september	officieren Landmacht
13 oktober	studenten Forelman College - Heerhugowaard
15 oktober	studenten Pabo - Sittard
20 oktober	visserijbiologen - Canada
23 oktober	medewerkers Afdeling Mijnbouw en Petroleumwinning - TU Delft
28 november	leden Werkgroep Noordzee
17 december	medewerkers Bezoekerscentrum 'De Oude Centrale' Schiermonnikoog

4.1. TECHNISCHE HULPAFDELINGEN

Algemeen

De explosieve groei van het instituut en de ingebruikname van de 'Pelagia' met de daarmee gepaard gaande groeiende vraag naar technische, operationele en logistieke ondersteuning noodzaakten ertoe dit jaar een herschikkingsplan te ontwikkelen met de bedoeling de structuur van de Technische Dienst beter te laten aansluiten op de in gang zijnde ontwikkelingen. Door scheiding en/of samenvoeging van historisch gegroeide technische afdelingen worden een vijftal evenwichtige en duidelijke diensten gecreëerd, waardoor naar verwachting nog slagvaardiger kan worden geopereerd. De herschikking is per 1 januari 1993 ingegaan.

Ter versterking van de technische ondersteuning op de 'Tyro' tijdens het NIOP programma zijn een drietal contractmedewerkers aangenomen.

Bij de Dienst Electronica werd een vacature vervuld; de nieuwe medewerker is gespecialiseerd in het 'grijze' overgangsgebied tussen hard- en software. Tevens werd de dienst versterkt met een medewerker die primair voor de 'Pelagia' als electronicus/systeembeheerder assistentie aan boord kan verlenen en die daarnaast allerlei electronica voor gebruik op vaartuigen ontwikkelt. Op de 'Pelagia' werd een vacature in de machinekamer opnieuw bezet. Als gevolg van langdurige ziekte van een tweetal bemanningsleden zijn die functies tijdelijk vervuld door contractmedewerkers. In het structureel tekort aan bemanningsleden wordt eveneens voorzien door een tweetal contractmedewerkers.

Het hoofd van de Dienst Houtbewerking ging in deeltijdvut. De schipper van de 'Navicula' werd ontslag verleend.

Ontwikkelingen en activiteiten van de diensten

Naast de normale en periodieke onderhoudsactiviteiten aan installaties, laboratoriumopstellingen en apparatuur werden dit jaar ondermeer in eigen beheer ontwikkeld, gebouwd, geïnstalleerd en/of uitgevoerd:

- De overgang van Neil Brown CTD naar Sea Bird met bijbehorende software, voor de SOZ.
- De overgang van het BOLT airgunsysteem naar Halliburton sleeve guns, voor de SOZ.
- De CAD - CAM koppeling, voor de besturing van de CNC-freesbank.

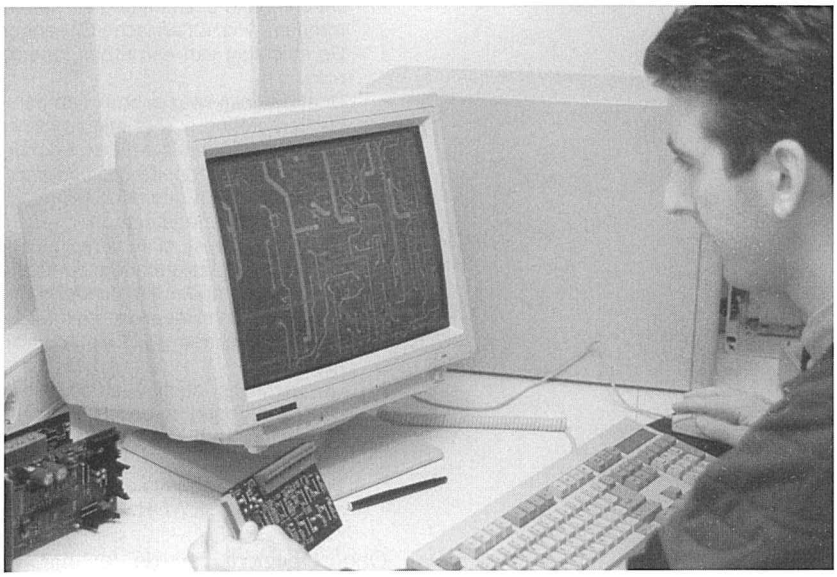
- Een verbeterde versie van de *in situ* plankton-analyzer waarvoor tevens een nieuwe onderwaterbehuizing werd geproduceerd, voor Pelagische Systemen.
- Een XRF corescanner, voor Mariene Geologie.
- Een container betimmerd en ingericht, voor de XRF corescanner.
- Besturingen voor drie coulometers, voor Chemische Oceanografie.
- Een zestal geheel computerbestuurde meervoudige zuurstof-/pH-monitoren, voor Benthische Systemen en BEWON.
- De kleppen en besturingen voor twee CO_2 analyzers, voor het AWI te Bremerhaven.
- Een werkend proefmodel van een speciale mesocosm waarvan er nog een drietal zullen worden gebouwd, voor Pelagische Systemen.
- Drie titratiecellen, waarvan twee voor Chemische Oceanografie en een voor een onderzoeker in Bangladesh.
- Een gecontaineriseerd laboratorium incl. betimmeringen en inrichting, voor de SOZ ten behoeve van het landstation in Kenia - NIOP programma.
- Een gecontaineriseerd nat laboratorium incl. betimmeringen en inrichting, voor de 'Navicula'.
- Drie verbeterde CTD - rosettesampler-frames, waarvan twee voor de SOZ en een voor de 'Pelagia'.
- De complete betimmering en herinrichting van een gecontaineriseerd schoon laboratorium, voor Chemische Oceanografie.
- De inrichting van een droog laboratorium in het aquariumgebouw, voor Kustsystemen.
- Drie tow links voor gebruik aan boord van de 'Pelagia' en de 'Tyro'.
- De verbetering en het testen van een aantal bodemlanders op het RV 'Ravello' in maart in de Adriatische Zee, voorafgaand aan het NIOP programma.
- Een drietal z.g. epi-bentos bodemschrapers, voor BEWON.
- Een hydraulisch gedreven lier t.b.v. het op- en afspoelen van draden op andere lieren, voor algemeen gebruik.
- Een pistoncorestoel en corepijpsteunen op de 'Pelagia'.
- Een nieuwe planktonpomp op de 'Pelagia'.
- Nieuwe uitlaatdempers en leidingen op de 'Navicula'.
- Een seismisch sleeplichaam naar Deens ontwerp, voor Mariene Geologie.
- Een sleeplichaam voor de acoustic Doppler currentprofiler, voor Fysische Oceanografie.
- De verlichting, de mist- en de geleidelichten op de haven.
- Drie klimtrappen en enkele stootbuffers voor de havenkade.
- Een begin werd gemaakt met de bouw van 'turbo flitsers' voor de diepzeecamera van Mariene Geologie.
- Een begin werd gemaakt met de bouw van een visverwerkingscontainer voor Kustsystemen en BEWON.

Onder toezicht van de technische diensten werd ondermeer door derden gebouwd, ingericht en of uitgevoerd:

- Een gecontaineriseerd schoon laboratorium voor Chemische Oceanografie.
- Een gecontaineriseerd nat laboratorium voor de SOZ.
- De overhaul van de seismiekcompressoren.
- Een nieuw frame voor de verloren gegane CTD-rosettesampler.
- Een nieuw asfaltdek op de 'Navicula'.
- Het stralen en schilderen van het bovenwatercasco van de 'Navicula'.
- Het vernieuwen van een motorblok op de 'Navicula'.
- Het installeren van een DGPS plaatsbepalingsysteem op de 'Pelagia'.
- Een tekenkamer bij de Dienst Electronica voor gecomputeriseerd ontwerpen en schema/print tekenen, mede in verband met de ingebruikname van CAD-CAM software.
- Schilderwerk aan de buitenzijde van de paviljoens A t/m E.
- Twee meer- en spudpalen in de haven.
- Extra golfslagbeschermers aan de steiger.

- Extra taludbescherming van de haven.
- Een energieonderzoek door het NOVEM en de PEN voor het besparen van energie d.m.v. een warmtekrachtcentrale (voorlopig niet rendabel) en het toepassen van hoogfrequente en zuiniger TL verlichting (nog in onderzoek).
- Het vernieuwen van de draaikrans van de windgeneratormolen.
- Een onderzoek/inventarisatie door een expertisebureau naar de in- en uitwendige gebreken aan de NIOZ-gebouwen resulterend in een rapport met bevindingen, fotomateriaal, aanbevelingen en een kostenraming.

Veel voorbereidend werk werd verricht aan de voorgenomen bouw en inrichting van een semi-permanent laboratorium met kantoren ten behoeve van de Delftse TU groep Geochemie die zich in 1993 op het NIOZ zal vestigen. Voorbereidend werk werd verricht voor de bouw van een opslagloods op het haventerrein. Hangende een art. 19 procedure werd de bouw hiervan gegund vooropgesteld dat een bouwvergunning wordt verleend.



Een medewerker van de Dienst Electronica aan het werk in de nieuwe tekenkamer.

Oceaanprogramma

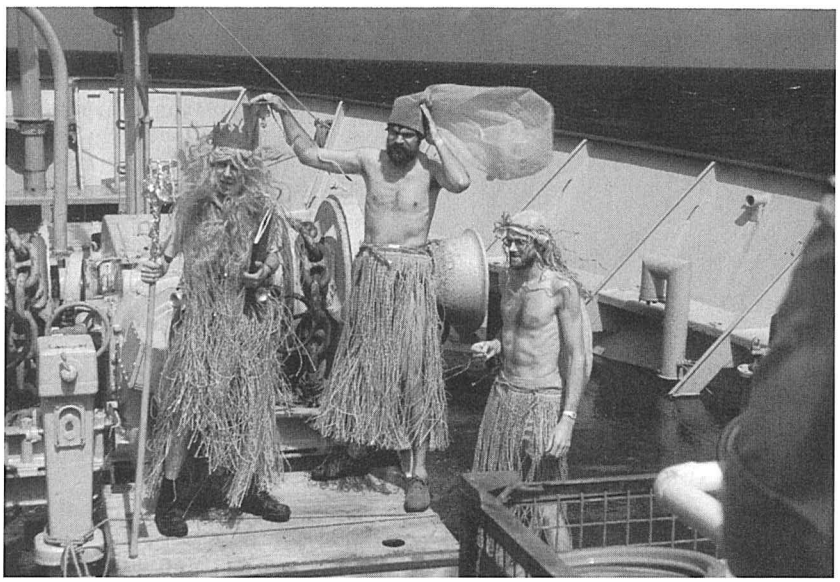
De voorbereiding voor het NIOP programma kwam in januari pas goed op gang nadat de 'Tyro' en de technici teruggekeerd waren van expedities in de Middellandse Zee. De gehele Technische Dienst heeft alles op alles moeten zetten om alles op tijd gereed en aangeleverd te krijgen. Naast de gebruikelijke onderhoudswerkzaamheden aan powerpacks, lieren en apparatuur zijn op de 'Tyro' een aantal aanpassingen tot stand gekomen die de werkbaarheid op zee verbeteren. Midscheeps over stuurboord werd een 1 tons knikboomkraan vervangen door een 2 tons kraan, de 1 tons kraan werd verder naar achter geplaatst als hulpkraan voor de pistoncore. De pistoncorestoel werd eveneens verplaatst, zodat de corepijp nu naar het achterschip wijst en geen obstakel meer vormt voor beide diepzeelieren. Het A-frame van de kevlarlier werd een

halve meter verlengd, tevens werden langere en zwaarder uitgevoerde uitzetcilinders gemonteerd e.e.a. wegens het volumineuzer worden van de uit te zetten apparatuur. Een bordes werd gemaakt om containers die voor de brug op elkaar gestapeld staan, tijdens het werk te kunnen bereiken. Een nieuwe planktonpomp met een ontluchtingsvat werd in het voorschip geïnstalleerd. Er werden twee werkbootplaatsen aan dek gecreëerd. Op de tussendekken werden een tiental extra koel/vrieskasten voor monsteropslag geïnstalleerd evenals een geprefabriceerd kantoor en een 'nieuwe' tweedehands draaibank.

In totaal werden 26 laboratorium- en hulpcontainers en 300 ton materiaal op de 'Tyro' geladen.

Op 28 april werd een instrumenten-testvaart gemaakt en op 4 mei voer het schip onder grote belangstelling de NIOZ-haven uit, richting Middellandse Zee, waar op weg naar de Indische Oceaan een ingelast programma werd uitgevoerd voor de Universiteit van Utrecht.

Op 26 mei tijdens het eerste deel van het NIOP-programma kwam het bericht dat men in de Rode Zee op 2100 meter diepte een CTD met rosettesampler had verloren. Aan boord was echter voldoende materiaal aanwezig om een tweede exemplaar op te bouwen. Het gaf wel aanleiding om zo snel mogelijk een vervangend exemplaar te fabriceren dat met vereende krachten van derden en de nog op het NIOZ aanwezige technici, op 11 augustus in Djibouti aan boord kon worden afgeleverd. Wegens elektrische energieproblemen op de 'Tyro' werd de energiecontainer naar Djibouti verzonden en aan boord opgesteld. Op 19 september draaiden een koppeling en een hydropomp van de kevlarlier stuk waarbij een pistoncore werd verspeeld. Een nieuwe koppeling en een toevallig direct te verkrijgen tweedehands pomp konden nog op tijd naar Karachi worden verzonden en met de nodige improvisatie (de pomp bleek net iets anders dan het origineel) worden gemonteerd, waarna de lier weer naar behoren draaide.



Koning Neptunus en twee van zijn beeldschone nimfen bezoeken RV 'Tyro' tijdens het passeren van de evenaar.
(Foto: T. de Bruin).

Tijdens de gehele expeditie die uit 13 programmadelen bestaat en die tot eind maart 1993 duurt, zullen een tiental technici bij toerbeurt aan boord ondersteuning verlenen aan de verschillende expeditieleiders en hun wetenschappelijke teams.

Het Antarctica-programma met de 'Polarstern' vroeg aan boord geen assistentie van de technische diensten, wel zijn er diverse apparaten, modificaties en uitbreidingen verwezenlijkt. Tevens is veel logistieke steun aan diverse projecten verleend, containers en materiaal werden op transport gesteld naar o.m. Punta Arenas, Kaapstad, Verona, Marseille en Djibouti.

Haven en Vaartuigen

Dit jaar werden op de haven de kadeverlichting en tevens de geleide- en mistlichten geïnstalleerd. Aan de kade werden enkele stootbuffers en een drietal klimtrappen gemonteerd. Voor het afmeren van de schepen werden twee stalen palen geheid en twee spudpalen voor de houten vlonders waar de kleine schepen afmeren. Ter voorkoming van taludschade door golfwerking bij hoogwater werd het gras vervangen door grasklinkers. Aan de houten steiger werden langere golfslagbrekers gemonteerd ter bescherming van de kleine schepen bij harde oostenwind; het resultaat is echter pover zodat naar een betere oplossing zal worden gezocht.

De 'Pelagia' werd in mei gedokt voor garantie waarbij de kimkielen aan voorschipzijde wat minder stomp zijn gemaakt waardoor hinderlijk optredend gedreun op de brug drastisch werd gereduceerd zonder dat de slingereigenschappen noemenswaard werden aangetast. Tevens werd een wegneembare waterkering gemaakt t.b.v. het natte laboratorium op het hoofddek.

Voor de Rijks Geologische Dienst werd een expeditie van zes weken naar de Søndre strømfjord in Groenland gevaren. Hiervoor werden de nodige voorzieningen getroffen zoals het maken en aanbrengen van pistoncore-voorzieningen en het wijzigen van de achterlier t.b.v. de z.g. trilflip vibrocore van de RGD.

Aan de wens van het NIOZ om nauwkeuriger de positie van het schip te kunnen bepalen werd tegemoet gekomen door in oktober een DGPS plaatsbepalingssysteem aan boord te installeren.

In mei werden middels een open dag de 'Pelagia' en het NIOZ gepresenteerd aan de Universiteit van Bergen in Noorwegen ter gelegenheid van het 100-jarig bestaan van de universiteit en in september aan het Biologisch Instituut te Helgoland ter gelegenheid van het 100-jarig bestaan van het instituut aldaar. Het schip trok zeer veel publieke belangstelling.

Al met al werd een druk en gevarieerd vaarprogramma afgewerkt. In totaal stapten 308 onderzoekers aan boord en werd 230 dagen gevaren.

De 'Navicula' onderging een grote onderhoudsbeurt. Het bovenwaterschip werd gegritstraald en geschilderd. Het asfaltdek werd vernieuwd. De stuurboordmotor kreeg een nieuw shortblok. Van alle motoren werden de uitlaatdempers en de uitlaatleidingen vernieuwd. Ten behoeve van een EG programma voor vogelonderzoek maakte men een respectievelijk vijf en drie weken durende tocht langs de kust naar Denemarken. In totaal stapten 750 onderzoekers aan boord en werd 155 dagen gevaren.

De 'Griend' voer 114 dagen en zag 352 onderzoekers aan boord stappen. Ten gevolge van het goede weer kon er dit jaar vaker op de kust worden gewerkt.

De fuikvisserij werd voor het 33ste achtereenvolgende jaar bedreven. Vanaf 1 april werd dagelijks de vangst verzameld, gedetermineerd en gemeten. Levende vissen werden verzameld voor laboratoriumonderzoek en voor de

afdeling studiemateriaal te Den Helder. De vangsten lagen onder het gemiddelde van vorige jaren en veel hinder werd ondervonden van grote aantallen kwallen. Vermoedelijk werd e.e.a. veroorzaakt door de hoge zeewatertemperatuur.

Magazijn en transport
De voorbereiding van het NIOP programma bezorgde het magazijn en de magazijnadministratie veel hoofdbrekens en geregel om aan de verlangens van de in de startblokken staande onderzoekers tegemoet te komen. Daarnaast werden dit jaar nog zo'n 200 goederenzendingen van uiteenlopende aard gereed gemaakt voor verzending naar vele landen en werden 2340 zendingen in ontvangst genomen voor distributie over de afdelingen. De vrachtwagen legde 60000 km af t.b.v. het magazijn.

4.2. ADMINISTRATIE

De administratie is per 1 april j.l. aangesloten op het elektronisch betalingssysteem van de Credit Lyonnais. Hierdoor kunnen de fakturen veel sneller verwerkt en betaald worden. Door de groei van het aantal projekten nemen de administratieve werkzaamheden nog steeds toe.
Per 1 december is mevr. C. Gerritsen uit dienst getreden. Zij heeft administratieve werkzaamheden verricht t.b.v. het inventarisbeheer. Deze aanstelling is betaald uit de post 'decentrale werkgelegenheidsgelden'.

4.3. WETENSCHAPPELIJKE HULPAFDELINGEN

Centrum voor Informatieverwerking en Automatisering (CIA)
Begin 1992 is het ethernet-netwerk dat draait onder UNIX opgeleverd. Dit bracht met zich mee dat in 1992 veel tijd werd besteed aan het optimaliseren hiervan. Bijna elke afdeling heeft op dit moment één of meerdere PC's aan het net gekoppeld. In de loop van het jaar werd duidelijk dat de gekozen configuratie aan de eisen voldoet. Eind 1992 werd een cursus georganiseerd, die de gebruikers in staat stelt goed geïnstrueerd over te gaan op dit nieuwe systeem. Het dataloggingsysteem ABC van de 'Pelagia' heeft in 1992 ook de aandacht gevraagd. Door het drukke vaarprogramma van de 'Pelagia' is hier enige achterstand opgelopen. Deze achterstand zal ingehaald worden in het eerste kwartaal van 1993.

Er is een goede oplossing gevonden om alle aanwezige Macintosh computers op het netwerk aan te sluiten. Vanwege de hoge werkdruk is hieraan nog maar ten dele uitvoering gegeven.

Technische Commissie/Gebruikerscommissie
In plaats van de bestaande Computercommissie zijn in 1992 een Gebruikerscommissie en een Technische Commissie ingesteld.

De Gebruikerscommissie behandelt vragen en problemen vanuit de afdelingen betreffende hard- en software. Ook adviseert de commissie de directie op het punt van het automatiseringsbeleid binnen het instituut. De Gebruikerscommissie bestaat uit:

J. van der Meer	voorzitter
R. Dapper	CIA
G.M. Manshanden	CIA

L.R.M. Maas	Fysische Oceanografie
K. Booij	Chemische Oceanografie
J.H.F. Jansen	Geologie
J.J. Beukema	Kustsystemen
H.J. Witte	Pelagische Systemen
G.C. Duineveld	Benthische Systemen
H. Malschaert	BEWON

P. Ruardij neemt als voorzitter van de Technische Commissie deel aan de vergaderingen. Agendaleden van de Gebruikerscommissie zijn:

N. Barten-Krijgsman	Redactie
R.P.D. Aggenbach	Reprografische Afdeling
S.H. Hashemi Saleh	Bibliotheek
I. Wernand-Godee	Administratie

Electronica en de gezamenlijke werkplaatsen hebben nog geen vertegenwoordiging.

C. Blaauboer-de Jong is behalve agendalid namens het secretariaat en secretaresse van de Gebruikerscommissie ook redactielid van het periodiek 'Octopus'. H. Malschaert en G. Manshanden completeren de redactie. Het periodiek is in 1992 één maal verschenen ter gelegenheid van de officiële opening van het NIOZ-netwerk door M.J. Rietveld op 25 september.

De Gebruikerscommissie komt iedere twee maanden bijeen en heeft in 1992 drie maal vergaderd.

Om tot een betere uitwisseling te komen van de op de diverse afdelingen aanwezige technische kennis op automatiseringsgebied is de Technische Commissie opgericht. Deze commissie bespreekt onder meer automatiseringsproblemen en -knelpunten en de specificaties van aan te schaffen computerapparatuur en brengt vervolgens advies uit aan de directie. De commissie bestaat uit:

P. Ruardij	voorzitter
R. Dapper	CIA
F. Eijgenraam	CIA
G.M. Manshanden	CIA
E. Embsen	BEWON
B. Koster	Elektronica
R.X. de Koster	Fysische Oeanografie

J. van der Meer neemt als voorzitter van de Gebruikerscommissie deel aan de vergaderingen, C. Blaauboer-de Jong notuleert.

De Technische Commissie is in 1992 negen maal in vergadering bijeen geweest.

Bibliotheek

Er werden 82 boeken aangeschaft en 2 atlassen. Het tijdschriftenbestand is uitgebreid met de volgende tijdschriften:

- Reviews in Aquatic Sciences vol 5(1) 1991 -
- Globec News 1991 (1) -
- Technical Report (Globec) 1991 (4) -
- Isva Progress Report
- Technical University Denmark Lyngby 70 (1990) -
- Isva Paper Series 50 (1990) -
- Polar Research 11(1) 1992 -

Redactie
Naast twee volumes van het Netherlands Journal of Sea Research (zie 2.1.1.) werden een jaarverslag, rapporten en interne verslagen drukklaar gemaakt. Ook werd veel kleiner zetwerk verzorgd, ondermeer teksten voor posters en dia's.

Het oude zetsysteem van CompuGraphic werd vervangen door SUN's met het opmaakprogramma FrameMaker. In combinatie met het netwerk kunnen teksten worden ingelezen vanuit een grote verscheidenheid aan tekstverwerkingsprogramma's. Ook is het nu mogelijk om tekeningen op de computer binnen de teksten te verwerken.

Reprografische Afdeling
In dit verslagjaar is door de reprografische afdeling assistentie verleend bij het tot stand komen van een aantal in- en externe rapporten en andere publicaties. Bovendien werd veelvuldig assistentie verleend bij het dupliceren van rapporten. Ook werd er veel apparatuur gefotografeerd ten behoeve van publicaties, lezingen en symposia.

Als uitbreiding van het bestaande computersysteem is een flatbedscanner aangeschaft die bestaande tekeningen geschikt kan maken voor computergebruik.

Er werden tekenwerkzaamheden ten behoeve van het Netherlands Journal of Sea Research verricht.

Audiovisuele dienst
In 1992 nam de bemoeienis met tekst-lay-out bij de produktie van interne verslagen toe, terwijl het omslagontwerp en de uitwerking, veelal in vier kleuren, volledig door de dienst werden verzorgd.

Voor de afdeling BEWON werd een promotiebrochure vervaardigd. Voor het Platvis-symposium werd al het drukwerk ontworpen en verzorgd. Daarnaast werden logos ontworpen voor speciale onderzoekprojecten, een workshop en een symposium.

Het in gebruik nemen van de computer met grafische programma's maakte de uitvoering van deze werkzaamheden flexibeler en perfecter.

Er werd vaker om advies gevraagd bij de voorbereiding van verslagen en dissertaties door studenten en OIO's.

In 1992 zijn er 20 posters gemaakt met als leuk detail dat de 1e prijs is gewonnen in Denver, USA. Vier posters waren bestemd voor Space 4 Association des États Generaux. Drie posters voor het 100-jarig bestaan van de Biologische Anstalt Helgoland. Verder is medewerking verleend aan de tentoonstelling 'Oceanology International' in Brighton, Great Britain, waar het NIOZ een presentatie van de bodemlanders heeft verzorgd. Het geheel was in samenwerking met de Rijks Geologische Dienst, Seabed en de SOZ. Diverse posters zijn gemaakt ten behoeve van de Verweydagen.

Op het honderdjarig bestaan van de Biologische Anstalt Helgoland is een complete tentoonstelling ingericht met als thema NIOZ vroeger en nu.

De video-activiteiten zijn het afgelopen jaar uitgebreid met editwerk ten behoeve van het wulkenonderzoek (C. ten Hallers) en het kanoetenonderzoek (J. van Gils, P. de Goeij). Verder is gewerkt aan de videofilm voor de MAST-dagen in Brussel (in samenwerking met Marine Laboratory Aberdeen, T.M. Innes).

Het werk aan de Noordzeefilm is voorlopig opgeschort.

Biologisch Studiemateriaal

De afdeling Studiemateriaal in Den Helder was ook in 1992 weer in staat een gevarieerd aanbod aan zeeorganismen voor de universiteitslaboratoria, scholen en educatieve instellingen te verzorgen. Over het algemeen kan men zeggen dat zowel inkoop als verkoop zich enigszins hebben gestabiliseerd.
De aankoop van haaien verloopt soepeler dan afgelopen jaren. Moest in 1991 worden gesmeekt om aanvoer van haaien, in 1992 bracht een aantal vaste schepen elke week trouw een deel van de haaienvangst. Voor de aanvoer van prikken welke, na het overlijden van de leverancier aan de Maas, er zeer somber uitzag, werd een nieuwe mogelijkheid gevonden. Deze bleek bovendien dichter bij huis.

Ook voor de aankoop van emballage, zoals de bekende 30-liter vaten met deksel, werd een nieuw adres ontdekt waar tegen een redelijke prijs gebruikte vaten worden gekocht. Dit is een milieuvriendelijke oplossing.

Wat verkoop en daarmee samenhangende opbrengst betreft, is er een verschuiving te merken naar de iets duurdere dieren. Zeesterren liepen iets terug, doornhaaien en hondshaaien waren meer geliefd, zodat de aantallen dieren terugliepen, maar de opbrengsten nagenoeg gelijk bleven.

Een gat in de markt bleek de in 1991 gestarte verkoop van plakken diepgevroren Mysis (aasgarnalen), ideaal voor aquarianen. De verkoop is van 28 kg à f. 10,-- in 1991 opgelopen tot 165 kg in 1992.

In 1992 is er tweemaal overleg geweest met de gemeente Den Helder in verband met een aanstaande huuraanpassing van de Petotjoloods op basis van het indexeringscijfer. Gelukkig kon de huidige huurprijs voor 1993 blijven gehandhaafd, ondanks de slechte financiële situatie van de gemeente Den Helder.

De fakturering via de computer is medio mei gestart en loopt voorspoedig, doch de koppeling met gegevensbeheer van de NIOZ-administratie op Texel wil nog niet vlotten. De gegevens voor het jaarverslag zijn in 1992 nog handmatig verzameld, maar zullen in 1993, als computergegevens en schaduwboekhouding vergeleken zijn, compleet uit de computer rollen. Het financiële jaarverslag van de afdeling zal er dan misschien iets anders uitzien, maar vergelijkingen met voorgaande jaren zullen mogelijk blijven.

Afgelopen jaar was de afdeling ook weer opgenomen in de 'Frisse Neuzen Tocht' van de J.P. Thijsseschool, zodat de afdeling enige dagen in september 261 kinderen van een lagere school op bezoek kreeg. Door middel van een film over sepia, wat 'stinkende' beesten op de aanrecht en de levende dieren in de aquaria, werd hen een kijkje in de keuken van de Noordzee gegund.

5. Sociaal Jaarverslag

5.1. ALGEMEEN

In de voorgaande hoofdstukken zijn samenvattingen opgenomen van de wetenschappelijke activiteiten en ontwikkelingen. Dat deze 'interne' ontwikkelingen consequenties hebben op de infrastructuur van het instituut moge duidelijk zijn. Echter, ook externe factoren nopen tot aanpassing van het te voeren financiële, personele en organisatorische beleid. Te denken valt aan de ontwikkeling van het zee-onderzoek in Nederland, de mogelijke fusie tussen de SOZ en het NIOZ en het decentrale overleg inzake arbeidsvoorwaarden tussen de centrales van overheidspersoneel en de werkgevers die ressorteren onder de NWO-koepelorganisatie.

In dit hoofdstuk is de samenstelling van het Bestuur en de Wetenschapscommissie opgenomen alsmede de personeelslijst per 1 januari (1993). In verband met de herstructurering van de Technische Dienst is het organogram aangepast. Verder wordt in het kort ingegaan op de arbeidsvoorwaarden, het formatie-onderzoek, de arbeidsomstandigheden en het gevoerde overleg. Tot slot doet de personeelsvereniging verslag van haar activiteiten.

5.2. BESTUUR EN WETENSCHAPCOMMISSIE

Bestuur Stichting NIOZ

De samenstelling van het bestuur bleef in 1992 ongewijzigd. Wel zijn er afspraken gemaakt over wijzigingen die per 1 januari 1993 zullen plaatsvinden.
Per 31 december 1992 was het bestuur als volgt samengesteld:

Prof. dr.ir. J.A. Battjes	voorzitter	Afd. Civiele Techniek, Technische Universiteit Delft
Prof. dr. J.E. van Hinte	vice-voorzitter	Instituut voor Aardwetenschappen, Vrije Universiteit Amsterdam
Prof. dr. H.J.Th. Goos	secretaris/penningm.	Vakgroep Experimentele Dierkunde, Rijksuniversiteit Utrecht
Ktz. b.d. Th. G. Loeber		Hilversum
Prof. dr. J.G. Kuenen		Vakgroep Microbiologie en Enzymologie,Technische Universiteit Delft

Het bestuur kwam in het verslagjaar 1992 vijf maal met de directie in vergadering bijeen: op 6 + 7 februari en 22 april te Texel en 28 september, 10 novem-

ber, 17 december in Amsterdam. Op 22 april werd tevens een gezamenlijke bestuursvergadering met het bestuur van de SOZ gehouden. De vergaderingen werden namens de algemeen directeur van NWO bijgewoond door Dr. H. van Dommelen. Genotuleerd werd door mevrouw C.S. Blaauboer-de Jong.

Wetenschapcommissie NIOZ

De Wetenschapcommissie adviseert het Bestuur en de Directie over het algemene wetenschappelijk beleid van de Stichting en het Instituut, zij evalueert periodiek het wetenschappelijk programma en zorgt voor de wetenschappelijke beoordelingsprocedure van de eigen NIOZ OIO-voorstellen.
De Wetenschapcommissie NIOZ was per 31 december 1992 als volgt samengesteld:

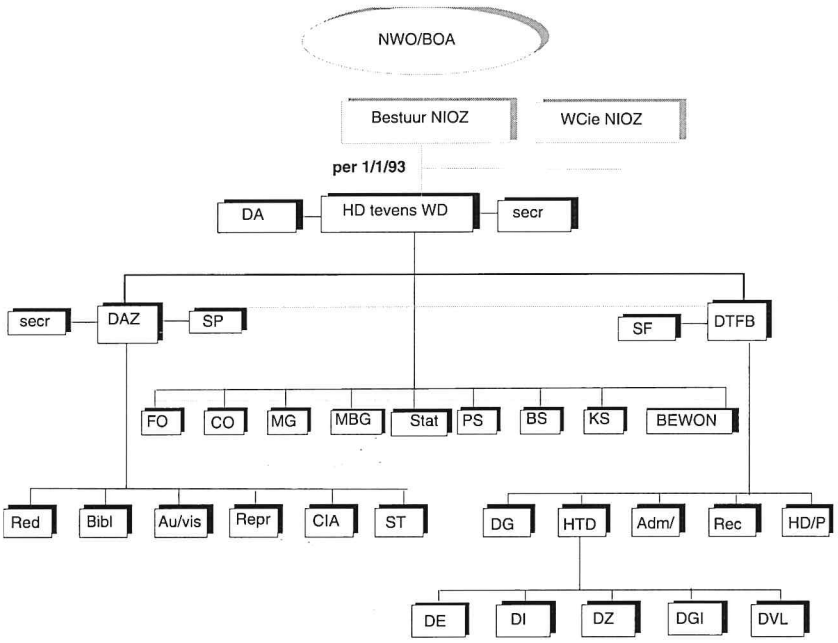
Prof. dr. J.E. van Hinte voorzitter	Instituut voor Aardwetenschappen, Vrije Universiteit Amsterdam
Prof. dr. B.L. Bayne	Plymouth Marine Laboratory, Plymouth, U.K.
Prof. dr. R.H. Drent	Zoölogisch Laboratorium, Rijksuniversiteit Groningen, Haren
Prof. dr. J.C. Duinker	Institut für Meereskunde, Universität Kiel, Duitsland
Prof. dr. C.H.R. Heip	Centrum voor Estuariene en Mariene Oecologie, Yerseke
Prof. dr. W.P.M. de Ruijter	Instituut voor Marien en Atmosferisch Onderzoek, (IMAU), Rijksuniversiteit Utrecht
Prof. dr. V. Smetacek	Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven, Duitsland
Prof. dr. W.J. Wolff	Instituut voor Bosbouw en Natuurbeheer, Leersum

De Wetenschapcommissie kwam in 1992 twee maal bijeen: op 7 - 8 mei 1992 en 15 -16 december 1992. Aan de vergaderingen werd deelgenomen door de directeuren Prof. dr. W.G. Mook en mevrouw drs. M.J. Rietveld. De verslaglegging werd verzorgd door J.W. Rommets.

Op 7 - 8 mei vond evaluatie plaats van de afdeling BEWON. Het evaluatierapport werd onder meer aan de ICONA en de RAZ gezonden.

Op 15 - 16 december presenteerde de afdeling Chemische Oceanografie zich aan de commissie.

5.3. ORGANOGRAM NIOZ



Verklaring van afkortingen in organogram NIOZ

Adm/I	:Administratie en Inventarisbeheer
Au/vis	:Audiovisuele Afdeling
BEWON:	:Afdeling Beleidsgericht Wetenschappelijk Onderzoek NIOZ
Bibl	:Bibliotheek
BOA	:Gebiedsbestuur Biologische-, Oceanografische- en Aardwetenschappen
BS	:Afdeling Benthische Systemen
CIA	:Centrum voor Informatieverwerking en Automatisering
CO	:Afdeling Chemische Oceanografie en Zeeverontreiniging
DA	:Directie-assistent
DAZ	:Directeur Algemene Zaken
DE	:Dienst Electronica
DGI	:Dienst Gebouwen en Installaties
DGM	:Dienst Goederenontvangst en Magazijn
DI	:Dienst Instrumentmaken
DTFB	:Directeur Technisch en Financieel Beheer
DVL	:Dienst Vaartuigen en Logistiek
DZ	:Dienst Zeetechniek
FO	:Afdeling Fysische Oceanografie
HD	:Hoofddirecteur
HD/P	:Huishoudelijke Dienst/Potvis
HTD	:Hoofd Technische Diensten
KS	:Afdeling Kustsystemen
MBG	:Afdeling Mariene Biogeochemie
MG	:Afdeling Mariene Geologie en Geochemie
NWO	:Nederlandse Organisatie voor Wetenschappelijk Onderzoek

PS :Afdeling Pelagische Systemen
Rec :Receptie/telefoniste
Red :Redactie
Repro :Reprografische afdeling
Secr :Secretaresse
SF :Staffunctionaris Financiën
SP :Staffunctionaris Personeelszaken
St :Afdeling Studiemateriaal
Stat :Statisticus
WCie :Wetenschapcommissie NIOZ
WD :Wetenschappelijk directeur

5.4. PERSONEELSLIJST 31-12-92

NAAM	UREN	FUNCTIE	PERIODE
DIRECTIE			
Mook W.G. *Prof. dr.*	34.6	hoofddirecteur, tevens wetenschappelijk directeur	
Rietveld M.J. *Drs.*		directeur algemene zaken	
Abs E. van *Ing.*		directeur technisch en financieel beheer	
ALGEMENE DIENST			
Hart-Stam J.M.G.		dir. secretaresse	
Blaauboer-de Jong C.S.		dir. secretaresse	
Rommets J.W.		wet. dir. ass.	
Witte J.IJ.		wet. dir. ass.	
Meer J. v.d. *Drs.*		statisticus	
Arkel M.A. van *Drs.*		stafm. fin. zaken	
Vooys P.C.		stafm. pers. zaken	
Heetvelt L.H.M.	7.6	formatiedeskundige	
Wolf P. de *Dr.*		onderzoeker	
AFDELING BENTHISCHE SYSTEMEN			
Wilde P.A.W.J. de *Prof. dr.*		afdelingshoofd	
Vosjan J.H. *Dr.*		senior onderzoeker	
Bak R.P.M. *Prof. dr.*		senior onderzoeker	
Duineveld G.C. *Drs.*		onderzoeker	
Pauptit E.		assistent	
Kok A.		assistent	
Berghuis E.M.		assistent	
Nieuwland G.		assistent	
Noort G.J. van		assistent	
Hondeveld B.J.M. *Drs.*		OIO NIOZ (50% BEWON)	
Witbaard R. *Drs.*		OIO NIOZ	
Tahey T.M. *Drs.*		OIO EG	
Holtmann S.E. *Drs.*	34.0	onderzoeker (project-)	m.i.v. 15-06
Balen A.L.H.H. van		assistent (project-)	m.i.v. 01-11
Belgers J.J.M.		assistent (project-)	m.i.v. 19-11
M. Lavaleije *Drs.*		onderzoeker	van 30-3 tot 20-04
AFDELING PELAGISCHE SYSTEMEN			
Fransz H.G. *Dr. ir.*		afdelingshoofd	
Baars M.A. *Dr.*		senior onderzoeker	
Klein Breteler W.C.M *Dr.*	32.0	senior onderzoeker	
Kuipers B.R. *Dr.*		onderzoeker	

Veldhuis M.J.W. *Dr.*		onderzoeker	
Reckermann M. *Drs.*		onderzoeker	van 01-08 tot 01-09
Hansen F.C. *Dr.*		post doc. NIOZ	m.i.v. 01-04
Wal P. van der *Dr.*		post doc. NWO	
Kraay G.V.		assistent	
Oosterhuis S.S.		assistent	
Gonzalez S.R.		assistent	
Witte H.J.		assistent	
Schogt N.		assistent	
Bleijswijk J.D.L. van *Drs.*		OIO NIOZ	
Stolte W. *Drs.*		OIO NIOZ (50% BEWON)	
Schut F. *Drs.*		OIO RUG/NIOZ	tot 01-07
Heemst J.D.H. van *Ir.*		OIO NWO/VVA	m.i.v. 16-11
Buitenhuis E.T. *Ir.*		OIO NWO/VVA	m.i.v. 16-12
Kempers E.S.		assistent (project-)	

AFDELING KUSTSYSTEMEN

Beukema J.J. *Dr.*		afdelingshoofd/hoofdredacteur	
Swennen C. *Dr.*		senior onderzoeker	
Fonds M. *Dr.*		senior onderzoeker	
Spaargaren D.H. *Dr.*		senior onderzoeker	
Cadée G.C. *Dr.*		senior onderzoeker	
Veer H.W. van der *Dr. ir.*		onderzoeker	
Duiven P.		assistent	
Bruin W. de		assistent	
Puyl P. v.d.		assistent	
Hegeman J.		assistent	
Zuidewind J.		assistent	
Flach E. *Drs.*		OIO NIOZ	
Bolle L. *Drs.*		OIO NIOZ (50% BEWON)	
Goeij P.J. de *Drs.*		OIO NIOZ	m.i.v. 01-07
Honkoop P.J.C. *Drs.*		OIO NOP	m.i.v. 01-04
Walker P.A. *Drs.*		OIO NAM	m.i.v. 01-02
Leopold M.F. *Drs.*		onderzoeker (project-)	
Dekker R.*Drs.*	30.0	onderzoeker (project-)	
Poot M.J.M *Drs.*	26.0	onderzoeker (project-)	m.i.v. 01-12
Kwast D.		assistent (project-)	m.i.v. 01-04
Tulp I.		assistent (project-)	van 15-04 tot 01-09

AFDELING CHEMISCHE OCEANOGRAFIE & ZEEVERONTREINIGING

Helder W. *Dr.*		afdelingshoofd	
Everaarts J.M. *Dr.*		senior onderzoeker	
Baar H.J.W. de *Prof. dr. ir.*		senior onderzoeker	
Booy K. *Dr.*		onderzoeker	
Brummer G.J.A. *Dr.*		post doc.	
Timmermans K.R. *Dr.*		post doc. NWO	
Hillebrand M.T.J.		assistent	
Nolting R.F.		assistent	
Ooyen J.L. van		assistent	
Kloosterhuis H.T.		assistent	
Bakker K.M.J.		assistent	
Koutrik A. van		assistent	
Weerlee E.M. van		assistent	
Jansen S.		assistent	van 15-06 tot 01-08
Sleiderink H.M. *Ir.*		OIO NIOZ (50% BEWON)	
Lohse L. *Drs.*		OIO NIOZ	
Leeuwe M.A. van *Drs.*		OIO NIOZ	
Epping H.G. *Drs.*	32.0	OIO NWO/BION	tot 01-12

Bakker D.C.E. *Ir.*		OIO NOP	
Wilde H.P.J. de *Ir.*		OIO NOP	
Stoll M. *Drs.*		OIO NWO/CO2	
Löscher B.M. *Drs.*		OIO NWO/AWON	m.i.v. 01-08
Wiebinga C.J. *Drs.*	30.4	OIO NWO/VVA	m.i.v. 16-12
Majoor A.A.J. *Drs.*		OIO NWO/VVA	m.i.v. 01-12
Hoppema J.M.T. *Dr.*		onderzoeker (project-)	tot 01-04
Hey H. de *Drs.*		onderzoeker (project-)	
Dekker M.H.A.	28.5	assistent (project-)	
Jong J.T.M. de		assistent (project-)	
Fischer C.V. *Drs.*	28.0	assistent (project-)	m.i.v. 01-06
Kerkhoven F.A.		assistent (A&O-fonds)	m.i.v. 15-05

AFDELING FYSISCHE OCEANOGRAFIE

Veth C. *Drs.*		afdelingshoofd	
Aken H.M. van *Dr.*		senior onderzoeker	
Otto L. *Dr.*		senior onderzoeker	
Zimmerman J.T.F. *Prof. dr.*	26.6	senior onderzoeker	
Maas L.R.M. *Dr.*		onderzoeker	
Munck de J.C. *Dr.*		post doc.	
Verkley W.T.M. *Dr.*		post doc. NWO	tot 01-02
Bruin T.F. de *Drs.*		onderzoeker BCRS	
Chaddock S.E. *Drs.*		onderzoeker BCRS	m.i.v. 01-07
Wernand M.R.		assistent	
Manuels M.W.		assistent	
Ober S. *Ing.*		assistent	
Koster R.X. de		assistent	
Hiehle M.A.		assistent	
Wit A. de		assistent	van 01-07 tot 01-08
Toorn R. v.d. *Ir.*	32.0	OIO NIOZ	
Lam F.P.A. *Drs.*		OIO NIOZ	m.i.v. 01-12
Boer C. de *Drs.*		OIO NWO/MFO	
Gerkema Th. *Drs.*		OIO NWO/MFO	
Beerens S.P. *Drs.*		OIO NWO/MFO	

AFDELING MARIENE GEOLOGIE EN GEOCHEMIE

Eisma D. *Prof. dr.*		afdelingshoofd	
Jansen J.H.F. *Dr.*		senior onderzoeker	
Weering T.C.E. van *Dr.*		senior onderzoeker	
Bennekom A.J. van *Drs.*		onderzoeker	
Gaast S.J. v.d.		wet. assistent	
Berger G.W.		assistent	tot 01-08
Kalf J.		assistent	
Iperen J. van	8.0	assistent	
Okkels E.	32.0	assistent	
Vaars A.J.		appl. technicus	
Moodley L. *Dr.*		OIO NIOZ	tot 15-04
Zuo Z. *Dr.*		OIO NIOZ	tot 16-09
Ufkes E. *Drs.*		OIO NIOZ	
Beks J.P. *Drs.*		OIO NIOZ	
Werff W. van der *Drs.*		OIO NIOZ/UvA	
Witte A.	20.0	assistent (project-)	
Graaff J.W.M. de *Drs.*		erk.gewetensbezwaarde	m.i.v. 24-02

AFDELING BEWON

Lindeboom H.J. *Dr.*		afdelingshoofd	
Bol-den Heijer A.C.	24.2	secretaresse	
Baretta J.W. *Drs.*		senior onderzoeker	buitengew. verlof

Berg A.J. van den *Drs.*		onderzoeker	
Bergman M.J.N. *Ir.*		onderzoeker	
Boon J.P. *Dr.*		onderzoeker	
Daan R. *Dr.*		onderzoeker	
Duyl F.C. van *Dr.*		onderzoeker	
Raaphorst W. van *Dr. ir.*		onderzoeker	
Ridderinkhof H.J. *Dr.*		onderzoeker	
Riegman R. *Dr.*		onderzoeker	
Ruardij P. *Drs.*		onderzoeker	
Veer H.W. van der *Dr. ir.*		onderzoeker	
Kop A.J.		assistent	
Malschaert H.		assistent	
Mulder M.		assistent	
Lewis W.E.	32.0	assistent	
Noordeloos A.A.M.		assistent	
Oostingh R.		assistent	tot 01-09
Embsen E.G.M. *Ing.*		techn.wet.progr. (EG)	
Smit J.P.C. *Ing.*		techn.wet.progr. (EG)	
Brussaard C.P.D. *Drs.*		OIO EG	
Osinga R. *Drs.*		OIO NOP	
Slomp C.P. *Ir.*		OIO NOP	
Boekel W.H.M. van *Drs.*	32.0	OIO EG	tot 01-08
Mensink B.P. *Drs.*		OIO VROM/DGW	m.i.v. 01-11
Sleiderink H.M. *Ir.*		OIO NIOZ (50%)	
Bolle L.J. *Drs.*		OIO NIOZ (50%)	
Stolte W. *Drs.*		OIO NIOZ (50%)	
Hondeveld B.J.M. *Drs.*		OIO NIOZ (50%)	
Vooys C.G.N. de *Dr.*	20.0	onderzoeker (project-)	van 01-04 tot 01-12
Marinus M.P. *Drs.*	6.25	onderzoeker (project-)	van 01-04 tot 01-05
Reichert M.J.M. *Drs.*		onderzoeker (project-)	tot 01-04
Hovenkamp F. *Dr.*		onderzoeker (project-)	m.i.v. 15-10
Camphuijzen C.J.		wet.assistent (project-)	m.i.v. 01-08
Hoek J. van der		assistent (project-)	tot 01-04 en van 20-10 tot 20-12
Klein R. *Drs.*		erk. gewetensbezwaarde	m.i.v. 07-01

WETENSCHAPPELIJKE & ADMINISTRATIEVE HULPAFDELINGEN

CENTRUM VOOR INFORMATIEVERWERKING EN AUTOMATISERING

Dapper R.		automatiseringsdeskundige
Eijgenraam F.		automatiseringsdeskundige
Manshanden G.M.	30.4	automatiseringsdeskundige

AUDIO-VISUELE/REPROGRAFISCHE AFDELING

Hobbelink H.		hoofd
Hart W.	24.0	audio-visueel assistent
Aggenbach R.P.D.		wnd. hoofd reprografie
Verschuur B.	35.15	tekenaar
Nichols R.C.		tekenaar
Graaf A.C. de	20.0	reprografisch assistent

REDAKTIE

Beukema J.J. *Dr.*		hoofd-redacteur
Bak-Gade B.	19.0	redaktie-assistente
Mulder-Starreveld J.P.	28.5	redaktie-assistente
Barten-Krijgsman N.	34.2	redaktie-assistente

Lindeboom-Pollen P.R.	15.2	assistent-redacteur	

BIBLIOTHEEK

Wal v.d.-Doornekamp J.	29.9	hoofd	
Bruining-du Porto M.	33.25	bibliotheekassistent	
Hashemi Saleh S.H.	8.0	bibliotheekassistent	

STUDIEMATERIAAL

Nieuwenhuizen J.M.		hoofd	
Eliveld E.		medewerker	

ADMINISTRATIE EN INVENTARISBEHEER

Wernand-Godee I.		hoofd	
Bruin D.J.		adm. medewerker	
Keijser A.		adm. medewerkster	
Spel M.M.		adm. medewerkster	
Porto S.W. de		med. inventarisbeheer	
Gerritsen C.		adm.med. inventarisbeer	tot 01-12

RECEPTIE

Zonnenberg G.	35.15	telefoniste	
Zoetelief H.	8.0	telefoniste	
Kikkert A.	14.75	telefoniste	

HUISHOUDELIJKE DIENST/POTVISBEHEER

Steenhuizen G.H.		hoofd Potvis	
Borculo T.C. van	19.0	medewerkster Potvis	
Ruizendaal S.E.		medewerkster Potvis	van 23-06 tot 01-07
Spigt H.		hoofd kantine	
Jourdan M.T.		medewerkster kantine	

DIENST GOEDERENONTVANGST & MAGAZIJN

Ran A.		hoofd	
Gieles S.J.M.		medewerker	

TECHNISCHE DIENSTEN

Bakker C.L.		hoofd	

DIENST ZEETECHNIEK

Porto H.H. de		hoofd	
Schilling J.		plv.hoofd	
Bos E.B.M.		1e medewerker	
Wijsman M.A.		medewerker	m.i.v. 01-02
Nieuwpoort E.J.		medewerker	m.i.v. 01-02
Willems C.		medewerker	m.i.v. 01-02
Polman W.		medewerker	
Bakker M.G.		medewerker	
Blom J.J.		medewerker	
Persoon P.L.T.		medewerker	
Boekel J.E.L.		medewerker	van 01-02 tot 01-05

DIENST VAARTUIGEN & LOGISTIEK

Buisman T.C.J.		hoofd	
Zwieten C. van		med.naut.zaken	
Visser A.J.		chauffeur	
Gerssen C.		gezagvoerder Pelagia	
Souwer A.J.		1e stuurman Pelagia	

Groot J.C.		2e stuurman Pelagia	
Pieterse J.M.		hoofdwerktuigkundige Pelagia	
Seepma J.		1e werktuigkundige Pelagia	
Kalf J.J.		2e werktuigkundige Pelagia	
Koomen W.		scheepskok Pelagia	
Grisnich P.W.		scheepsgezel Pelagia	
Saalmink P.W.		scheepsgezel Pelagia	
Mozes C.J.		scheepsgezel Pelagia	tot 06-07
Rebel R.		scheepsgezel Pelagia	
Wisse C.H.		schipper Navicula	tot 14-12
Anthonijsz R.J.R.		machinist Navicula	
Tuntelder J.C.		scheepsgezel/kok Navicula	
Adriaans E.J.		schipper Griend	
Jongejan W.P.		komvisser	

DIENST INSTRUMENTMAKEN

Boekel H.J.		hoofd	
Heerwaarden J. van		medewerker	
Keijzer E.J.H.		medewerker	
Kooi J. van der		medewerker	van 15-06 tot 04-07

DIENST ELEKTRONIKA

Groenewegen R.L. *Ing.*		hoofd	
Koster B. *Ing.*		plv. hoofd	
Franken H. *Ing.*		hoger electronicus	
Laan M.		hoger electronicus	
Oost L.M. *Ing.*		hoger electronicus	tot 01-04
Nieuwenhuis J.		middelbaar electronicus	
Derksen J.D.J.		electronicus Pelagia	m.i.v. 20-04
Lamers E.P.		electronicus	van 12-06 tot 13-07

DIENST GEBOUWEN & INSTALLATIES

Schilling F.J.		hoofd	
Alkema P.R.		med. werktuigbouw	
Groot S.P.		med. werktuigbouw	
Kuip T.		med. werktuigbouw.	
Lakeman R.		med. werktuigbouw	
Heerschap L.	34.2	med. houtbewerking	
Daalder R.M.		med. houtbewerking	
Witte R.J.C.		med. houtbewerking	

5.5. STAGIAIRES

Onderstaande studenten hebben in 1992 in het kader van hun middelbare of hogere beroepsopleiding praktische ervaring opgedaan op ons instituut.

Naam	Periode	Afdeling	Opl. instituut
Y. van der Waaij (mw.)	01/01/92 - 31/01/92	Benthische Sys.	I.A.H. Larenstein
A.L.H. van Balen	01/01/92 - 19/01/92	Benthische Sys.	I.A.H. Larenstein
I. Slot	01/02/92 - 30/06/92	Benthische Sys.	IJmond College
A. Mets	01/09/92 - 31/12/92	Benthische Sys.	IJmond College
P. Hurkmans	01/01/92 - 28/02/92	Bewon	HS. Noorderhaaks
J.H. van Surksum	17/02/92 - 17/07/92	Bewon	HS. Enschede
R. Driessen	01/04/92 - 01/07/92	Bewon	HS. Enschede
T. Mosch	24/03/92 - 30/06/92	Bewon	HS. Noorderhaaks
R.A.J. Hamer	01/04/92 - 01/07/92	Bewon	HS. Enschede
C.J.M. Simon (mw.)	07/07/92 - 07/10/92	Bewon	Van Hall Instituut
J.G.A. v.d. Berg	24/08/92 - 31/12/93	Bewon	HS. Amsterdam
J.P. Kraayenoord	16/11/92 - 31/12/93	Bewon	Oms.Milieukunde
J. Kralt	16/11/92 - 31/12/92	Bewon	Oms.Milieukunde
P. Adema	01/01/92 - 31/05/92	Chem.Oceanogr.	HLO- Alkmaar
S. Kofman (mw.)	01/01/92 - 31/05/92	Chem.Oceanogr.	HLO- Alkmaar
A. Ramkema (mw.)	01/01/92 - 31/05/92	Chem.Oceanogr.	HLO- Alkmaar
M. van Dalen	01/01/92 - 31/08/92	Chem.Oceanogr.	HLO- Alkmaar
D. Kwast (mw.)	01/01/92 - 31/03/92	Chem.Oceanogr.	Bakhuis Roozeboom
I.C. Vrauwdeunt (mw.)	01/01/92 - 05/06/92	Chem.Oceanogr.	Reynevelt College
S. Jansen	20/01/92 - 18/06/92	Chem.Ocenaogr.	HS. IJsselland
A. de Keizer	02/03/92 - 31/07/92	Chem.Oceanogr.	Van Hall Inst.
J.H. den Das	31/08/92 - 31/12/92	Chem.Oceanogr.	HS. Alkmaar
P. Zillen	01/09/92 - 31/12/92	Chem.Oceanogr.	HS. Alkmaar
A. Buijs	01/09/92 - 31/12/92	Chem.Oceanogr.	HS. Alkmaar
C.C. van den Berg	01/09/92 - 31/12/92	Chem.Oceanogr.	IJmond College
M.C. Witte	01/01/92 - 29/02/92	Fysische Oc.	Tech.HS. Rijwijk
M.C. Vlaming	01/01/92 - 01/03/92	Geologie	Van Hall Instituut
S. Visser (mw.)	01/01/92 - 31/01/92	Kustsystemen	Bakhuis Roozeboom
G. Boots	01/01/92 - 31/01/92	Kustsystemen	Bakhuis Roozeboom
R. Harding	01/02/92 - 30/06/92	Kustsystemen	IJmond College
A. Eleveld	01/02/92 - 30/06/92	Kustsystemen	IJmond College
J.F. Borsje	15/10/92 - 31/12/92	Kustsystemen	Van Hall Inst.
R.C.J. Koenis	01/01/92 - 10/01/92	Energietechn.	MTS Alkwaard
M. Bijker	01/01/92 - 10/01/92	Energietechn.	MTS-Noorder Hooft
R. Molenaar	13/01/92 - 12/06/92	Energietechn.	MTS-Alkwaard
R. Dienaar	13/01/92 - 12/06/92	Energietechn.	MTS-Noorder Hooft
C.C. Tielemans	24/08/92 - 31/12/92	Energietechn.	MTS-Alkwaard
M. van Gerven	24/08/92 - 31/12/92	Energietechn.	MTS-Noorder Hooft
A. Bey	01/01/92 - 31/12/92	Electronica	MTS-Noorder Hooft
B.P. de Vries	01/01/92 - 10/01/92	Electronica	MTS-Alkwaard
E.P. Lamers	13/01/92 - 12/06/92	Electronica	MTS-Alkwaard
C. Kuip	13/01/92 - 26/06/92	Electronica	MTS-Noorder Hooft
E.G. Verschoor	24/08/92 - 31/12/92	Electronica	MTS-Alkwaard

C. Sieders	24/08/92 - 31/12/92	Electronica	MTS-Noorder Hooft
R.C. de Ridder	25/11/92 - 31/12/92	Electronica	HS. Utrecht
T. de Jong	01/01/92 - 28/02/92	Instrumentm.	MTS-Noorder Hooft
J. van der Kooi	02/03/92 - 15/06/92	Instrumentm.	MTS-Noorder Hooft
T. Roeters	30/11/92 - 31/12/92	Instrumentm.	MTS-Noorder Hooft
A. de Wit	01/02/92 - 01/02/92	Rekencentrum	HS. Leeuwarden
K. van der Meulen	01/09/92 - 31/12/92	Rekencentrum	HS. Leeuwarden

5.6. ARBEIDSVOORWAARDEN

Op 27 mei werd tussen de centrales van overheidspersoneel en de minister van Binnenlandse Zaken de centrale overeenkomst gesloten over het arbeidsvoorwaardenbeleid voor het overheidspersoneel over de periode 1 april 1992 - 31 maart 1993.

Hieronder worden in het kort de drie belangrijkste wijzigingen aangegeven.

Algemene salarisverhoging

De salarisverhoging is in twee etappen doorgevoerd: met ingang van 1 april met 3% en vervolgens per 1 januari (1993) met 1%. Deze verhoging werkt door naar de toelagen die onder de bezoldiging vallen.

Eenmalige uitkering

In de maand oktober is over het salaris dat men in september genoot een eenmalig bedrag uitgekeerd van 6% van het bruto-salaris. Hierbij zijn niet in aanmerking genomen de vakantietoeslag en eventuele andere toelagen.

Wijzigingen met betrekking tot de VUT

Door het vervallen van de tijdelijke verlaging van de VUT-gerechtigde leeftijd is de leeftijdsgrens om gebruik te kunnen maken van de VUT gesteld op 61 jaar. Alleen degenen die voor het bereiken van de 61-jarige leeftijd over 40 dienstjaren beschikken, kunnen eerder gebruik maken van deze regeling.

Het VUT-uitkeringspercentage is per 1 januari (1993) verlaagd van 80 naar 75. Uitgezonderd van deze maatregel zijn degenen die voor deze datum als 61-jarige (of ouder) dan wel op grond van 40 dienstjaren een uitkering genieten en degenen die reeds voor 1 juni (1992) een uitkering genieten in het kader van een aan de VUT 61 jaar en ouder direct voorafgaande uittredingsregeling, zoals de VUT-60 en de deeltijd-VUT.

In samenhang met de verlaging van bovenbedoeld percentage is tevens bepaald, dat uitsluitend voor degenen die VUT-gerechtigd zijn maar (voorlopig) ervan afzien van de VUT gebruik te maken, een verhoogde pensioenopbouw zal gelden. Deze verhoogde opbouw is, in plaats van de normale opbouw van 1,75% per dienstjaar, bij 61 jaar 2%, vervolgens bij 62 jaar 2,25% en bij 63 en 64 jaar 2,5% respectievelijk 2,75% (tot een maximum van 70%). Deze verhoogde opbouw is strikt gekoppeld aan de leeftijd 61 jaar. Dit betekent bijvoorbeeld dat bij het bereiken van 40 dienstjaren voor de 61-jarige leeftijd, de verhoogde pensioenopbouw pas wordt toegekend op het moment dat men 61 jaar wordt.

Decentrale arbeidsvoorwaarden regelingen

De decentrale arbeidsvoorwaardenregelingen, te weten: ouderschapsverlof, deeltijd-VUT, verlenging bevallingsverlof en kinderopvang, die in 1990 na overleg met de centrales bij ons instituut zijn ingevoerd, zijn ook in dit verslagjaar van toepassing geweest.

Geconcludeerd kan worden dat de regeling ouderschapsverlof binnen de

NWO-koepel-organisatie waarvan het NIOZ deel uitmaakt in populariteit is gestegen.

Aan het Kinderdagverblijf Texel is wederom een subsidie toegekend ter financiering van 1 'kindjaarplaats'.

Van de regeling deeltijd-VUT hebben in het eerste kwartaal twee medewerkers gebruik gemaakt. Daar de regeling op dat moment nog gebaseerd was op de 59-jarige leeftijd, behouden deze personen aanspraak op deze regeling tot het bereiken van de VUT-gerechtigde leeftijd (61 jaar).

In 1992 heeft 1 medewerkster bevallingsverlof genoten.

Deeltijd

Het NIOZ biedt medewerkers de mogelijkheid onder bepaalde voorwaarden in deeltijdverband werkzaam te zijn. Ten opzichte van 1991 is het aantal deeltijdwerkers dit jaar ongeveer gelijk gebleven (ruim 15% van het personeelsbestand).

5.7. FORMATIE-ONDERZOEK

De eerste fase van het formatie-onderzoek dat door de heer L.H.M. Heetvelt, als formatiedeskundige tijdelijk in NIOZ-dienst, wordt uitgevoerd, richtte zich op de Technische Dienst en kon aan het einde van dit jaar worden afgerond.

Aan de organisatie van de Technische Dienst is om een aantal hieronder genoemde redenen een andere structuur gegeven. Met deze herstructurering wordt beoogd de taakstelling van de afzonderlijke diensten inzichtelijker te maken en de prioriteitstelling, planning en coördinatie te verbeteren.

De aanleiding tot deze herschikking komt voort uit een drietal zaken:

- de komst van de 'Pelagia', waardoor het karakter van de zeegaande expedities veranderde en verschuivingen optraden in het gebruik van de NIOZ-vaartuigen;
- de grote groei van het NIOZ en van het Nederlandse zee-onderzoek;
- de verouderde structuur van de Technische Dienst.

In de nieuwe structuur zijn een aantal oorspronkelijke afdelingen geïntegreerd in de navolgende diensten:

- dienst Electronica
- dienst Instrumentmaken
- dienst Zeetechniek
- dienst Gebouwen en Installaties
- dienst Vaartuigen en Logistiek.

In de maand december zijn aan alle medewerkers van de Technische Dienst de functiebeschrijvingen uitgereikt met de bij de functie behorende schaalniveaus, waartoe een externe commissie heeft geadviseerd. Er is een interne commissie ingesteld om het proces van herschikking te begeleiden.

5.8. ARBEIDSOMSTANDIGHEDEN

Bedrijfsgezondheidszorg

De in het 4e kwartaal van 1991 gestarte besprekingen met de G.G.D. te Den Helder over het eventueel sluiten van een overeenkomst in het kader van verbetering van Bedrijfsgezondheidszorg, hebben in 1992 een vervolg gehad. Ook door twee andere diensten zijn aangepaste offertes uitgebracht. Op verzoek van het NIOZ zijn deze offertes toegesneden op het relatief lage ziekteverzuimpercentage bij ons instituut.

Uitgangspunt hierbij is dat de werkgever zelf verantwoordelijk is voor een goede ziekteverzuimbegeleiding en dat een deskundige dienst een meer ondersteunende en adviserende rol heeft.

Verwacht wordt dat in de loop van 1993 een overeenkomst zal worden

gesloten met een Bedrijfsgezondheidsdienst.

Ziekteverzuim

Door de overheid worden maatregelen getroffen om het arbeidsongeschiktheidsvolume in Nederland terug te dringen. Naast intensivering van bestaande beleidsinstrumenten dienen er nieuwe te worden ontwikkeld. Als uitgangspunt geldt hierbij dat de werkgever primair verantwoordelijk is voor het daadwerkelijk terugdringen van het ziekteverzuim.

Binnen het NIOZ en de gehele NWO-koepelorganisatie ligt het verzuimpercentage ten opzichte van het landelijk gemiddelde aan de lage kant. Om die reden is de aanvankelijke, door de overheid opgelegde, taakstellende korting op het personeelsbudget voor 1992 niet doorgegaan. Voor 1993 is deze budgetvermindering wel vastgesteld. Aan de hand van de verzuimcijfers, de kwaliteit van een adequaat verzuimregistratiesysteem en overige genomen maatregelen zal worden beoordeeld in hoeverre en in welke mate deze korting op het budget zal worden herzien.

Bij ons instituut is het totale ziekteverzuim ten opzichte van 1991 gelijk gebleven, te weten 4%. Dit komt neer op 1960 verzuimdagen. Ook het verzuim bij het wetenschappelijk en niet wetenschappelijk personeel is nauwelijks veranderd (w.p.: 1,9% tegen 2% in 1991; n.w.p.: 5,25% tegen 5,1% in 1991). Het verzuimpercentage onder de laatstgenoemde categorie wordt negatief beïnvloed door een aantal langdurig zieke personeelsleden.

Eind 1992 is de ziekmeldingsprocedure veranderd en is er een begin gemaakt met de ontwikkeling van een geautomatiseerd ziekteregistratiesysteem.

Arbo-wet

Door de overheid zijn middelen beschikbaar gesteld ten behoeve van het project Arbeidsomstandigheden. Hiermee wordt beoogd een extra impuls te geven aan reeds genomen en te nemen maatregelen op het gebied van de veiligheid en de gezondheid binnen organisaties. Door het NIOZ is een voorstel ingediend die betrekking heeft op het maken van een videofilm over het veilig werken aan boord van schepen. Verder kan gebruik worden gemaakt van een aantal door de NWO-koepel centraal gecoördineerde faciliteiten zoals het tijdelijk inhuren van specifieke deskundigheid voor Arbo-zaken en verdere opleiding en training voor Arbo-veiligheidsfunctionarissen.

5.9. OVERLEG

Georganiseerd Overleg

Aan het GONWO (Georganiseerd Overleg - NWO) nemen deel de centrales van overheidspersoneel ABVA/KABO, AC, CFO, CMHF en de werkgevers NWO, FOM, SMC en NIOZ. Periodiek wordt er in het GONWO overleg gevoerd over algemene (personele) aangelegenheden ten behoeve van het personeel dat in dienst is van voornoemde werkgevers.

Een belangrijk punt van overleg waren de besprekingen in het kader van de vorming van een Collectieve Arbeidvoorwaardenregeling (CAR) die moet gaan gelden voor alle werknemers van de NWO-koepelorganisatie.

Mede gelet op de verder gaande decentralisatie van het (overheids-) arbeidsvoorwaardenbeleid achten de genoemde centrales en werkgevers het zinvol te komen tot een dergelijke regeling. De (concept-)CAR beperkt zich nog tot een gedeelte van de arbeidsvoorwaarden, maar zal afhankelijk van de voortgang van de decentralisatie worden uitgebreid met andere onderwerpen.

Bij de gevoerde besprekingen zijn een aantal uitgangspunten in acht genomen, zoals:

- de CAR mag geen bepalingen bevatten die strijdig zijn met wettelijke regelingen;

- de verschillende werkgevers dienen regelingen ten aanzien van tijd en geld op uniforme wijze toe te passen.

Er wordt naar gestreefd de regeling per 1 april (1993) in werking te laten treden.

Overleg O.R. - Directie

Het overleg tussen de O.R. en de Directie heeft dit jaar geregeld en op constructieve wijze plaatsgevonden en richtte zich ondermeer op de overkomst van de groep Organische Geochemie van de TU-Delft naar het NIOZ. Verder werden aan de orde gesteld de herschikking van de Technische Dienst, de gezondheidszorg op het NIOZ en de afvoer van chemicaliën waarover met de gemeente Texel overleg is gevoerd.

5.10. VERSLAG VAN DE PERSONEELSVERENIGING

Het eerste evenement georganiseerd door de personeelsvereniging was de jaarlijks terugkerende toneelavond met na afloop het NIOZ feest. De 'Comedia de la NIOZ' voerde voor een uitverkochte zaal het toneelstuk 'De Thuiskomst' van Harold Pinter op. Na afloop kon iedereen genieten van de 'De als je maar niet denkt dat je beter bent band'. Tevens vlogen de hotdogs en gehaktballen als broodjes over de toonbank.

Op 13 maart vond het traditionele kinderfeest weer plaats. Zoals gebruikelijk werden er weer vierhonderd pannekoeken gebakken door het PV-bestuur en vrijwilligers. De toneelvereniging 'Julia' uit Den Helder speelde de 'De Bellenbende' van de Texelse toneelschrijver Aris Bremer.

Deze zomer hebben wij, als bestuur, tuinmeubilair aangeschaft voor het terras bij de kantine, om het zitten buiten aantrekkelijker en vooral gezelliger te maken.

Afgelopen 24 september zijn wij met 50 personen naar de stad Amsterdam geweest in het kader van het PV-reisje. Eerst hebben wij een bezoek gebracht aan de diamantslijperij 'Samuel Gassan Diamonds'. Na de lunch hebben wij een rondvaart gemaakt door de grachten en haven. Door de rondvaartboot zijn we bij de Stopera afgezet, voor 'een kijkje achter de schermen'. De dag werd afgesloten met een geslaagde gourmet bij Motel Den Helder.

Rond 30 november ontvingen wij een brief van de Sint, die het NIOZ vrijdag 4 december weer wilde bezoeken. Iedereen was daarom 4 december present in de kantine. Veel NIOZ'ers werden naar voren geroepen door de Sint.

De laatste week voor de Kerst was er voor de NIOZ'ers een broodmaaltijd in de kantine. Dit geheel werd muzikaal ondersteund door pianomuziek uitgevoerd door Charles Visser.

Exposities:

Eerste helft 1992: Kleurenfoto's gemaakt door Piet de Wolf.

Tweede helft 1992: Figuratieve kunst gemaakt door het duo Hamar uit Den Helder. Werk van dit duo is aangekocht.

De subsidie van Hfl. 300,00 is wederom gegeven aan de NIOZ volleybal -en voetbalvereniging.

Diverse langdurig zieke PV-leden werden verrast met een fruitmandje, aangeboden door de personeelsvereniging.